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RECRA ENVIRONMENTAL, INC.

Chemical Waste Analysis, Prevention and Control

SITE CHARACTERIZATION
AND
ENVIRONMENTAL ASSESSMENT
HANNA FURNACE, BUFFALO, NEW YORK
VOLUME I

PIN 5034.43.221
City of Buffalo - Arterial Route
Fuhrmann Blvd. - Hamburg Turnpike
Fed. Proj. BRF-1(120), Erie County
Map 326, Parcels 353, 354, 355
A.S. #87-44
Compt. No. D002483
Federal Employee I.D. 16-1263663

Prepared For

Regional Real Estate Office
State of New York
Department of Transportation
125 Main Street
Buffalo, New York 14203

Prepared By

Recra Environmental, Inc.
Audubon Business Centre
10 Hazelwood Drive, Suite No. 106
Amherst, New York 14150

August 1988

CERTIFICATE OF ENVIRONMENTAL ANALYST

I hereby certify:

That I have personally viewed the property herein and that I have afforded the property owner the opportunity to accompany me at the time of the site visit.

That to the best of my knowledge and belief, the statements contained in the report herein set forth are true, and the information upon which the opinions expressed therein are based is correct; subject to the limiting conditions therein set forth.

That I understand that such report may be used in connection with the acquisition of right-of-way for a highway to be constructed by the State of New York with the assistance of Federal-aid highway funds, or other Federal funds.

That neither my employment nor my compensation for making this report are in any way contingent upon the values reported herein.

That I have no direct or indirect present or contemplated future personal interest in such property or in any way benefit from the acquisition of such property.

That I have not revealed the findings and results of such report to anyone other than the proper officials of the New York State Department of Transportation or officials of the Federal Highway Administration, and I will not do so until authorized by State officials, or until I am required by due process of law, or until I am released from this obligation by having publicly testified as to such findings.

That my opinion of the order of magnitude Remediation Costs based on Published Regulatory Guidelines for reasonable cost conceptual effective Remedial design options as of the 1st day of August, 1988, ranges from $300,000 to $324,600,000 based upon my independent review of the data base and limitations cited within the Report and the exercise of my professional judgment.

8-22-88
Date

Robt K Wyeth
Robert K. Wyeth
Executive Vice President

EXECUTIVE SUMMARY

The New York State Department of Transportation (NYSDOT) has contracted Recra Environmental, Inc. to conduct an environmental assessment of an approximate 131-acre parcel located in Buffalo, New York. The site was originally owned by Hanna Furnace and is being considered for purchase by the NYSDOT. The site has an industrial history dating back to the early 1800's and was used for moderate to heavy industry until recently. The majority of recent industry on site involved the production of pig iron from iron ore. Significant volumes of flue ash and furnace debris were stored and landfilled on site.

An environmental assessment and site characterization was performed in order to survey site conditions for the absence/presence of chemical constituents that will assist in defining any potential environmental liability(s) associated with the property. The investigation included the sampling and analysis of key areas of the site for a limited list of parameters that are indicative of contamination from industrial or hazardous waste sites.

Results from geotechnical soil borings indicate that up to 13 feet of the surface soils are composed of fill material. Of the soil samples analyzed, much of this material contains elevated concentrations of oil and grease, heavy metals (i.e.; arsenic, chromium, copper and lead), ammonia and cyanide as compared to "naturally occurring" soils. Sediments in the Union Ship Canal contain similar contaminants.

Groundwater on site exceeds the class GA groundwater standards for arsenic, chromium, lead, cyanide, phenols and pH. It is presently believed that none of the above listed material in either the soil, sediment or groundwater are present in such a way as to pose a significant threat to human health and the environment.

A preliminary engineering assessment and cost estimate of remedial alternatives were investigated and four potentially feasible alternatives are presented with their associated costs. The alternatives suggested consist of the following:

- no action
- excavation, removal and treatment
- capping and in situ control and
- subsurface containment

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1.0 BACKGROUND

1.1 Overview

At the request of the New York State Department of Transportation (NYSDOT), Recra Environmental, Inc. of Amherst, New York, has undertaken a site characterization and an environmental assessment relative to the transfer of the past Hanna Furnace property located in the southern part of the City of Buffalo, New York. The scope of services described herein presents the technical approach to the characterization of the site conditions for the absence/presence of chemical constituents that could effect the potential environmental liabilities associated with the property.

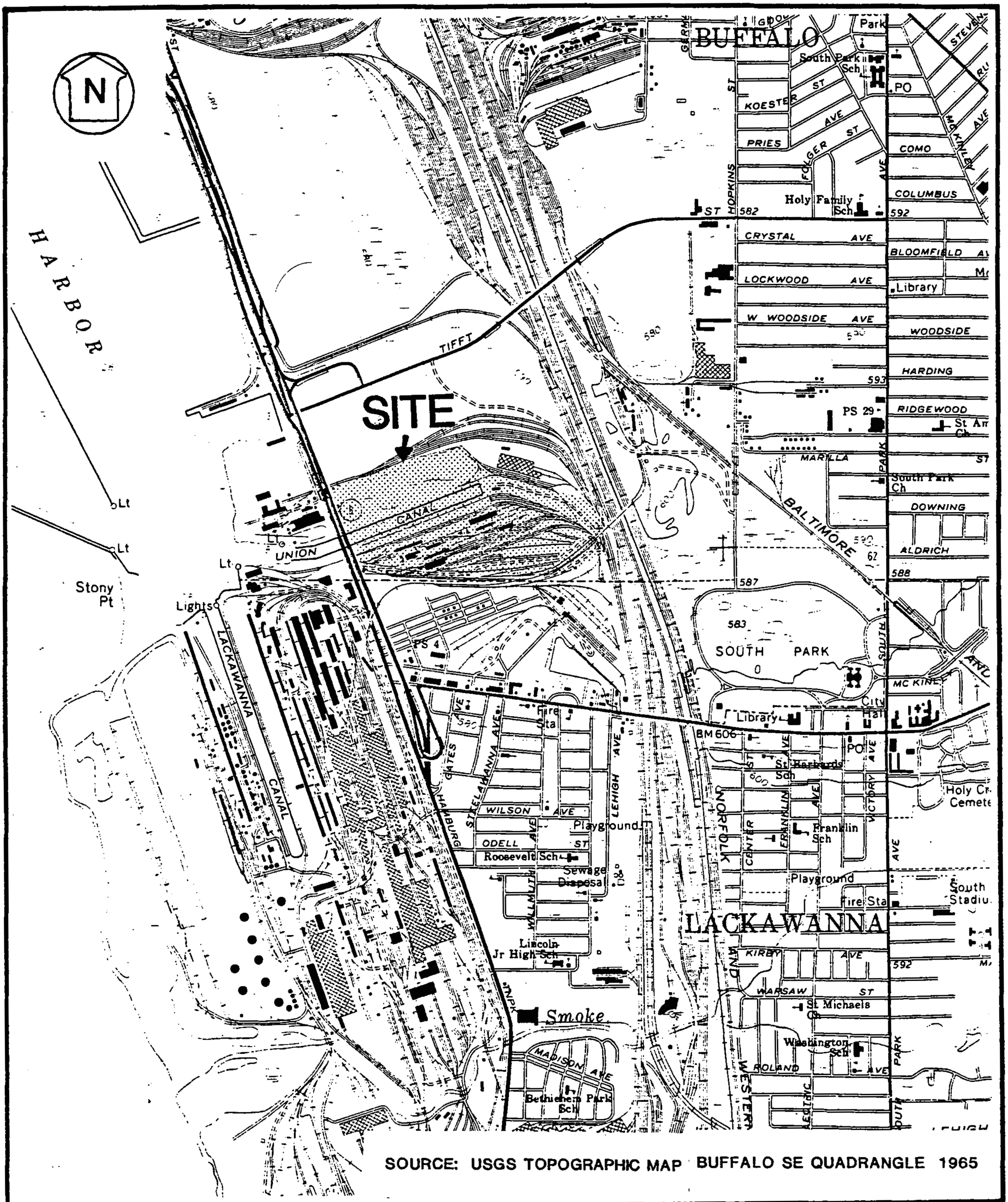
A major portion of this study was directed toward sampling and analysis of specific areas throughout the site in order to determine the overall extent of contaminants present, their distribution, volumes and concentrations. Laboratory analyses of the samples collected from the site have focused on a limited list of parameters that are indicative of commonly encountered contamination from industrial and hazardous waste sites. The overall testing program concentrated on those areas of obvious visual contamination or those suspected of high material contact from landfilling and/or transfer activities where periodic spills or discharges most likely could have occurred during the production and distribution of pig iron and its associated wastestreams.

1.2 Site Description

1.2.1 Introduction

The property of concern is located in the southern-most part of the City of Buffalo, New York in Erie County immediately north of the Buffalo/Lackawanna city boundary. The approximately 131-acre site is transversed, approximately in the middle, in a west-east direction by the Union Ship Canal (see Figure 1-1). The canal extends from near the eastern boundary of the site west to the Buffalo Harbor. Directly adjacent to the northern edge of the property is a 50-foot easement and right-of-way granted to Shenango Furnace. Directly north of this easement is a large rectangular area owned by Conrail Corporation. To the northeast of the site is property, including a foundry building, owned by Marlen Steel Corporation (Shenango Furnace Company); to the east is Conrail Corporation property; and to the south is property owned by the South Buffalo Railroad Company. Directly to the west of the site is Fuhrman Boulevard and the Hamburg Turnpike and further west of these thoroughfares is the Bethlehem Steel facility. The Father Baker Bridge forms the elevated portion of the Hamburg Turnpike at the western end of the site and was constructed to allow access of canal barges to the site via the Union Ship Canal.

Figure 1-2 presents a schematic cross section of the Union Ship Canal. This figure was developed from data collected by the Hanna Furnace Corporation in July 1961. These data indicate that the walls of the canal are comprised of a concrete dock face supported by timber cribbing, which bears on bedrock. These data also indicate that the base of the dock face is approximately three feet below the canal water surface.



SOURCE: USGS TOPOGRAPHIC MAP BUFFALO SE QUADRANGLE 1965

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NYSDOT
ENVIRONMENTAL ASSESSMENT
OF HANNA FURNACE SITE

SITE VICINTY MAP

Project No. 7C 745

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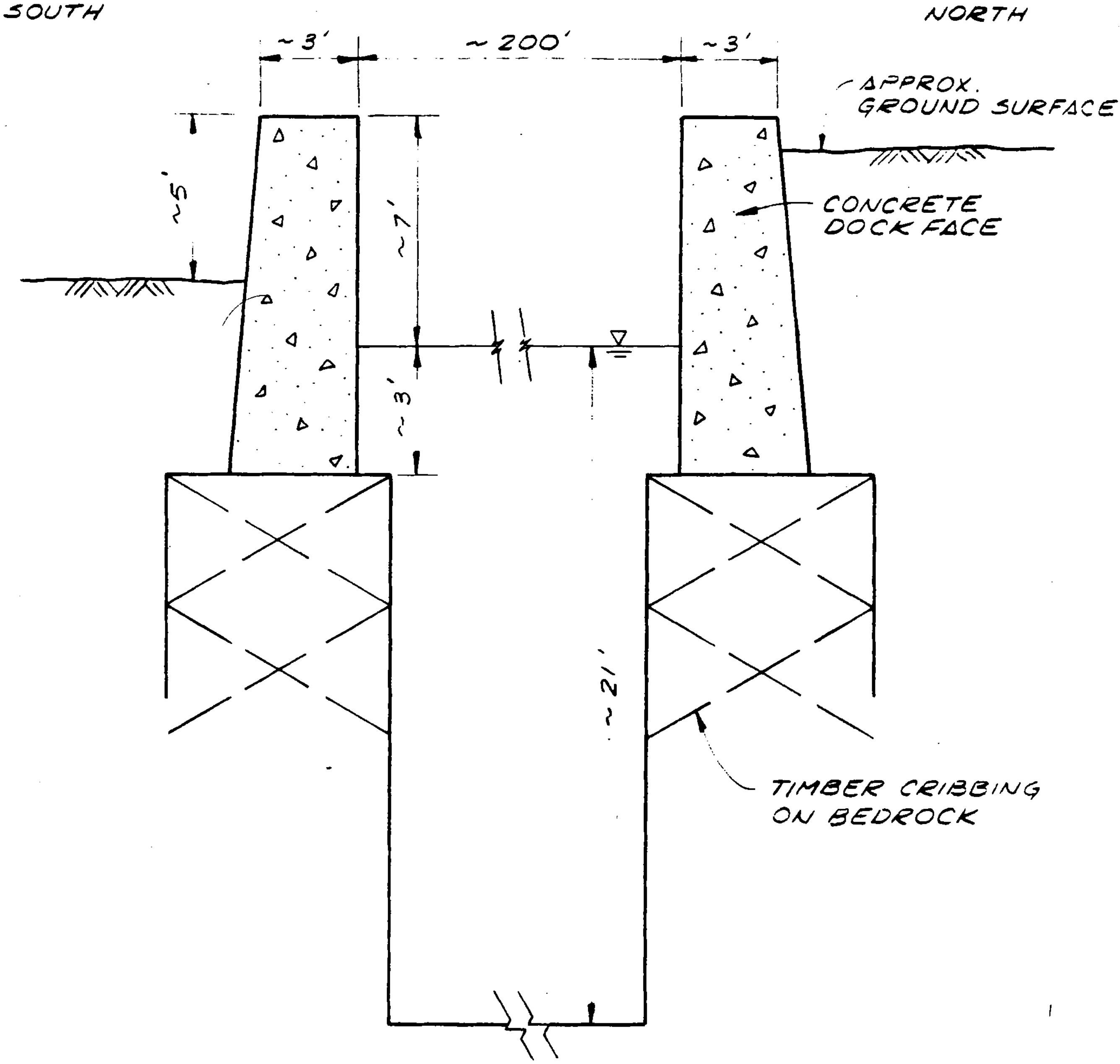
FIGURE 1-1



NOTES:

1. THIS DRAWING WAS ADAPTED FROM A HANNA FURNACE CORPORATION DRAWING OF UNION SHIP CANAL (DRAWING NO. 3681-JULY 1961).

NOT TO SCALE

HANNA FURNACE SITE
BUFFALO, NEW YORK

SCHEMATIC DRAWING OF UNION SHIP CANAL

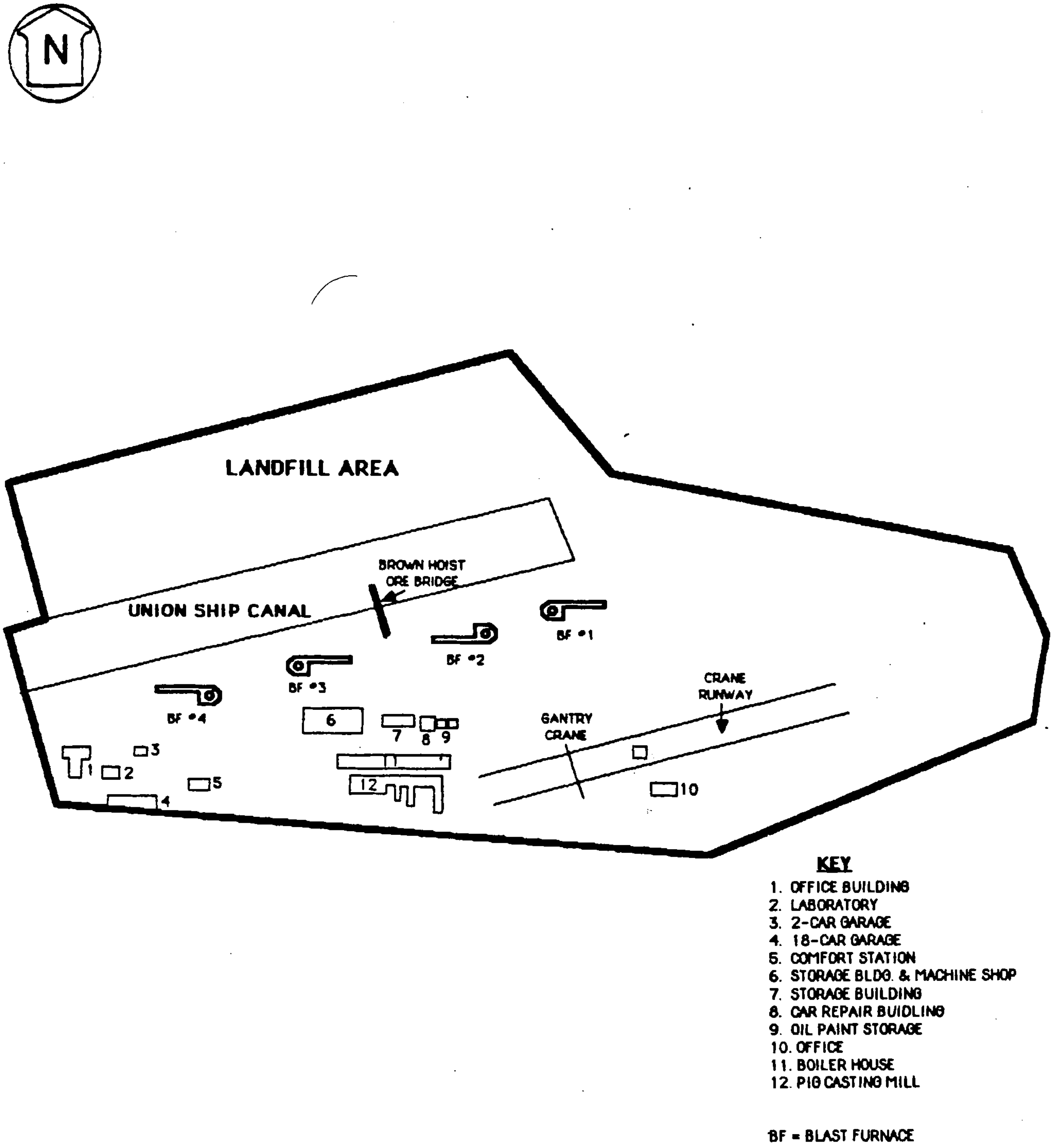
JUNE 1988

FIGURE 1-2

The site was utilized for a variety of purposes prior to the cessation of pig iron manufacturing in 1982. The total property consisted of approximately 131 acres of which approximately ten acres along the eastern boundary of the site and 20 surrounding acres to the north of the canal was utilized for landfilling generated waste and raw material storage. Approximately 30 acres to the southeast of the canal was utilized for pig iron storage; approximately 40 acres south of the canal was utilized for the production of pig iron and ancillary activities; approximately ten acres were and still are occupied by the Union Ship Canal; the remaining acreage was either utilized for miscellaneous storage or unused.

Since cessation of manufacturing operations on the southern portion of the site in 1982, a majority of the buildings have been dismantled. However, parts of many building foundations remain throughout the site. Several abandoned blast furnaces and plant buildings are located south of the canal. One of these buildings which is referred to as the "oil shack" is located in the south central portion of the site (Figure 1-3). The surface soils in this area appear to have been stained by petroleum products.

Since the northern portion of the property was utilized in part for waste disposal from approximately 1960 to 1982, following the purchase of the property from the Pennsylvania Railroad, natural topographic features have been altered by mounds of waste material which rise to a maximum of approximately 30 feet above grade. A small pond is still located in the northwestern portion of this area.



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NYSDOT

ENVIRONMENTAL ASSESSMENT

OF HANNA FURNACE SITE

Project No. 7C 745

SITE MAP

PROCESSING UNITS

A

FIGURE 1-3

1.2.2 Accessibility

The site is accessible by water, rail, and public roads. The Union Ship Canal, which transverses the majority of the site, supplies access to Lake Erie via the Outer Harbor.

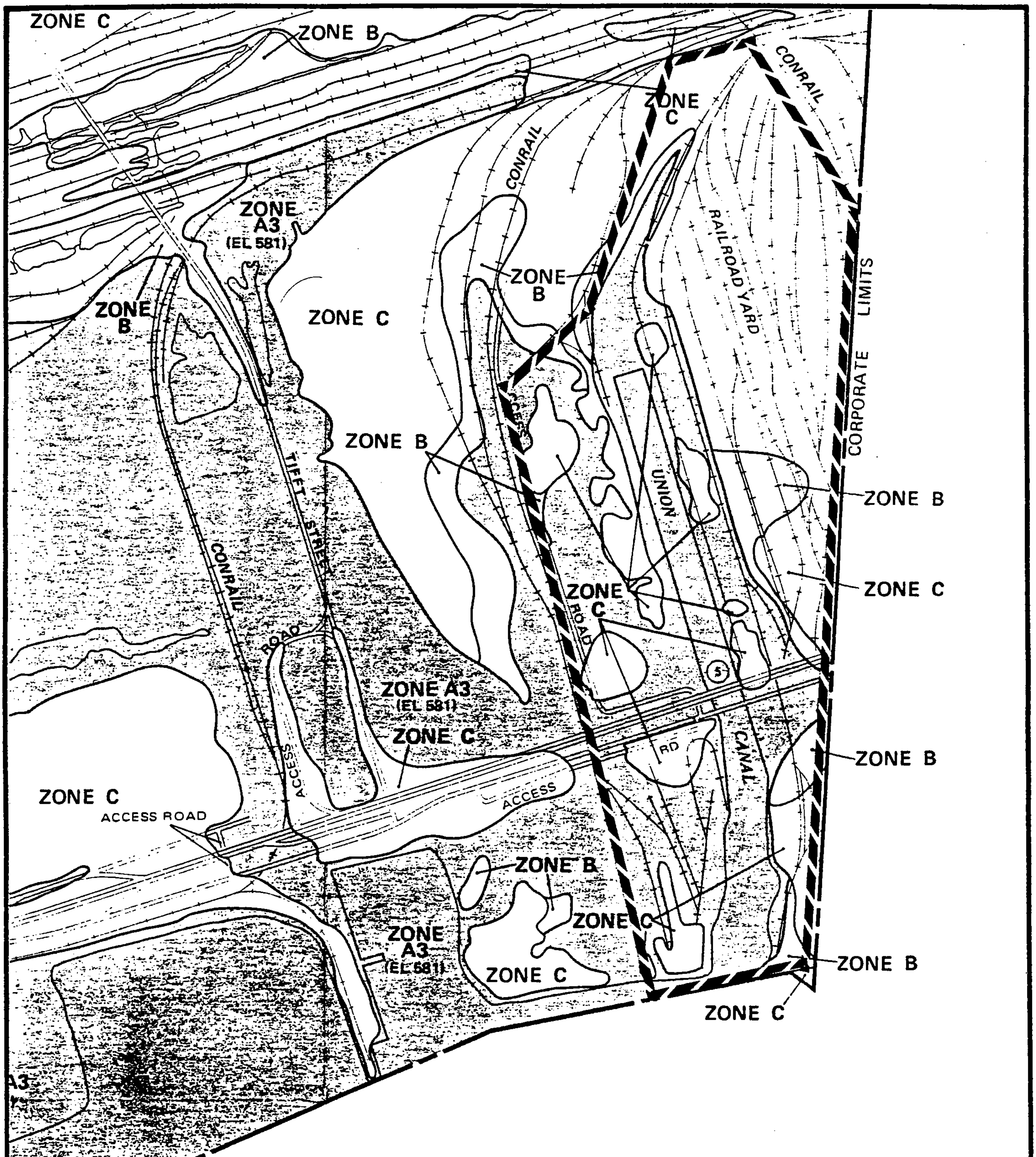
Numerous railroad spurs are available to provide access into the facility. In addition, Conrail and South Buffalo Railroad rail lines are located directly north, south, and east of the site.

Vehicles are able to directly enter the site via the Hamburg Turnpike and Fuhrman Boulevard.

1.2.3 Floodplains/Wetlands

As illustrated in Figure 1-4, the property of concern does contain areas which are zoned to be within the 100 year floodplain (Zone A) as defined by the Federal Emergency Management Agency (Community Panel #360230-0020-B).

The closest New York State Department of Environmental Conservation (NYSDEC) designated wetland is located approximately 1,000 feet north of the site (Figure 1-5).



SOURCE: F.E.M.A. FLOOD INSURANCE RATE MAP
PANEL NO. 360230 0020 B, 1981

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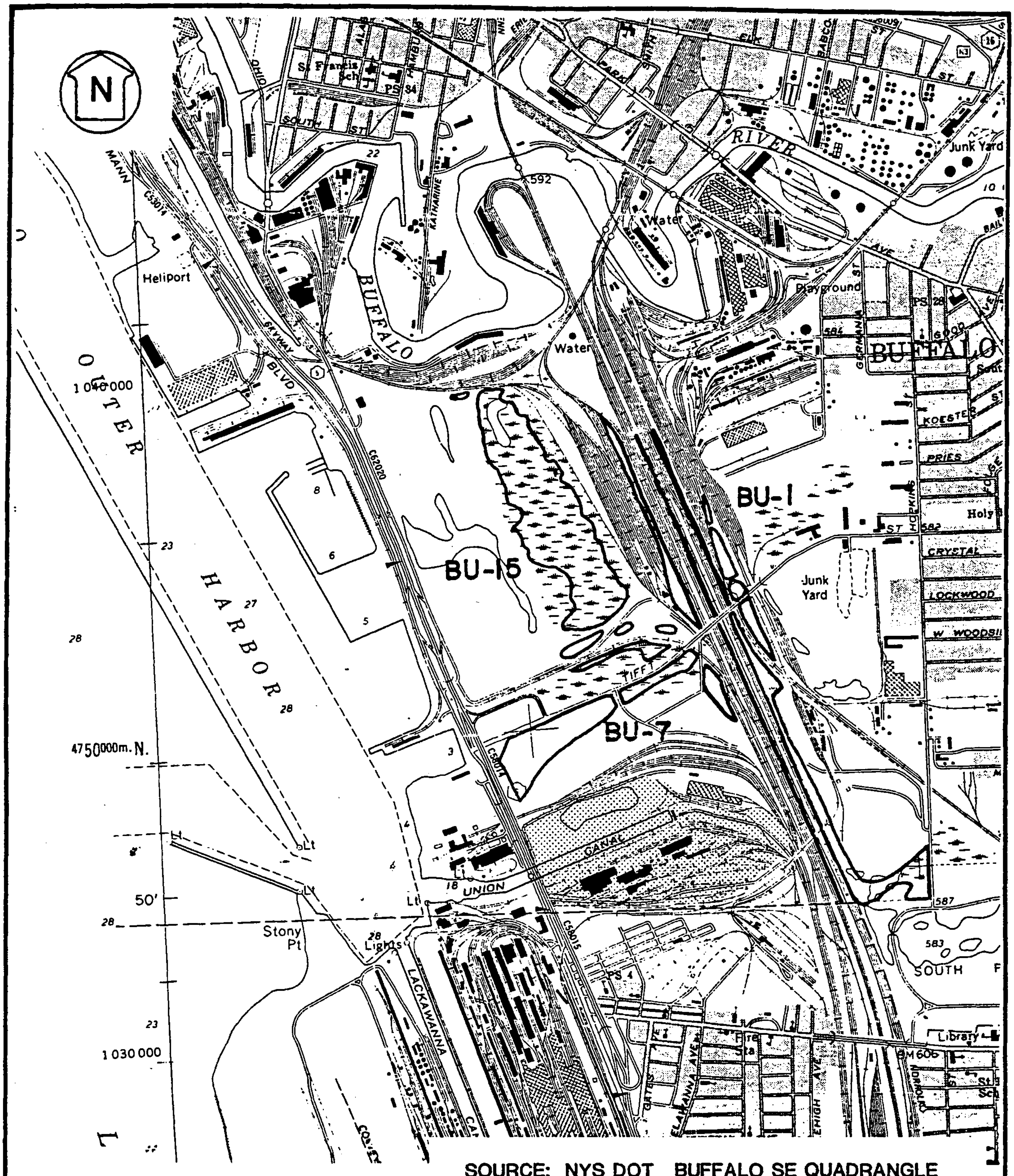
NYSDOT
ENVIRONMENTAL ASSESSMENT
OF HANNA FURNACE PROPERTY

Project No. 7C 745

FLOOD ZONES

A FIGURE 1-4



SOURCE: NYS DOT BUFFALO SE QUADRANGLE

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NYSDOT
ENVIRONMENTAL ASSESSMENT
OF HANNA FURNACE SITE

WETLANDS MAP

Project No. 7C 745

A

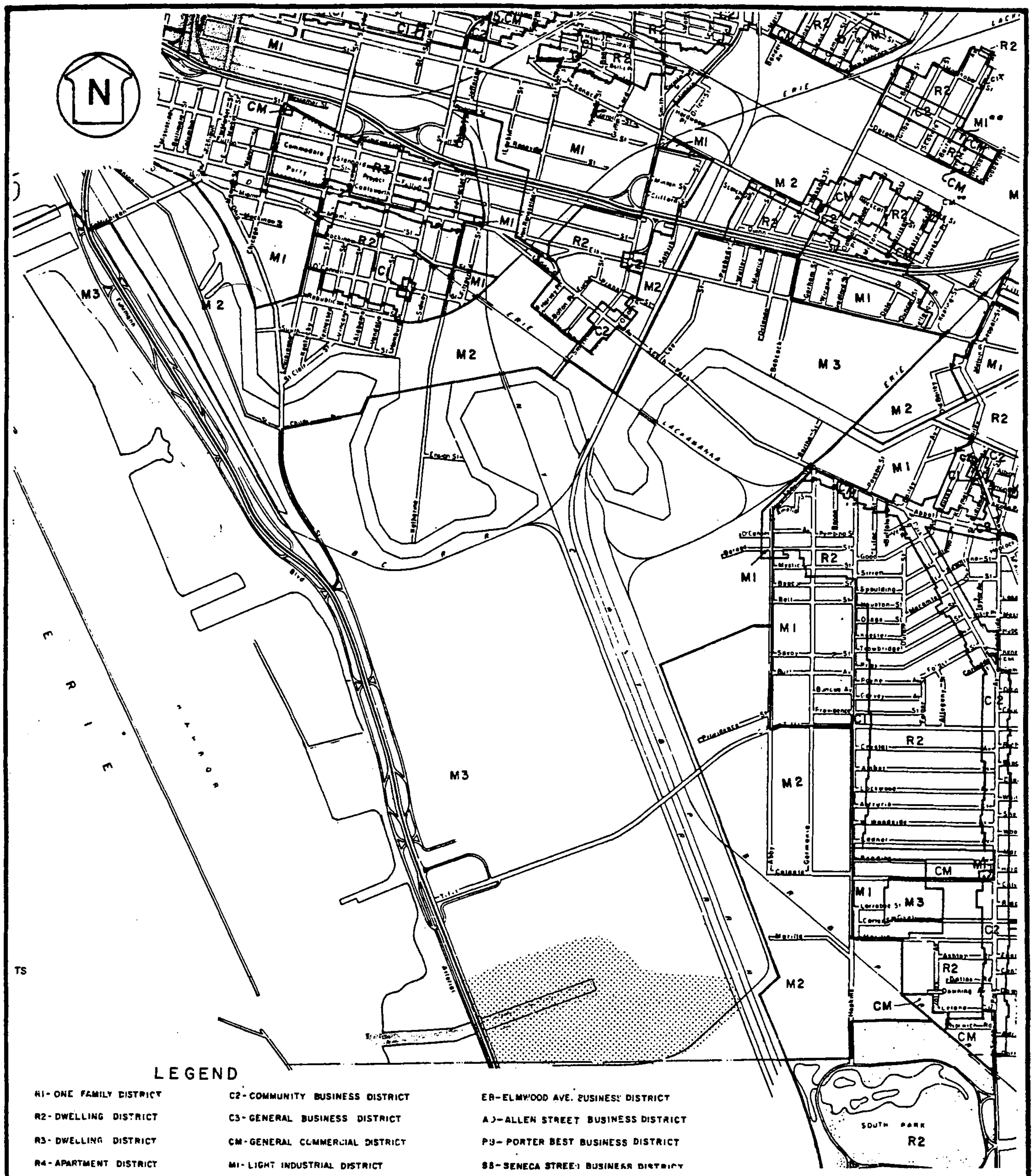
FIGURE 1-5

1.2.4 Zoning and Land Use

The site is located in an industrial-zoned area (Figure 1-6). The closest residential area is located approximately 0.25 miles southeast of the site in the City of Lackawanna. Within one mile of the site, the population is estimated at 6,000 persons. Land east, west, and directly south of the site is zoned for industrial uses. Approximately 0.5 miles to the north and 0.5 miles to the southeast lies the Tifft Farms Nature Preserve and South Park, respectively; both are public recreation sites.

1.2.5 Topography

The site is positioned east of Lake Erie within the Eastern Lake Section of the Central Lowlands physiographic province. It is relatively flat and has an average elevation of approximately 600 feet above mean sea level. The site is generally covered with fill material which supports some vegetative cover. Union Ship Canal approximately bisects the site into a northern and southern portion. The surface topography generally slopes towards the canal. Much of the land north of the canal was originally a swamp with an average depth of approximately twelve (12) feet. Flue ash and furnace debris from previous on-site pig iron production was used to fill this area. Presently the northern portion contains a topographic ramp which is approximately 25 feet high at the northwest end and tapers to a nominal level to the east. Much of this feature is composed of black flue ash and construction debris. Various shallow indentations are filled with water throughout the northern portion of the site. Water depths in these ponds seldom exceed more than a few inches.



LEGEND

- R1- ONE FAMILY DISTRICT
- R2- DWELLING DISTRICT
- R3- DWELLING DISTRICT
- R4- APARTMENT DISTRICT
- R5- APARTMENT HOTEL DISTRICT
- C1-NEIGHBORHOOD BUSINESS DISTRICT
- C2- COMMUNITY BUSINESS DISTRICT
- C3- GENERAL BUSINESS DISTRICT
- CM- GENERAL COMMERCIAL DISTRICT
- M1- LIGHT INDUSTRIAL DISTRICT
- M2- GENERAL INDUSTRIAL DISTRICT
- M3- HEAVY INDUSTRIAL DISTRICT
- EB-ELMWOOD AVE. BUSINESS DISTRICT
- AS-ALLEN STREET BUSINESS DISTRICT
- PB- PORTER BEST BUSINESS DISTRICT
- SS-SENECA STREET BUSINESS DISTRICT

SOURCE: ZONING MAP – BUFFALO, NY NOVEMBER 1964.

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OF HANNA FURNACE SITE

Project No. 7C 745

ZONING MAP

A

FIGURE 1-6

Two piles of iron ore are stockpiled on the north side and are located at either end of the canal. These piles rise to an elevation of approximately 30 feet above grade.

South of the Union Ship Canal the only variation in relief is where demolition debris from the original pig iron facility has been bulldozed into piles. Most of this southern portion is flat with less than twenty feet of relief.

1.2.6 Surface Water

The site is effected by two surface water bodies, Union Ship Canal and Lake Erie. Lake Erie lies due west of the site and connects directly to the site by the Outer Harbor and the Union Ship Canal. The canal was constructed to give access to raw material supply barges entering the site. The present depth of the canal is approximately twenty feet. Much of the precipitation falling on the highly porous surface soils seeps into the groundwater and eventually discharges into the canal. Connecting with the north end of the site are a series of swampy wetlands which form part of the Tifft Farm Nature Preserve.

1.3 Site History

1.3.1 Introduction

The historical information regarding the property has been secured through discussions with regulatory agencies, the general public who is knowledgeable about past operations, published reports, newspaper articles, and basic technical information sources. The information in this section has not been presented to accurately delineate all historical facts regarding the site, but to provide basic information regarding the probable activities and course of events which took place on the property.

In 1900, the southern portion of the property was purchased and incorporated by Buffalo Union Steel. In order to service the facility, in 1910 the Union Ship Canal was constructed near the northern edge of the Buffalo Union Steel property. Manufacturing of pig iron operations commenced with the construction of the blast furnaces during the period of 1900 to 1915. Following the construction of the furnaces, in 1920 the Hanna Furnace Company acquired the site from Buffalo Union Steel. Then in 1929, the site was purchased by the newly-formed National Steel Company and became known as Hanna Furnace Corporation, and an integral part of National Steel's conglomerate (Great Lakes Steel, Riverdon Furnace, and Hanna Furnace).

In 1960, approximately 25 acres of land north of the canal, was purchased by Hanna Furnace from the Pennsylvania Railroad. At the time of purchase, this portion of the site was occupied largely by swampy ponds which were approximately 15 feet deep. In 1962, approximately 18 acres in the northeastern section of this newly-acquired property was sold to Shenango Furnace Company.

At times of peak production, Hanna Furnace employed 800 employees. Due to foreign competition and the closure of Shenango Furnace Company, a primary recipient of Hanna's hot metal, in 1982, Hanna Furnace ceased all operations on this site. In 1983, the Jordan Foster Scrap Corporation, the current owner of the site, purchased the site from National Steel. Jordan Foster dismantled the blast furnaces, the casting mill, and several other buildings. During their four plus years of ownership, they also took in some scrap metal from several used Bethlehem Steel buildings, etc., for processing. The processed metal was then distributed via barge, rail, and roadway. Currently, the office building, garage, maintenance building, "oil shack" building and locker room are the only buildings remaining on site.

The Jordon Foster Scrap Corporation has filed bankruptcy since the purchase and currently leases the property to Equity Scrap Processing Company (Equity) which conducts salvage operations at the site.

1.3.2 Process Operations

The Hanna Furnace site, predominantly that portion south of the canal, was used for the manufacture of pig iron from the early 1900s to 1982. The pig iron manufacturing process is described below. Any negative environmental impact on the site from Jordan Foster's operations is considered minimal and thus, is not detailed below.

Raw Material Acquisition

In the production of pig iron, the following raw materials are utilized:

- Iron-Bearing Materials
    - Iron ore
    - Sinter pellets
    - Mill scale
    - Iron or steel scrap
- Coke
- Fluxes
    - Limestone (high magnesium oxide dolomite; high calcium oxide furnace stone)
    - Gravel

Iron ore and limestone were delivered to the facility via the Union Ship Canal. Until the development of self-contained unloaders on the supply barges, a maximum of six unloading stations were located alongside the canal to unload the ore and limestone. The unloaded materials were stored (stockpiled), along both the northern and southern edges of the canal. Coke was supplied from the nearby Donner Hanna Coke plant.

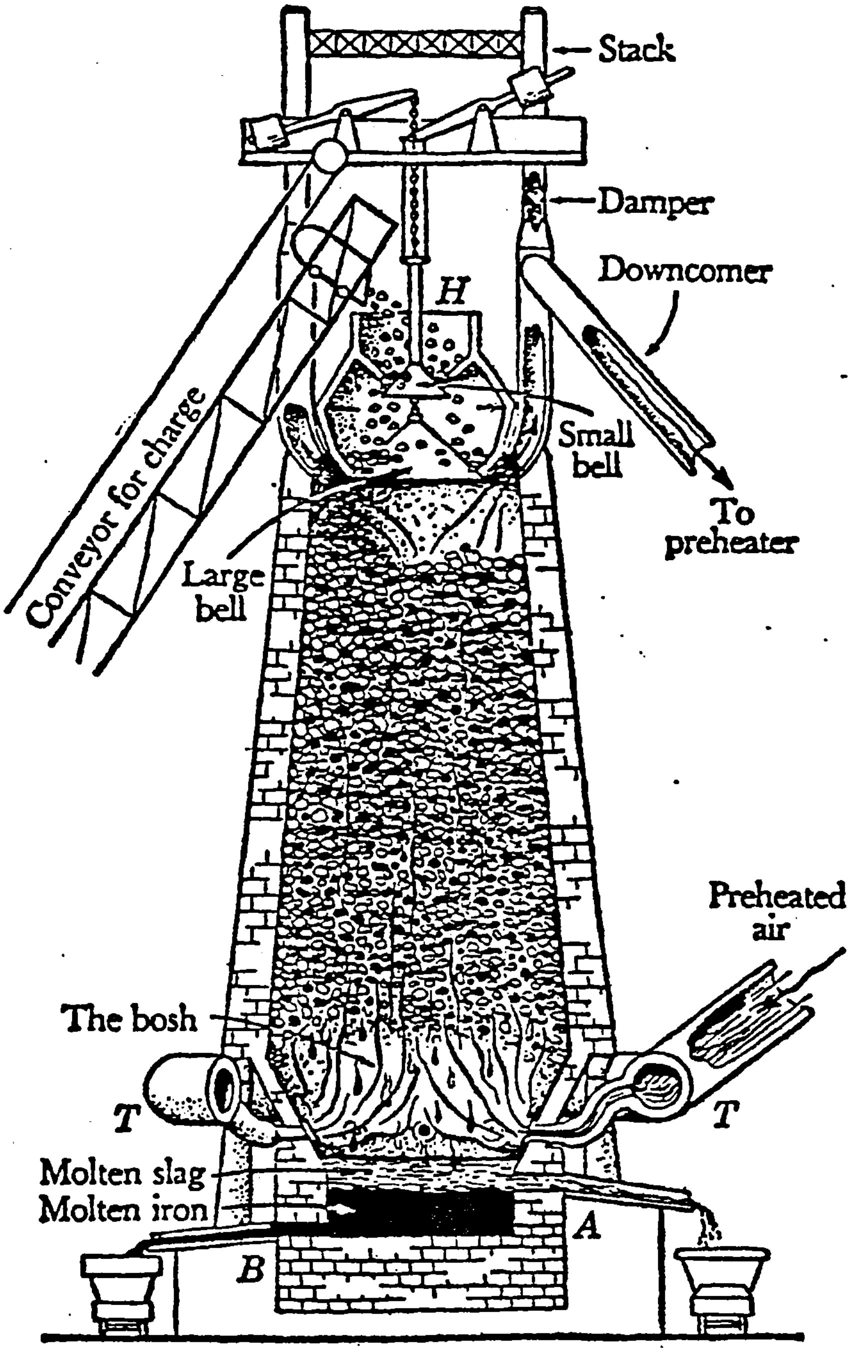
Processing Units

The approximate locations of Hanna Furnace's key processing units are illustrated in Figure 1-3.

Blast Furnace

The raw materials were transferred from their storage areas to surge hoppers at one of the four blast furnaces where it was weighed and transferred to the top of the furnaces by a skip hoist or by belt conveyor.

The raw materials were loaded into the blast furnace (see Figure 1-7) in the following order: coke, iron ore, limestone. Heated air was then introduced into the furnace above the hearth line through a nozzle (tuyere).



SOURCE: "ENVIRONMENTAL AND RESOURCE CONSERVATION CONSIDERATIONS OF STEEL INDUSTRY SOLID WASTE", EPA, 1979

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OF HANNA FURNACE SITE

Project No. 7C 745

EXAMPLE OF
BLAST FURNACE

A

FIGURE 1-7

To supplement the blast air, fuel oil, natural gas, oxygen, or collected by-product furnace gases were blown into the bottom of the furnace. Temperatures of approximately 1540°C were maintained in the furnaces along with a top-pressure of about 10-30 psi. The combination of the temperature and pressure resulted in the iron ore descending down the furnace, whereby reducing it and melting it into iron by the counter current flow of hot reducing gases created by the partial combustion of coke.

Hot metal was tapped from the furnace and transported to the on-site casting mill. Molten slag was removed from the furnaces through separate tapping holes which were at a higher elevation than the hot metal tap holes. The slag was discharged from the blast furnace into an on-site slag pit. An example of a blast furnace material balance is presented in Table 1-1. Auxillary to the production of pig iron, Hanna Furnace also produced "Silvery Pig Iron," a special pig iron use by special foundaries.

The capacity of the four furnaces are identified in Table 1-2. In 1974, Blast Furnace #2 was removed from operation. The remaining three furnaces were remained operable until the closure of Hanna Furnace in 1982.

TABLE 1-1

EXAMPLE OF BLAST FURNACE MATERIAL BALANCE

Material	Weight (Tons)*
INPUTS	
Iron Bearing Burden	
Iron Ore	0.3075
Flux sinter	1.226
Scrap	0.099
Flux	
Limestone	0.008
Gravel	0.008
Fuel	
Coke	0.514
Natural Gas	0.021 (0.027 million liters)
Blast	
Air	1.639 (1.254 million liters)
Moisture	0.016 (0.019 million liters)
OUTPUTS	
Hot Metal	1.0
Slag	0.25
Runner Scrap	0.006
Top Gas	2.461 (1.8 million liters)
Moisture	0.079 (0.093 million liters)
Dust and Sludge	0.042

* Metric tons (1,000 kg)

Source: "Industrial Process Profiles for Environmental Use: Chapter 24 - The Iron and Steel Industry," EPA, 1977.

TABLE 1-2

CAPACITY OF HANNA FURNACE'S BLAST FURNACES

Blast Furnace	Capacity
#1	700 net tons/day
#2	700 net tons/day
#3	700 net tons/day
#4	1,000 net tons/day

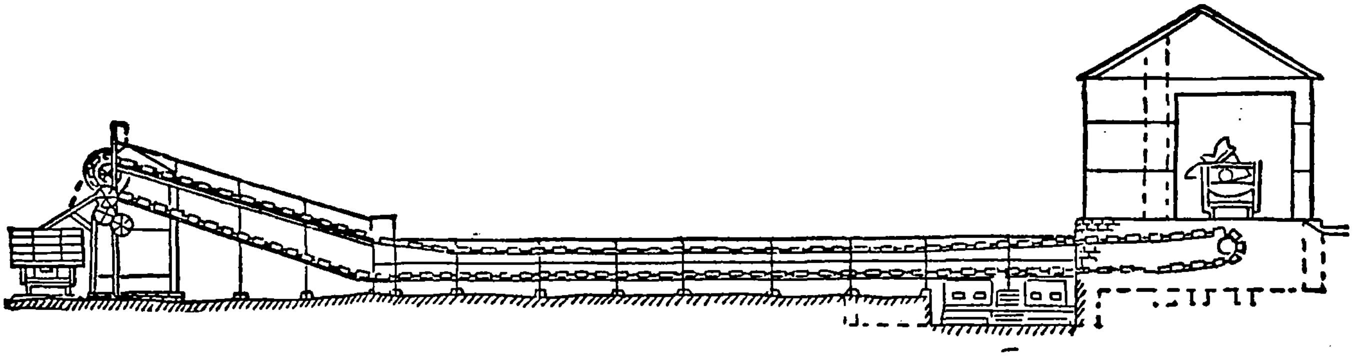
Casting Mill

The molten pig metal from the blast furnace typically contained 4.1% carbon, 0.9% silicone, 0.026% sulfur, 0.296% phosphorus, and 0.35% manganese. Upon its removal from the furnace into a ladle, the pig iron was transferred to Hanna Furnace's casting mill which was located south of Blast Furnaces #2 and #3. At the casting mill, molten iron was cast into a long continuous series of hollow metallic molds carried on endless chain (Figure 1-8). The casting molds consisted of three production strands. Two strands were available to produce 40-pound blocks of iron (i.e. pigs) and one production was available to produce 12-pound blocks.

The molten pig was chilled quickly against the metallic molds and recirculating water system, and by the time it reached the end of conveyor at the other end of the casting machine, it consisted of a solid pig of iron which dropped into a waiting railroad car. The molds then traveled back toward the ladle spout underneath the conveyor, hollow side down. Prior to being refilled, they were sprayed with whitewash (80% Revived Clay, 20% Sea Coal), the water of which quickly dried off by the heat of the mold, leaving a coating of lime to which the molten iron would not stick.

Utilities

The daily utility requirements of a "typical" or "generic" four-furnace plant similar to Hanna Furnace are illustrated in Table 1-3. The majority of the energy required to fuel the blast furnaces was in the form of recycled blast furnace off-gas.



SOURCE: "THE METALLURGY OF IRON AND STEEL", BRADLEY STOUGHTON, 1934.

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NYSDOT
ENVIRONMENTAL ASSESSMENT
OF HANNA FURNACE SITE

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EXAMPLE OF
PIG CASTING
MACHINE

A

FIGURE 1-8

TABLE 1-3

UTILITIES REQUIREMENTS OF A SELF-CONTAINED BLAST FURNACE PLANT WITH FOUR FURNACES PRODUCING A TOTAL OF 3,810 NET TONS* OF HOT METAL PER DAY†

Utility	Quantity Required Daily English
Recirculating water	32,000,000 gallons
Make-up water	500,000 gallons
Other service water	6,600,000 gallons
Water to utilities (boiler house, turbine condensers, etc.)	60,000,000 gallons
Potable water	140,000 gallons
Coke-oven gas	2,000,000 cubic feet
Natural gas for heat	340,000 cubic feet
Natural gas for heat (3 months)	41,000,000 cubic feet
Boiler house fuel	
Fuel oil	346,000 gallons
Blast furnace gas	890,000,000 cubic feet
Compressed air at 5.6 kgs/sq.cm. (80 psi)	2,000,000 cubic feet
Steam at 14.1 kgs/sq.cm. (200 psi) and 38°C (100°F) superheat	18,000,000 pounds
AC electricity - purchased	3,000,000 kilowatt hours
DC electricity - own-purchased	86,000 kilowatt hours

† Volumes of gases refer to 16°C (60°F) and 1 kg/sq.cm. (30 in. Hg), unless otherwise specified.

*Metric tons (1,000 kg)

Source: "Industrial Process Profiles for Environmental Use: Chapter 24 - The Iron and Steel Industry", EPA, 1977.

The off-gas that left the top of the blast furnaces passed through a cyclone, commonly called a dust collector and a high energy scrubber before it was diverted back to the blast furnace stoves where it heated the hot blast boilers which produced steam, etc. Approximately six tons of off-gases were produced for every ton of iron generated in the furnace. Natural gas and fuel oil were purchased and used to supplement the off-gas.

Miscellaneous Buildings

Other buildings utilized in the Hanna Furnace property include the Store House and Machine Shop, the Storage Building, the Car Repair Building, and the Oil/Paint Storage Building. The exact utilization of these buildings is not known but can be inferred by the name of the building.

Product Storage

Upon completion of the casting process, the solid pigs were automatically loaded into railroad cars and transferred to the pig iron storage area located in the southeastern portion of the property. At peak storage, up to 200,000 pounds of pig iron was stored on-site. Pig iron was also loaded into barges for storage at National Steel's storage yards in Detroit, Chicago, and New Jersey.

Product Distribution

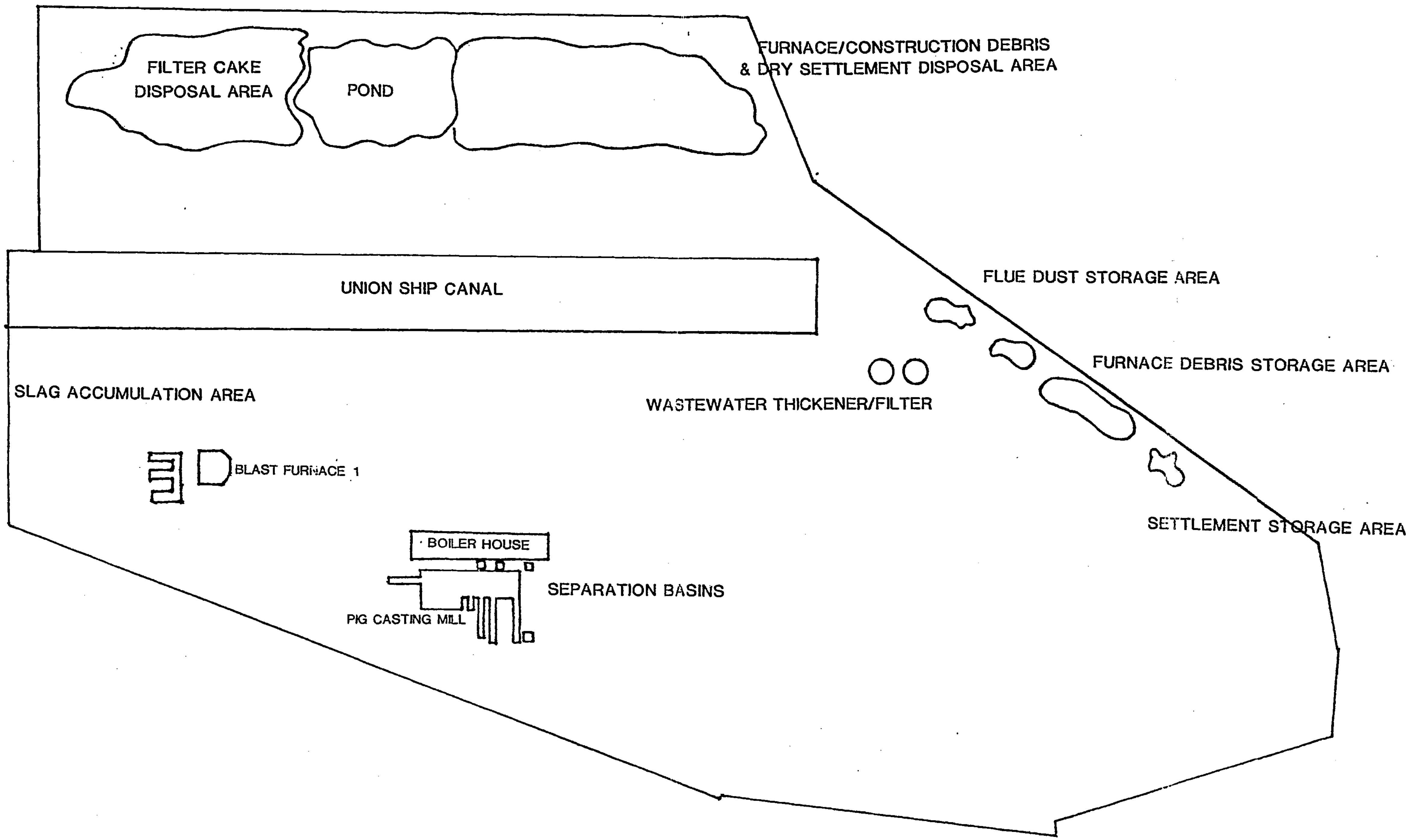
Pig iron manufactured at Hanna Furnace was supplied to numerous steel manufacturers and molding facilities throughout the east coast. Pig iron was also sold locally to nearby Bethlehem Steel, Republic Steel, and to the adjacent Shenango Steel Mold Plant.

The pig iron was transported off-site by barge (via Union Ship Canal), rail line, and truck.

1.3.3 Waste Generation/Disposal

Wastewater

Blow down from Hanna's boilers and recirculating water used to cool the pig iron in the molds was discharged to Hanna Furnace's separation basins (see Figure 1-9). The resultant wet sludge was moved by rail car to the settlement storage area where it was naturally dried. The dried material was then transported by rail car or open truck to the northern portion of the site (Figure 1-9) for landfilling. Approximately 500 tons of dried sludge was generated per year from approximately 3,100 tons of wet sludge. The wet sludge from the separation basins consisted of approximately 84% water, iron scale (or iron oxides), oxides of phosphorous, calcium, magnesium, silicon, iron, aluminum, phosphates of calcium and magnesium, magnesium silicate and calcium carbonate. It is anticipated that the separator basins water effluent along with the wastewater generated from the wet scrubbers was discharged to wastewater thickener/filler facility located at the eastern end of the Union Ship Canal (see Figure 1-9). At this facility, a thickener was added to the iron-laden water to increase its viscosity. The iron-laden thickened filter cake was then transported to the northern portion of the site where it was either stored for future sale or landfilled on-site (see Figure 1-9).



RECRA RESEARCH INC.
BUFFALO, NEW YORK

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ENVIRONMENTAL ASSESSMENT
OF HANNA FURNACE SITE

Project No.

SITE MAP

WASTE RELATED UNITS

B

FIGURE 1-9

BRUNING 61160-1

The filtered wastewater which was potentially contaminated with phenols, cyanides, fluorides and ammonia was then discharged into the canal. A SPDES permit was in place for this activity.

Slag

In the production of pig iron, various by-products are generated. The most abundant solid by-product is slag which was generated at a rate of approximately 0.25 tons for each ton of pig iron. In that slag functioned to remove harmful sulfur from the iron, its generation was imperative to the proper operation of the furnaces and formation of pig iron. Slag, which was tapped periodically from above the molten iron in the blast furnace, consisted primarily of lime, silica, and alumina. The "captured" sulfide compounds in the slag were emitted into the air during quenching. Hanna Furnace accumulated the slag in an on-site slag accumulation area (see Figure 1-9) where it was briefly stored until its acquisition by the Buffalo Slag Company. Buffalo Slag purchased and removed the slag from Hanna Furnace's accumulation area, processed it, removed the entrained iron, and sold the remaining slag for road making bases or railroad ballast.

Flue Dust/Flue Ash/Filter Cake

Actual particulate emissions released into the atmosphere from the blast furnaces were minimal due to the high degree of particulate emission control necessitated to keep the heat exchangers from plugging. It is estimated that approximately 75 kilograms of particulate material was generated per ton of product produced.

The flue dust, transported by the furnace top-gas, (i.e. flue gas) was directed out of the top of the furnaces into a primary gravity separator (i.e. dust collector). The collected dust, whose typical average composition and size is delineated in Tables 1-4 and 1-5, was hauled in open trucks or by railroad car from the separator to the northern portion of the site for storage (Figure 1-9). The stored flue dust was periodically sold to other industries which were interested in recovering its 30-60 % iron content. The amount of flue dust "stored" on site depended largely upon the fluctuating economic feasibility of recovering the iron. Approximately 5,600 and 7,200 tons of dry flue dust was generated every year.

From the dust collector, the top gas and remaining dust was directed to a high energy orifice wet scrubber and gravity/expansion chamber. The wet scrubber effluent consisted of reusable top gas and flue ash wastewater/sludge. The wastewater was then diverted to the gravity/sedimentation tanks for thickening and then through a vacuum filter where the flue ash filter cake was produced. The filter cake was removed from the filter and moved by open trucks to the northern section of the property (Figure 1-9). Approximately 6,800 to 10,800 tons of filter cake was landfilled on-site each year.

Analysis of the flue ash filter cake generated at Hanna Furnace is delineated in Table 1-6. Phenols and cyanides, believed to be potential contaminants of the filter cake, were not included in the analyses.

TABLE 1-4

CHEMICAL COMPOSITION OF DRY, BLAST FURNACE FLUE DUST

Component†	Weight Percent Range for Several Plants
Iron	36.5 - 50.3
Ferrous oxide	N/A
Silicon dioxide	8.9 - 13.4
Aluminum oxide	2.2 - 5.3
Magnesium oxide	0.9 - 1.6
Calcium oxide	3.8 - 4.5
Sodium oxide	N/A
Potassium oxide	N/A
Zinc oxide	N/A
Phosphorus	0.1 - 0.2
Sulfur	0.2 - 0.4
Manganese	0.5 - 0.9
Carbon	3.7 - 13.9

† - Tests on blast furnace scrubber samples from a plant in Midwest Indiana showed the presence of cadmium 14 ppm.

N/A - Not Available

Source: "Industrial Process Profiles for Environmental Use: Chapter 24 - The Iron and Steel Industry", EPA, 1977.

TABLE 1-5

SIZE ANALYSIS OF FLUE DUST FROM U.S. BLAST FURNACES†

Size		Range (percent)
U.S. Series Sieve	Microns	
20	833	2.5 - 20.2
30	589	2.9 - 10.6
40	414	7.0 - 11.7
50	295	10.7 - 12.4
70	208	10.0 - 15.0
100	147	10.2 - 16.8
140	104	7.7 - 12.5
200	74	5.3 - 8.8
<200	<74	15.4 - 22.6

† Dust collected in particulate control devices.
< Less than

Source: "Industrial Processing Profiles for Environmental Use: Chapter 24 - The Iron and Steel Industry," EPA, 1977.

TABLE 1-6

COMPOSITION OF FLUE ASH FILTER CAKE AT HANNA FURNACE SITE

Parameter	% of Dried Total Weight
Total Iron as FeO_3	43.57
Phosphorous Pentoxide	0.076
Manganous Oxide	0.34
Silica	9.96
Alumina	1.81
Calcium Oxide	3.45
Magnesium	2.05
Carbon	30.10
Loss on Ignition	34.17
pH (as received)	8.7
Moisture	8.17

Source: Hanna Furnace Corporation Waste
Management Facility, Rupley, Bahler,
and Blake Consulting Engineers,
10/18/79

Miscellaneous Wastes

Approximately 5,000-10,000 tons/year of furnace and construction debris consisting of soil, sand, bricks, lumber, cement and scrap metal was generated and stockpiled on the north portion of the Hanna Furnace property (see Figure 1-9). The debris was transported on-site by railroad car or truck. Upon removal of the salvageable scrap metal, a portion of the debris was utilized to fill in the adjacent pond.

It is anticipated that various quantities of waste paints, solvents, and oils were also generated on-site due to standard operating procedures and maintenance activities. The storage and disposal methods utilized for these wastes is not known.

1.3.4 Previous Studies

In 1970, the approximately 8-10 acre landfill located on the northern portion of the site was initially listed in the Interagency Task Force's draft report which detailed the known hazardous waste disposal sites in New York State. At this time it was thought that substantial quantities of hazardous materials were disposed of in the landfill. The reason for this hypothesis is not known.

Resulting from a September 1978 NYS Department of Environmental and Planning (DEP) inspection in 1979, the Hanna Furnace Corporation submitted an "Application for Approval to Construct a Solid Waste Management Facility," and an "Application for Approval to Operate a Solid Waste Management Facility," to the EPA. These applications referenced the northern portion of the site which was being reportedly used for the storage and disposal of "non-hazardous" industrial waste (Figure 1-9).

Prior to formal submission of this application, an investigation entitled "Hanna Furnace Corporation, Solid Waste Management Facility Report" was conducted by Rupley, Bahler and Blake, Consulting Engineers in 1979. This study included the analyses of surface water samples from the Union Ship Canal and an on-site pond. Phenols and soluble iron were measured in these samples at concentrations exceeding the water quality standards for the New York State Department of Environmental Conservation (NYSDEC) class GA waters. Class GA water are fresh groundwaters used as a potable water source.

Following the cessation of pig iron manufacturing, the landfill was inspected in April 1982 by the Erie County Department of Environmental Protection who generated a report entitled "Inactive Site Profile Report". This study reviewed the data collected during the 1979 study to evaluate the potential for hazardous waste at the site. The study recommended that the NYSDEC site classification be reduced from "E" to "F" (also designated as priority classifications 4 and 5). The "E" classification indicates continued monitoring of the site is required. The "F" classification indicates that further action is not warranted and that the site has little to not hazard potential.

In 1983, the site was inspected by NYSDEC and an "Inactive Hazardous Waste Disposal Site Report" was generated. The inactive landfill was assigned Site #915029 by the NYSDEC. Also in 1983, a study "Draft Report of Preliminary Evaluation of Chemical Migration to the Niagara River from Hazardous Waste Disposal Sites in Erie and Niagara Counties was generated by the United States Geological Survey (USGS). As a part of this investigation, seven test borings were made north of the canal to depths of between 6.5 and 15 feet. Soil samples from the borings were analyzed for chromium, copper, iron and lead. Based upon these analyses, the study concluded that there was a potential for lateral migration of contaminants at and away from the site. Then in 1985, the site was inspected again by the NYSDEC and another site report was generated. It was estimated that approximately 966,000 tons of the ash, plant debris, and filter cake was disposed of in the landfill. This latter inspection was also attended by Environmental Sciences and Dames and Moore, environmental consultants, who were contracted to perform a Phase I investigation of the site. The investigation was completed and published in January, 1986.

The purpose of the Phase I investigation at the Hanna Furnace site was to assess the hazard to the environment caused by the present condition of the site. This assessment is based on the Hazard Ranking System, which involves the compilation and rating of numerous geological, toxicological, environmental, chemical, and demographic factors and the calculation of an HRS score. During the initial portion of the investigation, available data and records, combined with information collected from a site inspection, were reviewed and evaluated. This study also included a review of the site's State Pollutant Discharge Elimination System (SPDES) permit documents for New York State. These documents indicated violations for phenol and cyanide in the effluent of the flue ash cake filtrate treatment system for the plant. This effluent was discharged into the Union Ship Canal prior to 1983.

The major portion of the Phase I investigation focused on the disposal of flue ash, flue ash filter cake, slag, and general plant debris in the northern portion of the site. Based on this initial evaluation of the Hanna Furnace site, the following preliminary HRS scores were secured:

S_M (migration potential) = 8.73

S_{FE} (fire and explosion potential) = 0

S_{DC} (direct contact potential) = 50

Generally, if a site receives a migration potential score of 28.5 or above, it becomes a candidate for inclusion onto the National Priorities List (NPL). If a site scores less than 28.5 it may either be removed from further investigation or it could undergo a Phase II investigation. Due to the unavailability and inadequacy of information needed to correctly score the site, the outcome of the Phase I investigation resulted in the recommendation that a Phase II investigation be initiated. The following recommendations were suggested for completion of Phase II:

- Collection of waste samples from the landfill and waste piles. Analyses to include phenols, cyanide, and heavy metals.
- Installation of groundwater monitoring wells in the vicinity of flue ash landfill.
- Surface water sand sediment analysis of the on-site pond and Union Ship Canal. Analysis to include phenols, cyanides, and heavy metals.
- Topographic survey to estimate volume of wastes on-site.

Currently, a Phase II investigation is being initiated by the NYSDEC with additional field exploration activities and the installation of monitoring wells and sampling of surface soil, surface water and groundwater.

The anticipated completion date for the Phase II study is not known.

The New York State Department of Transportation (NYSDOT) is currently considering purchasing the site. Due to past plant operations at the site and the findings of previous studies, NYSDOT is concerned that a potential on-site contamination problem may exist. Thus, NYSDOT retained Recra to complete a site characterization and environmental assessment for the site. The NYSDEC reviewed and approved the workplan for this investigation prior to its implementation and accompanied Recra/Goldberg-Zoino Associates during the well placement activities on-site.

2.0 FIELD INVESTIGATION

2.1 Overview

The field program undertaken for this study, as planned by Recra and approved by the NYSDEC, consisted of five separate events which were conducted between December 11, 1987 and April 11, 1988. These included a site reconnaissance, surface soil sampling, surface water and sediment sampling, boring and monitoring well installation, well development and groundwater sampling and surveying. General USEPA ASTM protocols and standard Recra testing methods were employed for all six events. They are presented in the following part of this report in five separate text sections consistent with field activities.

In order to determine the absence/presence of chemical constituents of concern, their distribution and concentration, a site-specific sampling program was developed by Recra for the Hanna Furnace site (Figure 2-1).

The sampling program was designed to obtain representative samples from various locations associated with the past activity at the Hanna Furnace site. In order to provide a preliminary assessment of the contaminant profile, a group of soil and water samples were collected which provide a data base for the study. These samples were collected from surface soils, subsurface soil borings, groundwater samples, and surface waters (from the canal and a pond on the north end of the site) and sediments from the canal and pond. All samples collected were placed in precleaned glass jars using established and approved EPA methods. The samples were kept cool and taken to Recra Environmental, Inc.'s laboratory for eventual analysis under chain of custody for analysis at the conclusion of each work day.

2.2 Site Reconnaissance

The site reconnaissance occurred on December 11, 22 and 23, 1987 and consisted of four distinct tasks: on-site inspection, air monitoring survey, staking sampling locations, and photographing the site. Most of these tasks were conducted simultaneously to conserve time. Right of access onto the site was gained by Mr. Murray Abbott, the Senior Right-of-Way Agent of the New York Department of Transportation (NYSDOT).

The on-site inspection consisted of a review of the site manufacturing processes and a site walk over noting those areas of obvious soil discoloration or stressed vegetation. Specific areas were noted where raw materials and wastestreams from pig iron manufacturing were stockpiled.

An air monitoring program was conducted on site using a HNu Model PL 101 photoionization analyzer. Readings were taken at both upwind and downwind locations in the zone of breathing. At no time during monitoring did the photoionization analyzer show any readings above ambient background conditions.

Twenty-nine surface locations were staked for the purpose of collecting surficial soil samples for laboratory analysis.

2.3 Surface Soil Sampling

Locations for sample collection consisted of those areas of apparent contamination (spills, etc.), or areas known to have histories of significant material handling. Areas used for material storage or active material transfer received specific examination. The locations of these sampling points are illustrated on Figure 2-1.

Twenty-nine surface soil samples were collected by means of grab sampling using pre-cleaned, stainless steel trowels. The sampling consisted of obtaining a representative sample from the following areas:

- five samples from the "oil shack" area
- ten samples from the northern section of the site (north of the Union Ship Canal); and
- fifteen samples evenly distributed over the southern section of the site.

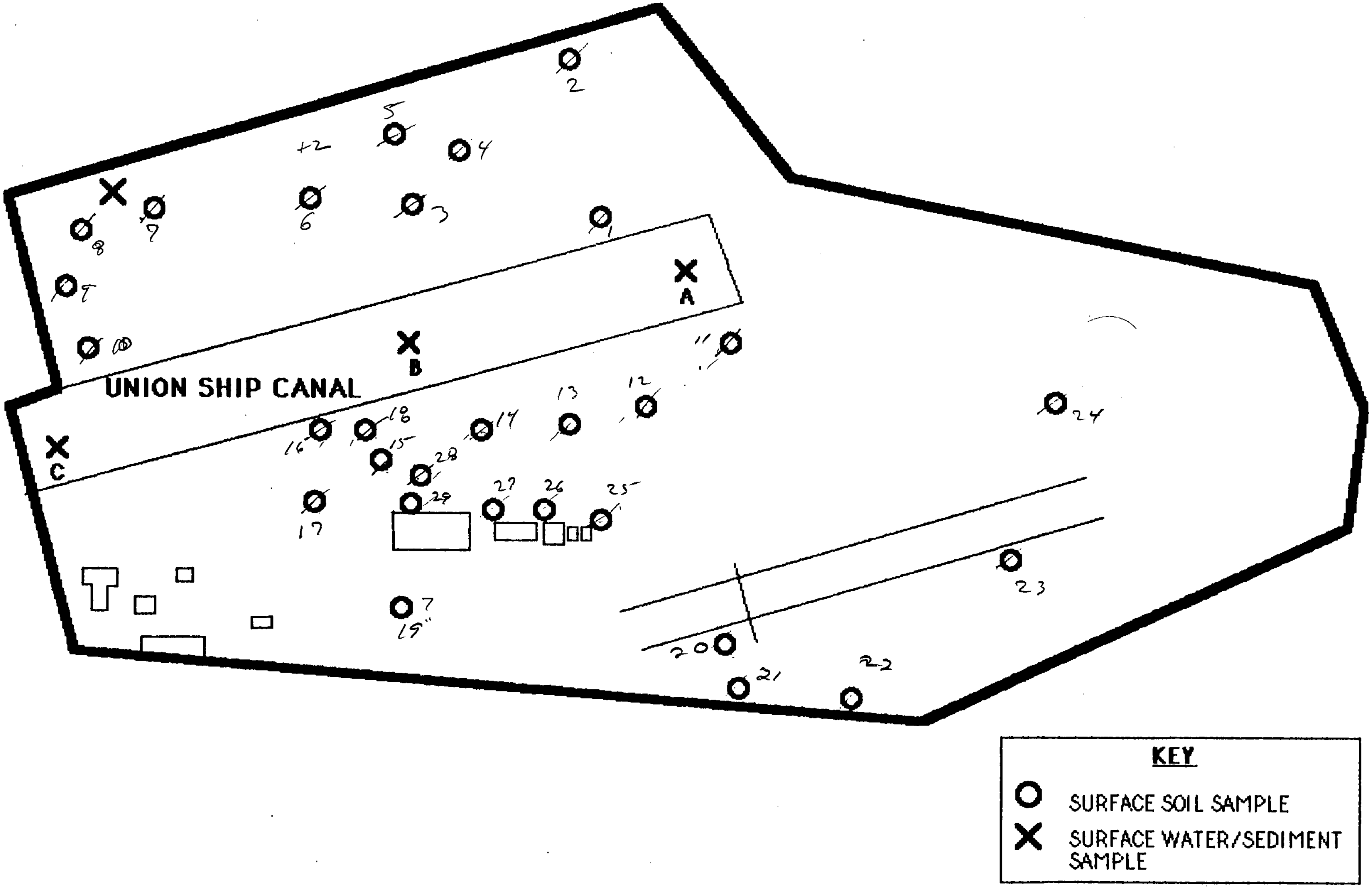
The sampling protocol for this investigation consisted of sampling the surface of the site (between 6" to 18" from the ground surface).

Each sample was analyzed for the parameters identified in the analytical section of this report.

2.4 Surface Water and Sediment Sampling

Pond Sampling

Two samples were collected from a ponded area north of the Union Ship Canal; a surface water and a sediment sample.



SCALE:		
	BY	DATE
DWN.	PCB	8/5/88
CKD.		8/88
APPVD.		8/88
REV.		

NYSDOT
ENVIRONMENTAL ASSESSMENT
OF HANNA FURNACE SITE

SITE SAMPLING LOCATIONS

PROJECT NO: 7C745

A

FIGURE 2-1

Canal Sampling

Three sets of surface water and sediment samples were obtained from the Union Ship Canal. The canal was divided into three distinct traverses designated A, B, and C (Figure 2-1). Traverse A was located approximately ten feet from the east end (closed end) of the canal. Traverse B was located at the approximate center of the canal and Traverse C was located at the entrance of the canal (west end). Prior to sample collection, field measurements were obtained from three depths at each traverse. This was done to determine any variations in pH, conductivity, or temperature. The data obtained from these measurements revealed no significant variations between the surface, mid-point, and bottom readings, therefore, a surface sample was obtained at each traverse. Surface water samples were collected using a bomb sampler connected to a 1/4" nylon rope. Prior to sampling each point, the bomb sampler was thoroughly rinsed with deionized water. Following surface water collection, a sediment sample was obtained at the midpoint of each transect using a Ponar dredge.

2.5 Borings and Monitoring Well Installation

2.5.1 Drilling Methods for Test Borings

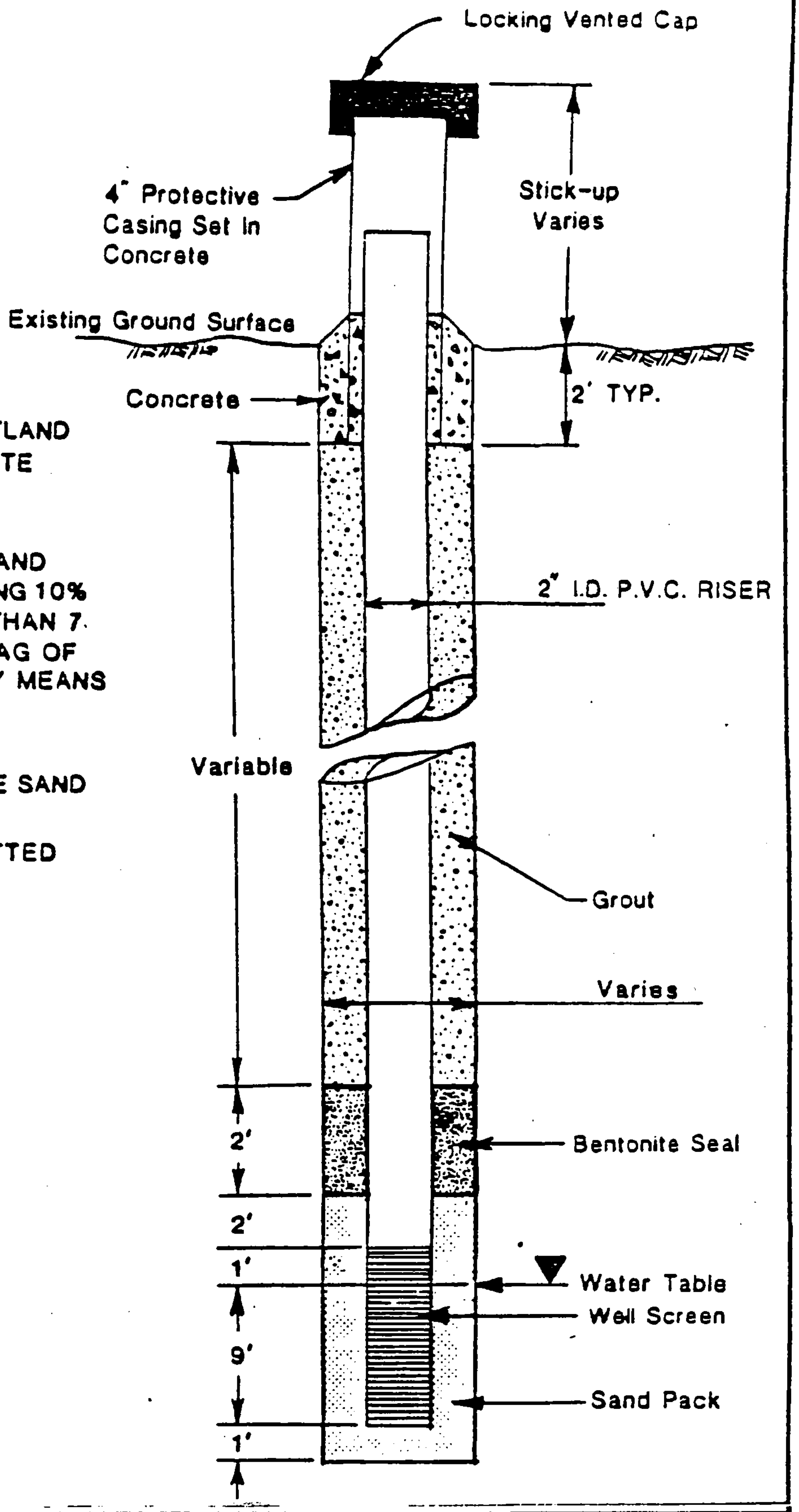
Recra, with its subcontractor GZA, and the NYSDEC jointly selected the boring/monitoring well locations which are presented on Figure 2-3. These locations were described in the Recra work plan/proposal and approved by NYSDEC. The geotechnical supervision of on-site operations and well construction was conducted by GZA. Recra retained Buffalo

Drilling Company, Inc. to drill the seven test borings and install overburden monitoring wells in the borings. Buffalo Drilling collected split spoon soil samples (ASTM D1586) continuously in each test boring. The monitoring wells were constructed of two-inch inside diameter (I.D.) flush joint PVC casing and screens. The screened section of the seven groundwater monitoring wells were sealed in the on-site fill materials (Figure 2-2).

The borings were advanced using a 4¼" inside diameter (I.D.) hollow stem auger (HSA) and a truck-mounted Diedrich-50 drilling rig. Prior to the drilling activities and between each test boring, the drill rig, augers, rods, split spoons, appurtenant equipment, as well as monitoring well risers/screens, were steam cleaned in the designated on-site cleaning area. All water used during drilling and steam cleaning was obtained from a potable water supply off-site.

Soil samples were collected continuously during standard penetration tests which were accomplished in general compliance with ASTM D-1586. The soil samples collected were described according to the Burmiester System and stratigraphic logs were prepared. These logs are presented in Appendix A and include the installation diagrams for the monitoring wells.

To confirm the soil descriptions, seven of the split spoon samples were analyzed for grain size (sieve and hydrometer, ASTM D422-63). GZA and Recra jointly selected one sample from each boring for these analyses. The grain size test results are included in Appendix B.



NOTES:

(1) CONCRETE: SAND AND PORTLAND CEMENT MIXTURE OR SAKRETE PREPACKED MIX

(2) GROUT: MIXTURE OF PORTLAND CEMENT AND BENTONITE USING 10% BENTONITE AND NO MORE THAN 7 GALLONS OF WATER PER BAG OF CEMENT. GROUT PLACED BY MEANS OF TREMIE GROUTING.

(3) SAND PACK: NO. 4 QUARTZITE SAND

(4) WELL SCREEN: 2" I.D. SLOTTED P.V.C. (0.01" SLOT)

SCALE:	NTS	
	BY	DATE
DWN.	PCB	8/5/88
CKD.		[illegible]
APPVD.		8/88
REV.		

NYSDOT
ENVIRONMENTAL
ASSESSMENT
OF HANNA FURNACE SITE

PROJECT NO. 7C745

TYPICAL
OVERBURDEN/BEDROCK
INTERFACE
MONITORING WELL

A FIGURE 2-2

All pertinent information obtained during the advancement of each test boring was recorded in a bound field notebook and has been transcribed into subsurface boring logs which are presented in Appendix A of this report. Data from the test borings were used to design the final monitoring well plan. Based upon the physical characteristics of the soil as determined from the borings and the in situ field measurements for permeability, the site specific geology and hydrology was determined and an estimate of the potentiometric surface was prepared.

Four soil borings (HF-2, HF-4, HF-5, HF-7) were advanced to the top of rock while the remaining three borings (HF-1, HF-3, HF-6) were advanced to completion within the lacustrine clay unit (located at varying depths above bedrock). Split spoon samples were collected from the saturated and unsaturated zones within each boring and two borings (HF-2, HF-7) were sampled continuously to the top of rock. ~~Borings HF-4 and HF-5 were sampled continuously to the top of rock.~~ Borings HF-4 and HF-5 were sampled continuously until the lacustrine clay unit was encountered and then sampled every five feet until completion in the top of rock. Borings HF-1, HF-3 and HF-6 were continuously sampled into the lacustrine clay unit where they were terminated.

2.5.2 Well Installation

Upon completion of each test boring, monitoring wells were installed and designated MW1 through MW7. The wells were constructed of number 10 slot (.010) (0.~~00~~1 inch opening), 2 inch I.D., threaded flush-joint Schedule 40 PVC screen and riser casings. Installation included a washed and graded number 4 sand pack surrounding the entire length of screen. A two-foot thick bentonite pellet seal was placed above the sand pack. The sand pack and bentonite pellets were installed through the augers using a vertical discharge tremie pipe, filling the annular space between the well and the borehole wall as the augers were slowly removed. The remaining annulus was backfilled to ground surface with a cement/bentonite grout. A four-inch diameter carbon steel protective casing with a vented locking cap was then placed over the well and cemented in place. The cement surface seal was mounded to promote drainage away from the well. A typical overburden monitoring well construction diagram is presented as Figure 2-2. The as-built diagrams for each of the wells installed during this study are included on the boring logs presented in Appendix A.

2.6 Well Development and Groundwater Sampling

2.6.1 Well Development

Each monitoring well was developed prior to sampling using a peristaltic pump (supplemented by bailing) with new 3/8" polyethylene tubing, dedicated 1 1/4" x 5' PVC bailers, and 1/4" braided nylon rope.

An ISCO 1520 peristaltic pump was utilized for the majority of water evacuation and sediment (fines) removal.

To insure that the wells were being developed properly, a bailer was periodically raised and lowered into the water column, keeping the fine sediment fraction in suspension and ensuring the movement of groundwater through the screened interval of the monitoring well. After this flushing action, the pump was used to remove the silt-ladened water. Development criteria concerning static water level, pH, conductivity, temperature, and turbidity (visual clarity) is presented in Appendix C.

Development was performed at each well until stabilization of pH, specific conductance, temperature and water clarity were established. The volume of water removed during this process was never less than three times the original standing water volume.

2.6.2 Well Purging

The well was unlocked carefully to avoid having any foreign materials enter the well. When required, the interior and exterior riser pipe was wiped with filter paper and deionized water.

An electronic water level indicator or a weighted steel chrome clad tape (the first few feet of which was cleaned prior to each use with liquinox soap and deionized water) was used to measure the depth to water from the top of casing. Following this measurement the well was sounded to obtain a bottom measurement. Using well installation data, the volume of water within the well was computed. The volume of standing water in each well was calculated using the formula: $r^2h/231$; where r = well radius in inches, h = height of water from well bottom in inches, and 231 = volumetric constant. Field personnel were supplied with tables such as that presented in Appendix C, Table 6. These tables will allow instant volume determination from the wells in question. Table 6 is specific to wells with a 2 inch radius.

An ISCO peristaltic pump was used to remove three times the well volume as measured into a calibrated pail. A well volume is defined as the volume of water standing inside the casing measured prior to evacuation.

During the evacuation at the well, the intake opening of the pump tubing was positioned just below the surface of the well water. If the water level dropped, the tubing was lowered as needed to maintain flow. Pumping from the top of water column insured proper flushing of the well.

2.6.3 Field Testing

Following sample collection on site, field measurements of pH, specific conductance and temperature were taken in accordance with protocol presented in the Methods of Chemical Analysis of Water and Wastes (EPA-600/4-79-020).

Thermometers used for temperature measurements were calibrated weekly using a NBS traceable or certified thermometer.

pH was measured using an Extech 601 digital pH meter. The meter was standardized using a pH 7 buffer and then calibrated with a pH 10 buffer once a day assuming an alkaline pH of groundwater. When acidic conditions were indicated, the meter was standardized using a pH 7 buffer and then calibrated with a pH 4 buffer. The buffer solutions were sealed and stored out of direct sunlight when not being used. Conductivity was measured using a Hydac Model #301353 combination digital, conductance, temperature, and pH meter. The meter was calibrated daily in the field using a standardized 1413 unit potassium chloride solution.

2.6.4 Groundwater Sampling/Bottle Preparation

After well purging, well samples were collected with pre-cleaned, dedicated 1¼" x 5' PVC bailers. Samples were placed in pre-cleaned bottles. Sample containers were constructed of a material compatible and non-reactive with the material it contained.

Sample containers were pre-cleaned prior to sampling as follows:

- o Plastic Bottles
  - soap washed
  - tap water rinsed
  - acid washed
  - deionized water rinsed
- o Glass Bottles
  - acetone rinsed
  - soap washed
  - tap water rinsed
  - acid washed
  - deionized water rinsed
  - pesticide quality acetone rinsed
  - deionized water rinsed 3 or 4 times

Volatile organic sample vials are not solvent washed. Vials used for volatile organic analysis were detergent washed, rinsed, and dried at 105°C for one hour prior to use. Additionally, sodium thiosulfate was added to each vial. Vials were stored and maintained in a solvent vapor-free area.

Each sample bottle was labelled with the following information:

- o Sample I.D. (i.e., MW-1)
- o Project Identification
- o Date
- o Sampler's Initials

Samples were kept on ice in coolers for transport to the laboratory at the conclusion of each day's field sampling activities.

2.6.5 Permeability Testing

Permeability tests of the newly installed monitoring wells were conducted on March 17 and 18, 1988. (Appendix C, Table 8). Initial static water level measurements were made in each well followed by the injection of a weighted slug of known specific volume. An instantaneous head displacement associated with this volume was created and the subsequent decline in water level was measured using a slope electronic water level indicator and engineer's rule. Upon head condition stabilization, the slug was removed from the well resulting in a negative head condition. The subsequent rise in water level was measured using an electronic water level indicator and engineer's rule. Data analysis involved the determination of the coefficient of permeability. The analysis utilized a technique provided by Harry R. Cedergren in Seepage, Drainage, and Flow Nets, 2nd Edition, whereby the natural log of the head ratio (dependent variable) was plotted with respect to elapsed time (independent variable). Data points for the permeability determination were obtained from a linearation of this plot and used in an appropriate equation. Permeability values for each well are presented in Appendix C, Table 5.

Range
(1.07×10^{-3} to 6.6×10^{-5})

2.6.6 Surveying

At the conclusion of the well installation program, a survey was conducted by Klette Land Surveyors of Niagara Falls, New York. The survey was undertaken on two separate days, April 5 and 11, 1988. The objective of the surveying activities was to obtain ground surface and top of casing elevation for each of the monitoring wells, locate the azimuth position and distance between the wells and plot these values on a general site map. The elevation survey values and a map illustrating the relative position of the monitoring wells are found in Figure 2-3 (in pocket).

Recra measured water levels at the seven groundwater monitoring wells on April 5, 1988 (see Appendix C). These water level measurements were made on the same day that Klettke measured surface water levels in the Union Ship Canal.

Elevations were established using standard acceptable surveying techniques. A United States Geological Survey (USGS) benchmark or other pre-existing benchmark was not available on site. Therefore, the determined elevations are relative to a previously established survey mark located on the west end of the office building at the entrance to the site. Horizontal control (i.e., azimuth location) of the monitoring wells was established by survey measurements taken from permanent site features.

3.0 GEOLOGY

This section presents a discussion of the physiographic setting and stratigraphy at the Hanna Furnace site. Groundwater elevation data for the test boring/monitoring wells discussed in this section are presented on Table 3-1. Goldberg-Zoino Associates (GZA) compiled this data using the Recra-generated boring logs and survey measurements made by Klettke Surveyors.

3.1 Physiographic Setting

The site is located on the physiographic region designated the Lake Erie Plain. This plain is approximately 6 to 12 miles wide and extends from the Onondaga Escarpment (northern border) to northern Chautauqua County (southern border). During the Pleistocene Period, this plain was covered by continental glaciers and glacial lakes which tended to generally flatten the area of the site.

3.2 Stratigraphy

Test boring data suggest that the overburden at the site consists of miscellaneous fills and glacially deposed natural soil. The fills were found in all seven test borings and extend from the ground surface to depths of between 4 and 13 feet. The fills observed consist primarily of plant waste (i.e. fly ash, cinders, etc.), fine to coarse sand and brown silty clay. Underlying the fills a black-brown organic clayey silt and a gray-brown clayey to silty clay (lacustrine clay) were observed overlying a black shale. A sand and/or gravel layer was also encountered in some of the test borings immediately overlying the black shale.

TABLE 3-1

SUMMARY OF HANNA FURNACE SITE GROUNDWATER MONITORING WELL ELEVATIONS

Monitoring Well #s	Top of Protective Casing Elevation (ft., SD)	Ground Surface Elevation (ft., SD)	Depth of Boring (ft., BGS)	Well Screen Elevation (ft., SD)	Sand Pack Elevations (ft., SD)
HF-1	586.5	582.6	15.5	577.1-572.1	579.1-572.1
HF-2	586.0	582.9	36.5	579.9-574.9	580.4-574.4
HF-3	587.7	583.9	14.0	578.9-573.9	580.9-573.4
HF-4	588.8	585.5	39.0	582.5-577.5	583.5-576.0
HF-5	584.0	581.0	34.0	576.0-571.0	578.0-570.5
HF-6	584.8	581.4	12.0	576.4-571.4	578.4-570.9
HF-7	584.4	581.2	48.0	577.2-572.2	578.2-571.7

NOTES:

1. These data have been compiled based upon survey data obtained by Klettke Land Surveyors on April 5, 1988.
2. All elevations shown are referenced to site.
3. SD - Site Datum
4. BGS - Below Ground Surface

Test boring data interpolated to develop geologic cross sections A-A', B-B' and C-C' presented on Figures 3-1 and 3-2 show the general stratigraphy of the overburden at the site. The overburden is comprised of the following sequence beginning at ground surface.

Fill - These soils were encountered in all seven test borings ranging in thickness from approximately four feet (MW-5) to eight feet (MW-2). Generally, these soils consist of fine to coarse brown sands, with varying amounts of gravel, silt and plant waste. These soils may have been deposited by the Hanna Furnace Company to fill low lying areas of the site.

Grain size analyses of the fill samples collected from zero to two feet in MW-1, MW-3 and MW-5 indicate that a minor percentage (less than 17 percent by weight) of this material is silt and clay. The majority of these soils are composed of sand and gravel. The sand and gravel fraction makes this fill conducive to groundwater flow.

Silty-Clay - Generally, these soils consist of brown, silty clay, with varying amounts of sand and gravel. The silty clay appears to be thickest on the eastern portion of the site (eight feet at MW-4) and appears to thin to the west of MW-2 and MW-5 (2.0 feet at MW-2 and 3.0 feet at MW-3). Because these soils were encountered above the organic clayey silt (i.e. remnants of former wetland area), these soils are suspected to be fill material.

Organic Clayey Silt - The organic clayey silt unit appears to be part of the wetlands that once covered the majority of the site. This unit consists of stiff, black to brown, organic clayey silt with varying amounts of fine to coarse sand and gravel. This unit is the uppermost natural soil encountered below ground surface. Based on the test boring data, the organic clayey silt layer appears to be thickest in the central portion of the site (MW-6) and thins laterally to the east and west. No measurable amounts of this material were encountered in MW-4 which is located in the southeastern portion of the site.

Grain size analyses of the organic clayey silt samples collected from MW-2 and MW-6 indicate that about 50 percent by weight of this material is silt and clay. Due to the stiffness and grain size of this unit, it does not appear to be conducive to groundwater flow.

Lacustrine Clay - The lacustrine clay unit was deposited when the Lake Erie Plain was occupied by glacial Lake Warren (approximately 11,000 to 12,000 years ago). This unit appears to underly the entire site. Test boring data suggest that this unit's thickness ranges from 10 feet (MW-7) to 21 feet (MW-4) and consists of medium to stiff, gray to brown silty clay to clayey silt.

Grain size analyses of lacustrine clay samples collected from MW-4 and MW-7 indicate that the composition of this material is primarily silt and clay. Due to the stiffness and composition of this unit, it appears that is is not conducive to groundwater flow.

Sand and Gravel Unit - This unit was only encountered in borings MW-2 and MW-4 and was found between the lacustrine clay and bedrock. It is very dense, fine to coarse sand and/or gravel and ranges in thickness from two (MW-2) to five feet (MW-4). The high density of this material indicates that it is probably glacial till.

Although sand and gravel deposits are generally good water transducers, the high density of tills restricts groundwater flow by limiting available pore space. Thus, it appears that this unit is not conducive to groundwater flow.

Bedrock-Levanna Shale - The bedrock underlying the site is a Middle Devonian shale (deposited approximately 375 million years ago), reportedly to be the Levanna Shale Formation (see Reference 3). This black sedimentary rock is fissile (easily broken along cleavage plains) and generally easily augered. This latter condition is evidenced by the fact that the augers were able to advance beyond the point where shale was first encountered in MW-7. During drilling at this location, shale fragments were collected in the split spoon sampler between 22 and 48 feet below ground surface. The shale retained by the split spoon sampler was layered with thin seams of silty clay.

4.0 GROUNDWATER

This section discusses groundwater flow in the on-site fill materials. Groundwater flow in the remaining geologic formations at the site was not studied and, thus, is not addressed herein.

4.1 Groundwater Conditions

Groundwater at the site was encountered in the fill materials at a depth of about five feet from ground surface. This water bearing zone is considered to be unconfined. Hence, this horizon is called the upper unconfined water bearing zone. This zone appears to be separated from the lower sand and gravel and bedrock formations by the lacustrine clay unit which appears to be continuous across the site, although additional data are required for confirmation.

A potentiometric surface contour map representing the groundwater conditions in this upper unconfined zone is presented as Figure 4-1. This map has been prepared utilizing linear interpolation methods between monitoring wells, the water level in the Union Ship Canal and an interpretation of site geology. The contour map is based upon groundwater and surface water level measurements made on April 5, 1988 which are included in Appendix C, Table 1. As indicated on Figure 4-1, the groundwater flow direction for this date in the upper unconfined zone was generally towards the Union Ship Canal from the north, south and east.

The hydraulic gradient at the site could only be computed for the areas between the monitoring wells and the Union Ship Canal (see Figure 2-3). The hydraulic gradient on the south side of the canal ranged from 0.013 to 0.026. The hydraulic gradient on the north side of the canal was slightly higher and ranged from 0.023 to 0.046. The monitoring wells are closer to the canal on the north side. Thus, the higher hydraulic gradient on the north side of the canal may indicate that the gradient increases in a direction toward the canal.

The hydraulic conductivities for the upper unconfined zone ranged from 1.6×10^{-5} centimeters per second (cm/sec, MW-3) to 2.5×10^{-3} cm/sec (MW-7). Permeability across the site did not appear to follow any spacial distribution pattern that would indicate that one area of the site was more permeable than another. The porosity of this zone was estimated to be 0.35. Horizontal flow rates for the upper unconfined zone were calculated using the Darcian equation and the following information:

Hydraulic Conductivity = 1.6×10^{-5} cm/sec to 2.5×10^{-3} cm/sec
Hydraulic Gradient = 0.013 to 0.046
Estimated Average Porosity = 0.35

Based upon these values, estimated flow rates between the monitoring wells and the canal are expected to range between 0.0017 and 0.93 feet per day.

4.2 Union Ship Canal

It was observed that the Union Ship Canal walls had numerous cracks and open seams in the concrete dock face. Groundwater was observed flowing through the timber cribbing into the eastern end of the canal where the surface water level was below the top of the cribbing. Based upon the above conditions, it appears that the canal walls are pervious. However, the permeability of the canal walls could not be estimated with the available data.

It appears that groundwater flow at the site is influenced by water levels in the canal, because the canal walls are pervious. On April 5, 1988, water levels in the canal were lower than nearby groundwater levels. Therefore, the canal was behaving as a sink. However, the water levels in the Union Ship Canal likely fluctuate with the levels of Lake Erie. Thus, seasonal as well as daily variations in groundwater levels, flow directions, gradients and velocities at the site may occur. Additional studies, such as the use of continuous water level recorders in the monitoring wells and the canal, would be required to monitor the effects of the canal water level fluctuations on the site groundwater conditions.

5.0 DISCUSSION OF ANALYSES

5.1 Introduction

Accompanying normal pig iron manufacturing and related industrial activities, specific types of materials and their wastestreams were commonly found in contact with the soils on-site. Such areas of visual discoloration or possible spillage that are commonly associated with product storage or material transfer were the focus of much of the sample collection for this investigation. Selection of analytical parameters were based on previous knowledge of the area and its industries as well as prior investigations of adjacent facilities, and from a knowledge of contaminants commonly found at such sites and specific wastestreams possibly present at the site.

The parameters in Table 5-1 were deemed appropriate to evaluate the pertinent areas of the site for related chemical contamination. This parameters list serves as the baseline or "indicator parameter list" to which the majority of samples were subjected during laboratory analysis. The overall sampling and analytical program is presented in Table 5-2.

5.2 Analytical Methodology

All the samples representing soils, sediments and aqueous matrices were analyzed using specific methodologies in accordance with USEPA protocol set forth in "Methods for Chemical Analysis of Water and Wastes" EPA-600/4-79-020, March 1979 (Revised December 1982). Results of the analytical program can be found in Appendix D.

TABLE 5-1

INDICATOR PARAMETER LIST

- pH (water only)
- Conductivity (water only)
- Total Recoverable Phenolics
- Total Cyanide
- Oil and Grease
- Ammonia
- Arsenic, Total
- Chromium, Total
- Copper, Total
- Lead, Total
- Volatile Organic Scan
- Halogenated Organic Scan
- Polychlorinated Biphenyls
- Asbestos (water only)
- EP Toxicity (metals only)/select samples

TABLE 5-2

SAMPLING AND ANALYSIS PROGRAM

SAMPLES	I.D. NUMBER	SUMMARY TABLE(S)	ANALYTICAL JOB NUMBER
Twenty-nine (29) surface soil samples for indicator parameters	1-29	5-3,5-4	88-1797 88-1797A
Four (4) sediment samples; three (3) from canal bottom and one (1) from pond for indicator parameters	A, B, C SS-1	5-5	88-408 88-408B 88-504 88-504A
Four (4) surface water samples; three (3) from canal and one (1) from pond for indicator parameters	A (1-3) B (1-3) C (1-3) P-3	5-6	88-408 88-408B 88-504 88-504A
Three (3) canal waters for total asbestos content			
Seven (7) subsurface soil samples from borings (saturated zone) for indicator parameters	HF-1/SB-3 HF-2/SB-4 HF-3/SB-6 HF-4/SB-5 HF-5/SB-5 HF-6/SB-4 HF-7/SB-9	5-5	88-123 88-123 A-D
Seven (7) subsurface soil samples from borings (unsaturated zone) for indicator parameters	HF-1/SB-2 HF-2/SB-2 HF-3/SB-2 HF-4/SB-2 HF-5/SB-3 HF-6/SB-3 HF-7/SB-2	5-5	88-123 88-123 A-D
One (1) composite soil sample from saturated zone/boring and one (1) composite soil sample from unsaturated zone/boring for HSL	Sat. Comp. Unsat. Comp.		88-123 88-123 A-D
Seven (7) grain-size analyses on select subsurface soil samples			

TABLE 5-2
(continued)

SAMPLING AND ANALYSIS PROGRAM

SAMPLES	I.D. NUMBER	SUMMARY TABLE(S)	ANALYTICAL JOB NUMBER
Seven (7) groundwater samples from monitoring wells for indicator parameters	MW1	5-6	
	MW2		88-384
	MW4		88-384A
	MW3		88-398
	MW5		88-398A
	MW6		
	MW7		
Seven (7) groundwater samples from monitoring wells for HSL	MW1		88-384
	MW2		88-384A
	MW4		
	MW3		88-398
	MW5		88-398A
	MW6		
	MW7		
Three (3) composite surface soil samples for EP Toxicity (metals only) to consist of:			
One (1) North of canal (LF) - Samples 3, 4, 5, 6, 7, 8, 9,	Comp 1		
One (1) oil shack area - Samples 25, 26, 27, 29	Comp 2		88-51
One (1) south of canal (random) - Samples 11. 12, 13, 14, 15, 16, 17, 28	Comp 3		
One (1) canal sediment	Canal Comp		88-438
One (1) subsurface boring saturated zone	HF-1/SB-3		88-123
	HF-2/SB-4		88-123 A-D
	HF-3/SB-6		
	HF-4/SB-5		
	HF-5/SB-5		
	HF-6/SB-4		
	HF-7/SB-9		
One (1) subsurface boring saturated zone	HF-1/SB-2		88-123
	HF-2/SB-2		88-123 A-D
	HF-3/SB-2		
	HF-4/SB-2		
	HF-5/SB-3		
	HF-6/SB-3		
	HF-7/SB-2		

TABLE 5-2
(continued)

SAMPLING AND ANALYSIS PROGRAM

SAMPLES	I.D. NUMBER	SUMMARY TABLE(S)	ANALYTICAL JOB NUMBER
Analyzed for EP Tox (Metals)			
Three (3) composite surface soil samples			88-51
(1) north of canal	Comp 1		
(1) oil shack area	Comp 2		
(1) south of canal	Comp 3		
One (1) composite canal sediment	Canal Comp.		88-438
One (1) composite soil sample from boring wells (saturated zone)	Sat. Comp.		88-123 88-123A-D
One (1) composite soil sample from boring wells (unsaturated zone)	Unsat. Comp.		88-123 88-123A-D
Analyzed by Phase Contrast Microscopy for Total Asbestos Fibers			
Grain Size Analysis			

One sample from each of the seven subsurface borings were selected for grain-size analysis using sieve and hydrometer, ASTM D422-63. The grain-size test results are included in Appendix B. A select group of three aqueous samples were analyzed for asbestos content by Transmission Electron Microscopy. Results of these analyses are presented in Appendix E.

The analytical results for soil and sediment samples collected at the site have been summarized in Tables 5-3, 5-4 and 5-5 and those for groundwater and surface waters in Table 5-6. The site map presented in Figure 2-1 shows the locations of the various sampling points.

Only analytical values above the maximum allowable concentration limits (i.e.; groundwater standards), as established by state or federal agencies, are presented in these tables, where appropriate. Analytical values for materials that do not have well defined maximum limits, such as total metals in soil or volatile organics (VO), are included in the appropriate tables, if these values appear noteworthy.

5.3 Environmental Assessment of Existing Site Conditions

5.3.1 Surface Soils

The surface "soils" at the site are predominantly not natural soils. Instead, they appear to be various types of fill material including cinders, ash, slag and debris from the demolition activities carried out on site. One or more heavy metals were found in virtually all of the surface "soils" at concentrations well above those typically found in natural soils such as silty or clayey loams (Table 5-3).

TABLE 5-3

COMPARISON OF EXPECTED HEAVY METAL CONCENTRATIONS FROM NATURALLY OCCURRING SOILS TO METAL CONCENTRATIONS FOUND IN SURFACE SOILS AT THE HANNA FURNACE SITE

SAMPLE I.D.	TOTAL METALS (PPM)			
	ARSENIC	CHROMIUM	COPPER	LEAD
Concentration Range in Naturally Occurring Soils (1) in PPM	5-10	15-100	20-50	8-30
Concentration Range in Soils Located in Industrial Area (2) in PPM	No Data	8-30	7-40	20-290
1	7.5	14	27	52
2	5.9	18	25	39
3	12	25	80	230
4	9.1	58	190	490
5	11	47	120	260
6	7.3	60	220	400
7	5.6	19	27	950
8	13	70	260	2,600
9	9.8	75	250	6,020
10	10	16	36	180
11	11	8.7	79	110
12	6.0	11	79	96
13	22	64	180	500
14	9.1	40	420	1,100
15	12	390	190	370
16	9.0	170	410	2,300
17	14	94	360	650
18	2.1	7.1	15	44
19	9.4	29	89	370
20	14	110	170	3,300
21	32	4,700	640	260
22	23	310	23	21
23	20	32	310	300
24	31	22	440	590
25	31	22	2,200	890
26	27	46	2,600	1,800
27	34	100	1,100	6,500
28	38	58	740	410
29	23	120	640	830

(1) Overcash, M.R., and Pal, D., (1979); Design of Land Treatment Systems for Industrial Wastes-Theory and Practice, Table 3.15, p. 107-108.

(2) EPA (1985), Preliminary Evaluation of Chemical Migration to Groundwater and the Niagara River from Selected Waste Disposal Sites, Table 13, p. 40, EPA-905/4-85-001.

TABLE 5-4

SUMMARY OF ORGANIC CONTENTS FOR SURFACE SOIL SAMPLES

SAMPLE I.D.	POLYCHLORINATED BIPHENYLS (AROCLOR) (PPM)	OIL & GREASE (PPM)	AMMONIA (PPM)
1	ND	340	52
2	ND	400	68
3	ND	900	62
4	0.23 (1260)	670	42
5	≤0.05 (1260)	640	48
6	0.070 (1254)	590	47
7	≤0.05 (1260)	540	ND
8	0.53 (1254)	21,000	21
	<0.05 (1260)		
9	0.17 (1254)	2,000	19
10	≤0.05 (1260)	380	53
11	ND	520	27
12	ND	320	43
13	ND	610	61
14	≤0.05 (1260)	2,100	64
15	0.39 (1242)	440	60
	1.0 (1242)		
16	0.43 (1254)	3,900	ND
17	≤0.05 (1242)	860	ND
18	≤0.05 (1242)	520	ND
19	ND	81,000	53
20	1.3 (1254)	3,400	90
21	0.37 (1242)	6,000	ND
22	ND	4,200	ND
	0.15 (1242)		
23	0.074 (1260)	1,700	110
24	0.35 (1254)	1,400	43
25	ND	156,000	59
26	ND	271,000	78
27	ND	22,500	94
28	≤0.05 (1260)	3,900	93
29	0.56 (1260)	33,000	25

ND - Indicates Constituents Were Not Detected

TABLE 5-5

COMPARISON OF EXPECTED HEAVY METAL CONCENTRATIONS FROM NATURALLY OCCURRING SOILS TO METAL CONCENTRATIONS FOUND IN SUBSURFACE (BORINGS) SOILS AT THE HANNA FURNACE SITE

SAMPLE I.D.	SOURCE	TOTAL METALS (PPM)			
		ARSENIC	CHROMIUM	COPPER	LEAD
Concentration Range in Naturally Occurring Soils (1) in PPM		5-10	15-100	20-50	8-30
Concentration Range in Soils Located in Industrial Area (2) in PPM		No Data	8-30	7-40	20-290
HF-1/SB-2	Unsaturated Zone	23	8.5	9.9	24
HF-2/SB-2	Unsaturated Zone	25	8.7	66	25
HF-3/SB-2	Unsaturated Zone	1.8	11	11	16
HF-4/SB-2	Unsaturated Zone	11	4.2	17	22
HF-5/SB-3	Unsaturated Zone	7.4	26	32	17
HF-6/SB-3	Unsaturated Zone	9.3	46	34	100
HF-7/SB-2	Unsaturated Zone	7.6	40	53	30
HF-1/SB-3	Saturated Zone	22	11	15	29
HF-2/SB-4	Saturated Zone	13	14	11	260
HF-3/SB-6	Saturated Zone	6.9	17	17	14
HF-4/SB-5	Saturated Zone	11	23	28	19
HF-5/SB-5	Saturated Zone	4.3	9.7	13	ND
HF-6/SB-4	Saturated Zone	14	10	29	33
HF-7/SB-9	Saturated Zone	1.5	4.9	ND	3.9
A	Canal	22	79	200	980
B	Canal	33	77	170	1,440
C	Canal	25	80	130	650
SS-1	Pond	11	29	74	130

(1) Overcash, M.R., and Pal, D., (1979); Design of Land Treatment Systems for Industrial Wastes-Theory and Practice, Table 3.15, p. 107-108.

(2) EPA (1985), Preliminary Evaluation of Chemical Migration to Groundwater and the Niagara River from Selected Waste Disposal Sites, Table 13, p. 40, EPA-905/4-85-001.

ND - Indicates Constituents Were Not Detected

TABLE 5-6

COMPARISON OF ANALYTICAL RESULTS OBTAINED FROM GROUNDWATER, SURFACE WATER AND POND WATER FROM HANNA FURNACE SITE TO NEW YORK STATE GROUNDWATER STANDARDS

Parameter	New York State Groundwater Standard (PPM)	New York State Effluent Standards or Discharge Limits to Groundwater (PPM)	MONITORING WELL						CANAL		POND
			MW-1	MW-2	MW-4	MW-5	MW-6	MW-7	A(1-3)	C(1-3)	P-3
PCBs (Aroclor)	0.001	0.001			≤0.1 (1242)	≤0.1 (1242) ≤0.1 (1260)		≤0.1 (1260)	≤0.1 (1260)	≤0.1 (1260)	1.3 (1248) 0.85 (1254)
Total Metals											
Arsenic	0.025	0.05	0.10		0.13						
Chromium	0.05	0.10	0.059		0.14						
Lead	0.025	0.05	0.12		0.35			0.05			
Total Recoverable Phenolics	0.001	0.002				0.02		0.013			
Total Cyanide	0.20	0.40	0.40		0.36		0.49				
pH	6.5-8.5	6.5-8.5	9.56	8.95	8.93						

LEAD

Lead concentrations ranged from 5 to 200 times the concentrations typical of natural soils. Copper was elevated relative to natural soils in 80% of the samples, most of which ranged from 5 to 10 times the natural levels with a few samples as much as 50 times those levels. Chromium was elevated in less than 20% of the samples and was very high in only one sample. Arsenic was marginally higher than natural soil concentrations in about half the samples, but never at more than four times typical natural soil concentrations.

Three composites of the surface soil samples were tested for the characteristic hazardous waste property of EP Toxicity. One composite consisted of samples from north of the Union Ship Canal, another from samples south of the canal, and the third of samples from the "oil shack area". None of the extracts exceeded the maximum allowable concentrations for any of the EP Toxicity metals. Lead was present in the extracts from all three composites and reached two thirds of the maximum allowable concentration in the extract of the composite from around the "oil shack area". While none of these composites exhibited the characteristic of EP Toxicity, there is a substantial possibility that individual samples or other areas of elevated concentrations, particularly from around the "oil shack", could exhibit the characteristic of EP Toxicity and be classified as hazardous wastes, if tested separately. In addition to its regulatory significance, the EP Toxicity results indicate that a small fraction of the lead present in the samples is leachable. Since lead is present at substantially greater than natural levels in almost every surface sample collected at the site, the surface "soils" could represent a substantial source of lead available for mobilization to ground and surface waters. This circumstance takes on added significance in light of a recent EPA proposal to reduce the maximum lead concentration permissible in drinking water from 50 to 5 parts per billion. (.005 ppm The maximum contaminant level allowed in EP Toxicity extracts has generally been set at 100 times the drinking water standard may portent a comparable reduction in the EP Toxicity criteria which would substantially increase the likelihood of some of the surface "soils" being classified as hazardous wastes.

PCBs were detected in a third to a half of the surface "soil" samples but the highest concentration detected was 1.3 ppm which is well below the concentration at which the need for clean up begins to be considered. PCBs do not appear to be a major concern at the site (Table 5-4).

Volatile organic substances were only detected at a high concentration in one sample from near the "oil shack", however, oil and grease exceeded 1,000 ppm in half the surface soil samples and was as high as 16% and 27% in two samples from the "oil shack" area (Table 5-4). The material identified as "oil and grease" include any substances soluble in freon which would include any lipophilic materials. The frequent occurrence of elevated levels of oil and grease probably reflects the long industrial history of the site and sloppy or careless material handling practices.

Phenols were detected in only 4 out of 29 samples, all of which were in the very low part per million range. Such concentrations in soils do not pose a serious concern. The key question for phenols at this site are the concentrations that may be present in ground or surface waters.

Ammonia was present in a majority of the surface "soils" at several times typical natural soil concentrations. Again, these soil concentrations are not a particular concern since the key question for ammonia, like phenol, is the concentrations in ground and surface waters. Certain cold water fish, including the salmonids, are quite sensitive to ammonia depending on the temperature and pH of the water.

Cyanide was also detected in most of the surface "soil" samples. Most of the samples had low part per million concentrations, however, two samples exceeded 250 ppm total cyanide. If the cyanide in these two samples proved to be "available cyanide" the samples could be classified as hazardous waste for exhibiting the characteristic of reactivity. The degree of concern posed by the cyanide found in the majority of the samples depends heavily on the chemical form of the cyanide present. Simple cyanide salts can be readily converted to hydrogen cyanide (HCN), which is the toxic form of cyanide; whereas, a number of the complex cyanides are not readily converted to HCN and are much less toxic. The readily converted cyanides are the ones considered to be "available cyanides." Available cyanides can be quite toxic to humans, wildlife and fish that may come in contact with them. Cyanides can be adsorbed by inhalation and ingestion and through the skin to some degree. The total cyanide concentrations found in the soils should be viewed with some concern but the appropriate degree of concern depends on the identity of the chemical species present.

5.3.2 Subsurface Soils

On the whole, the subsurface soil samples exhibited much less contamination than the surface soils. Out of 14 samples analyzed, only two had lead concentrations substantially higher than typically found in natural soils, three had slightly elevated arsenic concentrations, one had a very slightly elevated copper concentration, and none had abnormally high chromium concentrations (Table 5-5).

Two composite samples of soils from the subsurface, one each from the unsaturated and saturated zones, were tested for EP toxicity for metals. Very low levels of arsenic, barium, chromium and lead were found in the extracts, however the concentrations never exceeded one fiftieth (1/50) of the maximum allowable extract concentrations. It is very unlikely, therefore, that any of the subsurface soils would be classified as hazardous wastes for exhibiting the hazardous characteristic of EP toxicity. The lead concentrations in these extracts indicates that a small amount of the lead present in these samples is leachable but the subsurface soils appear to be of much less concern as a possible source of lead available to migrate to groundwater than do the surface soils.

PCBs and phenols were not detected in the subsurface soil samples and volatile and halogenated organics were not detected at levels that would be any cause for concern. Oil and grease was somewhat elevated in two samples but not to the degree evidenced in the surface soils.

Ammonia was elevated relative to typical natural soils in all of the samples and was substantially elevated in 4 of the 14 samples. As discussed above, the main concern with these results would be if the ammonia migrated to surface waters where it could have an adverse effect on sensitive fish populations.

Cyanide was detected in half of the subsurface soil samples but only one sample approached the concentration at which the soil might exhibit the hazardous characteristic of reactivity. Again, the degree of concern posed by the cyanide will depend on the chemical species present and the ability of the cyanide to migrate to surface waters or to be transported in groundwater.

Composites of the saturated and unsaturated zone subsurface samples were analyzed for volatile and semi-volatile Hazardous Substance List/Target Compounds List constituents. Acetone was detected at about 50 ppm and methylene chloride was found in the unsaturated zone composite at 2.5 ppm. In addition, a number of aromatic and polynuclear aromatic hydrocarbons were detected just at the detection limit. Acetone was used to clean the split spoon sampler between samples; therefore, a residue left on the sampling device maybe the source of the acetone. Methylene chloride is a common industrial and laboratory contaminant and the traces of aromatic and polynuclear aromatic hydrocarbons are consistent with the coking and iron and steel manufacturing activities conducted in the area. None of the organic substances at the concentrations detected in the subsurface soils pose any particular health threat or environmental impairment.

5.3.3 Sediments

Laboratory analyses were conducted on sediment samples from the bottom of the Union Ship Canal and an on-site pond. Generally, the sediment samples were very similar in concentration to the surface soil samples. Arsenic values in natural soils range from 5-10 ppm, whereas, sediments in the canal were slightly over twice this high (Table 5-5). The only pond sediment analyzed was close to the upper range for naturally occurring soils. Chromium values from the sediments never exceeded those values for natural soil concentrations. Copper was elevated relative to natural soils in 100% of the samples, most of which ranged from one to two times the natural levels. Lead values were significantly elevated relative to soils in a natural setting, most of which ranged from 4 to 48 times those values.

The three canal sediments were composited and were tested for the characteristic hazardous waste property of EP toxicity. None of the extracts exceeded the maximum allowable concentrations for any of the EP toxicity metals. Lead was present in the extract at approximately one-fourth the EPA maximum allowable concentration. Arsenic, barium and cadmium were also detected but at significantly lesser concentrations. While none of the extractions produced metals at concentrations that could be deemed a hazardous substance, if EPA changed the maximum contaminant level allowed in drinking water for lead, the canal sediments may require additional characterization.

PCBs were detected in all sediment samples but at concentrations well below SARA cleanup standards. The highest concentration found was 0.47 ppm.

Volatile organics (VOS) were found in very low concentrations in all sediments. Oil and grease exceeded 1,000 ppm in all canal sediments with average values of approximately 2%. Although the pond sediment was elevated with respect to oil and grease, its concentration was lower than most surface and subsurface soil samples.

Phenols were found in two of the canal sediments at low concentrations. No phenols were detected in the pond samples.

Ammonia was found in two of the canal sediments at very low concentrations. Cyanide was also detected in all of the samples but at low ppm concentrations. Even if this cyanide was "available" its concentration would still not generally be considered hazardous.

5.3.4 Surface Waters

The surface waters analyzed in this study consisted of samples taken from the Union Ship Canal and an on-site pond. Of the indicator parameters used in this investigation, only polychlorinated biphenyls (PCBs) exceeded New York State groundwater standards. Although present in three surface water samples, their concentrations were close to the detection limit (Table 5-6). Additional sampling and analysis would be required to confirm their presence.

No heavy metals were found in contravention of either NYS surface water or groundwater groundwater standards. Only chromium and copper were detected but at very low concentrations. Volatile organics and halogenated organics were observed but again at very low concentrations.

Three surface water samples from the Union Ship Canal were analyzed for total fibrous asbestos. The analysis was conducted by Transmission Electron Microscopy (TEM) using JEOL 100 SX with Tracor Northern Energy Dispersive X-Ray Spectrometry at a magnification of 10,000 X. A modification of the Jaffe protocol was utilized for the sample preparation. Twenty grid squares were counted for each analysis. Results of these analyses are presented in Appendix D along with the corresponding photomicrographs.

A total of ten milliliters of surface water was analyzed from each of the samples. The minimum detectable limit for the observations ranged from 5.4×10^5 to 5.7×10^5 fibers per liter. Asbestos fibers were observed in concentrations ranging from 5.4×10^5 to 1.08×10^6 fibers per liter. The type of asbestos present was chrysotile [$Mg_3Si_2O_5(OH)_4$] which is a mineral of the serpentine group. Even at the highest concentration of asbestos observed in this study of 1.08×10^6 it is substantially less than the EPA's Recommended Maximum Clearance Level of 7.1×10^6 which is the level commonly used to trigger remedial action.

5.3.5 Groundwaters

Laboratory analyses were conducted on groundwater samples from the newly installed monitoring wells. The samples were analyzed for the indicator parameters as well as the Hazardous Substance List (HSL) organics. When comparing the results of the indicator parameters for the groundwater to the New York State Groundwater Standards, the groundwaters are found in contravention of those standards for seven (7) of the parameters analyzed (Table 5-6).

PCBs were found in three (3) of the groundwaters collected from monitoring wells (MW-4, MW-5 and MW-7). Although in all three (3) wells their concentrations were very close to the detection limit, their presence is noteworthy. Additional sampling and analysis, however, would be required to confirm their presence.

Three total metals were found to exceed state groundwater standards; arsenic, chromium and lead. Arsenic was found in two wells at levels four and five times the state standards. Chromium also exceeded the state standards in two wells with a maximum concentration of over twice the acceptable level. Lead appears to be the primary source of concern for groundwater at the site. Three groundwaters had lead values of 2, 5 and 14 times the standard concentration limit. It should be noted that arsenic, chromium and lead were also found in elevated concentrations in many of the surface soils on-site and are believed to be the principal contributor to these groundwater values. Total recoverable phenolics were found elevated in two groundwater samples and in one sample, exceeding state groundwater standards by 20 times.

Total cyanide was observed in three groundwater samples at approximately twice the maximum allowable concentrations. This was not surprising due to the presence of cyanide in a majority of the surface soils analyzed. Due to the high mineralized state of the groundwater on-site, the species of cyanide is thought to be metal cyanide complexes and subsequently of little or no environmental significance.

The total pH, (hydrogen ion concentration) of groundwater also exceeds state standards having a range of values from the three wells of 8.95 to 9.56.

6.0 RISK ASSESSMENT

The environmental and health risk assessments developed for the site identified potential hazards to human health and the environment. These assessments were based upon on evaluation of the analytical test results collected during the study. The potential hazards as identified in these assessments are summarized below:

- Surface soils containing oil and grease, heavy metals (i.e.; arsenic, chromium, copper and lead), ammonia and cyanide.
- Groundwater exceeding the class GA groundwater standards for arsenic, chromium, lead, cyanide, phenols and pH.
- Sediments in the bottom of the Union Ship Canal containing oil and grease, heavy metals, ammonia and cyanide.

Concentrations of heavy metals in on-site soils were found to be elevated throughout the areas sampled. When subjected to EP Toxicity tests, these soils did not demonstrate characteristics of being hazardous. Even though heavy metals are abundant, their availability to receptors is limited. A common problem with elevated heavy metal concentrations in soil is inhalation of respirable dust. The Hanna Furnace site is presently undergoing demolition of site structures but conditions noted during various site visits did not demonstrate unusually dusty conditions. Some areas of the site had elevated concentrations of oil and grease. These areas were commonly observed around and adjacent to the oil shack building and maintenance area. The present on-site workers are subjected to these areas during normal working hours. Assuming that their involvement at the site will be of limited duration, the risk posed to their health and safety is believed to be minimal. There is, therefore, minor risk associated with direct contact or inhalation of surface soils to humans or wildlife. The potential exception to this could be cyanide, depending on the species present.

In some specific instances, groundwater was identified as exceeding drinking water standards. The following shows the class GA standards and the test data for samples collected at the site.

Monitoring Well	Parameter Analyzed	Class GA Standard (mg/l)	Measured Concentrations (mg/l)
MW-4	Arsenic	0.025	0.13
MW-1	Chromium	0.05	0.059
MW-4	Lead	0.025	0.35
MW-6	Cyanide	0.2	0.49
MW-5	Phenols	0.001	0.02
MW-1	pH	6.5-8.5	9.6

The potential risk associated with these concentrations is believed to be minimal in that the groundwater is not presently being used as a drinking water source. The major risk therefore is via discharge to the Union Ship Canal or to the outer harbor area. The heavy metal concentrations could be accumulated by fish and move up the food chain to humans, birds and other fish. The phenols, free or available cyanide and possibly ammonia could be directly toxic to fish but would not generally be concentrated and passed on. The Buffalo Water Intake is located approximately 1½ to 2 miles from the Hanna Furnace site which is far enough out in the lake so that water from the site is unlikely to be taken into the water lines in concentrations of any significance. Other potable water intakes are located along the Niagara River but similarly are far enough removed from the site to be of little concern.

The sediments at the bottom of the Union Ship Canal were not identified as being hazardous. Elevated levels of oil and grease, heavy metals, ammonia and cyanide were observed but were not in sufficient concentration to pose a risk to humans or aquatic life.

A commonly recognized method of initially identifying potential risk a site may pose to human health and the environment is by preparing a Hazardous Ranking System (HRS) score for the site.

As part of the present environmental assessment, a review of the NYSDEC Phase I HRS score was conducted. This was done in order to rescore the site based on updated information. Emphasis was placed on gathering information where data inadequacies were present in the Phase I. Based upon data acquired during the course of the present investigation, the following is a revised HRS score for the site.

SM = 12.28 (S_{gw} = 6.12 S_{sw} = 20.36 S_a = 0)
SFE = 0
SDC = 50.0

Original HRS scores generated during the Phase I investigation:

SM = 8.73 (S_{gw} = 4.08 S_{sw} = 14.55 S_a = 0)
SFE = 0
SDC = 50.0

The work sheets and select documentation records used to generate the revised HRS score are provided in Appendix H.

The factors causing the changes in scoring are primarily those dealing with potential migration of contaminants from the site, especially those related to groundwater. Although the migration score has changed, it remains well below the guidance value used for nomination onto the NPL (HRS score of 28.5 or greater).

7.0 PRELIMINARY ENGINEERING ASSESSMENT OF REMEDIAL ALTERNATIVES

This preliminary engineering assessment provides opinions with regard to feasible remedial measures and their effectiveness in remediating the environmental hazards that may exist at the site based on the data furnished in this study. These data are described in Sections 5.0 and 6.0. An order-of-magnitude cost estimate is presented for each feasible remedial measure and alternative. The identification (screening) of remedial measures and subsequent evaluation of remedial alternatives is based upon data collected during this study and the environmental and health risk assessments. It should be recognized that the available data base is limited to the information collected to date (Appendix G). Should additional data be collected, it is possible that the remedial measures presented may change.

7.1 Screening of Remedial Technologies

7.1.1 Screening of General Remedial Technologies

As an initial step, various categories of general remedial technologies were screened and identified that would be potentially applicable to the site. Table 7-1 presents a listing of the general remedial technologies as presented in the United States Environmental Protection Agency (USEPA) Handbook, "Remedial Action at Waste Disposal Sites, October 1985" (EPA Handbook) and opinions as to which general technologies are applicable to the potential hazards at the site. Based upon this initial screening process, leachate and groundwater controls, off-site disposal of wastes and soils, contaminated sediment removal and containment, in-situ treat-

TABLE 7-1

IDENTIFICATION OF GENERAL REMEDIAL TECHNOLOGIES

General Remedial Technology	Applicable	Not Applicable	Remarks
Surface Water Controls		X	Surface water not identified as a potential hazard
Air Pollution Controls		X	Air pollution not identified as a potential hazard
Leachate and Groundwater Controls	X		Applicable to potentially contaminated groundwater
Gas Migration Controls		X	Gas migration not identified as a potential hazard
On-site and Off-Site Disposal of Wastes & Soil	X		Applicable to potentially contaminated surface soil
Contaminated Sediments Removal and Containment	X		Applicable to potentially contiminated sediment
In-situ Treatment	X		Applicable to potentially contaminated surface soil
Direct Waste Treatment	X		Applicable to potentially contaminated soil and canal sediment
Contaminated Water Supply and Sewer Line Controls		X	Groundwater not used as water supply. Sewer lines not identified as a potential hazard

NOTE: The above categories represent USEPA groupings of general remedial technologies as presented in the USEPA handbook "Remedial Action at Waste Disposal Sites", October 1985.

ment, and direct waste treatment are general remedial technologies that could be applied to at least one of the potential hazards identified at the site.

7.1.2 Screening of Potentially Feasible Remedial Technologies

The potentially feasible remedial measures which are within general technologies identified in the previous section were reviewed and screened. Table 7-2 presents these potentially feasible measures and opinions as to which measures are technically feasible for the site. The identification of the technically feasible measures were based on the following three criteria as presented in the EPA Handbook:

(1) Site Characteristics - Site data were reviewed to identify conditions that may limit or promote the use of certain remedial measures.

(2) Waste Characteristics - The characteristics of the site contaminants were reviewed to identify properties that may limit or promote the use of certain remedial measures.

(3) Technology Limitations - The level of technology development, performance record, inherent construction, operation and maintenance problems were reviewed for each remedial measure.

Cost was not considered as a criteria for evaluating the technical feasibility of a remedial measure.

TABLE 7-2

SCREENING OF POTENTIALLY FEASIBLE REMEDIAL MEASURES

Potentially Feasible Remedial Measures	Feasible	Not Feasible	Remarks
LEACHATE AND GROUNDWATER CONTROLS			
Groundwater Pumping	X		
Subsurface Collection Drains	X		
Subsurface Barriers	X		
Capping	X		
ON-SITE AND OFF-SITE DISPOSAL OF WASTES			
Excavation and Removal	X		
Off-site Landfilling	X		
On-site Landfilling		X	Site does not meet RCRA requirements under 40 CFR Part 264. Majority of the site is within the 100 year flood plain.
CONTAMINATED SEDIMENTS REMOVAL AND CONTAINMENT			
Sediment Removal	X		
In-situ Control and Containment	X		
IN-SITU TREATMENT			
Bioreclamation		X	Bioreclamation is most effective in treating organic contaminants found at low levels at the site
Chemical Treatment	X		
Physical In-situ Methods		X	Physical in-situ methods are in the early development stage and are not proven technologies

TABLE 7-2
(continued)

SCREENING OF POTENTIALLY FEASIBLE REMEDIAL MEASURES

Potentially Feasible Remedial Measures	Feasible	Not Feasible	Remarks
DIRECT WASTE TREATMENT			
Aqueous Waste Treatment	X		
Solid Treatment	X		
Solidification/Stabilization	X		
Gaseous Waste Treatment		X	Gaseous waste was not encountered at the site
Thermal Destruction	X		

NOTE: The above categories represent USEPA groupings of general remedial technologies as presented in the USEPA handbook "Remedial Action at Waste Disposal Sites", October 1985.

The following sections provide a general description of the remedial measures that met the above criteria. Additionally, these sections describe the general applicability of each remedial measure at the site.

It should be noted that discharging of on-site groundwater into a POTW was investigated but was not included as a remedial option. The concentration of contaminants in the groundwater is below the maximum acceptable values for the local POTW, although the volume of groundwater that would need to be treated daily is estimated to be 21,600 gallons. It is believed that this volume of water could not be efficiently managed by a POTW (i.e.; Buffalo Sewer Authority) for extended periods of time.

7.1.2.1 Leachate and Groundwater Controls

Groundwater Pumping - Groundwater pumping involves the active manipulation and management of groundwater to contain, remove or prevent the formation of a contaminant plume. There are several types of wells and pumping configurations used in the management of contaminated groundwater. Thus, a detailed investigation of the sites hydrogeologic properties is required prior to development of a groundwater pumping system. The major limitations of groundwater pumping are the high operation and maintenance costs. Additionally, groundwater pumping usually requires on-site treatment and long-term monitoring of the system.

Groundwater contamination does not appear to be isolated to one particular area of the site. Thus, containment or removal of a specific contaminant plume does not appear feasible. However, groundwater pumping is a feasible measure if it is used to intercept migration of contaminants flowing towards the canal if such material warranted remedial action. Additionally, groundwater pumping could be utilized to redirect groundwater flow to a direction away from the canal.

Subsurface Collection Drains - Subsurface drains include various types of buried conduit used to convey and collect aqueous discharges by gravity flow. Subsurface drains function similarly to an infinite line of extraction wells and are used to direct groundwater flow towards a collection sump for subsequent pumping and treatment. The most common use of subsurface drains at waste sites is to intercept a plume at a location downgradient of the source. Subsurface drains are generally limited to shallow depths due to the high costs associated with trench excavations (i.e.; temporary shoring, construction dewatering, etc.). The groundwater collected by subsurface drainage usually requires on-site pumping and treatment. Long-term monitoring of the system is also required for this remedial measure.

The contravention of groundwater standards at the site appears to be the results of several potential sources located throughout the site. Thus, source isolation with subsurface drains does not appear feasible based on limited data available. However, due to the direction of groundwater flow towards the canal, a subsurface drain system installed around the perimeter of the canal could reduce the flow of contaminated groundwater into the canal.

Subsurface Barriers - Subsurface barriers are comprised of low permeability materials installed below the ground surface which are used to contain, capture or redirect groundwater flow. Commonly used subsurface barriers include slurry walls (i.e.; soil-bentonite, cement-bentonite, concrete, etc.), grout curtains and sheet piling cut-offs. Subsurface barriers, particularly soil-bentonite slurry walls, are a relatively inexpensive and effective way to control groundwater. The type of subsurface barrier used must be compatible with the types and concentrations of the contaminants at the site. Thus, compatibility tests and/or literature searches may be required under this remedial measure.

The feasibility of subsurface barriers at the site will depend on the thickness and permeability of the natural clay layer under the site. If this material is found suitable for containment, a subsurface barrier placed around the perimeter of the canal and keyed into the clay could reduce the flow of groundwater into the canal. However, the groundwater contained upgradient of the barrier will likely require pumping and treatment to prevent flooding and overtopping of the barrier. Thus, a subsurface barrier would likely be used at the site in combination with a pumping or drainage system. Long-term groundwater monitoring would still be required.

Capping - Capping involves the covering of buried waste materials to prevent human contact with the land surface and to reduce water percolation to the waste. Cap design usually conforms to Resource Conservation and Recovery Act (RCRA) landfill closure requirements. Under RCRA guidelines, caps are to be a three-layered system consisting of an upper-vegetative layer, underlain by a drainage layer over a low permeability layer. The cap functions by diverting infiltrating liquids from the vegetative layer through the drainage layer and away from the waste material. The limitations of capping include the restrictions it places on site development and the limited availability of the capping materials. Additionally, caps usually require long-term maintenance and monitoring programs.

Capping would address the majority of the potential hazards at the site. In addition to preventing direct contact with the surface soils, the cap could potentially reduce the flow of groundwater into the canal.

7.1.2.2 Off-Site Disposal of Wastes

Excavation and Removal - This remedial measure includes various methods and equipment which are used to excavate and remove contaminated soil/waste. Excavation and removal is followed by treatment and/or land disposal. Due to the high cost of excavation and removal, a frequent practice is to remove more contaminated "hot spots" and to use other remedial measures to address less contaminated areas.

Limited analytical test data suggest that contaminated soils are located throughout the site and no isolated contaminated areas exist with possible exception of the oil shack area. Therefore, the majority of the on-site fill material may be required to be excavated for subsequent disposal or treatment. However, if subsequent sampling and testing identify "hot spots" of contaminated soil, the volume of soil requiring excavation and removal may be decreased. Soil sampling, testing and excavation monitoring during construction would probably be required to identify excavation limits.

Off-Site Landfilling - Off-site landfilling supplements other remedial measures (i.e. excavation and removal) and involves the segregation and transport of hazardous material to an off-site containment facility. This technology, in some cases, can eliminate the contamination problem at a site and requires no long-term monitoring. However, off-site landfilling is becoming increasingly difficult and expensive due to increasing regulatory control. Additionally, wastes must be tested for compatibility, segregated and prepared prior to off-site transport.

Off-site landfilling is a technically feasible remedial measure for the site. However, additional studies are required to evaluate the waste transport permitting requirements and the availability of local off-site containment facilities.

7.1.2.3 Contaminated Sediments Removal and Containment

Sediment Removal - Sediment removal (dredging) involves the removal of bottom sediments from the canal and can be accomplished using various mechanical, hydraulic or pneumatic methods. Sediment turbidity controls (i.e. curtain barriers and dredging equipment modifications) must be implemented to control the resuspension of contaminated sediments during dredging. Following excavation, the contaminated dredged sediments are managed using various methods which include dewatering, transporting, treatment and disposal.

Dredging techniques could be applied to the potentially contaminated bottom sediments of the Union Ship Canal. Factors affecting the technical feasibility of this remedial measure at the site will include the availability of the dredge and permitting requirements required under the Clean Water Act and the Rivers and Harbor Act. Suspension of potentially contaminated sediments would also have to be addressed under this remedial measure. The need for sediment turbidity controls and/or dry excavation of the sediment could not be evaluated with available data.

Sampling, testing and excavation monitoring are required during dredging to identify the excavation limits.

In Situ Control and Containment - In situ control and containment measures are intended to reduce dispersion and leaching of a hazardous substance to other areas of the water body. This remedial measure includes retaining berms and dikes, cover materials, surface sealing and/or in situ grouting. Due to limited data regarding this remedial measure, laboratory and pilot scale testing is usually required prior to implementation at a site.

In situ control and containment is a potentially feasible remedial measure for controlling contaminated sediments in the Union Ship Canal, due to the suspected low flow velocities of the canal. Various cover and surface sealing methods are potentially applicable in this environment as a containment measure. Additional field investigations would be required to evaluate the current transport rate of contaminated sediments in the canal, prior to the selection of an effective control measure. Long-term, post construction monitoring is required to evaluate the effectiveness of this remedial measure.

7.1.2.4 In Situ Treatment of Contaminated Fill

Chemical Treatment - Chemical treatment includes a wide range of technologies used to immobilize, mobilize for extraction (soil flushing) or detoxify organic and inorganic contaminants. The majority of chemical treatment approaches involve the mixing of a reagent with contaminated soils. Thus, the feasibility of this technology is influenced by the site geology, groundwater flow and waste characteristics. Additionally, potential chemical reactions of the treatment reagents with the soils and wastes should be considered. Thus, extensive laboratory studies are usually required before implementation.

Chemical treatment of the soil would be limited to the more permeable sand fill areas of the site and would likely include treatment technologies for heavy metals (i.e. precipitation and/or soil flushing). This technology could potentially reduce contaminant levels in the groundwater and soil.

7.1.2.5 Direct Waste Treatment

Aqueous Waste Treatment - Aqueous wastes are generated by several of the remedial measures discussed previously (i.e. groundwater pumping, subsurface drains, etc.). Aqueous waste treatment can be accomplished using one of the following general methods:

- on-site mobile treatment systems;
- on-site construction and operation of treatment systems;
- pretreatment followed by discharge to a municipal sanitary sewer; and
- transport of waste to an off-site treatment plant.

The selection of the most effective method(s) depends on the cleanup technology and the nature and character of the aqueous waste streams generated.

The aqueous waste streams that would be generated by the aforementioned remedial measures (i.e. groundwater pumping, subsurface collection drains, excavation and removal, sediment removal and chemical treatment) could require treatment. Thus, if any of these remedial measures are used at the site, aqueous waste treatment would be a feasible supplemental remedial measure.

Solids Treatment - Solids treatment is generally used to supplement other cleanup technologies. This remedial measure involves the separation of solids from slurries and/or the separation of contaminated soils or slurries according to grain size. Separation of solids from slurries is accomplished by creating a liquid waste stream and a concentrated slurry of solids. These two waste streams can then be treated more efficiently than the original waste material. Separation of soils by grain size is accomplished through a variety of mechanical operations and is done to provide more efficient management of the waste and to isolate specific materials (i.e. clay and organic matter). Isolation of clay and organic matter is done because these materials tend to have higher affinities for some contaminants.

Solids treatment would be applied following excavation and removal of soil-waste material and/or dredging of sediments from the canal. This remedial measure would potentially be used on-site prior to treatment and disposal.

Solidification/Stabilization - Solidification/Stabilization involves the use of solidification reagents which are mixed with the waste to increase the structural integrity and reduce the mobility of the contaminants. This remedial measure is used to improve waste handling, decrease the surface area over which contaminant transfer can occur and limit the toxicity of the waste. A wide range of reagents are available which must be compatible with the environment and waste material to be effective.

A limitation of this remedial measure is that the end product of most solidification/stabilization technologies requires secondary containment. Additionally, solidification/stabilization technologies usually increase the weight and volume of the original material.

Solidification/stabilization could be effective in immobilizing the contaminants in the soil at the site, particularly the heavy metals. Additionally, this remedial measure could be used to solidify waste and dredged sediments prior to off-site transport.

Thermal Destruction (Incineration) - Incineration uses high temperature oxidation under controlled conditions to degrade a substance into less toxic by products. There are numerous types of transportable and non-transportable incinerators which have been developed for various applications. Incineration is most effective in degrading organic contaminants in liquid, gaseous or solid waste streams.

Incineration is a potentially feasible remedial measure for degrading the oil and grease wastes at the site. However, incineration is not considered to be effective in degrading the heavy metals which are prevalent at the site.

7.2 Cost Estimates

7.2.1 Technically Feasible Remedial Measures

Previous sections have discussed and identified technically feasible measures for remediation of the potential hazards at the Hanna Furnace Site. This section provides an order of magnitude cost estimate for these remedial measures. It should be noted that these estimates are based upon very limited data and are, therefore, considerably less reliable than those which would be developed as part of a Remedial Investigation/Feasibility Study (RI/FS). An RI/FS would be required prior to the selection of a remedial action plan for the site, the cost of which has not been included in these estimates.

Table 7-3 presents the cost estimates developed for the various technically feasible remedial measures. The EPA Handbook was consulted in developing the majority of these costs. The 1985 estimates included in this reference were brought up to 1988 costs by assuming a six percent inflation rate. Additionally, the U.S. Army Corps of Engineers (Corps) and various disposal contractors were contacted to verify unit costs presented in the EPA Handbook and to obtain unit costs for remedial measures not in the handbook.

TABLE 7-3

ORDER OF MAGNITUDE COST ESTIMATES FOR FEASIBLE REMEDIAL MEASURES

Remedial Measures	Construction Costs (x $1,000)	Operation and Maintenance Costs (x $1,000/year)
Groundwater Pumping	360	100
Subsurface Collection Drains	680	60
Subsurface Barriers	1,000	0
Capping	13,000	20
EXCAVATION AND REMOVAL		
Option 1: All on-site fill material	120,000	--
Option 2: Upper 3 feet of fill material	26,000	--
Option 3: All fill in oil shack area	15,000	--
OFF-SITE SANITARY LANDFILLING		
Option 1: All on-site fill material	170,000	--
Option 2: Upper 3 feet of fill material	36,000	--
Option 3: All fill in oil shack area	21,000	--
OFF-SITE SECURE LANDFILLING		
Option 1: All on-site fill material	740,000	--
Option 2: Upper 3 feet of fill material	160,000	--
Option 3: All fill in oil shack area	92,000	--

TABLE 7-3
(continued)

ORDER OF MAGNITUDE COST ESTIMATES FOR FEASIBLE REMEDIAL MEASURES

Remedial Measures	Construction Costs (x $1,000)	Operation and Maintenance Costs (x $1,000/year)
Sediment Removal	1,300	--
In-situ Control and Containment	140	--
CHEMICAL TREATMENT		
Option 1: All on-site fill material	1,100,000	--
Option 2: Upper 3 feet of fill material	250,000	--
Option 3: All fill in oil shack area	140,000	--
Aqueous Waste Treatment	160	34
SOLIDS SEPARATION		
Option 1: All on-site fill material	1,200	--
Option 2: Upper 3 feet of fill material	330	--
Option 3: All fill in oil shack area	170	--
SOLIDIFICATION/STABILIZATION		
Option 1: All on-site fill material	180,000	--
Option 2: Upper 3 feet of fill material	38,000	--
Option 3: All fill in oil shack area	22,000	--
THERMAL DESTRUCTION		
Option 1: All on-site fill material	1,300,000	--
Option 2: Upper 3 feet of fill material	280,000	--
Option 3: All fill in oil shack area	166,000	--

The cost estimates include the costs of construction and annual operation and maintenance. Construction costs include the costs of engineering, analytical testing, safety equipment, mobilization/demobilization, contingencies, construction and restoration. However, construction cost estimates do not include the costs associated with administrative and legal tasks. Operation and maintenance costs include long-term monitoring. The major assumptions and unit costs used to develop cost estimates are summarized for each remedial measure in the following sections.

7.2.2 Leachate and Groundwater Controls

Groundwater Pumping - The cost estimate for groundwater pumping assumes that a series of pumping wells would be installed around the perimeter of the Union Ship Canal. It is estimated that between 80 and 90 pumping wells, located around the canal and screened from just below the ground surface to the top of the clay layer, would be required. These wells would be approximately 13 feet deep, approximately 55 feet apart and approximately 35 feet from the canal edge. Each well would be equipped with a submersible pump.

A unit cost could range from approximately $500 to $1,000 per well installation, based upon installation costs of similar wells in the Buffalo area. Similarly, total well installation costs for the wells, including mobilization/demobilization, steam cleaning and all supplies was estimated to be approximately $49,000. A unit cost of approximately $2,800 per submersible pump was estimated based upon unit costs presented in the EPA Handbook. Engineering costs to design the pumping system were estimated to be approximately $30,000.

Operation and maintenance (O&M) costs are relatively high for groundwater pumping systems. A yearly O&M cost of $100,000 was estimated based upon unit costs presented in the EPA Handbook.

Subsurface Collection Drains - The cost estimate for a drainage system at the site assumes that a drainage pipe would be installed around the perimeter of the Union Ship Canal. Based on a limited data base, GZA estimated that approximately 4,800 feet of perforated PVC pipe, surrounded by a filter fabric, would be required. The pipe would be laid into a trench approximately 12 feet deep and 4 feet wide and backfilled with a gravel envelope. Water collected in the drain would flow to two collection basins on the eastern end of the canal for subsequent pumping and treatment.

The following unit costs, which are based upon the EPA Handbook and include all labor and materials, were used in the cost estimate:

Trench Excavation (bucket-ladder trencher)	$ 2.25/yd^3
Dewatering (2-centrifugal pumps)	500/day
Wall Stabilization (sheet piling)	8.30/ft^2
Pipe Installation (6 inch PVC)	4.22/ft
Filter Fabric (polypropylene)	1.73/yd^2
Manholes (20 feet deep, 4 feet diameter)	2,790/each
Backfill (gravel envelope)	12.25/yd^3
(soil backfill)	1.29/yd^3
Submersible Pumps with Accessories	2,800/each

Engineering costs for design of the drainage system were estimated to be approximately $30,000. Operation and maintenance costs were estimated in the EPA Handbook to be approximately $60,000/year.

Subsurface Barrier - The cost estimate for a subsurface barrier at the site assumes that a soil-bentonite slurry wall would be constructed around the perimeter of the Union Ship Canal. The slurry wall would be approximately 15 feet high (through 13 feet of fill plus a 2 foot key into the clay layer) and would be placed approximately 50 feet from the canal walls to provide a working area during construction.

A unit cost of approximately $14 per square foot of slurry wall was estimated based upon unit costs presented in the EPA Handbook. This unit cost includes the associated construction costs of engineering, demobilization/mobilization, safety equipment, etc. The costs for groundwater drainage (either pumping or gravity) are not included in this estimate but included separately above.

Capping - The cost estimate for capping assumes a multi-layer cover system would be constructed over the entire site. The multi-layer cover would meet RCRA guidelines for closure and would consist of 2 feet of topsoil underlain by 1 foot of crusher run stone over a geotextile and an HDPE liner and a 2 foot thick clay liner.

The site would be prepared prior to capping. This site preparation would include clearing, grubbing and grading. A unit cost for site preparation of $0.24 per square foot was estimated, based upon the EPA Handbook.

Following site preparation, the cover system would be constructed. A unit cost of approximately $2.35 per square foot for the cover system was estimated based upon typical closure costs for RCRA landfills in the Buffalo area. This unit cost includes installation and quality control costs.

Revegetation of the site would be done following completion of the cover system. This revegetation would include mulch and hydroseed. A unit cost of $1,310 per acre was estimated for revegetation based upon the EPA Handbook. Operation and maintenance of the cover would include a periodic six month inspection followed by grading and revegetation if required. The cost of operation and maintenance was estimated to be approximately $20,000 per year based upon local maintenance costs for landfill caps.

Off-Site Disposal of Wastes and Soils

Excavation and Removal - The cost estimates for the excavation and removal are based upon three separate clean-up options. Option 1 assumes that all on-site fill material will be excavated to a depth of approximately 14 feet (13 feet of fill plus 1 foot of clay below the fill to capture potentially contaminated soil). Option 2 assumes that the majority of the on-site contamination is at the ground surface and that only the upper 3 feet of soil across the site will be excavated. Option 3 assumes that the approximate 14 acre area in the vicinity of the oil shack (south central portion of site) will require excavation down to a depth of 14 feet. This area was estimated by Recra based upon the location of the surface soil samples which showed elevated levels of oil and grease. All three options assume excavation will be done with a backhoe (3-½ cubic yard capacity) and that the excavated areas will be restored with clean fill, contoured and seeded. On-site transport of materials will be done using an off-road dump truck . It should be noted that additional analytical soil testing is required to evaluate which of the above options is appropriate.

Unit costs of $20 per cubic yard for excavation, $2 per cubic yard for on-site trucking, and $25 per cubic yard for site restoration were obtained from local waste disposal contractors and include the associated construction costs of engineering, safety equipment, mobilization, demobilization, quality control, etc. The cost estimates for this technology assume that the excavated material will have a wet density of approximately 1.7 tons per cubic yard.

Off-Site Landfilling - The costs of off-site landfilling would include transportation of the waste to an off-site containment facility in the Buffalo area and subsequent disposal in a sanitary landfill or secure chemical landfill. The characterization data contained herein indicates that the fill is non-hazardous and would be suitable for disposal in a sanitary landfill. However, this assessment is based on limited data. Costs of secure land burial are presented for comparison. Secure land burial would be required if the fill is later classified as hazardous. Cost estimates were developed for each of the excavation quantities associated with the three excavation and removal options previously discussed and both disposal options.

Units costs of $30 per cubic yard for sanitary landfilling and $250 per cubic yard for secure chemical landfilling were obtained from local waste disposal contractors. Transportation costs from the site to the landfill and back were also estimated by local disposal contractors to be $34 per cubic yard. These unit costs assume that the excavated soil would have a wet density of 1.7 tons per cubic foot.

Contaminated Sediments Removal and Containment

Sediment Removal - The cost estimate for the removal of sediments assumes that approximately 4 feet of sediment would be removed from the bottom of the Union Ship Canal. This estimate of 4 feet was based upon Corps records which indicate that the current depth of sediment in the canal is 3 feet. An additional 1 foot of dredged material was assumed to capture potentially contaminated soils beneath the sediment.

A unit cost of approximately $20 per cubic yard for dredging was estimated based upon the EPA Handbook. Similarly, mobilization and demobilization costs for the dredge were estimated based upon the EPA Handbook to be $40,000. Unit costs for dredging assume that the dredged material would be stockpiled on site for subsequent treatment and/or disposal.

In Situ Control and Containment - The cost estimate for in situ control and containment of the sediments was based upon procedures and unit costs recommended by the Corps. The cost estimate assumes that clean dredged sediment would be excavated from a source near the Union Ship Canal and deposited over the potentially contaminated canal sediments. The thickness of the cover would be approximately 2 feet. Unit costs for this procedure were estimated by the Corps at approximately $3 per cubic yard.

This unit cost includes excavation, transport and deposition of the clean cover material. Mobilization/demobilization costs were estimated to be approximately $40,000 based upon the EPA Handbook.

In Situ Treatment

Chemical Treatment - The cost estimate for chemical treatment assumes that the potentially contaminated soil would be excavated, treated on-site and deposited in its original location. This estimate assumes that soil flushing and/or precipitation treatment methods would be successful in lowering the containment levels in the soil.

A unit cost of $425 per cubic yard was estimated based upon conservative estimates obtained from disposal contractors for a variety of treatment methods. A unit cost of $15 per cubic yard for material handling (i.e. excavation, restoration, etc.) was also estimated based again upon disposal contractor estimates. These unit costs assume the excavated soil would have a wet density of 1.7 tons per cubic yard.

Treatability studies would be done prior to implementation of this technology to provide more accurate estimates of the effectiveness and costs of chemical treatment. The costs of these treatability studies are minimal in comparison with the treatment costs.

Direct Waste Treatment

Aqueous Waste Treatment - The costs of aqueous waste treatment will vary depending upon the primary remedial technology selected. However, this cost estimate assumes that the groundwater currently discharging into the canal through the upper unconfined zone would be intercepted by pumping, drainage and/or subsurface barrier systems for subsequent treatment. This estimate also assumes that a permanent on-site treatment facility would be constructed.

The size and cost of the on-site treatment plan would be based upon the anticipated groundwater discharge toward the canal. It is estimated that the current groundwater discharge rate into the canal is between 10 and 20 gallons per minute. Construction costs for an on-site treatment plant meeting or exceeding this discharge rate were estimated to be $160,000 based upon the EPA Handbook.

Operation and maintenance costs for the treatment plant were estimated based on the EPA Handbook to be $34,000 per year.

Solids Treatment - The cost estimate for solids treatment assumes that a hydraulic classifier would be used to supplement other remedial measures (i.e. excavation and removal, sediment removal, etc.). This estimate also assumes that the hydraulic classifier(s) would be purchased, utilized at the Hanna Furnace site during remediation and disposed or salvaged following remediation. For cost estimation purposes it was assumed that the site remediation would be completed in one construction season (approximately 130 man days).

Costs for one hydraulic classifier were estimated to be $114,000 per unit, based upon the EPA Handbook. The capacity of each unit would be 200 tons per hour. Thus, the number of units required for excavation and removal options 1, 2 and 3 would be 6, 2 and 1, respectively. Operation costs for the classifiers were estimated to be $52,000 per unit per construction season.

Solidification/Stabilization - This cost estimate assumes that solidification/stabilization would follow excavation and removal and would include the mixing of the soil with a backhoe in a temporary on-site lagoon. This estimate also assumes that a compatible reagent would be available to solidify and/or stabilize the potentially contaminated soil.

A unit cost of $68 per cubic yard was estimated, based upon the EPA Handbook. This unit cost does not include excavation or restoration costs. The costs for these remedial measures were developed for each of the three excavation and removal options previously discussed.

Thermal Destruction - The cost estimate for thermal destructions assumes that an on-site incinerator would be used to degrade the potentially contaminated soil. This estimate assumes that no pre-treatment or separation would be required prior to incineration. Additionally, it was assumed that on-site contaminants would be completely destroyed and would not produce any residuals requiring further remediation.

A unit cost of $510 per cubic yard was estimated, based upon incineration costs obtained from waste disposal contractors. This unit cost includes the set-up and operation costs for an on-site incinerator. The total costs for this remedial measure were developed for each of the three excavation removal options previously discussed.

7.3 Summary of Remedial Alternatives

This section includes potential remedial alternatives for the site which are combinations of the various technically feasible remedial measures presented in the previous section. These remedial alternatives represent

GZA's opinion as to which combined remedial measures would be most cost-effective in remediating the hazard potential at the site. Thus, some of the remedial measures that were considered feasible from a technical standpoint were not included in the remedial alternatives, due to their excessive costs. It should be noted that these alternatives are preliminary and have been developed based upon limited data.

Table 7-4 presents an order of magnitude cost estimate for each of the remedial alternatives developed. This table also indicates which remedial measures have been combined in the development of a specific alternative. The remedial alternatives for the site are described as follows:

Alternative 1 - Under this alternative no remedial action other than groundwater monitoring would be taken at the site. The site would be monitored for a specific period to further assess the need for remediation. The implementation of remedial measures will be put off to a future date and there is a possibility that spreading of contaminants would continue until such time when remedial action is implemented.

Alternative 2 - Alternative 2 is the most expensive of the alternatives presented, however, provides a permanent remedial solution for the site. This alternative includes excavation of all of the potentially contaminated soil for subsequent off-site disposal in a sanitary landfill. The excavated area would then be filled-in with clean fill, graded and seeded. Additionally, the canal bottom sediments would be dredged and disposed of in a sanitary landfill. The excavated soil and sediments would be treated prior to off-site transport using hydraulic classifiers.

A major assumption used in developing this alternative was that all excavated/dredged material is suitable for disposal in a sanitary landfill. This assumption was made based upon the site assessment which indicates that the soil samples tested were non-hazardous. Additionally, it has been assumed that all the on-site fill material (upper 14 feet of overburden) is potentially contaminated and would require removal. Further investigations may indicate that only specific areas require remediation.

Alternative 3 - This alternative includes the installation of a cap over the entire site and the covering of the canal sediments with 2 feet of clean dredgings. The cap would comply with RCRA guidelines for a multi-layer system, as previously discussed.

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TABLE 7-4

SUMMARY OF REMEDIAL ALTERNATIVES

Remedial Measures	Construction Costs (x $1,000)	Operation and Maintenance Costs (x $1,000/year)	ALTERNATIVES monitor 1	 Exc., treat, removal 2	 cap 3	 slurry wall, drains, canal sed. cover 4
Groundwater Monitoring (10 years)	0.0	30.0	X			
Subsurface Collection Drains	680	60				X
Subsurface Barrier	1,000	0.0				X
Capping	13,000	20			X	
Excavation and Removal (Option 1)	122,000	0.0		X		
Off-Site Landfilling (Option 1 and Canal Sediment)	200,000	0.0		X		
Sediment Removal	1,300	0.0		X		
In situ Control and Containment	140	0.0			X	X
Aqueous Waste Treatment	160	34				X
Solids Treatment (Option 1 and Canal Sediment)	1,300	0.0		X		

Alternative 3 would address the potential hazards of surface contact at the site and would indirectly reduce groundwater flow into the canal. However, the potentially contaminated soil and sediment would remain on site and the cover system would require yearly maintenance and long-term monitoring. As previously mentioned, capping also placed constraints on future site development.

<u>Alternative 4</u> - This alternative would include the installation of a soil-bentonite slurry wall around the perimeter of the canal and in situ containment of the canal sediments. A subsurface collection drain would be installed on the upgradient side to collect potentially contaminated groundwater. This groundwater would be treated at an on-site water treatment facility. Additionally, the canal sediments would be covered with 2 feet of clean dredgings to prevent resuspension.

Alternative 4 is the least expensive of the alternatives, except for the no-action alternative, and addresses the potential transport of contaminated groundwater and canal sediments off-site. However, this alternative does not provide a permanent solution for the site and includes yearly operation and maintenance costs.

8.0 CONCLUSIONS

The environmental assessment at the site has provided information regarding the geology, groundwater (direction and velocity) conditions and chemical profile of the site. Additionally, the preliminary engineering assessment of remedial alternatives provides information regarding potentially feasible remedial alternatives for the site and the associated costs. Key findings of this investigation are presented below.

A revised HRS score was prepared for the site. The score was elevated slightly in regard to the potential migration pathway as a response primarily to an observed release of substances of concern to groundwater. Overall the revised score was still low enough as not to pose immediate concern to human health and the environment.

The boring data suggest that the overburden at the site consists of miscellaneous fills and naturally deposited soils. The fills were found throughout the site to extend from ground surface to depths of between 4 and 13 feet. Underlying the fills, the typical natural stratigraphy at the site consists of an organic black-brown clayey silt and gray-brown, silty clay to clayey silty (lacustrine clay) over a black shale. A sand and/or gravel layer was also encountered in some of the test borings immediately overlying the black shale.

Fill 4-13'
lacustrine
Till
Shale

The walls of the Union Ship Canal appear pervious to water. Thus, groundwater flow at the site is probably influenced by water levels in the canal which fluctuate with the levels of Lake Erie. Additional studies such as the use of continuous water level recorders in the monitoring wells and the canal would be required to monitor the effects of the canal water level fluctuations on the site groundwater conditions.

Groundwater at the site is typically encountered in the fill materials at a depth of about 5 feet from ground surface. This water bearing zone is considered to be unconfined. This zone appears to be separated from the lower sand and gravel and bedrock formations by a lacustrine clay unit.

A potentiometric surface contour map representing the groundwater conditions in the upper unconfined zone was developed for data collected on April 5, 1988. The site groundwater flow direction for this date in the upper unconfined zone was generally toward the Union Shop Canal from the north, south and east.

The hydraulic gradient and groundwater flow rate at the site could only be estimated for the areas between the monitoring wells and the Union Ship Canal. The hydraulic gradient on the south side of the canal ranged from 0.013 to 0.026. The hydraulic gradient on the north side of the canal was slightly higher and ranged from 0.023 to 0.046. The estimated flow rates between the monitoring wells and the canal were estimated to range between about 0.0017 and 0.93 feet per day.

The soils on-site were found to contain elevated concentrations of several heavy metals when compared to native or naturally occurring soils. This investigation identified these soils as being non-hazardous materials.

Groundwater on-site was found in contravention of New York State Groundwater Standards with respect to a variety of heavy metals, organics and pH. Due to the groundwater not being used for drinking and its proximity to ultimately being discharged into Lake Erie, it does not appear to present a significant threat to human health or the environment.

The preliminary engineering assessment of remedial alternatives presents four potentially feasible alternatives for the site. These alternatives are summarized as follows:

Alternative	Remedial Measures	Construction Costs (x $1,000)	O&M Costs (x $1,000)
1	Groundwater Monitoring	0	30 (yearly)
2	Excavation Sediment Removal Solids Treatment Off-Site Landfilling	324,600	0
3	Capping In Situ Control and Containment of Sediment	13,140	20
4	Subsurface Barrier Subsurface Collection Drains In Situ Control and Containment of Sediment Aqueous Waste Treatment	1,980	40