DOE/OR/21949-209.3

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 Tonawanda Site

Tonawanda, New York

August 1993

Printed on recycled/recyclable paper.

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DOE/OR/21949-209.3

FIELD SAMPLING PLAN FOR THE REMEDIAL INVESTIGATION/ FEASIBILITY STUDY-ENVIRONMENTAL IMPACT STATEMENT FOR THE TONAWANDA SITE

TONAWANDA, NEW YORK

AUGUST 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 field sampling plan (FSP) has been prepared as part of the scoping and planning process performed by the Department of Energy (DOE) to support remedial action at the Tonawanda site in western New York. Remedial action at the site is being planned as part of the DOE Formerly Utilized Sites Remedial Action Program.

Under the Comprehensive Environmental Response, Compensation, and Liability Act, a remedial investigation/feasibility study-environmental impact statement (RI/FS-EIS) must be conducted to support the decision-making process for evaluating remedial action alternatives. The RI/FS-EIS process was initiated by DOE to obtain sufficient site-specific information for assessment of the contamination at the Tonawanda site and evaluation of remedial action alternatives. The first step in the process was investigating the site to gain information about site characteristics and the nature and extent of contamination. This investigation required a phased approach that included performing a site characterization (in 1988 and 1989), identifying areas requiring additional investigations, and performing the additional investigations. The 1988-1989 characterization activities (i.e., first-phase activities) were conducted in accordance with the Characterization Plan for the Linde Air Products, Ashland 1, and Ashland 2 sites (BNI 1989). The additional investigations (i.e., second-phase activities) are guided by this FSP, which is one of five ancillary plans that are subsidiary to the principal RI/FS-EIS document, the work plan-implementation plan (WP-IP). Consistent with Environmental Protection Agency guidance for conducting an RI/FS-EIS, the WP-IP (1) summarizes information currently known about the Tonawanda site, (2) presents a conceptual site model that identifies potential routes of human exposure to site contaminants, (3) identifies data gaps from the first-phase activities, and (4) summarizes the process and proposed studies that will be used during the second-phase activities to fill the data gaps.

The ancillary plans were developed to direct field investigations to resolve the data gaps identified in the WP-IP.

The other plans are the quality assurance project plan, two health and safety plans, and the community relations plan.

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(continued)

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TABLES

ACRONYMS

AEC	Atomic Energy Commission
ARAR	applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
BFI	Browning-Ferris Industries
BNI	Bechtel National, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
CME	Central Mine Equipment
CRP	community relations plan
DOE	Department of Energy
EP	extraction procedure
EPA	Environmental Protection Agency
FSP	field sampling plan
FUSRAP	Formerly Utilized Sites Remedial Action Program
GC/MS	gas chromatography/mass spectrometry
GSA	General Services Administration
HSP	health and safety plan
ICPAES	inductively coupled plasma atomic emission spectrophotometry
MED	Manhattan Engineer District
NEPA	National Environmental Policy Act
NIST	National Institute of Standards and Technology
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Operations Office
OSHA	Occupational Safety and Health Administration
PDCC	project document control center
PQAS	project quality assurance supervisor
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RI/FS-EIS	remedial investigation/feasibility study-environmental impact statement

ACRONYMS
(continued)

SAIC	Science Applications International Corporation
SAP	sampling and analysis plan
SHSO	site health and safety officer
TCLP	toxicity characteristic leaching procedure
TMA/E	Thermo Analytical/Eberline
TOC	total organic carbon
TOX	total organic halides
WP-IP	work plan-implementation plan

UNITS OF MEASURE

cm	centimeter
ft	foot
gal	gallon
g	gram
h	hour
ha	hectare
in.	inch
kg	kilogram
km	kilometer
L	liter
m	meter
mi	mile
mg	milligram
μg	microgram
ml	milliliter
μR	microroentgen
pCi	picocurie
yd	yard

1.0 INTRODUCTION

In 1974 the U.S. Atomic Energy Commission (AEC), a predecessor agency to the Department of Energy (DOE), instituted the Formerly Utilized Sites Remedial Action Program (FUSRAP). The objective of FUSRAP, now managed by DOE, is to identify and clean up or otherwise control sites where 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. One of these sites is in Tonawanda, New York.

The Tonawanda site is composed of four individual properties: Ashland 1, Ashland 2, Seaway Industrial Park, and Linde Center. Ashland 1 is located on a portion of an inactive oil refinery owned by Ashland Oil Company. Ashland 2 is a vacant property also owned by Ashland Oil. Seaway Industrial Park (also called Seaway Landfill) is an operating commercial landfill. Linde Center is an operating industrial plant owned by Union Carbide Industrial Gases. In addition to these four properties, contamination is suspected on one commercial property adjacent to Linde Center. All contamination for which FUSRAP is responsible in the Tonawanda area stems from uranium processing performed for the Manhattan Engineer District (MED) at the Linde Center plant.

Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a remedial investigation/feasibility study-environmental impact statement (RI/FS-EIS) must be prepared to support the decision-making process for evaluating remedial action alternatives. This process is described in detail in the work plan-implementation plan (WP-IP), which (1) summarizes information currently known about the Tonawanda site, (2) presents a conceptual site model that identifies potential routes of human exposure to site contaminants, (3) identifies data gaps from the first-phase activities, and (4) summarizes the process and proposed studies that will be used during the second-phase activities to fill the data gaps.

The first phase of the RI/FS-EIS activities was conducted in accordance with the site characterization plan (BNI 1989). Results of these first-phase investigations are summarized in Section 2.0 of the WP-IP. The second-phase RI/FS-EIS activities at the Tonawanda site will be conducted in accordance with the WP-IP and the following ancillary plans:

- Community relations plan (CRP)
- Sampling and analysis plan (SAP)
- Two health and safety plans (HSPs)

The SAP actually consists of two separate documents: the field sampling plan (FSP) and the quality assurance project plan (QAPjP). This FSP will direct the field work for the radiological and chemical remedial investigation.

1.1 SITE CHARACTERIZATION RATIONALE

Under the integrated CERCLA/National Environmental Policy Act (NEPA) process, field activities are selected and prioritized to meet the following requirements in a timely manner:

- Identify and collect data to support removal actions for areas that present an immediate threat to the public or the environment

- Identify site characteristics and waste properties that can be used to identify permanent remedial action alternatives and appropriate treatment and/or recovery technologies

- Collect data needed as input to models used for engineering analyses and public health and environmental risk assessments

The Tonawanda site has been studied previously in great detail during the first phase of the RI; much information on site conditions already exists. This information (presented in

Section 2.0 of the WP-IP) has been incorporated into the appropriate RI/FS-EIS planning documents for the second-phase activities. The second-phase RI field activities described in this FSP focus on the few data gaps remaining to firmly establish boundaries of contamination to complete characterization of the Tonawanda site. Section 2.0 of this report identifies the objectives of the second-phase RI activities and the technical approach for achieving those objectives.

1.2 ORGANIZATION AND RESPONSIBILITIES

1.2.1 Project Organization

DOE is responsible for the overall implementation of FUSRAP. DOE Headquarters provides oversight and coordination. DOE Headquarters has contracts with Oak Ridge Institute for Science and Education (formerly Oak Ridge Associated Universities) and Oak Ridge National Laboratory (ORNL) to assist with designation of sites and properties under FUSRAP. These two organizations also provide independent verification of the successful completion of remedial action.

DOE Oak Ridge Operations Office (ORO) manages day-to-day FUSRAP activities. ORO has contracted with Bechtel National, Inc. (BNI) and Science Applications International Corporation (SAIC) to assist in the performance of FUSRAP activities. BNI serves as project management contractor for FUSRAP, and SAIC serves as environmental studies contractor. SAIC is responsible for the planning, management, and execution of the CERCLA RI/FS-EIS process and for meeting requirements of NEPA and the Resource Conservation and Recovery Act (RCRA). SAIC works closely with BNI. ORNL and Argonne National Laboratory are contracted by ORO to act as technical support contractors.

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

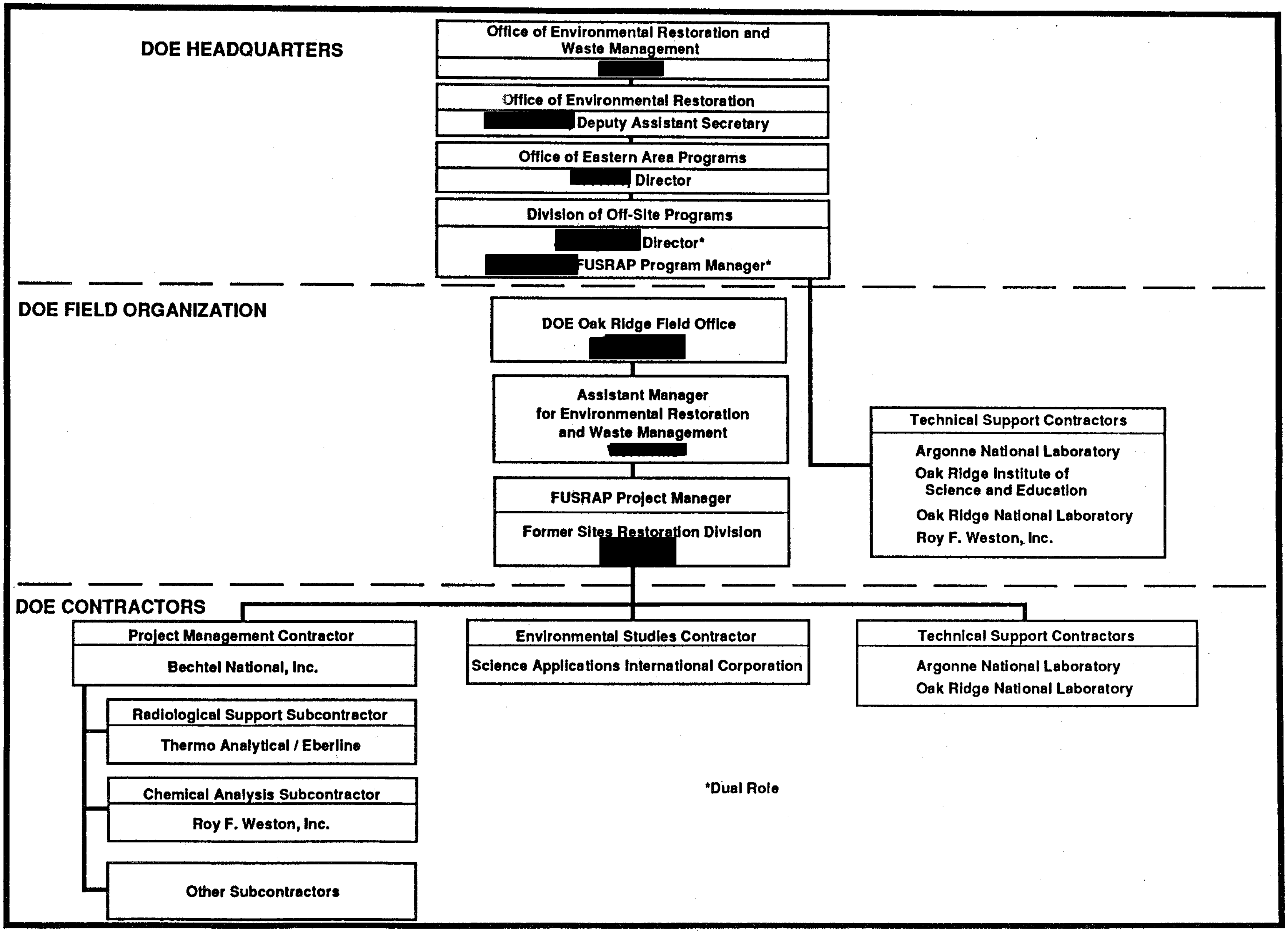

FIGURE 1-1 PROJECT ORGANIZATION

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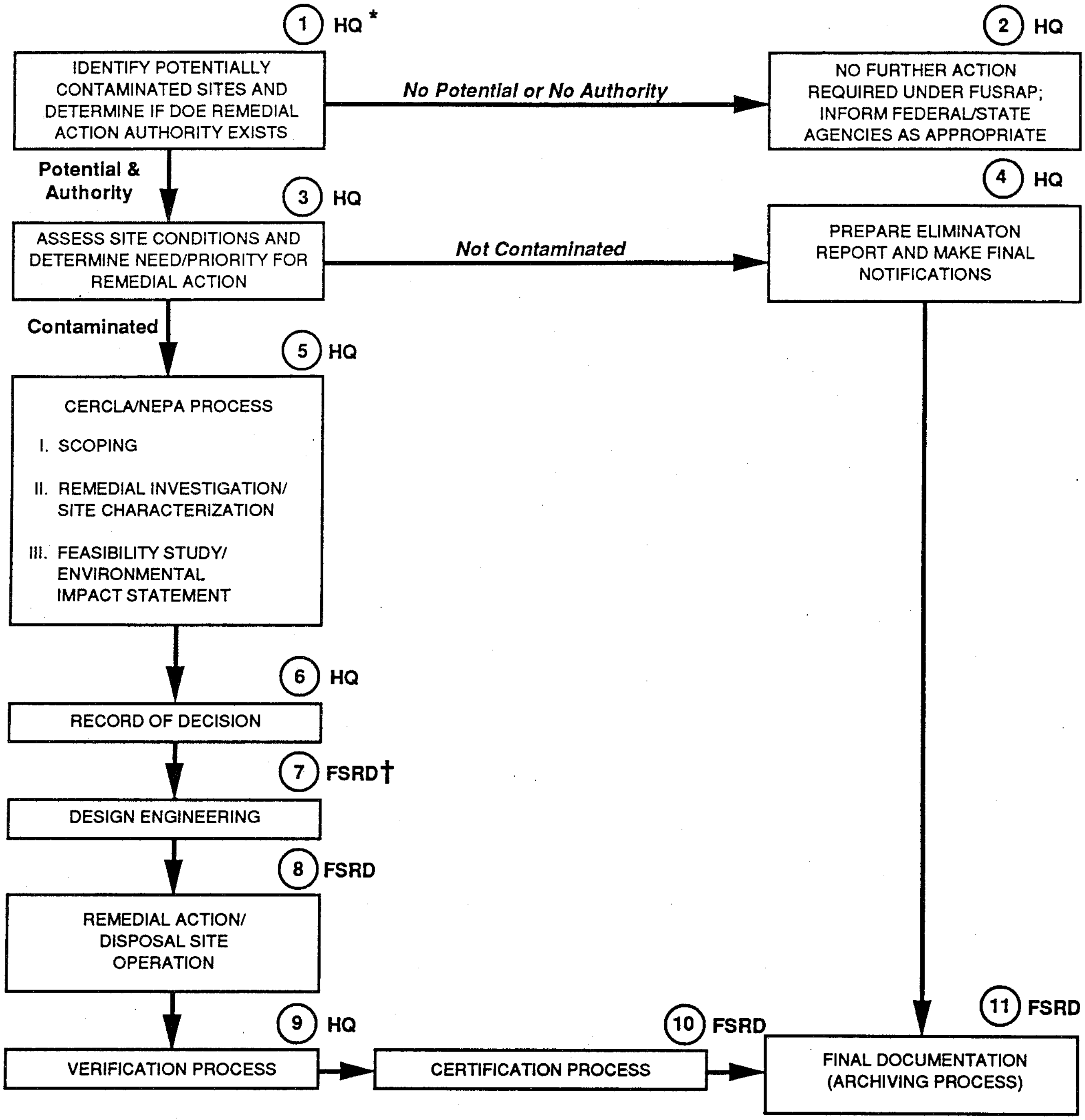

NOTE: THE STEP NUMBER AND RESPONSIBLE MANAGEMENT ORGANIZATION ARE INDICATED BESIDE EACH BOX

* DOE HEADQUARTERS

† DOE OAK RIDGE FIELD OFFICE, FORMER SITES RESTORATION DIVISION

FIGURE 1-2 PROJECT COORDINATION AND RESPONSIBILITY MATRIX

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1.2.2 Project Coordination and Responsibilities for Field Work

As project management contractor for FUSRAP, the Oak Ridge office of BNI provides management of and support to the field RI activities. Management and support include all activities necessary to implement the field work designated in the RI 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 (QA/QC) 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 successful 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 as follows.

Project manager

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

- Interacts directly with ORO site managers to implement DOE directions on a site-specific basis

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

Engineering

- Develops bid packages and technical specifications needed to subcontract RI 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

Construction

- Reviews all site plans for constructibility
- Monitors subcontract status (cost and schedule)
- Provides a site superintendent to administer subcontracts for onsite activities

Environmental, health, and safety

- Develops HSPs, health and safety objectives, and documentation; manages and evaluates chemical and radiological data obtained during characterization activities

- Manages subcontracts for radiological and chemical analysis services

- Provides technical group leader to support onsite RI efforts

- Coordinates and evaluates all health and safety matters

- 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 QAPjPs
- Audits QA 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 CRPs
- Coordinates community relations activities

Onsite management of characterization activities is conducted through the organizational structure shown in Figure 1-3. This structure provides well-defined responsibilities for 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

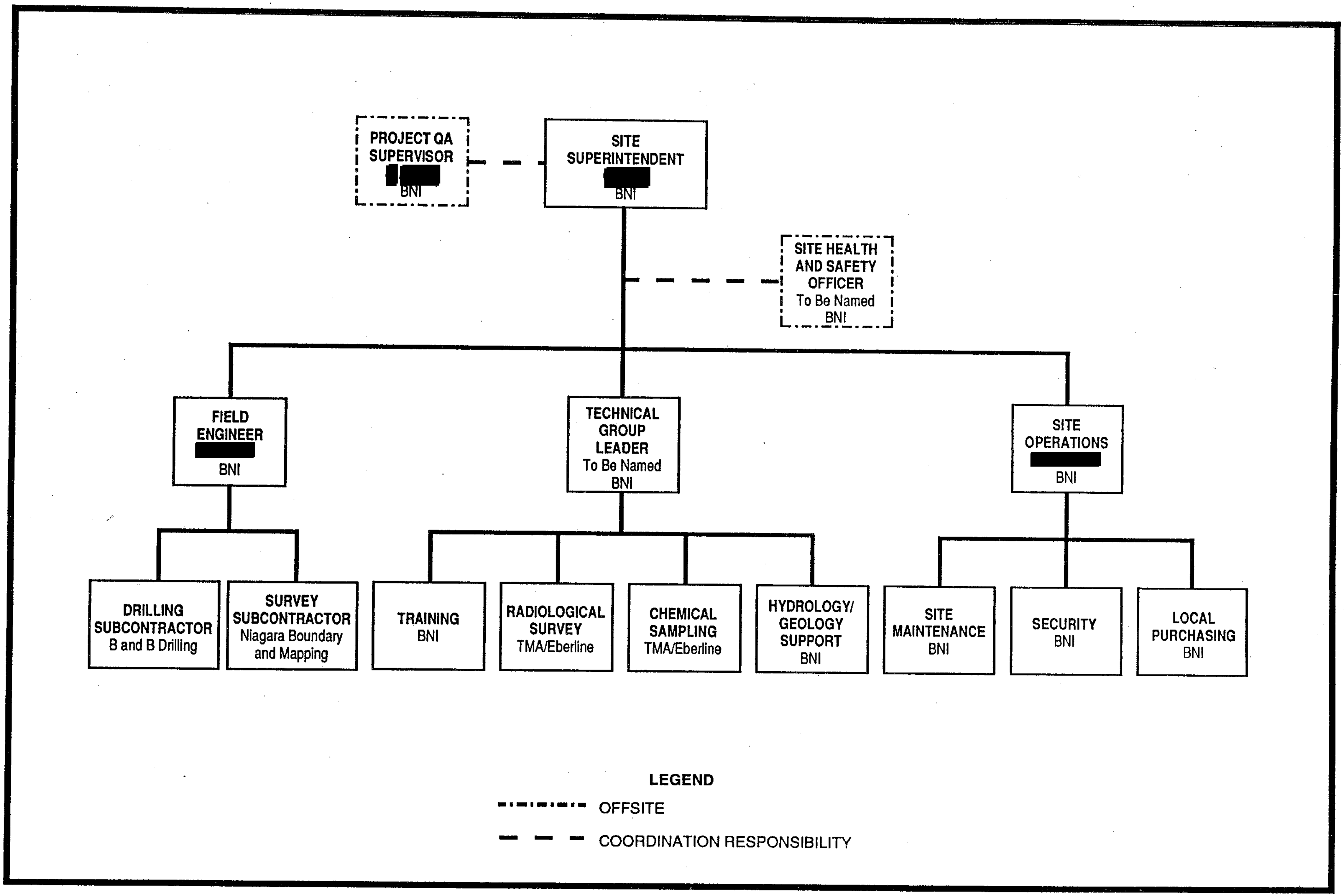

FIGURE 1-3 ONSITE ORGANIZATION

4.34 1949.1

at a specific site, this organization chart will be posted in a conspicuous location onsite. Individuals named in Figure 1-3 will be assigned at the time this report is issued; these assignments are subject to change. Responsibilities of each onsite position are as follows:

Site superintendent

The site superintendent is responsible to the BNI project manager for day-to-day operations at the site and directs the activities of the technical group leader, field engineer, and site operations personnel.

Technical group leader

The technical group leader is responsible for accomplishing the goals of the RI. All BNI or subcontractor personnel providing 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 coordinate daily activities with the field engineer to ensure support 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, QA/QC verification, and cost management.

Site operations personnel

Site operations personnel are responsible for site maintenance and security and for local purchasing of supplies and equipment. 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 administration and implementation of all health and safety matters that may adversely affect the health and well-being of the general public or 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 QA supervisor

The project QA supervisor (PQAS) conducts audits in the field (typically semiannually) to ensure implementation of the FSP and the HSP. Audits and surveillances are also conducted of the way in which the BNI environmental monitoring team handles and analyzes sample data after receipt of the data from the laboratories. The PQAS reports audit and surveillance results and evaluates the effectiveness of the QA/QC program for BNI management. The PQAS also conducts audits of subcontractors who have a direct bearing on the results and effectiveness of the FSP and the HSP. All QA/QC program procedures and instructions are submitted to the PQAS for review and sign-off before they are issued. The PQAS also provides training on QA procedures.

1.3 SITE DESCRIPTION

The Tonawanda site is in the western portion of New York in Erie County in the Town of Tonawanda. Tonawanda is immediately north of Buffalo and is bounded on the west by the Niagara River. Lake Erie lies less than 16 km (10 mi) to the southwest. The Tonawanda site includes Linde Center, Ashland 1, Ashland 2, and Seaway Industrial Park. Figure 1-4 shows the regional setting of the properties and their locations in relation to major population centers in the state of New York. Figures 1-5 and 1-6 show the locations of the four properties.

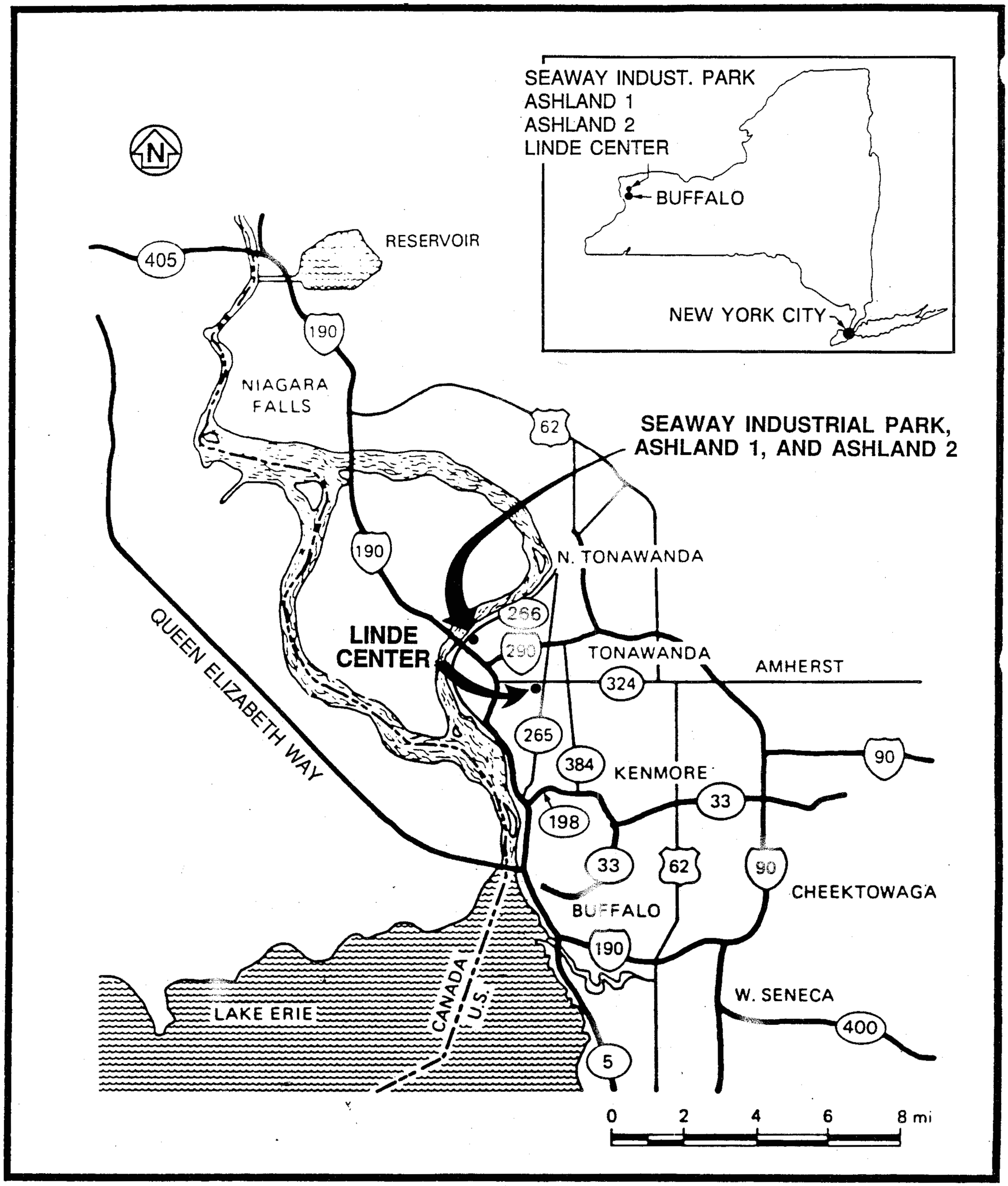

FIGURE 1-4 REGIONAL SETTING OF THE ASHLAND 1, ASHLAND 2, LINDE CENTER, AND SEAWAY INDUSTRIAL PARK PROPERTIES IN NEW YORK STATE

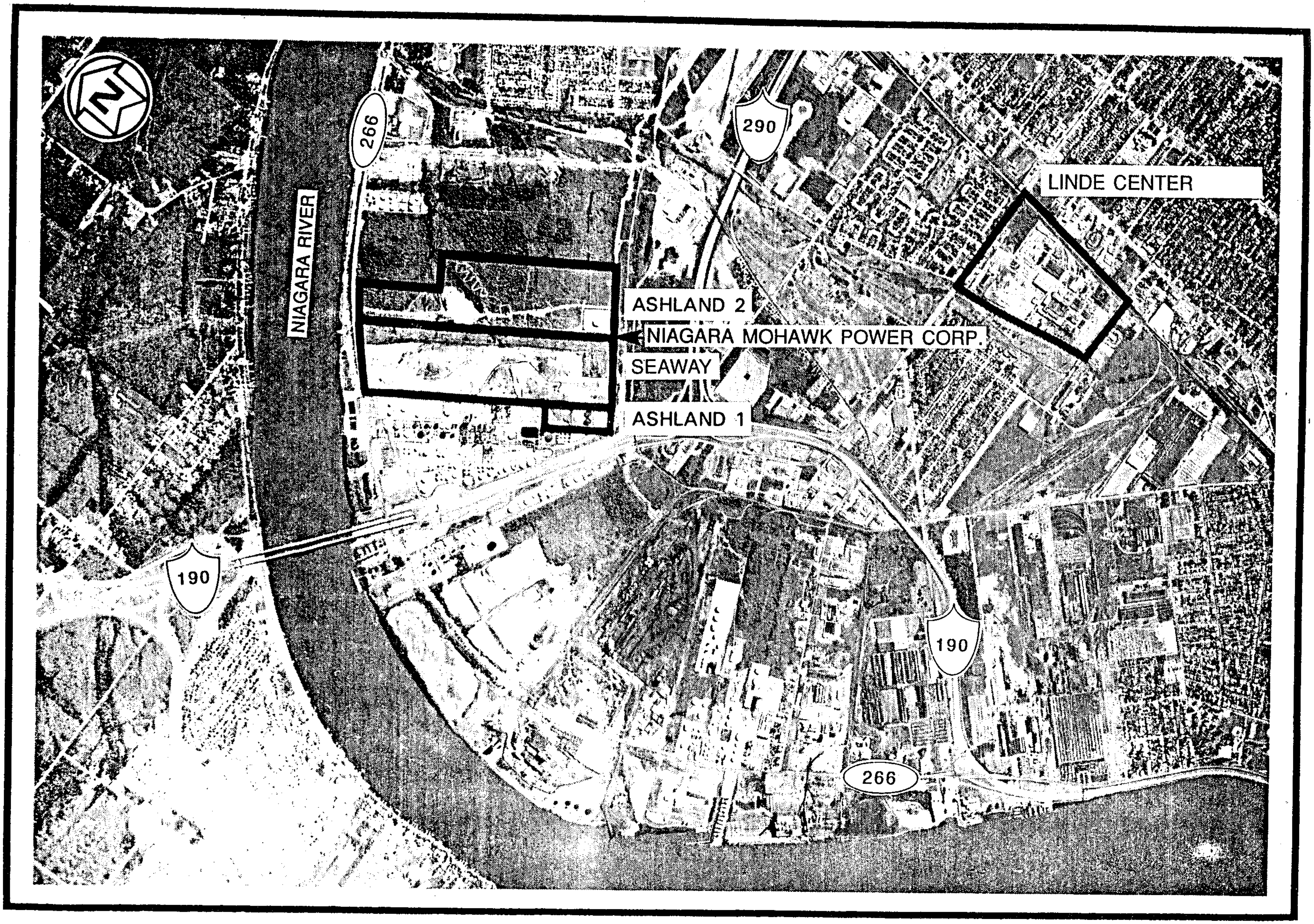

FIGURE 1-5 AERIAL VIEW OF THE ASHLAND 1, ASHLAND 2, LINDE CENTER, AND SEAWAY INDUSTRIAL PARK PROPERTIES

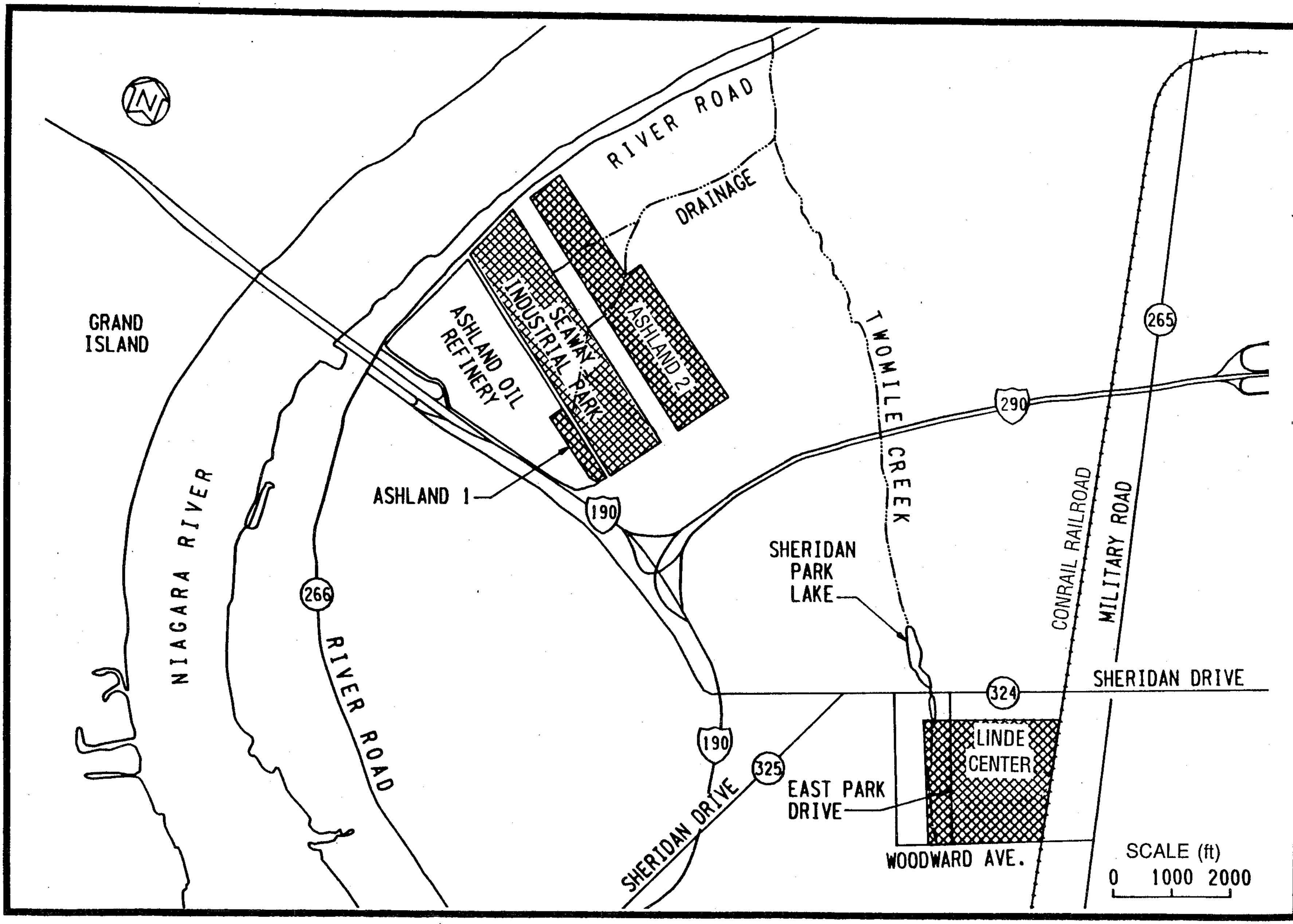

FIGURE 1-6 LOCATIONS OF THE ASHLAND 1, ASHLAND 2, LINDE CENTER, AND SEAWAY INDUSTRIAL PARK PROPERTIES

1.3.1 Linde Center

Linde Center covers approximately 55 ha (135 acres) and contains parking lots, office buildings, and several large buildings currently used as research laboratories, fabrication facilities, storage areas, and warehouses. Figure 1-7 is a plan view of the Linde Center property. Approximately 1,200 people are employed there. Portions of the Linde property were previously owned by the Town of Tonawanda, Excelsior Steel Ball Company, Metropolitan Commercial Corporation, and the Pullman Trolley Land Company; however, the land was not used by any of those owners. The property is bordered on the north and south by other industries and small businesses, on the east by Conrail railroad tracks and an open area, and on the west by a park (part of the former Sheridan Park Golf Course), which is now owned by Union Carbide and is open to the public.

Uranium sources, processing operations, waste streams, and buildings used are described in the WP-IP. Contamination is also suspected on the Conrail property. The property is described in the following instruments filed and recorded in the Erie County Courthouse: Liber 2524, page 327; Liber 2574, page 492; and Liber 2874, page 331.

1.3.2 Ashland 1 and Ashland 2

The two Ashland properties are in an industrialized area in the Town of Tonawanda, approximately 4.8 km (3 mi) northwest of Buffalo. Ashland 1 is on the southeastern side of Seaway Industrial Park, and Ashland 2 is on the northeastern side (see Figure 1-8). Ashland 1 is only a small part of the total Ashland Oil refinery property.

Ashland 1 (formerly known as the Haist property) is a 4.4-ha (10.8-acre) tract that has been owned since 1960 by Ashland Oil Company as part of an oil refinery. The oil refinery is no longer in operation; the only activity being conducted at the property is the dismantling of the refinery. The property is roughly rectangular [358 m (1,175 ft) long and 122 m (400 ft) wide]. There

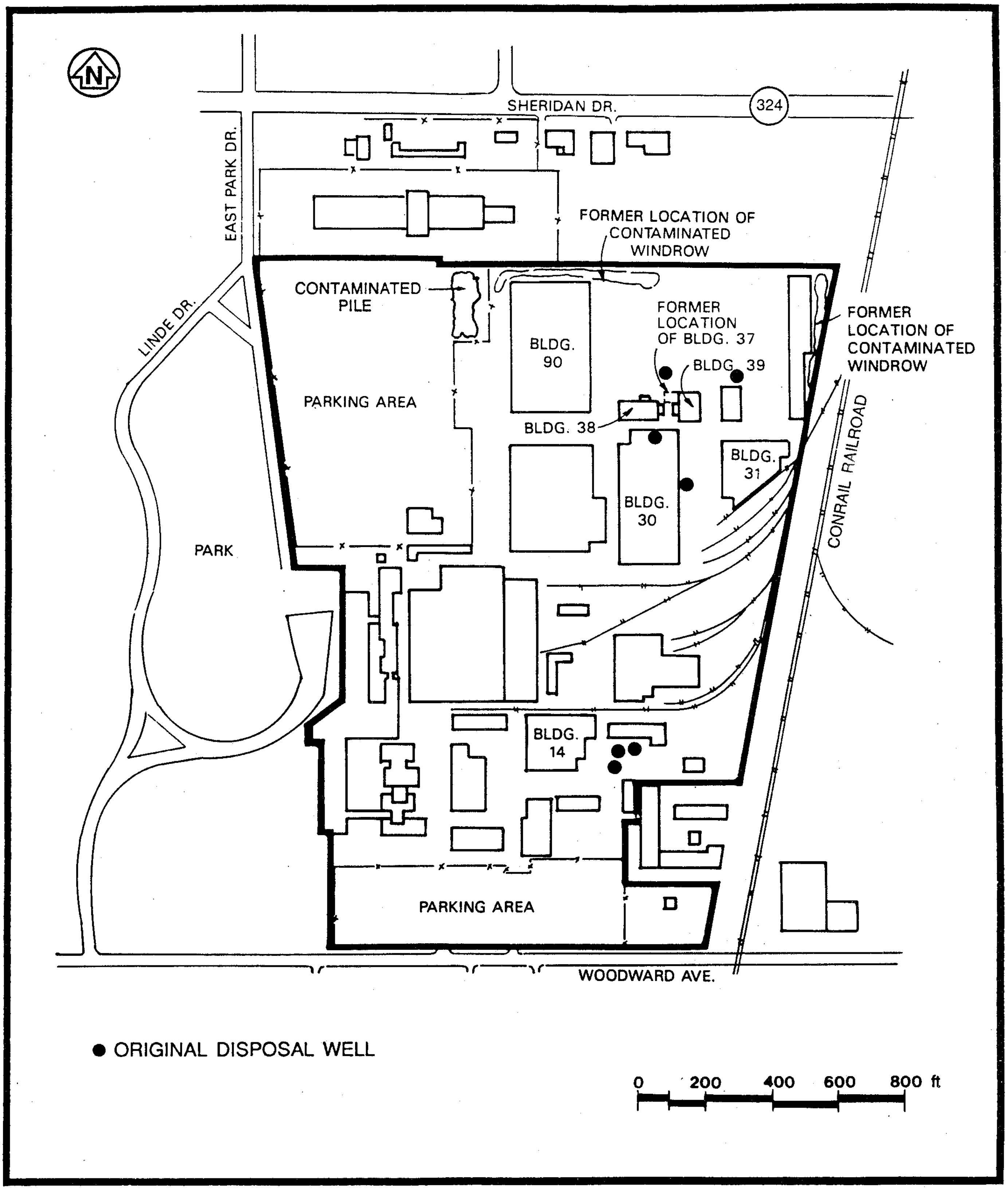

FIGURE 1-7 PLAN VIEW OF THE LINDE CENTER PROPERTY

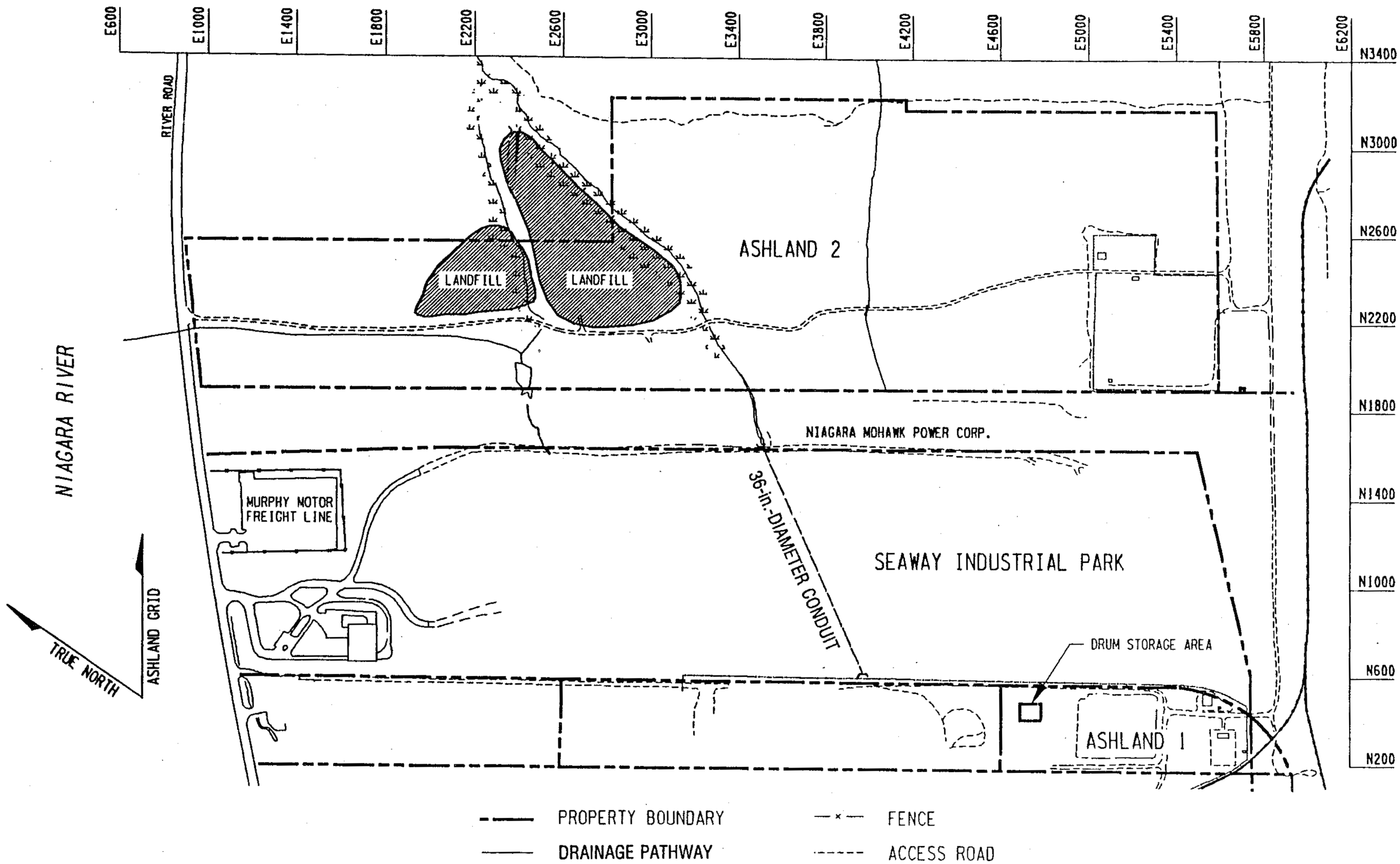

FIGURE 1-8 MAP OF THE ASHLAND 1, ASHLAND 2, AND SEAWAY INDUSTRIAL PARK PROPERTIES

is one building on the property, a fuel gas distribution center that is occupied for only a few hours each month, and an electrical switchyard. The property is divided into three sections by berms and is bounded on the east by a strip of land owned by Penn Central Transportation Company. The Penn Central land is bounded on the east by Seaway Industrial Park. The Niagara Mohawk Power Corporation owns land at the southern end of the property. Land along the northern and western boundaries is owned by Ashland Oil Company. This tract of land is described as Lot 94 in Liber 6558 of Deeds, page 663.

Ashland 2 is a large tract of land northeast of Ashland 1 and Seaway Industrial Park. It is separated from Seaway by a narrow strip of land owned by Niagara Mohawk Power Corporation. A small portion of Ashland 2 is contaminated with uranium residues from ore processing conducted for MED at the Linde property. The residues were initially disposed of at Ashland 1 and were later moved to Ashland 2 and Seaway, where they were placed in a fill area between two drainage ditches near the Ashland Oil Company industrial landfill. Ashland Oil also disposed of various chemical contaminants at Ashland 2 in the industrial landfill. No commercial operations are currently being conducted on this property.

Land near both Ashland properties is used for industrial, commercial, public, and residential purposes.

1.3.3 Seaway Industrial Park

The Seaway Industrial Park (also called the Seaway Landfill) is a 40.5-ha (100-acre) operating industrial landfill. The property is currently owned by the Seaway Industrial Park Development Co., Inc., and operated by Browning-Ferris Industries (BFI) through its subsidiary, Niagara Landfill, Inc. The property consists of a mound of refuse and fill material that is about 29 m (95 ft) high at some points. Located at the northwestern corner are two small buildings that serve as check-in and weigh-in stations for trucks entering the property.

1.4 SITE HISTORY

1.4.1 Uranium Processing Operations at Linde Center

From 1942 to 1946, Linde Center (a division of Union Carbide Corporation) processed uranium ores at its Tonawanda ceramics plant under contract to MED. Linde was selected because of its experience in the ceramics business, which involved processing uranium to produce the "salts" for colored ceramic glazes. Commercial operations began in 1943 after laboratory and pilot-plant studies were conducted to develop methods for processing these ores.

Buildings 14 (built by Union Carbide in the mid-1930s), 30, 31, 37, and 38 (built by MED on land owned by Union Carbide) were involved in uranium processing at the Linde Center plant (see Figure 1-7).

1.4.2 Acquisition of Ashland 1 for Waste Disposal

As plans were made for uranium processing at Linde in the early 1940s, efforts were also under way to identify a disposal site for waste residues. On June 25, 1943, MED leased a 4-ha (10-acre) tract known as the Haist property. On August 21, 1944, MED purchased the property from [redacted], [redacted], [redacted], [redacted], and [redacted]. A perpetual easement for access [1.6 to 2.4 ha (4 to 6 acres)] was also purchased with the land. The 4-ha (10-acre) tract served as a disposal site for ore refinery residues generated by Linde during its participation in the MED ore refinery operations. In 1949 the property was assigned to the jurisdiction of the General Services Administration (GSA). Following a radiological survey in 1958 by the Environmental Measurements Laboratory, AEC released the property for use without radiological restrictions (ORNL 1978a). In 1960 GSA transferred the property to the Ashland Oil Company, the current owner of the land.

1.4.3 Relocation of Contamination to Ashland 1, Seaway, and Ashland 2

Residues composed primarily of low-grade uranium ore tailings from the Linde refinery operation were deposited on Ashland 1 from 1944 to 1946. Records indicate that about 7,356 metric tonnes (8,000 tons) of residues composed of approximately 0.54 percent uranium were spread over roughly two-thirds of the property to depths of 0.3 to 1.5 m (1 to 5 ft) (ORNL 1978a).

In 1974 approximately 4,560 m^3 (6,000 yd^3) of these residues were excavated by Ashland Oil to prepare the property for construction of two petroleum product storage tanks. The excavated residues were disposed of in the adjacent Seaway Landfill (ORNL 1978b). The excavated soil was placed in three separate areas near the northern end of the Seaway property. Area A covers 4 ha (10 acres); Area B, about 0.2 ha (0.5 acre), is directly south of Area A; and Area C is about 0.6 ha (1.5 acres) in a narrow crescent shape southwest of Area B (Figure 1-9). Since the 1974 disposal, portions of the waste residues have been covered by refuse and fill material. Areas B and C are entirely covered with up to 12 m (40 ft) of material, and about 40 percent of Area A is covered by a layer of refuse up to 3.1 m (10 ft) in depth. Area D, discovered later, is a 46- by 46-m (150- by 150-ft), radioactively contaminated area on the southeastern border of the Seaway property. The New York State Department of Environmental Conservation has asked BFI to refrain from depositing any additional refuse on Area A.

From 1974 to 1982, Ashland Oil transported an unknown quantity of radioactive residues from Ashland 1 to Ashland 2, a nearby industrial landfill used by Ashland Oil to dispose of various catalysts, clays, and sludges associated with operation of the oil refinery. The radioactive residues transported to Ashland 2 were placed in an area adjoining the landfill. The industrial landfill was closed by Ashland Oil in 1982 and covered with clayey soil (Engineering-Science 1986).

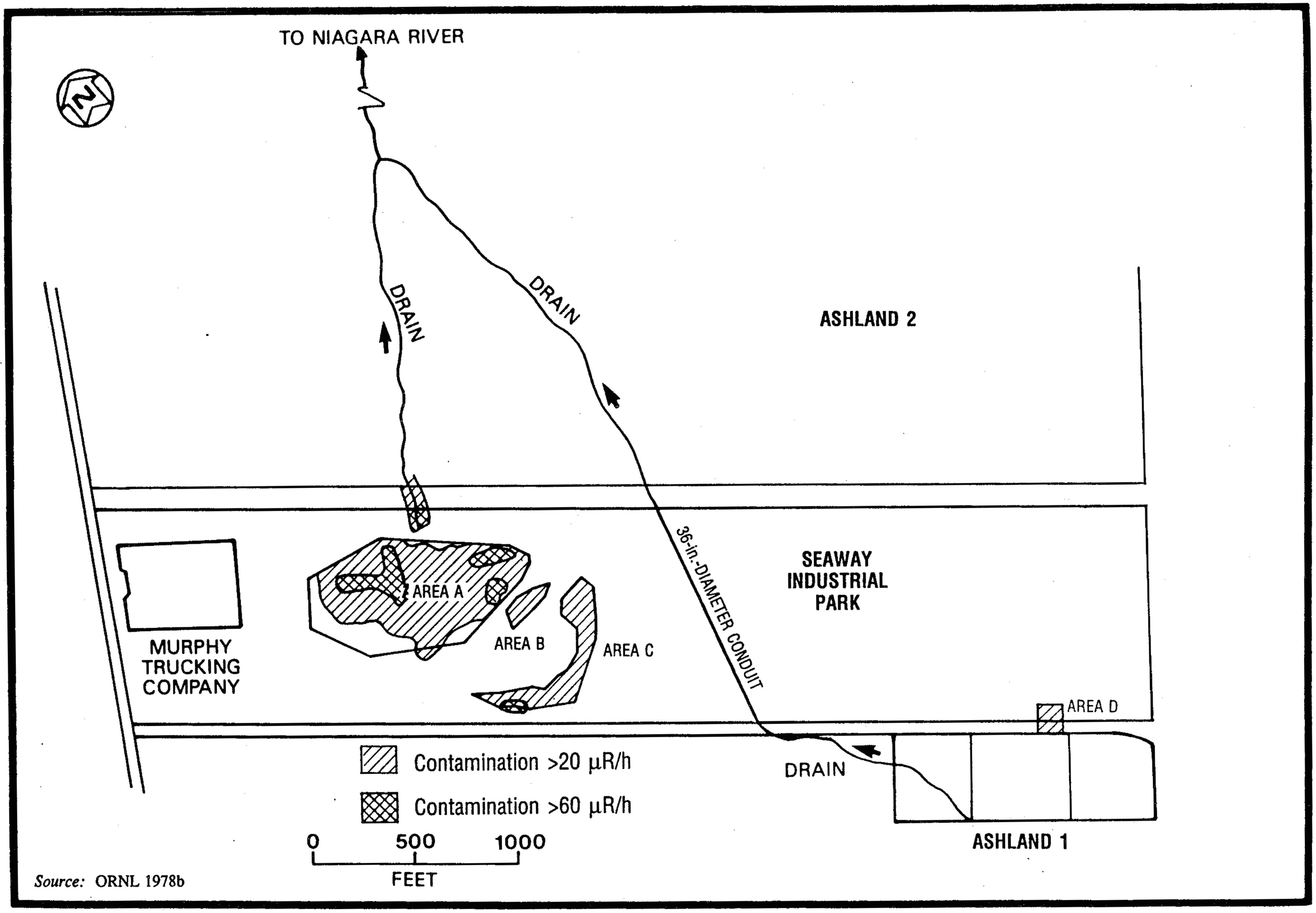

FIGURE 1-9 AREAS OF RADIOACTIVE CONTAMINATION AT SEAWAY INDUSTRIAL PARK

1.5 SUMMARY OF EXISTING DATA

Based on a review of historical documents and field investigations of the Tonawanda site, the radionuclides of concern are the radioisotopes of the uranium and thorium decay chains. Specific data for the four properties composing the site are summarized in the following sections. Supporting information for these summaries can be found in Section 2.0 of the WP-IP.

1.5.1 Linde Center

- Buildings 14, 30, and 38 contain surface contamination exceeding DOE guidelines [see DOE Guidelines For Residual Radioactive Material, Appendix A of the Tonawanda WP-IP (BNI 1993)]. Building 31 is not contaminated; Building 37 has been demolished. There is sufficient information on contamination in the buildings for the RI/FS to proceed.

- Soil is contaminated at levels exceeding DOE guidelines in four discrete areas. The boundaries and depths of these areas are well defined.

- Radioactive contamination was found up to the fence line at the northeastern corner of the property and probably extends onto the Conrail property.

- No above-guideline concentrations of radionuclides associated with MED activities have been detected in groundwater or surface water at Linde. Migration through the water pathways does not appear to be occurring at this time. Contamination levels in onsite storm sewer lines exceeded naturally occurring levels. Although no evidence of elevated radionuclide concentrations was found in the Twomile Creek drainageways, previous dredging operations may have moved the contamination to locations not yet identified.

- Some evidence of radioactive contamination exceeding DOE guidelines was discovered at depths of 30 m (100 ft); these depths correspond to the history of waste injection into onsite wells.

- Chemical sampling in the areas of radioactive contamination indicates that the waste is not mixed with hazardous wastes as defined by RCRA and is not, therefore, subject to RCRA regulations. However, widespread elevated concentrations of polynuclear aromatic hydrocarbons at depths of less than 0.6 m (2 ft) were found over much of the Linde property. Areas that are chemically contaminated as a result of non-MED activities do not fall under the purview of FUSRAP unless the chemical waste is mixed with radioactive waste.

- Elevated concentrations of some metals that may have been associated with MED processes were detected on the property in areas that also contained radioactive contamination. The degree and areal extent of contamination are known.

- The property is on a relatively thick [15 to 24 m (49 to 79 ft)] layer of glacial silty clay. Beneath this layer is a relatively thin [1 to 6 m (3 to 20 ft)] layer of diverse materials including a variety of glacial sands, gravel, and clay. The bedrock is Camillus shale, an argillaceous shale with abundant gypsum. For additional information on the geology of the property, see Section 2.0 of the WP-IP.

- A 1946 drawing of the Linde property indicated the presence of a "radioactive vault" buried 4.6 m (15 ft) from Building 73. The waste is believed to be in a 2.4- by 2.4-m (8- by 8-ft) vault-like container. The contents, exact location, and material makeup of the vault is unknown. No surface evidence of the vault was found during a recent survey of the area.

- A swampy area adjoining the property has standing surface water throughout much of the year.

- Groundwater monitoring wells have been inaccessible for weekly water level measurements during winter months when the snow was too deep or when weather created hazards; however, groundwater movement in the overburden and bedrock is assumed to be similar to that at the Ashland properties (very slow movement toward the Niagara River). Quarterly groundwater sampling has not been affected.

- Sufficient information exists concerning geological, hydrological, and hydrogeological conditions at Linde to allow remedial design to begin.

1.5.2 Ashland 1

- Virtually all of the property exhibits general surface radioactive contamination exceeding current DOE guidelines (see Appendix A of the WP-IP). The degree and areal extent of contamination are known.

- One sample exceeded the acceptable limit for the RCRA characteristic of extraction procedure (EP) toxicity, which may mean that a small portion of the Ashland 1 waste is a mixed radioactive and RCRA-hazardous waste and, therefore, subject to regulation under RCRA.

- Elevated concentrations of some metals that may have originated from MED chemical processes were detected on the property in the radioactively contaminated areas.

- The quality of surface water and groundwater does not appear to be significantly affected by the radioactive materials present at the property. Elevated concentrations of some radionuclides were found in the sediments in the drainageways, but no downstream migration of contamination exceeding DOE guidelines has been observed beyond Ashland 2.

- The geological sequence of soil/rock is similar to that of the Linde, Ashland 2, and Seaway properties, as described in Section 1.5.1.

- Groundwater at Ashland 1 moves very slowly toward the Niagara River.

- Except for local sand lenses (channels), the clay soil has low to very low permeability.

- There is sufficient information concerning geological, hydrological, and hydrogeological conditions at Ashland 1 to allow remedial design to begin.

1.5.3 Ashland 2

- General horizontal and vertical boundaries of radioactive contamination are known; however, some refinement of the boundaries is needed for remedial design work. In general, the radioactive contamination is restricted to a 0.8-ha (2-acre) area between the two primary drainage ditches.

- Groundwater and surface water quality does not appear to be significantly influenced by radioactive materials at Ashland 2. Results of the quarterly radiological and chemical groundwater monitoring are summarized in the WP-IP. Some evidence suggests that radioactively contaminated sediments have migrated onto Ashland 2 from Seaway and/or Ashland 1.

- Chemical sampling in the areas of radioactive contamination indicates that the waste is not mixed with RCRA-hazardous waste and is not, therefore, subject to RCRA.

- Elevated concentrations of some metals that may have originated from MED chemical processes were detected on the property in areas containing radioactive contamination.

- The geological sequence of soil/rock is similar to that at the Linde, Seaway, and Ashland 1 properties.

- Groundwater at Ashland 2 moves very slowly toward the Niagara River.

- There is sufficient information concerning geological and hydrological conditions at Ashland 2 to allow remedial design to begin.

1.5.4 Seaway Industrial Park

- The depth and extent of radioactive contamination in Areas A and D (Figure 1-9) are sufficiently understood to allow the RI/FS-EIS and remedial design to progress. The boundaries of radioactive contamination in Areas B and C are not as well understood because they have not been directly sampled for thorium-230; however, because of the depth below grade at which these contaminated areas are now located, inferring the impact of thorium-230 on the overall concentrations and depths should be sufficient to allow RI/FS-EIS and remedial design activities to proceed.

- No information exists as to whether the radioactive waste is mixed with RCRA-hazardous waste. Information on RCRA characteristics is needed to help evaluate disposal options; however, assessment of migration of hazardous wastes is not a DOE responsibility because no RCRA-hazardous wastes were associated with MED activities (based on characterization of Linde, Ashland 1, and Ashland 2).

- No information exists on metals related to MED activities in the landfill. However, based on survey results from the other three properties, it is reasonable to assume that elevated concentrations of several metals are present in the radioactive materials at Seaway.

- Surface water and sediment monitoring data suggest that radionuclides may be migrating onto Ashland 2 from Seaway (ORNL 1978a). This possibility has not been evaluated recently; changing conditions at the landfill resulting from construction may continually alter any sediment migration pathways.

- The potential for radionuclide migration through the groundwater pathway has not been evaluated at Seaway; however, based on characterizations of the other properties, this is probably not a realistic pathway. No uranium, radium, or thorium exceeding DOE guidelines (see Appendix A of the WP-IP) has been observed in groundwater at Ashland 1, Ashland 2, or Linde.

- The landfill is highly permeable.

- The landfill contains a perched groundwater system (above surrounding ground surfaces).

- A buried, 1-m (36-in.) concrete conduit replaced a creek channel that crossed through the middle of the landfill (see Figure 1-9). Possible infiltration of leachate from the landfill into the culvert warrants investigation because the culvert is a potential pathway for radionuclide and chemical migration.

- Geological and hydrogeological conditions below the landfill are approximately the same as those of the other three properties.

- Geological and hydrogeological data for Seaway are not sufficient for FS evaluations. Additional data are needed to assess migration pathways and engineering parameters.

2.0 REMEDIAL INVESTIGATION APPROACH

The additional data to be collected during the RI have been identified based on results of the detailed study of existing reports, preliminary identification of applicable or relevant and appropriate requirements (ARARs) and contaminants of concern, development of a conceptual site model, and preliminary identification of remedial action alternatives described in the WP-IP. When collected, these RI data and information from quarterly radiological and chemical monitoring of groundwater beneath the site will provide a better understanding of the site and will aid in evaluating remedial action alternatives.

The following sections delineate the data requirements for each of the four operable units (properties) of the Tonawanda site. The operable units of the Tonawanda site are as follows:

Operable Unit	Property
1	Linde Center
2	Ashland 1
3	Ashland 2
4	Seaway Industrial Park

2.1 DATA REQUIREMENTS AND TECHNICAL APPROACH

Based on the information reviewed and summarized in Sections 2.0 and 3.0 of the WP-IP, gaps in knowledge about these properties have been identified. Additional data will be needed to fill these gaps to enable the RI/FS-EIS process to continue and a remedial action alternative to be selected for the site. Data collected will meet DOE guidelines, RCRA criteria, and ARARs. These data are required to ensure that remedial actions will be consistent with applicable guidelines and ARARs. The following sections describe the data needed and the technical approach to be used at each of the Tonawanda properties.

2.1.1 Linde Center

Because the 1988-1989 BNI characterization was fairly comprehensive, few data gaps still exist at Linde. Specific data objectives are:

- Objective 1: Determine the extent to which radioactive contamination extends beyond the Linde fence to the northeast

- Objective 2: Evaluate the significance of radioactive contamination in the vicinity of the old injection wells at the depth of injection

- Objective 3: Attempt to locate and evaluate dredgings from Twomile Creek

- Objective 4: Locate a reported object identified only as a "radioactive vault" possibly buried on the property

The following sections present the technical approach to fulfill each data requirement at Linde Center.

Objective 1: Determine extent of radioactive contamination beyond Linde fence

First, a walkover scan will be performed to determine the boundaries of contamination that extend beyond the northeastern edge of the Linde property. This scan will identify the boundaries of gamma-emitting radioactive contamination (uranium, thorium-232, and radium) on the ground surface. Because this survey is for gamma emissions, it will not detect thorium-230, an alpha-emitter. Boundaries identified by this walkover will be field-marked.

When the boundaries of the gamma-emitting radionuclides are known, a sufficient number of soil samples will be collected to adequately characterize the degree of contamination. Soil samples will also be collected outside the marked area to determine whether thorium-230 contamination extends beyond the borders of the area containing gamma-emitting materials. These samples typically will be taken about 15 m (50 ft) apart; however, this spacing scheme may be adjusted by the field sampling team for adequate characterization.

Two samples will be collected from each of approximately five biased sampling locations: one from the surface to a depth of 15.2 cm (6 in.), the second from 15.2 to 30.5 cm (6 to 12 in.). The deeper sample will be analyzed only if the surface sample exceeds guidelines.

The depth of contamination will be determined by placing boreholes in areas determined by surface scanning and sampling to be contaminated. Boreholes will extend, at a minimum, to undisturbed soil. Samples from increasing depths in each borehole will be analyzed one at a time until a sample meets DOE guidelines (see Appendix A of the WP-IP). Samples from deeper in that borehole may not be analyzed but will be archived.

Objective 2: Evaluate significance of contamination in vicinity of injection wells

The presence of contamination at a depth of approximately 27 to 30 m (90 to 100 ft) near the old injection wells was determined based on the documentation available, which indicates that the wells became plugged soon after injection into them began (Aerospace 1981; ORAU 1981). During the 1988-1989 characterization, contamination was noted in a geological core sample taken near the old injection wells. To date, MED-related radionuclides exceeding background but substantially below DOE guidelines have been detected in water samples collected from the perimeter wells that monitor the aquifer into which the waste was injected. The significance of the presence of this waste must be assessed.

Based on the hydrogeological understanding of the property, one of two cases may apply.

- Case 1: The injected waste may have precipitated to solid form and lodged in fracture pore space around the wells, or it may be migrating at such low concentrations that it cannot be detected in the perimeter wells.

- Case 2: The injected waste may have already migrated beyond the perimeter wells or may have reached steady-state conditions in which the concentrations are indistinguishable from background concentrations.

For case 1, the waste that was injected has been in place for about 45 years and would not likely begin to migrate in significant quantities now if it has not already done so. For case 2, it is improbable that any plume of radionuclides could be located now, considering dynamics of flow rate, diffusion, dispersion, and dilution.

To further investigate the presence of contamination in the wells, the archived core samples will be examined to determine whether low-level contamination was overlooked and whether structural features in the material give clues to the fate of the waste. Fracture analysis of slightly elevated core samples, either bulk or thin-section, may indicate if sorption of waste materials occurred, if the waste precipitated and lodged in fractures near the old injection wells (accounting for the reported plugging of the wells during injection), or if the waste has dispersed.

The casing fill in one or more injection wells will be drilled out. The redrill cuttings will be monitored for the presence of radioactivity. If radioactivity is detected, cutting samples will be collected for analysis. The opened well will provide access to the injection zone where samples may be taken of precipitants attached to the screen or of the side wall of the borehole. The nature and extent of any radionuclides present in the core samples and/or sump sediments could indicate the potential for mobility or reveal the dispositional history of the wastes. Depending on the method that was used to close the wells, field permeability tests (falling head) may be conducted in the injection wells. Results from these tests will be compared with water quality data and permeabilities measured in the wells installed by BNI in 1988 and 1989. These results will help in assessing the potential for wastes to have remained in the vicinity of the injection wells.

Objective 3: Attempt to locate and evaluate dredgings from Twomile Creek

Liquid wastes dumped to surface drainage systems may have contaminated Twomile Creek. Recent surveys found no evidence of such dumping; however, the creek was dredged after MED activities occurred. The dredgings may have been disposed of at the Fire Tower Industrial Park. To locate these dredgings, DOE will use a scanning van to survey various roadways in the vicinity of Twomile Creek, Linde, the Town of Tonawanda garbage dump, and Fire Tower Industrial Park. If the scanning van detects gamma-emitting radioactive materials, follow-up surveys will be conducted in a manner similar to that described for the properties adjacent to Linde.

Objective 4: Locate buried "radioactive vault"

Radioactive waste may be buried in a vault 4.6 m (15 ft) from Building 73. A facsimile of the pertinent portion of a 1946 drawing of the Linde property is shown in Figure 2-1. The area where the vault is believed to be buried is paved with asphalt, and no surface evidence of its presence was found during a recent survey of this area.

To locate the suspected vault, an electromagnetic survey will be conducted. If this survey does not locate the vault, a ground-penetrating radar survey will be conducted. Both of these surveys are noninvasive methods that detect anomalies associated with buried vaults (i.e., rebar and voids). If neither of these surveys locates the vault, the vault will be investigated by trenching during remedial action at Linde.

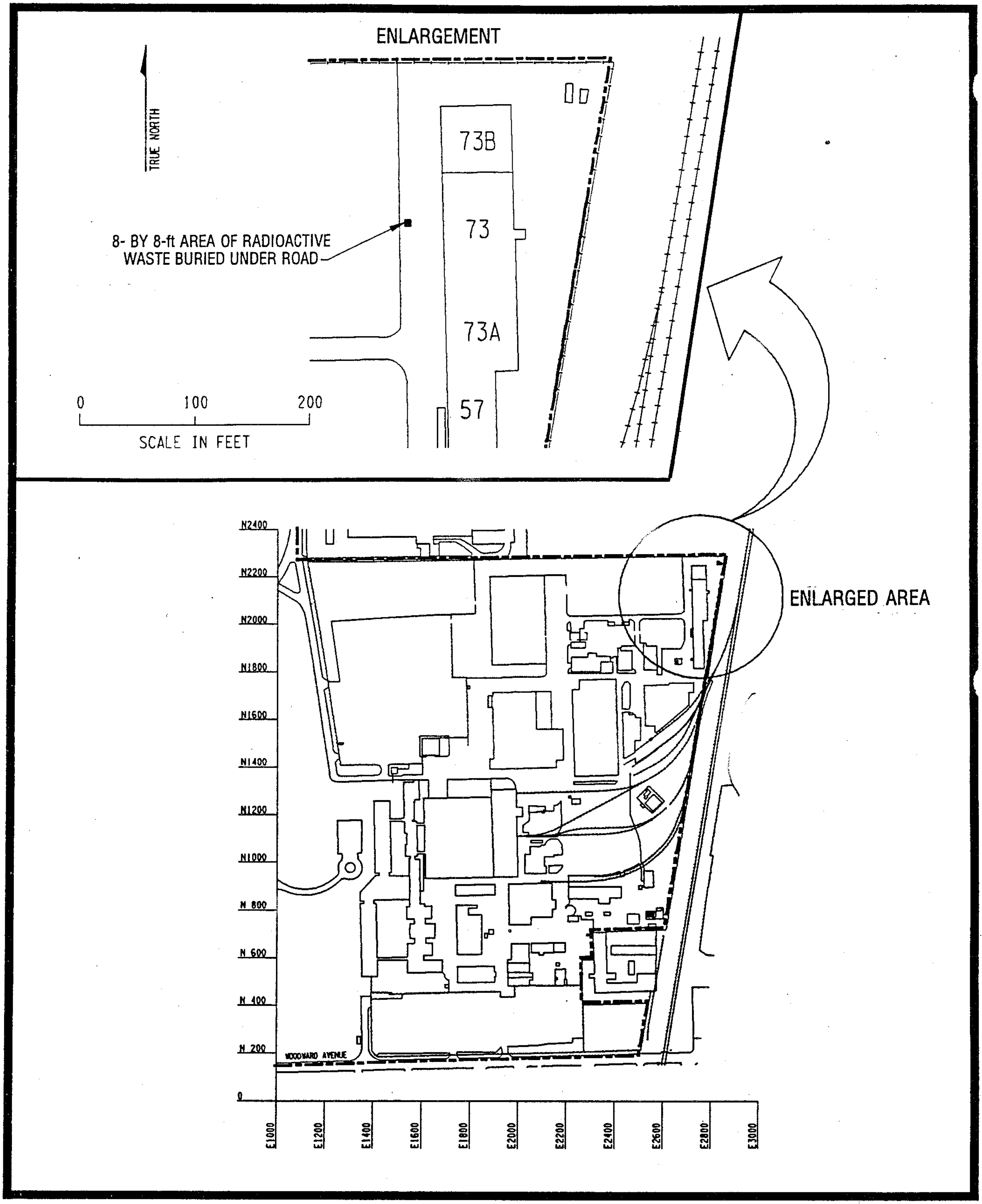

FIGURE 2-1 GENERAL LOCATION OF SUSPECTED BURIED WASTE AT LINDE CENTER

2.1.2 Ashland 1

Radioactive contamination at Ashland 1 has been thoroughly investigated, and no additional investigations are needed to allow RI/FS-EIS activities to continue. However, one data gap remains for chemical contamination.

Objective 1: Determine and evaluate extent of area exhibiting EP toxicity

One sample collected at Ashland 1 exhibited the RCRA-hazardous waste characteristic of EP toxicity for chromium. To confirm the EP toxicity test and to estimate the extent of the area failing the test, four samples will be collected at the same depth [2.4 m (8 ft)] as the sample that failed the test: one at the same grid point and three others equally spaced from that location at a distance of 3 m (10 ft). The samples will be analyzed only for toxicity characteristic leaching procedure (TCLP) metals.

2.1.3 Ashland 2

The 1988 BNI characterization defined the boundaries of most of the radioactive contamination; however, one specific data objective remains.

Objective 1: Determine the boundary of contamination along the western edge of the landfill area

A walkover survey will be conducted to define the boundary of contamination around the western portion of the landfill. This survey will identify the boundary of gamma-emitting radioactive contamination (uranium, thorium-232, and radium) on the ground surface. To define this boundary, four more boreholes will be drilled between grid locations N2000, E2400 and N2200, E2800. Boreholes will be continuously sampled to a depth of 2.4 m (8 ft). Samples will be analyzed as described in Section 2.1.1, Objective 1, for properties adjacent to Linde. During drilling, samples will also be collected to analyze for RCRA characteristics.

2.1.4 Seaway Industrial Park

Seaway has not been characterized as thoroughly as Ashland 1, Ashland 2, or Linde; therefore, the data gaps for this property are more numerous. Specific data objectives are:

- Objective 1: Define boundaries of contamination in Areas A and D

- Objective 2: Collect additional data from outside the Seaway Landfill boundary to fully understand engineering, geological, and hydrogeological properties of the soil and refuse below the radioactive waste in Area A, which will enable the risk assessment and feasibility analyses to be conducted

- Objective 3: Take corroborative samples from Areas A and D (Figure 2-2) to refine data on the depth of thorium-230 contamination

- Objective 4: Investigate the possibility that RCRA-hazardous waste may be mixed with radioactive waste

- Objective 5: Evaluate the potential for movement of radioactively contaminated sediments from Seaway onto the adjoining Niagara Mohawk and Ashland 2 properties

- Objective 6: Investigate infiltration of leachate from the landfill to the culvert because it is a potential pathway for radionuclide movement

The following sections present the technical approach to fulfill these data requirements.

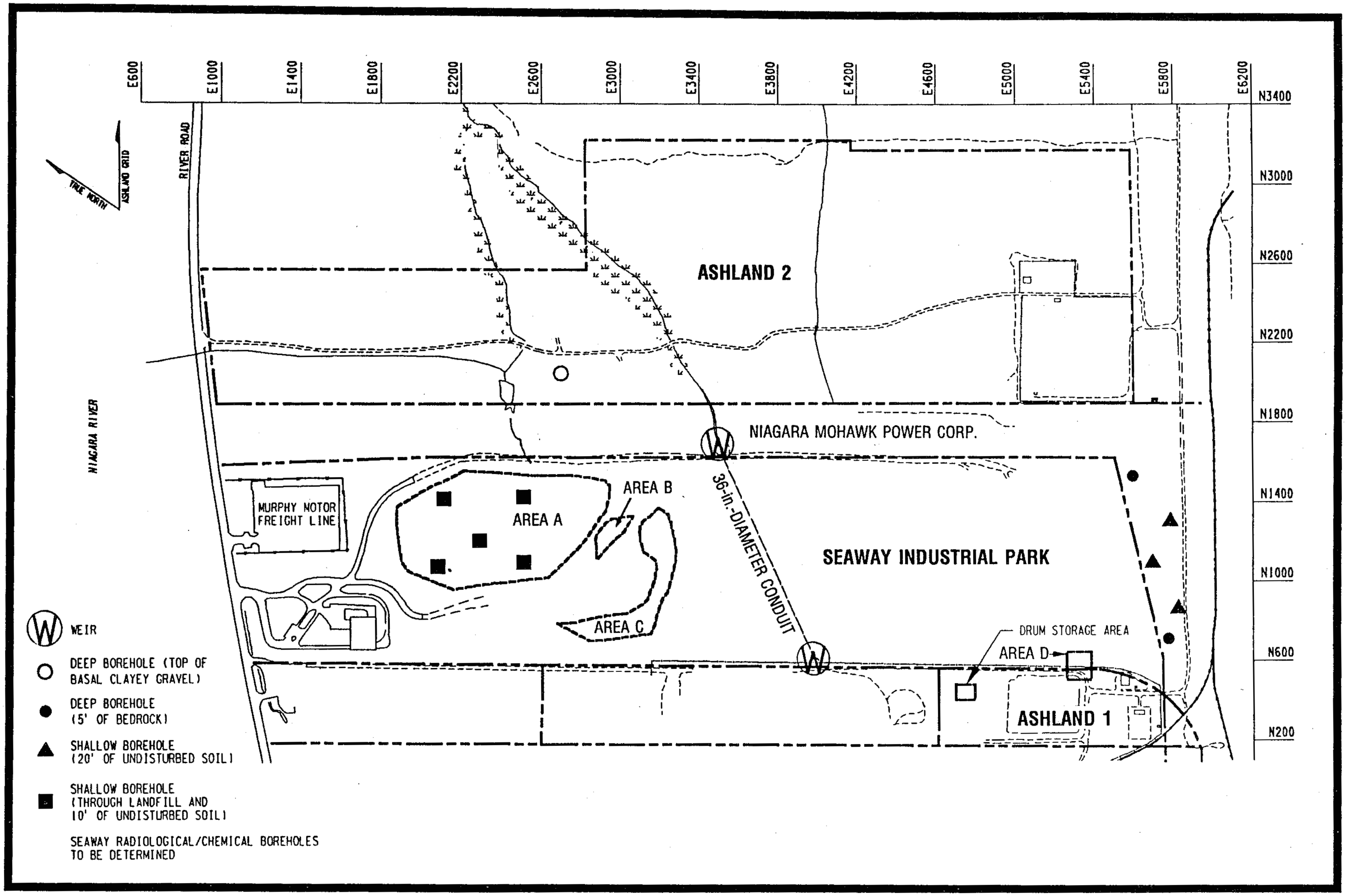

FIGURE 2-2 LOCATIONS OF PROPOSED BOREHOLES AND CONDUIT WEIRS

Objective 1: Define boundaries of contamination in Areas A and D

A walkover survey will be conducted to define the boundaries of gamma-emitting radioactive contamination (uranium, thorium-232, and radium) on the ground surface in Areas A and D.

Objective 2: Gather information on engineering, geological, and hydrogeological properties

Data on the physical properties of the landfill and its natural substrata are needed for both the risk assessment and FS portion of the RI/FS-EIS. Information is needed to enable modeling of contaminant transport and to evaluate structural stability of the waste. Additionally, the landfill is one of two properties large enough to be considered as a disposal site; knowledge of the engineering properties of the natural soil in the area is necessary to assess this option. To gain the required information, the following activities will be performed.

- Outside the southeastern boundary of the property, two geologic boreholes will be advanced to bedrock and the geological strata will be logged and sampled. The depth of penetration to bedrock will be to the point of auger refusal. One core run of 1.6 m (5 ft) into bedrock will be taken. Three additional geologic boreholes will be advanced approximately 6 m (20 ft) in natural soil. Sampling of the five boreholes will be in the initial 6 m (20 ft) of natural soil (Figure 2-2). Samples of disturbed and undisturbed soil will be taken using split spoon and Shelby tube samplers. These soil samples will be subjected to the following analyses for physical properties:

  a. Particle size analysis
  b. Soil classification
  c. Specific gravity
  d. Cation exchange capacity
  e. Centrifuge moisture equivalent
  f. Triaxial compression
  g. Consolidation
  h. Atterberg limits
  i. Moisture content
  j. Unit weight
  k. Distribution coefficient
  l. Permeability
  m. Direct shear

- At least five radiological/chemical boreholes will be advanced through the material in Area A [approximately 15 m (50 ft)] to natural soil. When natural soil is reached, as determined by the attendant geologist, the hole will be advanced an additional 3 m (10 ft). Sampling and analysis of the natural material will be similar to the analyses outlined above, with the exception of bearing or strength analyses (a, b, f, g, h, and m). Additional borehole locations may be selected based on results of the walkover survey. Radiological and chemical sampling will be continuous in Area A.

- The level at which water is encountered in each borehole within Area A will be recorded in geological logs to allow mapping of the perched water conditions within the landfill. Field permeability will be measured using a water level indicator and recorded on the permeability test field log.

Borings will be drilled using hollow-stem augers or by advancing and cleaning out the casing. The radiological/chemical boreholes will be drilled in accordance with the summary in Appendix A of this FSP. The number and types of laboratory tests for the geologic boreholes are presented in Table 2-1. A geological log of each drill hole will be prepared so that stratigraphy can be correlated across the property.

Objective 3: Confirm depth of thorium-230 contamination

While boreholes are being advanced in Area A, samples will be collected and analyzed for uranium-238, radium-226, and thorium-230. These analyses will be conducted to confirm results of the 1988-1989 BNI characterization, which has been the only survey to date to determine thorium-230 concentrations. Sample locations will also be selected to confirm the depth of thorium-230 contamination.

Table 2-1

Geologic Boreholes Planned for Seaway Industrial Park

Proposed Laboratory Test	Soil Type		Number of Tests		
	Disturbed[a]	Undisturbed[b]	SE Portion	Area A[c]	Total
Strength					
Particle size analysis	X	--	10	--	10
Soil classification	X	--	20	--	20
Triaxial compression	--	X	3	--	3
Consolidation (1-D)[d]	--	X	3	--	3
Atterberg limits	X	--	20	--	20
Direct shear	--	X	3	--	3
General Characteristics					
Specific gravity	X	--	10	5	15
Cation exchange capacity	X	--	3	3	6
Centrifuge moisture	X	--	10	5	15
Moisture content equiv.	X	X	10	5	15
Unit weight (wet/dry)	--	X	10	5	15
Distribution coefficient[e]	X	--	1	--	1
Permeability (vertical)[f]	--	X	4	--	4

[a]ASTM 1586; split spoon.

[b]ASTM 1587; Shelby tube.

[c]Does not include radiological and RCRA sampling.

[d]1-D: one-dimensional.

[e]Uranium-238.

[f]One sample was collected offsite (from Ashland 2) and analyzed for permeability to establish natural soil permeability.

Approximately ten samples will be collected from Area D to confirm previous results for uranium-238, radium-226, and thorium-230.

Objective 4: Investigate for the presence of RCRA-hazardous waste

The presence of RCRA-hazardous waste mixed with the radioactive materials could significantly affect options evaluated in the FS. To enable accurate evaluation of all available alternatives in the FS, the presence of RCRA-hazardous waste must be investigated.

During drilling of the geologic boreholes in Area A, four samples will be collected from within the radioactively contaminated soil. Four more samples will be collected from below the radioactive materials but above the natural ground surface (i.e., within the landfill material).

All samples will be analyzed for the RCRA characteristics of TCLP (metals and organics), corrosivity, and reactivity (cyanide and sulfide).

Objective 5: Evaluate the potential for movement of sediments

Historical references discuss potential movement of radioactively contaminated sediments from Seaway. Because of the continuous operation of the landfill, these observations need to be rechecked. Approximately ten sediment samples will be collected from the various drainages (both upstream and downstream) from and around the landfill, including the discharge point of the 1-m (36-in.) culvert that crosses the property beneath the pile.

Objective 6: Investigate possible infiltration of leachate to the culvert

To investigate the possible infiltration of leachate from the landfill to the 1-m (36-in.) culvert beneath the pile, the volume of influent will be compared with the volume of effluent. Weirs will be placed at both ends to detect change in the flow volume. Influents and effluents will be sampled and analyzed for radiological and chemical parameters. Investigation of possible leachate infiltration to or from the culvert should require approximately two months.

3.0 SAMPLE TYPES AND MEASUREMENTS

In general, three different types of samples (soil, surface water, and sediment) will be collected during the RI. Table 3-1 summarizes the types of samples that will be collected from each medium and analyzed. Soil samples collected for engineering, geological, and hydrogeological analysis will be selected in the field by the onsite geologist. Both disturbed (split spoon) and undisturbed (Shelby tube) soil samples will be collected. Surface water samples at 15 to 30.5 cm (6 to 12 in.) will be collected during normal flow conditions. Approximately 1 L (0.26 gal) of each sample will be filtered for metals analysis before preservation. Samples will be collected using methodologies compatible with A Compendium of Superfund Field Operations Methods (EPA 1987a). Standard radiological sampling and analytical procedures to be used are described in detail in the Health Physics Operational Procedures Manual (TMA/E 1989). Sample and measurement locations (i.e., boreholes) will be precisely determined by civil survey.

Because of the differing data needs, analyses to be performed on each type of sample vary for each operable unit; however, six categories of analysis are identified: radiological parameters, metals, organic contaminants, hazardous waste determinations, physical properties, and miscellaneous indicators.

Table 3-1

Analytical Parameters for Various Media

Parameter	Samples for Each Medium: Soil	Surface Water	Sediment
Radiological			
Thorium-232	0[a]	0	0
Radium-226	0	0	0
Uranium-238	0	0	0
Thorium-230	0	0	0
Metals			
ICPAES[b,c]	--	0	--
Mercury	--	0	--
Organics			
Volatile organics	--	0	--
Semivolatile organics	--	0	--
Hazardous Waste			
TCLP[d]	0	--	--
Corrosivity	0	--	--
Reactivity	0	--	--
Engineering and Geotechnical			
Gradation/hydrometer	0	--	--
Cation exchange capacity	0	--	--
Distribution coefficient	0	--	--
Atterberg limits	0	--	--
Unit weight (wet/dry)	0	--	--
Moisture content	0	--	--
Centrifuge moisture equivalent	0	--	--
Specific gravity	0	--	--
Direct shear	0	--	--
Consolidation	0	--	--
Triaxial compression	0	--	--
Soil classification	0	--	--
Permeability (laboratory)	0	--	--
Permeability (field)	0	--	--

Table 3-1

(continued)

Parameter	Samples for Each Medium Soil	Surface Water	Sediment
Miscellaneous Indicators			
Temperature	--	0	--
pH	--	0	--
Specific conductance	--	0	--
TOC[e]	--	0	--
TOX[f]	--	0	--

[a]0 = analysis required; -- = no analysis required.

[b]ICPAES - inductively coupled plasma atomic emission spectrophotometry.

[c]Includes aluminum, antimony, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc. Analysis for arsenic and lead is by furnace atomic absorption.

[d]TCLP - toxicity characteristic leaching procedure.

[e]TOC - total organic carbon.

[f]TOX - total organic halides.

4.0 SAMPLING FREQUENCY

Except for investigating possible infiltration of leachate into the culvert at Seaway, the sampling frequency specified in this plan is a one-time field sampling effort. The planned sampling is expected to complete the RI and allow the FS to begin. However, depending on analytical results, additional field work may be necessary to refine the understanding of site conditions.

Sampling frequency for this one-time effort varies for each operable unit, as described in Section 2.0. Table 4-1 summarizes the sampling planned for each operable unit and the data quality level for each activity planned. If field sampling reveals contaminated areas that were not previously known, additional samples will be collected and analyzed; therefore, Table 4-1 lists only approximate numbers of samples to be taken.

The required analytical levels range from Level I to Level V. Section 3.0 of the QAPjP outlines the QA requirements that will be implemented. Quality equivalent to Level III is common to most data needs and may be sufficient for most purposes. The analytical procedures used to evaluate chemical data are compatible with those found in the Contract Laboratory Program (CLP) and other Environmental Protection Agency (EPA) procedures. Standard industry methods will be used to ensure the quality of radiological analyses.

Table 4-1
Sampling Frequency

Operable Unit/Medium	Planned Activity	Approximate Number of Samples	Analyses	Data Quality Level
Linde Vicinity Property (Conrail Railroad)				
Soil	Identify surface radioactive contamination with walkover surveys	None	None	II
	Collect surface soil samples to confirm walkover results	15	Th-230, Th-232, Ra-226, U-238	III
	Drill ≈15 boreholes and collect subsurface soil samples to define subsurface radioactive contamination	45	Th-230, Th-232, Ra-226, U-238	III
Direct radiation	Take exposure rate measurements for direct gamma radiation	10	Gamma exposure rate	II
Linde Center				
Soil (Buried vault)	Obtain geophysical profiles to locate vault; characterize vault	None	Onsite interpretation	II
Soil (Injection wells)	Examine and analyze archived core samples from vicinity borehole	None	Th-230, Th-232, Ra-226, U-238	III
Soil/backfill material	Drill out and monitor fill material to define radioactive contamination	5	Th-230, Th-232, Ra-226, U-238	III
Ashland 1				
Soil	Drill ≈5 boreholes to confirm previous chemical sampling results	5	TCLP[a]-metals	III

Table 4-1

(continued)

Operable Unit/Medium	Planned Activity	Approximate Number of Samples	Analyses	Data Quality Level
Ashland 2				
Soil	Identify surface radioactive contamination with walkover surveys	None	None	II
	Collect surface soil samples to confirm walkover results	5	Th-230, Th-232, Ra-226, U-238	III
	Drill 5 boreholes and collect subsurface soil samples to define subsurface radioactive contamination	45	Th-230, Th-232, Ra-226, U-238	III
	Determine presence of mixed waste	21	TCLP-metals, reactivity, corrosivity, TCLP-pesticides/herbicides	III
Seaway				
Soil	Identify radioactive contamination using surface walkover surveys	None	None	II
	Collect surface soil samples to confirm walkover results	40	Th-230, Th-232, Ra-226, U-238	III
	Drill ≈40 boreholes and collect subsurface soil samples to define subsurface radioactive contamination	160	Th-230, Th-232, Ra-226, U-238	III
	Collect samples to define top of undisturbed soil	20	Particle size, soil classification, triaxial compression, consolidation, Atterberg limits, direct shear, specific gravity, cation exchange capacity, centrifuge moisture equivalent, moisture content, unit weight, distribution coefficient, permeability	III

Table 4-1

(continued)

Operable Unit/Medium	Planned Activity	Approximate Number of Samples	Analyses	Data Quality Level
Seaway (cont'd)				
	Determine presence of mixed waste	40	TCLP, corrosivity, and reactivity	III
Sediments	Collect upstream and downstream sediment samples to determine extent of radionuclide migration	10	Th-230, Th-232, Ra-226, U-238	III
Surface water	Collect influent and effluent samples from culvert and analyze for radiological and chemical parameters	10	Th-230, Th-232, Ra-226, U-238, ICPAES[b], mercury, arsenic, lead, volatile organics, semivolatile organics, miscellaneous indicators	III
Perched water/groundwater	Measure water levels in Area A boreholes	None	Water level	I

Source: EPA 1987b.

[a]TCLP - toxicity characteristic leaching procedure.

[b]ICPAES - inductively coupled plasma atomic emission spectrophotometry.

5.0 ANALYTICAL PROCEDURES

This section describes acceptable analytical methods and protocols and QA/QC requirements for the RI. The requirements are stated to ensure defensibility and integrity of the analytical data to DOE, peer reviewers, and regulatory agencies. These methods were selected for their ability to detect the maximum number of parameters and meet the required detection limits. Project-specific procedures that are followed and controlled for all aspects of the work are identified in the QAPjP. The QAPjP also contains greater detail on the QA/QC requirements, quality levels, and checks. As described in the WP-IP, these controls are intended to achieve a data quality equivalency of Level II to IV.

5.1 ANALYTICAL METHODS

Procedures for analyzing chemical and radiological parameters are listed in Tables 5-1 and 5-2. Engineering/geotechnical test methods are listed in Table 5-3. The published detection limits for each method (where appropriate) and method reference numbers are also included. The technical requirements for analyses are based on guidelines and standards developed by EPA and other sources. The chemical analysis laboratory will follow the protocol of the CLP (EPA 1986). Because the CLP does not address radiological analysis, the radiological laboratory will adhere to procedures developed by Environmental Measurements Laboratory-300 and the EPA-prescribed procedures for measuring radioactivity in drinking water. QA/QC checks will be used to monitor performance, as appropriate.

5.2 SAMPLE HANDLING AND PRESERVATION

Table 5-4 lists the preservatives, containers, and holding times used for samples being shipped to the laboratory for analysis.

Table 5-1

Methods for Analysis of Water

Parameter	Analytical Technique[a]	EPA Method No.	Published Method Detection Limit (mg/L)
Metals[b,c,d]	ICPAES	200.7-CLP-M	0.3-7.5[e]
Arsenic[c]	Furnace AA	206.2-CLP-M	0.001
Lead[c]	Furnace AA	239.2-CLP-M	0.001
Selenium[c]	Furnace AA	270.2-CLP-M	0.002
Thallium[c]	Furnace AA	279.2-CLP-M	0.001
pH	Electrometric	150.1	--
Specific conductivity	Electrometric	120.1	--
Temperature	Thermometric	170.1	--
TOC[f]	Oxidation	415.1	--
TOX[g]	Microcoulimetric	9020	--
Volatile organics	GC/MS	CLP-SOW[h]	--
Semivolatile organics	GC/MS	CLP-SOW	--

[a]ICPAES - inductively coupled plasma atomic emission spectrophotometry; Furnace AA - furnace atomic absorption; GC/MS - gas chromatography/mass spectrometry.
[b]Includes aluminum, antimony, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lithium, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, vanadium, and zinc.
[c]Samples will be prepared and analyzed in accordance with procedures outlined in Exhibit D of the CLP-SOW for inorganic analysis (EPA 1988c).
[d]For boron and molybdenum, which are not standard CLP analyses, the following will be done: interference corrections will be determined and reported, calibration standards will be prepared and a calibration curve determined, initial calibration verification (ICV) and calibration curve verification standards will be prepared at a midrange concentration, and a laboratory control sample may be prepared by digesting the ICV standard.
[e]Range of detection limits.
[f]TOC - total organic carbon.
[g]TOX - total organic halides.
[h]Analysis will be conducted in accordance with the procedures outlined in Exhibit D of the CLP-SOW for organic analysis (EPA 1988b).

Table 5-2

Methods for Analysis of Soil and Sediment

Parameter	Analytical Technique[a]	EPA Method No.
Thorium-230	Alpha spectrometry	C-02[b]
Uranium-238	Gamma spectrometry	C-02
Radium-226	Gamma spectrometry	C-02
Thorium-232	Gamma spectrometry	C-02
Metals[c,d]	ICPAES	200.7-CLP-M
Arsenic[d]	Furnace AA	206.2-CLP-M
Lead[d]	Furnace AA	239.2-CLP-M
Selenium[d]	Furnace AA	270.2-CLP-M
Thallium[d]	Furnace AA	279.2-CLP-M
Volatile organics	GC/MS	CLP-SOW[e]
Semivolatile organics	GC/MS	CLP-SOW
TCLP[f]	Various	--[g]
Corrosivity	Electrometric	111.0
Reactivity	Titration	335.2 & 376.2

[a]ICPAES - inductively coupled plasma atomic emission spectrophotometry; Furnace AA - furnace atomic absorption; GC/MS - gas chromatography/mass spectrometry.
[b]TMA/E utilities laboratory procedure developed by Environmental Measurements Laboratory-300 (DOE 1983).
[c]Includes aluminum, antimony, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lithium, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, vanadium, and zinc.
[d]Soil samples will be prepared and analyzed in accordance with procedures outlined in Exhibit D of the CLP-SOW for inorganic analysis (EPA 1988c).
[e]Analysis will be conducted in accordance with the procedures outlined in Exhibit D of the CLP-SOW for organic analysis (EPA 1988b).
[f]TCLP - toxicity characteristic leaching procedure.
[g]The extraction of the sample will be performed in accordance with 40 CFR Part 261. Analysis of the extract will be performed in accordance with the procedure.

Table 5-3

Methods for Engineering and Geotechnical Tests

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
Direct shear	ASTM D3080
Consolidation	ASTM D2435
Triaxial compression	ASTM D2850
Soil classification	ASTM D2487
Permeability (laboratory)	ASTM D2434
Permeability (field)	DOI EM[c] Desg. E-18

[a]ASTM - American Society for Testing and Materials (ASTM 1985).

[b]DA EM - Department of the Army, Corps of Engineers, Engineer Manual (DA EM 1980).

[c]DOI EM - Department of the Interior, Earth Manual (DOI EM 1963).

Table 5-4

Preservatives, Containers, and Maximum Holding Times[a]

Analyte	Matrix/ Treatment[b]	Container[c]	Quantity/Size of Bottles	Maximum Holding Time
Metals[d]	Water/adjust to pH <2 with nitric acid	Polyethylene bottle	1/1-L	180 days
	Soil and sediment[e]	Glass wide-mouth jar	1/250-ml	180 days
TCLP[f] (metals, organics), corrosivity, reactivity (sulfide/cyanide)	Soil	Glass wide-mouth jar	1/500-ml	None
pH and temperature	Water	Polyethylene or glass wide-mouth jar	1/500-ml	Onsite analysis
Specific conductivity	Water	Polyethylene or glass jar	1/500-ml	5 days
Volatile organics	Soil	Glass vial w/Teflon septum	2/120-ml	10 days
	Water	Glass vial w/Teflon septum	2/40-ml	7 days
Semivolatile organics and total polychlorinated biphenyls (PCBs)[g]	Soil	Glass, amber wide-mouth jar	1/500-ml	10 days for extractions/ 40 days after extractions
	Water	Glass, amber jar	1/950-ml	5 days for extractions/ 40 days after extractions
Alpha spectrometry	Soil	Polypropylene wide-mouth jar	1/500-ml	6 months
	Water	Collapsible polyethylene container	3,785-L (1-gal)	None
Gamma spectrometry	Soil	Polypropylene wide-mouth jar	1/500-ml	6 months
	Water	Collapsible polyethylene container	3,785-L (1-gal)	None
Physical characteristics	Disturbed soil	Split spoon	500-g	None
	Undisturbed soil	Shelby tube	1,000-g	

Table 5-4

(continued)

[a]Samples will be handled in accordance with Standard Methods for the Examination of Water and Wastewater (APHA 1989) and 1985 Annual Book of ASTM Standards (ASTM 1985).

[b]All samples will be shipped to the laboratory at 4°C.

[c]All bottles shipped to the site by Weston for chemical sample collection will be new bottles purchased from Eagle Pitcher. Analytical results for each bottle shipment are available upon request from Eagle Pitcher.

[d]Metals analyses include inductively coupled plasma atomic emission spectrophotometry, lithium, and lanthanides.

[e]Undisturbed soil samples to be analyzed for physical properties will be sealed with wax to preserve moisture content. No field preservatives are required for soil and sediment samples before shipment to the laboratory.

[f]TCLP - toxicity characteristic leaching procedure.

[g]Triple volume is required for QC analyses.

5.3 QUALITY CONTROL

QA/QC activities are described in detail in the QAPjP. Samples will contain sufficient volume to ensure detection limits, analytical parameters, and laboratory QA requirements. Radiological equipment will be carefully calibrated and maintained, and each calibration or maintenance action will be recorded in log books or files, as appropriate. Available National Institute of Standards and Technology (NIST) standards or standards traceable to NIST will be used for most primary calibrations. QC samples will be analyzed along with routine samples to determine whether results are in error because of improper operation, improper equipment calibration, deficiency in procedures, inadequate training, or cross-contamination. The QAPjP describes the blanks, splits, duplicates, and other QC samples required to measure field and laboratory performance.

5.4 DATA REPORTING

All data from each sample batch will be reported. Analytes will be reported using the International Union of Pure and Applied Chemistry system of chemical nomenclature (and if differing, the applicable Federal Register nomenclature for CERCLA) and Chemical Abstract Number. Analytical results for aqueous samples will be reported in milligrams/liter (mg/L), micrograms/liter (μg/L), or picocuries/liter (pCi/L). Analytical results for soil and sediments will be reported in milligrams/kilogram (mg/kg), micrograms/gram (μg/g), or picocuries/gram (pCi/g).

5.5 SAMPLE HANDLING, PACKAGING, AND SHIPPING

Samples will be packed in vermiculite to minimize the potential for breaking and will be shipped to the laboratory for analysis. Samples will be shipped, on ice if necessary, by priority mail on the same day they are taken. Chain of custody and sample handling will be conducted in accordance with the QAPjP and A User's Guide to the Contract Laboratory Program (EPA 1988a).

Because levels of radioactivity at the Tonawanda site are low, no special controls or labeling are necessary to package and ship these samples.

6.0 OPERATING PLAN

The scope of the operating plan includes the field activities required to achieve the work elements. The objective is to identify subcontract packages, field and analytical support, BNI support, documentation, technical specifications, and project instructions. A summary of technical specifications for borehole and monitoring well installations is provided in Appendix A. This section addresses the major elements of the operating plan for the Tonawanda site.

6.1 SAMPLING METHODOLOGY

Subsurface soil sampling typically will be performed by the drilling subcontractor, supported by subcontractor sampling personnel and a BNI geologist/field engineer. Sampling methods and sample handling will be specified in the technical specifications for the subcontract package. These procedures will also be audited by environmental health and safety personnel.

Groundwater, surface water, near-surface soil, and sediments will be sampled by subcontractor or BNI personnel using methods consistent with those given in A Compendium of Superfund Field Operations Methods (EPA 1987a). General practices are outlined in the following sections.

6.1.1 Presampling Activities

Many activities are conducted in the home office before field activities begin, including assembling and training the field RI team and procuring subcontracted services. Thermo Analytical/ Eberline (TMA/E) is responsible for collecting all samples and for analyzing radiological samples. Roy F. Weston, Inc., is responsible for analyzing chemical samples. The drilling subcontractor for this RI work is B and B Drilling, and civil surveying will be provided by Niagara Boundary and Mapping.

Finally, as required by DOE Order OR 548X.1, a readiness review will be conducted to ensure that all activities are properly planned and coordinated.

Before RI sampling begins, an access agreement will be negotiated with each property owner. An access agreement grants DOE permission to enter and conduct activities on the property and protects the interests of the property owner. Next, the civil surveyor will perform a survey of each property to be investigated to determine and stake the property boundaries. A drawing of each property will be prepared showing legal boundaries, buildings, significant surface features (concrete, gravel, etc.), major vegetation, and estimated value. These drawings will be submitted to BNI as early as practicable to allow their use in preplanning for the RI. Immediately before the commencement of field work, the civil surveyor will also establish the grid system by staking and marking intersections of perpendicular grid lines. The surveyor may also select precise locations of boreholes.

Approximately ten days before field sampling begins, all subcontractors will mobilize at the site. Mobilization entails the arrival of all personnel (BNI site superintendent, field engineers, geologists, technical group leader, operations supervisor, technicians, and drilling personnel); receipt of all equipment and instruments; ordering of sample containers; stocking of personal protective equipment; initial checkouts and calibrations; notifications (work plans) to the local communities and officials [Erie County Department of Environment and Planning, Coalition Against Nuclear material In Tonawanda (CANIT), and property owners]; final field training; and setup and testing of the decontamination facility. Each worker must show proof of a medical examination qualifying him to work at a hazardous waste site. Forty hours of Occupational Safety and Health Administration (OSHA) training will be given to members of the crew who were not previously trained (see the HSP for details). Field sampling may begin after site-specific training is completed.

Sample bottles and chain-of-custody forms will be provided, and proper sampling and decontamination procedures for the required analyses will be reviewed with the sampling team. Decontamination techniques are included in Appendix A.

All field instrumentation will be cross-checked and/or calibrated daily to ensure accurate field operation.

6.1.2 Sampling Activities

Walkover gamma scans will be conducted in established sampling locations using thallium-activated sodium iodide [NaI(Tl)] detectors in areas where exposure rates are less than 500 μR/h and using Geiger-Müller detectors in areas where exposure rates are greater than 500 μR/h. All surveys will be conducted with the detector close to ground surface. Surface samples will be collected with a garden trowel, and subsurface samples will be collected with a hand auger. Surface water samples will be collected in the required containers. The methods to be used will be consistent with the EPA-600/4-82-029, Handbook for Sampling and Sample Preservation of Water and Wastewater (EPA 1982).

Subsurface soil samples will be collected by the drilling subcontractor using techniques specified in the subcontract package and summarized in Appendix A. For radiological and chemical sampling, split-spoon sampling [or Central Mine Equipment (CME) sampling] is adequate to provide unmixed samples that retain their vertical distribution. After the driller withdraws the sample from the ground, TMA/E personnel will open the split spoon, withdraw the sample, and pack it. The level at which water is encountered in boreholes at Area A of Seaway will be measured with a water level indicator. All samples collected for analysis will be shipped to either the TMA/E or Weston laboratories.

TMA/E sampling personnel have been trained to avoid compromising the integrity of the sample. Methods include proper decontamination of sampling equipment (Appendix A) and sample handling, packing, preservation, and shipment. Chain of custody will be maintained from collection through shipment by the sampling team; chain of custody from shipment through analysis will be maintained by the laboratory.

6.1.3 Postsampling Activities

Boreholes will be backfilled and closed as discussed in Appendix A. In all cases, care will be taken to avoid creating a preferential pathway through which surface water may infiltrate the waste and reach groundwater. Disturbed areas will be restored to their original conditions.

All equipment and personnel entering a controlled area will be radiologically surveyed and decontaminated (if necessary) before leaving the area. The DOE thorium-230 surface contamination guidelines for release with no radiological restrictions will be used as release limits.

All field notes, chain-of-custody records, drawings, and files created during field activities will be forwarded to the BNI Oak Ridge office and entered into the Project Document Control Center (PDCC). PDCC will retain the records in a computerized database until the end of FUSRAP, when they will be transferred to DOE.

Analytical results from the radiological and chemical analysis laboratories will also be submitted through PDCC. PDCC will retain the originals and submit copies of the data to the environmental health and safety department for review and evaluation.

Data review activities to be conducted by environmental health and safety personnel are described in the QAPjP. These activities will include checking the data for completeness and QA/QC sample results. When these checks are complete and the results have been verified, the data will be released for evaluation and use.

6.2 SITE-SPECIFIC FEATURES

Known features of the properties (including utilities) that will affect the field program will be drawn on a plot plan that will be issued with all subcontract packages. Information about the locations of underground utilities will be obtained from local utility companies.

6.3 HEALTH AND SAFETY

The FUSRAP HSP and the property-specific HSPs will be in effect during all field activities.

6.4 LABORATORY PHASING

Because of the long holding times associated with the analyses, laboratory phasing of samples at the TMA/E laboratory will not be necessary. Advance notification of the sample loading for Weston laboratory will allow adequate time to phase samples so as to achieve holding times (see Table 5-4).

6.5 FIELD NOTES AND DOCUMENTATION

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

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

These notes will be transferred to geologic drill logs. For each sample taken, samplers will record weather conditions, sample location, sample type, time of day, chain-of-custody identification number, field measurements, and names of the samplers.

The field sampling team will also be responsible for maintaining and documenting appropriate chain-of-custody procedures. These procedures are more thoroughly described in the QAPjP.

6.6 FIELD TEAM ORGANIZATION

The field team will be organized as described in Section 1.2.

6.7 DECONTAMINATION

Decontamination of personnel and equipment will be conducted, as necessary, to ensure that personnel and equipment leaving a controlled area meet DOE guidelines for release.

Decontamination of sampling equipment will be conducted in accordance with technical specifications in the drilling subcontract and as discussed in Appendix A.

6.8 EXPENDABLE SUPPLIES

Expendable supplies such as coveralls, shoe covers, and gloves will be identified during the presampling readiness review to accommodate sampling, decontamination, and health and safety activities. Expendable supplies will be purchased and made available onsite before field activities begin. Purchase and delivery of supplies before drilling begins are the responsibility of the BNI operations supervisor. Any supplies not identified in advance can be purchased locally by the BNI operations supervisor. If the supervisor is unavailable, TMA/E may also purchase or rent small items.

6.9 EQUIPMENT

Equipment for sampling, decontamination, and personnel protection (as appropriate) will be identified during the readiness review and will be available onsite before field activities begin.

Major equipment required for the RI, such as ground penetrating radar, drilling rigs, split-spoon samplers, and radiation measuring instruments, will be supplied by subcontractors as specified in the technical specifications included in the subcontract packages. The purchase of nonexpendable sampling equipment and instrumentation is not anticipated.

7.0 ADDITIONAL PHASES OF REMEDIAL INVESTIGATION WORK

The activities planned and described in this FSP are intended to fill all currently known data requirements. However, depending on the results of these efforts, additional characterization of the Tonawanda site may be needed. Planning for these additional RI activities will begin as data are generated during the initial investigation. The overall objective of any additional work would be to augment data collected in the previous investigations and further define conditions at the Tonawanda site. Any data collected during the additional work effort would be used to:

- Refine estimates of contaminant source volumes
- Further evaluate potential impacts to human health and the environment
- Further evaluate remedial action alternatives

Specific follow-up activities may include:

- Completion of additional soil borings and analyses for chemical and radiological constituents

- Collection and analysis of additional groundwater and surface water samples (including groundwater elevation measurements)

- Site-specific testing of remedial action alternatives such as treatment of hazardous constituents

The approach for completing additional characterization activities will be based, in part, on information collected during previous characterization.

Procedures and specifications for collection and analysis of samples (including QC samples), completion of field measurements, installation of boreholes, sample handling and preservation, and equipment decontamination will be consistent with those described in Sections 2.0, 3.0, and 5.0 and in Appendix A.

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APPENDIX A

SUMMARY OF TECHNICAL SPECIFICATIONS FOR BOREHOLE AND MONITORING WELL INSTALLATION

SUMMARY OF TECHNICAL SPECIFICATIONS FOR BOREHOLE AND MONITORING WELL INSTALLATION

Characterization of FUSRAP sites typically includes a site geologic investigation and collection of various environmental samples for laboratory analysis. The principal support activities for site characterization include drilling radiological/chemical and geologic boreholes and installing groundwater monitoring wells. The specifications for these activities are summarized in this appendix.

Because specialized support activities are typically conducted by subcontractors, the primary source of details will be the scope of work and 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.

Specifications include a discussion of general requirements related to any contract activity. These requirements include standards that address quality control of the materials used for the activity and any standards specific to the activity.

A.1 RADIOLOGICAL AND CHEMICAL BOREHOLES

For radiological and chemical boreholes, all work is conducted in compliance with OSHA requirements (29 CFR 1926/1910). Specific requirements are summarized in the following sections.

Documentation

During drilling of radiological and chemical boreholes, field logs are required for recording specific information. 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, depth at which a sample was 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 identification of subsurface materials.

Equipment and Materials

Specific requirements for equipment and materials are developed for:

- Drill rig and support equipment
- Cement/bentonite grout
- Granular bentonite
- Cleaning material (deionized water, 10 percent nitric acid, Alconox®, reagent grade isopropyl alcohol)
- Temporary casing
- Surface protection materials (plastic sheeting, plywood)
- Perimeter barricade
- Borehole cover and markers
- Sediment barriers
- Sampling equipment

FIELD OPERATIONS

Predrilling

- Underground utilities in the work area are evaluated. For example, 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. These locations are identified and clearly marked.

- A water-handling procedure is developed. For example, water discharged from 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 as indicated in the design drawings.

- Safety and security measures are evaluated. For example, perimeter barricades are provided around work areas during all work operations if required. Barricades are placed in a manner that provides sufficient mobility for work operations within the barricaded area and that does not interfere with work activities. Barricades remain in place until all work is completed.

Drilling

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

- Before drilling, surface protection material is placed over and around the drill hole 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 unless otherwise specified.

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

- When unstable material or obstructions are encountered in drill holes, suitable methods are used to drill through such obstructions or the holes are abandoned if penetration cannot be achieved. Where necessary, temporary casings may be used to keep the holes open and ensure that they can be advanced.

- Drilling is not permanently interrupted before the required depth is reached 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 an adjacent supplementary hole. Abandoned holes are backfilled as specified.

- Until abandoned drill holes are backfilled, borehole covers and appropriate markers are placed over them to minimize hazards.

- 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, and/or apiezon grease (e.g., Dow Corning High Vacuum Grease or equivalent material). Oil and grease are not used on downhole items for chemical boreholes.

General

- All downhole items (e.g., augers and temporary casings) are cleaned and radiologically surveyed before work is started 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 Alconox® used for cleaning are handled and disposed of with the water from the decontamination operations. Used and unused solvents are handled as flammable materials. Nitric acid (10 percent) is handled and disposed of separately.

Cleaning for Radiological Boreholes

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

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 and Alconox®
- High-pressure water and Alconox®

(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 and Alconox®
- High-pressure water and Alconox®

(2) Rinse with deionized water
(3) Rinse with 10 percent nitric acid

(4) Rinse with deionized water
(5) Rinse with isopropyl alcohol
(6) Rinse thoroughly with deionized water
(7) Air-dry before use

Sampling

- Soil samples are obtained using a recognized sampling technique such as a split-spoon sampler, thin-walled tube sampler, CME sampler, and/or other technique approved by BNI before sampling. Samples to be analyzed for chemicals will be obtained using stainless steel samplers.

- Samples are submitted to BNI at the point and time of recovery. BNI is responsible for furnishing containers, placing samples into containers, and labeling containers as appropriate. In some cases, BNI delegates this authority to TMA/E sampling technicians.

Backfilling Boreholes

All boreholes are backfilled on direction from BNI unless noted otherwise. Boreholes drilled through 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. These methods are summarized as follows.

- The **dry pack method** is performed using granular bentonite in maximum lifts of 0.3 m (1 ft) and thoroughly rodded using a solid bar or suspended weight. Bentonite is emplaced in a manner that precludes the development of voids in the filled borehole. The dry pack method is not used when the borehole contains water, unless approved in advance by BNI.

- 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 kept below the surface of the grout at all times. Should loss or shrinkage of grout occur, holes are refilled until grout is within 1.3 cm (0.5 in.) of the required elevation shown on the design drawings.

- The **backfilling-with-spoils method** uses drill spoils from a borehole to fill that hole; this method is used only where permitted by the design drawings or scope of work. Backfilling is performed in maximum lifts of 0.3 m (1 ft). 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

For installation of geologic boreholes, all work will be conducted in accordance with the following standards and codes. Specific requirements are summarized in the following sections.

- OSHA 29 CFR — Occupational Safety and Health Standards (Part 1910 and Part 1916)
- 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)

Documentation

When geologic boreholes are drilled, field logs are required for recording specific information. All logs will 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, depth at which a sample was 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 identification of subsurface materials.

Equipment and Materials

Specific requirements for equipment and materials will be developed for:

- 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

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. These locations are identified and clearly marked.

- A water-handling procedure is developed. For example, water discharged from 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 as indicated in the design drawings.

- Safety and security measures are evaluated. For example, perimeter barricades are provided around work areas during all work operations if required. Barricades are placed in a manner that provides sufficient mobility for work operations within the barricaded area and that does not interfere with work activities. Barricades remain in place until all work within that area is completed.

Drilling

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

- Before drilling, surface protection material is placed over and around the drill hole 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 ensure that they can 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 an adjacent supplementary hole. Abandoned holes are backfilled as specified.

- Until abandoned drill holes are backfilled, borehole covers and appropriate markers are placed over them to minimize hazards.

- 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 using a recognized sampling technique such as a split-spoon sampler, thin-walled tube sampler, CME sampler, and/or other technique 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.

- All 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. In some cases, BNI delegates this authority to TMA/E technicians.

Conductor Casing

Conductor casings are installed through contaminated strata, as determined by BNI and 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 casing is installed in accordance with technical specifications. Conductor casings remain in place following installation.

Backfilling Boreholes

All boreholes are backfilled on direction from BNI unless noted otherwise. Boreholes drilled through 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. These methods are summarized as follows.

- The **dry pack method** is performed using granular bentonite in maximum lifts of 0.3 m (1 ft) and thoroughly rodded using a solid bar or suspended weight. Bentonite is emplaced in a manner that precludes voids in the filled borehole. The dry pack method is not used when the borehole contains water unless approved in advance by BNI.

- 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 kept below the surface of the grout at all times. Should loss or shrinkage of grout occur, holes are refilled until grout is within 1.3 cm (0.5 in.) of the required elevation shown on the design drawings.

- The **backfilling-with-spoils method** uses drill spoils from a borehole to fill that hole; this method is used only where permitted by the design drawings or scope of work. Backfilling is performed in maximum lifts of 0.3 m (1 ft). 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

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 (Part 1910 and Part 1916)
- 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

Documentation

The subcontractor will be required to document:

- Catalog cuts
- Samples of materials
- Certified sieve analyses
- Details or shop drawings

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

Equipment and Materials

Specific requirements for equipment and materials will be developed for:

- 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

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 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 in accordance with the technical specifications.

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

- After the grout has set, each monitoring well is tested 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.

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 can be drawn through the screen when the well is pumped under maximum conditions of drawdown.