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Formerly Utilized Sites Remedial Action Program (FUSRAP)

ADMINISTRATIVE RECORD

for Maywood, New Jersey

U.S. Department of Energy

0489-0613.1

110601

Bechtel

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Job No. 14501, FUSRAP Project
DOE Contract No. DE-AC05-91OR21949
Code: 7310/WBS: 138

NOV 15 1993

U.S. Department of Energy
Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, TN 37831-8723

Attention: Susan M. Cange, Site Manager
Former Sites Restoration Division

Subject: FUSRAP - Maywood Site - Transmittal of WP-IP Ancillary Documents

Dear Ms. Cange:

Enclosed for your use are publication copies of the ancillary documents for the Maywood work plan-implementation plan. Included are two field sampling plans, a quality assurance project plan, a health and safety plan, and a community relations plan. All comments received from reviewers have been incorporated into these documents.

Copies of each of these documents will be placed in the administrative record for the Maywood site.

Sincerely,

M. E. Redmon

M. E. Redmon
Project Manager - FUSRAP

MER:ebs:1346
Enclosure: As stated

ACTION REQ'D	[ ] YES	[X] NO	DUE DATE					
RESPONSE TO CHRON NO.								
☐ FFA	☐ Permit	☐ Milestone	☐ OcR	☐ CCN	☐ CAR	☐ Mid-Yr	☐ Yr-End	☐ Periodic Rpt

DOE/OR/21949-193.3

Formerly Utilized Sites Remedial Action Program (FUSRAP)
Contract No. DE-AC05-91OR21949

Field Sampling Plan for the Remedial Investigation/ Feasibility Study-Environmental Impact Statement for the Maywood Interim Storage Site

Maywood, New Jersey

November 1993

Printed on recycled/recyclable paper

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FIELD SAMPLING PLAN FOR THE REMEDIAL INVESTIGATION/ FEASIBILITY STUDY-ENVIRONMENTAL IMPACT STATEMENT FOR THE MAYWOOD INTERIM STORAGE SITE

MAYWOOD, NEW JERSEY

NOVEMBER 1993

Prepared for

United States Department of Energy

Oak Ridge Operations Office

Under Contract No. DE-AC05-91OR21949

By

Bechtel National, Inc.

Oak Ridge, Tennessee

Bechtel Job No. 14501

FOREWORD

This document has been prepared to document the scoping and planning process performed by the U.S. Department of Energy (DOE) to support remedial action activities at the Maywood site, located in northern New Jersey in the boroughs of Maywood and Lodi and in the township of Rochelle Park. Remedial action at the Maywood site is being planned as part of DOE's Formerly Utilized Sites Remedial Action Program.

Under the Comprehensive Environmental Response, Compensation, and Liability Act, a remedial investigation/feasibility study (RI/FS) must be prepared to support the decision-making process for evaluating remedial action alternatives. Consistent with U.S. Environmental Protection Agency guidance for conducting an RI/FS, the work plan-implementation plan (1) contains a summary of information currently known about the Maywood site, (2) presents a conceptual site model that identifies potential routes of human exposure to site contaminants, (3) identifies data gaps, and (4) summarizes the process and proposed studies that will be used to fill the data gaps. Other plans are developed to direct field investigations to resolve the data gaps identified in the work plan-implementation plan. These other plans are the quality assurance project plan, the health and safety plan, the community relations plan, and the field sampling plan.

Because the field work is phased, two separate field sampling plans address the field investigations. This field sampling plan directs the geological investigation of the Maywood site; the other directs the field work for the radiological and chemical remedial investigation.

The work described in this plan was performed between 1989 and 1991; the plan accurately represents the work that was performed. Authorization was given by DOE to proceed with the work using draft documents due to the lengthy review cycle that was necessary for approval by all agencies involved and the need to use available funding to perform the work. The review is now complete, and the plan has been approved for final publication.

CONTENTS

CONTENTS

(continued)

FIGURES

TABLES

ACRONYMS

AEC	Atomic Energy Commission
ANL	Argonne National Laboratory
ASTM	American Society for Testing and Materials
BNI	Bechtel National, Inc.
DOE	Department of Energy
EPA	Environmental Protection Agency
FUSRAP	Formerly Utilized Sites Remedial Action Program
MISS	Maywood Interim Storage Site
NJDEPE	New Jersey Department of Environmental Protection and Energy
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Operations Administration
OSHA	Occupational Safety and Health Administration
RI/FS-EIS	remedial investigation/feasibility study-environmental impact statement
SAIC	Science Applications International Corporation
SHSO	site health and safety officer

UNITS OF MEASURE

cm	centimeter
ft	foot
gal	gallon
ha	hectare
in.	inch
kg	kilogram
km	kilometer
L	liter
lb	pound
m	meter
μg	microgram
mg	milligram
mi	mile
pCi	picocurie
yd	yard

1.0 INTRODUCTION

In 1974, the United States Congress authorized the Atomic Energy Commission (AEC), a predecessor agency to the U.S. Department of Energy (DOE), to institute the Formerly Utilized Sites Remedial Action Program (FUSRAP). The objective of FUSRAP, now managed by DOE, is to identify, clean up, or otherwise control sites where residual radioactive contamination (exceeding current guidelines) remains from the early years of the nation's atomic energy program or from commercial operations causing conditions that Congress has authorized DOE to remedy. In addition to these sites, Congress authorized DOE to undertake remedial actions at four other sites where commercial operations had contaminated the environment with radioactive materials. One of these four sites is located in Maywood, New Jersey.

Operations at the former Maywood Chemical Works in Maywood resulted in contamination of numerous properties in Maywood, Rochelle Park, and Lodi, including the property previously owned by Maywood Chemical Works (now owned by the Stepan Company); the DOE-owned property referred to as the Maywood Interim Storage Site (MISS); and residential, commercial, and governmental vicinity properties. To organize and segment the investigation and remedial actions at these properties, DOE has grouped them into four operable units:

- The Stepan Company property
- The MISS property
- Residential properties
- Commercial or governmental properties

The Maywood site comprises these four operable units.

To select a corrective action to be implemented at the Maywood site, DOE is preparing a remedial investigation/feasibility study-environmental impact statement (RI/FS-EIS). This process is described in detail in the Work Plan-Implementation Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the Maywood Site, Maywood, New Jersey (ANL/BNI 1992). In general, the RI/FS-EIS process consists of conducting field investigations to understand the nature and extent of the contamination (remedial investigation) and then performing studies to assess the relative merits and impacts of possible remedial action alternatives (feasibility study-environmental impact statement).

The RI/FS-EIS at Maywood will be accomplished in accordance with the following plans:

- Work plan-implementation plan
- Sampling and analysis plan
- Health and safety plan
- Community relations plan

The sampling and analysis plan consists of the field sampling plans and the quality assurance project plan. This field sampling plan is limited to directing the geologic investigation of MISS, which is only a small segment of the overall remedial investigation field work at the Maywood site. A second field sampling plan directs the radiological and chemical investigation of MISS and other properties that are part of the Maywood site. The two field sampling plans were segmented so that the geologic investigation could be performed early, in the fall of 1989. The second plan directs collection of long-term data from the newly installed groundwater wells.

1.1 SITE CHARACTERIZATION RATIONALE

DOE's responsibilities are different for MISS than for the other three operable units. Because DOE owns MISS, DOE is responsible for remediation of all radioactive and chemical contaminants on or migrating from MISS. Based on the congressional assignment of the Maywood site to DOE, DOE is responsible for remediation of only those radioactive and chemical contaminants resulting from thorium operations at the Maywood Chemical Works that are present on, but not migrating from, the other three operable units. The contaminants for which DOE has responsibility include radionuclides and any chemicals used in the thorium processing operations.

The remedial investigation field activities described in this plan for MISS are intended to complete the characterization of the geologic and hydrogeologic properties of MISS. Information from previous investigations of MISS (a summary of which is presented in Section 2.4 of the work plan-implementation plan) was used when possible.

Section 2.0 of this report identifies the objectives of the remedial investigation and the technical approach for achieving the objectives.

1.2 ORGANIZATION AND RESPONSIBILITIES

1.2.1 Project Organization

FUSRAP is conducted as a team effort with multiple organizations responsible for its implementation. DOE is responsible for the overall implementation of FUSRAP. DOE-Headquarters provides oversight and coordination and contracts Oak Ridge Associated Universities and Oak Ridge National Laboratory (ORNL) to designate sites and properties for FUSRAP. These two organizations also provide independent verification of the successful completion of remedial actions leading to the release of properties from FUSRAP.

The DOE Oak Ridge Operations Office, (ORO), which manages day-to-day FUSRAP activities, has contracted Bechtel National, Inc. (BNI), Science Applications International Corporation (SAIC), and Argonne National Laboratory (ANL) to assist in the performance of FUSRAP activities. BNI is the project management contractor, and SAIC is the environmental studies contractor. ANL serves in an independent role as environmental compliance contractor. ORNL is also contracted by DOE-ORO to act as technical support contractor.

The remedial action process for the Maywood site will be conducted based on the project management structure currently in effect for the overall FUSRAP program (Figure 1-1). The flow of the remedial action process and the organization responsible for each step are shown in Figure 1-2.

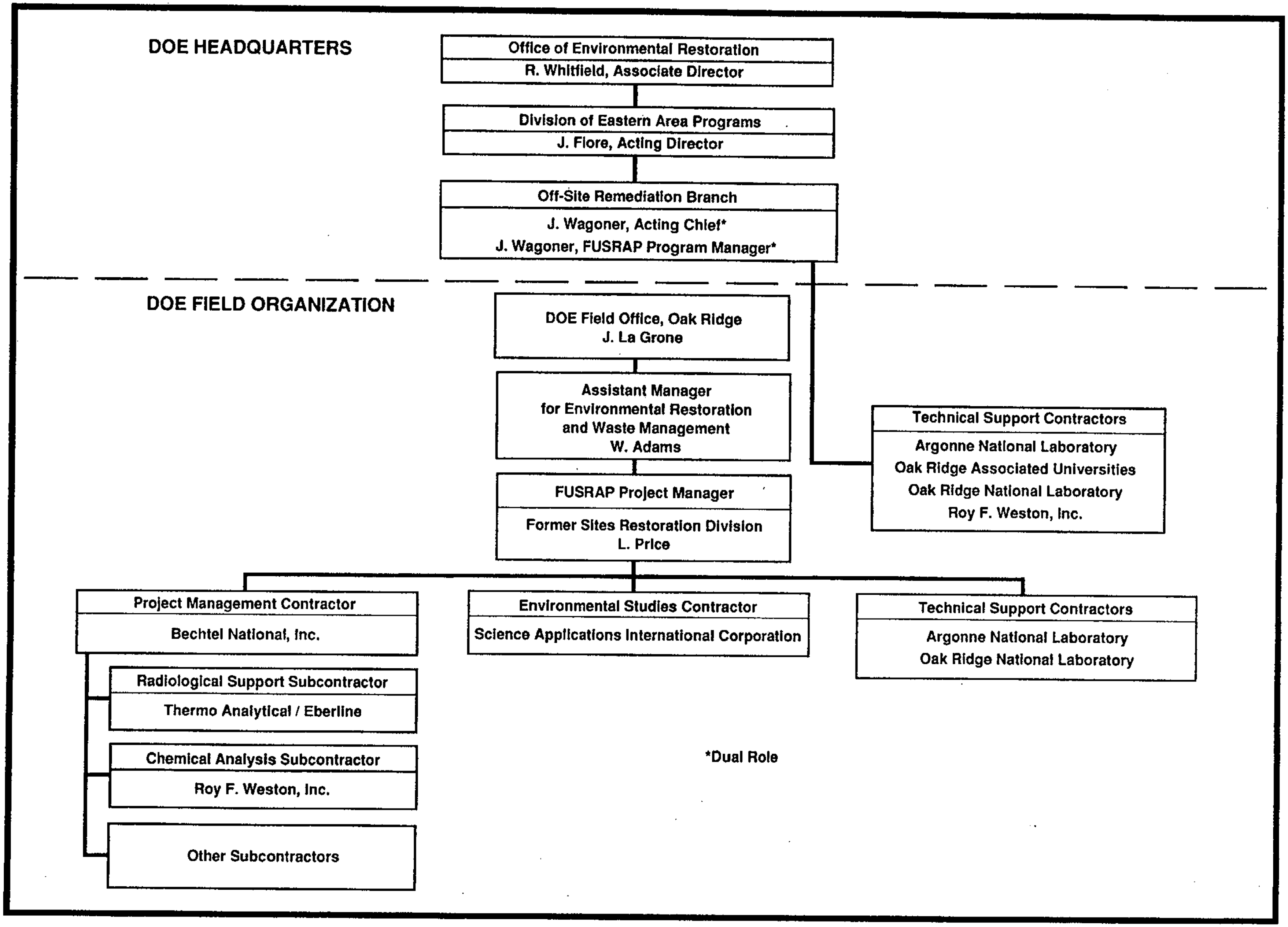

Figure 1-1
Project Organization

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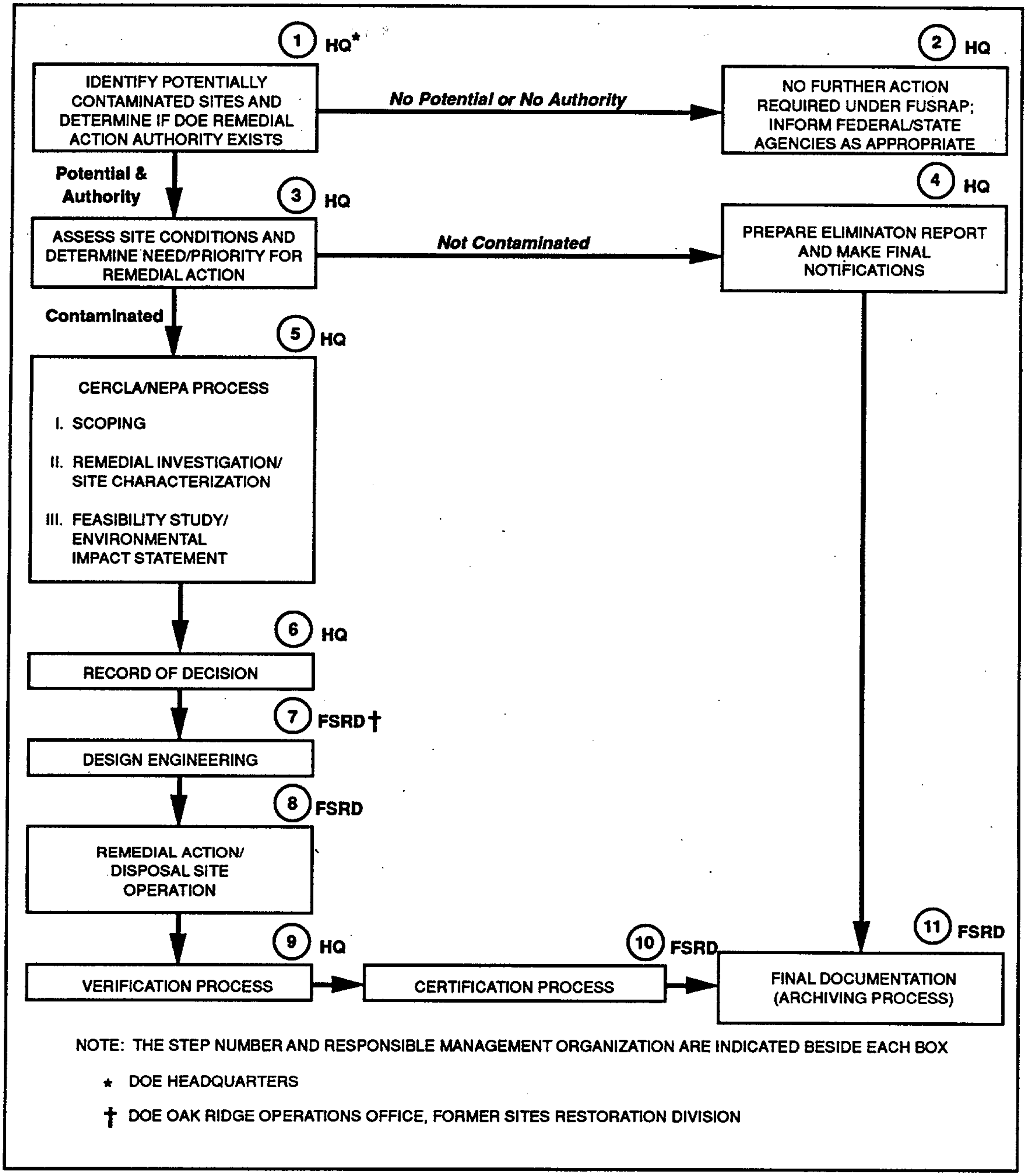

Figure 1-2
Project Coordination and Responsibility Matrix

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1.2.2 Coordination and Responsibilities for Field Work

As project management contractor for FUSRAP, BNI provides management of and support to the remedial investigation field activities, which include all activities necessary to implement the field work delineated in the remedial investigation plans. Typically, these activities include development and procurement of subcontract services; development, implementation, and overview of plans; collection and review of data, including sampling results, quality assurance/quality control submittals, and sample tracking and custody; technical guidance to onsite personnel; report preparation; cost management; and schedule control.

The BNI program manager is responsible to DOE for the completion of all aspects of the work. The program manager is supported by project managers and representatives from engineering, construction, environmental health and safety, procurement, operations, quality assurance, project administration, community relations, and project controls. The responsibilities of the project manager and each group are described below.

Project manager

- Implements overall guidance provided by the BNI program manager on a site-specific basis

- Interfaces directly with DOE-OR site managers to implement DOE directions on a site-specific basis

- Manages a team of BNI technical professionals from each of the disciplines described below to accomplish the goals of the DOE site managers and the BNI program manager for each site

Engineering

- Develops bid packages and technical specifications needed to subcontract remedial investigation work

- Performs engineering studies in support of the environmental compliance contractor to evaluate data and assess remedial action alternatives

- Provides field engineering services to monitor onsite work and modify technical specifications, as required

- Provides geotechnical field support to characterization efforts

Construction

- Reviews all site plans for constructibility
- Monitors subcontract status (i.e., cost, completion)
- Provides a site superintendent to administer subcontracts for onsite activities

Environmental health and safety

- Develops plans, objectives, evaluations, and documentation for all health and safety matters
- Manages and evaluates chemical and radiological data obtained during characterization activities
- Manages radiological and chemical analysis support subcontracts
- Provides technical group leader to support onsite remedial investigation efforts
- Provides a site health and safety officer (SHSO)

Procurement

- Identifies bidders for subcontract work
- Coordinates subcontract bid and award process
- Manages revisions to subcontracts

Site operations

- Performs site maintenance work
- Provides site security
- Manages local purchasing of equipment and supplies
- Provides year-round, onsite support, including collection of environmental samples

Quality assurance

- Evaluates implementation of the quality assurance project plan
- Audits quality assurance system and performance
- Conducts periodic reviews of program plans

Project controls

- Provides cost and schedule support, including budgeting, monitoring, variance analysis, and trend analysis

Project administration

- Provides administrative services such as document control, mail distribution, and reproduction
- Provides document editing services

Community relations

- Conducts community relations planning and prepares the community relations plan
- Coordinates community relations activities

Onsite management of characterization activities is accomplished through the organizational structure shown in Figure 1-3. Responsibilities of each onsite position are described below.

Site superintendent

The site superintendent is responsible to the BNI project manager for day-to-day operations at the site. If no health and safety representative is on site, the site superintendent also serves as the SHSO.

Technical group leader

The technical group leader is responsible for accomplishing the goals of the remedial investigation. All BNI or subcontractor personnel who provide training, radiological survey services, chemical sampling, and geological/hydrological support to the characterization work will report to the technical group leader. The technical group leader will plan daily activities with the field engineer to ensure coordination of subcontractor and sampling activities.

Field engineer

The field engineer will administer all subcontractor activities (excluding radiological and chemical support), including daily work assignments, completion of subcontract management documentation, quality assurance/quality control verification, and cost management.

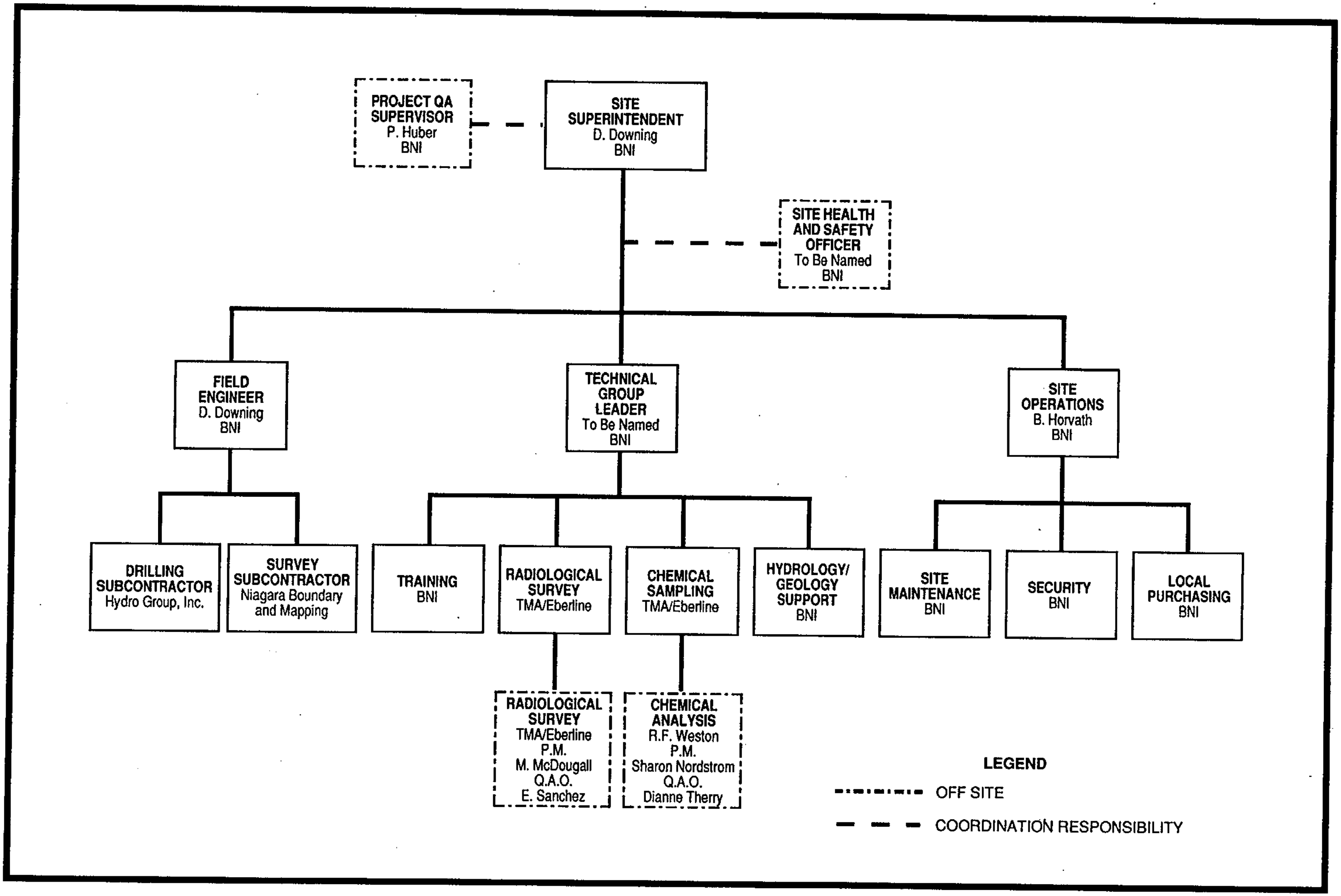

Figure 1-3
Onsite Organization

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Site operations personnel

Site operations personnel are responsible for maintenance and security and for purchasing supplies and equipment locally. Site operations personnel coordinate purchases with both the technical group leader and the field engineer to ensure that the needs of the characterization work are met.

Site health and safety officer

The SHSO is responsible for the administration and implementation of all activities and procedures to ensure the health and safety of the general public and site personnel. While onsite, the SHSO will work directly with the site superintendent or his designee to coordinate all matters related to health and safety. The SHSO has the authority to implement corrective measures or to stop work to ensure the health and safety of site personnel.

Project quality assurance supervisor

The project quality assurance supervisor conducts audits in the field (typically semiannually) to ensure implementation of the field sampling plan and the health and safety plan. Audits and surveillance are also conducted to see how the BNI environmental monitoring team handles and analyzes sample data after receipt of the data from the laboratories. The quality assurance supervisor reports the results of audits and surveillance and evaluation of the effectiveness of the quality assurance/quality control program to BNI management and conducts audits of subcontractors who are involved in the implementation of the field sampling plan and the health and safety plan and compliance with environmental regulations. All quality assurance/quality control program procedures and instructions are submitted to the quality assurance supervisor for review and sign-off before they are issued.

The onsite organization clearly defines the responsibilities of each group and allows the site superintendent to make decisions based on input from each group. However, depending on the level of effort at a particular site, individuals within the organization may be assigned multiple responsibilities. When activities are under way at a specific site, the names and telephone numbers of the individuals in the positions shown in Figure 1-3 will be posted in a conspicuous location at the site.

1.3 SITE DESCRIPTION

The Maywood site is in a highly developed area of northeastern New Jersey in the boroughs of Maywood and Lodi and the township of Rochelle Park. It is approximately 20 km (12 mi) north-northwest of New York City and 21 km (13 mi) northeast of Newark, New Jersey. The population density of this area is approximately 10,000 people per square mile. The Maywood site includes the former the Maywood Chemical Works property (now owned by the Stepan Company), the DOE-owned MISS, and several residential, commercial, and governmental vicinity properties. Figure 1-4 shows the location of the Maywood site. Because this field sampling plan deals only with work at MISS, descriptions of the other properties are not presented here. Further details on MISS and its vicinity properties are provided in other reports (ANL 1984; Carswell 1976; Cole et al. 1981; EG&G 1981; Morton 1982).

MISS is a 4.7-ha (11.7-acre) fenced lot that was once part of a 12.1-ha (30-acre) property owned by the Maywood Chemical Works. MISS includes an interim waste storage pile, two buildings (Building 76 and a pumphouse), temporary office trailers, a reservoir, and two rail spurs. It is bounded on the west by New Jersey Route 17; on the north by a New York, Susquehanna, and Western Railroad line; and on the south and east by commercial and industrial properties. Residential properties are located north of the railroad line and within 274 m (300 yd) to the west of MISS. The topography of MISS is generally flat, ranging in elevation from approximately 15.2 to 20.4 m (51 to 67 ft) above mean sea level. The highest elevations are in the northeastern portion of the property. Small mounds and ditches, the result of process waste storage by Maywood Chemical Works, are present. At least two partially buried structures remain from these waste operations.

The interim storage pile at MISS occupies approximately 0.81 ha (2 acres) and contains about 27,000 m^3 (35,000 yd^3) of contaminated soils and materials from removal actions conducted on vicinity properties.

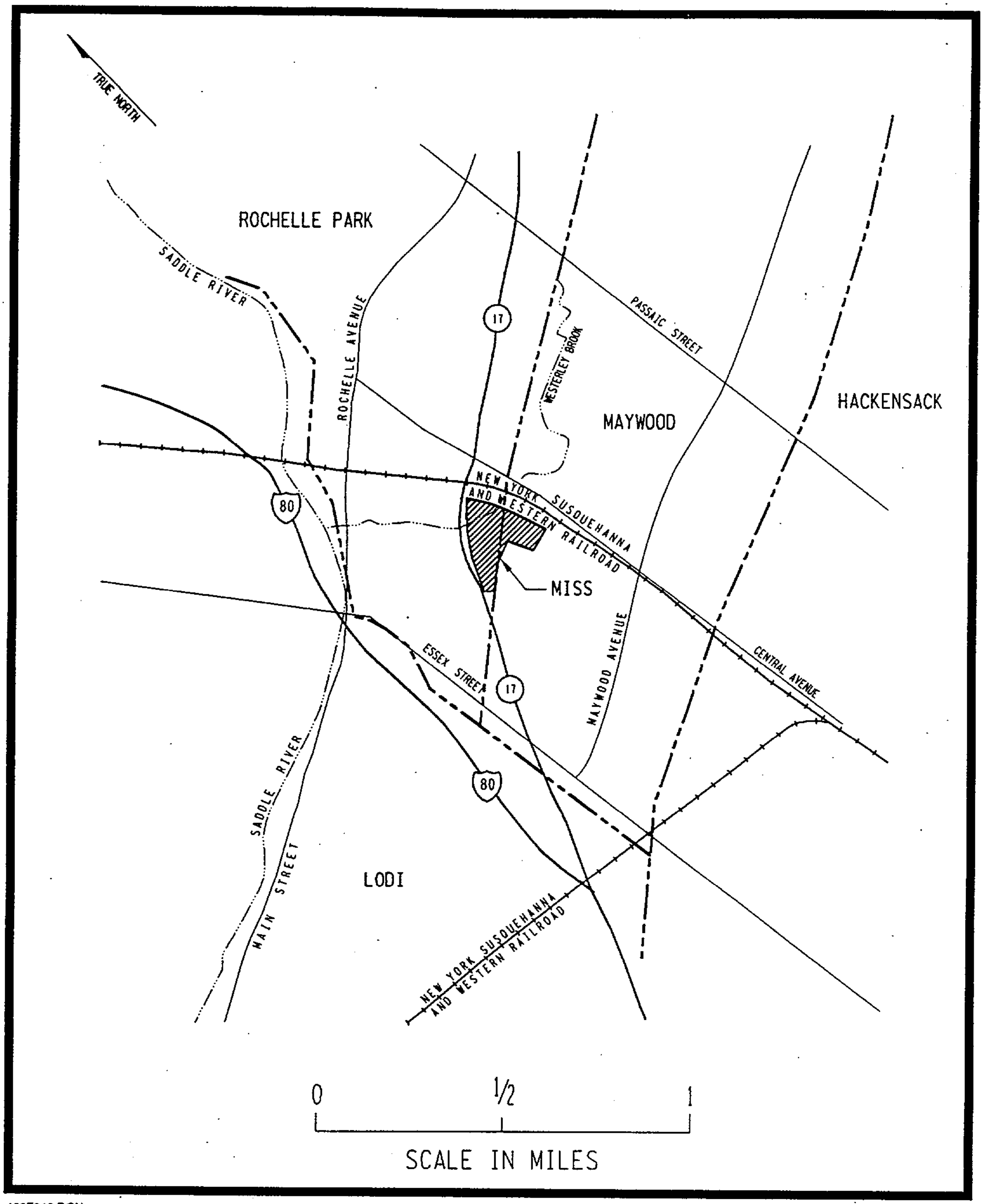

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Figure 1-4
Location of MISS

1.4 SITE HISTORY

The Maywood Chemical Works plant was constructed in 1895. In 1916, the plant began extracting thorium and rare earths from monazite sand for the manufacture of mantles for various gas lighting devices. The manufacturing process included the production of mantle-grade thorium nitrates and various lithium compounds, especially lithium hydroxide and lithium chloride. The primary radioactive contaminant at the Maywood site is thorium-232 and its associated daughter products, with lesser amounts of the uranium-238 decay chain. In addition, a variety of inorganic and organic chemicals have been identified in soils and groundwater at MISS (BNI 1985, 1986, 1987a, 1988, 1989).

The following description of the process used to produce mantle-grade thorium nitrate at Maywood Chemical Works is based on correspondence regarding plant operations and a reconstruction of the chemical processes (Heatherton 1951; Jones 1987; Albert 1966; Eister and Kennedy 1974; Stokinger 1981).

The process was initiated by dumping monazite sand from 23-kg (50-lb) sacks into a steam-jacketed tank or sulfating mill and digesting it with hot sulfuric acid for several hours. The resultant pasty mass was diluted with water to dissolve the thorium, uranium, and rare earths, leaving unreacted monazite, silica, rutile, and zircon. The mixture was then vacuum filtered. The filtrate was evaporated, separating the uranium and rare earths from the thorium sulfate solution. Reagents, perhaps oxalic acid (NRC 1981), were added to the thorium sulfate solution to form thorium oxalates, which were precipitated and removed by vacuum filtration to produce a cake. Purification involved redissolving the thorium oxalate and precipitating it as a hydroxide. During finishing, the thorium hydroxide was dissolved with nitric acid in large silica dishes and subsequently evaporated until crystallization was complete. The remaining thorium salt was hand-ground and packaged in 19-L (5-gal) bottles. The primary chemicals used in the extraction process are thought to have included sulfuric acid, nitric acid, ammonium hydroxide, oxalic acid, and ammonium oxalate.

Slurry that contained process waste from the thorium operations was pumped into two areas surrounded by earthen dikes on property west of the plant. In 1932, the disposal areas were separated from the plant and partially covered by the construction of Route 17. Some of the process wastes were removed from the Maywood Chemical Works property for use as mulch and fill on nearby properties, thereby contaminating them with radioactive thorium.

The Energy and Water Development Appropriations Act of 1984 authorized DOE to undertake a decontamination research and development project at the Maywood site, and the site was assigned to FUSRAP. DOE negotiated access to a 4.7-ha (11.7-acre) portion of the Stepan Company property (now known as MISS) for use as an interim storage facility for contaminated materials that were to be removed from vicinity properties. In late 1983, DOE instructed ORNL and BNI to begin a survey program for properties in the vicinity of the former Maywood Chemical Works plant. In 1984 and 1985, DOE conducted removal actions at 26 properties and placed the waste in temporary storage at MISS. In September 1985, ownership of MISS was transferred to DOE.

Further details of the Maywood site history and description can be found in the work plan-implementation plan.

1.5 SUMMARY OF GEOLOGIC AND HYDROGEOLOGIC DATA REQUIREMENTS

Geologic and hydrogeologic data requirements have been compiled based on the historical information available for MISS. The following information is known about the site:

- Geologic sequence of soil/rock
- Vertical distribution of water table and shallow bedrock
- General gradient of potentiometric surface of shallow bedrock aquifer
- Groundwater flow rates for regional aquifers

Further investigation is required to obtain the following information:

- Gradients for shallow groundwater systems offsite
- Cause of water table irregularity near west edge of site
- Site-specific groundwater flow rates

2.0 REMEDIAL INVESTIGATION APPROACH

2.1 DATA REQUIREMENTS

Based on detailed study of existing reports, the additional geological and hydrogeological data required during the remedial investigation of MISS have been identified. Collection of these data will provide a better understanding of MISS and will allow evaluation of remedial action alternatives. The data requirements for MISS are organized into the following two areas.

- Resolve anomaly in understanding of groundwater flow
- Determine soil-to-groundwater transfer/leaching potential for contaminants

2.2 TECHNICAL APPROACH

This plan and phase of the remedial investigation will focus on the resolution of data gaps associated with understanding the MISS groundwater system and migration pathways. This section provides the technical approach that will be followed to obtain the needed data.

2.2.1 Resolve Anomaly in Understanding of Groundwater Flow

Groundwater level data previously collected by BNI (Young and Sims 1987) show a hydrogeologic anomaly near the Westerley Brook conduit (wells MISS-5A, -6A, and -7A). The remedial investigation will include a geological/hydrogeological investigation of the conditions that may cause this anomaly; two monitoring wells and ten geological boreholes will be drilled for this effort. Possible explanations for the anomaly are (1) interaction with and flow along a relict buried stream channel, (2) near-surface groundwater recharge and flow into or along the buried Westerley Brook conduit, and (3) groundwater interaction between the upper (overburden) and the lower (bedrock) systems. Figures 2-1 and 2-2 show the potentiometric surface of the upper and lower aquifer units at MISS. The overburden aquifer flow gradient is anomalous, as compared with that of the bedrock aquifer.

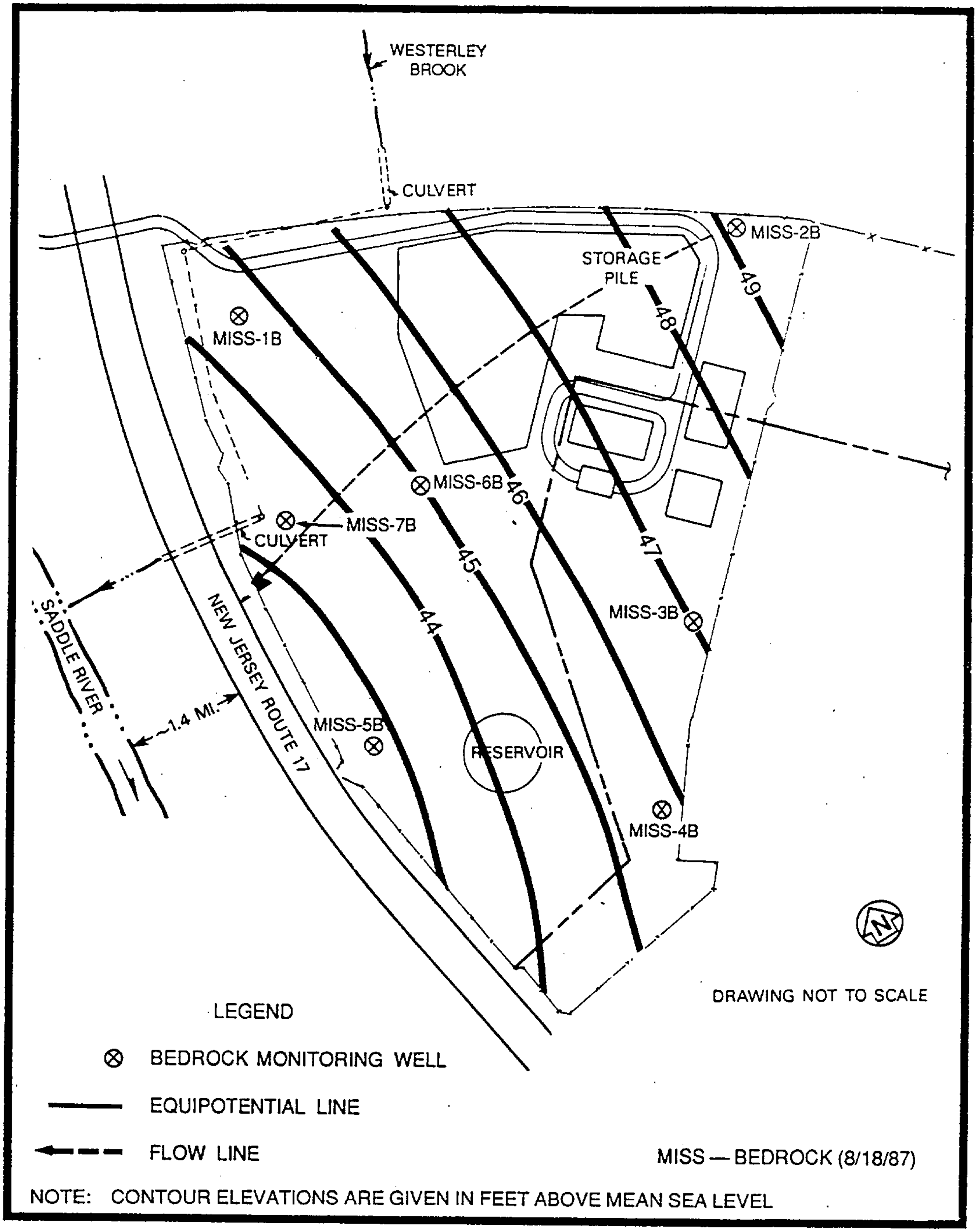

Figure 2-1
Potentiometric Contour Map of Groundwater
in the Bedrock Aquifer Beneath MISS

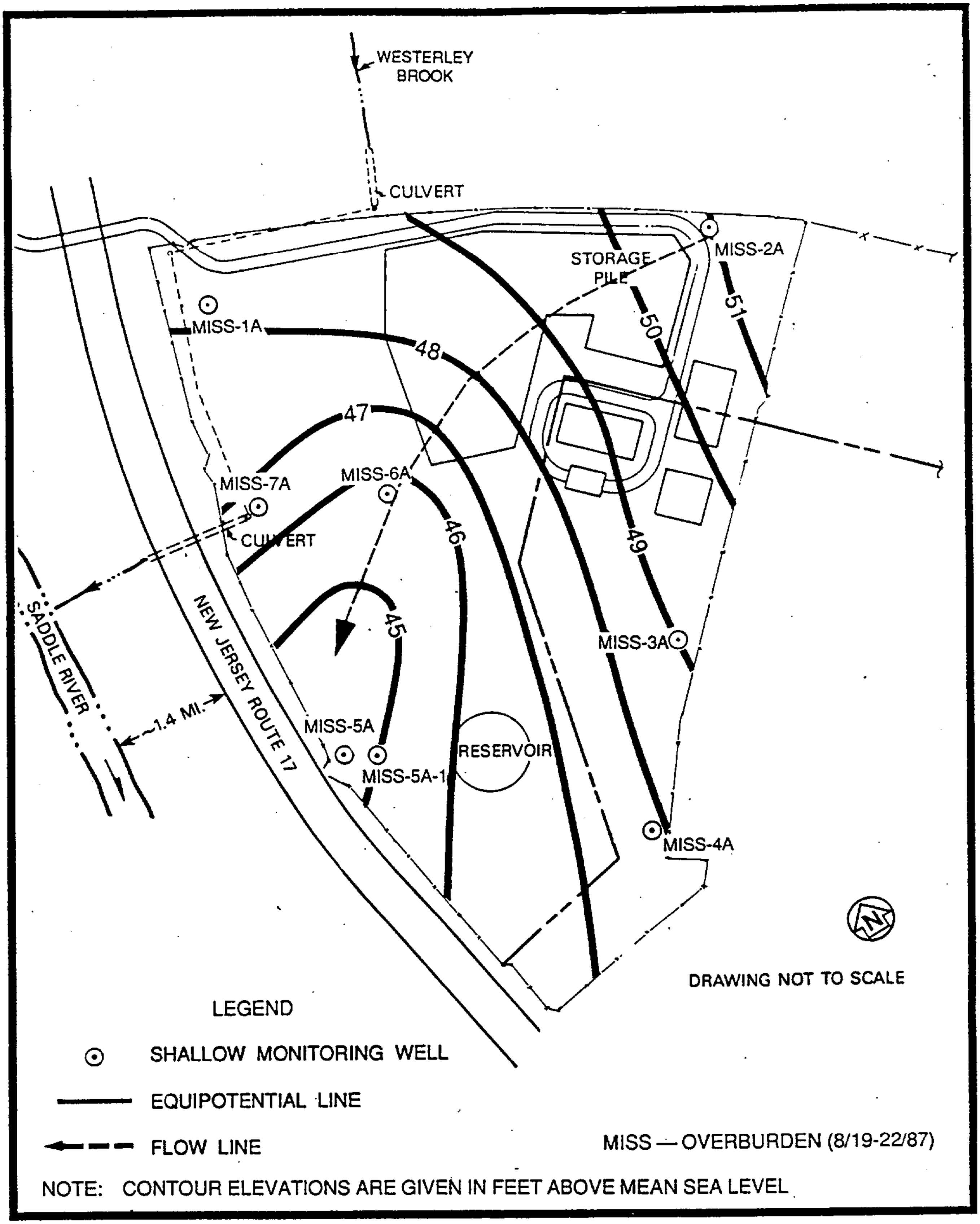

Figure 2-2
Potentiometric Contour Map of Groundwater in the Overburden Aquifer Beneath MISS

Relict surface water channels will be identified through completion of geologic borehole drilling. All logs will be reviewed to identify target areas for drilling of transects. Each transect will consist of a line of borings 3.04 m (10 ft) apart across the target area to provide a profile of any relict channels identified.

The inside of the Westerley Brook conduit will be visually inspected to detect groundwater discharge into the conduit. Flow will be sampled at the intake and discharge points.

To evaluate interaction between groundwater systems, continuous water level recorders will be installed in three pairs of shallow and deep wells and will be operated for a minimum of one year (see Figure 2-3 for locations). In addition, the two proposed monitoring wells will be paired to monitor the shallow overburden and bedrock systems near the hydrogeologic anomaly. The New Jersey Department of Environmental Protection and Energy (NJDEPE) requires overburden wells to be completed no less than 0.3 m (1 ft) above bedrock to avoid creating a conduit between overburden and bedrock systems; therefore, the deep well will be drilled first to determine the elevation of the bedrock. NJDEPE will be notified two weeks before groundwater monitoring wells are installed. The wells will be installed by a driller who is certified by the state of New Jersey.

Groundwater samples will be collected from each of the 31 existing monitoring wells (see Figure 2-4) and two new monitoring wells as part of the existing environmental monitoring program for MISS. Collection, analysis, and reporting of these samples are not addressed in this plan. A description of the ongoing environmental monitoring program is included in the work plan-implementation plan. The purpose of collecting groundwater samples is to evaluate the significance of the groundwater transport pathway and to determine solute concentrations at the known source locations.

Water quality parameters (pH, temperature, specific conductance, and dissolved oxygen) will be measured at all groundwater sampling locations. These measurements will help determine the likelihood of interaction among the hydrologic units and may be used to define the proximity to areas previously identified as sources of contamination.

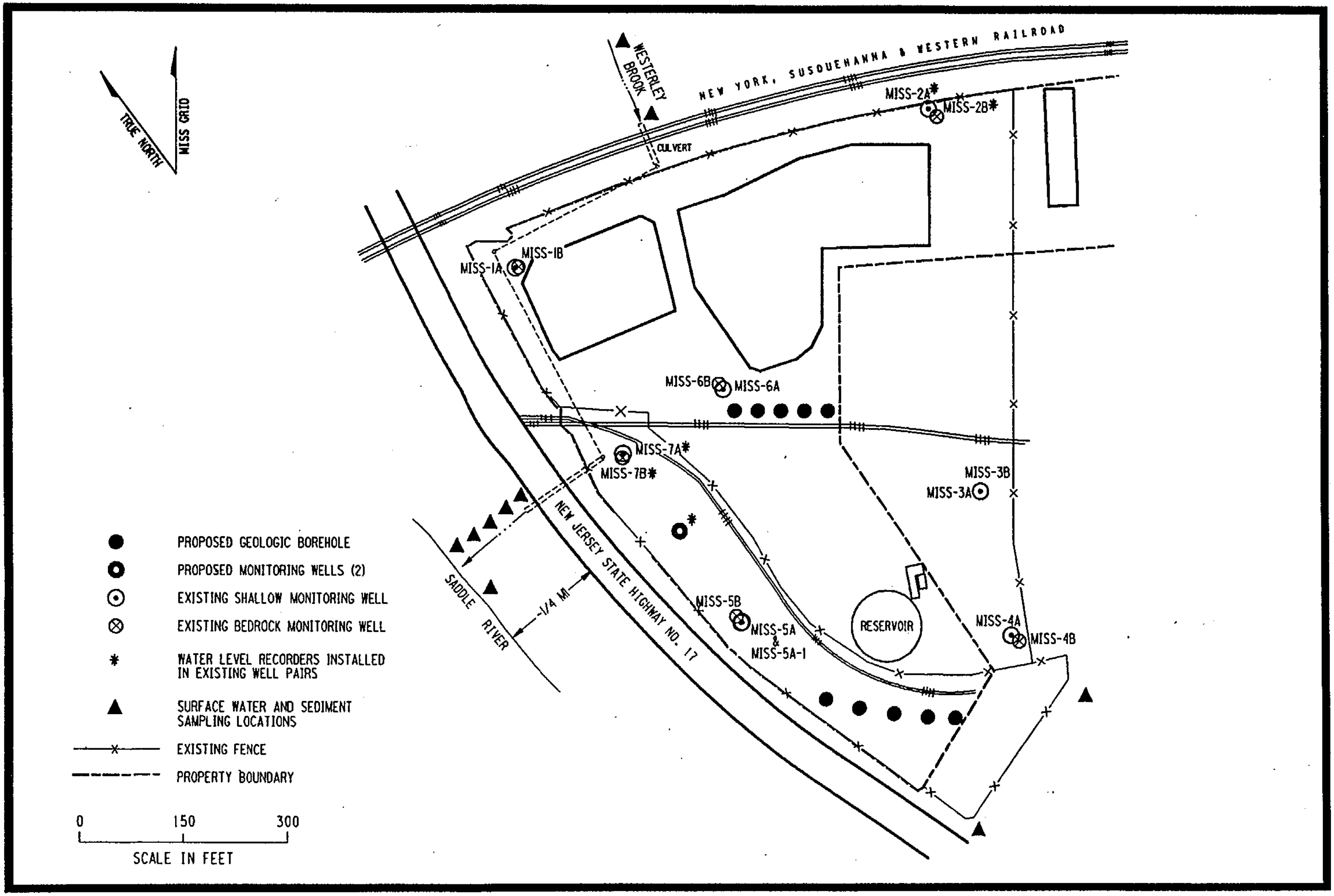

Figure 2-3
Proposed Locations of New Monitoring Wells, Water Level Recorders, and Geologic Boreholes

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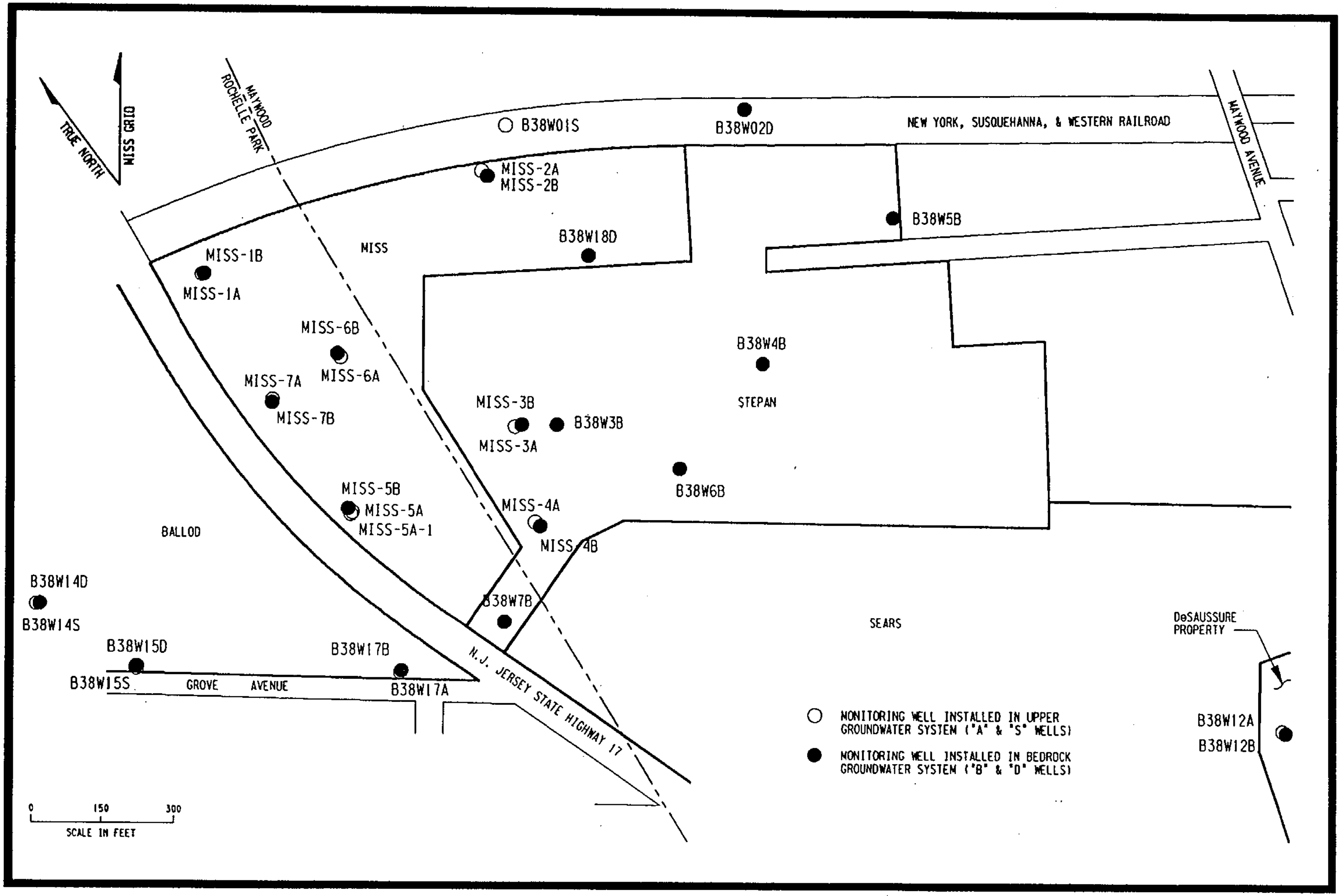

Figure 2-4
Locations of Existing Groundwater Monitoring Wells
at MISS and Vicinity

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New Jersey state water well permit records and local utility documents will be examined to identify existing wells within a 4.8-m (3-mi) radius of the site. This information will be used to locate wells for a well canvass and to delineate areas where groundwater is used. Data concerning well location and construction details, including depth, screened interval, type and size of casing, and rate of pumpage, will be obtained from the owner of the well or from well permit records. If other data collected during the remedial investigation suggest the need, groundwater samples may be collected as part of the well canvass, if the owner of the well agrees.

2.2.2 Determine Soil-to-Groundwater Transfer/Leaching Potential for Contaminants

Engineering and geotechnical measurements, including soil gradation, cation exchange capacity, distribution coefficient, Atterberg limits, specific gravity, unit weight (wet/dry), moisture content, and centrifuge moisture equivalent, will be conducted on samples obtained from selected borehole locations. These locations will include the two boreholes for monitoring wells and boreholes showing positive evidence of relict channels. The engineering parameters help determine depositional mechanisms and differentiation between stratigraphic units. The geotechnical properties provide information regarding contaminant migration and attenuation mechanisms. If organic contamination is identified, selected soil samples will be analyzed for total organic carbon.

Borings will be drilled using hollow-stem augers or by advancing and cleaning out a casing. The geological boreholes, the monitoring wells, and the radiological/chemical boreholes will be drilled in accordance with the technical specifications summarized in Appendix A. A schedule of quantities for the planned borings and wells is presented in Table 2-1. The borehole will be continuously sampled to total depth, except for the deep well, which will be sampled only at 1.5-m (5-ft) intervals below a depth of 6.1 m (20 ft). A geologic log of each borehole will be prepared so that the stratigraphy across the site can be correlated. Soils associated with the hydrogeological anomaly will be sampled to determine whether they affect the groundwater gradient (two borings associated with the anomaly). The evaluation will include determining the attenuation properties of stratigraphic units in the overburden by testing samples from these borings.

Table 2-1

Schedule of Proposed Quantities for Geologic Borings and Wells

	Shallow	Deep	Geologic Boreholes[a]	Totals
Boreholes				
Number	1[b]	1[b]	10	12
Total depth of each borehole	20 ft	50 ft	20 ft	270 ft
Well diameter	2 in.	2 in.	--	--
Well material - casing	PVC[c]	PVC	--	--
- screen	PVC	PVC	--	--
Feet of casing	17	47	--	64 ft
Feet of screen	5	5	--	10 ft
Sand/gravel pack	7 ft Ottawa sand	7 ft Ottawa sand	--	14 ft
Bentonite plug	2 ft	2 ft	--	4 ft
Grout to ground	X[d]	X	X	X
Coupling type	Flush threaded	Flush threaded		
Soil Samples				
Split spoon each borehole	X	X	X	135
Sampling interval	Continuous	Continuous $\geq$20 ft, @ 5-ft intervals	Continuous	--
Shelby tube	1	3	1	14
Rock core	--	--	--	--
In Situ Testing				
Permeability:	1	1	1 each	12
Falling/rising head	1	--	10	11
Constant head	--	1	--	1
Packer	--	--	--	--
Geophysical logging	--	--	--	--
Groundwater flow meter	--	--	--	--
Other	--	--	--	--
Other Specifications				
Large diameter augers				
Locking well caps	1	1	--	2
Well development by:				
Water surging	X	X	--	--
Air lift pumping	X	X	--	--
Surge block	--	--	--	--
Survey:				
Top-of-pipe elevation	1	1	--	2
Ground elevation	1	1	10	12
Areal location	1	1	10	12
Protective outer casing:				
Steel	1	1	--	2
Concrete pad	1	1	--	2
Well Logs:				
From samples	1	1	10	12
From auger cuttings	--	--	--	--
Aquifer separation:				
Outer casing (Conductor casing)	--	--	--	--

[a]Drilled as needed to define subsurface channel.

[b]Location of wells shown in Figure 2-3 (two wells depicted by single symbol).

[c]PVC - polyvinyl chloride.

[d]X = Analysis or specification required.

3.0 SAMPLE TYPES AND MEASUREMENTS

Although the boundaries of radioactive contamination are fairly well defined at MISS, all samples will be analyzed for thorium-232, radium-226, and uranium-238 [radionuclides detected during the 1986 characterization (BNI 1987b)]. New data will be used to confirm and more precisely define the vertical boundary of the radioactive contamination determined by the earlier surveys.

Soil samples will be selected in the field and analyzed by gamma spectrometry for thorium-232, radium-226, and uranium-238. The field sampling team will select these samples based on the results of borehole gamma logs. This procedure is described in greater detail in the field sampling plan for the Maywood site.

Engineering and geotechnical analyses [gradation/hydrometer, cation exchange capacity, distribution coefficient, Atterberg limits, specific gravity, unit weight (wet/dry), moisture content, centrifugal moisture equivalent, and pH] will be performed on samples taken from the two new monitoring wells and possibly from selected geologic boreholes.

4.0 SAMPLING FREQUENCY

The soil sampling described in this field sampling plan is intended to be a one-time sampling effort.

Sampling of the two new monitoring wells will be incorporated into the established environmental monitoring program for MISS. All wells in the environmental monitoring program are sampled quarterly. Water level measurements are made weekly except for wells equipped with continuous water level recorders (see Section 2.2.1). The locations of the monitoring wells, chemical boreholes, and geological boreholes will be precisely determined by civil survey. The technical specifications for drilling will address all NJDEPE requirements for monitoring well installation.

5.0 ANALYTICAL PROCEDURES

This section describes acceptable analytical methods and protocols and quality assurance/quality control requirements for the work. Analytical methods were selected based on their ability to detect the desired compounds and meet the necessary detection limits. Technical requirements for the methods are based on guidelines and standards developed by the Environmental Protection Agency (EPA), the American Society for Testing and Materials (ASTM), and other sources. The requirements are stated to ensure the defensibility and integrity of analytical data obtained.

The following sections describe the analytical procedures for radiological and physical parameters of soil samples. These procedures are intended to control analysis of samples collected during the remedial investigation. Control of samples collected from the wells on an ongoing basis will be through the existing environmental monitoring program. For a more in-depth discussion on quality assurance/quality control, see the quality assurance project plan.

5.1 ANALYTICAL METHODS

Procedures for analysis of engineering/geochemical parameters are shown in Table 5-1; the method reference numbers are also included.

5.2 SAMPLE HANDLING AND PRESERVATION

Approximately 1 kg (2.2 lb) of each soil sample will be collected and stored in containers appropriate for the individual sample analysis parameters. No field pretreatment is required for soil samples before they are shipped to the laboratory for analysis. Groundwater samples will be analyzed as part of the ongoing environmental monitoring program at MISS, as described in the work plan-implementation plan.

Table 5-1

Engineering/Geotechnical Test Methods

Test	Method
Gradation/hydrometer	ASTM[a] D422
Cation exchange capacity	ASTM STP-805
Distribution coefficient	ASTM D4319
Atterberg limits	ASTM D4318
Unit weight (wet/dry)	DA EM[b] 1110-2-1906
Moisture content	ASTM D2216
Centrifuge moisture equivalent	ASTM D425
Specific gravity	ASTM D854

[a]ASTM - American Society for Testing and Materials.

[b]DA EM - Department of the Army Engineer Manual.

5.3 QUALITY CONTROL

Quality control and quality assurance activities are described in detail in the quality assurance project plan.

5.4 REPORTING

All data from each sample batch will be reported using the Chemical Abstract number and the International Union of Pure and Applied Chemistry system of chemical nomenclature (and, if different, the applicable Federal Register nomenclature for the Comprehensive Environmental Response, Compensation, and Liability Act). Analytical results for aqueous samples will be reported in milligrams/liter (mg/L), micrograms/liter (μg/L), or picocuries/liter (pCi/L); solid sample analytical results will be reported in milligrams/gram (mg/g), micrograms/gram (μg/g), or picocuries/gram (pCi/g).

5.5 SAMPLE HANDLING, PACKAGING, AND SHIPPING

The samples will be packed in vermiculite to minimize the potential for breakage during shipment to the laboratory for analysis. Samples will be shipped, on ice if necessary, by priority mail on the same day they are collected. Chain of custody and sample handling will be conducted in accordance with methods described in A Compendium of Superfund Field Operations Methods (EPA 1987).

6.0 OPERATING PLAN

The scope of the operating plan includes field activities required to achieve the work elements for the field sampling. The objective is to identify the subcontract packages, field and analytical support, BNI support, documentation, technical specifications, and project instructions. The primary subcontract activities are discussed in Appendix A. The following sections address the major elements of an operating plan for MISS.

6.1 SAMPLING

Surface and subsurface soil sampling will be accomplished by the drilling subcontractor, who will be supported by subcontractor sampling personnel and a BNI geologist/field engineer. Sample handling will be controlled according to methods described in A Compendium of Superfund Field Operations Methods (EPA 1987) and will be audited by environmental health and safety personnel. Sampling will be done using split spoons and will be specified in the technical specifications of the subcontract package.

6.2 SITE-SPECIFIC FEATURES

Features and utilities affecting the field program will be drafted on a plot plan and issued with all subcontract packages.

6.3 HEALTH AND SAFETY

The health and safety plan for MISS will be in effect during all field activities.

6.4 LABORATORY PHASING

Laboratory phasing of samples will not be necessary because of the holding times associated with the analyses specified in the field sampling plan.

6.5 FIELD NOTES AND DOCUMENTATION

Geologists and sampling crews will keep indelible ink records of their field activities in bound field notebooks. Geologists' notes will include, as a minimum:

- Descriptions of each stratum encountered
- Soil sample collection data (including depth and type)
- Depths of stratum changes
- Measurements of water levels during drilling
- Industrial hygiene measurements taken during drilling (including Enmet readings, lower explosive limit measurements, and Draeger tube test results)
- Permeability test data
- Installation details for monitoring wells
- Grouting details for boreholes
- Any other observations made (including water loss zones, drilling character, and odor)

These notes will be transferred to geologic drill logs. Sampling personnel will record weather conditions, sample locations, sample types taken, time of day, chain-of-custody identification numbers, field measurements, and the sampler of record.

6.6 FIELD TEAM ORGANIZATION

The field team will be supervised by the technical group leader. Section 1.2 describes the overall organization of the sampling team.

6.7 DECONTAMINATION

Decontamination will be conducted as necessary to ensure that personnel and equipment leaving a controlled area meet DOE guidelines for release and that cross-contamination of samples does not occur. Decontamination will be conducted in accordance with technical specifications in the subcontract.

6.8 EXPENDABLE SUPPLIES

Expendable supplies will be identified to accommodate sampling, decontamination, and health and safety activities. Supplies will be purchased and available on site before field activities begin.

6.9 EQUIPMENT

Equipment will be identified for sampling, decontamination, and personnel protection (as appropriate) and will be available on site before field activities begin.

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APPENDIX A

Summary of Technical Specifications for Boreholes and the Installation of Monitoring Wells

APPENDIX A

Summary of Technical Specifications for Boreholes and the Installation of Monitoring Wells

Characterization of FUSRAP sites typically includes a site geologic investigation and collection of various environmental samples for analysis in the laboratory. The principal support activities to accomplish a site characterization include drilling radiological/chemical and geologic boreholes and installing groundwater monitoring wells.

Because all specialized support activities are typically conducted by subcontractors, details about the performance of these activities are contained in the scope of work and the technical specifications developed for a subcontract. The scope of work and drawings specifically define the tasks that will be done, and the technical specifications identify how the tasks are to be done. This appendix summarizes the requirements delineated in the subcontract document.

A.1 RADIOLOGICAL AND CHEMICAL BOREHOLES

The specifications include a discussion of general requirements related to any contract activity. These requirements include quality standards that address quality control of the materials used for the activity and any standards specific to the activity. For radiological and chemical boreholes, all work is conducted in compliance with Occupational Safety and Health Administration (OSHA) Standards (29 CFR 1926/1910). Specific requirements are summarized in the following sections.

A.1.1 Documentation

When radiological and chemical boreholes are drilled, specific information must be recorded in field logs. All logs show borehole number, date of drilling, locations (i.e., site coordinates), ground surface elevation, description of the material encountered by the boring, depth at which each change in material occurs, depths at which samples were obtained and the type of sample in each instance, percentage of sample recovery, depth to water table, depth to original ground, and any other data pertinent to the identification of subsurface materials.

A.1.2 Equipment and Materials

Specific requirements for equipment and materials are developed for the following items:

- Drill rig and support equipment
- Cement/bentonite grout
- Granular bentonite
- Cleaning material (deionized water, hydrochloric acid, soap, solvents)
- Temporary casing
- Surface protection materials (plastic sheeting, plywood)
- Perimeter barricade
- Borehole cover and markers
- Sediment barriers
- Sampling equipment

A.1.3 Field Operations

Predrilling

- Underground utilities in the work area are evaluated. Before drilling operations begin, all local utility companies (e.g., gas, water, sewer, electric, telephone) are contacted to determine and confirm locations of underground utilities in the work areas. All utility locations in the work areas are identified and visibly marked.

- A water-handling procedure is developed. All water discharged from the boreholes during drilling operations is collected in a mud tub. A mud pit will not be excavated. Contents of the mud tub are transferred to drums and disposed of or stored onsite where indicated on the design drawings.

- Safety and security measures are evaluated. Perimeter barricades are provided around work areas during work operations, if required. Barricades are placed to provide sufficient mobility for work operations within the barricaded area and not interfere with activities of occupants of the work areas. Barricades remain in place until all work within the barricaded area is completed.

Drilling

- Drilling operations are managed from the field site. Boreholes are drilled at locations shown on the design drawings and in the sequence determined at the site. Some adjustment of locations may be required at the site.

- Before drilling begins, surface protection material is placed over and around the drill hole location in a manner that will prevent the drill spoils from contacting the surrounding surfaces. Drill spoils are confined on the surface protection material around each borehole, collected, and transported to and disposed of in the spoils area shown on the design drawing.

- All drill holes are drilled straight and free of obstructions to permit free and easy installation of temporary casing for downhole radiological logging.

- When obstructions are encountered in drill holes or if unstable material is encountered, suitable methods are used to drill through such obstructions. Where necessary to keep the holes open and enable the holes to be advanced, temporary casings may be used.

- Drilling is not permanently interrupted before reaching the required depth without prior approval.

- Drill holes abandoned before reaching the required depth because of equipment failure, negligence, or other such causes are subject to rejection and replacement with a supplementary hole adjacent to the abandoned hole. Abandoned holes are backfilled as specified.

- Until abandoned drill holes are backfilled, borehole covers and appropriate markers are used to minimize the hazardous condition created by an open drill hole.

- Drilling is performed in a manner that permits continuous soil sampling.

- For drilling and sampling activities associated with chemical boreholes, the tool joint lubricant for assembly of drill rods, auger flights, sampling apparatus, and other downhole items is Teflon tape, graphite powder, or apiezon grease (e.g., Dow Corning High Vacuum Grease or equivalent material). Oil or grease are not used on downhole items for chemical boreholes.

General

- All downhole items such as augers and temporary casings are cleaned and radiologically surveyed before work commences at the next borehole. Cleaning is done with brushes, scrapers, rags, and other items as necessary to remove surface contamination. Materials are kept wet during brushing and scraping operations to reduce the potential for inhalation of contaminants.

- The deionized water and soap used for cleaning are handled and disposed of with the water from the decontamination operations. Solvent (isopropyl alcohol), used and unused, is handled as a flammable material. The hydrochloric acid (3-5 percent) is handled and disposed of independently.

Cleaning for radiological boreholes

The sampling apparatus and other downhole items used in radiological boreholes are cleaned before each use so that they are free of visible soil, debris, and other foreign matter.

Cleaning for chemical boreholes

The drill rod assemblies, lead auger flights, center plugs, sampling apparatus, and other downhole items that could affect sample integrity are cleaned before each use in a chemical borehole in accordance with the applicable method set forth below.

Method I: When not analyzing for metals

(1) Clean with one or both of the following:
  - Steam with soap
  - High-pressure water with soap

(2) Rinse with deionized water
(3) Rinse with isopropyl alcohol
(4) Rinse thoroughly with deionized water
(5) Air dry before use

Method II: When analyzing for metals

(1) Clean with one or both of the following:
  - Steam with soap
  - High-pressure water with soap

(2) Rinse with deionized water
(3) Rinse with nitric acid
(4) Rinse with deionized water
(5) Rinse with isopropyl alcohol
(6) Rinse thoroughly with deionized water
(7) Air dry before use

Soil samples

- Soil samples are obtained using a recognized sampling technique such as a split-barrel sampler, thin-walled tube sampler, Central Mine Equipment (CME) sampler, or other technique as approved by BNI before sampling.

- Samples are submitted to BNI at the point and time of recovery. BNI is responsible for furnishing containers, placing samples into containers, and labeling container as appropriate.

Backfilling boreholes

All boreholes are backfilled upon direction from BNI unless noted otherwise. Boreholes drilled thorough surface asphalt or concrete are backfilled with cement/bentonite grout using the tremie method and allowing for emplacement of an asphalt or concrete patch. Boreholes not drilled through surface asphalt or concrete are backfilled using either the dry-pack method or the tremie method. The dry-pack method is not used for drill holes that contain water. The backfilling-with-spoils method may be used only if specifically allowed in the subcontract scope of work or design drawings.

Dry-pack method

The dry-pack method is performed using granular bentonite emplaced in maximum 0.3-m (1-ft) lifts. Each lift is thoroughly rodded with a solid bar or suspended weight to prevent voids in the filled borehole. The dry-pack method is not used when the borehole contains water, unless approved in advance by BNI.

Tremie method

The tremie method uses cement/bentonite grout starting at the bottom of the borehole. Grout is emplaced in one continuous operation. The tremie pipe is withdrawn as grout is emplaced but is at all times kept below the surface of the grout. Should loss or shrinkage of grout occur, holes are refilled with grout until grout is within 1.3 cm (0.5 in.) of the required elevation as shown on the design drawings.

Backfilling-with-spoils method

Drill spoils from a borehole may be used to fill that hole only where permitted by the design drawings or scope of work. Backfilling is performed in maximum 0.3-m (1-ft) lifts. Each lift is thoroughly compacted using a solid bar or suspended weight to preclude voids. Backfill is emplaced until it is at the same elevation as the area surrounding the borehole.

A.2 GEOLOGIC BOREHOLES

The specifications include a discussion of general requirements related to any contract activity. These requirements include quality standards that address quality control materials used for the activity and any standard that is specific to the activity. For geologic boreholes, all work will be conducted using the specific requirements summarized in the following sections.

- OSHA 29 CFR — Occupational Safety and Health Standards (Parts 1910 and 1926)
- ASTM D 1586 — Penetration Test and Split-Barrel Sampling of Soils
- ASTM D 1587 — Standard Method for Thin-Walled Tube Sampling of Soils
- ASTM D 2113 — Standard Practice for Diamond Core Drilling for Site Investigation
- USBR E-18 — Field Permeability Tests in Boreholes (Earth Manual)

A.2.1 Documentation

When geologic boreholes are drilled, specific information must be recorded in field logs. All logs show borehole number; date of drilling; location (i.e., site coordinates); ground surface elevation; description of the material in the boring; depth at which each change in material occurs; depths at which samples were obtained and the type of sample in each instance; percentage of sample recovery depth to water table; depth to original ground; and any other data pertinent to the identification of subsurface materials.

A.2.2 Equipment and Materials

Specific requirements for equipment and materials will be developed for the following items:

- Drill rig and support equipment
- Permeability testing equipment
- Cement/bentonite grout
- Granular bentonite
- Hole support and conductor casings
- Surface protection materials (plastic sheeting, plywood)
- Protective barriers
- Sampling equipment

A.2.3 Field Operations

Predrilling

- Underground utilities in the work area are evaluated. Before drilling operations begin, all local utility companies (e.g., gas, water, sewer, electric, telephone) are contacted to determine and confirm locations of underground utilities in the work areas. All utility locations in the work areas are identified and visibly marked.

- A water-handling procedure is developed. All water discharged from the boreholes during drilling operations is collected in a mud tub. A mud pit will not be excavated. Contents of the mud tub are disposed of where indicated on the design drawings.

- Safety and security measures are evaluated. Perimeter barricades are provided around work areas during all work operations, if required. Barricades are placed to provide sufficient mobility for work operations within the barricaded area and not interfere with activities of occupants of the work areas. Barricades remain in place until all work within that barricaded area is completed.

Drilling

- Drilling operations are managed from the field site. Boreholes are drilled at locations shown on the design drawings and in the sequence determined at the site. Some adjustment of locations may be required at the site.

- Before drilling begins, surface protection material is placed over and around the drill hole location in a manner that will prevent the drill spoils from contacting the surrounding surfaces. Drill spoils are confined on the surface protection material around each borehole, collected, and transported to and disposed of in the spoils area shown on the design drawing.

- All drill holes are drilled straight and free of obstructions to permit free and easy installation of temporary casing for downhole radiological logging.

- When obstructions or unstable materials are encountered in drill holes, suitable methods are used to drill through such obstructions. Where necessary, temporary casings may be used to keep the holes open and enable the holes to be advanced.

- Drilling is not permanently interrupted before reaching the required depth without prior approval.

- Drill holes abandoned before reaching the required depth because of equipment failure, negligence, or other such causes are subject to rejection and replacement with a supplementary hole adjacent to the abandoned hole. Abandoned holes are backfilled as specified. Until abandoned drill holes are backfilled, borehole covers and appropriate markers are used to minimize the hazardous condition created by an open drill hole.

- Drilling is performed in a manner that permits disturbed and undisturbed sampling of the overburden and core sampling of rock where required.

- Core drilling begins at the top of rock, and all intervals in rock are advanced by diamond core drilling methods (ASTM D 2113). All drilling is done in a manner that allows the maximum amount of core recovery.

- No drilling additives, drilling mud, organic solvents or cleaning solutions may be introduced into drill holes without prior approval by BNI.

Sampling

- Soil samples are obtained by a recognized sampling technique using a split-barrel sampler, thin-walled tube sampler, CME-type sampler, or other device as approved by BNI before sampling.

- Core sampling is conducted in accordance with ASTM D 2113 unless directed otherwise by BNI. Sampling is continuous, and all core samples are preserved in labeled core boxes.

- Samples are submitted to BNI at the point and time of recovery. BNI is responsible for furnishing containers, placing samples in containers, and labeling containers as appropriate.

Conductor casing

Conductor casings are installed through contaminated strata, as determined by BNI, as shown on the design drawings. Boreholes that require conductor casings are reamed to the diameter and length shown on the design drawings, and the conductor casing is installed in accordance with the technical specifications. Conductor casings remain in place following installation. Specific wells and borings using conductor casing are those drilled in suspected or known areas of contamination. Details of monitoring well construction using conductor casing are shown in Figure A-1.

Backfilling boreholes

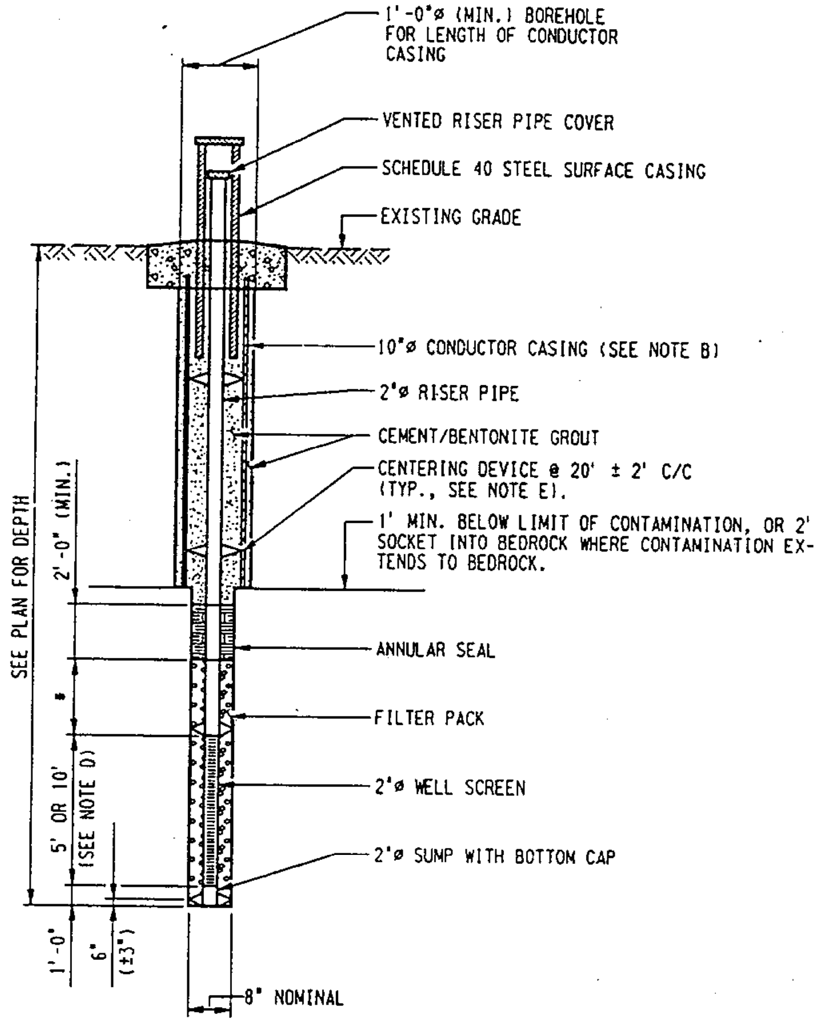
All boreholes are backfilled upon direction from BNI unless noted otherwise. Boreholes drilled thorough surface asphalt or concrete are backfilled with cement/bentonite grout using the tremie method to allow for placement of an asphalt or concrete patch. Boreholes not drilled through surface asphalt or concrete are backfilled using either the dry-pack method or the tremie method. The dry-pack method is not used for drill holes that contain water. The backfilling-with-spoils method may be used only if specifically allowed in the subcontract scope of work or design drawings.

Dry-pack method

The dry-pack method is performed using granular bentonite emplaced in maximum 0.3-m (1-ft) lifts. Each lift is thoroughly rodded with a solid bar or suspended weight to prevent voids in the filled borehole. The dry-pack method is not used when the borehole contains water unless approved in advance by BNI.

Tremie method

The tremie method uses cement/bentonite grout starting at the bottom of the borehole. Grout is emplaced in one continuous operation. The tremie pipe is withdrawn as grout is emplaced but is at all times kept below the surface of the grout. Should loss or shrinkage of



* = 2' TO 10' (AS DETERMINED IN THE FIELD BY BECHTEL)

TYPE III WELL INSTALLATION (SEE NOTES A & C)

NTS

NOTES:

A. TYPE III BOREHOLE IS FOR OUTDOOR LOCATIONS WHERE: A MONITORING WELL IS TO BE INSTALLED THROUGH A POTENTIALLY CONTAMINATED STRATA INTO AN UNCONTAMINATED STRATA; OR OVERBURDEN COLLAPSES UPON REMOVAL OF AUGER.

B. CONDUCTOR CASING SHALL BE INSTALLED TO THE REQUIRED DEPTH PRIOR TO DRILLING BELOW THE BOTTOM OF THE CONDUCTOR CASING. CONDUCTOR CASING SHALL BE EMBEDDED 1" TO 3" IN THE CONCRETE SURFACE SEAL (EXCEPT FLUSH MOUNT SEAL).

C. LIMIT OF CONTAMINATION WILL BE ESTABLISHED IN THE FIELD BY BECHTEL.

D. THE LENGTH OF THE WELL SCREEN WILL BE ESTABLISHED IN THE FIELD BY BECHTEL.

E. IN LIEU OF CENTERING DEVICES, INSTALLATION OF CASING, SCREEN AND FILTER PACK MAY BE MADE THROUGH HOLLOW STEM AUGER PROVIDED THAT RISER CASING AND SCREEN ARE LOCATED IN THE CENTER OF THE HOLE UPON COMPLETION.

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Figure A-1
Standard Well Installation

grout occur, holes are refilled with grout until grout is within 1.3 cm (0.5 in.) of the required elevation shown on the design drawings.

Backfilling-with-spoils method

Drill spoils from a borehole may be used to fill that hole only where permitted by the design drawings or scope of work. Backfilling is performed in maximum 0.3-m (1-ft) lifts. Each lift is thoroughly compacted using a solid bar or suspended weight to preclude voids. Backfill is emplaced until it is at the same elevation as the area surrounding the borehole.

A.3 INSTALLATION OF MONITORING WELLS

The specifications include a discussion of general requirements related to any contract activity. These requirements include standards that address quality control materials used for the activity and any applicable standards specific to the activity. For the installation of monitoring wells, all work will be conducted using the standards and codes listed below. Specific requirements are summarized in the following sections.

- OSHA 29 CFR — Occupational Safety and Health Standards (Parts 1910 and 1926)
- ASTM A 312 — Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipe
- ASTM C 136 — Standard Method for Sieve Analysis of Fine and Coarse Aggregates

A.3.1 Documentation

When monitoring wells are to be installed, the subcontractor will be required to provide the following documentation:

- Catalog cuts

- Samples of materials
- Certified sieve analysis
- Detail or shop drawings

All documentation will be transmitted to BNI at least two weeks before use, fabrication, or implementation.

A.3.2 Equipment and Materials

Specific requirements for equipment and materials will be developed for the following items:

- Drill rig and support equipment
- Conductor casing
- Riser pipe
- Screen
- Filter pack
- Annular seal
- Cement/bentonite grout
- Surface casing and protective cap
- Well cap
- Surface seal
- Centering device

A.3.3 Monitoring Well Installation

- Monitoring wells are installed in previously drilled boreholes at specified locations. If necessary, the boreholes are reamed to the size shown on the design drawings.

- The final depth of the hole is measured and the stainless steel riser pipe assembly (i.e., riser pipe screen, sump, and bottom cap) is constructed and installed in the borehole. Installation is conducted in accordance with technical specifications.

- After the riser pipe assembly is installed, the hole is cleaned by pumping water into the riser pipe and allowing it to flow to the surface through the annulus. The filter pack is installed during cleaning, as specified in the technical specifications.

- After installation of the filter pack, the annular seal is installed, and the remainder of the annular space is filled with grout. Should loss or shrinkage of grout occur, holes are refilled until they remain full.

- Each monitoring well is tested after the grout has set to confirm that the well is operative.

- The surface casing, cap, and seal are installed at each monitoring well, as shown on the design drawings.

A.3.4 Well Development

Installed wells are developed to maximize the yield of water per foot of drawdown and to extract from the water-bearing formation the maximum practical quantity of fines that may be drawn through the screen when the well is pumped under maximum conditions of drawdown. The subcontractor will be required to submit the well development procedures to BNI for review. Well development procedures will be in accordance with NJDEP Permit No. NJ0054500.