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NSTC GREAT LAKES
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October 1987

REMEDIAL INVESTIGATION VERIFICATION STEP WORK PLAN FOR THE NAVAL TRAINING CENTER GREAT LAKES, ILLINOIS

NEESA 21-011

NAVAL ENERGY AND ENVIRONMENTAL SUPPORT ACTIVITY
Port Hueneme, California 93043

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REMEDIAL INVESTIGATION
VERIFICATION STEP WORK PLAN
FOR THE
NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS

October 1987

Submitted to:

Naval Energy and Environmental Support Activity
Environmental Protection Department
Port Hueneme, California 93043

Prepared by:

Dames & Moore
(A Professional Limited Partnership)
7101 Wisconsin Avenue
Bethesda, Maryland 20814

Approved:

Richard C. Tucker, Program Manager

Stephen Lemont, Project Manager

EXECUTIVE SUMMARY

This is the Work Plan for the Step I Verification Step to be conducted at six sites at the Naval Training Center (NTC) Great Lakes, Illinois. The six sites are listed below:

- Golf Course Landfill, Site 1
- Fire Fighting Training Area, Site 4
- Transformer Storage "Boneyard," Site 5
- Recruit Training Center Silk-Screening Shop, Site 7
- Exchange Service Station, Site 8
- Harbor Dredge Spoil Area, Site 12.

The need for a Verification Step is based on the Initial Assessment Study (IAS) for the installation, which was completed in March 1986.

The Verification Step is the first step of the Remedial Investigation/Feasibility Study (RI/FS) and is a systematic, phased approach designed to address potential hazardous waste sites. RI/FS is part of the Navy Installation Restoration (IR) Program; the individual steps in the Navy IR program RI/FS process are described below.

Step	Name	Purpose/Description
I	Verification Step	To verify the existence of contamination
II	Characterization Step	To characterize the extent and rate of migration of contaminants
III	Feasibility	To evaluate remedial alternatives to achieve compliance, prepare cost estimates, and project effectiveness of alternatives
IV	Project Documentation	To prepare site operation plan and Government project documentation

The primary purpose of this Work Plan is to provide site-specific information based on the IAS and other information that can be used to delineate a health and safety plan, a quality assurance (QA) and quality control (QC) field and laboratory plan, and a field sampling and laboratory

analysis plan. These plans can then be implemented to provide the data needed to determine quantitatively whether contaminants are present and at concentrations that are toxic or hazardous to human health or the environment. The Verification Step will determine if the Characterization Step is required to further investigate and delineate the extent of contamination.

This work plan includes the following:

- Background information based primarily on data generated in the IAS.
- Field sampling and laboratory analysis plan for six sites previously designated for further study by the IAS.
- Field QA/QC plan.
- Laboratory QA/QC plan specific to the Navy IR Program.
- Site-specific health and safety plan.

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LIST OF ACRONYMS

AA	Atomic absorption
BNA	Base neutral and acid extractable organic compound(s)
ECD	Electron capture detector
EPA	U.S. Environmental Protection Agency
FFTA	Fire Fighting Training Area
FS	Feasibility study
GC	Gas chromatography
GC/MS	Gas chromatography/mass spectrometry
IAS	Initial Assessment Study
IC	Ion chromatography
ICP	Inductively coupled plasma atomic emission spectroscopy
IEPA	Illinois Environmental Protection Agency
IR	Infrared
IR	Installation Restoration
MSL	Mean sea level
MTSA	Mainside Transformer Storage Area
NA	Not applicable
NEESA	Naval Energy and Environmental Support Activity
NGVD	National Geodetic Vertical Datum of 1929
NTC	Naval Training Center
ORNL	Oak Ridge National Laboratory
PCB	Polychlorinated biphenyl(s)
PID	Photoionization detector
POL	Petroleum, oil, and lubricant(s)
ppm	Parts per million
PVC	Polyvinyl chloride
QA	Quality assurance
QA/QC	Quality assurance/quality control
QC	Quality control
RI	Remedial investigation
RI/FS	Remedial investigation/feasibility study
RTC	Recruit Training Center
TOC	Total organic carbon
VOC	Volatile organic compound(s)
VSWP	Verification Step Work Plan

REMEDIAL INVESTIGATION VERIFICATION STEP WORK PLAN FOR THE NAVAL TRAINING CENTER GREAT LAKES, ILLINOIS

1.0 INTRODUCTION

This document is the Verification Step Work Plan (VSWP) for the Navy Installation Restoration (IR) Program Remedial Investigation/Feasibility Study (RI/FS) at the Naval Training Center (NTC) Great Lakes, Illinois. It discusses in detail the technical approach for performance of the Navy IR Program RI/FS, Verification Step, program at six study sites at NTC Great Lakes, and subsequent data interpretation and reporting. These six sites, recommended for RI, Verification Step, studies in the Initial Assessment Study (IAS)* for the installation, are the following:

- Golf Course Landfill, Site 1
- Fire Fighting Training Area (FFTA), Site 4
- Transformer Storage "Boneyard," Site 5
- Recruit Training Center (RTC) Silk-Screening Shop, Site 7
- Exchange Service Station, Site 8
- Harbor Dredge Spoil Area, Site 12.

In addition to the VSWP--which presents the field and analytical programs, associated field quality assurance (QA) and data collection/management procedures, key personnel, data evaluation/interpretation, and reporting steps--the Health and Safety Plan for field activities (Appendix A), the Laboratory Work Plan (Appendix B), and the Laboratory QA Plan (Appendix C) are included herein. Appendix D presents a preliminary list of drinking water standards/guidelines for suspected contaminants at NTC Great Lakes. Appendix E is a copy of the Illinois Environmental Protection Agency's (EPA) "General Guidelines for Containment of Contaminated Solids and Liquids During Site Investigations."

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*Rogers, Golden & Halpern, March 1986. Initial Assessment Study, Naval Complex (NC) Great Lakes, Illinois, NEESA 13-102, prepared for Naval Energy and Environmental Support Activity, Port Hueneme, California.

The VSWP for a seventh site, the Mainside Transformer Storage Area (MTSA), Site 6, was submitted earlier, under separate cover, in response to the Navy's request to accelerate services at this one site. An easement is to be provided to the State in this area.

1.1 BACKGROUND

During the IAS for NTC Great Lakes, seven sites were identified as requiring RI's. These sites, shown in Figure 1-1, are the six listed above and the Mainside Transformer Storage Area; the RI Verification Step at the MTSA was addressed in a separate VSWP. The operational histories of the six sites are discussed in Section 1.3.2.

The IAS recommendations were based on information from historical records, aerial photographs, field inspections, and personnel interviews, the purpose of which was to identify and assess sites posing a potential threat to human health or to the environment due to contamination from past hazardous materials operations. Each of the sites was evaluated with respect to contamination characteristics, migration pathways, and pollutant receptors.

The IAS observed that both surface water and groundwater are potential contaminant migration pathways at the installation. Runoff from the activity may enter either Skokie Ditch or Pettibone Creek (see Figure 1-1). Furthermore, groundwater supplies much of the flow for Pettibone Creek and may supply water for intermittent flow in Skokie Ditch. Although neither of these streams is used as a source of potable or industrial water in the immediate area of the activity, both streams do flow into other bodies of water that are used for these purposes. Moreover, Pettibone Creek flows directly into Lake Michigan--which is used extensively for sport fishing; and Skokie Ditch becomes the Skokie River (apparently when it leaves the installation boundaries)--which eventually drains into the Mississippi River.

The IAS concluded that, "while none of the sites poses an immediate threat to human health or to the environment, seven sites warrant further investigation [under the Navy IR Program] to assess potential long-term impacts." An RI, involving sampling and monitoring of the seven sites, was recommended to attempt to identify the presence of the suspected contamination, if any, and to better define the extent of any problems that may exist.

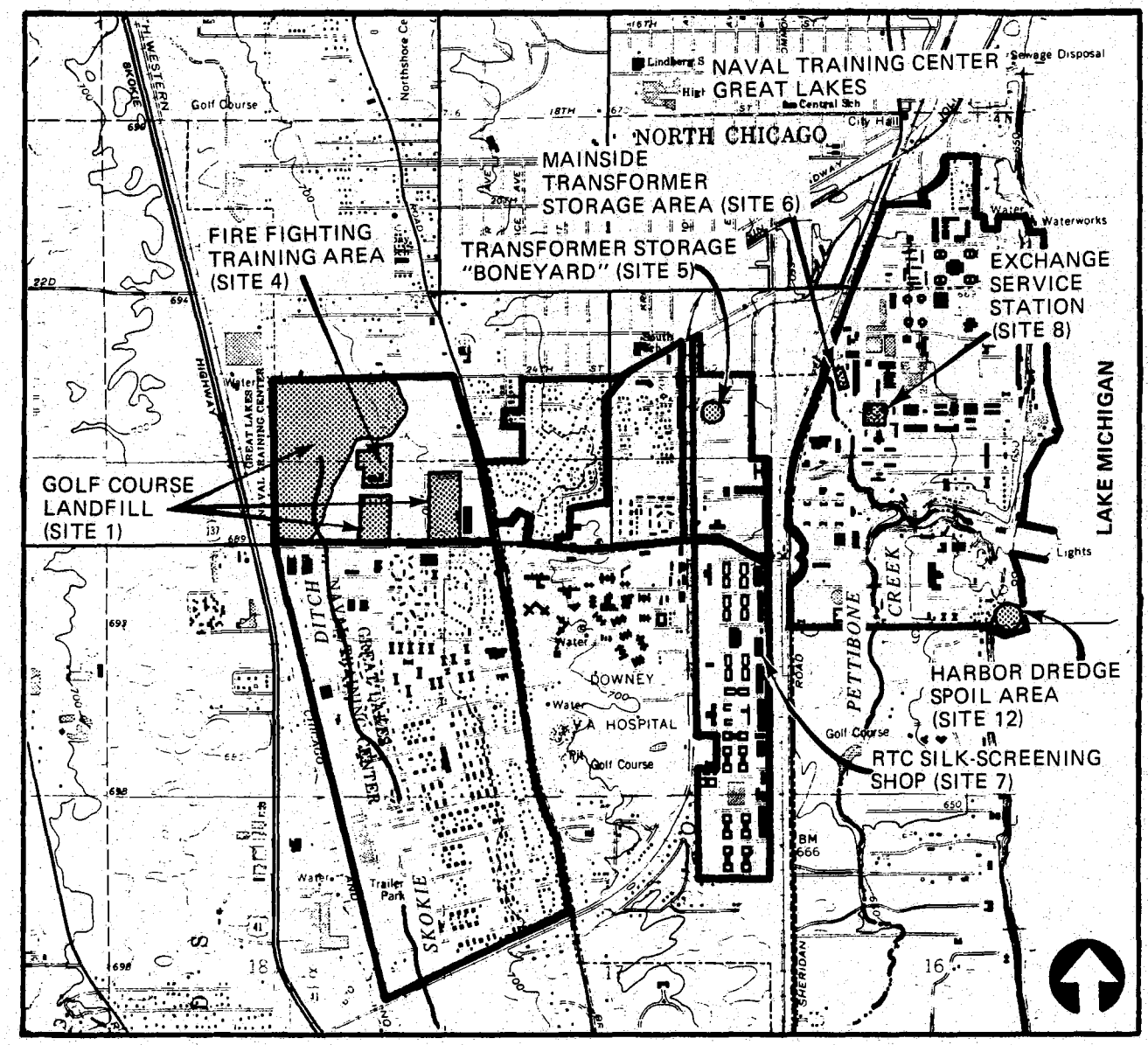


FIGURE 1-1
LOCATION OF STUDY SITES AT
NTC GREAT LAKES

REMEDIAL INVESTIGATION
NAVAL TRAINING CENTER
Great Lakes, Illinois

1.2 CURRENT STUDY OBJECTIVE AND SCOPE OF WORK

The objective of this project is to conduct an RI, Verification Step, for the six sites listed above at NTC Great Lakes. The goal of the Verification Step, as specified by the U.S. Navy, is to collect sufficient quantitative environmental data to either (1) verify the presence of hazardous or toxic waste and supply planning for an expanded monitoring program (Characterization Step), or (2) recommend no further action where such materials are not found.

The above-stated objective will be accomplished by conducting a limited field investigation of the six study sites to characterize potential contamination of groundwater, surface water, and/or soil at these locations. The investigation will include installation of groundwater monitoring wells; sampling/analysis of soil gas in the vicinity of the Exchange Service Station; sampling of groundwater, surface water, and soils; and chemical analysis of these samples. Details of the proposed investigation are summarized in Table 1-1, and are described in Section 2.0 of this work plan.

The Verification Step of the RI is designed to determine if contaminants are present at each of the sites in question, approximately what extent and degree of contamination exists (if any), and whether further site investigation is warranted. If significant contamination is detected, the need for a supplementary (Characterization Step) site investigation program to more fully characterize site conditions and contamination and to recommend appropriate remedial measures will be determined.

1.3 SITE DESCRIPTION

The information presented below has been taken largely from the IAS for NTC Great Lakes.

1.3.1 Installation Location, History, and Present Mission

1.3.1.1 Location. NTC Great Lakes is located in Shields Township, Lake County, Illinois, on the shore of Lake Michigan (see Figure 1-2). Dedicated in 1911, it is the largest naval training center (1,650 acres) in the United States and possibly in the world. It is bounded on the west by U.S. Route 41 (Skokie Highway), on the north by the City of North Chicago, and on the south by the Veterans Administration Hospital and Golf Course and by the Shore Acres Country Club. Lake Michigan lies to the east (see Figure 1-3).

TABLE 1-1

Summary of Proposed Field Investigation Program
Remedial Investigation, Verification Step
NTC Great Lakes, Illinois

Site Name	Number of Wells to be Installed	Type of Sample	Number of Locations	Description/Frequency of Sampling	Maximum Number of Samples	Parameters to be Analyzed
Golf Course Landfill	7	Groundwater Surface water	9 2	A maximum of two times A maximum of two times	18 4	Volatile organic compounds, semivolatile organic compounds, priority pollutant metals, PCB's, oil and grease, chloride, total organic carbon
Fire Fighting Training Area	4	Groundwater Surface water Soils	4[a] 4 12	A maximum of two times A maximum of two times One time; two samples will be collected, one each from surface and shallow depths, at each location.	8 8 24	Volatile organic compounds, semivolatile compounds, oil and grease, lead
Transformer Storage "Boneyard"	0	Soils	27	One time; two samples will be collected, one each from surface and shallow depths, at five of these locations. One surface sample will be collected at each of the remaining 22 locations.	32	PCB's, oil and grease, lead
RTC Silk-Screening Shop	0	Soils	3	One time; two samples will be collected, one each from surface and shallow depths, at each location.	6	Volatile organic compounds, silver, chromium (total), cadmium, lead
Exchange Service Station	6[b]	Soil gas Soils	82 6[b]	One time One time; three samples will be collected, one each from surface, shallow, and deep depths, in each well boring.	82 18	Soil gas: Fuel components (e.g., benzene, toluene, xylenes, ethyl benzene) Soil and groundwater: Volatile organic compounds, lead
		Groundwater	6[b]	To be determined[c]	(c)	
Harbor Dredge Spoil Area	0	Soil/sludge	14	One time; three samples will be collected, one each from surface, shallow, and deep depths, at each location.	42	Volatile organic compounds, priority pollutant metals, pesticides, PCB's

[a]One of these wells (MW4-1) will also serve as a background well for the Golf Course Landfill, and therefore will be sampled for all analytes of concern at the landfill.

[b]The number and location of soil borings/monitoring wells at this site are tentative. Final selections and recommended frequency of sampling will be based on the results of soil gas sampling and analysis.

[c]See Section 2.3.5.

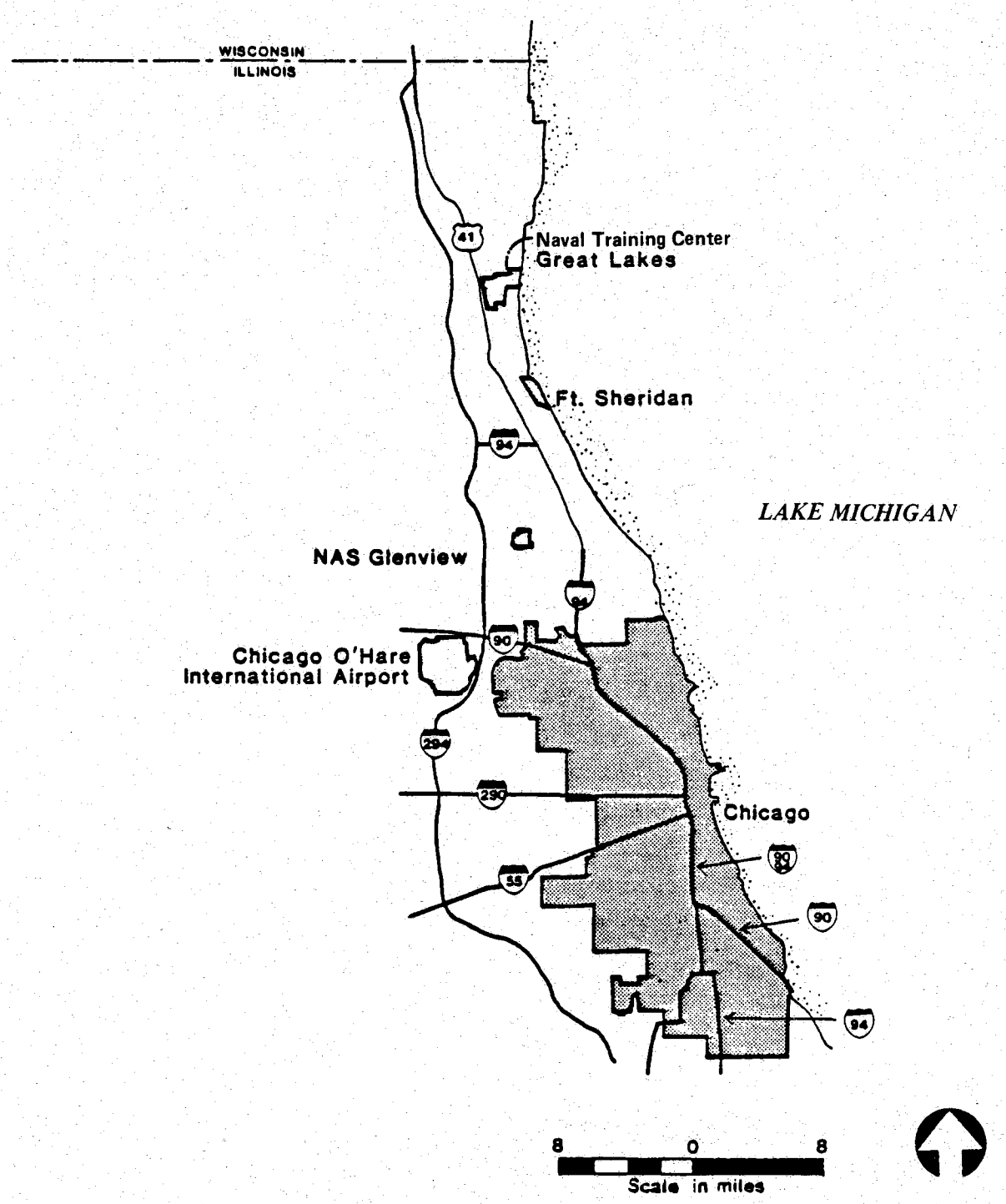


FIGURE 1-2
GENERAL LOCATION MAP
NTC GREAT LAKES

REMEDIAL INVESTIGATION
NAVAL TRAINING CENTER
Great Lakes, Illinois

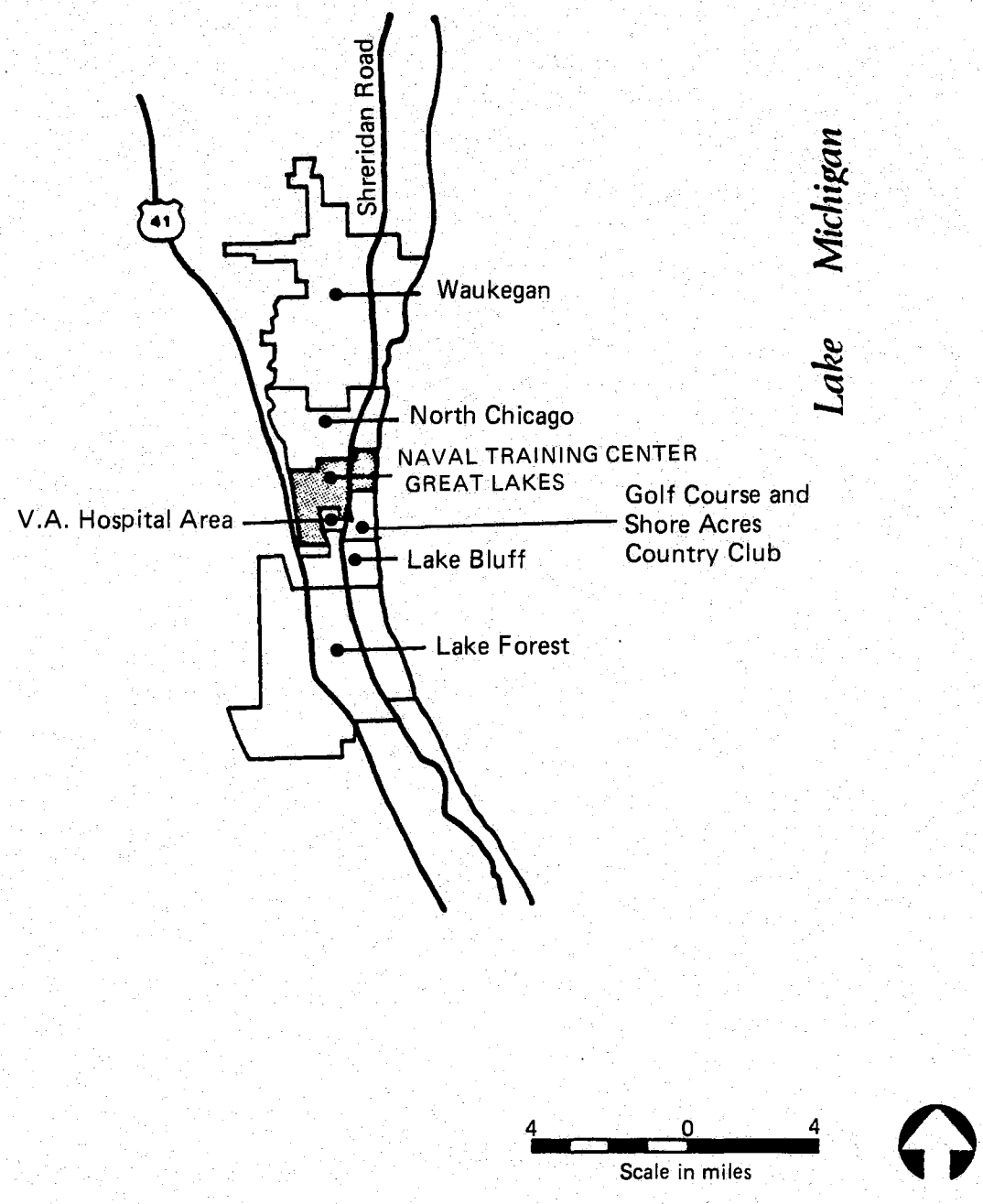


FIGURE 1-3
IMMEDIATE AREA SURROUNDING
NTC GREAT LAKES

REMEDIAL INVESTIGATION
NAVAL TRAINING CENTER
Great Lakes, Illinois

1.3.1.2 History. In 1902, Congress appropriated $5,000 to investigate sites in the Midwest at which to establish a naval training station. After considering 37 Great Lakes sites, a board of officers recommended the present Lake Bluff location, a 167-acre tract overlooking Lake Michigan. Advantages of this site included its proximity to Chicago and its excellent rail transportation via the Chicago and Northwestern Railroad and the now-defunct Chicago North Shore and Milwaukee Railroad.

In April 1904, the Naval Appropriations Act empowered the President to approve the Board's report and authorized purchase of the site. Previously, Congress had authorized $250,000 for the purchase of the land in its Naval Appropriations Act, thereby giving congressional approval to the purchase.

Captain A. A. Ross, the first Commandant of NTC Great Lakes, accepted command of the activity on behalf of the Government on July 1, 1905. Six years later, the activity was ready to accept its first recruit for training. Captain Ross presided at commissioning ceremonies on July 1, 1911, and the activity was officially dedicated by President Taft on October 28, 1911. The original activity, which consisted of 39 permanent buildings, was bounded on the west by Sheridan Road, on the north by Bronson Avenue, on the east by Lake Michigan, and on the south by an irregular line through what is now Hospitalside. Expansion to the present boundaries was accomplished by various land acquisitions from 1917 to 1942.

When the United States entered World War I, the population at NTC Great Lakes expanded quickly. Immediately prior to the war (April 1, 1917), 50 buildings served a complement of 2,500 men. At the peak of the war, the activity expanded to 1,200 acres, 775 buildings, and 47,721 men (as of August 27, 1918), thus becoming the largest naval station in the United States.

To accommodate the huge influx of personnel, the original Instruction Building and Drill Hall facing the parade ground on Mainside were converted to barracks, and thousands of tents were erected in vacant areas of the activity. The Service School Command expanded from four schools to 17; and under the direction of Captain W. A. Moffett, seven completely self-contained regimental units were designed and constructed. Each unit housed 1,726 men and included an administration building, an instruction building, a drill hall, a galley and mess hall, a dispensary, and a steam heating plant. By October 1917, all personnel were moved

out of tents and into temporary frame buildings. Most of these temporary buildings were demolished upon cessation of hostilities in 1918, though some stood through World War II.

By 1922, the Navy had stopped training recruits at NTC Great Lakes, and consideration was being given to closing the activity. Through the efforts of the Union League Club of Chicago and the Chicago, Waukegan, and North Chicago Chambers of Commerce, Congress was persuaded to restore NTC Great Lakes to its prewar training status.

All of the land west of Sheridan Road had been transferred to the Veterans Administration Hospital by 1932. The activity was then composed of 102 buildings on 507 acres. Only one of the 17 service schools that had been in operation during World War I remained in active status; however, by July 1933 no training activities were conducted, and the entire complement authorized for manning the activity consisted of a Marine Guard detachment of 40 men, a fire department of eight men, and a small public works force. The only regular maintenance activity consisted of mowing Ross Field.

The activity was reopened for training in 1935. The limited national emergency declared by President Roosevelt in 1939 marked the beginning of the second period of major growth for NTC Great Lakes. Service schools were reopened in 1940, and just prior to Pearl Harbor, authorization was given for the construction of temporary frame barracks. By 1942, eight camps--each housing a regimental unit of 4,500 recruits--had been constructed, bringing the activity's population to 44,000 men. By September 1942, six more of these camps were constructed in the Green Bay Road area, and the population of NTC Great Lakes grew to 68,000 men. By March 1944, the activity had reached an all-time peak of 100,156 men.

Although hostilities ended in 1945, NTC Great Lakes did not again revert to its prewar status as it had after World War I. The Navy retained many of the temporary World War II buildings to meet commitments related to the Korean and Vietnam conflicts. Since the Vietnam conflict, training requirements at NTC Great Lakes have remained at a high peacetime level. A complement of approximately 9,000 officers and men is stationed at the activity, maintaining facilities and training 80,000 recruits and students annually. Today, NTC Great Lakes consists of some 1,060 buildings on approximately 1,650 acres, with a replacement value of more than $1 billion.

1.3.1.3 Present Mission. The present mission of NTC Great Lakes is "to exercise command over, and coordinate the efforts of the assigned subordinate activities in effecting basic indoctrination (recruit training) for enlisted personnel, and initial skill, advanced, and/or other specialized training for officer and enlisted personnel of the regular Navy and the Navy Reserve, and to support other activities as directed by higher authority."

The full complement of host, tenant, and support operations personnel at NTC Great Lakes consists of 22,883 military (529 officers and 22,354 enlisted men and recruits) and 3,087 others (American civilians and foreign nationals).

The Naval Training Center is the major activity; it consists of the Administrative Command, the Recruit Training Command, and the Service School Command. Supporting roles are performed by the Public Works Center and the Naval Regional Medical Center.

Of the 30 tenant commands, only the following were found to generate significant quantities of hazardous waste--the Hospital Corps School, Naval Regional Dental Center, Naval Dental Research Institute, and Navy Publication and Printing Service Office. The remaining tenant commands generate only paper. Additional quantities of hazardous waste were generated by the two support organizations--the Naval Regional Medical Center and the Public Works Center.

1.3.2 Site Operational History

The information on site operational history presented below has been taken largely from the IAS for NTC Great Lakes and is supplemented by additional information obtained from Naval Energy and Environmental Support Activity (NEESA) files (including other installation-specific studies and records), aerial photography interpretation, observations made during the initial site reconnaissance, and information provided by NTC Great Lakes personnel during subsequent telephone interviews. Reasons for recommendation (in the IAS) of each site for remedial investigation are also presented. The locations of the six study sites at NTC Great Lakes are shown in Figure 1-1.

1.3.2.1 Golf Course Landfill. The Golf Course Landfill is located in the northwestern corner of NTC Great Lakes, underlying more than 50 acres of the present Golf Course. The northern and western boundaries of the site coincide with present installation boundaries. The Golf Course Landfill is bounded on the south by Buckley Road and on the east, in part, by the FFTA.

The landfill was operated as a trenching/burning operation between 1942 and 1967. Trenches were reported to be approximately 8 feet wide and 6 to 8 feet in depth, reaching down to the water table. It has been reported that trenches contained several feet of standing water at various times. It is estimated that up to 1.5 million tons of material were placed in these trenches and ignited. Types of waste reported to have been disposed at this location include domestic refuse; sewage sludge; petroleum, oil, and lubricants (POL); perchloroethylene, carbon tetrachloride, and other solvents; fly ash; and materials contaminated by polychlorinated biphenyls (PCB). The quantities of each type of waste disposed of are not known.

The oldest portion of the landfill lies in the northwest portion of the site, while the most recent portion was completed in the southeast section of the landfill. Review of aerial photographs covering 1946 to 1985 shows extensive activity in this portion of the installation, generally consistent with this description of the landfill. Additional areas of possible filling and grading not originally delineated in the IAS have been observed in aerial photographs--primarily along the south side of the FFTA and along the southeastern and southwestern corners of the Golf Course (see Section 2.2.1). In 1967, the landfill was completed and closed and covered with ash and a thin layer of topsoil. According to installation personnel, no documented closure plan is on file. The site has been grassed over, and there is no evidence of refuse at the surface.

The IAS points out that, though there is no demonstrable migration of contaminants from this landfill to Skokie Ditch, which appears to emanate from and run through part of the Golf Course, such contamination is possible. Potential receptors of contaminants would include fish taken from Skokie Ditch/River downstream of the activity and other industrial land uses, and any person entering the area. Because of the variety of toxic materials that may have been disposed of and the proximity of human receptors, the Golf Course Landfill was recommended for an RI in the IAS.

1.3.2.2 Fire Fighting Training Area. The FFTA is located just to the south of the Golf Course Landfill and is surrounded on all sides by the Golf Course. It consists of a 10-acre, partially paved area, occupied by four small practice burn buildings, several open steel tanks, and a former drum staging area and adjacent shed. The north and part of the west side of the area are bounded by a runoff catchment

ditch, equipped with a separator, while two waste oil/water lagoons occupy a portion of the west side of this area. The site has been actively used since 1942. Review of aerial photography from 1946 to 1985 indicates that no major changes have occurred at this site--and that the description provided in the IAS is accurate, with one exception at the drum storage area, as discussed below.

The area is used to stage fires for training exercises using #2 fuel oil and gasoline. Fires are extinguished using Aqueous Film Forming Foam and dry extinguisher chemicals. In the past, other flammable materials, including other petroleum products and solvents, have been used for igniting practice fires. During the initial site reconnaissance, the concrete pavement in the vicinity of the buildings and tanks was observed to be broken in many places, with vegetation growing through. The runoff ditch contained standing water covered with an oily sheen, while the lagoons also contained standing water/waste. The sides of the lagoons and surrounding area were black with heavy oily stains.

In addition, reportedly between 1942 and 1979, the southwestern portion of the site was used for storage of drums containing waste POL's and solvents, as well as oils and materials recovered from the training exercises. Up to 300 55-gallon drums of such materials were accumulated in this area by 1983. All materials have since been removed, and only a few empty drums awaiting disposal remain onsite. The ground in this area was black with heavy oily stains. Review of aerial photography generally confirms this description of activity. Barrels are evident beginning in 1970, along the southwest boundary of the FFTA between the lagoons and the southwest corner of the site. The photographs reveal that this storage area is more extensive than that originally shown in the IAS (see Section 2.2.2). Barrels were no longer visible in 1985.

As discussed in the IAS, given the possibility of contamination from the solvents and gasoline used in the liquid waste-burning episodes of the past, and the potential migration of any contaminants lost to the environment into Skokie Ditch/River, the pathways and potential receptors are the same as those described for the Golf Course Landfill. Individuals entering the fenced area and the aquatic life in Skokie Ditch/River are the main receptors identified. Therefore, the FFTA was recommended for an RI in the IAS.

1.3.2.3 Transformer Storage "Boneyard". This area consists of approximately 2 acres located in the northwestern end of the Camp Moffett section of the

installation. It currently consists of a partially paved yard located southwest of Building 1517, east of the Elgin, Joliet & Eastern Railroad right-of-way, and west of the Drill Field. Between 1945 and 1985, the yard was reportedly used primarily for the storage of out-of-service transformers, including some filled with PCB-containing oil. It is reported that the transformers may have been located anywhere within the yard during this period. Review of aerial photography covering this 40-year period reveals that objects of varying sizes and configurations have been stored in various locations in the storage yard, as well as in the Drill Field, the area surrounding Building 1517, and the area adjacent to the north side of the storage yard and Drill Field. In addition, a sizable building, previously unidentified, filled most of the center of the current storage yard until sometime between 1964 and 1970, when it was no longer visible and obviously demolished. Current installation personnel do not have any knowledge of this former structure or its uses. Since 1985, all PCB-contaminated materials have been removed to a specialized storage facility.

During the initial site reconnaissance, it was observed that the yard is currently occupied by a new salt storage dome; some out-of-service non-PCB transformers and capacitors; coils of lead-insulated cable; heavy equipment; and other miscellaneous scrap metal and materials. Open drums of motor oil and other lubricants were located near the salt dome and heavy equipment. Ground stains were evident in this and other areas of the site.

Four surface soil samples were collected in the yard in 1984. Reported analysis results indicate that the soils contain between 50 and 100 parts per million (ppm) of PCB's. No information appears to be available on the location or depth of these samples. The IAS presented these results, but did not reference the source.

As discussed in the IAS, oily wastes and PCB's at this site are most likely tied up in the shallow soils; the most probable migration pathway is by being tracked out on vehicle tires or the shoes of employees who walk in that area. In addition, surface runoff from major storm events may erode some of the surface soils from unpaved areas. However, the site is very flat, and no distinct drainageways are visible. Eroded materials may pool around the site or be redeposited a short distance from the site. Receptors could thus include those employees who frequently work in the Transformer Storage "Boneyard" and those who work in nearby areas to which "Boneyard" employees may track the contaminated soils. Therefore, the site was recommended for an RI in the IAS.

1.3.2.4 RTC Silk-Screening Shop. The RTC Silk-Screening Shop is located in Building 1212, in the northeastern portion of the Camp Porter section of the installation. It has been in use since 1965. A small pipe draining the washwater booth in the building permitted wastewater to exit the building through the northern exterior wall onto the adjacent unpaved ground.

The shop used a variety of materials including paint, inks, water and oil-based lacquers, enamels, mineral spirits, acetone, thinners, and photographic emulsions. Up until 1985, washwater from the finishing of silk screens, possibly contaminated with these products, was allowed to drain onto the ground, sometimes reportedly forming pools behind the building and along Ohio Street. Although this practice was discontinued in 1985, ground stains are evident on the gravelled lot in the vicinity of the drain outlet.

The IAS reports that the pools of liquid remained until they either infiltrated the soil, were flushed away by precipitation, or evaporated. The surface soils in this area are classified either as made land (filled or developed) or silty loam. The in situ loam is characterized as slowly-to-moderately permeable. However, no site-specific information is known that describes site soils and their permeability. In the vicinity of this site, the water-bearing zones that could be considered to be aquifers lie at a depth of approximately 15 to 50 feet below the ground surface. The generally tight nature of the surface materials that might be expected here could restrict the migration of contaminants into these deeper layers. However, sandy layers could act as more permeable conduits. A more likely pathway would be via stormwater runoff, which may have carried the contamination directly into Pettibone Creek via overland flow or through the storm sewers. Once in the creek, the contamination would be free to flow directly into Lake Michigan (though along the overland flow path, through the storm sewers, and upon entering Pettibone Creek, the washwater would have been mixed with water from several other sources and diluted by a factor of several orders of magnitude).

The IAS indicated that possible receptors include the fish and other organisms living in Pettibone Creek, the harbor, and Lake Michigan. Direct exposure of personnel living in the RTC camps is likely to be limited because of the relative inaccessibility of the area within RTC, and the lack of idle time allocated to personnel in the area. The above concern led to the recommendation in the IAS that an RI be conducted at this site.

1.3.2.5 Exchange Service Station. The Navy Exchange Service Station is located in the central part of the Mainside area of the installation. It consists of a pump island and a small service garage (Building 144). The Post Office (Building 112) is located to the west, while Building 105 is located to the east.

In 1983, a pipeline leak resulted in the loss of approximately 3,000 gallons of leaded fuel into the soils underlying the station. Cleanup and recovery operations were implemented in this area. However, conflicting reports of the extent of cleanup and monitoring are provided by the IAS and NTC Great Lakes personnel present during these operations. The IAS reports that several wells were installed for recovery/monitoring, and that contaminated soils in the vicinity were excavated and removed from the installation for disposal. NTC Great Lakes Department of Public Works personnel present during the cleanup report that only one shallow recovery well was installed and is still used intermittently, and that no soils or contaminated materials were excavated or removed from the site. An estimated 1,800 gallons of fuel has been recovered. Public Works personnel were unable to confirm whether tank pressure testing was continued after the cleanup and recovery operation, or whether it has been performed recently. Available aerial photography does not cover the period of cleanup/recovery operations.

In addition, employees in the adjacent Post Office building, which is within 100 feet of the site of the fuel leak, continue to detect gasoline odors in the basement, frequently after heavy rain. Reportedly, residual gasoline in the unsaturated zone or on the water table is being displaced by infiltrating precipitation. Public Works personnel also cite the possibility of gasoline entering steam condensate lines in the area leading to the Post Office, after the rising water table reaches the level of the steam lines. Installation personnel report that gasoline continues to collect in the recovery well after heavy rains.

The IAS points out that the area is underlain by a sand-and-gravel aquifer at a depth of less than 15 feet below the surface. Gasoline may have entered this aquifer and been carried to Pettibone Creek or Lake Michigan. At the very least, residual gasoline contamination remains in the soils underlying the service station.

Potential pathways identified in the IAS include migration in the shallow subsurface sorted sand aquifer, which could ultimately discharge into Pettibone Creek, several hundred feet west of the spill site. Receptors include employees in

the Post Office and the organisms in Pettibone Creek, the harbor, and Lake Michigan. Anyone consuming catches from the nearby areas of the lake could ingest fractions of the gasoline from this source. Thus, the IAS recommended the Exchange Service Station for an RI.

1.3.2.6 Harbor Dredge Spoil Area. During harbor dredging activities in 1952 and 1970, dredge spoils were reportedly disposed of in an area directly south of the harbor and present wastewater treatment tanks, along the lakeshore. The sludge can have a high organic material concentration (though exposure to the air could have resulted in oxidation and accelerated decomposition of the organics), and may potentially also contain heavy metals, oils, pesticides, and PCB's from industries upstream of NTC Great Lakes.

The IAS delineates the area designated as a dredge spoil disposal area near the southern installation boundary and along the lakeshore. However, no other evidence is available to confirm this location. Review of aerial photography taken at intervals from 1946 to 1985 indicates evidence of some filling and other modifications of the area over this period. However, these filling activities do not coincide with or closely follow the reported dates of harbor dredging (1952 and 1970) and, therefore, do not appear to be related to the disposition of dredge spoils, as originally reported by the IAS. Further, discussions with installation personnel regarding the 1970 dredging operations indicate that spoils from this period were placed in the lake, approximately 5 miles from shore. Installation personnel were not able to provide any personal knowledge of the 1952 dredging activities.

The NTC Great Lakes Master Plan cites contamination of the Inner Harbor sediments with heavy metals, PCB's, and oils. The source of these contaminants is apparently the industries located upstream from the activity. Some of these industries are identified in the land use section of Chapter 4 of the Master Plan. The Inner Harbor is not Navy property; however, Site 12, the Harbor Dredge Spoil Area, is Navy property.

The IAS concluded that hazardous wastes generated by private industry upstream of the activity may have entered the harbor, and these wastes may pose a threat to the environment, even though there is no history of direct dumping in the harbor. Similarly, the sediments dredged from the harbor in 1952 and 1970 may contain concentrations of hazardous materials high enough to warrant further

study. Hence, the Harbor Dredge Spoil Area was recommended for an RI in the IAS.

1.3.3 Topography, Geology, and Hydrology

The main sources of information for the discussion of installation-wide characteristics include published reports and maps on regional geology, hydrology, and hydrogeology from the Illinois State Geological Survey and the U.S. Geological Survey; a soil survey from the USDA Soil Conservation Service; a variety of aerial photographs from 1953 to the present; the 7½-minute quadrangle topographic maps that cover the installation (see Figure 1-1); and information summarized in the IAS. Review of IAS information sources was not possible since, in many cases, sources were not cited for site-specific information.

The main sources of information for the discussion of site-specific characteristics include aerial photographs, topographic maps (see Figure 1-1), the IAS, observations made during the field reconnaissance, and discussions with installation personnel. Attempts to obtain site-specific geologic data (i.e., boring and well logs) were unsuccessful. The installation Public Works Department explained that the three files containing all foundation boring and other geologic logs for the installation are missing. Discussions with engineers in neighboring towns yielded little information. Therefore, descriptions of site geology remain sketchy at best. Published reports are too broad in scope to focus on the installation's location.

1.3.3.1 Installation. The land surface at NTC Great Lakes ranges in elevation from 590 to 700 feet above mean sea level (MSL). However, the majority of the area is relatively level, with an almost constant elevation of 650 feet--reflecting the level lake deposits that underlie it. The lower elevations are found in the vicinity of creeks and along the lakeshore.

NTC Great Lakes is located in the Wheaton Morainal Country of the Great Lakes section of the Central Lowland Province. This province is characterized by gently sloping and poorly drained areas, with many streams ending in depressions and marshes. The installation is further located on top of the Bluff-Ravine Complex, one of three topographic subcomplexes in this area. The Bluff-Ravine Complex is found within the narrow Lake Michigan watershed and is comprised of level tablelands that are typically bordered by steep lake-facing bluffs and a

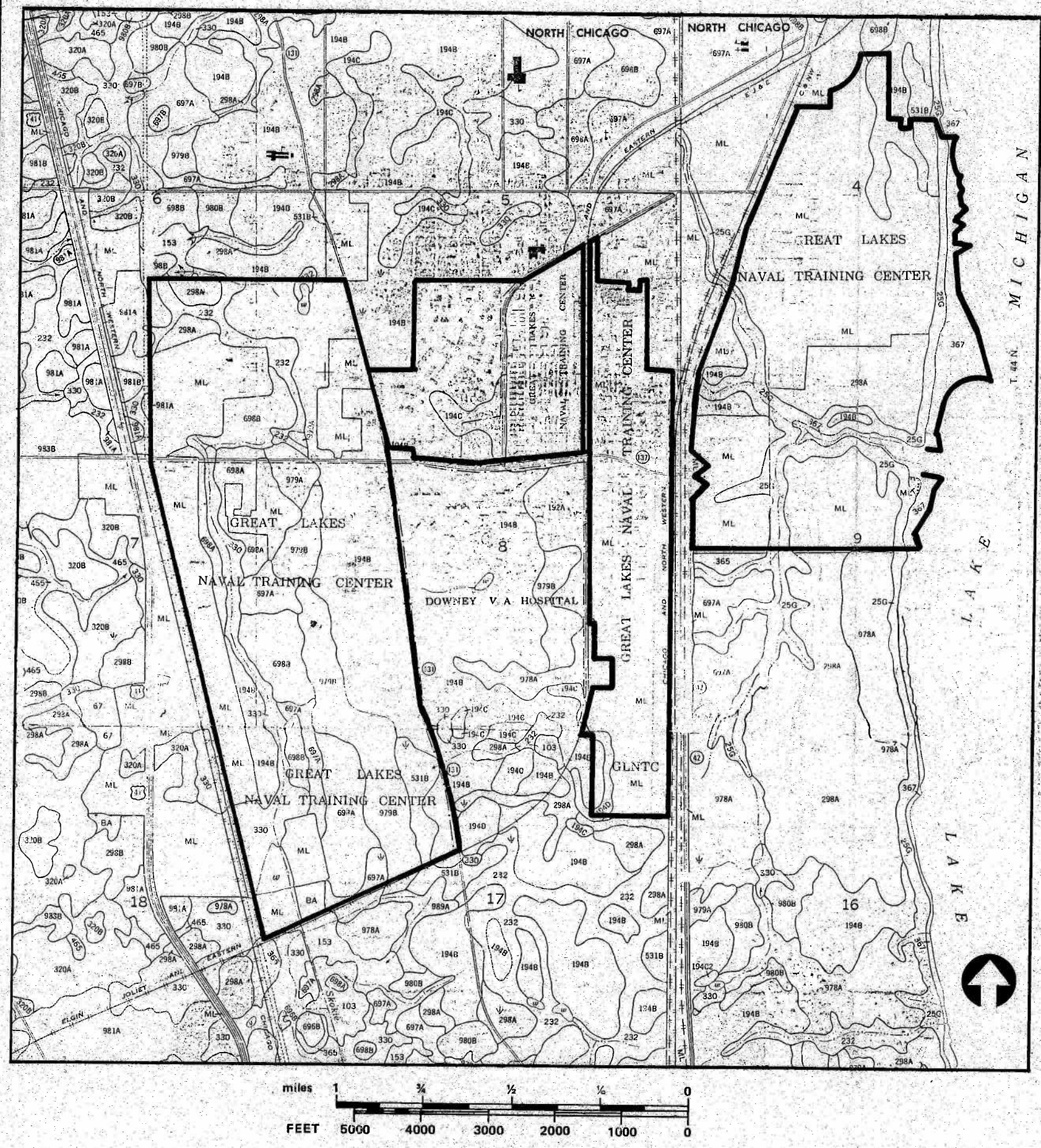
network of interior ravines. The lake bluffs and ravines found at NTC Great Lakes are highly susceptible to erosion, as is characteristic of this topographic complex. The lake bluffs range up to 70 feet high along this section of shoreline.

The Soil Survey of Lake County, Illinois, indicates that surface soils of the installation have been classified primarily into two groups--the Morley-Beecher-Hennepin association and Made Land (see Figure 1-4). Made land is defined as areas of manmade cuts and fills, and areas covered by roads and buildings. Fill materials include a variety of soils and nonsoil materials that have not been distinguished. The Morley-Beecher-Hennepin association consists primarily of loams and silty loams that are characterized as nearly level-to-very steep in deep ravines, well drained-to-somewhat poorly drained, and having moderately slow-to-moderate permeability.

NTC Great Lakes is underlain by glacial deposits, such as end moraines and unsorted till. These vary greatly in thickness from 50 to 200 feet due to the variable bedrock surface underlying the area, but average approximately 170 feet in the vicinity of the installation. The deposits in the vicinity of the installation are reported to belong to the Wadsworth till member. This till member is composed primarily of a clayey, silty phase and some intervals of a sandier phase. In general, the unsorted deposits are characterized by low hydraulic conductivity. However, well sorted sand and gravel sheets and lenses interspersed throughout the till may transmit significant volumes of groundwater. The hydraulic conductivity of these deposits is several orders of magnitude higher than that of the surrounding till.

The till is underlain by Silurian dolomites of the Alexandrian and Niagaran series. The beds dip slightly to the east. The surface of these beds has been highly eroded; as a result, the thickness of overlying till and depth to bedrock are also highly variable. A high permeability zone of rubble of undescribed origin between the till and the competent dolomite has been noted in well logs from the local area. This zone constitutes a usable aquifer. In addition, the dolomitic formations themselves are a current source of water. These formations are in turn underlain at depth by a series of shales, limestones and dolomites, and sandstones.

The installation is located within two major drainage basins--the Lake Michigan North Drainage Basin (feeding the St. Lawrence River) and the North



SOIL LEGEND

A number shows the soil type or a group of undifferentiated soils. A capital letter, A, B, C, D, E, F, or G, shows the slope. W preceding the number shows a wet soil. Most symbols without a slope letter are those of nearly level soils. A final number, 2, after the slope letter indicates an eroded soil.

SYMBOL	NAME
25F	Hennepin loam, 15 to 30 percent slopes
25G	Hennepin loam, 30 to 60 percent slopes
27B	Miami silt loam, 2 to 4 percent slopes
27C	Miami silt loam, 4 to 7 percent slopes
27C2	Miami silt loam, 4 to 7 percent slopes, eroded
27D	Miami silt loam, 7 to 12 percent slopes
27D2	Miami silt loam, 7 to 12 percent slopes, eroded
V54	Plainfield sand, slightly acid variant, 1 to 4 percent slopes
57B	Montmorenci silt loam, 2 to 4 percent slopes
57C2	Montmorenci silt loam, 4 to 7 percent slopes, eroded
67	Harpster silty clay loam
93F	Rodman gravelly loam, 15 to 50 percent slopes
W97	Houghton peat, wet
103	Houghton muck
W103	Houghton muck, wet
107	Sawmill silty clay loam
146A	Elliott silt loam, 0 to 2 percent slopes
146B	Elliott silt loam, 2 to 4 percent slopes
153	Pella silty clay loam
189A	Martinton silt loam, 0 to 2 percent slopes
189B	Martinton silt loam, 2 to 4 percent slopes
192A	Del Rey silt loam, 0 to 2 percent slopes
192B	Del Rey silt loam, 2 to 4 percent slopes
194B	Morley silt loam, 2 to 4 percent slopes
194B2	Morley silt loam, 2 to 4 percent slopes, eroded
194C	Morley silt loam, 4 to 7 percent slopes
194C2	Morley silt loam, 4 to 7 percent slopes, eroded
194D	Morley silt loam, 7 to 12 percent slopes
194D2	Morley silt loam, 7 to 12 percent slopes, eroded
194E	Morley silt loam, 12 to 25 percent slopes
194E2	Morley silt loam, 12 to 25 percent slopes, eroded
232	Ashkum silty clay loam
228A	Nappanee silt loam, 0 to 2 percent slopes
228B	Nappanee silt loam, 2 to 4 percent slopes
228C2	Nappanee silt loam, 4 to 7 percent slopes, eroded
298A	Beecher silt loam, 0 to 2 percent slopes
298B	Beecher silt loam, 2 to 4 percent slopes
320A	Frankfort silt loam, 0 to 2 percent slopes
320B	Frankfort silt loam, 2 to 4 percent slopes
323C2	Casco loam, 3 to 10 percent slopes, eroded
325A	Dresden loam, 0 to 2 percent slopes
325B	Dresden loam, 2 to 4 percent slopes
327A	Fox loam, 0 to 2 percent slopes
327B	Fox loam, 2 to 4 percent slopes
327C2	Fox loam, 4 to 7 percent slopes, eroded
327D2	Fox loam, 7 to 12 percent slopes, eroded
330	Peotone silty clay loam
W330	Peotone silty clay loam, wet

SYMBOL	NAME
365	Aptakisic silt loam
367	Beach sand
370B	Saylesville silt loam, 1 to 4 percent slopes
370C2	Saylesville silt loam, 4 to 7 percent slopes, eroded
442A	Mundelein silt loam, 0 to 2 percent slopes
442B	Mundelein silt loam, 2 to 4 percent slopes
443A	Barrington silt loam, 0 to 2 percent slopes
443B	Barrington silt loam, 2 to 4 percent slopes
465	Montgomery silty clay
490A	Odell silt loam, 0 to 2 percent slopes
490B	Odell silt loam, 2 to 4 percent slopes
495A	Carwin silt loam, 0 to 2 percent slopes
495B	Carwin silt loam, 2 to 4 percent slopes
513	Granby loamy fine sand
531B	Markham silt loam, 1 to 4 percent slopes
531B2	Markham silt loam, 2 to 4 percent slopes, eroded
531C	Markham silt loam, 4 to 7 percent slopes
531C2	Markham silt loam, 4 to 7 percent slopes, eroded
531D2	Markham silt loam, 7 to 12 percent slopes, eroded
696A	Zurich silt loam, 0 to 2 percent slopes
696B	Zurich silt loam, 2 to 4 percent slopes
696C	Zurich silt loam, 4 to 7 percent slopes
696C2	Zurich silt loam, 4 to 7 percent slopes, eroded
696D2	Zurich silt loam, 7 to 15 percent slopes, eroded
697A	Wauconda silt loam, 0 to 2 percent slopes
697B	Wauconda silt loam, 2 to 4 percent slopes
698A	Grays silt loam, 0 to 2 percent slopes
698B	Grays silt loam, 2 to 4 percent slopes
706B	Boyer sandy loam, 1 to 4 percent slopes
706C2	Boyer sandy loam, 4 to 10 percent slopes, eroded
978A	Wauconda and Beecher silt loams, 0 to 2 percent slopes
978B	Wauconda and Beecher silt loams, 2 to 4 percent slopes
979A	Grays and Markham silt loams, 0 to 2 percent slopes
979B	Grays and Markham silt loams, 2 to 4 percent slopes
980B	Zurich and Morley silt loams, 2 to 4 percent slopes
980C2	Zurich and Morley silt loams, 4 to 7 percent slopes, eroded
981A	Wauconda and Frankfort silt loams, 0 to 2 percent slopes
981B	Wauconda and Frankfort silt loams, 2 to 4 percent slopes
982A	Aptakisic and Nappanee silt loams, 0 to 2 percent slopes
982B	Aptakisic and Nappanee silt loams, 2 to 4 percent slopes
983B	Zurich and Nappanee silt loams, 2 to 4 percent slopes
984B	Barrington and Varna silt loams, 2 to 4 percent slopes
989A	Mundelein and Elliott silt loams, 0 to 2 percent slopes
989B	Mundelein and Elliott silt loams, 2 to 4 percent slopes
BA	Borrow area
GP	Gravel pits
MA	Marsh
ML	Made land

FIGURE 1-4
SOIL SURVEY FOR LAKE COUNTY, ILLINOIS
(Adapted From SCS, 1970)

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Branch Chicago River Drainage Basin (feeding the Mississippi River). Areas east of Green Bay Road drain into Lake Michigan, some via Pettibone Creek. Areas west of the road drain into the Skokie Ditch/River feeding the Chicago River. These two small streams are the major surface water drainageways on the installation, other than overland flow. Water quality in both streams is reported to be generally poor, based on Illinois Environmental Protection Agency (IEPA) water quality standards.

1.3.3.2 Study Sites. This summary of site geology is generally limited to the shallow geology in the vicinities of the study sites. Based on the thickness of low permeability glacial till underlying these areas, the limited extent and discontinuity of water-bearing sand and gravel zones, and the limited scope of this initial investigation, it is most appropriate to examine the zone of immediate impact underlying these sites. Initial indications are that contaminant migration from the sites of interest will most likely occur in the shallow zone due to low hydraulic conductivity of the till. In addition, there are no water wells on the installation currently being used for water supply that could be impacted by contaminant migration.

The IAS presents a generalized map of the extent and depth of sand and gravel zones underlying the installation. The basis for this mapping is not cited. The IAS shows that at those sites located in the northern portion of the installation, a sand and gravel zone lies 10 to 15 feet below the surface. At sites located just to the south of Buckley Road, a sand and gravel zone lies between 15 and 50 feet below the surface. In the area generally southwest of Mainside, sand and gravel are found at depths greater than 50 feet below the surface.

The Golf Course Landfill and contiguous FFTA are located in a gently undulating topography with poorly drained soils marked by a small valley trending northwest-southeast through these sites. Surface ponding and soft, wet soils were noted in many locations in the Golf Course during the initial site reconnaissance, particularly along the northern installation boundary. The surface of the training area is mostly covered with pavement or gravel. Elevations at the sites range around 700 feet above mean sea level. This area is reported in the IAS to be underlain by approximately 10 to 15 feet of till above a sandy, water-bearing zone. The water table is reportedly located from 6 to 8 feet below ground surface in this

vicinity. Surface drainage is collected by Skokie Ditch/River, which arises in the middle of the Golf Course and receives some effluent from the FFTA. No groundwater/leachate seeps were visible in Skokie Ditch/River at the time of the site visit.

The Transformer Storage "Boneyard" area is located in a flat-lying field approximately 1,000 feet west of a branch of Pettibone Creek, with elevations ranging around 650 feet above mean sea level. The surface is partially paved and gravelled. This area is also reportedly underlain by approximately 10 to 15 feet of till, above a sandy, water-bearing zone. No site-specific data on water table elevation are available for this area. Water levels are expected to be less than 10 feet below ground surface. No surface drainageways are evident on this site.

The RTC Silk-Screening Shop is located in a flat, developed area with elevations around 650 feet above mean sea level. The surfaces surrounding the building are gravelled and paved. The area directly below the drain pipe is currently unpaved, hard-packed gravel, sloping slightly away toward Ohio Street. This area of the site is apparently underlain by 15 to 50 feet of till, overlying a sandy, water-bearing zone. No site-specific data on water table elevation are available for this area. Again, it is expected that the water table is fairly shallow there. Surface drainage in this vicinity is via roadways, gutters, and other low pathways.

The Exchange Service Station is located in a flat, developed area in Mainside, about 500 feet east of Pettibone Creek. The ground elevations are approximately 650 feet above mean sea level. The surfaces surrounding this site are paved, with grassy areas around existing buildings. This area is underlain by approximately 10 to 15 feet of till above a sandy, water-bearing zone. Aerial photography confirms the presence of a building consistent with the site being used as a coal storage area; installation personnel speculate that foundations from an old storage building may be buried beneath the service station. Groundwater is reportedly encountered between 6 and 8 feet below ground surface. There are no drainageways at the site; surface runoff is conducted away from the site by roadways, gutters, and storm sewers.

The Harbor Dredge Spoil Area is located in a flat area on the lakeshore, beneath a bluff, south of the installation sewage treatment plant. Ground elevations at the site are approximately 585 feet above mean sea level, only a few

feet above lake level. The surface is partially hard-packed gravel and partially dirt and grasses. This area may be underlain by approximately 15 to 50 feet of till above a sandy, water-bearing zone. No site-specific water level data are available. However, due to the site's proximity to the lakeshore, water levels are expected to be very shallow, with some groundwater discharge to the lake. Surface runoff drains directly into Lake Michigan.

2.0 VERIFICATION STEP SITE INVESTIGATION PROGRAM

This section describes the proposed RI Verification Step field investigation program to be conducted at the six study sites at the installation. The key elements of this program are summarized in Table 1-1. Included are discussions of monitoring well installation, sampling and other data collection, chemical analysis, field procedures, fieldwork QA, key fieldwork personnel, data evaluation/interpretation, and reporting. If preliminary field results or other conditions warrant a change to this work plan, any such changes will be documented.

2.1 SITE RECONNAISSANCE AND RECORDS REVIEW

To develop a technical approach to the site investigation program, a site reconnaissance and records review were conducted. The initial site reconnaissance of the seven sites (including the Mainside Transformer Storage Area discussed previously), to be addressed in the RI/FS, was conducted on December 15-16, 1986. Histories of the various sites, services to be performed at each site, and current installation activity were discussed. During the site visit, conditions at each of the sites were observed and recorded, including surface conditions, location and condition of structures and other physical facilities, evidence of past operations/facilities, visual identification of potentially contaminated areas, topography, condition of/lack of vegetation, location of existing wells and surface water, conditions that may impede site access, and other site-specific features.

In conjunction with and following the site reconnaissance, a review of pertinent documents and photographs was performed. These consisted primarily of the IAS document; the NEESA files containing IAS interview notes, maps, and a set of 1953 aerial photographs, as well as other pertinent documents collected by NEESA; additional aerial photographs obtained by Dames & Moore covering the period 1946 to 1985; and additional geologic and hydrogeologic reports on the region and the site. In addition, this information was supplemented by telephone discussions with installation personnel. Information from these sources was used to develop a Verification Step site investigation program that is consistent with facility history, operations, and conditions.

Historic aerial photography covering six sites at NTC Great Lakes was evaluated to detect changes in site conditions over the years and thereby locate

potential contamination sources. The investigation involved the stereoscopic interpretation of individual aerial photographs acquired for the years 1946, 1953, 1965, 1970, 1972, 1975, 1981, and 1985, and the monoscopic interpretation of oblique aerial photographs taken in 1958. For each year analyzed, the aerial photographic investigation determined the conditions at each site, including evidence of manmade changes and activity, particularly at the landfill, and the presence of features such as "flow stains" or barrels that may indicate contamination sources.

It should be noted that the records review will continue during the site investigation and data analysis, as additional data and data sources become available. Several conflicts in the information received to date remain to be resolved--i.e., the extent of cleanup and recovery operations at the Exchange Service Station, and the exact location of the Harbor Dredge Spoil Area. Resolution of these discrepancies may require assistance from NEESA or other knowledgeable sources.

2.2 MONITORING WELL INSTALLATION AND WATER LEVEL MEASUREMENTS

Installation of new monitoring wells is planned for three of the six sites--the Golf Course Landfill, Fire Fighting Training Area, and Exchange Service Station. These areas were selected for well installation based on the preliminary assessment of groundwater being a likely pathway for contaminant migration, the presence of shallow, water-bearing sands underlying some of these areas, and the lack of existing monitoring wells in their vicinity. As discussed in Section 1.3.3.2, the efforts during this limited initial investigation will focus on the shallow unconsolidated saturated zone. Based on the limited site-specific subsurface information available, it is assumed--for the purposes of siting and designing monitoring wells at the Golf Course Landfill and at the adjacent FFTA--that the sites are mostly underlain by a single unconfined aquifer system. Given the extensive low permeability clayey till described in this area, localized areas of perched, semiconfined groundwater are expected. However, the few shallow wells at the installation and in the surrounding area do not indicate that confined conditions exist. Data collected from the new monitoring wells planned for this investigation are necessary for determining the groundwater gradient in the vicinity of the study sites, as well as for collecting samples for chemical analysis. Data collected during the field program will be given a preliminary review as they become available to test the validity of the assumptions. Changes in well siting

and design will be made as necessary, if field conditions are found to be different than originally assumed.

The following sections describe and discuss the rationale for the planned well networks. Section 3.2 discusses the field procedures to be employed for well drilling/installation and associated operations.

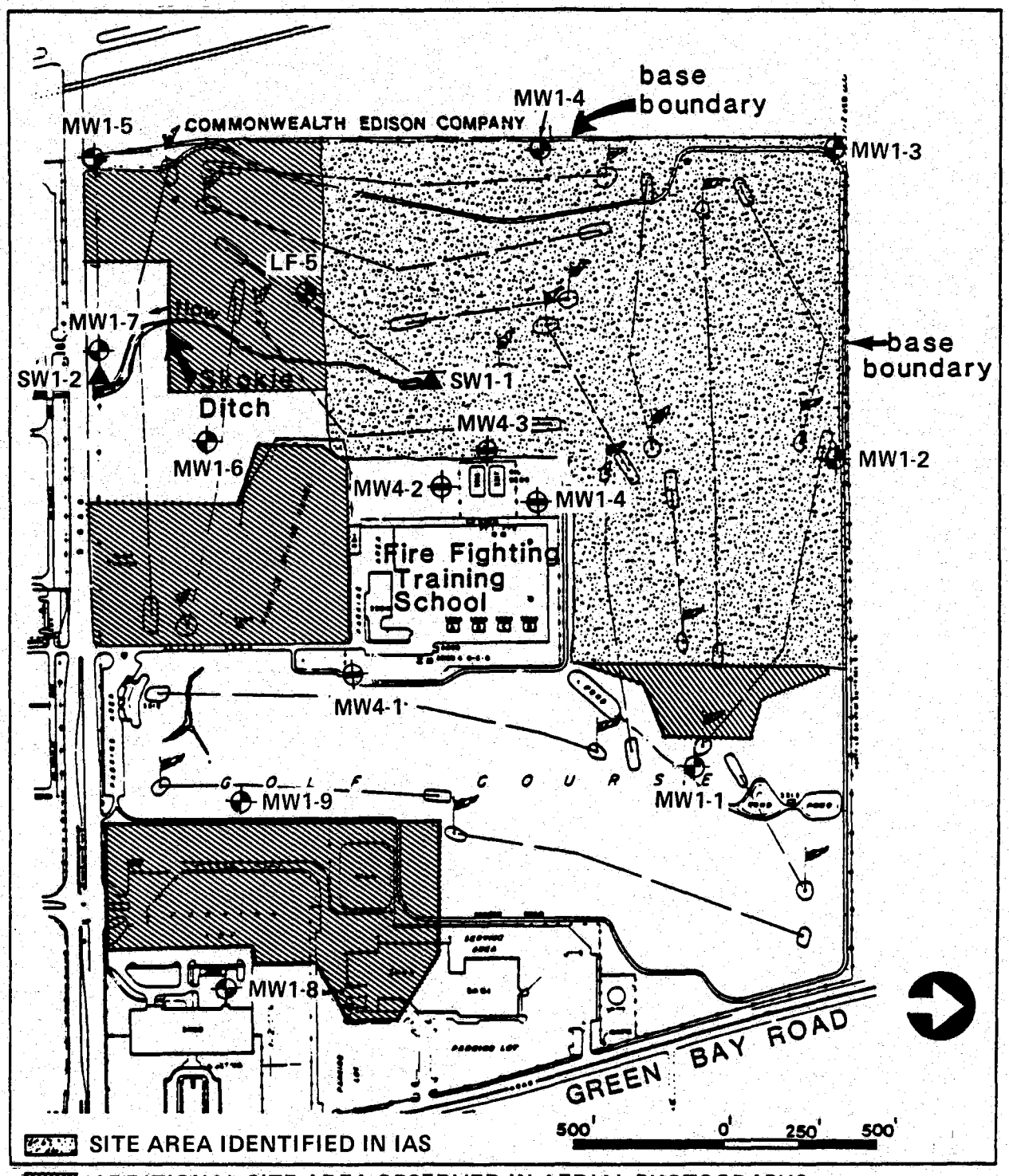
2.2.1 Golf Course Landfill

Seven shallow monitoring wells will be installed at the Golf Course Landfill. Since wastes and their residues were reportedly placed in contact with groundwater during filling operations, there is a strong likelihood that leachate is being generated and may migrate with groundwater flow. One of the functions of these wells will be to provide access to the shallow regime for the collection of groundwater samples for chemical analysis for the presence of leachate.

There is also a necessity to determine the hydraulic gradient in the vicinity of the landfill, since this will influence the direction of leachate migration. Groundwater in the Bluff-Ravine Complex commonly flows toward and discharges to surface drainage. However, there are little data to confirm this possibility in the vicinity of the landfill. In addition, activities such as trenching and landfilling, which disturb the in situ permeability of the natural soils, may result in groundwater mounding and alteration of the natural hydraulic gradient. Therefore, these monitoring wells will be used to measure the water table elevation in the vicinity of the landfill to better define the hydraulic gradient.

Based on information obtained to date, tentative locations for nine monitoring wells are shown in Figure 2-1. It is assumed that well MW1-1, on the southern edge of the landfill, will be located to provide groundwater samples representative of background ambient water quality not affected by the landfill. However, given the possibility of mounding and radial flow at this site, combined with uncertainty regarding the exact location of fill materials, changes in well locations may be necessary as drilling proceeds and the fill and direction of flow are evaluated.

Wells MW1-2, MW1-3, and MW1-4 are located along the landfill/installation boundary east side, northeast corner, and north side, respectively. The main purpose of these wells is to act as sentinels for contamination leaving the installation across these boundaries. The wells may be located upgradient of the



ADDITIONAL SITE AREA OBSERVED IN AERIAL PHOTOGRAPHS

MW4-1 Proposed FFTA Wells (See Figure 2-2)

SW1-1 Proposed Surface Water Sampling Locations

MW1-1 Proposed Monitoring Well and Groundwater Sampling Locations

FIGURE 2-1
PROPOSED MONITORING WELL AND SAMPLING LOCATIONS
GOLF COURSE LANDFILL (SITE 1)

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landfill; however, if radial flow exists at this site, it may result in contaminants moving toward the wells and across installation boundaries.

Wells MW1-5 and MW1-6 are located along the western edge of the fill area, north and south of Skokie Ditch, respectively. These wells, along with MW1-7 located on the western edge of the Golf Course along the road, are currently assumed to be downgradient of the landfill and in proximity to the oldest portions of the landfill. These locations are included to detect leachate migrating from the landfill and possibly moving toward and/or discharging to Skokie Ditch. Wells MW1-8 and MW1-9 are planned to monitor a potential area of fill (as identified in aerial photographs) in the southeastern portion of the Golf Course.

It should be noted that groundwater in this area may also be affected by any contaminants migrating from the FFTA.

It may be difficult to distinguish contaminants detected in the landfill monitoring wells from contaminants contributed by the FFTA. It has been reported in the IAS that some of the same compounds used at the FFTA may also have been disposed of directly in the landfill. The analysis of groundwater samples from FFTA monitoring wells should aid in the identification of contaminants currently emanating from the FFTA. Depending on the compounds identified at the FFTA, it may be possible to "fingerprint" this source by examining the ratios between various contaminants at the FFTA and see if these ratios are reflected in the landfill wells. However, depending on what is found--and since the compounds and their quantities used/disposed at these two sites have varied over time, it may not be possible to establish distinctive ratios for compounds or to eliminate the FFTA as a source for some compounds found in landfill monitoring wells downgradient of the FFTA.

The proposed well network provides for one additional well over that recommended in the IAS. The proposed network also shifts the recommended lcoations. These changes are proposed to provide better coverage of the long perimeter/installation boundary that defines this area, to provide better coverage of presumed downgradient areas, and to provide data necessary to determine the hydraulic gradient.

All monitoring wells will be designed to accommodate both water level measurements and groundwater sample collection. They will be constructed of 4-inch-diameter Schedule 5 stainless-steel casing and screen. Based on available

geologic information, it is currently believed that wells will be installed to a maximum depth of 25 feet in glacial deposits. Wells will be constructed using a 10-foot-long screen. Well depths shallower than 15 feet will require a shorter screen (5 feet) to ensure proper installation. Since POL's are contaminants of concern at this site, the well screens will be placed to straddle the water table, since POL's float on the water table. Further details of well construction are discussed in Section 3.2.

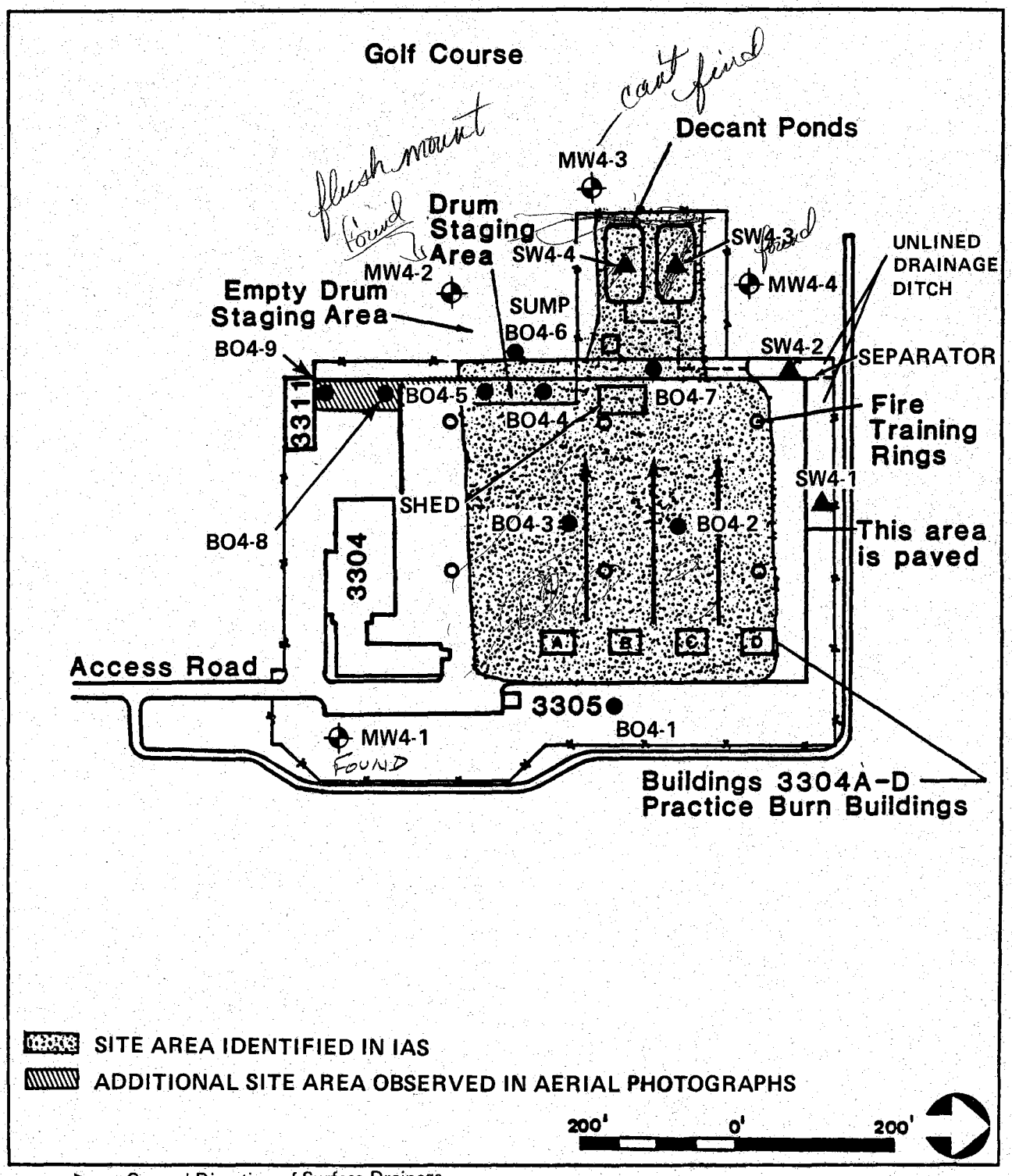
2.2.2 Fire Fighting Training Area

Four shallow monitoring wells are planned for the FFTA. Due to the nature of the activities in this area, large volumes of potentially contaminated surface runoff are generated and collected in an unlined ditch and lagoons. This may result in infiltration of contaminated surface water and contribution of contaminants to groundwater and the subsurface environment in this area. In addition, percolation of surface runoff through contaminated soils can also add constituents to the groundwater. Monitoring wells will provide access for the collection of groundwater samples for chemical analysis for the presence of contaminants.

In addition, there currently are insufficient data to define the hydraulic gradient in this area. It is important to understand how the characteristics of fill material and possible infiltration from the ditch and lagoons may influence the gradient. Since groundwater flow and movement of contaminants will be influenced by the gradient, monitoring wells will be used to obtain measurements of the local water table elevations.

Based on information obtained to date, tentative locations for the four monitoring wells are shown in Figure 2-2. It is currently assumed that the proposed well MW4-1 in the southeastern corner of the FFTA is located to provide groundwater samples representative of background, ambient water quality unaffected by the training area. (It also serves as a background well for the landfill.) However, given the lack of site-specific data on the hydraulic gradient in this area, changes to well locations may be necessary as drilling progresses and data become available to assess flow direction.

Wells MW4-2, MW4-3, and MW4-4 are located along the northern edge of the training area and the lagoons, interposed between it and the Golf Course Landfill.



General Direction of Surface Drainage

MW4-1 Proposed Monitoring Well and Groundwater Sampling Locations

BO4-1 Proposed Soil Sampling Location (Samples will be collected at depths 1.5-3 ft. and 3.5-5 ft.*)

SW4-1 Proposed Surface Water Sampling Location

*NOTE: Soil samples for chemical analysis will also be collected at these depths in the borings for wells MW4-2, MW4-3, and MW4-4.
Soil samples collected at these locations will be designated by the codes WB4-2, WB4-3, and WB4-4.

FIGURE 2-2
PROPOSED MONITORING WELL AND SAMPLING LOCATIONS
FIRE FIGHTING TRAINING AREA
(SITE 4)

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Well MW4-2 is located opposite the former drum storage area. Well MW4-3 is located opposite the lagoons. Well MW4-4 is located adjacent to the lagoons and opposite one end of the collector ditch/separator. All of these wells are currently presumed to be downgradient of their respective areas of concern. However, infiltration from the unlined lagoons and/or collector ditch could cause mounding on the water table and alter the hydraulic gradient.

The monitoring well network includes one additional well over the IAS recommendations. The proposed network also shifts the locations recommended in the IAS. These changes are proposed to provide better coverage downgradient of areas of concern, to provide additional data that can serve as a basis for distinguishing the effects of this area on groundwater from those that result from potential leachate from the Golf Course Landfill, and to provide a better basis for defining the hydraulic gradient in this area, including any effects of mounding on the water table. To ensure the most cost-effective approach to monitoring groundwater in these areas, well locations for the FFTA were selected in conjunction with those for the Golf Course Landfill due to the proximity of these sites.

All groundwater monitoring wells will be constructed of 4-inch-diameter Schedule 5 stainless-steel casing and screen, and will be designed to accommodate both water level measurements and groundwater sample collection. Based on available geologic information, it is currently believed that wells will be installed to a maximum depth of 20 feet in glacial deposits. Wells will be constructed using a 10-foot screen, located to straddle the mean high water table. This configuration will be necessary for effective sampling of constituents such as fuel oils that tend to migrate near the top of the water table. Final well depths may have to be adjusted in the field to achieve this objective. In addition, well depths shallower than 15 feet will require a shorter screen (5 feet) to ensure proper installation.

2.2.3 Exchange Service Station

Several shallow groundwater monitoring wells are planned around the Exchange Service Station. Due to a pipeline leak, a large volume of gasoline entered the subsurface and considerable material may still be present beneath this area. Monitoring wells may be used to measure the thickness of free product on the water table (if any), to collect groundwater samples for chemical analysis of

free product and dissolved fuel concentrations, and to allow measurement of water table elevations for the purpose of defining the hydraulic gradient.

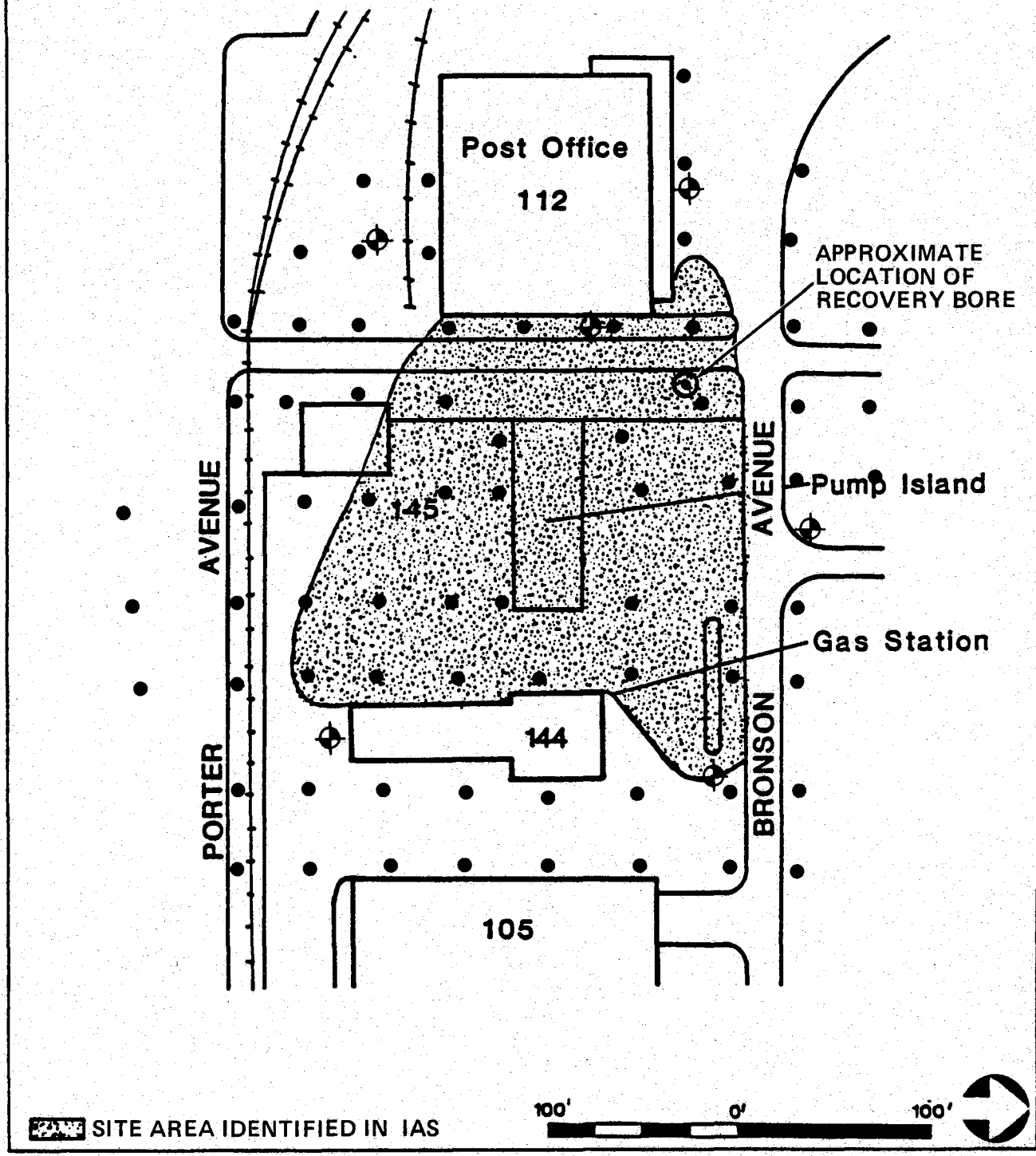
The example well locations shown in Figure 2-3 are for informational purposes only. These locations demonstrate how a well network may be configured based on the extent of contamination delineated in the IAS and on the documented contamination detected in the Post Office building. The actual number and location of monitoring wells needed in this area will be finalized based on the results of a soil gas survey (see Section 2.3.5.1).

Locations of high concentrations of gasoline-related volatile constituents or hot spots that are detected by soil gas testing will be the focus of subsurface monitoring efforts. Although soil gas concentrations do not directly indicate the absolute concentrations of contaminants in groundwater, past experience indicates that these data can reliably predict the relative concentration of volatile organic compounds contaminating a shallow environment. Therefore, based on the results of the proposed soil gas survey, monitoring wells can be more effectively located to confirm and define the extent of contamination.

All groundwater monitoring wells will be constructed of 4-inch-diameter Schedule 5 stainless-steel casing and screen, and will be designed to accommodate both water level measurements and groundwater sample collection. Based on available geologic information, it is currently believed that wells will be installed to a maximum depth of 15 feet in glacial deposits. Wells will be constructed using a 10-foot screen where possible. Well depths shallower than 15 feet will require a shorter screen (5 feet) to ensure proper installation. The screens will be located to straddle the mean high water table to allow effective sampling of gasoline, which tends to migrate near the top of the water table. Final well depths may have to be adjusted in the field to achieve this objective.

2.3 SAMPLING PROGRAM

The sampling program at the six sites at NTC Great Lakes will involve collection and analysis of soil, groundwater, and surface water samples for site-specific constituents of interest. Also, soil gas sampling will be conducted in the vicinity of the Exchange Service Station. No sediment samples are included during this part of the program because it is believed that a small number of these samples is of limited usefulness during this initial effort. In some cases, the



● Proposed Gas Sampling Location (NOTE: An additional 10 locations will be selected in the field.)

⊕ Example Monitoring Well and Groundwater Sampling Location (NOTE: Actual locations to be determined based on soil gas results. From each well boring, three soil samples will be collected for chemical analysis.)

FIGURE 2-3
TENTATIVE MONITORING WELL AND SAMPLING LOCATIONS
EXCHANGE SERVICE STATION (SITE 8)

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number of samples has been increased over that recommended in the IAS. In the sections that follow, the rationale for sampling locations and frequencies is described in detail for each of the six sites under consideration. These discussions will demonstrate why it is believed that additional samples are warranted and their value to the program objectives. All locations shown are tentative and may be subject to revision based on observations of field staff both prior to and during sampling.

Details of the sampling program at NTC Great Lakes are discussed below. Sample collection and associated QA procedures are discussed in Section 3.3.

2.3.1 Golf Course Landfill

Groundwater and surface water sampling is proposed in the vicinity of the landfill during this investigation, as discussed below.

2.3.1.1 Groundwater. Groundwater samples will be collected from the seven newly installed monitoring wells proposed for this area, as shown in Figure 2-1. As discussed in Section 2.2.1, it is planned that wells MW1-1 and MW1-8 will yield groundwater representative of background ambient water quality not affected by the landfill. Well MW4-1 at the FFTA will also serve as a background well for the landfill, and will therefore be monitored for all parameters of interest at both the landfill and the FFTA. Wells MW1-2 through MW1-7 and MW1-9 are intended to provide samples that will monitor for the presence of leachate.

As shown in Table 1-1, analytes for this set of samples include volatile and semivolatile organic compounds, priority pollutant metals, oil and grease, PCB's, chloride, and total organic carbon (TOC). All but the last two analytes were selected based on the need to scan for a broad range of unknowns, as well as reported waste composition (including, but not limited to, domestic refuse, sewage sludge, petroleum products, various solvents, fly ash, and PCB-contaminated wastes). The latter two analytes were selected as general indicators of the presence of leachate.

These samples will be collected a maximum of two times during the Verification Step program. All wells will be sampled in the first round. Results from analysis of the first-round samples will be used to plan a second round of sampling approximately 3 months after completion of the first round. If sample locations generally test negative (i.e., if contaminants are not detected) for

the analytes listed above during the first round, the wells will be subjected to second-round sampling and analysis. After two rounds of negative results, a location may be considered uncontaminated. Positive results (i.e., detected contaminants) will be treated as probable contamination, and associated sites may be recommended for further examination during a confirmation step.

2.3.1.2 Surface Water. Two surface water sampling locations are planned in this area, as shown on Figure 2-1. Sample SW1-1 is located at the outcrop of Skokie Ditch in the center of the Golf Course, where effluent from the Fire Fighting Training Area emerges through the culvert. This sample represents the head, or most upstream end of Skokie Ditch/River, and will reflect any influence from the FFTA. Sample SW1-2 is located downstream at the eastern edge of the Golf Course before Skokie Ditch/River crosses under the road. This sample would reflect the influence of any landfill-contaminated groundwater that may be discharging to the ditch and represent the quality of water in the ditch prior to its leaving the site.

The proposed analytes for this set of samples are the same as those for groundwater samples, as discussed in Section 2.3.1.1.

These surface water samples will also be collected a maximum of two times during the Verification Step based on the same criteria as for groundwater sampling, as discussed above in Section 2.3.1.1. Given the relatively low flow and shallow depth of Skokie Ditch, surface water here is expected to be frozen during winter months. Sampling will be scheduled to avoid these conditions if possible.

2.3.2 Fire Fighting Training Area

Groundwater, surface water, and shallow soil sampling from this area is proposed during the field investigation, as discussed below.

2.3.2.1 Groundwater. Groundwater samples will be collected from the four newly installed wells proposed for this area, as shown in Figure 2-2. As discussed in Section 2.2.2, it is planned that well MW4-1 will yield groundwater representative of the background, ambient water quality not affected by the training area. Wells MW4-2 through MW4-4 are intended to monitor for influence of surface runoff, infiltration of contaminants from the lagoons and the collector ditch, and migration of any contaminants from the former drum storage area, in a direction presumably downgradient of the training area.

As shown in Table 1-1, analytes for this set of samples include volatile and semivolatile organic compounds, oil and grease, and lead. These were selected based on materials reportedly used and stored at this site--including but not limited to POL's (including leaded gasoline) and various solvents.

As discussed in Section 2.3.1.1, a maximum of two rounds of sampling will be conducted.

2.3.2.2 Surface Water. Four surface water sampling locations are planned for this area, as shown in Figure 2-2. Sample SW4-1 is located in the surface runoff collector ditch upstream of the separator. This sample could provide information on the type and concentration of constituents contained in activity-generated surface runoff that could infiltrate to the subsurface environment via the unlined ditch. Sample SW4-2 is located in the ditch just after the separator. This sample would be representative of the materials skimmed by the separator that stand in that portion of the ditch. Samples SW4-3 and SW4-4 will be taken from the two lagoons and will provide an indication of the materials concentrated in the lagoons that may be infiltrating to the subsurface environment.

The analytes for this set of samples are the same as those for groundwater proposed in Section 2.3.2.1.

As discussed in Section 2.3.1.1, these samples will also be collected a maximum of two times during the Verification Step, based on the same criteria previously discussed.

2.3.2.3 Soil. Twelve soil sampling locations are planned for this area, as shown in Figure 2-2. It is planned to collect two composite soil samples from each location--one at near surface depths of 1.5 to 3 feet and one at shallow depths of 3.5 to 5 feet. This sampling scheme is designed to provide an indication of the contamination residual in soils due to surface spills and infiltration of contaminated surface runoff, as well as an indication of vertical migration of contaminants that have reached the subsurface environment.

The location for BO4-1 was selected to be representative of background, ambient soil conditions not affected by site activities. Locations for BO4-2 and BO4-3 were selected to serve as checks on infiltration of contaminated surface runoff through cracked and broken pavement. Locations for BO4-4 through BO4-9 were selected to sample areas of heavy surface contamination in the general

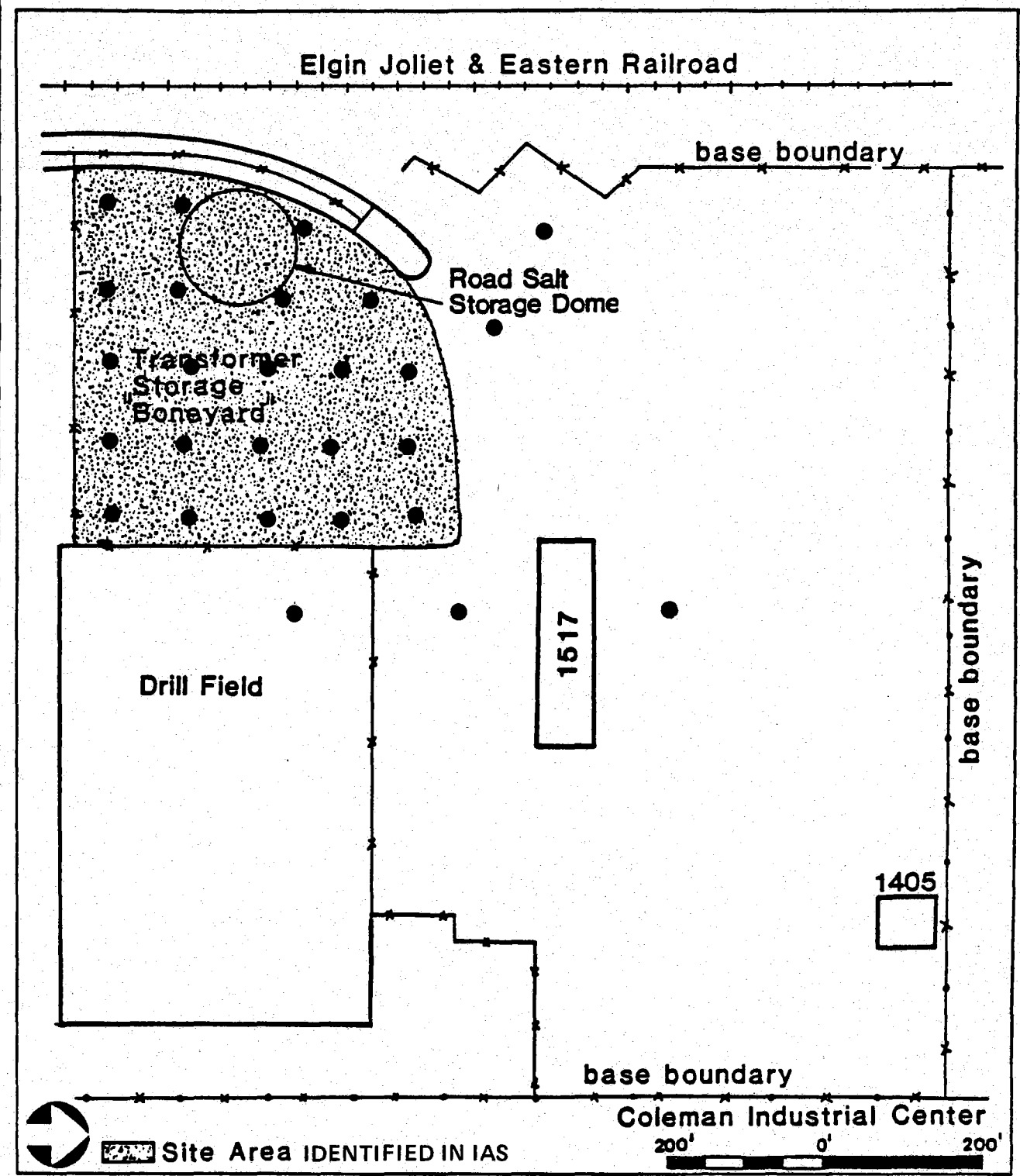
vicinity of the drum storage area and lagoons. In addition, three sets of samples from approximately the same depth intervals will be obtained from the boreholes drilled for wells MW4-2 through MW4-4, located around these same areas. These locations and depths provide minimum coverage of this site. Additional sampling and/or monitoring may be found necessary on the basis of the analytical results for these samples. The proposed analytes for these samples are the same as those listed for groundwater in Section 2.3.2.1.

These samples will be collected on a one-time basis to provide an overall view of soil conditions. Changes in the soil regime are expected to occur slowly over time; therefore, additional sampling at these locations during the period of the project may yield little additional information about site conditions.

2.3.3 Transformer Storage "Boneyard"

Based on the nature and behavior of the primary contaminant, PCB's, in this area (i.e., PCB's have relatively low mobility in soils) and the probable lack of concentrated contaminant source areas, it is believed that sampling of the shallow soil zones may be sufficient to give an indication of the horizontal and vertical extent of contamination. It is not believed that groundwater and surface water sampling is necessary during this limited initial investigation. No sediment sampling is required since no distinct drainageways, lined or unlined, were observed at this site. If results of the soil sampling effort indicate probable migration of contaminants to greater depths, groundwater sampling may become appropriate.

This plan is consistent with the IAS recommendation to take approximately 32 shallow soil samples from this site. Previous soil samples taken from this site contained between 50 to 100 ppm of PCB's. However, location and depth information for these samples does not appear to be available. Therefore, this sampling program is designed to provide coverage of the entire site area. Twenty-two proposed sampling locations (BO5-1 through BO5-22) are shown on Figure 2-4. Near surface samples will be collected from the approximate depth interval of 0.5 to 1 foot at each of these locations. In addition, five locations will be selected at the time of sampling for the collection of samples from a depth interval of 1.5 to 2 feet to provide data on vertical extent. These locations will be selected on the basis of accessibility, evidence of soil contamination, and other factors judged appropriate by the Dames & Moore field sampler.



● Proposed Soil Sampling Location (samples collected at 0.5-1 ft. depth)
(Site designations are BO5-1 through BO5-27.)

NOTE: Among the 27 sampling locations, five willbe selected in the field for deeper sampling, at a depth of 1.5-2 ft.

FIGURE 2-4
PROPOSED SOIL SAMPLING LOCATIONS
TRANSFORMER STORAGE "BONEYARD"
(SITE 5)

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An additional five samples outside the Boneyard (BO5-23 through BO5-27) have been selected to be sampled at 0.5 to 1 foot or other depths to be selected in the field. These locations were selected to coincide with other areas of possible transformer storage noted in aerial photographs. These samples provide a preliminary indication of conditions beyond the Boneyard itself.

As shown in Table 1-1, the analytes for these samples include PCB's, oil and grease, and lead. These were selected based on the composition of materials stored at this site, including PCB-containing transformer oils, other oils and lubricants, and lead-insulated cable.

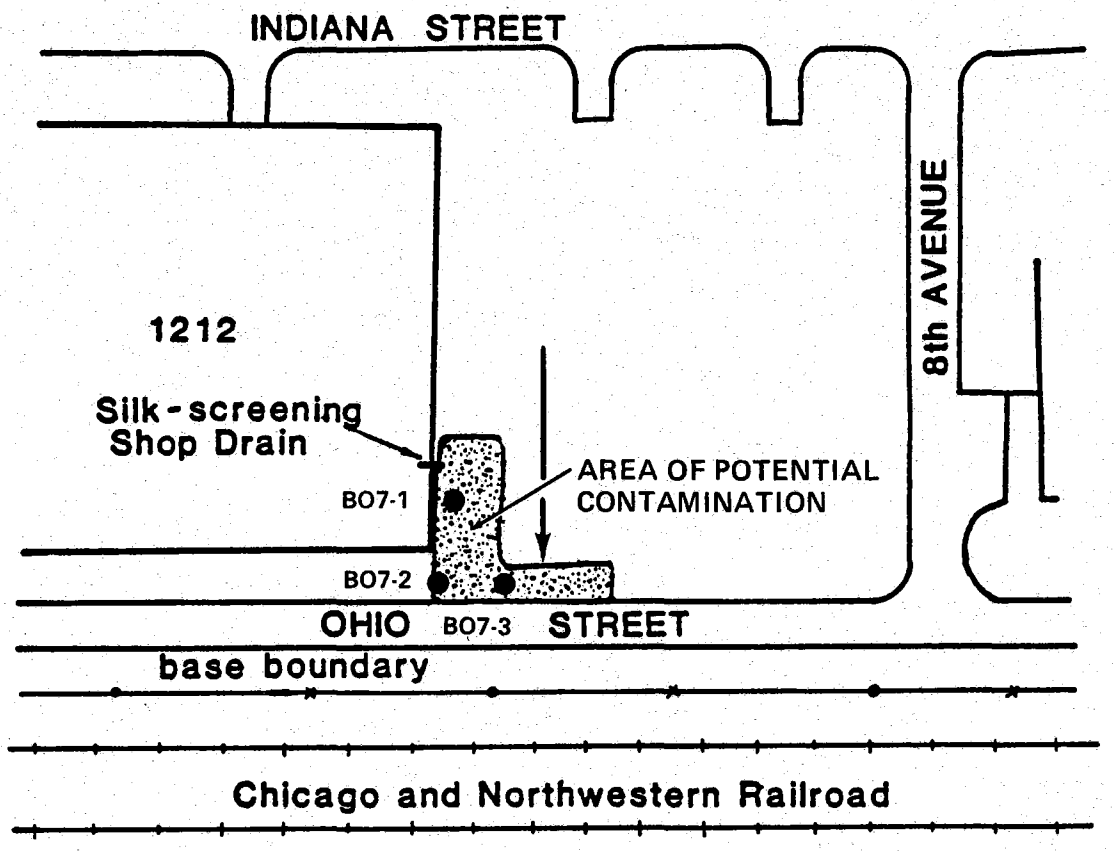
As discussed in Section 2.3.2.3, these soil samples will be collected on a one-time basis.

2.3.4 RTC Silk-Screening Shop

It is planned to sample only shallow soils at this site. Groundwater and surface water sampling are not being included at this time due to the small volume of contaminants discharged and the intermittent nature of the contaminant source, the greater depth to sandy aquifer materials at this location, and the lack of surface water. Groundwater samples may become appropriate if significant levels of contamination are detected in soils, or if results indicate that significant downward vertical migration is occurring in this area.

Based on the small size of the area potentially contaminated and the limited goals of this initial investigation, soil samples will be collected at three locations (BO7-1 through BO7-3), shown approximately on Figure 2-5, rather than five locations as recommended by the IAS. The three locations have been selected to provide information on the area between the shop drain and the street, where contaminated wash waters would have flowed. It is believed that sufficient coverage can be obtained by spacing sampling points approximately 50 feet apart in this area. Two samples will be collected at each location, at depth intervals of 0.5 to 1 foot and 1.5 to 2 feet. This program will provide an indication of the extent and shallow vertical distribution of constituents, if any, at this location. Additional locations and depths for sampling may be found necessary if these samples reveal significant contamination.

As shown in Table 1-1, the analytes for these samples are volatile organic compounds, silver, chromium (total), cadmium, and lead. These were selected



Site Area IDENTIFIED IN IAS

100' 0' 100'

BO7-1 ● Proposed Soil Sampling Location (samples collected at depths of 0.5-1 ft. and 1.5 to 2 ft.)

→ General Direction of Surface Drainage

FIGURE 2-5
PROPOSED SOIL SAMPLING LOCATIONS
RTC SILK-SCREENING SHOP (SITE 7)

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based on the types of materials that may have been disposed with wash water through the drain, including paints, inks, water and oil-based lacquers, enamels, mineral spirits, acetone, thinners, and photographic emulsions.

As discussed in Section 2.3.2.3, these soil samples will be collected on a one-time basis.

2.3.5 Exchange Service Station

Due to the nature of contamination at this site, a phased subsurface investigation is proposed. Initially, it is proposed to use soil gas sampling and analysis to locate possible concentrations of gasoline constituents in site soils that warrant further investigation and monitoring. This would be followed by drilling of boreholes for soil sampling and monitoring well installation (see Section 2.2.3) to confirm the extent of contamination and to provide data that may be useful for planning remedial actions.

2.3.5.1 Soil Gas. As discussed in Section 2.2.3, results of soil gas sampling can be correlated to concentrations of volatile organic compounds in the subsurface. Therefore, this technique provides a cost-effective means of screening a large area in detail over a short period of time. At this site, it may be used to define the limits of the area or areas where residual gasoline is present in the soils and groundwater, and on the water table.

Soil gas samples are planned at approximately 82 stations at this site. This would cover an area approximately 400 feet by 400 feet centered on the station pump island, using a 50-foot grid, as shown in Figure 2-3. Seventy-two locations are shown, with ten sampling locations held in reserve. The latter will be located in the field based on analytical results. All locations are tentative and may be modified in the field. Although there has been a preliminary identification of the subsurface location of the utilities at this site from installation maps provided by NEESA, the assistance of NTC Great Lakes personnel in confirming these locations prior to the start of sampling and subsequent well drilling may be required. The presence of numerous utilities may preclude sampling in some of the areas proposed.

The technique to be employed for collecting soil gas samples is presented in Section 3.3.1.1. The samples will be analyzed onsite for fuel components, as discussed in Section 2.4.1. In most cases, results will be available on the same day

as sample collection, allowing the use of real time data to map zones of contamination and to modify sampling locations as work progresses. Based on the ability to obtain real time data using this technique, it is anticipated that soil gas sampling will be required only one time at this site.

2.3.5.2 Soil. It is proposed that soil samples for chemical analysis, in addition to or in conjunction with samples for visual examination, be collected from boreholes drilled for the installation of monitoring wells. This will allow examination of the degree of contamination in the unsaturated zone and its vertical distribution.

The final number and locations of boreholes/wells will be based on the results of soil gas sampling and analysis, and any additional information on the site that may become available. Approximately three soil samples are planned for chemical analysis from each borehole--one in the first 5 feet in the unsaturated zone, one at an intermediate depth just above the water table, and one at a greater depth in the more permeable, sandy zone. As shown in Table 1-1, the analytes for these samples are volatile organic compounds and lead, based on gasoline as the primary contaminant.

These soil samples will be collected on a one-time basis. The need for additional samples may be determined at the time of drilling and sampling, based on conditions encountered at the site.

2.3.5.3 Groundwater. Groundwater sampling is planned from all new wells installed at this site. As discussed in Section 2.2.3, the final number and location of wells will be based on the results of soil gas sampling and analysis. Well locations will be selected to provide samples from areas of concentrated contamination, to define the maximum extent of contamination, and to provide information on the hydraulic gradient at the site. Water level measurements and measurements of free product thickness in the wells will be made at the time of sample collection. The analytical parameters are the same as those for soil samples, as discussed in Section 2.3.5.2.

As discussed above, it is planned to measure the free-product thickness in each monitoring well installed at the service station area to derive a rough estimate of how much gasoline remains in the subsurface at this site. These measurements will be accomplished using a weighted steel measuring tape and hydrocarbon-sensitive paste. The paste reacts with hydrocarbons to produce a

color change. The tape will be coated on both sides with the paste and lowered into the well. Caution must be exercised in minimizing contact of the tape with sections of well casing that may be coated with a film of fuel. After the weight reaches the water/hydrocarbon interface, the tape will be retrieved. The length of tape where a color change has occurred provides an indication of the thickness of the free-product zone in that well.

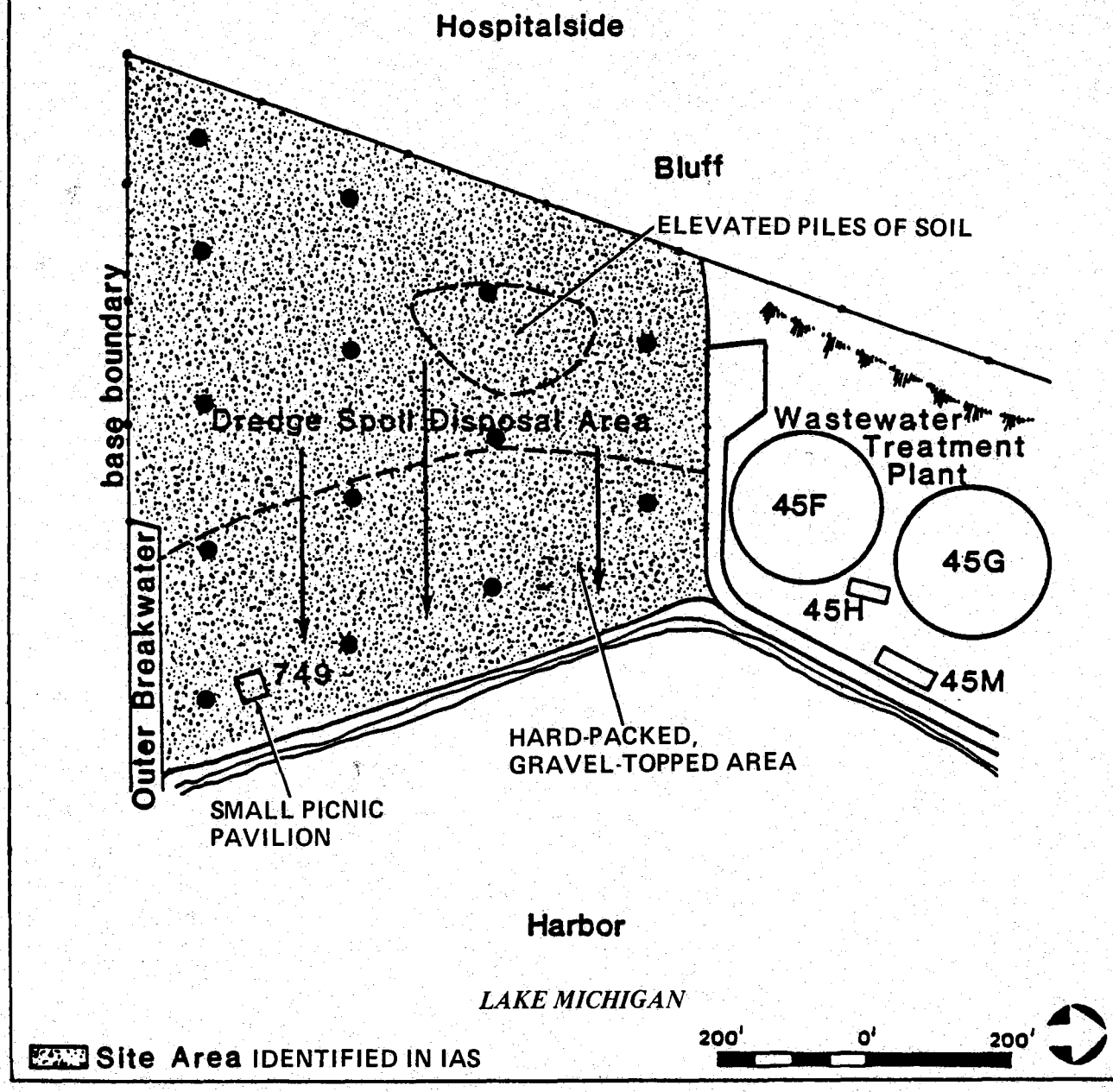
The above method may have limited accuracy when the free-product layer in a well is very thin (i.e., less than approximately 0.1 foot). In addition, well hydraulics and the physics of gasoline movement in soils may cause a greater or lesser thickness of free product to accumulate in the well than is actually found on the water table. Therefore, these data must be carefully evaluated and used with caution.

As discussed in Section 2.3.1.1, these samples will be collected a maximum of two times during the Verification Step, though this recommendation may be changed based on a further understanding of site conditions at the Exchange Service Station.

2.3.6 Harbor Dredge Spoil Area

Sampling and analysis of soils and sludge materials will be used to characterize the presence (or absence) and chemical composition of dredge spoils. Surface water and groundwater sampling does not appear to be warranted until the presence of dredge spoils has been confirmed and their chemical nature is better understood. As discussed in Section 1.3.2.6, there appears to be some uncertainty as to the exact location of dredge spoils from the two operations in 1952 and 1970. Review of aerial photography taken at intervals from 1946 to 1985 indicates that there is only a small likelihood that dredge spoils from operations conducted in 1952 or 1970 are located at this site. It is, therefore, strongly recommended that NTC Great Lakes and NEESA personnel assist in determining the exact location or locations of the dredge spoils prior to the start of soil sampling. If the presently designated location is to be studied, the following program will be implemented.

Fourteen soil sampling locations are planned for this area, as shown in Figure 2-6. Three composite soil samples are planned to be collected from each location--one at near surface depths of 0.5 to 2 feet, one at shallow depths of 3.5 to 5 feet, and one at greater depths of approximately 6.5 to 8 feet. This sampling scheme



● Proposed Soil/Sludge Sampling Location (samples collected at depths of 0.5-2, 3.5-5, and 6.5-8 ft.) ,BO12-1 through BO12-14

→ Assumed General Direction of Surface Drainage

FIGURE 2-6
PROPOSED SOIL/SLUDGE SAMPLING LOCATIONS
HARBOR DREDGE SPOIL AREA
(SITE 12)

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includes four additional locations over the IAS recommendation and is designed to provide complete coverage of the site, both horizontally and vertically.

As shown in Table 1-1, the analytes for these samples are volatile organic compounds, priority pollutants metals, pesticides, and PCB's. These were selected based on the types of constituents that could be contributed to harbor sediments by activities upgradient of the installation, including various organic solvents, heavy metals, oils, pesticides, and PCB's.

As discussed in Section 2.3.2.3, these soil samples will be collected on a one-time basis.

2.4 CHEMICAL ANALYSIS PROGRAM

As part of the RI program discussed above, field chemical analyses of soil gas will be conducted in the vicinity of the Exchange Service Station, and laboratory chemical analyses of groundwater, surface water, soils, and/or sludges will be conducted for environmental samples collected at the six study sites. The approaches to these field and laboratory analyses are outlined below.

2.4.1 Soil Gas Testing

The rationale and field approach for soil gas sampling at the Exchange Service Station are discussed in Section 2.3.5.1. Chemical analysis of soil gas samples will be conducted by testing for compounds indicative of fuel products (e.g., benzene, toluene, xylenes, ethylbenzene) using a portable, field gas chromatograph equipped with a photoionization detector (PID).

At this stage of the Verification Step, a soil gas testing contractor has not yet been selected. When developing the cost proposal for Verification Step work performance, a subcontractor will be selected and this firm's QA/QC plan will be submitted for review/approval.

2.4.2 Laboratory Analysis

The laboratory chemical analysis plan for this project involves integration of analytical criteria, selection of appropriate and acceptable analytical methods, coordination of field and laboratory activities, and analysis of samples in accordance with appropriate QA/QC procedures. The first three issues are discussed later in this section. The Laboratory Work Plan is provided as Appendix B. QA/QC procedures for sample analyses are presented in Appendix C.

2.4.2.1 Chemical Analysis of Environmental Samples. This section discusses the laboratory chemical analysis methods to be employed in this investigation. The analytical parameters for each study site have been selected based on potential contaminants expected to be associated with known or suspected activities or occurrences at each site. The specific parameters selected and the rationale for selection in each case are discussed in association with the sampling program for each site (see Section 2.3). Chemical analyses for this project will be performed by metaTRACE, Inc., Earth City, Missouri, under subcontract to Dames & Moore.

Information pertinent to the analytical methods for this investigation is summarized in Table 2-1. For each analytical parameter and sample matrix (i.e., water, soil/sludge), the table shows the analytical technique, EPA Method number, and analytical method detection limit. (Detection limits for volatile organic compounds (VOC) and base-neutral and acid extractable organic compounds (BNA)/pesticides/PCB's by gas chromatography/mass spectrometry (GC/MS) are presented in Tables 2-2 and 2-3, respectively. Detection limits for pesticides and PCB's by gas chromatography (GC) are provided in Table 2-4.)

The analysis of metals will be performed using inductively coupled plasma (ICP) atomic emission spectroscopy, with the following exceptions--arsenic, selenium, and thallium will be determined using graphite furnace atomic absorption (AA) spectroscopy, and mercury will be determined using cold vapor AA. For cadmium, lead, and nickel analyses, AA methods will be used for samples in which the metal cannot be detected by ICP at a level at least two times the ICP detection limit (see Table 2-1).

The analysis of volatile organics and semivolatile organics (BNA's, pesticides, and PCB's) will employ GC/MS screening techniques. Priority pollutants (excluding pesticides/PCB's) will be identified and quantified. In addition, pesticides, PCB's, and unknown responses in the mass chromatogram that account for greater than 10 percent of the concentration of the nearest internal standard will be library searched to attempt identification and quantification.

Where lower detection limits than those obtainable by GC/MS are desired for pesticides or PCB's--i.e., in cases where such compounds are believed to be present--pesticides or PCB's will be determined by GC with an electron capture detector (ECD). A florisil cleanup procedure is conducted to eliminate

TABLE 2-1

Information on Chemical Analysis Methods
RI, Verification Step, at NTC Great Lakes

Analytical Parameter	Analytical Technique	Water		Soil/Sludge	
		EPA Method No.[a]	Detection Limit (ug/l)	EPA Method No.[b]	Detection Limit (ug/g)
Priority pollutant metals:					
Antimony	ICP	200.7	10	6010	1
Arsenic	Graphite Furnace AA	206.2	60	7060	6
Beryllium	ICP	200.7	5	6010	0.5
Cadmium	ICP/Graphite Furnace AA[c]	200.7/213.2	5	6010/7131	0.5
Chromium (total)	ICP	200.7	10	6010	1
Copper	ICP	200.7	25	6010	2.5
Lead	ICP/Graphite Furnace AA[c]	200.7/239.2	5	6010/7421	0.5
Mercury	Cold Vapor AA	245.1	0.2	7471	0.1
Nickel	ICP/AA[c,d]	200.7/249.2	15	6010/7520	1.5
Selenium	Graphite Furnace AA	270.2	5	7740	0.5
Silver	ICP	200.7	10	6010	1
Thallium	Graphite Furnace AA	279.2	10	7841	1
Zinc	ICP	200.7	20	6010	2
Volatile organic compounds	GC/MS[e]	624	(f)	8240	(f)
Semivolatile organic compounds (BNA's/pesticides/PCB's)	GC/MS[e]	625	(g)	8250	(g)
Pesticides/PCB's[h]	GC/ECD	608[i]	(j)	8080	(j)
Total organic carbon	Combustion/Oxidation	415.1	1,000	NA[k]	--
Oil and grease	Spectrophotometric, IR	413.2	1,000	413.2[l]	100
Chloride	IC	300.0	20	300.0[l]	1.25

TABLE 2-1 (cont'd)

[a]EPA methods for water analyses are described in the following references:

EPA Method No. Series	Reference
200 through 400	USEPA, March 1979. Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983.
600	USEPA, July 1982. Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA-600/4-82-057.

[b]EPA methods for analysis of solid matrix samples are described in USEPA, November 1986. Test Methods for Evaluating Solid Waste, SW-846, Third Edition.

[c]The AA method will be used if the metal cannot be detected by ICP at a level at least two times the ICP detection limit. The detection limit shown is for the AA method.

[d]Graphite furnace AA for water samples; direct aspiration AA for soil/sludge samples.

[e]Includes library search to detect nonpriority pollutant compounds.

[f]See Table 2-2.

[g]See Table 2-3.

[h]Where lower detection limits are desired for pesticides or PCB's, in cases where compounds of this type are believed to be present or of concern, GC/ECD will be employed rather than GC/MS.

[i]In the RI program described herein, no water samples are scheduled for pesticide analysis by GC/ECD.

[j]See Table 2-4.

[k]NA = not applicable.

[l]See note "a." Modified method will be used for solid matrix analyses.

TABLE 2-2

Detection Limits for Volatile Organic Compounds by GC/MS

Compound Name	Water Detection Limits[a] EPA 624 (ug/l)	Soil Detection Limits[a] EPA 8240 (ug/g)
Chloromethane	10	0.010
Bromomethane	10	0.010
Vinyl chloride	10	0.010
Chloroethane	10	0.010
Methylene chloride	5	0.005
1,1-Dichloroethene	5	0.005
1,1-Dichloroethane	5	0.005
1,2-Dichloroethene (total)	5	0.005
Chloroform	5	0.005
1,2-Dichloroethane	5	0.005
1,1,1-Trichloroethane	5	0.005
Carbon tetrachloride	5	0.005
Bromodichloromethane	5	0.005
1,2-Dichloropropane	5	0.005
cis-1,3-Dichloropropene	5	0.005
Trichloroethene	5	0.005
Dibromochloromethane	5	0.005
1,1,2-Trichloroethane	5	0.005
Benzene	5	0.005
trans-1,3-Dichloropropene	5	0.005
Bromoform	5	0.005
Tetrachloroethene	5	0.005
1,1,2,2-Tetrachloroethane	5	0.005
Toluene	5	0.005
Chlorobenzene	5	0.005
Ethylbenzene	5	0.005

[a]Unknown responses in the mass chromatogram that account for greater than 10 percent of the concentration of the nearest internal standard will be library searched to attempt identification and quantification.

TABLE 2-3

Detection Limits for Semivolatile Organic Compounds by GC/MS

Compound Name	Water Detection Limits EPA 625 (ug/l)	Soil Detection Limits EPA 8250 (ug/g)
Base-Neutrals		
Acenaphthene	10	0.33
Benzidine	50	1.6
1,2,4-Trichlorobenzene	10	0.33
Hexachlorobenzene	10	0.33
Hexachloroethane	10	0.33
Bis (2-chloroethyl) ether	10	0.33
2-Chloronaphthalene	10	0.33
1,2-Dichlorobenzene	10	0.33
1,3-Dichlorobenzene	10	0.33
1,4-Dichlorobenzene	10	0.33
3,3-Dichlorobenzidine	20	0.66
2,4-Dinitrotoluene	10	0.33
2,6-Dinitrotoluene	10	0.33
1,2-Diphenylhydrazine	10	0.33
Fluoranthene	10	0.33
4-Chlorophenyl phenyl ether	10	0.33
4-Bromophenyl phenyl ether	10	0.33
Bis (2-chloroisopropyl) ether	10	0.33
Hexachlorobutadiene	10	0.33
Hexachlorocyclopentadiene	10	0.33
Isophorone	10	0.33
Naphthalene	10	0.33
Nitrobenzene	10	0.33
N-Nitroso-di-n-methylamine	10	0.33
N-Nitroso-di-n-propylamine	10	0.33
Butyl benzyl phthalate	10	0.33
Di-n-butyl phthalate	10	0.33
Di-n-octyl phthalate	10	0.33
Diethyl phthalate	10	0.33
Dimethyl phthalate	10	0.33
Bis (2-chloroethoxy) methane	10	0.33
Benzo (a) anthracene	10	0.33
Benzo (b) fluoranthene	10	0.33
Chrysene	10	0.33
Acenaphthylene	10	0.33
Anthracene	10	0.33
Benzo (g,h,i) perylene	10	0.33
Fluorene	10	0.33
Phenanthrene	10	0.33
Dibenzo (a,h) anthracene	10	0.33

TABLE 2-3 (cont'd)

Compound Name	Water Detection Limits EPA 625 (ug/l)	Soil Detection Limits EPA 8250 (ug/g)
Base-Neutrals (cont'd)		
Indeno (1,2,3-cd) pyrene	10	0.33
Pyrene	10	0.33
Bis (2-ethylhexyl) phthalate	10	0.33
Benzo (a) pyrene	10	0.33
Acid Extractables		
2,4,6-Trichlorophenol	10	0.33
2-Chlorophenol	10	0.33
2-Nitrophenol	50	1.6
4-Nitrophenol	50	1.6
2,4-Dinitrophenol	50	1.6
2,4-Dichlorophenol	10	0.33
Pentachlorophenol	50	1.6
2,4-Dimethylphenol	10	0.33
Phenol	10	0.33
4-Chloro-3-methyl phenol	10	0.33
4,6-Dinitro-2-methyl phenol	50	1.6
Pesticides/PCB's and Library-Searched Compounds	(a)	(a)

[a]Pesticides, PCB's, and unknown responses in the mass chromatogram that account for greater than 10 percent of the concentration of the nearest internal standard will be library searched to attempt identification and quantification.

TABLE 2-4

Detection Limits for Pesticides and PCB's by GC/ECD

Compound Name	Water Detection Limits EPA 608 (ug/l)	Soil Detection Limits EPA 8080 (ug/g)
Pesticides		
alpha-BHC	0.003	0.008
beta-BHC	0.003	0.008
delta-BHC	0.009	0.008
gamma-BHC (Lindane)	0.003	0.008
Heptachlor	0.003	0.008
Aldrin	0.004	0.008
Heptachlor epoxide	0.083	0.008
Endosulfan I	0.014	0.008
Dieldrin	0.002	0.016
4,4-DDE	0.004	0.016
Endrin	0.006	0.016
Endosulfan II	0.004	0.016
4,4-DDD	0.011	0.016
4,4-DDT	0.012	0.016
Endrin aldehyde	0.023	0.016
Endosulfan sulfate	0.066	0.016
Chlordane	0.014	0.008
Toxaphene	0.24	0.008
PCB's		
PCB-1016	0.065	0.08
PCB-1221	0.065	0.08
PCB-1232	0.065	0.08
PCB-1242	0.065	0.08
PCB-1248	0.065	0.08
PCB-1254	0.12	0.16
PCB-1260	0.12	0.16

interferences. In the RI program specified herein, such analyses are proposed to be conducted for pesticides in sludges at the Harbor Dredge Spoil Area, and for PCB's in samples collected at the Golf Course Landfill, Transformer Storage "Boneyard," and Harbor Dredge Spoil Area.

TOC will be determined in water samples by combustion/oxidation (EPA Method 415.1). Oil and grease will be analyzed using the infrared (IR) spectrophotometric method (EPA Method 413.2). This method allows for recovery of both heavy and light oil fractions. Chloride will be analyzed using ion chromatography (IC), EPA Method 300.0.

For chemical analyses conducted under this investigation, the maximum analytical lot size will be 20 samples. This is the actual number of field samples analyzed. The lot size including laboratory QC samples is larger (see Appendix C). The turnaround time for analytes will be 4 to 6 weeks from sample receipt by the laboratory.

2.4.2.2 Coordination of Field and Laboratory Activities. Dames & Moore will conduct the field sampling program in close coordination with the laboratory. The following issues illustrate the extent of this coordination and its importance to the project:

- Sampling schedules will be developed by Dames & Moore and submitted to the laboratory for review/approval to ensure that the samples will be collected and processed in a manner such that lot sizes are maximized and samples are analyzed within required holding times.
- Information regarding shipping forms (e.g., chain-of-custody documents) and sample labeling will be discussed and finalized (see Section 3.3.4 and Appendix C). This will aid in the orderly transfer of field information to the laboratory and proper laboratory personnel, and ensure that each sample receives the specified analysis.
- Shipping arrangements will be determined and agreed to in advance. For this project, Dames & Moore will ship samples to the lab by overnight courier on the day of collection, where feasible. Sample delivery/receipt times will be prearranged. Any required late or weekend deliveries will be carefully coordinated.

- Sample containerization and preservation requirements and sampling equipment decontamination procedures will be specified (see Section 3.3).
- A Dames & Moore field coordinator and laboratory project manager will be designated to serve as points of communication.

The point regarding sampling schedules bears further discussion. In Dames & Moore's experience with field data collection efforts, it has been recognized that maximum sample collection rates in the field are frequently the rate-limiting step for achieving analytical lot sizes. Exceeding the rate-limiting step will result in sample backlog (though with a maximum analytical lot size of 20 for analyses in the project, such a backlog is highly unlikely). A backlog is highly undesirable since it means that samples, which may have a limited shelf life, must be stored before being analyzed. Conversely, if the sampling rate is so low that the maximum lot size cannot be achieved by holding samples until enough are received without violating the holding times, the actual lot size will have to be adjusted downward, possibly resulting in increased analytical costs. Therefore, Dames & Moore has developed a sample collection scheduling procedure designed to ensure that specified holding times are met while maximizing analytical lot sizes for the most cost-effective analysis.

Upon approval of this work plan and before implementation of sampling, Dames & Moore will categorize the samples to be collected by required analysis and matrix type. A schedule will be drafted specifying dates of sample collection versus anticipated maximum number of samples to be collected, sample location identification with sample type, and analyses requested. This schedule will be reviewed for compliance with holding times and desired lot sizes provided by the analytical laboratory and adjustments made as necessary to meet these requirements. The schedule will be submitted to the laboratory for review and approval. It will then be distributed to all sampling personnel to effect coordination of the sample collection effort with laboratory scheduling. This schedule also acts as a check on sample shipments so that the laboratory can be alert for shipments not arriving as scheduled. Any deviations from the anticipated schedule are coordinated in a timely fashion between field and laboratory personnel.

2.5 KEY PERSONNEL INVOLVED IN FIELD SAMPLING AND DATA COLLECTION

The Lead Hydrogeologist will oversee the monitoring well installation and field sampling/data collection efforts conducted by onsite field personnel. He/she will also serve as the overall field QA supervisor/coordinator. In the latter role, the Lead Hydrogeologist will make an unannounced visit to the field during sampling to ensure that sampling is conducted in a manner consistent with the QA procedures established for this investigation.

One Dames & Moore staff member will be present in the field to supervise drilling/soil boring operations; soil gas sampling/analysis activities; and collection, packaging, and shipment of environmental samples. During field sampling, this staff member will be assisted by a field technician.

The Lead Hydrogeologist and field staff members will be identified shortly before fieldwork is to begin. Their resumes will be submitted to ORNL and the Navy for approval prior to project implementation.

2.6 DATA EVALUATION/INTERPRETATION AND VERIFICATION STEP REPORTS

Data obtained during the RI Verification Step will be evaluated to determine the presence of contaminants at sampled locations, the generalized extent of contamination, and the characteristics of subsurface materials that will influence contaminant movement and affect possible remedial alternatives. Data will be examined on a site-specific basis, as well as an installation-wide basis, to obtain a better understanding of the general conditions that influence the fate of contaminants. In preparation for the presentation of assessment results, a site base map of appropriate scale will be prepared to display topography, all sampling points, and locations of suspected contaminant sources.

Data on subsurface geology will be compiled from logs of boreholes* and observations made during field sampling to produce descriptions and cross-sections, where appropriate. These will allow for the general determination of the areal and vertical distribution of geologic formations, as well as the estimation of formation properties such as hydraulic conductivity.

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*An example of Dames & Moore's boring log form is shown in Figure 3-1, Section 3.2.1.

Water level measurements from sites with monitoring wells will be compiled and groundwater elevations mapped in the plan view as well as on cross-sections, where possible, to refine the estimate of site-specific hydraulic gradients. These gradients will be used to estimate groundwater flow velocity and, coupled with contaminant distribution, to assess potential contaminant migration pathways. Field investigation data will be supplemented with data from available literature on hydrologic characteristics.

Dames & Moore's standard presentation of boring logs with well diagrams on one figure consolidates much of the relevant information for a particular boring that must be compared during the data evaluation to better define site hydrogeology. More specifically, all surveyed elevations relevant to a particular location (e.g., ground surface, top of casing, etc.) will be noted on the boring log/well diagram. Dames & Moore uses a consistent set of symbols to represent major geologic units encountered in the boring and juxtaposes those with a written description of lithologies. The screened interval and a static water level from a round of contiguous water level measurements in all wells will be indicated on the well diagram. By placing this diagram on the same scale and opposite the boring log, comparisons can be made among lithologies, location of water bearing zones, and location of water intake into the casing. This facilitates data evaluation and assessment.

Analytical results will be tabulated and also displayed in graphical form, as appropriate. Analytical results for groundwater and surface water will be reviewed for positive detections of the analytes of interest at each site. Positive detections from the first or second round of groundwater/surface water sampling and from the single round of soil sampling may be considered indicative of contamination. The corresponding sampling locations will be examined for correlation to known contaminant sources. Negative detections from sampling may be treated as currently uncontaminated media, unless other information indicates otherwise. Contaminant concentrations may be plotted on maps and cross-sections to indicate their areal and vertical distribution. Contaminant concentrations will be compared to applicable regulatory standards and action levels, with all exceedances identified. A preliminary list of drinking water standards/guidelines for suspected contaminants at NTC Great Lakes, to which comparison with analytical results will be made, is provided in Appendix D. Also, the results for method, trip, and field

blanks will be examined to identify contaminants and their respective concentrations that may have been introduced by field or laboratory procedures. These results will be taken into account when evaluating the significance of constituents detected in environmental samples (i.e., constituent detection in blanks may not be indicative of actual contamination).

At the Exchange Service Station, data on hydrogeologic characteristics and analytical results will be used to examine the degree of residual gasoline contamination in the unsaturated and capillary soil zones, the thickness of free product (if any) on the water table in each borehole (if this thickness is measureable), and the concentrations of dissolved constituents in groundwater. This information will be displayed on site cross-sections, as appropriate.

The assessment of investigation results will include a preliminary, site-specific evaluation of potential public health impacts based on identification of contaminants present at these sites, concentrations found, comparison with regulatory standards/guidelines and action levels (where available), qualitative data from general literature sources on the relative toxicities of detected contaminants (e.g., Sax, N.I., 1984. Dangerous Properties of Industrial Chemicals, Van Nostrand Reinhold Company, Sixth Edition), physical characteristics, behavior in soils, migration potential and possible migration pathways, and other characteristics relevant to their fate. Information on physical characteristics and behavior will be used in conjunction with information developed on the hydrogeologic characteristics of the site and installation to evaluate the potential fate of contaminants. An additional determination of whether critical habitats or food sources of endangered or threatened species are subject to contamination will be based on Federal and State identification of these species. The location of identified habitats and food sources relative to contaminant sources and potential movement and fate will be examined.

Based on the findings resulting from the RI Verification Step program detailed in this work plan, Dames & Moore will recommend for each site one of three options: (1) no further action is required, (2) proceed to the Navy IR Program Feasibility Step, in which remedial alternatives would be evaluated, or (3) expand the site investigation and monitoring in the Characterization Step. If initial results indicate the need for additional investigation and monitoring, a Characterization Step Work Plan and cost estimate for those sites will be prepared.

A summary of the work performed, including documentation of any changes to the Work Plan due to unanticipated field conditions, an explanation for the rationale used in selecting sampling locations and analytical parameters, and conclusions reached during the investigation will be presented in the Verification Step First Draft Report. This report will present the results of data evaluation for each site, including descriptions, maps, cross-sections and other graphical displays. The main topics covered will be interpretation of surface and subsurface conditions, confirmation of disposal locations and contaminant sources, information on toxicity, regulatory standards, etc., and identification of any critical habitats or food sources of endangered or threatened species subject to contamination. All relevant raw data forms will be included as appendices to the report. The report will be prepared in a format in accordance with the U.S. Environmental Protection Agency's (EPA) guidance for RI reports.

The First Draft Report will be submitted for review. Comments and suggestions from ORNL and NEESA on the technical content, completeness, and adherence to regulatory and Navy policy will be addressed in preparation of the Verification Step Preliminary Draft Report. Comments on the Preliminary Draft Report will be received from ORNL, NEESA, NTC Great Lakes representatives, and regulatory agencies at the report review meeting. The Verification Step Final Draft Report, which addresses the comments received at the meeting, will then be submitted. After approval of the Final Draft Report, the Verification Step Final Report will be submitted.

3.0 FIELD PROCEDURES/EQUIPMENT/MATERIALS AND FIELDWORK QA PLAN

3.1 OVERVIEW

This section provides specific descriptions of the field procedures to be employed for groundwater monitoring well installation and associated activities; for collection of samples at the six study sites; and for verifying and maintaining performance quality for monitoring well installations, collection of environmental samples, and subsequent chemical analysis of the samples. The Laboratory QA Plan for chemical analysis is presented in Appendix C.

In this RI program, monitoring wells will be drilled and installed by a drilling subcontractor, under the supervision of a qualified Dames & Moore field staff member. Soil gas sampling/analysis, performed under subcontract to Dames & Moore, will also be supervised in the field by Dames & Moore. Samples of groundwater, surface water, soil, and sludge will be collected at NTC Great Lakes by Dames & Moore field personnel. As discussed in Section 2.5, the Lead Hydrogeologist will oversee all field efforts, and will also serve in the capacity of field QA supervisor/coordinator. In this latter role, he/she will be responsible for:

- Familiarizing field staff with the sampling program and established sample collection and QA protocols.
- Developing a sampling schedule that allows for maximizing lot sizes while maintaining compliance with maximum holding time requirements.
- Making one or more unannounced trips to the site, as appropriate, to inspect the sampling and ensure that sampling is conducted in a manner consistent with the QA program specified herein.

Chemical analysis of the samples will be performed under subcontract to Dames & Moore by metaTRACE, Inc., Earth City, Missouri.

Included in this section are descriptions of the following:

- Groundwater monitoring well drilling/installation/development procedures and approach to associated activities (e.g., borehole logging, water level measurements).
- Decontamination procedures to be employed during well drilling/installation.

- Sample collection and sampling equipment decontamination procedures.
- Sample containerization, preservation, and holding times.
- Sample chain-of-custody.
- Specifications for field QA/QC samples.
- Specifications for field data collection and data management.
- Approach to office data organization and management.
- Requirements for the disposal of wastes generated during the field investigation.

The sections that follow discuss field procedures and associated QA requirements for soil boring/monitoring well installation and water level measurements (Section 3.2), sample collection and management (Section 3.3), and disposal of wastes generated during the field investigation (Section 3.4).

3.2 SOIL BORING/MONITORING WELL INSTALLATION AND WATER LEVEL MEASUREMENTS

3.2.1 Drilling and Borehole Logging

Boreholes drilled in glacial till and sand for soil sampling and monitoring well installation at NTC Great Lakes will be drilled using the rotary-wash technique with potable water as the drilling fluid, whenever possible. The potable water source to be used for drilling will be supplied by NTC Great Lakes. Prior to the start of drilling, all equipment and well casing will be cleaned as described in Section 3.2.3.

Drilling will be supervised by qualified Dames & Moore field staff members, who will prepare detailed logs of each borehole. Logs will indicate field classification of soils, sampling depths, first encountered and static groundwater levels, progress of drilling, drilling fluid losses or gains, final completion depth, and the nature and resolution of any problems encountered. A sample of the boring log form used by Dames & Moore is shown in Figure 3-1.

During drilling operations, disturbed soil samples will be collected using a hammer-driven split spoon every 5 feet or when a major stratigraphic change is noted. If the collection of undisturbed soil samples is deemed desirable, a thin walled tube or similar sampler will be used. Samples will be retained and returned to the Dames & Moore soils laboratory for detailed examination.

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
	DRILLING METHOD:		BORING NO.
			SHEET OF
	SAMPLING METHOD:		DRILLING
			START TIME / FINISH TIME
	WATER LEVEL		
	TIME		
	DATE		DATE / DATE
DATUM	CASING DEPTH	ELEVATION	

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT. SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						0	

FIGURE 3-1
SAMPLE - STANDARD BORING LOG FORMAT

REMEDIAL INVESTIGATION
NAVAL TRAINING CENTER
Great Lakes, Illinois

3.2.2 Well Construction

Monitoring wells designed for the collection of samples for organic constituents will be constructed of 4-inch-diameter Schedule 5 stainless-steel casing and manufactured screen. This includes all wells currently planned for installation during the Verification Step. All casing and screen will be flush threaded. Screen and casing will be lowered into the borehole to within 5 feet of the bottom of the borehole. Clean, appropriately sized coarse sand will be placed in the annulus around the screen to approximately 2.5 feet above the top of the screen. A 2.5-foot bentonite seal will be placed in the annulus directly above the sand pack using bentonite pellets. The remainder of the annulus will be sealed with a neat bentonite-cement slurry. A 5-foot long protective steel casing with a locking cap will be installed around the well casing stickup. A sloped, raised cement pad will be installed at ground surface around the well to minimize ponding and infiltration of surface water. Proposed well construction is illustrated in Figure 3-2. All details of well construction will be noted on a well diagram and placed in the project files.

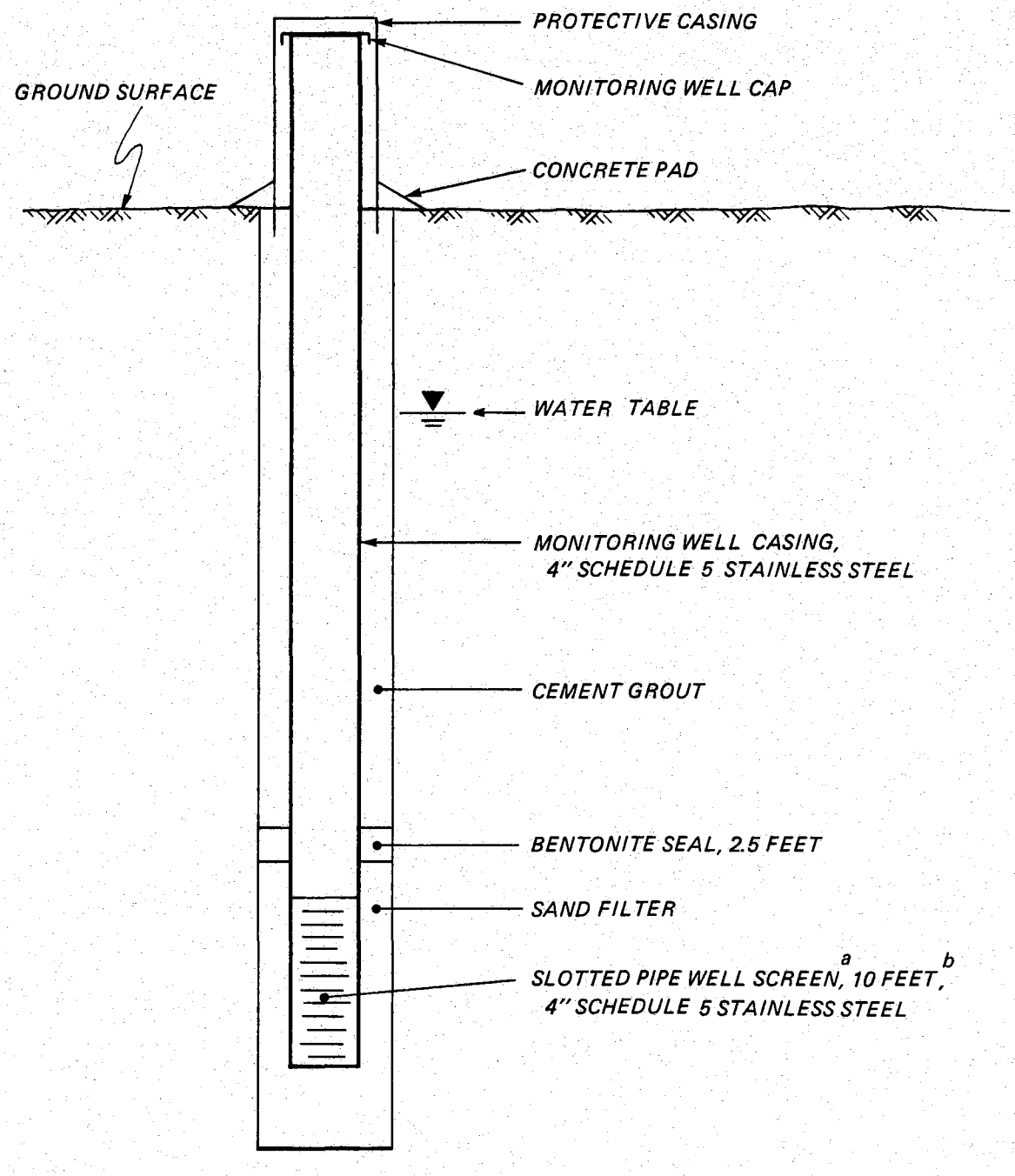
3.2.3 Decontamination Procedures

To minimize contamination of the subsurface environment resulting from drilling and other operations, all equipment will be decontaminated before use. The drill rig and all drilling tools will be steam cleaned using a high-pressure steam cleaner and potable water prior to the start of any drilling. In addition, all downhole tools, samplers, purging pumps, and other downhole equipment will be steam cleaned between boreholes to avoid carryover of contaminants. All casing and screen materials will be washed with potable water to remove all foreign matter prior to installation in the borehole. All cleaned materials will be placed on or wrapped in plastic sheeting during storage and transport to the site, so as to avoid contact with the ground or contaminated surfaces. The drilling rig and tools will also be decontaminated onsite prior to leaving the installation, to avoid transporting contaminants off the installation following completion of fieldwork.

3.2.4 Well Development

Proper well development functions to remove water, drilling muds, and other fluids or materials introduced into the aquifer as a result of borehole drilling operations. It also functions to reduce the amount of fine-grained sediment around

NOT TO SCALE



NOTES:

[a] Where POLS are of concern, the well screen will be placed so as to straddle the mean high water table.

[b] For shallow wells ($\leq$ 15 feet deep), short well screens ($\sim$5 feet) will be used.

FIGURE 3-2
TYPICAL CONSTRUCTION FOR WELLS USED TO MONITOR FOR ORGANIC CONSTITUENTS

REMEDIAL INVESTIGATION
NAVAL TRAINING CENTER
Great Lakes, Illinois

the gravel-packed portions of the annulus, which might otherwise clog the well screen, and to enhance porosity for free flow in the screened zone.

Well development techniques that could potentially contaminate or alter the chemistry of the water-producing zones will be avoided. Pumping, surging, or bailing are proposed for use as development methods. Air lift using compressed air has been found to be undesirable when dealing with groundwater that is potentially contaminated with hazardous constituents, unless water discharge from the well can be controlled and directed. Generally, pumping with a submersible pump will be used to develop wells. Surging may be recommended in place of or in addition to pumping. Shallow and/or low flow wells may be developed by bailing.

All well development equipment will be appropriately decontaminated prior to use and between wells, to minimize cross-contamination (see Section 3.3.1.2). Prior to development, the static water level will be measured and recorded. Development will endeavor to obtain water that is visually free of sediment. Field conductivity and pH measurements of development water samples may be made to track changes that indicate the complete removal of potentially contaminated water from the well. In the case of slow or no recharge, or excessive sediment, Dames & Moore may recommend an alternative approach.

3.2.5 Field Measurement of Temperature, pH, and Conductivity

Changes in the pH, conductivity, and temperature of groundwater/surface water can indicate changes in the condition of an aquifer/stream. Changes in pH, conductivity, and temperature of a water sample can affect the chemistry of the sample. Measurements of temperature, pH, and conductivity may be made in the field during development as described above in Section 3.2.4, and will be performed on aliquots of all water samples collected at the site to track changes in water quality and changes in samples after collection, respectively.

Measurements will be made using portable meters and EPA Methods 170.1 (temperature), 120.1 (pH), and 150.1 (conductivity). All instruments will be calibrated prior to the beginning of the project. pH and conductivity meters will continue to be calibrated in the field at the beginning and end of each day of use, using standard solutions. All probes will be decontaminated prior to each sample to minimize cross-contamination.

In general, the procedure for taking a field conductivity measurement will consist of measurement of the temperature of the water sample at the sampling

site; adjustment of the temperature to correct readings of conductivity at 25°C (unless the meter automatically measures and corrects for temperature); rinsing the conductivity probe in the water sample aliquot contained in a small plastic beaker; discard of the beaker contents and replacement with fresh aliquot; reading and recording temperature-corrected conductivity; and rinsing the conductivity probe with distilled water.

Field pH measurements will be made within 15 minutes after sampling to avoid changes in pH that occur during sample storage. The general measuring procedure will be as follows, with variations according to manufacturer's recommendations: measurement of calibration buffer solution temperature; adjustment of pH meter temperature compensation control to buffer temperature; adjustment of the meter to the buffer pH's using two buffer solutions that bracket the expected sample pH; adjustment or repair of the pH meter if the measured pH of either buffer differs from the buffer pH by more than 0.1 pH unit; measurement of the sample temperature, site temperature compensation, and reading sample pH; and rinsing the pH probe and storing in distilled water.

3.2.6 Surveying of Well Locations and Elevations

Accurately locating wells in relation to each other, as well as to other known locations, is necessary to interpret the data from these points and to define the site-specific hydrogeology. The elevation of the well is also an important factor in relating water level measurements from well to well, and in relating the vertical distribution of constituents in the subsurface.

The locations and elevations of all reference marks, borings, monitoring wells, and other relevant locations (surface water sampling points in Skokie Ditch/River) will be determined by a licensed surveyor after all well installations are completed. Location coordinates will be provided for each point to within ±1 foot and related to longitude and latitude or to the Illinois State Planar Coordinate System. Ground elevations for reference marks, borings, and wells; elevations for the top of well casings; and elevations of the water surface at stream sampling points will be determined to within ±0.05 foot, based on the National Geodectic Vertical Datum (NGVD) of 1929.

3.2.7 Water Level Measurements

Water level measurements during and after drilling of a borehole/well are useful for assessing the hydraulic gradient and appropriate locations for new

monitoring wells. These measurements are also necessary for finalizing the optimum well design and construction (e.g., screen and seal placement).

Water table elevations can be measured in a variety of ways, using a variety of tools. The depth to water table can be obtained using a calibrated measuring tape with a weight on the end, electric water level reader, continuous recording water level meter, pressure transducers, etc. For the purposes of discrete water level measurements during drilling and well development operations, and during sample collection, a measuring tape with a weight that can be lowered into the open borehole or well casing will be used. Other methods will be implemented when appropriate.

3.2.8 Boring/Well Abandonment Procedures

It is important to employ proper procedures in abandoning boreholes or wells, to protect the integrity of the subsurface environment and underlying aquifer. Improperly sealed boreholes/wells can provide a direct conduit for surface runoff and contaminants to reach the subsurface.

Consistent with Illinois Environmental Protection Agency (IEPA) requirements, shallow boreholes (up to 5 feet) will be backfilled with cuttings; deeper abandoned boreholes and wells will be grouted shut. A tremie pipe will be used to place grout in the deeper holes from the bottom to ground surface. In wells, the annular space between casing and borehole above the bentonite seal, if any, will also be grouted.

In each case, the decision to abandon a borehole or well will be made in conjunction with the ORNL Project Officer. A complete record of the borehole/well and abandonment procedures will be made and placed in the project files.

3.3 SAMPLE COLLECTION AND MANAGEMENT

The procedures described in this section ensure that representative environmental samples to be characterized are obtained, and that these samples are properly containerized, preserved, shipped, and otherwise handled to maintain their chemical integrity. The use of these sampling and associated techniques will significantly reduce the possibility of sample contamination from external sources and allow for verification of proper sampling and sampling equipment decontamination procedures.

3.3.1 Sample Collection and Sampling Equipment Decontamination Procedures

This section describes procedures to be employed for collection of soil gas, groundwater, surface water, and soil samples at NTC Great Lakes, and associated procedures for sampling equipment decontamination. The techniques to be employed in collecting and preparing replicate samples in the field are also discussed. The source of potable water to be used during equipment decontamination, as specified below, will be supplied by NTC Great Lakes.

3.3.1.1 Soil Gas. In the vicinity of the Exchange Service Station, soil gas samples will be collected in 100-ml, pre-evacuated glass vials with self-sealing septa. The following sampling procedures will be employed:

- Purge the entire sampling system with prepurified nitrogen.
- Using a hammer and rod, create a ½-inch-wide by 4-foot-deep hole at the sampling location. (NOTE: A hammer and rod will be used at unpaved areas and possibly at areas paved with asphalt. However, at asphalt and concrete-paved areas, a pick, concrete drill, or air hammer will be needed to open holes for sampling.)
- Insert probe with perforated tip into the hole and pack off the surface.
- Purge the entire system with in situ soil gas.
- Collect a sample of the soil gas in a pre-evacuated, 100-ml glass vial and pressurize it to 15 psig using a vacuum pump.
- Maintain soil gas pumping to ensure that an adequate gas flow from the vadose zone is maintained.
- Bag and label the sample and store in a cool, dark location until analyzed that day in the field laboratory.
- Purge the sampling system with prepurified nitrogen.
- Decontaminate the slide hammer and probe by washing them with soapy water and rinsing with distilled water.

If necessary, the sample pipes can be capped and marked until the soil gas is analyzed to permit resampling. Each sample will be assigned a discrete number that will be used to track the hard copy of the analysis result. The survey stake number will be recorded as the sampling location for each sample collected.

The exact procedures may vary somewhat depending on the subcontractor selected for soil gas testing.

3.3.1.2 Groundwater. To ensure that cross-contamination between wells does not occur, all reusable equipment that is used to measure and sample the groundwater (e.g., bailers, pumps, tapes, ropes) will be cleaned prior to use in each well. All non-dedicated sampling equipment will be decontaminated by washing with a nonphosphate detergent, rinsing with hexane (where oily materials may be contacted), rinsing with potable water, and final rinsing with distilled water. All pumps and equipment used for purging wells will be washed with nonphosphate detergent, rinsed with potable water, and final rinsed with distilled water. Expendable equipment that is difficult or impractical to clean (e.g., wire, ropes, filter media, etc.) will be discarded after each sample and replaced by new equipment for subsequent samples. Similar procedures will be employed during sample collection of surface water and soils.

The sampling equipment will be protected from ground surface contamination at all times by spreading clean plastic sheeting around the well. To ensure that contamination does not occur from the plastic sheeting, new protective sheeting will be used at each well (or other type of sampling location). Additionally, to prevent equipment contamination from wind-blown particles, all sampling equipment will be covered with plastic sheeting prior to its insertion into the well.

A primary consideration in obtaining a representative groundwater sample from a monitoring well is to guard against mixing the sample with standing, stagnant water in the well casing. In a nonpumping well, there will be little or no vertical mixing of the volume of water above the screened interval, and stratification may occur. Such stagnant water may contain foreign or degraded material, resulting in an unrepresentative sample and misleading chemical data. Therefore, purging of nonpumping wells is necessary prior to sample collection.

Dames & Moore will use the following procedures when collecting groundwater samples from all nonpumping monitoring wells:

- For newly installed wells, collect samples no sooner than 2 days after well development has been completed.
- Upon removal of the well cap and prior to sampling, the air above the well head will be sampled with a photoionization detector. The

procedure to be followed if high concentrations of volatile organics are detected is presented in the Health and Safety Plan (Appendix A).

- Prior to purging and sampling each well, measure (to within ±0.1 foot) the depth from the top of the well casing (not protective casing) to the top of the water and record the depth in the sampling logbook.
- Measure (to within ±0.1 foot) and record the depth from the top of the casing to the bottom of the well casing.
- Subtract the depth to the top of the water from the depth to the bottom of the well casing to determine the height of standing water in the casing and saturated annulus. The diameter, height, and estimated porosity of the sand pack, as recorded by the Dames & Moore field drilling supervisor during well construction, will be available during sampling activities.
- Remove a quantity of water from the well equal to five times the calculated volume of water in the well, including the saturated annulus.
- If recharge rates are slow, wells will be purged to dryness at least once and the water level allowed to recover prior to sample withdrawal.
- Collect samples for chemical analysis immediately after pumping or bailing are complete and the water level has recovered to a level sufficient for sampling. Employ methods that minimize sample aeration.
- Collect the samples using either a submersible pump with Teflon transfer tubing or a bailer, as appropriate. The pump intake will be placed in the screened interval. Teflon tubing will be tagged and used for only one well. All reusable sampling equipment will also be decontaminated between samples.
- Place all samples in properly sized and cleaned containers. Sample containers of appropriate volume and construction will have been prepared and provided by the laboratory to ensure the collection of sufficient volumes for all specified analyses. The samples will be collected so as to minimize aeration as water enters the bottle. Care will be taken to avoid external contamination of the sample container cap after it has been removed and prior to replacement on the filled container.

- Do not take samples for volatile analysis by pumping, which might promote air stripping. Instead, these samples will be bailed and collected in screw-cap, septum-top glass vials and filled so that there are no air bubbles present to allow volatilization to occur. These samples will not be filtered.
- After obtaining chemical analysis samples, draw a second sample for temperature, conductivity, and pH measurements and record results in the sampling logbook.
- Filter samples for metals analysis in the field using an 0.45-micron filter, and preserve samples according to EPA requirements and laboratory instructions. Samples for VOC's, TOC, and oil and grease will not be filtered. Samples for other nonvolatiles will be filtered in the laboratory as specified.
- Add any appropriate preservative and cap securely.
- Label samples in accordance with chain-of-custody procedures.
- Place sample bottle(s) in an ice (4°C) chest immediately after sampling and deliver to the laboratory by overnight courier.

3.3.1.3 Surface Water. All reusable sampling equipment will be cleaned and treated as specified in Section 3.3.1.2. Before sampling, the pre-cleaned sampling equipment will be rinsed downflow of the sampling point to prevent disturbance of the sediment near the sampling point and to prevent cross-contamination. After sampling is completed at one location, the equipment will be decontaminated before the next sample is collected.

Samples may be collected by immersing the sample container or by lowering samplers and then transferring the sample to the proper container; the appropriate preservative will be added; and the container will be capped securely. Surface water samples will not be filtered. Finally, the container will be labeled and placed in an ice (4°C) chest to be delivered to the laboratory. A water sample will also be collected at each location for temperature, pH, and conductivity measurements.

3.3.1.4 Soils. In general, Dames & Moore will observe the following procedures when collecting soil samples and samples from sludge (i.e., dredge spoil) deposits:

- All sample points will be marked with a painted wooden stake that displays a sample point code number. The location will be recorded on a suitable installation map for future reference. If not surveyed, locations will be determined by tape measurements from permanent or semipermanent landmarks.
- Prior to sampling, all surface vegetation, rocks, and debris will be removed to allow collection of a clean and representative sample.
- Shallow soil samples may be collected using a split-spoon sampler during borehole drilling, or with a hand auger, shovel, or soil scoop, as appropriate. Deep soil samples will be taken with the drill rig employing the rotary-wash technique (appropriate for glacial till) and split-spoon sampler. Split-spoon samples will be composited over a depth interval of approximately 1.5 to 2 feet or the length of sample recovered in the sampler.
- Reusable sampling equipment will be decontaminated prior to sampling and between sampling locations to prevent cross-contamination. The drill rig and all drilling tools will be steam cleaned prior to the start of drilling. Between boreholes, all downhole tools, samplers, etc., will be steam cleaned.
- Samples for chemical analyses will be placed, stored, and shipped (in a cooler at 4°C) in wide-mouth glass bottles.
- Samples will be marked with identifying information and logged in the field notebook.

In the case where samples have been collected over a long depth interval (e.g., at the FFTA, Exchange Service Station, and Harbor Dredge Spoil Area), it may be necessary to composite the material retrieved from that depth interval to obtain a representative sample of correct volume for analysis.

Samples collected for analysis of volatile organic compounds will be collected using the following procedure: The sampler will be opened, and the outer layer of the sample (which was in contact with the sampler) will be stripped away using a stainless-steel spatula or knife. A "strip" of soil the length of the sample will be

removed using a clean spatula or knife and placed directly into the appropriate cleaned sample container. This will be accomplished as quickly as possible to avoid loss of volatiles and to minimize other changes to the sample. The container will be immediately capped and stored in a cooler at 4°C.

Samples for other analyses will be collected using the following procedure: Soil materials will be extracted from the split-spoon sampler or similar sampling device and placed in a clean stainless-steel bucket or on a clean sheet of aluminum foil. In the case of loose, unconsolidated sediments, the Dames & Moore field samplers will use a clean, stainless-steel trowel or spatula to mix the soil to form a more homogeneous mixture. The mixture will then be quartered and placed in a sample container(s) appropriate to the required analyses. In the case of cohesive sediments, the Dames & Moore field samplers will use a clean, stainless-steel trowel or spatual to extract a sufficient number of segments from the sample at regular intervals to obtain a sufficient sample volume for analysis. Compositing will be accomplished as quickly as possible to minimize changes to the sample. All reusable equipment used will be thoroughly cleaned between sampling locations (as specified in Section 3.3.1.2) to minimize cross-contamination.

3.3.1.5 Replicate Samples. Replicate samples of water and soil/sludge will be collected and analyzed to check laboratory precision (see Section 3.3.3). Collection procedures described in the preceding sections will be used. The frequency of field replicate collection is specified in Section 3.3.3.

All duplicate soil and water samples, other than those for volatile organic analysis, will be composited upon collection in an appropriately large container with the original sample in the field. The samples will then be homogenized and subsampled, using the appropriate unit sample containers, at a suitable, uncontaminated location. Duplicate samples for volatile organic analysis will be collected in succession in glass vials with Teflon septa caps. The volatiles will not be subsampled.

3.3.2 Sample Containers, Preservation, and Maximum Holding Times

3.3.2.1 Sample Containers. For water samples, sample containers will be chosen that are compatible with the analytes of interest. In general, glass bottles with Teflon-lined caps will be used for samples for organics analysis, and plastic (polyethylene) bottles will be used for samples for metals analysis. Samples for

volatiles analysis will be collected in glass vials with Teflon septa caps. For soil and sludge samples, wide-mouth, glass bottles with Teflon-lined lids will be used. Specific sample container requirements are specified in Table 3-1. All sample containers will be cleaned in the laboratory prior to shipment to the field.

3.3.2.2 Sample Preservation. Water samples for metals analyses will be collected in polyethylene bottles and preserved with nitric acid to pH< 2. Groundwater samples will be filtered prior to preservation. Each sample for metals analyses will then be cooled to 4°C. Samples for chloride analysis require no preservation. Water samples for organic analyses, with the exception of TOC and oil and grease, will be collected in appropriate glass bottles, cooled to 4°C, and stored in the dark inside a sealed ice chest. Samples for TOC and oil and grease will be acidified to pH < 2, then cooled to 4°C. All soil and sludge samples will be collected in appropriate glass bottles, cooled to 4°C, and stored in the dark. Sample preservation requirements are summarized in Table 3-1.

To provide for the shortest in-transit storage periods, all environmental samples will be shipped in appropriate containers by priority air express so that they will reach the laboratory for immediate placement in refrigerated storage.

3.3.2.3 Sample Holding Times. The time that a preserved sample may be held between sampling and analysis is based on the analyte(s) of interest. Holding time limitations are intended to minimize chemical change in a sample before it is analyzed. The holding time is the maximum time allowable between sample collection and analysis. Allowable holding times apply to both solid and aqueous samples. For NC Great Lakes chemical analyses, the maximum holding times for samples are provided in Table 3-1.

metaTRACE will ensure that all samples are analyzed within these specified holding times to maintain sample viability. To permit expedient analysis and to minimize the possibility of exceeding holding times, Dames & Moore will send the samples to metaTRACE on the day of collection by overnight courier.

3.3.3 Field QA/QC Samples

Dames & Moore proposes that the QA/QC protocol for this project require the use of field QA/QC samples to verify the soundness of sample techniques, chain-of-custody, and chemical analysis results. The following types of samples will be prepared/collected:

TABLE 3-1

Information on Sample Containers, Preservation, and Holding Times
RI, Verification Step, at NTC Great Lakes

Analyte	Container Requirements	Preservation	Maximum Holding Time
	Water Samples		
Priority pollutant metals	1-quart plastic bottle	HNO_3 to pH < 2, cool to 4°C	28 days for mercury, 6 months for others
VOC's	40-ml glass vials with Teflon septum caps, 2 per sample	Cool to 4°C	7 days
BNA's/pesticides/PCB's (by GC/MS)	1-gallon amber glass bottle with Teflon-lined cap	Cool to 4°C, store in dark	7 days until extraction, 40 days after extraction
Pesticides/PCB's (by GC/ECD)	1-gallon amber glass bottle with Teflon-lined cap	Cool to 4°C, store in dark	7 days until extraction, 40 days after extraction
TOC	8-ounce amber glass bottle	HCl or H_2SO_4 to pH<2, cool to 4°C	28 days
Oil and grease	1-quart glass jars, 2 per sample	H_2SO_4 to pH<2, cool to 4°C	28 days
Chloride	1-quart plastic bottle	None required	28 days
	Soil/Sludge Samples		
All analytes listed above except VOC's	250-ml wide-mouth amber glass jar with Teflon-lined cap[a]	Cool to 4°C, store in dark	Same as above for corresponding water samples
VOC's	40-ml glass vials with Teflon septum caps, 2 per sample	Cool to 4°C	10 days

[a]For sampling soil/sediment with very high water content, two 1-quart wide-mouth amber glass jars are required.

- VOC trip blanks--consisting of distilled water in VOC bottles, to monitor any sample contamination that might occur during handling or shipping. These bottles will be shipped to the field and returned to the laboratory, but not opened in the field.
- Field blanks--consisting of distilled water poured through the cleaned bailer assembly or other sampling equipment into appropriately preserved bottles, to check the effectiveness of sampling equipment decontamination procedures.
- Replicate samples (see Section 3.3.1.5)--to check laboratory analytical precision.

In addition, a sample of the potable water to be used in drilling and for washing/rinsing equipment will be collected from a source designated by NTC Great Lakes, and analyzed for all constituents of concern in the RI.

Specifications for the preparation/collection of the above samples for shipment to the laboratory, as part of the sampling program for NTC Great Lakes specified in Table 1-1, are presented in Table 3-2. Each sample, with the exception of the VOC trip blanks, will be analyzed for all parameters listed in Table 2-1. The trip blanks will be analyzed only for VOC's.

3.3.4 Sample Chain-of-Custody

3.3.4.1 Sample Collection, Handling, and Identification. Field records will be completed at the time a sample is collected and will be signed or initialed, including the date and time, by the sample collector(s). Field records, to be maintained in a bound notebook, will contain the following information:

- Names and affiliations of sample collector(s)
- General description of the day's field activities
- Documentation of weather conditions during the previous 48 hours
- Field equipment calibration data
- Unique sample number
- Project/installation name or identification
- Purpose of sample/analysis
- Field measurements of temperature, pH, and conductivity
- Date and time of sampling

TABLE 3-2

Specifications for Field QA/QC Samples
RI, Verification Step, at NTC Great Lakes

Field QA/QC Sample Type	Frequency
VOC trip blanks	5% of all samples per round of sampling
Field blanks	5% of all samples per round of sampling
Replicate samples	5% of samples of each matrix per round of sampling
Drilling/wash/rinsing water	One time per water source

- Source/location of sample
- Sample matrix
- Method of sample collection
- Volumes of groundwater removed before sampling, where applicable
- Water level measurements (where applicable)
- Preservative used
- Analyses required
- Serial number(s) on seal(s) and transportation case(s), if any.

Also, at the time of sample collection, each sample will be identified by affixing a pressure-sensitive gummed label on the container. Notations on the label will be made in waterproof, indelible ink. Information on the sample label will include:

- Unique sample number.
- Project number or identification.
- Source of sample (including identification number, name, location, and sample type).
- Preservative used.
- Analyses required.
- Name of collector(s).
- Date and time of collection.

Chain-of-custody forms will also be completed for each sample or groups of samples as appropriate. Examples of the chain-of-custody record and sample bottle labels are provided in Figures 3-3 and 3-4, respectively.

The sample container is then placed in a transportation case (i.e., ice chest) along with the custody record form and pertinent field records. The transportation case is then sealed and labeled.

3.3.4.2 Transfer of Custody and Shipment. When transferring the possession of the samples, the transferee will sign and record the date and time on the chain-of-custody record. Custody transfers will account for each individual sample, though samples may be transferred as a group. Every person who takes custody will fill in the appropriate section of a chain-of-custody record. To prevent undue

JOB NO:	PROJECT NAME–CLIENT:
SAMPLER (Signature):	

Sample No.	Date	Time	Comp.	Grab	Matrix	Station Number and Location	Total No. of Containers	ANALYSES REQUESTED									REMARKS

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks:	

DISTRIBUTION:
- White: Accompanies Shipment
- Yellow: Project Files
- Pink: Field Log
- Gold: QA Files

FIGURE 3-3
CHAIN-OF-CUSTODY RECORD

REMEDIAL INVESTIGATION
NAVAL TRAINING CENTER
Great Lakes, Illinois

DATE: _____ TIME: _____

ANALYSES: _____

PRESERVATIVE: _____

SAMPLED BY: _____

_____

DATE: _____ TIME: _____

ANALYSES: _____

PRESERVATIVE: _____

SAMPLED BY: _____

_____

DATE: _____ TIME: _____

ANALYSES: _____

PRESERVATIVE: _____

SAMPLED BY: _____

_____

FIGURE 3-4
SAMPLE CONTAINER LABELS

proliferation of custody records, the number of persons involved in the chain of possession will be as few as possible.

The sampling crew chief is responsible for seeing that samples are properly preserved, labeled, packaged, and dispatched to the laboratory for analysis. This responsibility includes filling out, dating, and signing the appropriate portion of the chain-of-custody record.

All packages sent to the laboratory will be accompanied by the chain-of-custody record and other pertinent forms. A copy of these forms will be retained by the sample collectors and transferred to the project files upon completion of sampling at the installation.

Samples will be shipped daily via overnight courier to the laboratory by the sampling crew. Samples will be packed in coolers to avoid breakage, and all samples will be iced. The sampling crew chief will provide airbill numbers to the laboratory sample custodian when samples are shipped. Delivery from the airport directly to the laboratory will be made by the overnight courier service. Overnight couriers do not need to sign the individual chain-of-custody forms. Airbill receipts will be considered valid addendums to the chain-of-custody forms.

3.3.5 Field Measurements of Temperature, pH, and Conductivity

See Section 3.2.5 for a discussion of these procedures.

3.3.6 Field Data Management/Recordkeeping

Accountability for a sample begins when the sample is taken from its natural environment. A bound logbook will be maintained to record the acquisition of each sample. Entries will be made in waterproof ink. Only samples for one installation will be entered in a given logbook. The logbook will contain information to distinguish one sample from another. The information to be included is presented in Section 3.3.4.

In addition to the field notebook, each sample will be labeled and chain-of-custody records will be prepared as discussed in Section 3.3.4.

When samples are shipped to the laboratory, entries will be made in the logbook noting date of shipment, number of shipping containers, samples sent, and carrier.

Chain-of-custody records for all environmental samples and field QA/QC samples, laboratory results, and any other data generated as a result of this task will be maintained on file. Copies will be provided for review by ORNL and regulatory agencies as requested.

Sampling locations will be noted on site drawings, which become part of the permanent project records. Monitoring well locations will be surveyed, as discussed in Section 3.2.6. Other sampling locations will be noted with respect to permanent landmarks or site features (i.e., surface water samples) or, where necessary, will be taped off from permanent or semipermanent site features (i.e., soil boring and sampling locations).

3.3.7 Office Data Organization and Management

The numerous pieces of data associated with a single sample will require organization and tracking. These data may include sample identification; sample collection date and conditions; field measurements of temperature, pH, and conductivity; well purging information, etc. In addition, the collection and analysis of two rounds of samples from some locations will result in more than one set of chemical and other data for these sampling points.

Dames & Moore has experience in the use of minicomputers and spreadsheet programs for organizing and managing sampling data. This has been found to be an efficient and flexible method for organizing certain types of sampling/analysis data. For example, the results of chemical analysis of samples and blank samples can be tabulated and checked using such programs. Some advantages of this method include ease of data manipulation, ease of generation of tables and graphic displays for analysis and reporting, transferability to other programs for analysis (e.g., statistical packages), and ease in handling large quantities and different types of data.

Use of in-house computer facilities and programs is proposed to manage and analyze data generated during this investigation, as appropriate. Sampling data will be entered into a format designed by Dames & Moore in conjunction with the ORNL and NEESA Project Officers to satisfy the anticipated needs of the proposed program. Data entry will be cross-checked for errors prior to data analysis. At minimum, these data will include the sample identification, collection date, and results of chemical analyses and field measurements. Management of other types of data will be included as appropriate.

3.4 DISPOSAL OF WASTES GENERATED DURING THE FIELD INVESTIGATION

During the course of the field investigation at NTC Great Lakes, it may be necessary to implement specific procedures for the containerization and disposal of materials generated during drilling and sampling, if significant concentrations of contaminants are encountered. This may especially become a concern in areas such as the FFTA, Exchange Service Station, and Transformer Storage Boneyard.

Appendix E presents the IEPA "General Guidelines for the Containment of Contaminated Solids and Liquids During Site Investigations." These guidelines will be adhered to as much as possible. Situations not clearly covered by these guidelines will be handled in consultation with IEPA and NEESA personnel.

In most cases, it is not anticipated that the levels of contaminants encountered in soil, cuttings, or purged groundwater will be significant enough to require special handling. As appropriate, it is proposed to spread soils and cuttings in the vicinity of the borehole and to dispose of water purged from wells on the ground in a location downgradient of each well. Washwater from drill rig and sampling equipment cleaning will be disposed of in a similar manner. Any other expendable/disposable supplies that become contaminated will be sealed in plastic trash bags for disposal in appropriate waste containers.

In some cases, it is anticipated that containment will be required. Discussions with IEPA indicate that PCB-contaminated soils should be containerized for disposal offsite. If PCB concentrations are under 50 ppm in soil, soils may be disposed of as a special waste in designated Illinois landfills. If PCB concentrations are greater than 50 ppm, soils must be disposed of as hazardous waste in accordance with EPA regulations under the Toxic Substances Control Act (TSCA). Previous sampling results from the Transformer Storage Boneyard indicate PCB concentrations between 50 and 100 ppm in soil. Therefore, cuttings extracted during operations in this area will be drummed, stored, and secured on the installation, pending results of soil analyses and disposition of soils by the installation.

In areas where gasoline and other volatile organic compounds are suspected to be present, the borehole will be monitoried during drilling by the Dames & Moore field drilling supervisor using equipment and procedures mandated by the

Health and Safety Plan (see Appendix A). In the case where monitoring indicates consistent levels greater than 50 ppm, it will be necessary to place contaminated soils and cuttings from drilling operations in 55-gallon drums to be sealed for ultimate appropriate disposal by the installation.

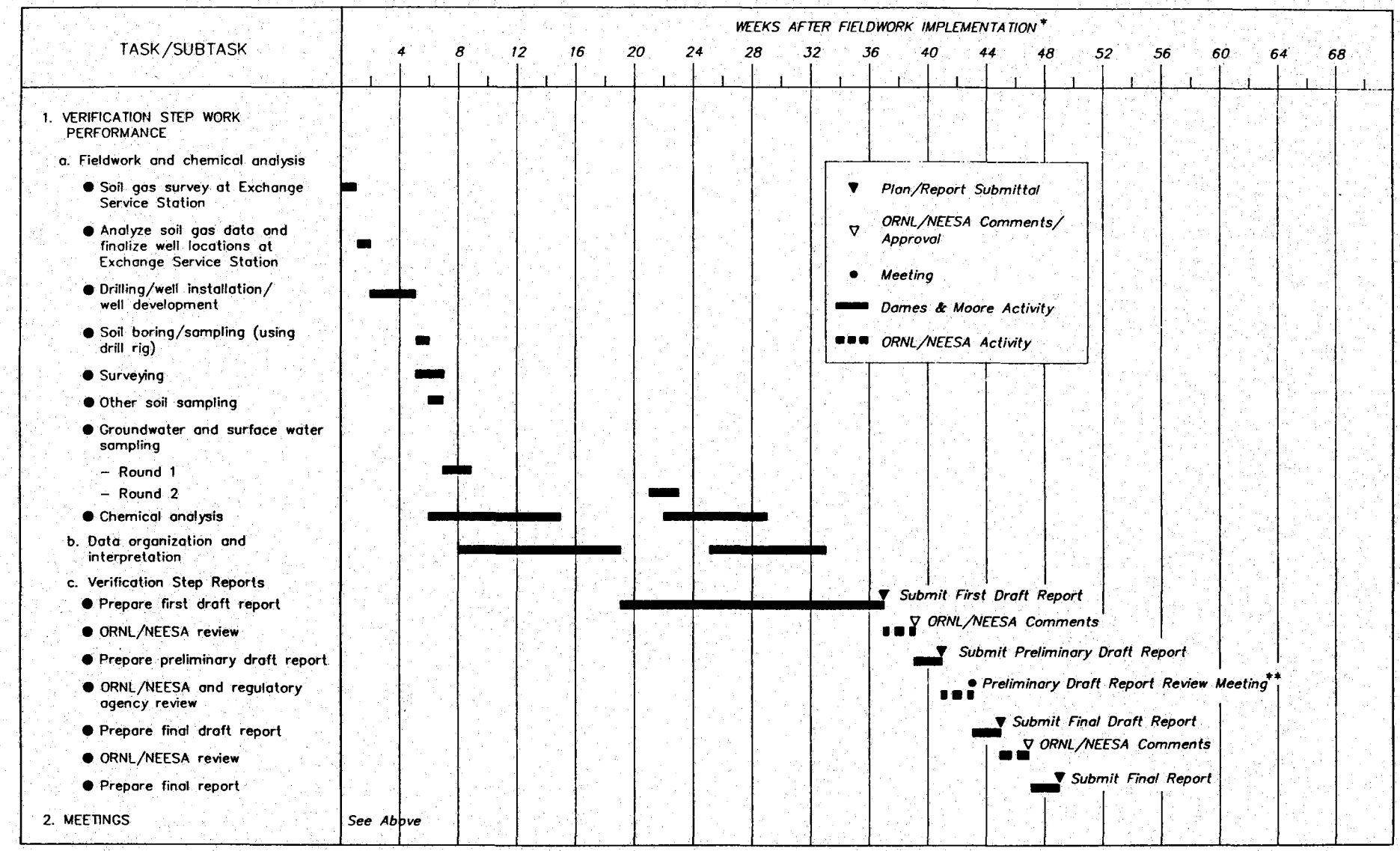
Well development and pre-sampling well purging operations can also generate a significant volume of contaminated water. As described above, where it is determined that contaminant concentrations exceed the 50-ppm criterion, wastewater will be drummed for appropriate disposal by NTC Great Lakes. Other alternatives may be considered, depending on the nature of the contamination. For example, it may be possible to consider piping of wastewater to municipal treatment plants that are capable of handling the levels of contaminants encountered.

4.0 SCHEDULE

The proposed schedule for performance of the services described in this work plan is shown in Figure 4-1, which illustrates work to be accomplished and key milestones versus project time after notice to proceed. The schedule shown in Figure 4-1 has been prepared in accordance with the schedule presented in Section 7 of the ORNL Statement of Work for the Remedial Investigation, Verification Step, at NTC Great Lakes (October 26, 1986, Rev. 1).

In addition to the milestones shown in Figure 4-1, additional task milestones are as follows:

Deliverable/Milestone	Schedule
Monthly reports	7th working day of each month
Summary meetings' minutes	5 working days after meeting
Laboratory progress reports	Submitted with monthly report during sampling/analysis



* Upon receiving authorization to proceed, Dames & Moore can implement fieldwork within approximately three weeks.

** Additional review time may be needed to allow for regulatory review.

FIGURE 4-1
PROPOSED SCHEDULE
RI VERIFICATION STEP AT
NTC GREAT LAKES

REMEDIAL INVESTIGATION
NAVAL TRAINING CENTER
Great Lakes, Illinois

APPENDIX A:

Health & Safety Plan
Remedial Investigation, Verification Step
Naval Training Center
Great Lakes, Illinois

DAMES & MOORE

HEALTH & SAFETY PLAN

Project Name and Number:	Remedial Investigation, Verification Step Naval Training Center Great Lakes, Illinois 00124-189(27)
Project Site Location:	Lake County, Illinois
Project Manager:	Stephen Lemont
Site Safety Officers:	Undetermined
Plan Preparers:	William Levitan Ronald L. Frew
Plan Reviewer:	David Dahlstrom
Preparation Date:	July 20, 1987
Revision Date:	October 2, 1987

APPROVED:

Regional Health & Safety Manager

_____
(Date)

Office Safety Coordinator

_____
(Date)

Partner (Ltd.)

_____
(Date)

Project Manager

_____
(Date)

Health & Safety Plan Approval No.

_____

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1.0 PURPOSE

The purpose of this plan is to assign responsibilities, establish personnel protection standards and mandatory safety practices and procedures, and provide for contingencies that may arise while operations are being conducted at the site.

2.0 APPLICABILITY

The provisions of the plan are mandatory for all onsite Dames & Moore employees engaged in hazardous material management activities--including, but not limited to, initial site reconnaissance, preliminary field investigations, mobilization, project operations, and demobilization. This plan has been developed under U.S. Environmental Protection Agency (EPA) guidelines and complies with all regulations--including OSHA 29 CFR 1910, the recent 1910.120 interim final rule, and 1926 standards.

It is recommended that other field contractors provide a health & safety plan for their employees to cover any exposure to hazardous materials, and all work shall be completed in accordance with that plan. If the contractor chooses to use Dames & Moore's Health & Safety Plan for reference purposes only, the contractor shall hold Dames & Moore harmless from, and indemnify it against, all liability in the case of any injury. Dames & Moore maintains no responsibility whatsoever for the safety and welfare of any onsite personnel except its own employees.

3.0 SITE DESCRIPTION

3.1 GENERAL INFORMATION

Site: Naval Training Center Great Lakes, Illinois Job No.: 00124-189(27)

Objectives: To determine the potential impact of base operations and past waste management practices on groundwater, surface water, and soil quality.

Proposed Date of Investigation: To be determined

Background Review: Complete: X Preliminary: ____

Documentation/Summary (Overall Hazard): Serious: ___ Moderate: X

Low: ___ Unknown: ___

3.2 SITE HISTORY

Naval Training Center (NTC) Great Lakes is located in Shields Township, Lake County, Illinois, on the shore of Lake Michigan. Dedicated in 1911, it is the largest naval training center (1,650 acres) in the United States and possibly in the world. It is bounded on the west by U.S. Route 41 (Skokie Highway), on the north by the City of North Chicago, and on the south by the Veterans Administration Hospital and Golf Course and by the Shore Acres Country Club. Lake Michigan lies to the east.

The mission of NTC Great Lakes is "to exercise command over, and coordinate the efforts of the assigned subordinate activities in effecting basic indoctrination (recruit training) for enlisted personnel, and initial skill, advance, and/or other specialized training for officer and enlisted personnel of the regular Navy and the Navy Reserve, and to support other activities as directed by higher authority."

The full complement of host, tenant, and support operations personnel at NTC Great Lakes consists of 22,883 military (529 officers and 22,354 enlisted men and recruits) and 3,087 others (American civilians and foreign nationals). Of the 30 tenant commands, only the following were found to generate significant quantities of hazardous waste: the Hospital Corps School, the Naval Regional Dental Center, the Naval Dental Research Institute, and the Navy Publication and Printing Service

Office. The remaining tenant commands generate only paper. Additional quantities of hazardous waste were generated by the two support organizations--the Naval Regional Medical Center and the Public Works Center.

There are six sites of concern that will be addressed in this study--Site 1, Golf Course Landfill; Site 4, Fire Fighting Training Area; Site 5, Transformer Storage Boneyard; Site 7, RTC Silk-Screening Shop; Site 8, Exchange Service Station; and Site 12, Harbor Dredge Spoil Area. The Golf Course Landfill was the active disposal area for NTC Great Lakes from 1942 through 1967. It was operated as a trench burn landfill. An estimated 1.5 million tons of material may have been burned or disposed of at this site, including general refuse and trash, liquid oil, and coal ash. Other chemicals that may been disposed of include solvents (perchloroethylene, carbon tetrachloride), PCB's, and motor crankcase oil. In 1967, the area was closed and covered with ash and a thin layer of topsoil.

The Fire Fighting Training Area has been in constant use since 1942. From 1942 to 1979, waste petroleum, oils, lubricants, and waste solvents were stored in drums in this area. The contents were hauled away between 1983 and 1985, but the soils are heavily soaked with residual oil from spillage.

The Transformer Storage Boneyard was the primary storage area for out-of-service transformers, including those filled with PCB oils, between 1945 and 1985. Four surface soil samples collected in 1984 had PCB levels of between 50 and 100 ppm.

The RTC Silk-Screening Shop is used to produce flags and banners. Between 1965 and 1985, the wash water for finished silk screens drained directly to the ground. Stains are obvious on the ground around the discharge and extend to a dirt road behind the building.

In 1983, 3,000 gallons of leaded gasoline leaked at the Exchange Service Station. Although contaminated soil, gasoline, and groundwater were removed, a gasoline odor is still detectable in the basement of a nearby building after a heavy rain.

The harbor was dredged twice in the history of NTC Great Lakes--in 1952 and 1970. The dredge spoils were disposed of on land and are believed to contain metals, PCB's, and oils.

3.3 FACILITY DESCRIPTION

Waste Types:	Liquid X	Solid X	Sludge ___	Gas via volatilization
Characteristics:	Corrosive ___	Ignitable X	Radioactive ___	
	Volatile X	Toxic X	Reactive ___	Unknown X

Unusual Site Features (dike integrity, power lines, terrain, etc.): None

Status (active, inactive, unknown): Golf Course Landfill and Harbor Dredge Spoil Area are inactive; all other sites are active

3.4 HAZARD EVALUATION

D&M field activities are outlined in Table 7-1 (Section 7.0). The main constituents of concern are carbon tetrachloride; Fuel Oil #2; gasoline; fuel components, including benzene, ethyl benzene, toluene, and xylene; PCB's; perchloroethylene; tetraethyl lead; and several metals--including lead and mercury. The exposure limits, recognition qualities, acute and chronic effects, and first aid treatments are presented in Tables 7-2 and 7-3 (Section 7.0). Many of these constituents are volatile, and therefore respiratory protection will be required. Others, such as PCB's and metals, are not volatile, but are damaging to the respiratory system in the particulate form. Thus, if dusty conditions exist, respiratory protection will be needed for these substances. Many of the contaminants of concern can enter the body through skin contact, so appropriate protective clothing will be required. Tables 7-4 and 7-5 (Section 7.0) provide monitoring methods, action levels, and protective equipment required for this project.

All drilling and sampling at the Transformer Storage "Boneyard" will be performed in Level C in accordance with NIOSH/OSHA recommendations for work in PCB-contaminated areas. Although PCB's are included as possible contaminants at the Golf Course Landfill and the Harbor Dredge Spoil Area, respiratory protection will be required at these sites only as indicated by action levels in Table 7-4. There is no indication that PCB's are, in fact, present at these two sites; therefore, caution and monitoring are indicated as proper procedures rather than mandatory use of Level C.

Drilling and well installation at the Golf Course Landfill will take place outside the limits of the fill as identified by previous studies. Other sites will be sampled by field activities within their known limits.

4.0 EMERGENCY INFORMATION

4.1 EMERGENCY CONTACTS

Contact	Person or Agency	Work Telephone Numbers
Police	Base police (Bldg. 130)	x3430
Fire	Base fire (Bldg. 106)	x3324
Ambulance	Base ambulance (Bldg. 200H)	x5555
Hospital	Naval Hospital (Bldg. 200H)	x5618
Poison Control		1-800-962-1250
Client Contact	John Ketchik	x2796
D&M Project Manager	Stephen Lemont	(301) 652-2215
D&M MPIC	Richard C. Tucker	(301) 652-2215
Office Safety Coordinator	Ron Frew	(301) 652-2215
Regional H&S Manager	David Dahlstrom	(404) 262-2915
Firmwide H&S Director	Chuck McDaris	(213) 683-1560

4.2 LOCATION OF SITE RESOURCES

Water Supply: See Table 7-1

Telephone: See Table 7-1

4.3 EMERGENCY ROUTE TO HOSPITAL

The hospital is on base at the corner of 6th Street and B Street.

4.4 ADDITIONAL ARTICLES TO BE TAKEN INTO FIELD

1. First aid kit
2. Disposable eye wash (1 liter or more).

5.0 SITE SAFETY WORK PLAN

5.1 MONITORING

5.1.1 Monitoring Requirements

Air monitoring will be conducted for hazards presented in Table 7-2. Equipment necessary for monitoring at this site consists of PID/OVA, a combustible gas indicator (CGI), particulate monitor, detector cards, and detector tubes. The type of monitoring instruments specified by the hazard and the action levels to upgrade personal protection is shown in Table 7-4. All monitoring equipment shall be maintained following procedures outlined in the D&M Standard Operating Manual for Monitoring Equipment.

5.1.2 Monitoring Schedule

5.1.2.1 Instrument Calibration. All applicable instruments shall be calibrated daily. Readings shall be recorded on the Daily Instrument Calibration Check Sheet provided in Section 8.0.

5.1.2.2 Background Readings. Before any field activities commence, the background levels of the site will be read and noted. Daily background readings shall take place away from areas of potential contamination to obtain accurate results.

5.1.2.3 Air Monitoring Frequency. All site readings shall be noted on the Air Monitoring Record provided in Section 8.0, along with the date, time, background level, weather conditions, wind direction and speed, and location where the background level was recorded.

The following schedule will be followed for air monitoring activities as specified for each activity:

Equipment	Monitoring Frequency	
CGI	Continuously/Daily/Other	Monitor every 10 min. at Sites 1, 4, 8 and 12.
Colorimetric tubes for carbon tetrachloride.	Continuously/Daily/Other	Monitor every 10 min. or with each change in soil color or presence of odor at Sites 1, 4, 7, 8, and 12.

Equipment	Monitoring Frequency	
PID	Continuously/Daily/Other	At Sites 1, 4, 7, 8, and 12.
H_2S Detector Cards	Continuously/Daily/Other	At Site 1.
Particulate monitor	Continuously/Daily/Other	All sites.

5.2 LEVELS OF PROTECTION

Level D+ protection is needed to perform work on-site, as described in Table 7-5, with upgrade potential to Level C.

5.3 RESPIRATORY PROTECTION

If air purifying respirators are required, organic vapor, high-efficiency dust and mist cartridges will be used. However, these cartridges provide limited protection against carbon tetrachloride.

The drilling and soil and groundwater sampling activities will be initiated at Level D+. If organic vapors as measured on the PID exceed 3 ppm as measured in the breathing zone, don respirators. However, if the air contaminants as measured on the PID exceed 10 ppm or as measured on the detector tubes exceed 4 ppm for carbon tetrachloride, evacuate the area. Conditions for return to the site are described in Table 7-4; monitoring will be performed by the site safety coordinator. All ambient air measurements which are taken to evaluate personnel exposure shall be taken within the individual's breathing zone and shall be fairly constant for a duration of at least 30 seconds.

5.4 WORK LIMITATIONS

In general, fieldwork will be conducted during daylight hours only. At least two personnel will be in the field at all times. The Project Manager or Regional Health & Safety Manager must grant special permission for any field activities conducted beyond daylight hours. All Dames & Moore personnel working in the field shall have completed the D&M 40 hour personnel protection and safety course (or its equivalent), have been declared fit for duty, and where respiratory protection is necessary, have been properly trained, fit-tested, and declared fit for respirator use. At least one D&M employee will be certified in first aid and cardiopulmonary resuscitation and be on-site at all times. No drilling shall take place without first confirming the absence of subsurface transmission lines.

5.5 FIELD PERSONNEL

The field team will consist of the following persons:

Project Manager:	Stephen Lemont
Site Safety Coordinator:	Undetermined
Work Party #1:	_____
Work Party #2:	_____

These individuals were briefed on the contents of this plan on _____ at _____ by _____ (title: _____).

6.0 DECONTAMINATION

6.1 STANDARD PROCEDURES

1. Locate a decontamination area between the Hot Line (upwind boundary of the Exclusionary Area) and the Clean Area boundary.
2. Establish a personnel decontamination station (PDS).
3. Upon leaving the contamination area, all personnel should proceed through the appropriate Contamination Reduction Sequence.
4. All protection gear should be left onsite during any lunch break following decontamination procedures.

The maximum decontamination layout for Level C is shown in Figure 6-1, and a description is given below.

Maximum Measures for Level C Decontamination

Station 1:	Segregated Equipment Drop	1.	Deposit equipment used onsite (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different plastic-lined containers. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, a cool-down station may be set up within this area.
Station 2:	Boot Cover and Glove Wash	2.	Scrub outer boot covers and gloves with decon solution or detergent and water.
Station 3:	Boot Cover and Glove Rinse	3.	Rinse off decon solution from Station 2 using as much water as necessary.
Station 4:	Tape Removal	4.	Remove tape around boots and gloves and deposit them in the plastic-lined container.
Station 5:	Boot Cover Removal	5.	Remove boot covers and deposit them in the plastic-lined container.

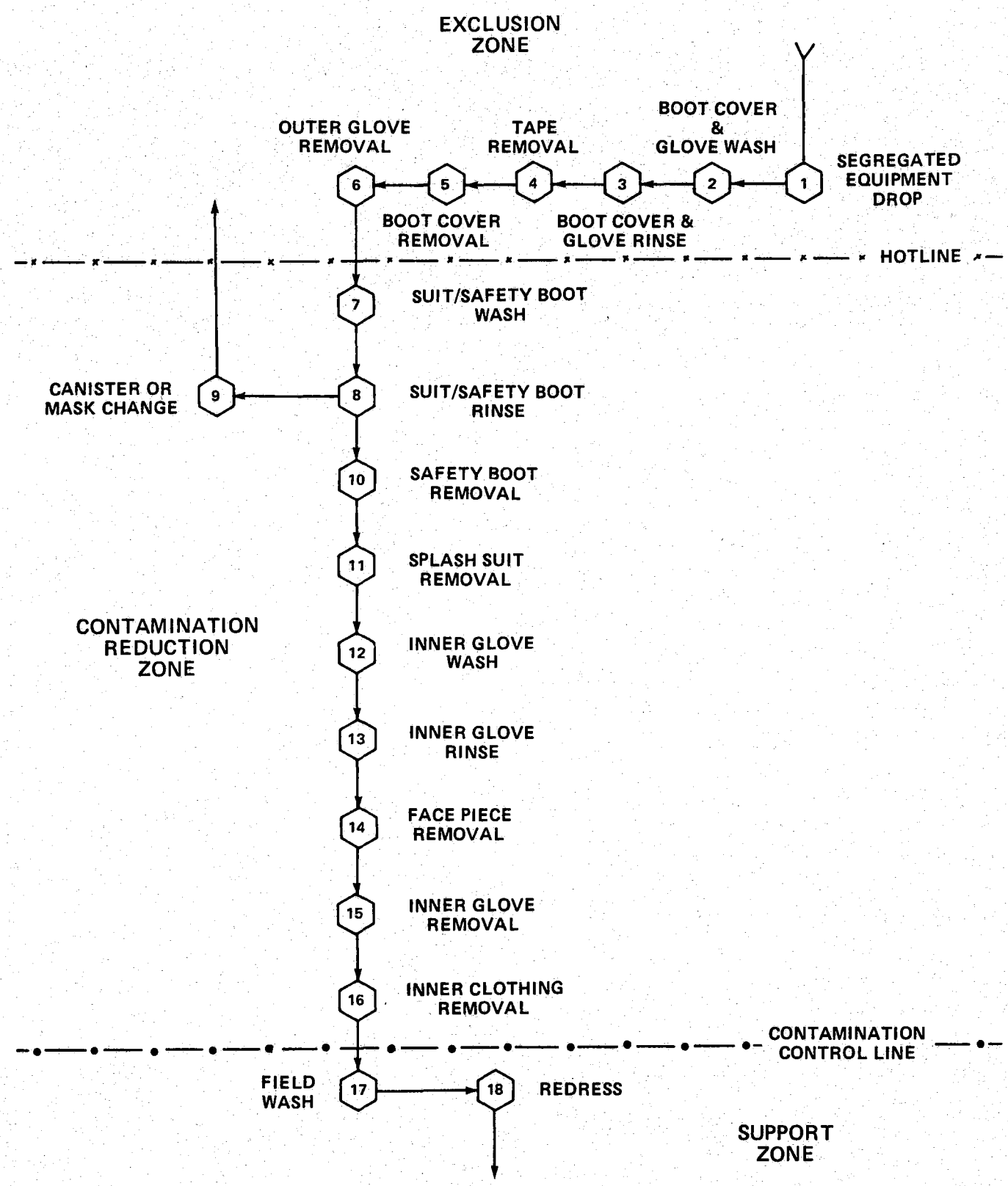


FIGURE 6-1

MAXIMUM DECONTAMINATION LAYOUT FOR LEVEL C PROTECTION

Dames & Moore

Station 6:	Outer Glove Removal	6.	Remove outer gloves and deposit them in the plastic-lined container.
Station 7:	Suit and Boot Wash	7.	Wash splash suit, gloves, and safety boots. Scrub with long-handled scrub brush and decon solution.
Station 8:	Suit and Boot, and Glove Rinse	8.	Rinse off decon solution using water. Repeat as many times as necessary.
Station 9:	Cartridge or Mask Change	9.	If worker leaves exclusion zone to change cartridges (or mask), this is the last step in the decontamination procedure. Worker's cartridges exchanged, new outer gloves and boot covers donned, and joints taped. Worker returns to duty.
Station 10:	Safety Boot Removal	10.	Remove safety boots and deposit them in the plastic-lined container.
Station 11:	Splash Suit Removal	11.	With the helper's assistance, remove splash suit. Deposit it in the plastic-lined container.
Station 12:	Inner Glove Wash	12.	Wash inner gloves with decon solution.
Station 13:	Inner Glove Rinse	13.	Rinse inner gloves with water.
Station 14:	Face Piece Removal	14.	Remove face piece. Deposit it in the plastic-lined container. Avoid touching face with fingers.
Station 15:	Inner Glove Removal	15.	Remove inner gloves and deposit them in the plastic-lined container.
Station 16:	Inner Clothing Removal	16.	Remove clothing soaked with perspiration and place it in the plastic-lined container. Do not wear inner clothing offsite, since there is a possibility that small amounts of contaminants might have been transferred in removing the fully encapsulating suit.

Station 17:	Field Wash	17.	Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
Station 18:	Redress	18.	Put on clean clothes.

6.2 MINIMAL DECONTAMINATION

Less extensive procedures for decontamination can be established when the type and degree of contamination are known, or when the potential for transfer is judged to be minimal by the Site Safety Coordinator. These procedures generally involve one or two washdowns only.

The drill rig and all drilling tools will be steam cleaned prior to sampling and at the completion of the work. All downhole tools, samplers, and other downhole equipment will be steam cleaned between boreholes. Under sloppy conditions, the back end of the drill rig will also be steam cleaned, as needed, between boreholes. It has been assumed that an appropriate decontamination area near the site will be designated by the client for drill rig steam cleaning/decontamination operations. This should consist of a concrete or asphalt area with appropriate drainage to sanitary or storm sewers. If such an area is not available, a decontamination pad will have to be constructed prior to the start of drilling operations.

6.3 CLOSURE OF THE PERSONNEL DECONTAMINATION STATION

All disposable clothing and plastic sheeting used during the operation should be double-bagged, labeled, and contained onsite to await disposition by the client. Decon and rinse solutions should also be contained onsite for ultimate disposition by the client. Reusable rubber clothing should be dried and prepared for future use. (If gross contamination has occurred, discard the item.) Cloth items should be bagged and removed from the site for final cleaning. All wash tubs, pail containers, etc., should be thoroughly washed, rinsed, and dried prior to removal from the site.

7.0 TABLES

TABLE 7-1

Summary of Remedial Investigation, Verification Step Field Program
NTC Great Lakes, Illinois

Site No.	Site Name	Installation of Wells	Types of Samples	Potential Contaminants	Nearest Water and Telephone
1	Golf Course Landfill	Yes	Groundwater Surface water	TOC, volatile organics, semi-volatile organics, priority pollutant metals, chloride, PCB's mercury	Bldg. 3312
4	Fire Fighting Training Area	Yes	Groundwater Surface water Soil	Oil and grease, lead, volatile organics, semivolatile organics	Bldg. 3304
5	Transformer Storage "Boneyard"	No	Soil	PCB's, lead, oil and grease	Bldg. 1517
7	RTC Silk-Screening Shop	No	Soil	Volatile organics, silver, chromium, cadmium, lead	Bldg. 1212
8	Exchange Service Station	Yes	Groundwater Soil gas Soil	Lead, volatile organics	Bldg. 1414
12	Harbor Dredge Spoil Area	No	Sludge	PCB's, priority pollutant metals, volatile organics, pesticides	Bldg. 13

TABLE 7-2

Exposure Limits and Recognition Qualities

Compound	Exposure Standard[a] (ppm, unless otherwise indicated)	IDLH Level[b] (ppm, unless otherwise indicated)	Recognition Qualities		
			Odor	LEL[c]	Ionization Potential
Carbon tetrachloride	5	300	Ether-like	Noncombustible	11.47
Chromium	1.0 mg/m^3	500 mg/m3	Variable	Noncombustible	--
Fuel oil #2	None specified	None specified	Aromatic	6.0	--
Gasoline	300	None specified	Gasoline (0.25 ppm)	1.4	--
Lead	0.15 mg/m^3	Variable	Variable	Variable	--
Mercury	0.1 mg/m^3	28 mg/m^3	Odorless	Noncombustible	--
Perchloroethylene	50	500	Sweet	--	9.32
Tetraethyl lead	200	2,000	Slightly musty	--	--
Benzene	10[d]	2,000[e]	Aromatic	1.3	9.25
Ethyl benzene	100	2,000	Aromatic	1.0	8.76
Toluene	100	2,000	Aromatic	1.3	8.82
Xylene	100	10,000	Aromatic	1.1	8.5

[a]OSHA permissible exposure limit or American Conference of Governmental Industrial Hygienists threshold limit value.

[b]Immediately dangerous to life and health.

[c]Lower explosive limit.

[d]Effective December 1987, the permissible exposure limit for benzene is 1 ppm; action levels (Table 7-4) reflect this change.

[e]NIOSH recommends that the substance be treated as a potential human carcinogen.

TABLE 7-3

Acute and Chronic Effects and First Aid Treatment

Compound	Routes of Entry	Eye Irritant	Acute Effects	Chronic Effects
Carbon tetrachloride	Inhalation Absorption Ingestion Contact	Yes	Drowsiness, dizziness, loss of coordination	Suspected carcinogen, lungs and kidneys
Chromium	Inhalation Ingestion	No	--	Lung fibrosis, carcinogen
Fuel Oil #2	Inhalation Contact	Yes	Respiratory irritant, headache, dizziness	Blood
Gasoline	Inhalation Ingestion Contact	No	Skin irritation, nausea, vomiting, drowsiness, headache	Central nervous system, depression, ventricular fibrillation
Lead	Inhalation Ingestion Contact	No	Lassitude, insomnia	Abdominal pain, anorexia, anemia, hypotension
Mercury	Inhalation Ingestion Contact	Yes	Cough, bronchitis, irritability, skin irritation	Weight loss
PCB's	Inhalation Ingestion Contact	Yes	Chloracne, dermatitis, nausea, vomiting, diarrhea	Liver damage, possible carcinogen
Perchloroethylene	Inhalation Ingestion Contact	Yes	Nausea, dizziness, headache	Possible carcinogen
Tetraethyl lead	Inhalation Ingestion Absorption Contact	Yes	Lassitude, nausea, anxiety	Hypotension, hallucinations, convulsions
Benzene	Inhalation Absorption Ingestion Contact	Yes	Dizziness, headache, nausea, fatigue, staggering gait	Aplastic anemia, leukemia
Ethyl benzene	Inhalation Ingestion	Yes	Dizziness, fatigue, nausea	Eye, skin, upper respiratory system, and central nervous system damage
Toluene	Inhalation Ingestion	--	Fatigue, confusion, dizziness	Central nervous system, liver and kidney damage
Xylene	Inhalation Absorption Ingestion Contact	Yes	Dizziness, excitement, drowsiness, vomiting	Dermatitis, anorexia

General First Aid Treatment

Eye: Irrigate Immediately
Skin: Soap Wash Promptly
Inhalation: Move to Fresh Air
Ingestion: Get Medical Attention

TABLE 7-4

Hazard Monitoring Methods, Action Levels, and Protective Measures

Hazard	Monitoring Method	Action Level	Protective Measures[a]	Monitoring Schedule
Organic Vapors	PID	Background to 3 ppm in breathing zone[c]	Level D+	Continue drilling with continuous monitoring
		and		
	Detector tube[b]	Background to 4 ppm in breathing zone		Monitor every 10 min or with each change in soil color or presence of odor
	PID	3 to 10 ppm in breathing zone[c]	Level C	Continue drilling with continuous monitoring
	PID	>10 ppm[c]	EVACUATE AREA[d] NOTIFY PROJECT MANAGER	
		or		
	Detector tube[b]	>4 ppm		
Toxic Dust	Particulate Monitor	No dust or dry conditions	Level D+	Continuous monitoring
		Dusty or dry conditions (>4 mg/m^3)	Implement dust suppression measures or Level C	
		Dusty (4 mg/m^3) after dust suppression	Level C	
Explosive	Explosimeter	<10% of LEL		Continue drilling with monitoring every 10 min/every sample retrieved
		10-25%		Continuous monitoring
		>25%	EVACUATE AREA NOTIFY PROJECT MANAGER EXPLOSION HAZARD[e]	
Hydrogen Sulfide	Detector cards	>10 ppm	EVACUATE AREA NOTIFY PROJECT MANAGER	

[a] See Table 7-5 for Level C and Level D+ descriptions.

[b] Detector tubes for carbon tetrachloride shall be used. These may be in the form of passive dosimeters worn by members of the work team around the drilling locations.

[c] Continuous reading for greater than 30 seconds.

[d] After sufficient ventilation period, approach work area with PID and carbon tetrachloride detector tube monitoring. If OVA reading is below 10 ppm and carbon tetrachloride detector tube reading is below 4 ppm, continue working at the appropriate level of protection.

[e] If encountered in a boring hole or monitoring well, purge boring or well with nitrogen until safe levels (<10%) are obtained. If 25% LEL persists, abandon boring and evacuate area temporarily. After at least ½ hour, reapproach borehole from an upwind direction while continuously monitoring with explosimeter. If levels are still unsafe, backfill hole and abandon.

TABLE 7-5

Protective Equipment for On-Site Activities

Activity	Level	Protective Equipment
Drilling, soil sampling, and groundwater sampling[a]	D+	Chemical-resistant (tyvek) clothing[b] Outer nitrile or butyl rubber and inner (chemical-resistant) gloves Steel-toed boots Nitrile or butyl rubber outer boots Hard hat Safety glasses[c]
Drilling, soil sampling, and groundwater sampling, at action levels noted in Table 7-4; all drilling and sampling at the Transformer Storage Boneyard	C	Same as above, but full-face respirator with an organic vapor/high-efficiency dust and mist cartridge are worn instead of safety glasses

[a]If dusty or dry conditions exist, the area should be hosed down to try to minimize the potential for the inhalation of contaminated dust.

[b]Personnel working around the drill rig may wish to wear one- or two-piece PVC rain wear to prevent/limit the progressive permeation of contaminated mud and water through the disposable suits. Also, this raingear is less susceptible to rips and tears thereby offering better and more consistent protection.

[c]Personnel working around an operating drill rig may choose to wear hearing protection.

8.0 FORMS

The following forms are contained in this section:

Exposure History Form
Daily Instrument Calibration Checksheet
Air Monitoring Record
Plan Acceptance Form
Plan Feedback Form
Medical History Form
Accident Report Form
Site Safety Briefing Form
Heat Stress Monitoring Form

The Plan Acceptance Form should be filled out by all employees working on the site. The Plan Feedback Form should be filled out by the Site Safety Coordinator (SSC) and any other onsite employee who wishes to fill one out. The Accident Report Form should be filled out by the Project Manager in the event that an accident occurs. The Site Safety Briefing Form is filled out by the SSC and signed by all persons who received the site safety briefing.

ALL COMPLETED FORMS SHOULD BE RETURNED TO THE OFFICE SAFETY COORDINATOR FOR FORWARDING TO THE REGIONAL H&S PROGRAM OFFICE.

EXPOSURE HISTORY FORM

Job Name: _____

Job Number: _____

Dates From/To: _____

D&M Personnel Onsite

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

Suspected Contaminants	Verified Contaminants and Airborne Concentration Thereof

DAILY INSTRUMENT CALIBRATION CHECKSHEET

Instrument: _____

Serial #: _____

Date	Pure Air (y/n)	Calibration Gas (ppm)	Battery Check (good/bad)	Calibrated by	Remarks

AIR MONITORING RECORD

GENERAL INFORMATION

Name(s): _____ Background Level: _____

Date: _____ Weather Conditions: _____

Time: _____

Project: _____

Job No: _____

Estimated Wind Direction: _____

Estimated Wind Speed
(i.e., calm, moderate, strong, etc.): _____

Location where background level was obtained: _____

EQUIPMENT SETTINGS

HNU		Explosimeter	
Range:	_____	Alarm Trigger-%LEL	_____
Span Pot:	_____	Alarm Trigger-%02	_____
Calibration Gas:	_____	Calibration Gas:	_____

FIELD ACTIVITIES

Field Activities Conducted: _____

_____

Time	OVA	Explosimeter %LEL	Explosimeter %02	Drager Tube	Radiation Meter
	Equivalent units			ppm-constituent	

PLAN ACCEPTANCE FORM

PROJECT HEALTH & SAFETY PLAN

Instructions: This form is to be completed by each person to work on the subject project work site and returned to the Office Safety Coordinator.

Job No. _____

Client: _____

Project: _____

Location: _____

Date: _____

I represent that I have read and understand the contents of the above plan and agree to perform my work in accordance with it.

_____
Name (Printed)

_____
Signature

_____
Assigned Dames & Moore Office

_____
Date

PLAN FEEDBACK FORM

Job Number: _____

Job Name: _____

Date: _____

Problems with plan requirements:

_____

_____

_____

_____

_____

Unexpected situations encountered:

_____

_____

_____

_____

_____

Recommendations for future revisions:

_____

_____

_____

_____

_____

MEDICAL HISTORY FORM

	Name	Allergies	Other Restrictions
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

ACCIDENT REPORT FORM

To _____ From _____

_____ _____

_____ _____

Telephone (include area code) _____

Name of Injured or Ill Employee _____

Date of Accident _____ Time of Accident _____ Exact Location of Accident _____

Narrative Description of Accident _____

_____

_____

Nature of Illness or Injury and Part of Body Involved _____ Lost Time Yes ___ No ___

_____

_____

Probable Disability (Check One)

Fatal	Lost Work Day With Days Away From Work	Lost Work Day With Days of Restricted Activity	No Lost Work Day	First Aid Only
___	___	___	___	___

Corrective Action Taken by Reporting Unit _____

_____

_____

Corrective Action That Remains to be Taken (by whom and by when)

_____

_____

Name of Supervisor _____ Title _____

Signature _____ Date _____

SITE SAFETY BRIEFING FORM

Project _____

Date _____ Time _____ Job No. _____

Address _____

Specific Location _____

Type of Work _____

_____

_____

SAFETY TOPICS PRESENTED

Protective Clothing/Equipment _____

_____

Chemical Hazards _____

_____

Physical Hazards _____

_____

Emergency Procedures _____

_____

Hospital/Clinic _____ Phone _____

Hospital Address _____

Special Equipment _____

_____

Other _____

_____

ATTENDEES

Name (Printed)	Signature

Meeting Conducted by: _____ _____
Name (Printed)

Site Safety Coordinator _____ Team Leader _____

HEAT STRESS MONITORING FORM

Date/Time: _____

Name: _____ Site: _____

Company: _____ Location: _____

Pulse Rate Monitoring (30-second rest prior to first measurement):

Starting Time: _____ Pulse Rate: _____ beats/minute

rest 30 sec.	_____	rest 30	_____	b/m
rest 30 sec.	_____	rest 60	_____	b/m
rest 60 sec.	_____	rest 60	_____	b/m

Starting Time: _____ Pulse Rate: _____ beats/minute

rest 30 sec.	_____	rest 30	_____	b/m
rest 30 sec.	_____	rest 60	_____	b/m
rest 60 sec.	_____	rest 60	_____	b/m

Starting Time: _____ Pulse Rate: _____ beats/minute

rest 30 sec.	_____	rest 30	_____	b/m
rest 30 sec.	_____	rest 60	_____	b/m
rest 60 sec.	_____	rest 60	_____	b/m

Starting Time: _____ Pulse Rate: _____ beats/minute

rest 30 sec.	_____	rest 30	_____	b/m
rest 30 sec.	_____	rest 60	_____	b/m
rest 60 sec.	_____	rest 60	_____	b/m

Method of Measurement:

Carotid Artery: _____ Instrument (specify type): _____

Self-Determined & Reported: _____

Site Safety Coordinator: _____ _____

Name (Printed) (Signature)

ATTACHMENT A:

Chemical Hazard Evaluation

(Material safety data sheets are maintained in the project files.)

ATTACHMENT B:

Responsibilities

B.1 PROJECT MANAGER

The Project Manager will direct onsite investigations and operational efforts. The Project Manager, assisted by the Site Safety Coordinator (SSC), has primary responsibility for:

1. Ensuring that appropriate personnel protective equipment and monitoring equipment are available and properly used by all onsite personnel.
2. Ensuring that Dames & Moore personnel receive this plan and understand its provisions, are instructed in safe work practices, and are familiar with planned emergency procedures.
3. Ensuring that all field personnel have had a minimum of 40 hours of training.
4. Ensuring that personnel are aware of the potential hazards associated with site operations through their active participation in the initial site safety briefing.
5. Monitoring the safety performance of all Dames & Moore personnel to ensure that the required work practices are employed.
6. Correcting any work practices or conditions that may result in personal injury, exposure to hazardous substances, or a release of hazardous materials to the environment.
7. Preparing any accident/incident reports (see the Accident Report Form) and ensuring that the affected party does the same.
8. Ensuring the completion of Plan Acceptance and Feedback Forms by all Dames & Moore onsite personnel.

B.2 SITE SAFETY COORDINATOR

The SSC shall:

1. Implement project Health & Safety Plans and report to the Project Manager for action if there are any deviations from the anticipated conditions described in the plan and authorize the cessation of work, if necessary.

2. Calibrate all monitoring equipment on a daily basis and record results on the Daily Instrument Calibration Checksheet (see Section 8.0).

3. Ensure that all monitoring equipment is operating correctly according to manufacturers' instructions and provide maintenance if it is not.

4. Confirm that personnel working onsite have the proper medical surveillance program and health & safety training that qualifies them to work at a hazardous waste site. Also be responsible for identifying all Dames & Moore site personnel with special medical problems (i.e., allergies).

5. Conduct and document the initial site safety briefing.

B.3 PROJECT PERSONNEL

Project personnel involved in onsite investigations and operations are responsible for:

1. Taking all reasonable precautions to prevent injury to themselves and to their fellow employees.

2. Performing only those tasks that they believe they can do safely, and immediately reporting any accidents and/or unsafe conditions to the SSC.

3. Notifying the Project Manager and SSC of any special medical problems (i.e., allergies) and ensuring that all onsite personnel are aware of any such problems.

ATTACHMENT C:

Standard Safe Work Practices

C.1 GENERAL

1. Eating, drinking, chewing gum or tobacco, and smoking are prohibited in the contaminated or potentially contaminated area, or where there is a possibility for the transfer of contamination.

2. Contact with potentially contaminated substances should be avoided. Do not walk through puddles, pools, mud, etc. Avoid, whenever possible, kneeling, leaning, or sitting on equipment or the ground. Do not place monitoring equipment on a potentially contaminated surface (i.e., ground, etc.).

3. Spillage should be prevented, to the extent possible. In the event that a spillage occurs, contain the liquid, if possible.

4. Splashing of contaminated materials should be prevented.

5. All field crew members should use their senses (all senses) to alert them to potentially dangerous situations (i.e., presence of strong, irritating, or nauseating odors).

6. Field crew members must be familiar with the physical characteristics of investigations, including:

   - Wind direction in relation to the ground zero area
   - Accessibility to associates, equipment, and vehicles
   - Communications
   - Hot zone (areas of known or suspected contamination)
   - Site access
   - Nearest water sources
   - Routes and procedures to be used during emergencies.

7. The number of personnel and equipment in the contaminated area should be minimized, but only to the extent consistent with workforce requirements of safe site operation.

8. All wastes generated during Dames & Moore or subcontractor activities at the site must be disposed of as directed by the Project Manager.

9. No one wearing contact lenses or having a beard will be permitted in the work area if Level C or higher protection is required.

C.2 DRILLING AND SAMPLING PROCEDURES

The following standard safety procedures should be employed for all drilling and sampling activities:

1. All drilling and sampling equipment must be cleaned before proceeding to the site.

2. Drilling or sampling equipment must be cleaned after each use. Refer to the work plan for instructions.

3. Work in "cleaner" areas should be conducted first, where practical.

4. The minimum number of personnel necessary to achieve the objectives should be within 25 feet of the drilling or sampling activity.

5. If emergency and backup subcontract personnel are at the site, they should remain 25 feet from the drilling or sampling activity, where practical.

6. Exclusion zones will be established within designated hot lines. Delineation of a hot line will reflect the interface between areas at or below a predetermined hazard or threshold contaminant concentration, based on available data, including the results of monitoring and chemical analyses, information from site personnel regarding historical site activities, and general observations. This determination will be made by the Project Manager in conjunction with the SSC and site personnel.

ATTACHMENT D:

Emergency Procedures

D.1 CONTACTS

Should any emergency require outside or support services, the appropriate contacts should be made by the SSC. The list of appropriate contacts is given in Section 4.1.

D.2 PROCEDURES

In the event that an emergency develops onsite, the procedures delineated herein are to be immediately followed. Emergency conditions are considered to exist if:

- Any member of the field crew is involved in an accident or experiences any adverse exposure symptoms while onsite, or
- A condition is discovered that suggests the existence of a situation more hazardous than anticipated.

The following emergency procedures should be followed:

1. Personnel onsite should use the "buddy system" (pairs). The team should prearrange hand signals or other emergency signals for communication in case of lack of radios or radio breakdown (see the following items):
    - Hand gripping throat: Out of air, can't breathe.
    - Gripping partner's wrist or placing both hands around waist: Leave area immediately, no debate.
    - Hands on top of head: Need assistance.
    - Thumbs up: Okay, I'm alright, I understand.
    - Thumbs down: No, negative.
2. Site work area entrance and exit routes should be planned, and emergency escape routes should be delineated by the SSC.
3. Visual contact should be maintained between "pairs" onsite, with the team remaining in proximity to assist each other in case of emergencies.

4. In the event that any member of the field crew expriences any adverse exposure symptoms while onsite, the entire field crew should immediately halt work and act according to the instructions provided by the SSC.

5. Wind indicators visible to all onsite personnel should be provided by the Project Manager to indicate possible routes for upwind escape.

6. The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated should result in the evacuation of the field team and re-evaluation of the hazard and the level of protection required.

7. In the event that an accident occurs, the Project Manager and the injured person are to complete an Accident Report Form for submittal to the OSC, who will forward a copy to the Regional Health & Safety Manager and the Firmwide Health & Safety Director. The OSC should ensure that follow-up action is taken to correct the situation that caused the accident.

8. In the event that an accident occurs, the Project Manager and the injured person are to complete an Accident Report Form for submittal to the manager (Partner (Ltd.)) of the office. The manager should ensure that follow-up action is taken to correct the situation that caused the accident.

ATTACHMENT E:

Heat Stress/Cold Stress

If site work is to be conducted during the winter, cold stress is a concern in the health and safety of personnel. Of special note for cold stress on this site is the wearing of tyvek suits. Disposable clothing does not breathe; therefore, perspiration cannot evaporate. During strenuous physical activity, an employee's clothes can become wet. Wet clothes combined with cold temperatures can lead to hypothermia. If the air temperature is less than 40°F and an employee perspires, the employee must change to dry clothes. The onsite heated trailer facility or a personnel vehicle may be used as a change area.

If site work is to be conducted during the summer, heat stress is a concern in the health and safety of personnel. Persons required to wear protective equipment will be allowed the following rest periods when wet bulb temperatures fall within the indicated ranges:

- 76-80°F: 15 minutes each hour
- 80-85°F: 30 minutes each hour
- 85-90°F: 45 minutes each hour
- Over 90°F: No work

When the wet bulb glove temperature exceeds 75°F, the heart rate of each person using protective equipment who is working in the field activities zone will be taken by the SSC when that person leaves the zone (see Heat Stress Monitoring Form). If the heart rate of a person exceeds 90 plus his/her age in years, or a maximum of 160 beats per minute, the individual will be required to take a rest period. All persons working in the field activities zone will be trained to recognize the signs and symptoms of heat-related illness, to prevent such a situation, and to provide first aid for such illnesses.

Water will be made available to personnel, and its use will be encouraged.

ATTACHMENT F:

Respirator Care

Respirators belong to, and are only used and maintained by, the individual to whom they have been issued. Each Dames & Moore employee who anticipates working onsite must be trained, fit-tested, and declared medically fit to wear respiratory equipment prior to participating in field activities. Proper methods for respirator selection, use, and maintenance are defined in the Dames & Moore Respiratory Protection Manual.

ATTACHMENT G:

Certificate For Field Employees

A Fit for Duty Certificate, Training Certificate, and First Aid/CPR Certificate for each Dames & Moore employee working onsite must be included in this section.

APPENDIX B:

Laboratory Work Plan

LABORATORY WORK PLAN
REMEDIAL INVESTIGATION, VERIFICATION STEP
NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS

1. LABORATORY IDENTIFICATION

metaTRACE, Inc.
13715 Rider Trail North
Earth City, MO 63045
(314) 298-8566
(FTS) (314) 298-8757

NEESA Project Manager - Richard H. Mannz

Laboratory Quality Assurance Coordinator - Marleah M. Martin

2. SCOPE OF WORK FOR THE REMEDIAL INVESTIGATION, VERIFICATION STEP

a. Number and types of samples to be acquired:

The site investigation program, including the number and types of samples to be acquired at each site, is summarized in Table 1.

b. Type and number of determinations to be done on the above samples: See Table 1.

c. Analytical methods citations:

Analytical methods to be used by metaTRACE are included in Table 2. Detection limits that will be attained under normal sample conditions are presented in Tables 2, 3, 4, and 5.

d. Sampling melthods, procedures, and preservation methods:

All samples will be preserved according to the methods cited in Table 6. Sample container requirements and maximum holding times are also listed in Table 6. When requested, metaTRACE will provide properly prepared sample containers and coolers for transport from the sampling event.

3. SCHEDULE

a. Planned times for acquiring field samples:

Times for acquiring field samples are to be determined. As shown in the attached Verification Step schedule (Figure 1), sampling will be

conducted over four distinct time periods. The first quarter samples will include collection of soil, groundwater, and surface water samples. There will be three additional quarters of groundwater and surface water sampling thereafter.

b. Planned times for conducting analyses:

See Figure 1 for relative times for conducting analyses versus each sampling event. Turnaround time for chemical analyses will be 4 to 6 weeks.

TABLE 1

Summary of Proposed Field Investigation Program
Remedial Investigation, Verification Step
NTC Great Lakes, Illinois

Site Name	Number of Wells to be Installed	Type of Sample	Number of Locations	Description/Frequency of Sampling	Maximum Number of Samples	Parameters to be Analyzed
Golf Course Landfill	7	Groundwater Surface water	9 2	A maximum of two times A maximum of two times	18 4	Volatile organic compounds, semivolatile organic compounds, priority pollutant metals, PCB's, oil and grease, chloride, total organic carbon
Fire Fighting Training Area	4	Groundwater Surface water Soils	4[a] 4 12	A maximum of two times A maximum of two times One time; two samples will be collected, one each from surface and shallow depths, at each location.	8 8 24	Volatile organic compounds, semivolatile compounds, oil and grease, lead
Transformer Storage "Boneyard"	0	Soils	27	One time; two samples will be collected, one each from surface and shallow depths, at five of these locations. One surface sample will be collected at each of the remaining 22 locations.	32	PCB's, oil and grease, lead
RTC Silk-Screening Shop	0	Soils	3	One time; two samples will be collected, one each from surface and shallow depths, at each location.	6	Volatile organic compounds, silver, chromium (total), cadmium, lead
Exchange Service Station	6[b]	Soil gas Soils	82 6[b]	One time One time; three samples will be collected, one each from surface, shallow, and deep depths, in each well boring.	82 18	Soil gas: Fuel components (e.g., benzene, toluene, xylenes, ethyl benzene) Soil and groundwater: Volatile organic compounds, lead
		Groundwater	6[b]	To be determined[c]	(c)	
Harbor Dredge Spoil Area	0	Soil/sludge	14	One time; three samples will be collected, one each from surface, shallow, and deep depths, at each location.	42	Volatile organic compounds, priority pollutant metals, pesticides, PCB's

[a]One of these wells (MW4-1) will also serve as a background well for the Golf Course Landfill, and therefore will be sampled for all analytes of concern at the landfill.

[b]The number and location of soil borings/monitoring wells at this site are tentative. Final selections and recommended frequency of sampling will be based on the results of soil gas sampling and analysis.

[c]See Section 2.3.5.

TABLE 2

Information on Chemical Analysis Methods
RI, Verification Step, at NTC Great Lakes

Analytical Parameter	Analytical Technique	Water		Soil/Sludge	
		EPA Method No.[a]	Detection Limit (ug/l)	EPA Method No.[b]	Detection Limit (ug/g)
Priority pollutant metals:					
Antimony	ICP	200.7	10	6010	1
Arsenic	Graphite Furnace AA	206.2	60	7060	6
Beryllium	ICP	200.7	5	6010	0.5
Cadmium	ICP/Graphite Furnace AA[c]	200.7/213.2	5	6010/7131	0.5
Chromium (total)	ICP	200.7	10	6010	1
Copper	ICP	200.7	25	6010	2.5
Lead	ICP/Graphite Furnace AA[c]	200.7/239.2	5	6010/7421	0.5
Mercury	Cold Vapor AA	245.1	0.2	7471	0.1
Nickel	ICP/AA[c,d]	200.7/249.2	15	6010/7520	1.5
Selenium	Graphite Furnace AA	270.2	5	7740	0.5
Silver	ICP	200.7	10	6010	1
Thallium	Graphite Furnace AA	279.2	10	7841	1
Zinc	ICP	200.7	20	6010	2
Volatile organic compounds	GC/MS[e]	624	(f)	8240	(f)
Semivolatile organic compounds (BNA's/pesticides/PCB's)	GC/MS[e]	625	(g)	8250	(g)
Pesticides/PCB's[h]	GC/ECD	608[i]	(j)	8080	(j)
Total organic carbon	Combustion/Oxidation	415.1	1,000	NA[k]	--
Oil and grease	Spectrophotometric, IR	413.2	1,000	413.2[l]	100
Chloride	IC	300.0	20	300.0[l]	1.25

TABLE 2 (cont'd)

[a]EPA methods for water analyses are described in the following references:

EPA Method No. Series	Reference
200 through 400	USEPA, March 1979. Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983.
600	USEPA, July 1982. Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA-600/4-82-057.

[b]EPA methods for analysis of solid matrix samples are described in USEPA, November 1986. Test Methods for Evaluating Solid Waste, SW-846, Third Edition.

[c]The AA method will be used if the metal cannot be detected by ICP at a level at least two times the ICP detection limit. The detection limit shown is for the AA method.

[d]Graphite furnace AA for water samples; direct aspiration AA for soil/sludge samples.

[e]Includes library search to detect nonpriority pollutant compounds.

[f]See Table 3.

[g]See Table 4.

[h]Where lower detection limits are desired for pesticides or PCB's, in cases where compounds of this type are believed to be present or of concern, GC/ECD will be employed rather than GC/MS.

[i]In the RI program described herein, no water samples are scheduled for pesticide analysis by GC/ECD.

[j]See Table 5.

[k]NA = not applicable.

[l]See note "a." Modified method will be used for solid matrix analyses.

TABLE 3

Detection Limits for Volatile Organic Compounds by GC/MS

Compound Name	Water Detection Limits[a] EPA 624 (ug/l)	Soil Detection Limits[a] EPA 8240 (ug/g)
Chloromethane	10	0.010
Bromomethane	10	0.010
Vinyl chloride	10	0.010
Chloroethane	10	0.010
Methylene chloride	5	0.005
1,1-Dichloroethene	5	0.005
1,1-Dichloroethane	5	0.005
1,2-Dichloroethene (total)	5	0.005
Chloroform	5	0.005
1,2-Dichloroethane	5	0.005
1,1,1-Trichloroethane	5	0.005
Carbon tetrachloride	5	0.005
Bromodichloromethane	5	0.005
1,2-Dichloropropane	5	0.005
cis-1,3-Dichloropropene	5	0.005
Trichloroethene	5	0.005
Dibromochloromethane	5	0.005
1,1,2-Trichloroethane	5	0.005
Benzene	5	0.005
trans-1,3-Dichloropropene	5	0.005
Bromoform	5	0.005
Tetrachloroethene	5	0.005
1,1,2,2-Tetrachloroethane	5	0.005
Toluene	5	0.005
Chlorobenzene	5	0.005
Ethylbenzene	5	0.005

[a]Unknown responses in the mass chromatogram that account for greater than 10 percent of the concentration of the nearest internal standard will be library searched to attempt identification and quantification.

TABLE 4

Detection Limits for Semivolatile Organic Compounds by GC/MS

Compound Name	Water Detection Limits EPA 625 (ug/l)	Soil Detection Limits EPA 8250 (ug/g)
Base-Neutrals		
Acenaphthene	10	0.33
Benzidine	50	1.6
1,2,4-Trichlorobenzene	10	0.33
Hexachlorobenzene	10	0.33
Hexachloroethane	10	0.33
Bis (2-chloroethyl) ether	10	0.33
2-Chloronaphthalene	10	0.33
1,2-Dichlorobenzene	10	0.33
1,3-Dichlorobenzene	10	0.33
1,4-Dichlorobenzene	10	0.33
3,3-Dichlorobenzidine	20	0.66
2,4-Dinitrotoluene	10	0.33
2,6-Dinitrotoluene	10	0.33
1,2-Diphenylhydrazine	10	0.33
Fluoranthene	10	0.33
4-Chlorophenyl phenyl ether	10	0.33
4-Bromophenyl phenyl ether	10	0.33
Bis (2-chloroisopropyl) ether	10	0.33
Hexachlorobutadiene	10	0.33
Hexachlorocyclopentadiene	10	0.33
Isophorone	10	0.33
Naphthalene	10	0.33
Nitrobenzene	10	0.33
N-Nitroso-di-n-methylamine	10	0.33
N-Nitroso-di-n-propylamine	10	0.33
Butyl benzyl phthalate	10	0.33
Di-n-butyl phthalate	10	0.33
Di-n-octyl phthalate	10	0.33
Diethyl phthalate	10	0.33
Dimethyl phthalate	10	0.33
Bis (2-chloroethoxy) methane	10	0.33
Benzo (a) anthracene	10	0.33
Benzo (b) fluoranthene	10	0.33
Chrysene	10	0.33
Acenaphthylene	10	0.33
Anthracene	10	0.33
Benzo (g,h,i) perylene	10	0.33
Fluorene	10	0.33
Phenanthrene	10	0.33
Dibenzo (a,h) anthracene	10	0.33

TABLE 4 (cont'd)

Compound Name	Water Detection Limits EPA 625 (ug/l)	Soil Detection Limits EPA 8250 (ug/g)
Base-Neutrals (cont'd)		
Indeno (1,2,3-cd) pyrene	10	0.33
Pyrene	10	0.33
Bis (2-ethylhexyl) phthalate	10	0.33
Benzo (a) pyrene	10	0.33
Acid Extractables		
2,4,6-Trichlorophenol	10	0.33
2-Chlorophenol	10	0.33
2-Nitrophenol	50	1.6
4-Nitrophenol	50	1.6
2,4-Dinitrophenol	50	1.6
2,4-Dichlorophenol	10	0.33
Pentachlorophenol	50	1.6
2,4-Dimethylphenol	10	0.33
Phenol	10	0.33
4-Chloro-3-methyl phenol	10	0.33
4,6-Dinitro-2-methyl phenol	50	1.6
Pesticides/PCB's and Library-Searched Compounds	(a)	(a)

[a]Pesticides, PCB's, and unknown responses in the mass chromatogram that account for greater than 10 percent of the concentration of the nearest internal standard will be library searched to attempt identification and quantification.

TABLE 5

Detection Limits for Pesticides and PCB's by GC/ECD

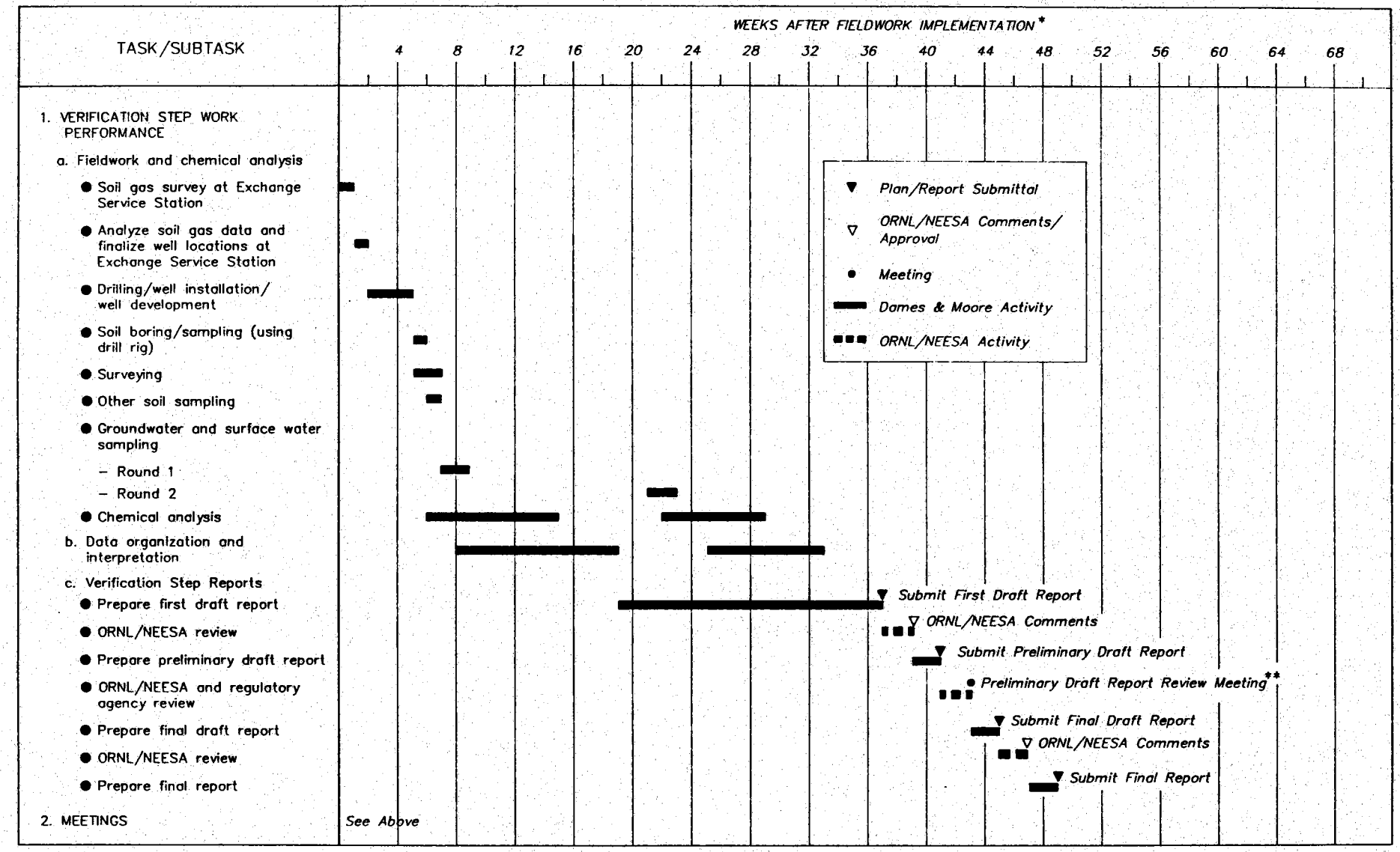
Compound Name	Water Detection Limits EPA 608 (ug/l)	Soil Detection Limits EPA 8080 (ug/g)
Pesticides		
alpha-BHC	0.003	0.008
beta-BHC	0.003	0.008
delta-BHC	0.009	0.008
gamma-BHC (Lindane)	0.003	0.008
Heptachlor	0.003	0.008
Aldrin	0.004	0.008
Heptachlor epoxide	0.083	0.008
Endosulfan I	0.014	0.008
Dieldrin	0.002	0.016
4,4-DDE	0.004	0.016
Endrin	0.006	0.016
Endosulfan II	0.004	0.016
4,4-DDD	0.011	0.016
4,4-DDT	0.012	0.016
Endrin aldehyde	0.023	0.016
Endosulfan sulfate	0.066	0.016
Chlordane	0.014	0.008
Toxaphene	0.24	0.008
PCB's		
PCB-1016	0.065	0.08
PCB-1221	0.065	0.08
PCB-1232	0.065	0.08
PCB-1242	0.065	0.08
PCB-1248	0.065	0.08
PCB-1254	0.12	0.16
PCB-1260	0.12	0.16

TABLE 6

Information on Sample Containers, Preservation, and Holding Times
RI, Verification Step, at NTC Great Lakes

Analyte	Container Requirements	Preservation	Maximum Holding Time
	Water Samples		
Priority pollutant metals	1-quart plastic bottle	HNO_3 to pH < 2, cool to 4°C	28 days for mercury, 6 months for others
VOC's	40-ml glass vials with Teflon septum caps, 2 per sample	Cool to 4°C	7 days
BNA's/pesticides/PCB's (by GC/MS)	1-gallon amber glass bottle with Teflon-lined cap	Cool to 4°C, store in dark	7 days until extraction, 40 days after extraction
Pesticides/PCB's (by GC/ECD)	1-gallon amber glass bottle with Teflon-lined cap	Cool to 4°C, store in dark	7 days until extraction, 40 days after extraction
TOC	8-ounce amber glass bottle	HCl or H_2SO_4 to pH<2, cool to 4°C	28 days
Oil and grease	1-quart glass jars, 2 per sample	H_2SO_4 to pH<2, cool to 4°C	28 days
Chloride	1-quart plastic bottle	None required	28 days
	Soil/Sludge Samples		
All analytes listed above except VOC's	250-ml wide-mouth amber glass jar with Teflon-lined cap[a]	Cool to 4°C, store in dark	Same as above for corresponding water samples
VOC's	40-ml glass vials with Teflon septum caps, 2 per sample	Cool to 4°C	10 days

[a]For sampling soil/sediment with very high water content, two 1-quart wide-mouth amber glass jars are required.



* Upon receiving authorization to proceed, Dames & Moore can implement fieldwork within approximately three weeks.

** Additional review time may be needed to allow for regulatory review.

FIGURE 1
PROPOSED SCHEDULE
RI VERIFICATION STEP AT
NTC GREAT LAKES

REMEDIAL INVESTIGATION
NAVAL TRAINING CENTER
Great Lakes, Illinois

APPENDIX C:

Laboratory Quality Assurance Plan

metaTRACE, Inc. 13715 Rider Trail North ▪ Earth City, MO 63045 ▪ (314) 298-8566
A subsidiary of TRC Companies, Inc.

QUALITY ASSURANCE MANUAL

JULY 1987

metaTRACE, Inc.
13715 Rider Trail, North
Earth City, MO 63045

The enclosed Quality Assurance Manual is the work product of metaTRACE, Inc.

metaTRACE, Inc. 13715 Rider Trail North ▪ Earth City, MO 63045 ▪ (314) 298-8566

July 16, 1987

Dr. Stephen Lemont
Dames & Moore
7101 Wisconsin Avenue
Suite 700
Bethesda, Maryland 20814

Dear Dr. Lemont:

Attached please find metaTRACE's Quality Assurance Manual. This manual has been reviewed by Martin Marietta for compliance with NEESA guidelines. Deficiencies were noted and revisions were made to comply with NEESA's requirements. Other concerns that were discussed during the Martin Marietta audit are addressed in Standard Operating Procedures G005, G006, and G034 which are attached to the QA manual.

We are in receipt of Martin Marietta's audit report and will be responding to their findings in the near future. If you require additional information, please do not hesitate to call.

Very Truly Yours,

Richard H. Mannz

Richard H. Mannz
Manager/ Environmental Programs

RHM:bcb

Encls.

FORWARD

metaTRACE, Inc. is committed to establishing an effective Quality Assurance/Control (QA/QC) Program. metaTRACE realizes the importance in planning and implementing the appropriate quality measures to ensure a quality product for metaTRACE's clients. This Quality Assurance Manual outlines the procedures and/or systems that metaTRACE incorporates to provide that "value-added" service.

I. Quality Assurance Policy

metaTRACE management is fully committed to an effective Quality Assurance/Quality Control (QA/QC) Program whose objective is the delivery of a quality product. The Quality Assurance Program works to provide complete, precise, accurate, representative data in a timely manner. In all cases, the end use of the product and the existing budget contraints are considered in planning and implementing quality measures.

Quality assurance is defined as the overall management system which operates to ensure that the quality control systems are functioning well. Quality assurance audits, interlaboratory comparisons, on-site systems audits, periodic evaluation of quality control procedures and data, and a corrective action system.

Quality control refers to the continuing routine checks on quality within each segment of project activity such as analysis, and data collection and handling. metaTRACE Standard Operating Procedures detail specific quality control procedures for these segments. They include such activities as periodic instrument calibrations, routine equipment maintenance, sample handling, edit tests with error diagnostics, etc.

II. Quality Assurance Organization

metaTRACE's Quality Assurance Program conforms with EPA and NIOSH recommendations and is directed by the QA Manager who reports directly to the Technical Director (see Figure 1) metaTRACE Organizational Chart thereby giving the QA Manager the necessary authority and independence to find and correct any existing quality problems. The QC Coordinator is responsible for the laboratory QC program; he reports to both the Technical Director and QA Manager.

metaTRACE's program includes Standard Operating Procedures, specific QA Project Plans, personnel training, QA audits and corrective action procedures. The program is designed to provide both continuity and flexibility in ongoing QC activities in all departments. Continuity, structure and direction are provided by the QA Manager and QC Coordinator: their responsibilities are outlined in this section.

A. QA Manager

The QA Manager is an employee of Alliance Technologies Corporation under contract to metaTRACE. He reports directly to the Technical Director and is, therefore independent of the laboratory operations. The QA Manager oversees the QA Program, selects

projects for audit and conducts audits of metaTRACE's and subcontractor work. He consults with the QC Coordinator on ongoing QC activities, reviews QA Project Plans, reviews work plans and reports for QA requirements, and initiates or follows up on corrective actions, as necessary. Revisions to the QA Manuals and specialized training sessions are coordinated by the QA Manager, through the laboratory QC Coordinator

B. QC Coordinator

A QC Coordinator is appointed by and reports to the Technical Director and is under the review of the QA Manager. The QC Coordinator is on staff to the Technical Director to ensure his independence from the technical staff generating data. The QC Coordinator is responsible for the QC program in the laboratory. He has the authority and responsibility to bring quality problems to the attention of the Technical Director and the QA Manager. The QA Manager meets individually with the QC Coordinator on a regular basis and on an ad hoc basis as appropriate. The QC Coordinator is responsible for maintaining awareness of active projects and their QC needs, providing QA/QC information to staff, coordinating technical review of reports, and providing a quarterly written report on QC activities to the Technical Director and QA Manager.

The QC Coordinator oversees and implements the ongoing laboratory Quality Control Program.

The QC Coordinator reports directly to both the Technical Director and the QA Manager. The duties of the Coordinator include:

- reviewing new tasks and ensuring QA Project Plans are prepared as needed
- reviewing Lab Coordination Sheets for compatibility of sampling and analytical procedures
- supervising the operation of the QC Sample Bank
- directing the preparation and inclusion of blind QC samples in the sample load in a fashion unrecognizable to the analysts
- monitoring use of know QC samples, blanks and duplicates as required by individual programs

- maintaining records of performance on known and blind QC samples as a measure of analytical precision and accuracy
- maintaining an inventory of NBS and EPA reference materials for use as QC samples
- ensuring that project problems are identified and corrective actions implemented
- ensuring that QA sections are prepared for reports requiring them

C. Project Specific QA/QC Plans

metaTRACE's technical staff operates under the guide lines of the QA Program using appropriate procedures provided in the Standard Operating Procedures and the analytical method manuals. He ensures that even small projects have written QC procedures provided.

For larger projects or those with detailed QA/QC needs, a QA/QC Project Plan is prepared outlining QA requirements and providing specific QC procedures. These plans utilize procedures from metaTRACE's Standard Operating Procedures as appropriate, but they are specific to an individual project. A QA/QC Project Plan may contain sampling and analysis equipment calibration and maintenance procedures.

The Plan content is designed to incorporate the appropriate QC procedures and to meet client specifications. Most QA Project Plans are prepared according to the EPA's "Interim Guidelines and Specifications for Preparing Quality Assurance Plans," QAMS-005/80, U.S. Environmental Protection Agency, Washington, D.C. 1980. The QC Coordinator and the QA Manager have copies of this guideline document available.

These plans are subject to review and approval by the QA Manger.

D. Standard Operating Procedures

metaTRACE Standard Operating Procedures includes sections on general laboratory quality control, data recording and reporting, analytical instrument calibration and maintenance, sample identification and chain-of-custody.

The indexing format for the Standard Operating Procedures Manuals includes, at the top of each page, the following information:

- Section:____
- Revision:____
- Date:____
- Page:__ of ___
- Replaces:____

"Section" identifies major three-digit sections; "Revision" represents the most current version of the section with the first version represented as "0"; "Date" indicates the date of the most recent revision; and "Page" includes the number of the specific page and total number of pages in the section; "Replaces" indicates the most recent SOP section that the current revised SOP is replacing.

For each three-digit level or data form, the text begins on a new page. The format groups the pages together to allow convenient revision of the section or form. Even if only part of a section is revised, the whole section is given a new Revision Number and replaced in the handbooks. The Table of Contents is also updated so that it lists the most recent revision of each section or data form.

III. Elements of Quality Assurance

The following elements of quality assurance have been included in the design of metaTRACE's QA/QC Program:

- Personnel Training
- Document Control
- Procurement Quality Control
- Equipment Maintenance and Calibration
- Preliminary or Pretest Preparation
- Sample Handling
- Sample Analysis
- Intralaboratory and Interlaboratory Testing
- Data Reporting
- Data Validation
- Statistical Analysis of Data

- Audit Procedures
- Corrective Action Procedures

The remainder of the Manual describes the general application of these quality control elements to meet metaTRACE's goal of producing quality data. Some individual Standard Operating Procedures (SOP) contain a more detailed discussion of the QA elements appropriate to that technical activity and include specific QC procedures.

A. Personnel Training

The objectives of QA training are to make metaTRACE's personnel aware of the importance of quality assurance and to inform them of the overall QA Program and their personal part in it. The significance of each person's job and performance is emphasized to foster personal involvement in the Program.

Employees are trained in their job operations so they can apply QC procedures to a sound base. Sampling and analysis programs involve complex technical procedures and precise following of directions, so special attention is given to on-the-job training for new employees, or to a staff member working with a procedure for the first time. The employee first studies the written technical procedures, performs the operations under the direct supervision of an experienced staff member and then, if appropriate, uses a standard or other QC sample to test his mastery of the procedure. The employee is told the results of the QC checks to help improve his performance, if necessary, and to develop a positive attitude on his part. In most cases, excellent results are quickly obtained and the employee takes pride in knowing he is performing well.

The Standard Operating Procedures are an important tool in this training, providing both an overview of policy and specific procedures to be followed. Under the direction of the QA Manager, the QC Coordinator works to have all staff members follow these procedures. Current procedure write ups are used to avoid word-of-mouth transfer of incorrect technical instructions. metaTRACE's QC Coordinator provides continuing information on quality assurance activities to all staff; technical seminars and training sessions are scheduled as appropriate.

B. Document Control

The varied activities of metaTRACE require many forms

of document control to provide completeness and traceability, clear sample identification and chain-of custody information, confidentiality, current technical and QC procedure descriptions, and retrieval of information. Documents generated include computer programs, lab data sheets,, technical drawings, official project memos and reports. The Standard Operating Procedures address document control procedures appropriate to each technical work area; general information is provided in this section.

1. Measures to Ensure Completeness and Traceability

Notebooks and standardized data forms are used, and logs of gathered data and its sources are maintained to ensure completeness and traceability. Bound and paginated notebooks are used for laboratory analysis. The notebooks are page-numbered in single-or double-page versions; the page numbering ensures that data is not removed or added. Completed pages are dated and witnessed. The double-page books are used with carbon paper to provide a copy of the data. The Laboratory Standard Operating Procedures contain detailed sections on laboratory notebook use.

Standardized data forms are designed to gather the complete set of data needed for a particular technical activity. Telephone Conversation Reports, and Instrument Calibration Sheets are examples of the many types of data sheets used by metaTRACE's staff members. The standardized forms also ensure the comparability of data gathered by different people working on the same task.

Document control of data gathered from various sources is maintained by keeping a record or log of all the data. The log includes the title and/or description of each item, its source and/or author and the date it was received. It is useful to number each data item and provide a keywork or other very brief summary of the contents.

2. Chain-of-Custody Information

The documentation of sample identification and handling, and assignment of a responsible person are essential in many metaTRACE projects. Section:8 Sample Collection and Handling in this Manual discusses chain of-custody policies and the Standard Operating Procedures provide more detail. QA Project Plans include the specific custody forms to be used.

3. Confidentiality Procedures

A confidentiality requirement extends to the documents cited above. The Document control Coordinator ensures that metaTRACE makes every effort to provide and maintain confidentiality at all stages of the data handling. Certain EPA Programs require metaTRACE to obtain a security clearance to receive confidential business information specific to various other regulatory authorities. When these clearances are required under specific programs the appropriate procedures are submitted and metaTRACE employees then execute confidentiality agreements on a need to know basis. Specific security Standard Operating Procedures are prepared for these regulatory authorities and are available from the metaTRACE Document Control Coordinator.

4. Project Memos and Reports

The project manager is responsible for the control of all official memos and reports issued and for the completeness of the project file. Upon completion of a project, the document Control Coordinator is responsible for collecting all information pertaining to a specific project including but not limited to: raw data, copies of laboratory notebook pages, chain-of-custody records, sample bottle tags, notes, memos, telephone records of conversation, and interim and /or final reports and storing them in locked filing cabinets.

5. Project Document Inventory

Some projects require the compilation of a document inventory containing all project documents. EPA's National Enforcement Investigations Center (NEIC) has outlined requirements for this type of document control in two publications: "NEIC Policies and Procedures Manual" and "Enforcement Consideration for Evaluation of Uncontrolled Hazardous Waste Disposal Sites by Contractors."

metaTRACE follows the rigorous NEIC requirements when appropriate. They include the designation of a Document Control Coordinator and the identification of accountable documents. Preserialized sample identification tags and chain-of-custody records are used and a unique project code is used for all project documents.

6. Procurement Quality Control

In general, procurements fall into two classes- materials and services.

Materials
When applicable, Purchase Requisitions include quality requirements and these requirements are incorporated in the Purchase Order. Appropriate materials are subjected to acceptance tests or incoming inspection and records of these tests are maintained.

The requisitioning laboratory (GC,GC/MS, etc) is responsible for evaluating the quality of purchased materials and notifying the Operations Manager of any deficiency. The Operations Manager initiates Vendor Corrective Action if necessary.

Limited shelf life materials such as chemicals are identified and the expiration date noted on individual containers. Documentation of QC approved lots of reagents, QC check results, dates of receipt and expiration dates are maintained by the QC Coordinator.

Services
In addition to the control over procured materials, a rigorous program of procured services control is maintained. Any subcontractors employed by metaTRACE, Inc. are required to conform to metaTRACE's quality program. For example, if a service laboratory performs some analytical work under contract to metaTRACE, that laboratory must describe its QC procedures and submit documentation of the QC work performed. In addition, metaTRACE routinely incorporates QC samples (blanks, duplicates or samples whose true values are know to metaTRACE) in the sample load so that they are unrecognizable to the subcontractor. The results on these samples provide an independent measure of the quality of the subcontractor's work.

7. Equipment Maintenance and Calibration

For analytical laboratory activities, preventive maintenance includes attention to glassware, water supply, reagents and analytical balances as well as to more complex instrumentation. metaTRACE's quality control procedures for these components are detailed in specific standard operating procedures; instrument maintenance and calibration procedures are included.

8. Sample Collection and Handling

metaTRACE's Quality Control Coordinator (QCC) will coordinate with the field sampling crews to assure that standard methods of collection are being implemented. This includes the appropriate sample containers, preparation and preservation of all samples along with any specific quality control

requirements.

Chain-of-custody procedures related to samples which are collected for laboratory analysis will be initiated by the field crew. The purpose of these procedures is to document the identity of each sample and its handling, from its first existence as a sample until all laboratory analysis has been completed and, if appropriate, the information derived from the sample that has been introduced as evidence in litigation. metaTRACE's Standard Operating Procedures discuss these chain-of-custody procedures in more detail.

All samples submitted to metaTRACE's laboratories are brought to the Sample Custodian who establishes or continues the chain-of-custody by assigning a metaTRACE Control Number to each sample which identifies it through all further handling. The sample is recorded in the Master Log under this Number and the Control Number is written on the sample container. An internal chain-of-custody record is initiated for each sample and each handling of the sample is documented on that record.

metaTRACE maintains large, locked, refrigerated and nonrefrigerted storage areas with provisions for hazardous material storage. After necessary preservation of subdivision, the Sample Custodian stores each sample in the appropriate area, filed under its metaTRACE Control Number. Records are maintained of sample transfer within the laboratory. Samples which will not be analyzed by metaTRACE's laboratories are handled in essentially the same way with the Project Manager responsible for notifying the Sample Custodian of receipt of samples. Samples transferred to an outside laboratory are accompanied by a custody record.

9. Sample Preparation

Sub-sampling will be done on a well-mixed sample. Exercising caution to remove or avoid twigs and rocks in all soil sub-sampling procedures. All sub-sampling aliquots will be as large as the method allows to ensure a representative sample.

If metaTRACE receives any samples that have not been previously filtered in the field, as required then samples will be passed through a 0.45 micron glass fiber filter.

All dilutions will be carried out as serial dilutions using volumetric pipets and flasks. Any dilution

greater than 1:100 will be carried out in multiple steps to decrease dilution errors.
Preparation and use of calibration standards is outlined in metaTRACE's SOP's.

10. Sample Analysis

metaTRACE, Inc. conducts a wide variety of analyses requiring reliable chemical procedures. The individual laboratories perform all of these analyses using the appropriate elements of quality assurance in the programs as documented in specific standard operating procedures.

11. Laboratory Analysis Quality Control

Standard Operating Procedures document QC procedures which are implemented by the entire laboratory staff with direction from the QC Coordinator. The QC Coordinator reports to both the Technical Director and the QA Manager and is therefore independent of the technical sections of the laboratory. Written analytical procedures are contained in several methods manuals; specialized project method manuals are prepared when appropriate.

Limits of detection are determined as outlined in SOP G034. The MDL's obtained by this procedure are used to judge the significance of a single measurement and is designed for a broad variety of physical and chemical methods.

12. Intralaboratory/Interlaboratory Testing

metaTRACE makes use of intralaboratory testing to achieve the best possible performance within its own laboratories and interlaboratory testing to compare that performance with other laboratories.

Intralaboratory testing is performed to demonstrate that the analytical system is in control, to identify any sources of error within the measurement method, and to establish the precision and accuracy of the method.

metaTRACE uses a laboratory blank prepared according to the specific method and matrix requirements. Method blanks are run with every analysis batch; they aid in demonstrating good control, or in investigating problems. Some of the potential sources of error are the operator or analyst, equipment, calibration, or the operating conditions.

metaTRACE uses Laboratory Control Standards (LCS), and/or spiked blank whose true values are known to the analyst to establish that the analytical procedure is in control. A laboratory control standard is a blank into which a known amount of the analyte(s) of interest is(are) spiked. Samples must be tied to the LCS by means of a date or batch identifier. Recorded data generated by the analysis of the LCS will be used to construct a control chart (see Attachment 2) and control limits will be established. After analysis of each batch of samples, the analyst must check the appropriate control chart to ensure that the analysis value for the LCS falls within the control limits for that method. If the LCS exceeds the control limits, corrective action is taken; no further samples are analyzed until analysis of an LCS shows the methodology is in control.

A surrogate standard is a mixture of compounds spiked into all samples unless a specific exception is made in the method itself. The surrogate standard has applications to organic analytes determined by GC & GC/MS procedures and may be used to determine recoveries and therefore matrix interferences.

A matrix spike is an environmental sample spiked with the compounds of interest or a representative cocktail of these compounds. The matrix spike is used to determine the effect of the matrix on recovery, rather than as a control sample. The matrix spike has applications to inorganic and organic analyses and may be used to determine chemical recoveries from the environmental matrix.

Precision is determined on replicate samples; if these replicate samples are standard reference materials, accuracy can be determined at the same time. Acceptance limits are established using the range between the duplicates.

During analysis, if the range of a set of duplicates falls beyond the control limit, the data will be regarded as unreliable. Immediate corrective action will be taken and the analyses repeated.
Matrix spike and matrix spike duplicate samples per CLP protocol will be used to satisfy the duplicate criteria for GC and GC/MS analyses.

Quality Control criteria for GC and GC/MS analyses, when not CLP protocol, will be determined by windows established from such analyses performed using the type of quality control frequencies listed below.

Frequency of all quality control analyses will be performed as outlined in the chart below.

TYPE	FREQUENCY[1]	CONTROL
ORGANIC ANALYSES		
Blank	1	Surrogate Compounds
LCS and/or Spiked Blank	1	% Recovery, analytes of interest
Duplicate	1	RPD
Matrix Spike	1	% Recovery of target analyte(s)
Matrix Spike Dup.[2]	1	RPD and % Recovery
INORGANIC ANALYSES		
Blank	1	No contamination
LCS and/or Spiked Blank	1	% Recovery, analytes of interest
Duplicate	1	RPD
Matrix Spike[2]	1	% Recovery of target analyte(s)

Blind QC samples are periodically inserted into a sequence of samples by the QCC. Blind QC samples are prepared by the QCC or designee independently from the laboratory operations staff and serve as an independent check on the analyst's performance. Blind QC samples may be obtained from reference materials purchased from the EPA, NBS, ERA or any other certified quality control source. Blind QC samples can also be prepared from sample splits or previously analyzed samples of known concentrations under the guidance and control of the QCC. They are initiated into metaTRACE's chain-of custody routine as a normal sample and handled as such until analysis and reporting of results is complete.

Interlaboratory tests are designed to compare the performance of several laboratories. Usually, identical sample sets are submitted to a relatively

1 Frequency is based a batch of 20 samples or less of a similar matrix or whenever samples are extracted, whichever is more frequent.

2 MS/MSD analyses will be performed per client request.

A coordinating lab received all the results and summarized the data so that any participating laboratory can evaluate and improve its own performance. metaTRACE laboratories participate egularly in Water Supply Performance Evaluations; Water Pollution Performance Surveys; Asbestos Bulk Sample Analysis QA Program; and specialized audit programs such as that for Level 1 Environmental Assessment analyses. Both internal staff members and the QC Coordinator evaluate the results; if any results are not within the control limits established by the coordinating laboratory, corrective action is initiated at metaTRACE.

13. Data Reporting

Procedures for recording and reviewing data at several levels are used at metaTRACE to minimize human and automated data handling errors.

a) Manual Recording
Standard Operating Procedures describes the QC procedures used for laboratory notebooks and includes data worksheets which are routinely used in the reduction of quantitative instrument data to a report format expressed in terms of concentration. This instrumental data is then entered on summary worksheets.
Data gathering tabulation forms are designed to be complete, appropriate, and to include checks on the reasonableness of responses. Care in entering and transcribing responses is emphasized.

b) Automated Recording
Many of analytical measurements made by metaTRACE staff members are automatically recorded; e.g., complex analytical instruments (Hewlett-Packard 5988 and 5995 GC/MS systems, Jarrell-Ash 855 ICP, etc.) have their own computerized data systems. metaTRACE instrument checklists include checks on the operation of these data handlers and internal validity checks are used to flag data resulting from electronic interferences.

c) Calculation of Results
Whenever possible, calculations are computerized for efficiency and to avoid human error. The analytical data systems mentioned above calculate results as programed and provide hard copy in the desired format. In all cases, computerized data are verified for error control, and careful handling of computer storage peripherals is stressed. Tests are built into the programs to

trap transcription errors or missing items, and acceptance limits are included in computerized systems when appropriate. The record of the run contains the calculation results, and the input data. Analytical results are reduced to the correct number of significant figures for the measurement technique.

d) Data Review

The analyst and data gatherer should be alert to the importance of the data they are recording. Acceptance limits are provided to help the operator spot questionable data and control charts are used whenever possible to show if the procedure is in control.

The Quality Control Coordinator initiates control charts for instrument performance and specific analytical methods, and reviews routine and specialized QC sample results as they pertain to each project.

In the laboratory, the Project Manager and the Operations Manager review data promptly to ensure its reasonableness and determine if corrective action is needed.

e) Data Validation

Data validation is the process of filtering data and accepting or rejecting it on the basis of sound criteria. metaTRACE supervisory and QC personnel use validation methods and criteria appropriate to the type of data and the purpose of the measurement. Records of all data are maintained even those judged to be "outlying" or spurious values.

Usually acceptance limits or control chart control limits are used as the rejection criteria. The QA Project Plan states the number of data items to be validated, the allowable number of errors and further action to be taken when an error is found. Analytical data is validated using the following general criteria:

- Documentation of sample identity and handling, e.g., preservation, and required analyses
- Use of approved analytical procedures
- Use of QC checked reagents
- Use of know QC samples (LCS) to ensure analytical system was in control
- Analysis of required blanks, duplicated and blind QC samples completed

- o Precision and accuracy achieved on replicate and blind QC samples

The experience of the laboratory staff is relied on for judgment; questionable results are noted and investigated but not usually rejected. As noted in Section___12.e_ the laboratory QC personnel perform this validation in their review of data reports.
Manual data validation criteria apply to computerized data also. Acceptance limits are used when enough experience and information on analyzing the same type of samples exists.
Programed checks on the reasonableness of gathered or previously existing data used for planning and analysis projects aid in validating the data. The computer programs contain edit checks to be sure the proper information is entered, and provide for easy correction of mistakes. The input values and error messages are provided with the calculated results for ease in checking.
QC and supervisory personnel validate all computerized data; the QA Manger may audit the validation by running a dummy set of data through the computer. The Project Manager is consulted for technical judgment if a validity question is found.

14. Statistical Analysis of Data

Statistical tools and techniques are used with discretion to aid in the analysis of collected data. The Project Manager defines the type and extent of statistical analysis to be performed for each project.

Computerized statistical treatment is facilitated by use of the appropriate routines. QA/QC samples are analyzed statistically to derive the maximum benefit from their use; frequently used statistical techniques are briefly described in this section.

a) Frequency distribution
The frequency distribution is a means of presenting data in a form which makes clear the central tendency and the dispersion of the data. Plotting these histograms of the data points or using probability graph paper establishes the type of distribution present; it is necessary to know how data are distributed to correctly choose other statistical tools. In sampling and analysis, the most frequently encountered continuous distributions are normal and

lognormal. Most QC samples are normally distributed.

b) Mean, Standard Deviation, Coefficient of Variation

These summary statistics are used to simplify the presentation of data and are especially useful in evaluating quality control samples. The accuracy achieved on QC samples is evaluated by comparing the mean of repeated measurements with the known value of the reference material; the precision achieved is shown by the standard deviation and coefficient of variation.

The mean is a location parameter which describes the central tendency of the data; the arithmetic mean is used unless the data is known to be lognormally distributed. In that case, the geometric mean is used. The standard deviation and coefficient of variation (relative standard deviation) are measures of the dispersion of the data. The range between the largest and the smallest value in a small set of data ($2 \geq n \leq 8$) sometimes used instead of the standard deviation, especially in Shewhart Control Charts.

c) Identification and Treatment of Outliers

A data point which deviates markedly from others in its set of measurements may be referred to as an outlier. The outlier may result from an error in the measurement system or technique or, it may be a valid value due to unique circumstances at the time of sampling, analysis, or data collection. The suspected outlier value is recorded and retained in the data set while it is investigated. There is a great reluctance to reject an observation even if confirmed as an outlier.

The laboratory notebook should indicate any unique circumstances which occurred during analysis. It is useful to also perform a simple statistical test on suspected outliers, metaTRACE staff members usually use one or both of the following tests to identify outliers. Dixon's test for extreme observations is an easily computed procedure for determining whether a single, very large, or very small value is consistent with the remaining data. The one-tailed t test for difference may also be used in this case. If the suspect value is statistically identified as an outlier, further investigation is initiated. The operator, analyst, or data gatherer who worked with the sample is consulted for his knowledge of the specific sample and his experience with the similar samples. This may

give an experimental reason for the outlier and a decision can then be made as to whether the outlying value should be kept in the data set. Further statistical analyses are performed with and without the outlier to determine its effect on the conclusions. In many cases, two data sets will be reported, one including and one excluding the outlier.

In summary, every effort is made to include the outlying value in the reported data. If the value is rejected, it is identified as an outlier, reported with its data set and its omission is noted.

d) Regression analysis

Regression analysis is a statistical technique for estimating the parameters of an equation relating a particular set of variables to another set of variables. Lease-squares linear regression is widely used in analytical work to relate concentration values to instrument readings.

This statistical technique minimizes the sum of the squares of the deviations of the data points from the straight line of best fit, and gives the parameters of the linear regression equation. The correlation coefficient indicates how well the data actually fits the least-squares line.

15. Control Charts

The control chart displays data in a form which graphically compares the variability of all test results with the average or expected variability of small groups of data. The variability may be due to random (indeterminate) or to assignable (determinate) causes. The control chart distinguishes indeterminate from determinate variation in a process or method by its control limits. If a value falls outside the control limits, it is considered out-of-control, almost certainly due to a determinate cause which has been added to the indeterminate variations. The control chart signals the need to investigate, find the determinate cause and correct it. metaTRACE uses the Shewhart type of chart with control limits defined by the client, or calculated on the basis of the mean plus or minus 2 or 3 times the standard deviation of the statistic used. If only indeterminate variations are occurring and control limits are set at plus or minus 2 standard deviations, 95.5 percent of the plotted values will fall within the control limits. If plus or minus 3 standard deviations from the mean are used as control limits, 99.7 percent of the

plotted values fall within these limits. When this happens, the process or method is considered in control.Construction of a control chart requires a minimun of 14 to 20 duplicate sets of data points which limits its use somewhat. Quality control samples and instrument calibrations lend themselves most readily to the gathering of the data. metaTRACE uses X, R charts for plotting accuracy and precision of analytical QC samples. Calculation of control limits and the values are usually plotted chronologically so that trends or cycles can be readily detected. If QC sample measurements show an out-of-control condition, it can be expected that subsequent sample analyses might yield invalid data. The control chart is an effective indicator of the need for corrective action.

16. Audit Procedures

metaTRACE's Quality Assurance Program includes both performance and system audits as independent checks of the quality of data obtained from laboratory analysis, and data gathering activities. Every effort is made to have the audit assess the measurement process in normal operation. Audits of assembly or inspection procedures are conducted during instrument manufacture. Either type of audit may show the need for corrective action.

17. Performance Audits

The analysis and data handling segments of a project are checked in performance audits. The QC Coordinator ordinarily arranges the audits so they are unknown to the project staff, or a different operator/analyst performs the audit operation to ensure the independence of the <u>quantitative</u> results. The auditing frequency is outlined in the QA Project Plan and is based on past experience with particular sampling and analysis procedures, client guidelines and project needs. An audit rate ranging from 5 to 10 percent is commonly used and results are plotted on control charts to permit continuous, rapid evaluation of quality control effectiveness. Reference standards may be randomly dispersed among samples awaiting analysis to check the analytical procedure. Data handling is checked by using the original raw data and performing all necessary calculations and entry of data. The audit results are recorded and compared with routinely obtained data.

18. System Audits

This qualitative review checks that the QC measures outlined in the QA Project Plan are in use; it is a general overview of the whole quality system for that project. The QA Manager usually conducts a system audit onsite at the start of a program. A qualitative review of analytical work is usually conducted at metaTRACE's facility; however, the QA Manager is experienced in auditing subcontractor work at other locations.

19. Corrective Action Procedures

Perhaps the single most important part of any quality assurance program is a well-defined, effective policy for correcting quality problems. metaTRACE maintains a closed-loop corrective action system under the direction of the QA Manager with full management support. While the entire Quality Assurance Program operates to prevent problems, it also serves to identify and correct those that may exist. Usually these quality problems require either on-the-spot immediate corrective action or long-term corrective action.

20. Immediate Corrective Action

Instrument and equipment malfunctions and associated repairs are most amenable to immediate corrective action by the analyst, before erroneous data is generated. metaTRACE's quality control procedures incorporate method or equipment specific operating ranges or instrument tuning and/or calibration procedures designed to define instrument or equipment performance. Analysts are responsible for ensuring that each piece of equipment and instrument meets method or manufacturer required criteria prior to sample analyses. When any equipment or instrument fails to meet established criteria, the cause of the failure is investigated and corrected. This may simply mean retuning or recalibrating the instrument or it may involve disassembly and cleaning or replacement of defective parts. metaTRACE maintains service contracts on major instrumentation as a precaution against major instrument down time. All instrument repairs are recorded in individual laboratory maintenance notebooks. These everyday evaluations and corrective actions are part of the QA/QC system. Other QC problems do not lend themselves to this type of immediate corrective action. The following subsections discusses metaTRACE's system for effectively handling these long-term actions.

21. Long-Term Corrective Action

Any quality control problem identified by standard QC procedures, control charts, performance or system audits which cannot be resolved by immediate corrective action falls into the long-term category. metaTRACE uses established QC parameters to identify out-of-control situations, identifies procedure to ensure that out-of-control situations are reported to appropriate supervisory personnel who are responsible for ensuring that the problem is corrected as part of a closed-loop action. The essential steps in the metaTRACE closed-loop corrective action system are:

- Identify the out-of-control situation. This is best accomplished through the daily review of established Quality Control charts which define acceptable method performance.

- Assign responsibility for investigating the problem.

- Investigate the cause of the out-of-control situation and identify affected data.

- Determine a corrective action plan to eliminate the problem. Action plans may require changes or additional standard operating procedures, additional training for personnel involved, or maintenance or repair of equipment or instrumentation.

- Assign responsibility and implement the corrective action plan.

- Monitor and evaluate data to establish the effectiveness of the corrective action.

- Verify that the chosen corrective action plan has eliminated the out-of-control problem. Reanalyze effected samples and report data.

Documentation of the problem is important to the system. A Corrective Action Report is completed by the person finding the quality problem and submitted to the QC Coordinator immediately. This report identifies the problem, possible causes and the person responsible for action on the problem. The responsible person may be an analyst, QC Coordinator or the QA Manager. If no person is identified as responsible for action, the QC Coordinator investigates the situation and determines who is responsible.

The Corrective Action Report includes a description of the corrective action planned and the date it was initiated, and space for follow-up. The QC Coordinator checks to be sure that the initial action is appropriate and has been implemented and, at appropriate later dates, checks again to see if the problem has been fully solved. The report aids the QA Manager in follow-up and makes any quality problems visible to management; and may also prove valuable in listing a similar problem and its solution. This system has proved quite effective in handling sequential types of corrective action since it brings to the QA Manager's attention at a time appropriate to check on the next stage of corrective action.

Carol L. Byington
Technical Director

7/16/87
Date

Marleah M. Martin
Quality Control Coordinator

7-16-87
Date

ATTACHMENT

Standard Operating Procedures

1. G005 - Quality Control Measurement
2. G006 - Out-of-Control Event Guidelines and Corrective Action
3. G034 - Definition and Procedure for the Determination of the Method Detection Limit

STANDARD OPERATING PROCEDURE

Quality Control Measurement

I. General Scope and Application

A. Quality control is used to monitor the precision and accuracy of laboratory measurements and the sampling process. Procedures must be in place to determine precision and accuracy and these data compared to acceptance criteria established for the analyte and method. Corrective action must be taken when the measured precision or accuracy is outside the acceptance criteria.

II. Quality Control Measures

A. Quality Control Measures

Quality control measures which are applicable to environmental analyses include the use of laboratory blanks, reference standards, and/or spiked blanks, surrogate standards, and duplicate analysis. Equivalent quality control measures may be used if all the specified elements are incorporated in the procedure.

B. For frequency of each quality control measure, refer to Standard Operating Procedure SOP #G026.

1. Reference Standard and/or Spiked Blank.

a. A reference standard and/or spiked blank is a sample prepared by spiking a known amount of analyte into an appropriate solvent. The concentrate or quality control standard preferably, should be obtained from an external source. A standard prepared in-house may be used if it is prepared independently of the calibration standard. Samples must be tied to the reference standard and/or spiked blank by means of a date or batch identifier.

b. Recorded data generated by the analysis of reference standards and/or spiked blanks will be used to construct a control chart and control limits established. See attached instructions for constructing a control chart and computing limits. Attachment I thru V.

c. If a result falls outside the control limits, the analysis is out of control and immediate action should be taken to determine the cause of the outlying results. For "Out of Control" limits refer to Standard Operating Procedure # G006. Data generated on the same day as the outlying result will be regarded as unreliable and the analysis repeated after corrective action has been taken and the procedure is back in control.

d. A new control chart with freshly computed control limits will be begun annually. The last 20 reference standard data points for the previous year will be used to compute the new control limits.

2. Surrogate Standard

a. A surrogate standard is a compound or a mixture of compounds which, when spiked into an environmental sample, behaves in the same manner as the analyte or analytes of interest. The surrogate standard has application to organic analytes determined by GC and GC/MS procedures and may be used to determine chemical recoveries from environmental samples. When surrogate standards are applicable to a method, all samples will be spiked with a surrogate standard unless a specific exception is made in the method itself.

b. Record the percent recovery for each surrogate standard, then calculate and tabulate the established control limits. See attached instructions for the tabulation and computation of limits.

c. If a surrogate standard should fall beyond the control limits, the data will be regarded as unreliable. Immediate corrective action will be taken and the analysis repeated.

d. A new tabulation with freshly computed control limits will be begun annually. The last 20 data points for the previous year will be used to compute new acceptance limits.

3. Duplicate Analysis

   a. A duplicate analysis is required only when a sample yields a positive result. A minimum of 10 percent of all positive samples for a given analyte will be analyzed in duplicate.
   b. Record the range between the duplicates and tabulate the established acceptance limits.
   c. If the range of a set of duplicates should fall beyond the control limit, the data will be regarded as unreliable. Immediate corrective action will be taken and the analyses repeated.
   d. A new tabulation with a freshly computed acceptance limit will be begun annually. The last 20 data points for the previous year will be used to compute the acceptance list.

4. Until sufficient data points have been analyzed for each parameter, metaTRACE will use ±20% as the warning level and ±30% as the control level. As the necessary data point are accumulated, quality control charts will be established for each parameter.

Approved By: T. Will Solomon Date: 2/11/87
Operations Manager

Carol X Byington Date: 2/11/87
Technical Director

Reference Standard

A chart is constructed as follows:

1. the measured values and dates of analysis of the reference standard sample are tabulated,
2. when at least 20 reference standard samples have been tabulated compute the mean, $\bar{X}$
3. using the mean, compute the standard deviation, SD as in the following example using the formula:

$$SD = \sqrt{\frac{(X - \bar{X})^2}{N - 1}}$$

where

X = the measured value of an individual reference standard

$\bar{X}$ = the mean of the measured values

N = the number of data points

$(X-\bar{X})^2$ = the sum of the squares of all the differences of the mean and measured values.

An example of this calculation is shown on the next page.

EXAMPLE

	DATE	X	$(X-\overline{X})$		$(X-\overline{X})^2$	
1.	4-25-85	207	(207-207 = 0)	0	(0 x 0 = 0)	0
2.	5-03-85	214	(214-207 = +7)	+7	(7 x 7 = 49)	49
3.	5-10-85	200	(200-207 = -7)	-7	(7 x 7 = 49)	49
4.	5-17-85	210	(210-207 = +3)	+3	(3 x 3 = 9)	9
5.	6-10-85	219	(219-207 = +12)	+12	(12x12 = 144)	144
6.	6-10-85	190	(190-207 = -17)	-17	(17x17 = 289)	289
7.	6-18-85	203	etc.	-4	etc.	16
8.	6-27-85	210	"	+3	"	9
9.	7-03-85	204		-3		9
10.	7-11-85	207		0		0
11.	7-19-85	207		0		0
12.	8-01-85	201		-6		36
13.	8-10-85	204		-3		9
14.	8-17-85	200		-7		49
15.	8-27-85	221		+14		196
16.	9-03-85	205		-2		4
17.	9-11-85	210		+3		9
18.	9-20-85	201		-6		36
19.	9-30-85	217		+10		100
20.	10-10-85	210		+3		9
N=20	Total X =	4104				= 1022

EXAMPLE

$$N = 20$$

$$\overline{X} = 4140 \text{ -- } 20 = 207$$

$$\Sigma(X - \overline{X})^2 = 1022$$

$$SD = \sqrt{\frac{\Sigma(X - \overline{X})^2}{N - 1}}$$

$$SD = \sqrt{\frac{1022}{19}}$$

$$SD = 7.33$$

4. Determine the warning limits (WL), and the control limits (CL) as in the following example using the formulas:

$$WL = \overline{X} \pm 2\ SD$$

$$CL = \overline{X} \pm 3\ SD$$

where

$\overline{X}$ = the previously computed mean

SD = the standard deviation

$$WL = 207 \pm (2 \times 7.33)$$

The warning limits(WL) in the example, are 221.66 for the upper warning limit and 192.34 for the lower warning limit.

$$Cl = 207 \pm (3 \times 7.33)$$

The control limits(CL) in the example are 228.99 for the upper control limit and 185.01 for the lower control limit.

5. Construct an control chart as done below for the example:

$\overline{X}$ +3 SD = 228.99 ----------

$\overline{X}$ +2 SD = 221.66 ----------

$\overline{X}$ = 207 ----------

$\overline{X}$ -2 SD = 192.34 ----------

$\overline{X}$ -3 SD = 185.01 ----------

Date on batch ID

The measured values of the reference standard samples are then plotted on the chart.

Surrogate Standard

The percent recovery, P, is calculated as follows:

P = the percent recovery

M = the measured value

T = the target value, (i.e. the known value of surrogate spiked into the sample)

A tabulation of percent recoveries must be maintained for each surrogate. The tabulation must include the analysis date, the percent recovery and the control limits for P. Control limits, using a minimum of 5 data points for each surrogate standard are calculated as follows:

$$CL = \overline{X} \pm 3SD$$

where:

CL = the control limits

$\overline{P}$ = the mean percent recovery

SD = the standard deviation (see section on reference standard for example)

Duplicate Analysis

The difference (i.e. range) between duplicate analyses is determined as follows:

R = the difference (or range)

X_1 = the greater of the measured values

X_2 = the lower of the measured values

A tabulation of duplicates must be maintained for each analyte listing dates of analysis, X_1, X_2, R, and the acceptance limit for R. The acceptance limit may be established using the following equation:

$$UCL = 3.27\ R$$

where:

UCL = the acceptance limit

R = the average range for a minimum of 5 sets of duplicates in a specified concentration range

STANDARD OPERATING PROCEDURE

Out-Of-Control Event Guidelines and Corrective Action

I. General

A. An out-of-control situation may be indicated by:

1. A value outside the control limits or classified as an outlier by a statistical test.
2. A series of seven successive points on the same side of the central line.
3. A series of five successive points going in the same direction.
4. A cyclical pattern of control values, or;
5. Two consecutive points between the UWL[1] and UCL[2] or the LWL[3] and LCL[4].

B. Whenever one of these conditions is detected, the analysts and QC Coordinator investigate to determine the cause and document actions taken. Data acquired concurrently with one of these conditions will be discarded and samples reanalyzed unless the investigation of the problem proves that the analysis was in control.

C. If a lot is still out of control after reanalysis, all method-related activities will stop immediately. A detailed laboratory-wide investigation will be conducted to isolate and correct faulty operations. Sample security, integrity of standards, reagents, glassware, laboratory notebooks, instrument performance, and adherence to certified methods should be included in the investigation.

[1]UWL (Upper Warning Level) = +20% initially, +2 σ. when there is enough data.
[2]UCL (Upper Control Level) = +30% initially, +3 σ later.
[3]LWL (Lower Warning Level) = -20% initially, +3 σ later.
[4]LCL (Lower Control Level) = -30% initially, +3 σ later.

II. Corrective Actions

A. When, as a result of audits or QC sample analysis, or analysis systems are shown to be unsatisfactory, a corrective action will be implemented. The Operations Manager, Analytical Supervisor, QC Coordinator, and Analyst may be involved in the corrective action. If previously reported data are affected by the situation requiring correction, the action will directly involve the Project Manager. Corrective actions are of two kinds:

1. Immediate, to correct or repair nonconformance equipment and systems. The need for such an action will most frequently be identified by the analyst as a result of calibration checks and QC sample analyses.
2. Long term, to eliminate causes of nonconformance. The need for such actions will probably be identified by audits. Examples of this type of action include:

   a. Staff training in technical skills, or in implementing the QA Program;
   b. Rescheduling of laboratory routine to insure analysis within allowed holding times;
   c. Identifying vendors to supply reagents of sufficient purity, and;
   d. Revision of QA system or replacement of personnel.

For either immediate or long-term corrective actions, steps comprising a closed-loop corrective action system are as follows:

a. Define the problem;
b. Assign responsibility for investigating the problem;
c. Investigate and determine the cause of the problem;
d. Determine a corrective action to eliminate the problem;
e. Assign and accept responsibility for implementing the corrective action;
f. Establish effectiveness of the corrective action and implement the correction, and;
g. Verify that the corrective action has eliminated the problem.

III. Documentation

A. Depending on the nature of the problem, the corrective action employed may be formal or informal. In either case, occurrence of the problem, corrective action employed, and verification that the problem has been eliminated, must be documented. (See attached form)

Completeness of the attached form along with signatures for verification will then be filed by the QC Coordinator for future reference and documentation.

Approved By: T. Will Solomon Date: 2/23/87
Operations Manager

Carol S Byington Date: 2/23/87
Technical Director

Corrective Action Request Form No._____

Originator_____ Date_____
Person Responsible for Replying_____ Contract Involved_____

Description of problem and when identified:_____

_____
_____
_____
_____

State cause of problem, if known or suspected:_____

_____
_____

Sequence of Corrective Action: (If no responsible person is identified, notify QC Coordinator immediately. Submit all CA forms to QC Coordinator for initial approval of CA.)

State Date, Person, and Action Planned:

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CA Initially Approved By:_____ Date_____

Follow-up Dates_____ _____

Final CA Approved By:_____ Date_____

Information copies to:

Responsible Person/Department QC Coordinator:_____

QC Manager:_____

Department Manager:_____

STANDARD OPERATING PROCEDURE

Definition and Procedure for the Determination of the Method Detection Limit

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from the analysis of a sample in a given matrix containing the analyte.

I. SCOPE AND APPLICATION

This procedure is designed for applicability to a wide variety of sample types ranging from reagent (blank) water containing the analyte to wastewater containing the analyte. The MDL for an analytical procedure may vary as a function of sample type. The procedure requires a complete, specific and well defined analytical method. It is essential that all sample processing steps of the analytical method be included in the determination of the method detection limit.

The MDL obtained by this procedure is used to judge the significance of a single measurement of a future sample.

The MDL procedure is designed for applicability to a broad variety of physical and chemical methods.

II. PROCEDURE

A. Make an estimate of the detection limit using one of the following:

1. The concentration value that corresponds to an instrument signal/noise ratio in the range of 2.5 to 5. If the criteria for qualitative identification of the analyte is based upon pattern recognition techniques, the least abundant signal necessary to achieve identification must be considered in making the estimate.
2. The concentration value that corresponds to three times the standard deviation of replicate instrumental measurements for the analyte in reagent water.
3. The concentration value that corresponds to the region of the standard curve where there is a significant change in sensitivity at low analyte concentrations, i.e., a break in the slope of the standard curve.
4. The concentration value that corresponds to known instrumental limitations.

It is recognized that the experience of the analyst is important to this process. However, the analyst must include the above considerations in the estimate of the detection limit.

B. Prepare reagent (blank) water that is as free of analyte as possible. Reagent or interference free water is defined as a water sample in which analyte and interferent concentrations are not detected at the method detection limit of each analyte of interest. Interferences are defined a systematic errors in the measured analytical signal of a established procedure caused by the presence of interfering species (interferent). The interferent concentration is presupposed to be normally distributed in representative samples of a given matrix.

C.

1. If the MDL is to be determined in reagent water (blank), prepare a laboratory standard (analyte in reagent water) at a concentration which is at least equal to or in the same concentration range as the estimated MDL. (Recommend between 1 and 5 times the estimated MDL.) Proceed to Step D.
2. If the MDL is to be determined in another sample matrix, analyze the sample. If the measured level of the analyte is in the recommended range of one to five times the estimated MDL, proceed to Step D.

   If the measured concentration of analyte is less than the estimated MDL, add a known amount of analyte to bring the concentration of analyte to between one and five times the MDL. In the case where an interference is coanalyzed with the analyte:

   If the measured level of analyte is greater than five times the estimated MDL, there are two options:

   a. Obtain another sample of lower level of analyte in same matrix if possible.
   b. The sample may be used as is for determining the MDL if the analyte level does not exceed 10 times the MDL of the analyte in reagent water. The variance of the analytical method changes as the analyte concentration increases from the MDL, hence the MDL determined under these circumstances may not truly reflect method variance at lower analyte concentrations.

D.

1. Take a minimum of seven aliquots of the sample to be used to calculate the MDL and process each through the entire analytical method. Make all computations according to the defined method with final results in the method reporting units. If blank measurements are required to calculate

the measured level of analyte, obtain separate blank measurements for each sample aliquot analyzed. The average blank measurement is subtracted from the respective sample measurements.

2. It may be economically and technically desirable to evaluate the estimated MDL before proceeding with D1. This will: (1) prevent repeating this entire procedure when the costs of analyses are high and (2) insure that the procedure is being conducted at the correct concentration. If is quite possible that an incorrect MDL can be calculated from data obtained at many times the real MDL even though the background concentration of analyte is less than five times the calculated MDL. To insure that the estimate of the MDL is a good estimate, it is necessary to determine that a lower concentration of analyte will not result in a significantly lower MDL. Take two aliquots of the sample to be used to calculate the MDL and process each through the entire method, including blank measurements as described above in D1. Evaluate these data:

   a. If these measurements indicate the sample is in the desirable range for determining the MDL, take five additional aliquots and proceed. Use all seven measurements to calculate the MDL.
   b. If these measurements indicate the sample is not in the correct range, reestimate the MDL, obtain new sample as in C and repeat either D1 or D2.

E. Calculate the variance (S^2) and standard deviation (S) of the replicate measurements, as follows:

$$S^2 = \frac{1}{n-1}\left[\sum_{i=1}^{n} X_i^2 - \left(\sum_{i=1}^{n} X_i\right)^2 \Big/ n\right]$$

$$S = (S^2)^{1/2}$$

Where: the X_i, i = 1 to n are the analytical results in the final method reporting units obtained from the n sample aliquots and $\sum_{i=1}^{n} X_i^2$ refers to the sum of the X values from i = 1 to n.

F.

1. Compute the MDL as follows:

$$MDL = t(n-1,\ 1-\alpha = .99)\ (S)$$

Where:

MDL = the method detection

$t(n-1, 1- = .99)$ = the students t value appropriate for 99% confidence level and a standard deviation estimate with n-1 degrees of freedom. (See Table of Students't Values)

S = standard deviation of the replicate analyses.

2. The 95% confidence limits for the MDL derived in F1 are computed according to the following equations derived from percentiles of the chi square over degrees of freedom distribution (X^2/df) and calculated as follows:

$MDL_{LCL} = 0.69\ MDL$
$MDL_{UCL} = 1.92\ MDL$

where MDL_{LCL} and MDL_{UCL} are the lower and upper 95% confidence limits respectively based on seven aliquots.

G. Optional iterative procedure to verify the reasonableness of the estimated MDL and calculated MDL of subsequent MDL determinations.

1. If this is the initial attempt to compute MDL based on the estimated MDL in Step B, take the MDL as calculated in Step F, spike in the matrix at the calculated MDL and proceed through the procedure starting with Step D.
2. If the current MDL determination is an iteration of the MDL procedure for which the spiking level does not permit qualitative identification, report the MDL as that concentration between the current spike level and the previous spike level which allows qualitative identification.
3. If the current MDL determination is a iteration of MDL procedure and the spiking level allows qualitative identification, use S^2 from the current MDL calculation and S^2 from the previous MDL calculation to compute the F ratio.

$$\text{if} \quad \frac{S^2_A}{S^2_B} < 3.05$$

then compute the pooled standard deviation by the following equation:

$$S_{pooled} = \left[\frac{6S^2_A + 6S^2_B}{12} \right]^{1/2}$$

if $\frac{S^2_A}{S^2_B} > 3.05$, respike at the last calculated MDL and

process the samples through the procedure starting with Step 4.

4. Use the S_{pooled} as calculated in G2 to compute the final MDL according to the following equation:

$$MDL = 2.681\ (S_{pooled})$$

where 2.681 is equal to $t_{(12,1-\alpha = .99)}$.

5. The 95% confidence limits for MDL derived in G3 are computed according to the following equations derived from percentiles of the chi squared over degrees of freedom distribution.

$$MDL_{LCL} = 0.72\ MDL$$
$$MDL_{UCL} = 1.65\ MDL$$

where LCL and UCL are the lower and upper 95% confidence limits respectively based on 14 aliquots.

III. REPORTING

The analytical method used must be specifically identified by number or title and the MDL for each analyte expressed in the appropriate method reporting units. If the analytical method permits options which affect the method detection limit, these conditions must be specified with the MDL value. The sample matrix used to determine the MDL must also be identified with the MDL value. Report the mean analyte level with the MDL. If a laboratory standard or a sample that contained a known amount analyte was used for this determination, report the mean recovery, and indicate if the MDL determination was iterated.

If the level of the analyte in the sample matrix exceeds 10 times the MDL of the analyte in reagent water, do not report a value for the MDL.

IV. REFERENCE

Glaser, J.A., Foerst, D.L., McKee, G. D., Quave, S.A., and Budde, W. L., "Trace Analysis for Wastewaters," Environmental Science and Technology, 15, 1426 (1981).

Table of Students' t Values at the 99 Percent Confidence Level

Number of Replicates	Degrees of Freedom (n-1)	$t_{(n-1, 1-\alpha = .99)}$
7	6	3.143
8	7	2.998
9	8	2.896
10	9	2.821
11	10	2.764
16	15	2.602
21	20	2.528
26	25	2.485
31	30	2.457
61	60	2.390
oo	oo	2.326

Approved By T. Will Solomon Date 6/9/87
Operations Manager

Carol L. Byington Date 6/9/87
Technical Director

APPENDIX D:

Preliminary List of Drinking Water Standards/ Guidelines for Suspected Contaminants at NTC Great Lakes

TABLE D-1

Preliminary List of Drinking Water Standards/
Guidelines for Suspected Contaminants at
NTC Great Lakes

Chemical Constituent	Federal/State Drinking Water Standards[a,b] (ug/l)	Other Criteria[c] (ug/l)
Priority pollutant metals		
Antimony	--	146[d]
Arsenic	50	--
Beryllium	--	11[e]/0.0039[d]
Cadmium	10	--
Chromium (total)	50	--
Copper	1,000[f]	--
Lead	50	--
Mercury	2	--
Nickel	--	15.4[d]
Selenium	10	--
Silver	50	--
Thallium	--	12.8[d]
Zinc	5,000	--
Volatile organic compounds		
Benzene	--	5[g]
Vinyl chloride	--	1[g]
Carbon tetrachloride	--	5[g]
1,2-Dichloroethane	--	5[g]
Trichloroethylene	--	5[g]
1,1-Dichloroethylene	--	7[g]
1,1,1-Trichloroethane	--	200[g]
Trihalomethanes (total)	100	--
cis-1,2-Dichloroethylene	--	70[h]
Toluene	--	2,000[h]
trans-1,2-Dichloroethylene	--	70[h]
Xylene	--	440[h]
Ethylbenzene	--	680[h]
Tetrachloroethylene	--	0.88[d]/10[i]/200[j]
pH	6.5-8.5[k]	--
Chloride	250,000	--

TABLE D-1 (cont'd)

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[a]National Primary or Secondary Drinking Water Regulations, 40 CFR Part 141 or 143, respectively.

[b]The Illinois EPA has adopted the National Primary Drinking Water Regulations.

[c]Provided only where no Federal/State standard is available.

[d]Clean Water Act, Water Quality Criteria for Human Health--Adjusted for Drinking Water only (USEPA, April 1985. Guidance on Feasibility Studies Under CERCLA, pp. 5-9 to 5-14.)

[e]For protection of aquatic life in soft fresh water. In hard fresh water the level is 1,100 ug/l. (USEPA, July 1976. Quality Criteria for Water.)

[f]The Illinois standard for copper is 5,000 ug/l.

[g]Proposed Maximum Contaminant Level (MCL). (Federal Register, November 13, 1985.)

[h]Proposed Maximum Contaminant Level Guideline (MCLG), formerly known as Recommended Maximum Contaminant Level (RMCL). (Federal Register, November 13, 1985.)

[i]World Health Organization, 1984. Guidelines for Drinking Water Quality, Volume I, Geneva, Switzerland.

[j]Safe Drinking Water Act, Health Advisory--Chronic (longer term). (USEPA, April 1985. Guidance on Feasibility Studies Under CERCLA, pp. 5-9 to 5-14.)

[k]pH 6.5-8.5 is the acceptable range.

APPENDIX E

Illinois Environmental Protection Agency General Guidelines for Containment of Contaminated Solids and Liquids During Site Investigations

Illinois Environmental Protection Agency

GENERAL GUIDELINES FOR THE CONTAINMENT OF CONTAMINATED SOLIDS AND LIQUIDS DURING SITE INVESTIGATIONS

Note: Review and Understanding of the text to which this table is attached is essential to proper use of table.

SOLIDS	SOURCE AREA	HIGH SURFACE CONTAMINATION DECREASING WITH DEPTH	NO CONTAINMENT:	Surface exposures are already in existance and surfacing sediments or water with lower levels of contamination will not create a problem
		CLEAN SURFACE WITH HIGH CONTAMINATION AT DEPTH	NO CONTAINMENT:	may need to contain depending upon clean-up operations and/or site owners request
	ADJACENT AREA	HIGH SURFACE CONTAMINATION DECREASING WITH DEPTH	NO CONTAMINMENT:	may have to relocate to accommodate property owner
		CLEAN SURFACE WITH HIGH CONTAMINATION AT DEPTH	NO CONTAINMNET:	contain in 55 gallon drums and relocate to staging location on site
LIQUIDS	SOURCE AREA	HIGH LEVEL CONTAMINATION $\geq$ 50 units (ppm) OVA,HNU	CONTAINMENT:	pump liquids from containment tanks (ie. mud pits, decontamination tanks, etc.) into 55 gallon drums and relocate to staging area on site
		LOW LEVEL CONTAMINATION $<$ 50 units (ppm) OVA,HNU	NO CONTAINMENT	
	ADJACENT AREA	HIGH LEVEL CONTAMINATION $\geq$ 50 units (ppm) OVA,HNU	CONTAINMENT:	pump liquids from containment tanks (ie. mud pits, decontamination tanks, etc.) into 55 gallon drums and relocate to staging area on site
		LOW LEVEL CONTAMINATION $<$ 50 units (ppm) OVA,HNU	NO CONTAINMENT:	may have to contain in 55 gallon drums and relocate to staging area on site to accommodate property owner

Note: Containment of inorganics will depend on chemical and its toxicity - check with Office of Chemical Safety

Approved WCC

GUIDELINES FOR CONTAINMENT OF CONTAMINATED SOLIDS AND LIQUIDS DURING SITE INVESTIGATIONS

Indroduction

During the site investigation, sediments are brought to the land surface as drill cuttings, and water is brought up during drilling, well development and well sampling. Sediment and water is also accumulated during decontamination of equipment. Proper handling and disposition of this possibly contaminated material must be determined before detailed and reliable lab analyses are available. To contain all sediment and water in drums is time consuming, expensive and may expose field personnel to unnecessary additional hazards.

Each site is unique in terms of ownership, public accessibility and community concerns. Within each site, the separate drilling locations will have their own potential for probability, type, configuration and level of contamination. There are many other practical aspects to consider, such as the availability of equipment and personnel for handling, sampling and shipping the drums, and available alternatives to containment in drums.

The geologist or field engineer must rely on previously existing chemical analyses, general information of activity and materials handled on the site, personal observations during site inspection and drilling, and information generated from field analytical equipment. Obviously, much of the decision process must be done in the field, with the discretion of adjusting procedures to meet the conditions encountered as work progresses. This report provides a framework of technical and practical considerations to guide the geologist and field engineer in making these decisions.

Field determination of contamination

Field determination of contamination may or may not be confirmed by laboratory analyses. However, if the following "tools" are used by an experienced geologist or engineer, the decision can be made whether to contain the sediments and liquids generated during site investigations.

The most frequently used and readily available "tools" used in the field are: 1) Review of Existing Information; 2) Field Analytical Equipment and 3) Field Observations, both Visual and Olfactory. These tools are discussed below:

Review of Existing Information

As is the case with any site investigation, all available information, specific to the area of concern, should be reviewed. Special emphasis should be placed on chemical analyses of sediments or groundwater. Knowledge of the history of the site (chemical processes, waste generated, location of lagoons, buried waste, chemical spills, etc.) will aid in the process of listing potential contaminants and how they may be entering the environment.

After listing the potential contaminants, the following questions should be addressed:

1. What hazards are involved?
    - Toxicity of the chemical?
    - Relative Exposure by"
        - Ingestions?
        - Breathing?
        - Skin contact?

2. How do the chemicals behave in the environment?
    - Are they an airborn hazard?
        - gas?
        - vapor?
        - dust?
    - Are they reactive with oxygen, water or other chemicals which may be present?

3. What are the sensitivities of the field analytical equipment to the chemical and how does this relate to the chemical's Threshold Limit Value (TLV) and Immediate Danger to Life and Health (IDLH) values (if available)?

The list that follows represents some of the source of information, if available, that should be reviewd:

- chemical analyses:
  - sediment
  - groundwater
  - surface water
  - processes
  - waste
  - products
- site mapes:
  - waste storage
  - buried waste, piping, tanks
  - lagoons, spill areas
  - process areas
  - sample, boring, well locations
- site records:
  - shipping manifests
  - ownership and use
  - history of spills

Field Analytical Equipment

The use of field analytical equipment is the most important tool in determing hazardous or potentially hazardous conditions for both safety and for characterizing the "level" of contamination that is being encountered at the borehole.

Organic Vapors & Gases

If the potential contaminants are organic substances and the material is volatile or can become airborne, air measurements for organics can be made with one or more appropriate survey instruments. Instruments for some specific organic volatiles are available but if types of organic vapors/gases are unknown, instruments such as the photoionizer (HNU) and/or the portable gas chromatograph (OVA) should be used to detect organic volatiles. The instruments should be operated in their total read out mode when the identy of the vapor or gas is unknown. The reading on the instrument will represent the total concentration of airborne substances to which the instrument is responding. How to operate the instrument, its sensitivities and limitations, should be well understood by the user.

The instruments should be used at each borehole during drilling, placing the end of the probe close to the cuttings and/or water which is surfacing at the borehole. Care should be exercised to not allow plugging of the end of the probes with sediment or to allow water to be drawn into the instrument. If readings are $\geq$ 50 units (ppm) continuously (at least 10 seconds) then field contamination can be considered "high". Discontinuous "pegs" or "bursts" of volatiles may occur but are quickly diluted as the cuttings are exposed to air. If field personnel are having to upgrade to respiratory protection due to surfaced cuttings water, containment of cuttings should be considered.

Monitoring of the borehole should continue until total depth has been reached. The retained sediment or rock core can also be monitored to detect specific zones of contamination. Detailed records should be kept of ambient air temperatures during sampling and the unit (ppm) measurements at the various depths at the borehole during drilling, and on the core when the sample is retrieved.

Inorganic vapors & Gases

The ability to detect and quantify nonspecific inorganic vapors and gases is limited. The HNU has limited detection but the OVA has none. If specific inorganic species are known or suspected, specific instruments may be available for use. Colorimetric tubes can be used if the appropriate tubes are available.

Visual and Olfactory Observations

Before accurate judgement can be made as to whether or not the sediment or rock is contaminated, the geologist or field engineer must know what may be naturally occuring in the materials. The most common visual sign of contamination is discoloration of the natural sediments or rock. If fractures, root traces, or other vertical pathways for contaminant migration

are present, their surfaces may be discolored or the entire void may be filled with contaminants (ie. resins, tar, creosote). Contaminants may accumulate on the surface of less permeable sediments or rock layers. Discoloration and "oily sheens" on the groundwater or drilling water may indicate contamination but again, natural conditions such as drilling through coal seams, organic rich buried soils, natural oil seeps, etc., can also cause "oily sheens" on drilling water and groundwater.

As chemicals volatilize from the surfaced cuttings/water, chemical odors may be detected. These observations should be recorded along with the visual observations and field analytical equipment results with reference to which zone or depth at which they were encountered. Some chemicals react readily with air and water and may release vapors that can be seen, heard and/or smelled.

Vertical Distribution of Contamination

After determining that potentially "high" concentrations of contamination exists, the vertical distribution of the contamination must be considered. If the high levels of contamination are at land surface and decreases with depth, the displacement of lesser contaminated or clean sediments to the surface will not degrade the environment or become a health threat greater than that already in existance at the surface.

If high levels of contamination exist at depth and the surface is clean, other factors must be considered. If the clean surface is a yard, landfill cover or clean fill, contaminated water or sediments generally should not be left on the surface. However, if the degree of contamination is very small or the contaminants are quickly volatilized, containment is not warranted.

Types of Containment

If the previously discussed "tools" determine that containment should be considered, other factors including site ownership and location, public accessibility and community concerns should be evaluated to determine the type and degree of containment. Several types of containment are listed below:

1. Total Containment in 55 Gallon Drums

   -this includes drill cuttings, drill water, decontamination water and sediments, monitor well development and purging water

   -may be warranted in situations of very high sediment and groundwater contamination at depth with clean surface or low levels of contamination at the surface

   -most practical on sites that are starting clean-up operations and sophisticated decontamination systems are available for containment of water and sediments generated from cleaning the equipment

2. Containment of Drill Cuttings, Drill Water and Decontamination Sediments in 55 Gallon Drums

   -may be warranted in situations of high sediment contamination and groundwater contamination at depth with clean or low levels of contamination at the surface

   -large clumps of sediment from equipment should be placed in the cutting drums prior to decontamination

3. Containment of Drill Cuttings and Decontamination Sediments in 55 Gallon Drums or on Plastic with Plastic Cover

   -situations of high levels of contamination in sediments but low levels of contamination or clean groundwater

   -site is being considered for immediate removal or clean-up in the near future

4. Containment of Drill Water, Well Development and Purging Water, and Drill Cuttings below the high water table elevation in 55 Gallon Drums

   -situations of high levels of contamination in the groundwater but sediments above the water table are clean or have low levels of contamination

5. Confine Drill Cuttings to a Single Location on Site and/or Keep Decontamination Area in single location

   -low levels of contamination exist or highly volatile contaminants are present and quickly are diluted upon exposure to air

Guidelines Table

The table attached to this report is a visual summary of some key site characteristics and guidelines for containment of solids (drill cuttings, decontamination sediments, etc.) and liquids (drill water, well development and purging water, decontamination water) during site investigations. Quantitative contamination information and community concerns must be evaluated in addition to the guidelines included on the table.

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