REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

PHASE I / PHASE II REMEDIAL INVESTIGATION REPORT

Buffalo Outer Harbor Site
City of Buffalo, Erie County, New York
(Site Registry No. 9-15-026)

Dvirka and Bartilucci
Consulting Engineers

December 1995

PHASE I/PHASE II REMEDIAL INVESTIGATION REPORT

BUFFALO OUTER HARBOR SITE
CITY OF BUFFALO
ERIE COUNTY, NEW YORK

(SITE REGISTRY NO. 9-15-026)

PREPARED FOR
NEW YORK STATE DEPARTMENT
OF ENVIRONMENTAL CONSERVATION

BY
DVIRKA AND BARTILUCCI
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SYOSSET, NEW YORK

DECEMBER 1995

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION REPORT

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Section 1

1.0 INTRODUCTION

1.1 Project Objective

As part of New York State's Superfund Program to investigate and remediate hazardous waste sites, the New York State Department of Environmental Conservation (NYSDEC) has issued a Work Assignment to Dvirka and Bartilucci Consulting Engineers of Syosset, New York under its Superfund Standby Contract with the State to undertake a remedial investigation and feasibility study (RI/FS) for the Buffalo Outer Harbor Site located in the City of Buffalo, Erie County, New York. The registry number for this New York State Superfund site is 9-15-026.

The 113-acre Buffalo Outer Harbor is the result of filling activities which occurred over the past 100 years. Fill materials, including incinerator ash, casting sands, blast furnace slag, dredged lake spoils and miscellaneous construction and demolition debris comprising concrete, brick, wood, ash, glass and plastics, have been disposed of at the site. The majority of the site, which was most recently utilized as a transfer station for dry bulk materials such as gypsum, sand, salt, iron pellets, coke and possibly coal, is currently vacant. The only current occupant at the site is the Allen Boat Company which operates a boat yard in the center of the site.

The purpose of the RI/FS is to perform a remedial investigation to determine the nature, extent and source(s) of contamination at the site and the risk to human health and the environment, and to perform a feasibility study which will identify, evaluate and recommend a cost-effective, environmentally sound, long-term remediation plan.

This document, entitled "Phase I/Phase II Remedial Investigation Report for the Buffalo Outer Harbor Site" presents the detailed activities comprising the components of a multi-phased RI/FS prepared in accordance with the federal Comprehensive Emergency Response, Compensation and Liability Act (CERCLA), Superfund Amendments and Reauthorization Act (SARA) and the NYSDEC Superfund Program, including NYSDEC Technical and Administrative Guidance Memoranda, "Guidelines for Remedial Investigation/Feasibility Studies."

The Phase I Remedial Investigation (Phase I RI) involved the analysis of existing information and environmental data in combination with the performance of a targeted field investigation/sampling program. The purpose of this phase was to provide an initial determination regarding the location and characterization of sources of contamination and to begin defining migration pathways, extent of contamination and exposed receptors, as well as to assist in refining the type and location of additional sampling and subsequent investigation, if required.

The purpose of the Phase II Remedial Investigation was to further define the extent of contamination and refine recommendations for remediation.

The overall objectives of this RI/FS include the following:

1. Define the nature and extent of contamination on the site.
2. Define/redefine site boundaries.
3. Characterize groundwater contamination in order to determine if the site is impacting the Buffalo Outer Harbor.
4. Determine and project the migration of contaminants, and current/future potentially impacted areas and receptors.
5. Prepare a qualitative health risk and environmental assessment to determine the need for remedial action at the site.
6. If necessary, develop a remediation plan for the site.

The Phase I/Phase II RI field program for the Buffalo Outer Harbor Site involved construction of soil borings, installation of piezometers and monitoring wells, excavation of test pits, sampling and analysis of surface soil, subsurface soil, groundwater, surface water and surface water sediment, and a wildlife habitat survey.

1.2 Site Location, Ownership and Access

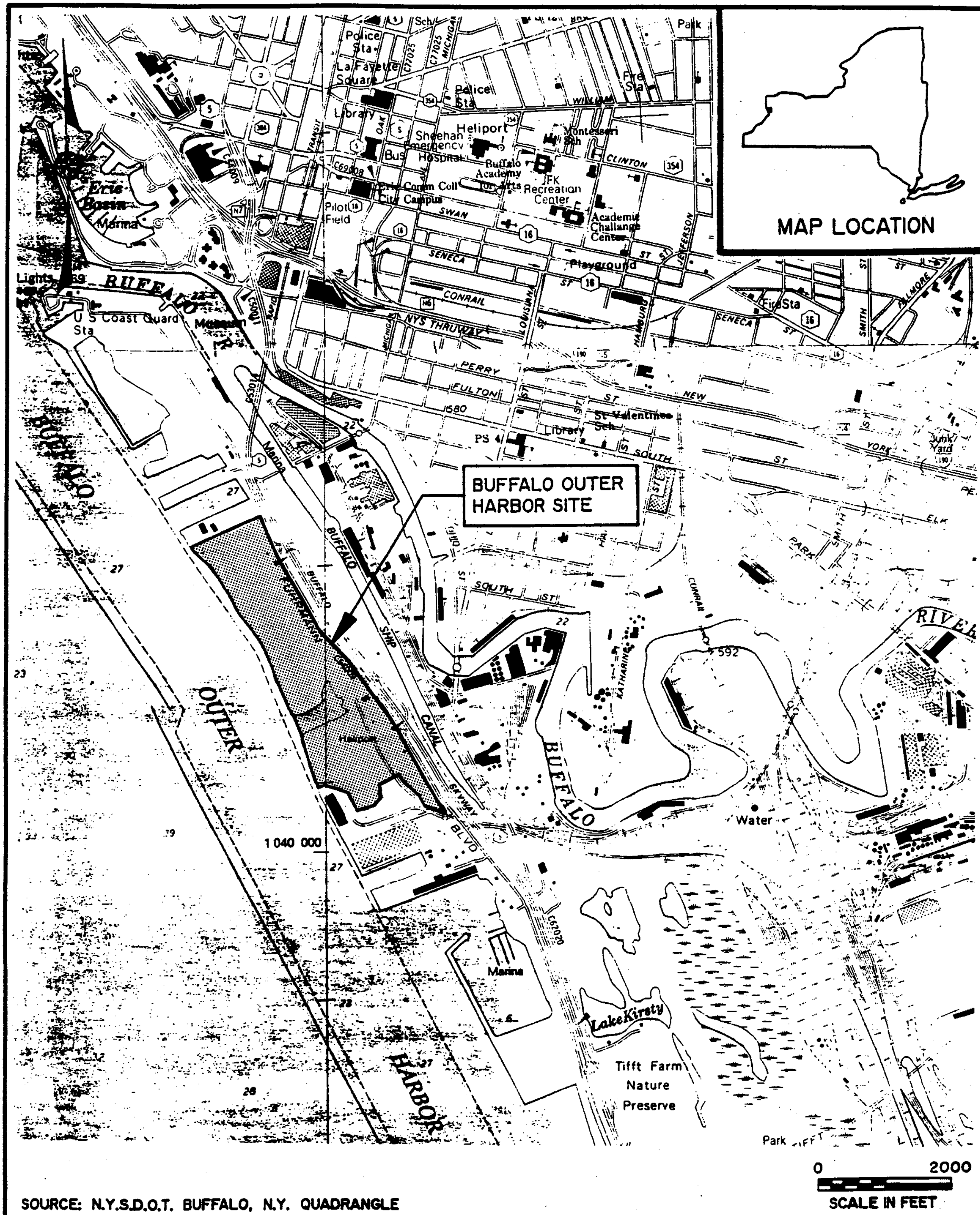
The Buffalo Outer Harbor Site is located in the City of Buffalo in Erie County, New York (see Figure 1-1). The 113-acre site is located approximately 1 mile south of downtown Buffalo, and is bordered to the west by the Buffalo Outer Harbor. The Buffalo Ship Canal and the Buffalo River are located approximately 500 feet and 2,000 feet to the east of the site, respectively.

The site is currently owned by the Niagara Frontier Transportation Authority (NFTA) which acquired the property from the U.S. Army Corps of Engineers in the 1950s. The majority of the site is currently vacant. The Allen Boat Company is located near the center of the site and operates a boat yard adjacent to the Bell Slip (see Figure 1-2). The Bell Slip provides access to the Allen Boat Company from the Buffalo Outer Harbor.

The eastern and southern boundaries of the site are fenced. Access to the site is from Fuhrmann Boulevard. One access road enters the site just north of Allen Boat Company and a second access road is located to the north of the site connecting The Pier restaurant with Fuhrmann Boulevard. The third access road enters the site from south of the Allen Boat Company and passes through a continually operated guard booth used for controlling access to the TOPPS Distribution Center and monitoring TOPPS Distribution Center trucks. TOPPS Distribution Center occupies the entire NFTA Port Terminal A building (except for the NFTA offices) and the entire Port Terminal B building located immediately to the south of the site.

1.2 Site Description

The only existing structures located on-site are two single story buildings, one leased by the Allen Boat Company and the other a small metal building located on the northeastern portion of the site which was previously used as a scale house. The metal building has been used during the past several environmental site investigations primarily for storage of drilling materials and supplies and is accessed by a concrete driveway connecting Fuhrmann Boulevard with the access road leading to the Pier Restaurant.

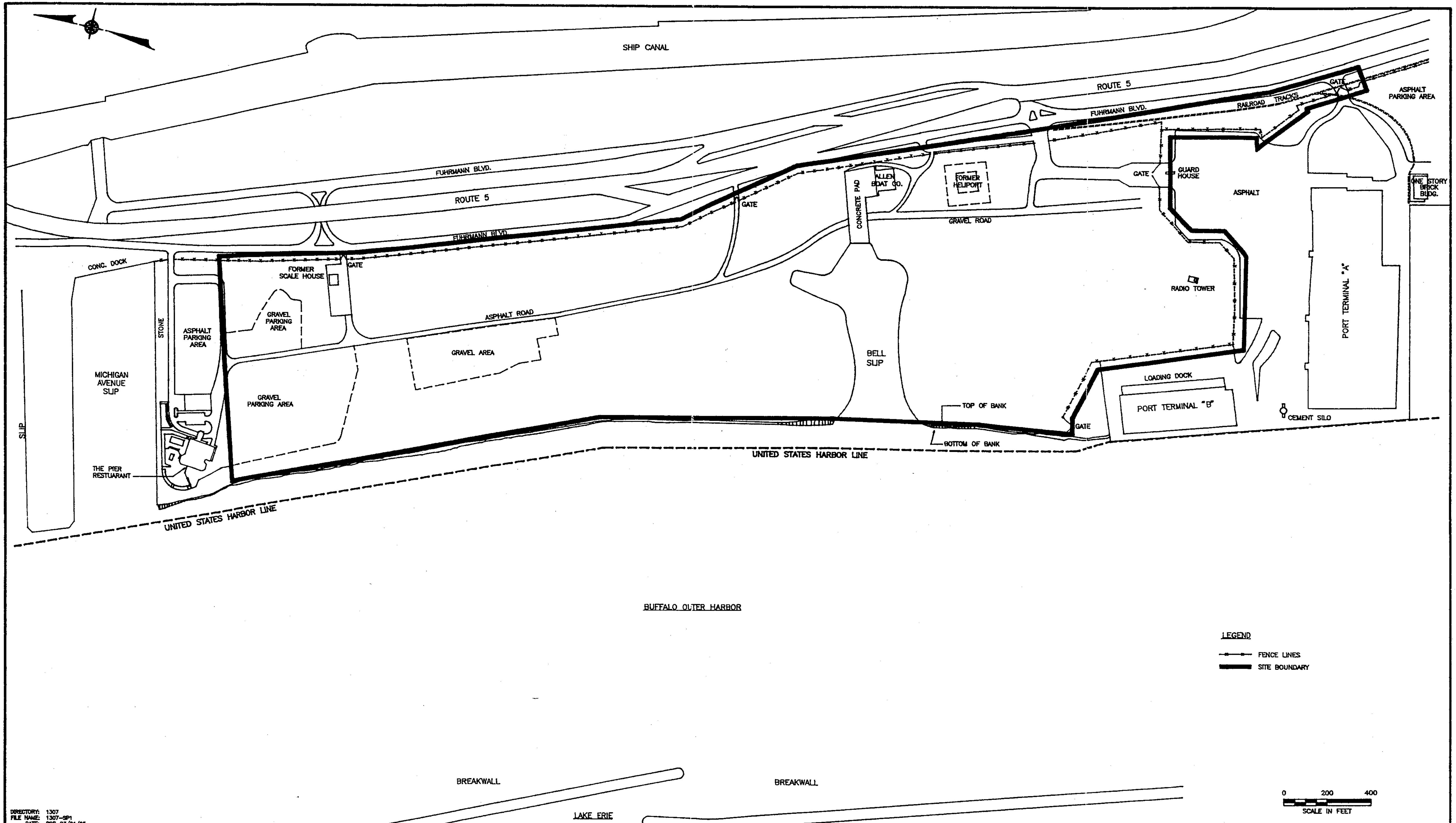


BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

Dvirka and Bartilucci CONSULTING ENGINEERS

SITE LOCATION MAP

FIGURE 1 - 1



DIRECTORY: 1307
FILE NAME: 1307-SP1
DATE: RDS-03/01/95

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CONSULTING ENGINEERS

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

SITE PLAN

PROJECT NO. 1307
DATE MARCH 1995
SCALE 1"=200'

FIGURE 1–2

Several dirt and gravel roads exist throughout the site. The site is almost entirely covered with tall weeds, fragmites and young trees. Several scattered piles of rock and soil can be found in the central and southern portion of the site. The flat grade of the site drops sharply, approximately 10-12 feet, to the shoreline at the Bell Slip and the Outer Harbor. The shoreline at the Bell Slip and Outer Harbor consists of piled construction and demolition debris including large concrete blocks, wood, brick, fire brick, steel reinforcement bar, metal and marble remains of a church.

A few scattered rusty 55-gallon drums were noted near the shoreline and Allen Boat Company and have been inspected for possible concern. These drums were determined to be empty and no stressed vegetation was observed near any of the drums.

1.3.1 Land Use

The area surrounding the site is primarily industrial. Immediately to the north of the site is the Pier Restaurant and immediately to the south of the site is NFTA Port Terminals A and B. The site is bordered to the west by Buffalo Outer Harbor and to the east by Fuhrmann Boulevard. New York State Route 5 Skyway, runs north-south directly east of Fuhrmann Boulevard. Directly north of the Pier Restaurant is the Michigan Avenue Boat Slip, and directly south of the NFTA Port Terminal A building is another boat slip hereinafter referred to as the Terminal A Boat Slip.

The site is currently zoned for industrial use, however, according to the City of Buffalo Planning Division, commercial use may be permitted.

The site is currently vacant and has been used in the recent past for storage of bulk materials. Future use of the site is unknown.

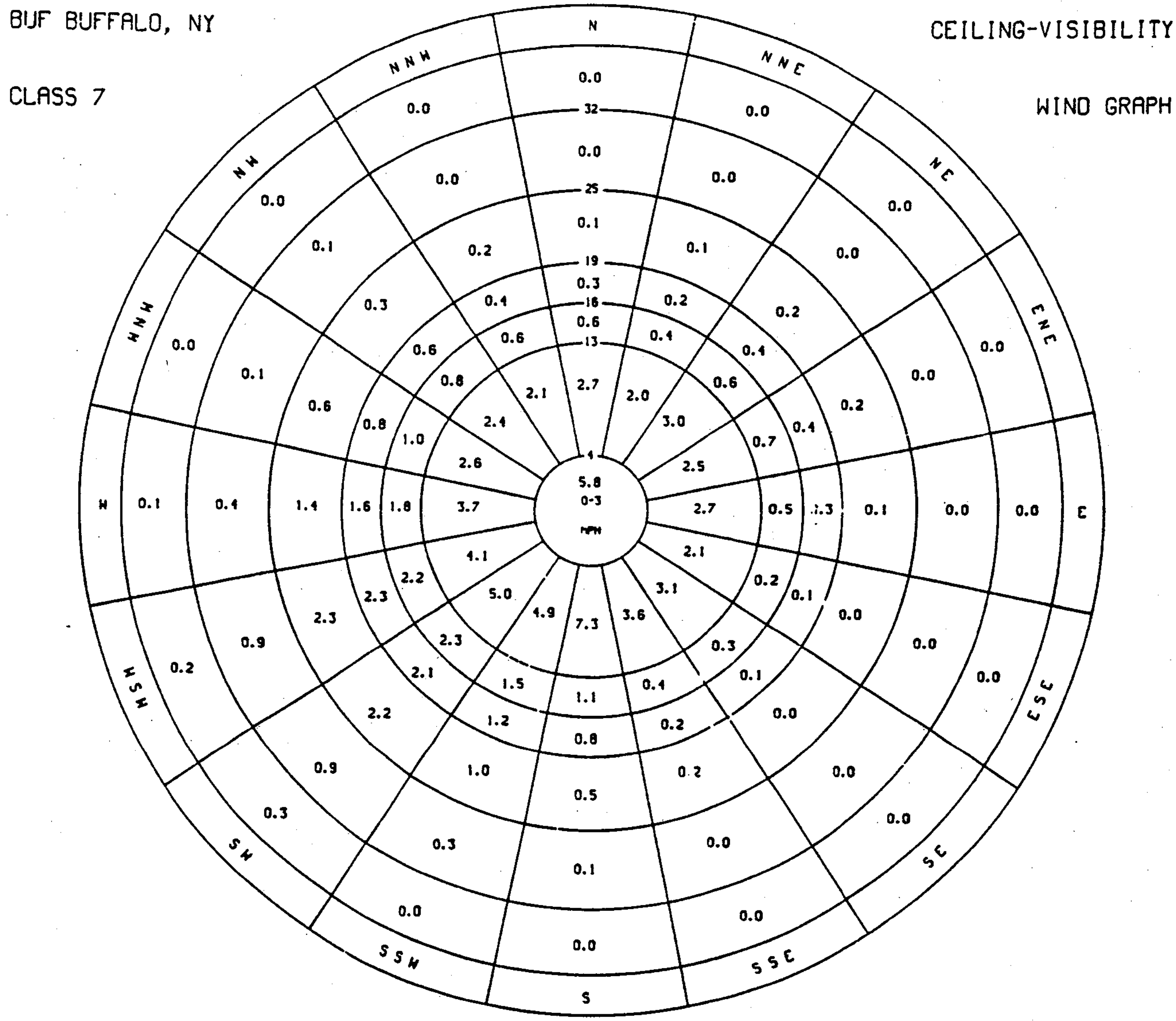
1.3.2 Climate

According to the Local Climatological Data Summary for 1993 prepared by the National Climatic Data Center, the average annual precipitation for the Buffalo area is 36 inches. Summer seasons are relatively short and the winter seasons are relatively long. The average temperature is reported to be 47°F, with temperatures ranging in 1993 from -9°F to 95°F. Wide seasonal temperature variations are tempered significantly by the proximity of Lakes Erie and Ontario. Buffalo is located near the mean position of the polar front. During the winter months, temperature variations crossing the lakes (simultaneously measured) range from 10 to 30°F. Since Lake Erie lies to the southwest of Buffalo, and in the direction of the prevailing wind, the wind speed averages are substantial. Wind speeds and direction by month are presented by the windrose in Figure 1-3. In 1993, the wind speed averaged just under 11 miles per hour. The mean annual lake or seasonable evaporation is 27 inches.

Precipitation events were recorded and measured by a rain gage which was placed adjacent to existing monitoring well GW-4A throughout the Phase I RI. The area near GW-4A is an open area away from any buildings which could deflect the wind and decrease accumulation in the rain gage, therefore underestimating the actual amount of precipitation. Table 1-1 presents the daily accumulations of rain as recorded in the rain gage for the months of September and October during which the Phase I RI field program was performed.

1.3.3 Topography

The topography of the Buffalo area is characterized by the Erie-Ontario lowlands physiographic province of New York. The regional topography is associated with glacial drift deposited during the Pleistocene Epoch, subsequent ice sheets and more recent deposits. The land to the east and south of Buffalo is gently rolling, rising to pronounced hills within 10 to 20 miles, and reaching 1,000 feet above mean sea level (msl) about 35 miles south-southeast of the City. Approximately 1½ miles north of Buffalo, the land drops 50 to 100 feet in elevation in an east-west trending escarpment (Onondaga Escarpment).



SOURCE: U.S. DEPARTMENT OF COMMERCE
NATIONAL CLIMACTIC DATA CENTER, ASHEVILLE, N.C.
1993 LOCAL CLIMATOLOGICAL DATA (ANNUAL SUMMARY)

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

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WINDROSE FOR BUFFALO, N.Y.

FIGURE 1 - 3

Table 1-1

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
ON-SITE DAILY PRECIPITATION RECORD FOR
SEPTEMBER AND OCTOBER 1994

September	Rain in Inches[1]	October	Rain in Inches[1]
-	-	3	0.3
-	-	4	NR
-	-	5	NR
1	0.3	6	NR
2	NR	7	NR
5	NR	10	NR
6	NR	11	NR
7	NR	12	NR
8	NR	13	NR
9	NR	14	NR
12	NR	17	NR
13	NR	18	< 0.25
14	Drizzle	19	0.40
15	NR	20	0.30
16	NR	21	NR
19	NR	24	NR
20	NR	25	0.9
21	NR	26	NR
22	NR	27	NR
23	Drizzle	28	< 0.1
26	0.6	31	NR
27	1.5		
28	0.6		
29	0.5		
30	< 0.1		

Notes:

[1] Rain gage read on Monday morning includes accumulation from the past Friday and reflects precipitation over the weekend.
- Other rain events prior to September 1: August 25 - 0.13 inches.
Drizzle - Rain amount recorded was a fraction.
NR - No rain recorded.

The present surface of the Buffalo Outer Harbor Site is a result of land filling practices performed over the past 100 years. The site is relatively flat with scattered rock, debris and soil piles, primarily in the southern and central portions of the site. The site is approximately 10 feet above the level of Lake Erie which is approximately 570 feet above msl. The slope of the intervening terrain as measured from the site to Buffalo Outer Harbor is less than 1 percent (except at the shoreline).

1.3.4 Soil

Based on previous investigations, the subsurface soils on the site are fill materials consisting of incinerator ash, casting sands, blast furnace slag, dredged lake spoils and miscellaneous construction and demolition debris intermixed with silt, sand and clay. The construction and demolition debris consists of concrete, wood, steel, cinder, ash, glass, plastic, red brick, yellow firebrick, iron pellets, marble and varying grades of slag. The fill materials are intermixed with permeable hydraulic fill sands and dredged lake spoils (silts and clay) of lower permeability. Significant variations in the thickness and composition of the fill material are present depending on the specific on-site location. Historically, the thickness of the fill zone has been determined to range from 8 feet to 32.5 feet. The fill zone was encountered from 0 to 26 feet below grade in the borings drilled during the Phase I RI. Underlying the fill material are the native overburden lake deposits consisting of stratified silt and clay (possibly intermixed with sand and gravel). Underlying the native overburden is limestone bedrock (Onondaga limestone).

1.3.5 Surface Drainage

During the Phase I RI field program, few days with measurable precipitation were recorded. However, following these events, ponded water was observed in several areas on the southern portion of the site. The only significant history of ponding on-site has occurred directly south of the Bell Slip. In 1989, Empire Soils Investigation, Inc. (ESI) reported in their Phase II Site Investigation Report that a large ponded area was present south of the Bell Slip in 1970 and 1978, and a smaller circular area in 1972 directly south of the Bell Slip. This ponding may have occurred due to poorly drained soils and subsequent landfilling has most likely eliminated this ponding.

Additionally, while no overland flow was observed, rills were identified in many places along the top of the bank along the shore of Lake Erie indicating that storm water may flow overland towards the lake under certain conditions.

1.3.6 Floodplains

Based on information obtained from the Flood Insurance Rate Map (FIRM) for the area, dated November 18, 1981, the majority of the site is classified as Zone C, areas of minimum flooding. This area of minimal flooding includes the entire eastern, northern, central and far southern portion of the site. In addition, the area immediately east of the site along Fuhrmann Boulevard and Route 5 is also classified as Zone C. Two small areas, one east of the Bell Slip and one on the southwestern corner of the site have been classified Zone B, or areas between limits of the 100-year and 500-year flood. The remaining portions of the site, immediately along the shore line, directly surrounding the Bell Slip and large area south of the Bell Slip have been classified as Zone A3, or areas within the 100-year flood.

1.3.7 Surface Water

The regional surface waters in the proximity of the Buffalo Outer Harbor Site include Lake Erie (and the Buffalo Outer Harbor), the Niagara River, the Buffalo River, and the Buffalo Ship Canal. The drainage systems of the western Erie Ontario lowlands physiographic province discharge into Lake Erie and the Niagara River to the north. The land upgradient of this study area is drained by numerous tributaries (streams) of Lake Erie. Seasonal stream flow is highly variable, and generally, streams in the upland regions (to the south) have higher rates of flow. Numerous United States Geological Survey (USGS) gaging stations have been established to monitor the regional surface water gradients and water quality. Lake Erie has been designated by the NYSDEC as Class A Special International Water which is best used as a source of water supply.

The Buffalo Outer Harbor borders the site to the west along an approximate 1-mile section of shoreline. The Outer Harbor is separated from Lake Erie by a breakwall (Outer Harbor Breakwall) which is located approximately 1,600 feet from the shoreline for the entire length of the site. The breakwall restricts wave action and reduces accretion in the Outer Harbor. The Buffalo Outer Harbor has been designated by the NYSDEC as a Class B surface water which is best used for primary and secondary contact recreation and fishing.

The Buffalo River meanders west towards the site, then flows northwest within 2,000 feet and parallel to the site, finally discharging into Lake Erie approximately 2,000 feet north of the site. The land directly upgradient of the site is drained by the Buffalo River (which is fed by the Buffalo Creek and Cazenovia Creek tributaries). The Buffalo Ship Canal, a tributary of the Buffalo River, forms near the mouth of the Buffalo River and runs parallel to the site approximately 500 feet to the east.

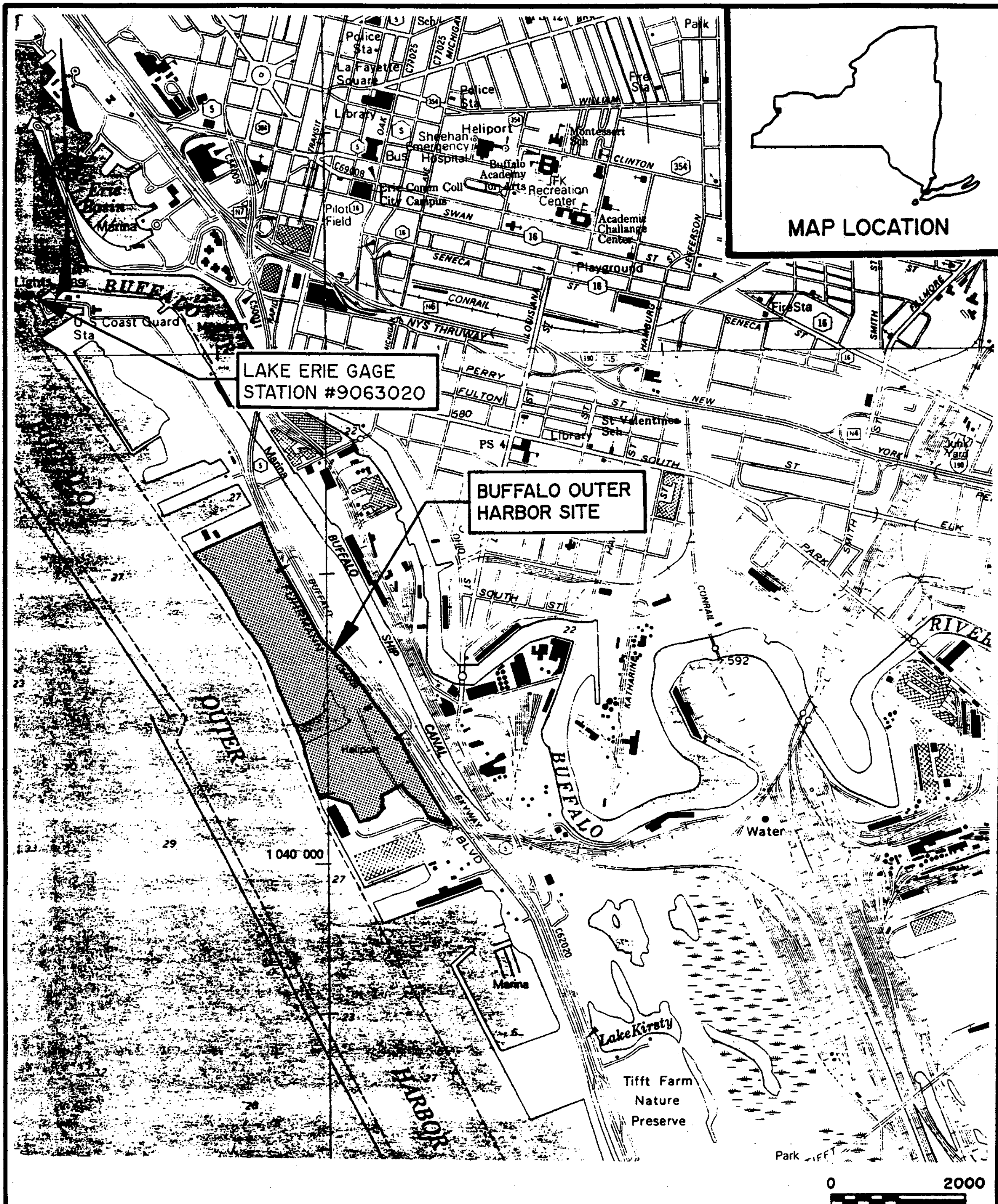
There is no apparent gradient in the Buffalo River within approximately 4 miles of the site and a gradient of approximately 10 feet per mile further upgradient. This shallow gradient has created difficulties for local industries on the Buffalo River seeking to maintain compliance with their discharge permits for industrial cooling waters. The Buffalo River Improvement Corporation has supported five major industries by pumping water from the Buffalo Outer Harbor into the Buffalo River upgradient of the industries since the 1960s. According to Mr. Richard Swiniuch of NYSDEC Region 9, the Buffalo Improvement Corporation is currently supporting two major industries by pumping an average of 20 million gallons per day (mgd) into the Buffalo River. The activities of the Buffalo River Improvement Corporation may artificially steepen the gradient of the Buffalo River in the immediate vicinity of the site especially during high discharge rates. Additionally, during extended periods of high west winds (prevailing wind direction) a backflow condition on the Buffalo River can be created for approximately 4 miles upstream where the lack of gradient exists. During winter months, ice jams near the mouth of the Buffalo River can cause slight flooding of the river.

The USGS maintains surface water gage stations in the proximity of the site. These gaging stations are the Buffalo River at Ohio Street Station (#04215790) where the sediment is monitored for chemical constituents and temperature only, and the Lake Erie at Buffalo Station (#04215900) where surface water is monitored for elevation by gage heights only. Two gaging stations are operated upgradient of the site along source streams of the Buffalo River and monitored for daily discharge rates only. These include Cazenovia Creek at Ebenezer Station (#04215500) and Buffalo Creek at Gardenville Station (#04212145), which is the head of the Buffalo River.

The monthly mean Lake Erie water elevation measured from Gage Station #906-3020 between August and October, 1994 was 572.26 feet relative to the International Great Lakes Datum (National Oceanic Service). Station #906-3020 is located at the mouth of the Buffalo River on Lake Erie approximately 2,000 feet north of the Buffalo Outer Harbor Site (see Figure 1-4). The daily fluctuations of surface water on this portion of Lake Erie between August and October commonly did not exceed 0.20 feet. Table 1-2 represents hourly Lake Erie surface water levels from the same gage station on October 20, 1994, which corresponds the time frame when the monitoring wells, piezometers and staff gages were measured for water levels during the Phase I RI and used to generate the groundwater contour maps.

The only surface water within the site boundary is the Bell Slip, a boat slip connecting Allen Boat Company with the Outer Harbor. Two other boat slips exist north and south of the site, Michigan Avenue and Terminal A Boat Slips, respectively.

During the Phase I RI, four staff gages were installed to monitor the surface waters surrounding the site by measuring the water levels during each monitoring event. The purpose of the staff gages is to correlate surface water elevations surrounding the site (off-site) to groundwater elevations measured in the on-site monitoring wells.



SOURCE: N.Y.S.D.O.T. BUFFALO, N.Y. QUADRANGLE

Dvirka and Bartilucci
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BUFFALO OUTER HARBOR
BUFFALO, NEW YORK
LAKE ERIE SURFACE WATER GAGING STATION (#906-3020) IN RELATION TO SITE

FIGURE I - 4

Table 1-2

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
LAKE ERIE HOURLY WATER LEVELS (in feet) FOR
OCTOBER 20, 1994 MONITORED FROM
GAGING STATION #906-3020

Eastern Standard Time	Water Level Elevation
0100	572.17
0200	572.30
0300	572.30
0400	572.14
0500	571.91
0600	571.65
0700	571.91
0800	571.88
0900	571.91
1000	571.78
1100	572.04
1200	572.20
1300	572.17
1400	572.37
1500	572.20
1600	572.27
1700	572.34
1800	572.17
1900	571.97
2000	571.88
2100	571.81
2200	571.55
2300	571.61
2400	571.61
Mean	572.01

* Measurements reported in feet converted from meters relative to the International Great Lakes Datum (IGLD) of 1985.

Source: U.S. Department of Commerce
NOAA/NOS - Silver Spring, Maryland
Great Lakes Water Levels N/OES211

Staff gage SG-1 is located at the Michigan Avenue Boat Slip (bolt on bulkhead); SG-2 is located in the Bell Slip (metal fence post with notch filed into side); SG-3 is located on the Terminal B dock (nail on front of bulkhead); and SG-4 is located on an old dock in the Buffalo Ship Canal (nail on side of dock). these staff gages were surveyed for horizontal distance and vertical elevation with respect to the International Great Lakes Datum (IGLD) of 1985.

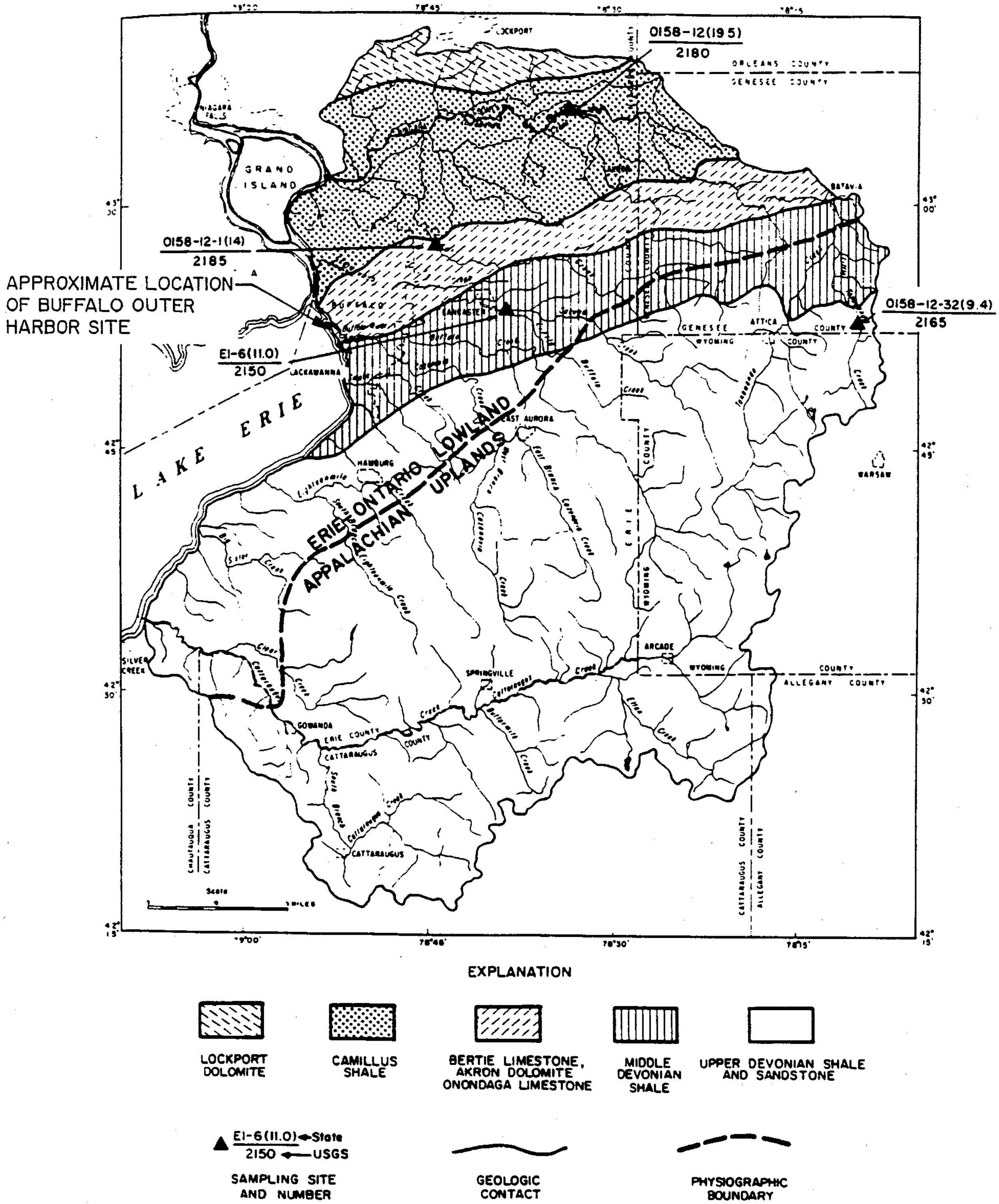
1.3.8 Regional Geology

1.3.8.1 - Bedrock

The bedrock formations which characterize the framework of the Erie-Ontario lowlands consist of a series of sedimentary rock units comprised of limestone, dolomite, sandstone and shale. These sedimentary rocks were deposited during the Ordovician, Silurian and Devonian periods and are gently southward dipping (at approximately 30-40 feet per mile) east-west trending formations. The limestone, dolomite and shale units in western Erie County were deposited during the Silurian and Devonian periods. These bedrock units are bedded or layered since the units were formed in ancient epicontinental seas by fine-grained sediment deposition throughout the Siluvian and Devonian periods. The discussion of bedrock geology presented here will be limited to the uppermost units found in the vicinity of the site.

The Late Silurian/Middle Devonian bedrock sequence in the western portion of the Lake Erie plain is comprised primarily of limestone and shale (see Figure 1-5). The bedrock beneath the Buffalo Outer Harbor Site consists of three geologically distinct units which overlies a relatively thick shale formation.

These limestone units, from top to bottom, are: the Onondaga limestone (Lower Devonian), Akron dolomite (Upper Silurian) and the Bertie limestone (Upper Silurian). The limestone units are underlain by the Camillus shale (Middle to Upper Silurian).



SOURCE: ARCHER, LA SALA, AND KAMMERER, CHEMICAL QUALITY OF STREAMS IN THE ERIE–NIAGARA BASIN, NEW YORK, 1968

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

GENERALIZED BEDROCK GEOLOGY AND PHYSIOGRAPHIC BOUNDARIES IN THE PROXIMITY OF THE SITE

Dvirka and Bartilucci
Consulting Engineers
A Division of William F. Cosulich Associates, P.C.

FIGURE 1–5

The exposed bedrock in Erie County represents the record of Silurian and Devonian rock. The Onondaga Escarpment is a surface feature (north-facing cliff) marking the northern boundary of the Onondaga limestone which trends east-west from Buffalo to Akron in this region and east all the way to Albany and south-southwest to Port Jervis. The existence of the Onondaga Escarpment is indicative that the Onondaga limestone is relatively resistant to erosion.

The Onondaga limestones average 140 feet thick in the Erie-Ontario lowlands and approximately 110 feet thick where it outcrops. La Sala (1968) offers a breakdown of the Onondaga limestone into three unnamed component units. The upper unit consists of a dark gray to tan limestone commonly 50-60 feet thick. The middle unit is comprised of a gray coarse-grained limestone with blue chert and is commonly 40-45 feet thick. The lowest unit of the Onondaga limestone consists of a gray coarse-grained limestone commonly only a few feet thick. Since these three units only amount to approximately 110 feet, this interpretation may be limited to the Onondaga Escarpment region (to the north of the site).

The Akron dolomite underlies the Onondaga limestone and is approximately 8 feet thick and consists of a greenish-gray fined-grained dolomite. Underlying the Akron dolomite is the Bertie limestone. The Bertie limestone is comprised of a gray and brown dolomite and dolomitic limestone with some interbedded shale (approximately 50-60 feet thick).

1.3.8.2 - Unconsolidated Deposits

Unconsolidated deposits of glacial origin cover most of the bedrock in the Erie-Ontario lowlands. The regional surface features in the vicinity of the site are characterized by recessional moraines and lacustrine shoreline deposits. The unconsolidated deposits in western Erie County were deposited during the Pleistocene Epoch by extensive glaciation between approximately 10,000 and 15,000 years ago. The nature and thickness of these deposits (locally) is dependent on the preglacial erosion of the bedrock surface and subsequent modification by glaciation. The glacial geology of this region corresponds to the Port Huron substage of the Late Wisconsin Glacial Stage (Muller, 1960).

The early stages of glacial deposition in the present Lake Erie basin represent sandy beach deposits and bottom deposits consisting commonly of red clay (and varied clays locally). These lacustrine deposits most likely originated from glacial Lake Whittlesey which was approximately 300 miles long and existed approximately 13,000 years ago. This glacial lake was formed following the Port Huron advance between the high ice front to the north and the Appalachian to the south. The deposits from Lake Whittlesey record the highest beaches which stood at 740 feet above msl (850 feet above msl after postglacial uplift). Another glacial lake, Lake Warren, existed in this region approximately 11,000 to 12,000 years ago at an elevation of 690 feet above msl whose lake beach deposits vary in elevation from 760 feet above msl in southern Erie County to 850 feet above msl at Alden, New York following postglacial uplift.

The bedrock surface in this region has been significantly modified by a series of continental ice-sheets which widened pre-existing valleys, depositing variable and widespread areas of till, and stratified sand and gravel at ice-contacts. Glacial pavement and glacial striations are prescribed on several outcrops of the Onondaga limestone (Buehler and Tesmer, 1963). Glacial till overlies the bedrock in this region and thicknesses vary from 2 feet to more than 200 feet. The maximum thickness of the till corresponds to areas along the divides of the local creeks and streams such as Buffalo Creek. The glacial till consists of silt, clay and a mixture of sand, gravel, cobbles and boulders, and were directly deposited from the base of the glacial ice sheets. Till is the most widespread unconsolidated deposit in this region, although it only forms a thin cover on the bedrock in most areas of the Lake Erie plain. Till on the soluble rocks is light red and silty, and in some morainic ridges it is mostly fine sand (LaSala, 1968).

The recession of the glacial ice-sheets left stagnant ice-masses which later melted forming glacial lakes upgradient characteristic of this region. The melting of ice-sheets produced melt water channels (glacial streams generated from the ice-contact zones) which deposited predominantly sand and gravel locally. The most extensive and thickest glacial deposits overlying the till layer are the lacustrine (lake) deposits. The lake deposits consist of stratified clay and silt, which settled out in lakes fed by melting ice. The upper zone of the unconsolidated deposits overlying the lacustrine (or sand and gravel deposits locally) consist of streams and swamp deposits. The stream deposits consist of fine organic silts and sediment (alluvium) formed in recent times and swamp deposits formed by the accumulation of decayed plant and other organic matter.

The native overburden deposits range in thickness from approximately 50 feet in the northern portion of the Erie-Ontario lowlands to approximately 600 feet thick towards the southern portion of the lowlands area.

The surficial deposits in may of the Lake Erie shoreline regions are a result of man-made landfilling practices for expansion.

1.3.9 Regional Hydrogeology

A summary of the regional hydrogeology including composition, sequence, flow characteristics, and quality of the water-bearing (or saturated) bedrock and unconsolidated deposits is presented in the following sections.

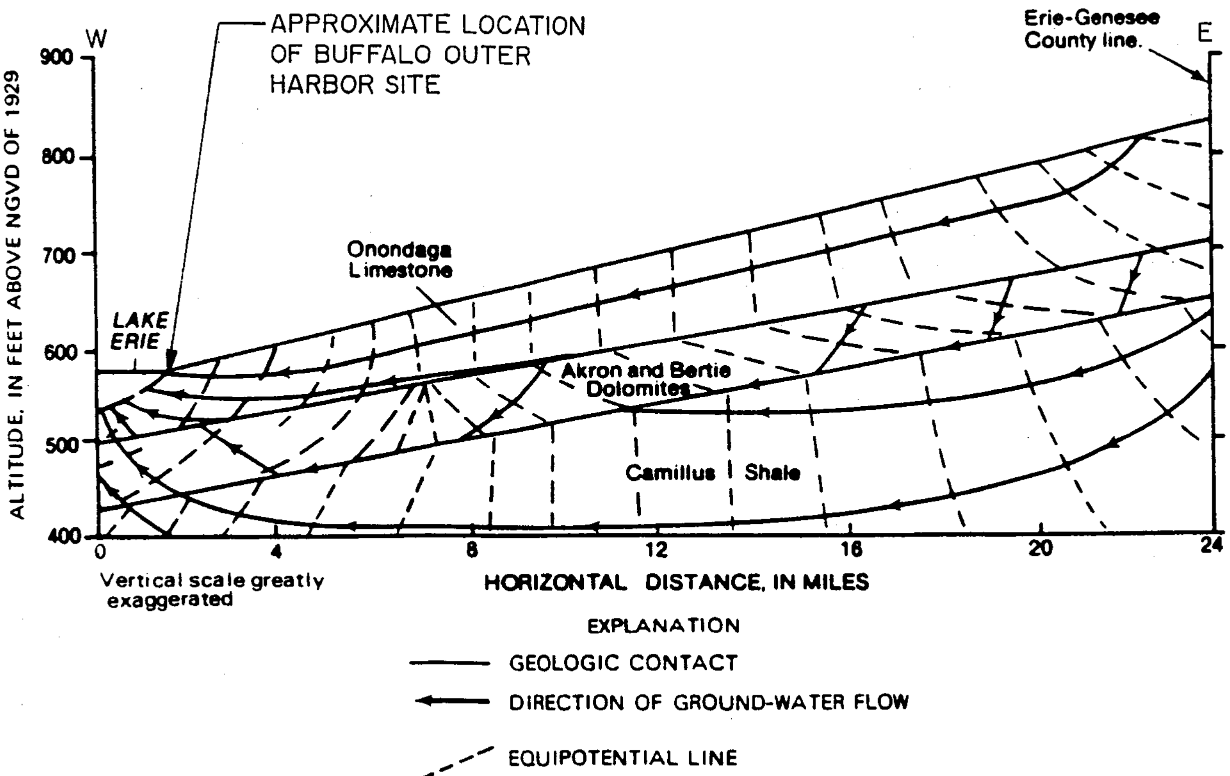
1.3.9.1 - Bedrock

The principle water-bearing bedrock deposits in the Buffalo region are the limestone sequence including the Onondaga limestone, Akron dolomite and the Bertie limestone and the Camillus shale (with interbedded gypsum). The groundwater-bearing characteristics vary considerably between the limestone sequence and the shale formation. The limestone unit sequence is considered, for hydrogeologic purposes, one single aquifer (although stratigraphically distinct). Even though only small to moderate supplies of less than 50 gallons per minute (gpm) are generally available from the shale and individual limestone formations, wherever joints or fractures have been widened by solution of carbonate and gypsum minerals, the rocks can supply large quantities.

The limestone and shale units are comprised mainly of soluble rocks which are vulnerable to dissolution from acids in groundwater. Limestone is composed mainly of the mineral calcite (natural form of calcium carbonate), dolomite is comprised of calcium-magnesium carbonate (however, less soluble than limestone) and gypsum is comprised of calcium-sulfate (more soluble than limestone).

The occurrence of groundwater in the Onondaga limestone is attributable to the number and size of fractures (regularly spaced joints occurring in sets) and larger scale faults caused by geologic forces acting throughout broad areas (in addition to solution openings). These joints typically develop along planes of weakness in the layers of rock and are roughly parallel to the bedding planes. Faults are larger fractures along which adjacent masses of rock units have been offset usually providing very large quantities of water. Groundwater yield in Onondaga limestone bedrock wells can attain 100 to 300 gpm (more commonly 100 gpm) where solution openings or multiple fractures are present. The coefficient of transmissivity of the Onondaga limestone probably ranges from about 300 to 25,000 gallons per day per foot (gpd/ft) (LaSala, 1968). Although the Bertie limestone and Akron dolomite formations supply the lowest transmissivities and groundwater yield, the Camillus shale has the highest transmissivities and well yield of all bedrock formations in this region.

The major source of recharge for the Onondaga aquifer is from precipitation which reaches the aquifer by direct infiltration of rain and snow-melt through the unconsolidated deposits, stream flow into the fracture zone, and seepage from lowland and glacial deposits. The potentiometric surface of the Onondaga aquifer generally parallels the slightly undulating land surface (Staubitz and Miller, 1987). The horizontal component of groundwater movement in the Onondaga aquifer flows regionally from the east (recharge area of higher elevations) to the west towards Lake Erie (discharge area of lower elevation) (see Figure 1-6). However, regional flow to the south of Buffalo and this line of geologic cross section is north-northwest from the land to the south and southeast (of significantly higher elevation).



SOURCE: STAUBITZ AND MILLER, GEOLOGY AND HYDROLOGY OF THE ONONDAGA AQUIFER IN EASTERN ERIE COUNTY, NEW YORK, 1987.

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

GENERALIZED EAST–WEST GROUNDWATER FLOW THROUGH BEDROCK TOWARDS LAKE ERIE AND SITE

Dvirka and Bartilucci
Consulting Engineers
A Division of William F. Cosulich Associates, P.C.

FIGURE 1–6

The groundwater contained in the upper fracture area of the Onondaga aquifer is in hydraulic connection with the glacial till directly above.

1.3.9.2 - Unconsolidated Deposits

The glacial unconsolidated deposits which overlie the bedrock within the Erie-Ontario lowlands consist of till, lacustrine sediments, sand and gravel, and stream and swamp sediments (and fill material locally).

The fracture zone in the upper surface of bedrock and the overlying fill layer (typically one to three feet thick) act as a single water-bearing zone where the fill is overlain by clayey fill or finer grained silt and clay of much lower permeability. The lacustrine deposits (stratified silt, clay, and fine sand) are most prevalent in the lowlands bordering present Lake Erie near the site. These deposits are quite extensive and have very low permeabilities often yielding very small quantities of water to wells. In the areas where the lacustrine deposits contain thick sections of fine sand, higher than expected lateral groundwater movement can occur. Aquifer characteristics of the lacustrine deposits can vary depending on the percentages of these sand layers.

Lacustrine deposits constitute a water-bearing unit (aquifer) above the bedrock and fill hydrologic unit. As previously mentioned, this unit is extensive and can be very thick, however, it does not transmit water readily. Therefore, this hydrologic unit acts mainly as a aquitard, limiting infiltration of recharge to the underlying formations, probably upward movement of groundwater from beneath characteristic of discharge areas (including the Buffalo Outer Harbor Site). The complexity of bedding and composition in the lacustrine deposits locally can also vary its water bearing nature significantly. Monitoring wells which tap into this unit are usually for the purpose of determining water quality and not for yielding water for drinking. Aluminum and swamp deposits overlie lacustrine deposits throughout the region and, due to their generally low permeability, are not a significant source of water. Many areas of the lowlands region, especially through the Lake Erie shoreline, have been landfilled to expand areas and eliminate ponded areas. In these landfilled areas, groundwater is under water table conditions in the fill material and underlying stream, swamp, lacustrian, or sand and gravel deposits. In the western portion of the western Lake Erie plain (south Buffalo and the Buffalo Outer Harbor Site), the horizontal groundwater flow direction generally parallels the topography and is overall towards the west and Lake Erie.

The greatest potential for groundwater resources are these contained in a peripheral belt of extensive thick sand and gravel deposits located upland (south to southeast of Buffalo). Several communities obtain public water supplies from these deposits in which supply wells typically yield 500 to 1,400 gallons per minute (gpm). This upland region is considerably higher in elevation and very distinct from Lake Erie making it unfeasible to obtain potable water from the surface waters of Lake Erie. However, the sand and gravel deposits in this region provide a self-sufficient supply of groundwater to these upland communities. On the other hand, the communities of the Lake Erie plan and the City of Buffalo (of lower elevation) obtain their drinking water supplies from the surface waters of Lake Erie.

1.3.9.3 - Groundwater Quality

The chemical quality of groundwater in bedrock is primarily a result of the presence of relatively soluble minerals contained in the rock materials. Therefore, the groundwater of the Onondaga aquifer is high in hardness due to the high levels of calcium carbonate. Groundwater of the Onondaga aquifer is generally lower in total dissolved solids than water in the underlying formations. Water samples collected periodically from six wells which tap the Onondaga aquifer in eastern Erie County had a lower mean value of specific conductance, lower concentrations of calcium, magnesium, bicarbonate, and sulfate than water from underlying formations (Staubitz and Miller, 1985).

The USGS has a listing of all groundwater wells for this region, however, since drinking water is derived from Lake Erie, relatively few observation wells have been installed in this area and therefore only limited data is available.

A current list of groundwater wells within a one-mile radius of the site was obtained from the USGS database in Albany. The list includes nine wells, five of which were installed to total depths ranging between 14 and 180 feet (four of the wells do not have total depths listed, although bedrock was penetrated in one of these four wells).

Table 1-3 depicts historical groundwater quality data (of typically analyzed chemicals) form three wells penetrating the Onondaga and underlying limestone aquifers in western Erie County.

The groundwater quality of the unconsolidated deposits in the Lake Erie plain is highly variable and depends on location relative to industries, hazardous waste sites, and rivers or streams. Other factors influencing groundwater quality include the presence of overlying fill materials and site specific contamination problems. Very limited groundwater quality data is available for the unconsolidated deposits within the immediate vicinity of the site due to the relatively limited number of observation wells reported by the USGS in this area. Generally, the groundwater contained in the unconsolidated deposits is lower in dissolved solids, hardness, and chemicals common in bedrock aquifers including magnesium, sulfate and calcium.

1.3.10 Water Supply

Water for the City of Buffalo is supplied by a water intake in Lake Erie located 8,000 feet northwest from the site. There is no known use of private wells for potable water supply in the vicinity of the site. Industrial facilities may utilize groundwater or surface water in the vicinity of the site for cooling water.

1.3.11 Storm Water

Information obtained during the Phase I RI field program indicated the presence of five discharge pipes within the site boundary: one 24-inch concrete pipe/culvert located on the northern portion of this site just west of the gravel parking area for the pier restaurant; one 3-foot

Table 1-3

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
CHEMICAL CONTENT OF GROUNDWATER BEDROCK WELLS
PENETRATING THE LIMESTONE IN AQUIFER LOCATED
WITHIN TWO MILES OF THE SITE

Well #	Depth of Well (ft)	Diameter of Well (inches)	Water Bearing Material	Iron	Magnesium	Bicarbonate	Sulfate	Dissolved Solids	Special Condition (micromhos)	pH	Calcium Magnesium Hardness (As $CaCO_3$)
251-850-2	116	6	Ls	-	-	-	104	-	1,750	7.2	338
252-850-1	180	6	Ls;Cam	0.08	124	500	560	1,720	2,310	6.8	1,040
252-852-3	127	8	Ls	5.6	62	499	150	2,000	3,680	7.3	890

Estimated Pumpage	Depth to Bedrock (ft)	Use	Approximate Distance Relative to Site (ft)	Approximate Direction Relative to Site	Miscellaneous
-	-	-	10,000	SE	This well may penetrate the Onondaga aquifer only.
300 gpm 300,000 gpd	20	Unused	10,000	E	-
40,000 gpd	30	-	3,000	E-NE	Hydrogen sulfide gas in groundwater

Notes:
All chemicals reported in mg/kg.
Ls - Limestone sequence including Onondaga limestone, Akrondolonite, and Bertie limestone formations.
Cam - Camillus shale formation.
gpm - Pumping rate in gallons per minute.
gpd - Pumping rate in gallons per day.

concrete pipe discharging to the eastern edge of the Bell Slip; and three 18-inch ductile iron pipes located south of the Bell Slip discharging to the Outer Harbor.

Information provided in the ESI Phase II Site Investigation indicated that the 24-inch concrete pipe is part of the storm drainage system for the southern side of the restaurant parking and roadway areas. The roof drains from the restaurant also are believed to be tied into this storm drain.

The source of the 3-foot concrete pipe discharging to the Bell Slip is unknown, however, plans for construction of the guard house and parking lot expansion provided by the NFTA indicate that the storm water from those areas are directed to this outfall.

The source of the three iron pipes is also unknown. The pipes are almost completely submerged in the Outer Harbor. Several off-site drainage pipes were located near the Port Terminal A and B buildings and The Pier restaurant. Refer to Section 3.1 for additional information.

1.4 Site History

In the early 1800s, the Lake Erie shoreline was east of Fuhrmann Boulevard and the present day Buffalo Skyway. In about 1840, a sea wall was constructed along the shoreline approximately at the location of the present Buffalo Skyway. From approximately 1865 to 1890, the outer harbor breakwall was constructed approximately 2,000 feet offshore. During this period, the area near the foot of Michigan Avenue was occupied by numerous railroad facilities and storage yards.

The majority of the Buffalo Outer Harbor Site was created as a result of land reclamation and filling activities that have occurred over the past 100 years. Landfilling activities began in 1874 when a sand catch pier was built south of the present Bell Slip. The Michigan Avenue Pier, located north of the site, was constructed in 1926 and 1927. The pier, located on the southern portion of the site where the present day Port Terminal A is located, was constructed in 1931. The material used to construct these piers is unknown.

The remaining portions of the site were filled over the 100-year period by various methods. The Phase II Investigation Report prepared by Empire Soils Investigation, Inc. in 1991, reported the following filling activities:

1927-1935	Landfilling at the foot of Michigan Avenue
1935-1951	Filling along the shoreline
1951-1960	Filling along the southern shoreline
1960-1965	Dredge filling of northern portion of the site
1965-1968	Dredge filling of southern portion of the site
1968-1978	Filling of the ponded water on the southern portion of the site
1970-1986	Miscellaneous filling and bulk storage

The Ford Motor Company occupied the Terminal A building in the 1940s. The filled area located just north of the Terminal A building was allegedly used by Ford to dispose of cafeteria, office and general plant refuse. Unknown quantities of furnace casting sands from the Chevrolet plant located in Buffalo were also disposed of in this area.

A report prepared by Greeley and Hansen in September of 1944, entitled "Report on the Collection and Disposal of Refuse," Buffalo, New York, indicated "there are four dumps in active use for the disposal of ashes, noncombustible rubbish and the residue from the incineration plant." One of the areas described is Fuhrmann Boulevard. "Dumping at this site extends along the harbor front from the city pier opposite the end of Michigan Avenue about 3,000 feet to the south, and is on property owned partly by New York State and partly by the New York Central and the Buffalo Creek Railroads. As presently operated, and without the construction of a bulkhead to retain the fill, there remains a dumping capacity of approximately 250,000 cubic yards at this site."

In the 1950s, the U.S. Army Corps of Engineers contracted the Great Lake Dredge and Dock Company to dredge the Buffalo Outer Harbor Shipping Channel and dike the area north of Terminal A. The spoil was dredged from the area in the vicinity of the Union and Lakawanna Canals and was placed in the southern portion of the site. Dredging spoil removed from the outer harbor channel was used to fill the northern portion of the site. An estimated 2,130,000 cubic yards of dredged material was used to fill the site. The harbor dredging and filling operations were completed in 1964.

Also during the 1950s, the NFTA acquired the site from the U.S. Army Corps of Engineers. The southern portion of the site was still a wetland area. Additional fill operations were conducted between 1965 and 1979 in this area and an estimated 930,000 cubic yards of construction excavation fill was disposed at the site by various contractors. No records exist with regard to the fill activities.

From approximately 1969 to approximately 1988, William Pfohl Trucking Corporation operated a transfer station at the site, where dry bulk materials were stored and delivered from the site. The materials included rock salt, zircon and futile sand, foundry sand (from Chevrolet Motors and River Road Foundry Plant), iron ore pellets, ball and china clay, gypsum rock, potash and scrap metal.

The site is currently vacant except for the Allen Boat Company located adjacent to the Bell Slip. Bulk materials are no longer stored on-site.

1.5 Findings from Previous Investigations

In June 1972, the U.S. Environmental Protection Agency (USEPA) collected two samples of Buffalo Outer Harbor sediment just west of the site. Samples were analyzed for volatile solids, chemical oxygen demand (COD), total Kjeldahl nitrogen, oil and grease, mercury, lead and zinc. The results of the analysis indicated that both of the samples exceeded the USEPA criteria with regard to total Kjeldahl nitrogen and oil and grease, and one of the samples exceeded the criteria for mercury and COD.

Five borings were constructed by Empire Soils Investigations, Inc. (ESI), in 1980, prior to construction of the Radio Tower on the southern portion of the site. The borings were constructed to depths of between 19 and 70 feet below grade. During construction of the borings, black ash and sand, decomposed wood, brick, concrete, glass and coal were encountered. No samples were collected for chemical analysis.

In August 1982, the U.S. Geological Survey constructed four test borings on-site. One sample was collected from each boring at varying depths. Each of the samples was analyzed for cadmium, chromium, copper, iron, lead, nickel and phenols. The results of the analysis did not indicate the presence of elevated levels of any of these contaminants.

The Erie County Department of Environment and Planning prepared a report on the NFTA site in September 1982. The report was in response to a document prepared by the Interagency Task Force, in Volume III of Hazardous Waste Disposal Sites in New York State. In general, the report supported the Task Force evaluation and classification of the site that no further action is required and did not recommend any further study be conducted at the site.

A Phase I Investigation was prepared by Engineering Science in association with Dames and Moore for NYSDEC in January 1986. The investigation included collection and review of all available information, preparation of a Hazard Ranking System score, performance of a site inspection and conduct of interviews. No samples were collected during this investigation. Based upon the results of the Phase I Investigation, it was recommended that a Phase II Investigation be performed.

As a result of the proposed development of the Buffalo Outer Harbor Site, ESI conducted a subsurface and geotechnical investigation at the site from December 1986 through January 1987. Eighteen borings were constructed and six groundwater monitoring wells were installed to determine site geology and depth to groundwater. No samples were collected for chemical analysis.

In May 1988, Anthony T. Voell prepared an Environmental Review for Impact on adjacent 2A Site for the NFTA. The report was prepared as a response to a request from NFTA to determine if there is evidence of disposal of significant amounts of hazardous waste in the area of the proposed industrial park, approximately 7 acres to be used north of Terminal A for parking and access. No samples were collected for analysis for this report.

On June 24, 1988, Anthony T. Voell prepared a report entitled "Lakeside Industrial Park Phase I Summary of Soil Chemical Investigations." ESI conducted the subsurface exploration. This investigation was conducted to evaluate the subsurface conditions for the potential presence of contamination in the subsurface soil immediately north of the Terminal A facility for renovations to the parking area. Four test borings were constructed in the parking area to the northeast of the Terminal A building. Two borings were completed to a depth of 8 feet and two borings were completed to a depth of 4 feet. The subsurface soils encountered in the test borings consisted of "miscellaneous and dredge spoil fills." The fill encountered was variable, generally dark brown to gray with varying amounts of gravel, sand, silt and clay, intermixed with cinders, slag, wood, bricks and suspected lime. Four composite samples were collected for chemical analysis. All samples were split with NYSDEC. Only low levels of semivolatile organics (individual compounds all less than 2 ppm) were detected in the samples.

A report entitled "Environmental Site Assessment, Former Site of Buffalo Municipal Pier Proposed Shooters International" was prepared by Empire Soils Investigation in January 1989. The environmental site assessment was prepared in conjunction with an ESI report entitled "Geotechnical Investigation, Shooters Restaurant." ESI constructed 10 test borings on-site. Four of the borings were completed to the top of bedrock, two of the borings were completed to 5 feet into the bedrock and the remaining borings were constructed to a depth of 5 feet below ground surface. One groundwater monitoring well was installed to a depth of 25 feet. Two composite soil samples were collected from two of the borings and analyzed for USEPA Superfund Target List Compounds. In addition, one groundwater sample was collected from the monitoring well. The results of the analysis did not indicate the presence of volatile organic compounds (VOCs), pesticides/polychlorinated biphenyls (P/PCBs) or semivolatile organic compounds (SVOCs) in the water sample. VOCs and P/PCBs were also not detected in the soil samples. Low levels of SVOCs, less than 6 ppm total, were detected in the soil samples. Only low levels of metals were detected in both the water and soil samples.

In November 1991, ESI prepared a Phase II Site Investigation Report for the NFTA. The initial investigation, conducted in the summer and fall of 1989, consisted of a site reconnaissance, a limited geophysical investigation, construction of 22 borings and three test pits, installation of 10 shallow, two intermediate and two deep monitoring wells, and collection of 20 subsurface soil samples and seven composite surface soil samples. In addition, groundwater samples were collected from each of the monitoring wells. All samples were analyzed for Target Compound List (TCL) parameters.

In April 1991, ESI conducted a follow-up sampling program that consisted of the collection of three groundwater samples for total mercury analysis, collection of two groundwater samples for cyanide analysis, and collection of five surface soil samples for SVOC and P/PCB analysis. Also in April 1991, GZA GeoEnvironmental of New York conducted a supplemental sampling program to confirm the findings of the initial Phase II Site Investigation. This investigation consisted of the collection of four surface soil samples on the Michigan Avenue Pier for mercury analysis, collection of two surface soil samples near the Allen Boat Company for VOC analysis, collection of five subsurface soil samples for EP Toxicity Characteristics and collection of one groundwater sample for EP Toxicity and total mercury analysis.

The results of the Phase II Site Investigation subsurface investigation indicated the presence of fill material to depths of between 13 to 33 feet. The fill material consisted of very dense gravel, sand and silt with varying proportions of ashes, brick, wood, roots, cinders, glass, metal, iron pellets, slag, reinforcement bar, coal, flyash, asphalt, concrete, salt, paper, plastic, construction and demolition debris, rock fill and sand fill.

The results of the analysis conducted during the Phase II Investigation indicated the presence of lead above New York State groundwater standards in the majority of the wells sampled, particularly in the wells along the eastern edge of the site. Two of the five soil samples collected by GZA for EP Toxicity analysis exceeded the lead limits for characterization as a hazardous waste. The results from the five samples analyzed for EP Toxicity by ESI and the results from the remaining samples analyzed for EP Toxicity by GZA did not exceed limits. ESI indicated that the samples collected which exceeded the EP Toxicity limits for lead were collected in the vicinity of the former landfill along Fuhrmann Boulevard.

In addition to the elevated levels of lead detected along Fuhrmann Boulevard, significantly elevated levels of volatile organic and semivolatile organic compounds were detected in the subsurface soil sample collected by ESI in the vicinity of the Radio Tower. Toluene was detected at 6,000 ug/kg and chlorobenzene was detected at 2,600 ug/kg. In addition to the elevated levels of polycyclic aromatic hydrocarbons detected, other SVOCs, such as nitrobenzene, were detected at significantly elevated concentrations. Nitrobenzene was detected at 1,571,197 ug/kg.

Based upon the results of the Phase II and supplemental investigations performed by ESI and GZA, ESI recommended that additional investigations be performed in the vicinity of the Radio Tower, the low wetland area reportedly filled in by construction excavation fill, the area of suspected foundry sand disposal and the Allen Boat Company septic system. In addition, ESI recommended that background groundwater quality be identified, that a habitat-based assessment be performed and that migration of contaminants to the Outer Harbor be evaluated.

In June 1991, the site was reclassified from a NYSDEC Class 2a site to a Class 2 site. The site was reclassified based upon the results of the supplemental investigation, including the high levels of lead detected and the samples collected for EP Toxicity analysis that exceeded the limits for lead.

In September 1993, GZA prepared a draft work plan for NFTA for performance of a Phase I remedial investigation/feasibility study (RI/FS) for the Buffalo Outer Harbor Site. After negotiations with the NYSDEC, NFTA signed a consent order under which NFTA will reimburse NYSDEC for conducting the RI/FS utilizing a State Superfund consultant.

1.6 Overview of the Remedial Investigation and Report Organization

The Buffalo Outer Harbor Site Remedial Investigation was designed as a multi-phased program for the characterization of the nature and extent of the contamination at the site. In conjunction with the NYSDEC, the objectives of the RI were developed and the approach designed to meet the needs of the sampling and data analysis programs. The approach of the RI was to utilize the existing data obtained from previous investigations as the basis for its design. This approach enabled the investigation to focus on the need for additional assessment of soil, groundwater, surface water and sediment quality data through the implementation of a multifaceted field program.

The RI report is presented in a fashion which allows for a logical and ordered progression of the descriptions and findings of the investigation. Section 1.0 discusses the project's objectives and background, as well as a review of the site history, including a discussion of previous investigations and a summary of their results. Section 2.0 is a detailed description of the field program. Section 3.0 describes the results of the physical and ecological characteristics of the study area, including surface features, geology, hydrogeology and ecology. Section 4.0 discusses the nature and extent of the contamination, including a discussion on the standards, guidelines and criteria for the various sampling media, data validation, the analytical results, and the fate and transport of the contaminants detected.

Section 5.0 presents the conclusions and recommendations of the RI, including discussions on surface soil, subsurface soil and fill material, groundwater, surface water and surface water sediment. Also included in Section 5.0 is a discussion of the identified contaminants of concern and areas of the site recommended for remediation on a preliminary basis. This discussion includes a qualitative analysis of the hazards, exposures and risks to human health and the environment based on the types of contaminants identified and their reported concentrations, and recommendations for long-term remedial actions based on the overall findings of the RI investigation.

Section 2

2.0 STUDY AREA INVESTIGATION

2.1 Site Facilities

The field operations undertaken during the remedial investigation included the establishment of a field office at the Buffalo Outer Harbor Site. For the Phase I Investigation, the office was located in the one story brick building south of the Terminal A building. For the Phase II Investigation, the office was located on the second floor of the Terminal A building.

Equipment, materials and supplies used for the investigation were stored in the metal building (former scale house) located in the northern portion of the site. The temporary decontamination pad was located adjacent to and west of this building. The pad was constructed of heavy plastic sheeting as a liner, clean sand and a wooden frame and platform to support equipment. Soil cuttings, decontamination water and used personal protective equipment (PPE) generated during the Phase I and Phase II Remedial Investigations (RI) are stored in New York State Department of Transportation (NYSDOT) approved, 55-gallon, ring-top drums in the building.

2.2 Field Activities/Site Characterization

The Phase I/Phase II RI field programs for the Buffalo Outer Harbor Site included the following:

- Surface Soil Sampling
- Borehole Construction
- Monitoring Well and Piezometer Installation
- Test Pit Excavation
- Subsurface Soil Sampling

- Surface Water Sampling
- Surface Water Sediment Sampling
- Groundwater Sampling
- Ambient Air Sampling
- Air Monitoring and Radiation Survey
- Wildlife Habitat Survey
- Monitoring Well and Borehole Survey

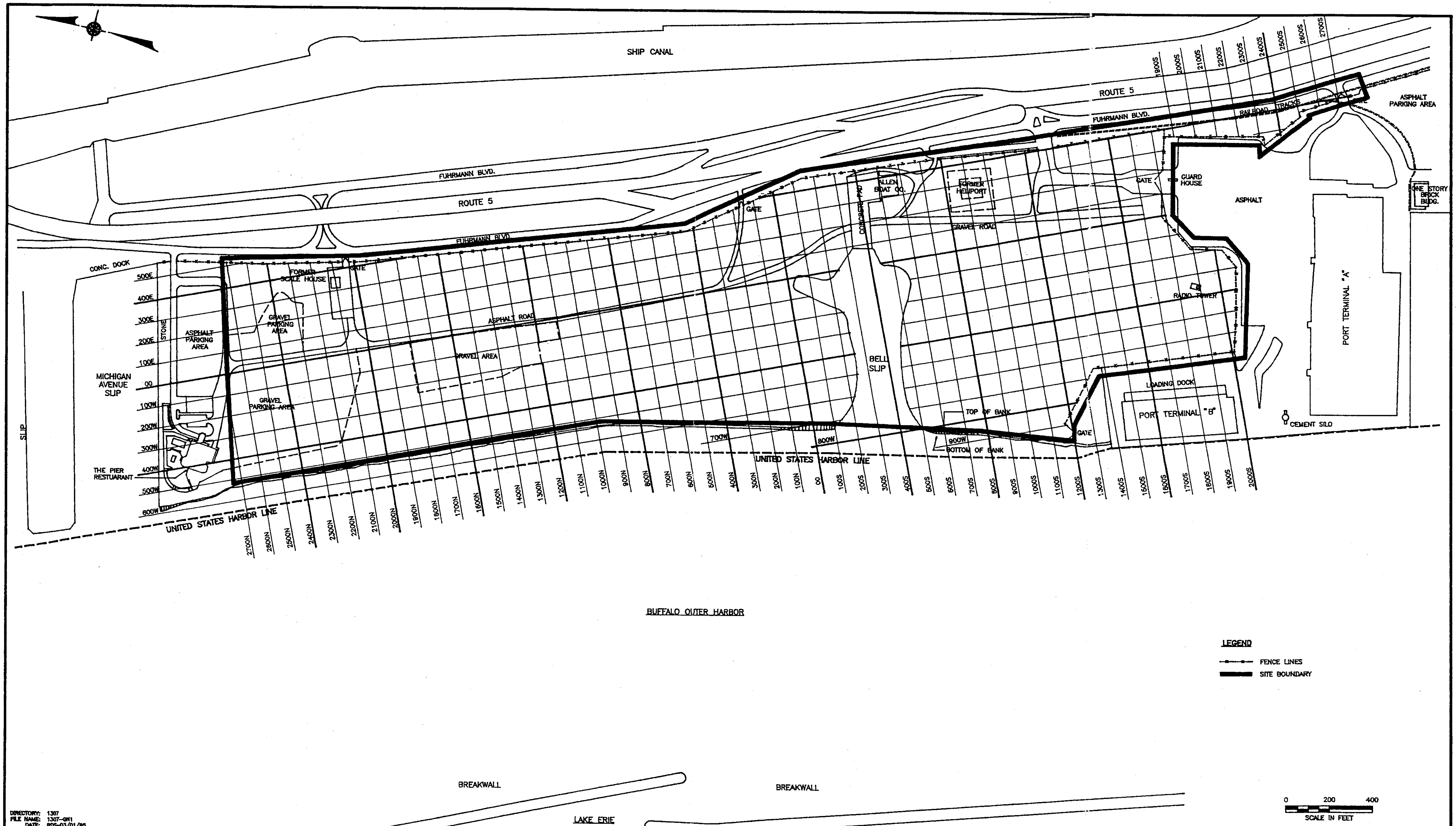
A detailed discussion of the field programs are presented below. The results of the field activities are presented in Sections 3.0 and 4.0, and the findings are discussed in Section 5.0.

2.3 Grid Network Survey

A grid system was developed for the collection of unbiased surface and subsurface soil samples and was based on a 100-foot grid (see Figure 2-1). The original grid network was established by Empire Soils Investigations (ESI) during their 1989 Phase II Investigation and was resurveyed by Om P. Popli, P.E. during the Phase I Remedial Investigation. This latest survey was performed to allow ground surface staking and flagging for the identification of surface soil and soil boring sampling locations, as well as placement of monitoring wells and piezometers. The surface soil sampling utilized the 100-foot by 100-foot grid and the subsurface soil sampling utilized a 400-foot by 400-foot grid.

2.4 Surficial Soil Sampling

A total of 112 surficial soil samples were collected throughout the Buffalo Outer Harbor Site as part of the Phase I RI. Each sample location was a composite of four nodal points based on the 100-foot by 100-foot grid. The locations of these samples are shown in Figure 2-2. Surficial soil



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DVIRKA AND BARTILUCCI
CONSULTING ENGINEERS

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

GRID NETWORK

PROJECT NO. 1307
DATE: MARCH 1995
SCALE: 1"=200'

FIGURE 2-1

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DVIRKA AND BARTILUCCI
CONSULTING ENGINEERS

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

SURFACE SOIL SAMPLE LOCATIONS

PROJECT NO. 1307
DATE MARCH 1995
SCALE 1"=200'

FIGURE 2-2

was collected, utilizing a disposable polyethylene scoop, from each nodal point from 0 to 6 inches below ground surface (bgs) and placed in a separate bottle. The soil from the four nodal points was composited and analyzed as one sample in the laboratory.

Due to surface features, such as the gravel parking areas and sand piles covering the surface soil of all four nodal points of a sample, 12 samples originally planned were not collected. The 12 samples included SS-3, SS-4, SS-5, SS-9, SS-10, SS-23, SS-28, SS-33, SS-48, SS-52, SS-58 and SS-122 (see Figure 2-2).

Additionally, certain sample nodes were obstructed due to piles of debris, asphalt paving, concrete pads or other material. These nodal points were moved slightly from their planned locations to locations where representative surficial soil samples could be collected.

Based upon the results of the Phase I RI, 10 additional surface soil samples were collected in the vicinity of the gravel parking area.

The 122 surface soil samples were collected and analyzed for Target Compound List (TCL) semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (P/PCBs) metals and cyanide. Each sample collected from each node point was screened for total volatile organic vapors utilizing a photoionization detector (PID). Only those samples exhibiting elevated readings on the PID of 2 ppm total organic vapors or greater were selected for analysis of TCL volatile organic compounds (VOCs). The select node point samples analyzed for VOCs, and the levels detected on the PID are presented in Table 2-1. Sample Information Records are provided in Appendix A.

Five off-site samples were collected to the east of the Buffalo Outer Harbor Site at various locations along Fuhrmann Boulevard. The appropriate sample locations are shown in Figure 2-2 and the exact locations are provided on sample location sketches in Appendix B. Each off-site sample was collected as a grab sample and was not composited. The off-site samples were analyzed for full TCL +30 parameters.

Table 2-1

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIATION INVESTIGATION
SURFACE SOIL SAMPLES COLLECTED FOR
VOLATILE ORGANIC ANALYSIS

Location	PID (ppm)
SS-54C	10.4
SS-73B	159
SS-77D	10.4
SS-85D	50
SS-86D	11.1
SS-97C	48.1
SS-106D	16
SS-108D	13
SS-114D	22
SS-117D	15.9

2.5 Soil Boring Program

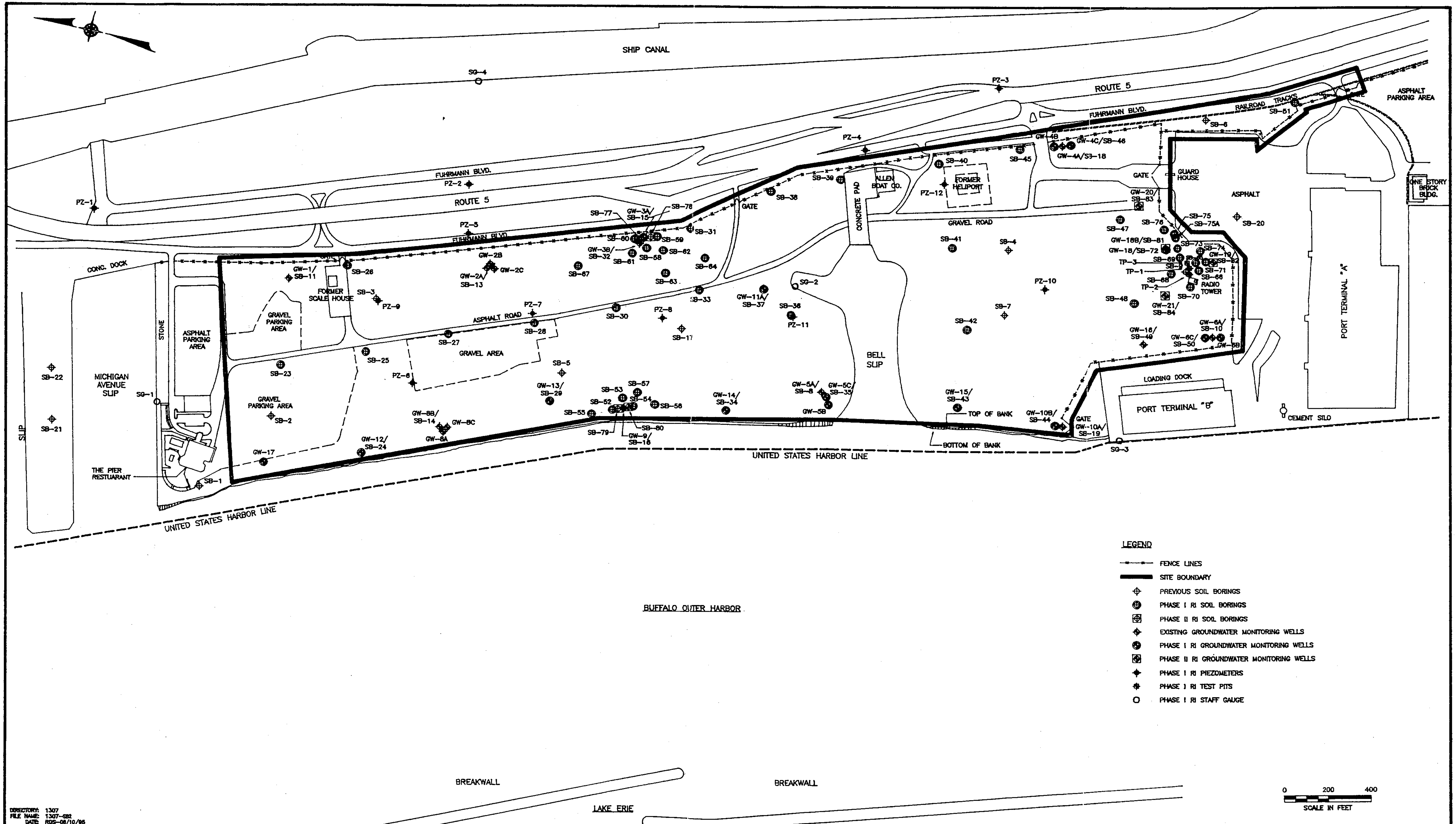
A total of 62 soil borings were installed and 117 subsurface soil samples were collected at the Buffalo Outer Harbor Site to characterize the nature and thickness of the fill material. The soil borings were labeled SB-23 through SB-84 and are shown on Figure 2-3. In addition, five subsurface soil samples were collected during installation of four of the on-site piezometers.

2.5.1 Borehole Sampling

Soil borings SB-23 through SB-84 were constructed by Buffalo Drilling Company with Mobil B-61 and CME-75 drill rigs. The majority of the borings were constructed utilizing 4¼-inch ID hollow stem augers (HSA). Three of the soil borings constructed for the deep monitoring wells, GW-4C, GW-5C and GW-6C, were installed by the spin casing method below the fill using 6-inch ID steel casing. SB-23 through SB-76, and SB-81 through SB-84 were continuously sampled using a decontaminated 2-inch OD split barrel sampler (split spoon) from the ground surface to the completed depth of the borehole for visual classification, total organic vapor screening, and possible chemical analysis of either composite or grab samples. SB-77 through SB-80 were only sampled at discrete intervals. The split spoon sampler was driven with a 140-lb hammer with a 30-inch drop and the 6-inch blows were recorded in dedicated bound field books by the field geologist. Prior to beginning each soil boring, all downhole instruments and tools were decontaminated as described in Section 6.8.2 of the Buffalo Outer Harbor Site Work Plan.

Of the 62 soil borings, 29 "unbiased" locations were predetermined and uniformly located throughout the site based on the 400-foot by 400-foot grid described in Section 2.3. These locations include the following 18 soil borings which were drilled to the base of the fill:

SB-23	SB-31	SB-41
SB-25	SB-33	SB-42
SB-26	SB-36	SB-45
SB-27	SB-38	SB-47
SB-28	SB-39	SB-48
SB-30	SB-40	SB-51



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FILE NAME: 1307-G82
DATE: RDS-06/10/95

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CONSULTING ENGINEERS

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

SOIL BORING, MONITORING WELL, PIEZOMETER AND TEST PIT LOCATIONS

PROJECT NO. 1307
DATE MARCH 1995
SCALE 1"=200'

FIGURE 2-3

Ten of the 11 remaining unbiased soil borings were completed as groundwater monitoring wells. These borings included:

SB-24 (GW-12)	SB-43 (GW-15)
SB-29 (GW-13)	SB-44 (GW-10B)
SB-32 (GW-3B)	SB-46 (GW-4C)
SB-34 (GW-14)	SB-49 (GW-16)
SB-35 (GW-5C)	SB-50 (GW-6B)

Soil boring SB-37 was originally planned to be completed as monitoring well GW-11B, however, clay was encountered from beneath the fill down to bedrock, and therefore it would not be feasible to obtain a groundwater sample in this material. The boring was subsequently abandoned and grouted with cement bentonite grout. In addition, SB-50 was planned to be completed as GW-6C, however GW-6B was drilled first at the GW-6 well cluster and logged as SB-50. During the spin casing advancement of GW-6C, split spoon sampling was conducted from 36 feet below the ground surface to the bedrock surface to supplement the information obtained during the installation of GW-6B.

Thirty three "biased" soil borings were installed in three areas where elevated levels of subsurface contamination were previously detected. These areas include subsurface soil in the vicinity of the Radio Tower, GW-3A and GW-9. Fifteen biased soil borings were completed (SB-65 through SB-76, excluding SB-67 and SB-81 through SB-84) in the Radio Tower area; eight biased soil borings were completed in the area directly surrounding GW-9 (SB-52 through SB-57, SB-79 and SB-80), and eight biased soil borings were completed in the area directly surrounding GW-3A (SB-58 through SB-64, SB-67, SB-77 and SB-78). Five of the biased soil borings drilled near the Radio Tower, SB-72 and SB-81 through SB-84, were completed as a monitoring wells (GW-18A, GW-18B, and GW-19 through GW-21).

All of the biased and unbiased soil borings except SB-77 through SB-80 were continuously sampled and were visually logged by a geologist utilizing the Modified Burmeister Soil Classification System. SB-77 through SB-80 were only sampled at discrete intervals. (See

Appendix C for the Boring Logs.) Immediately after opening each split spoon, the soils were screened with a PID and/or flame ionization detector (FID) and a radiation meter.

Soil samples from the first four split spoons (0 to 8 feet bgs) from each of the continuously sampled boreholes were collected for laboratory analysis (TCL +30 less VOCs). These first four samples collected from each borehole (labeled as A, B, C and D) were composited in the laboratory for analysis as one sample. At least one grab sample from the fill interval was selected from the remaining split spoons collected from the borehole for laboratory analysis based on visual staining, elevated PID/FID readings and/or odors. Table 2-2 indicates the depths at which the deep biased samples were collected and the classified fill unit from which the sample was obtained. Samples exhibiting elevated PID/FID readings (above 10 ppm) were collected for TCL VOC analysis. Fifteen samples were collected and analyzed for volatile organic compounds. Table 2-3 indicates the location and the depths of these samples. Sample Information Records are provided in Appendix A.

In addition to the composite and grab samples collected for chemical analysis, a soil sample was collected from the screened portion of each of the monitoring wells installed during the Phase I RI and analyzed for grain size, including sieve and hydrometer analysis in accordance with ASTM D422-63. The grain size analysis results are presented in Appendix D.

All soil borings not associated with the construction of monitoring wells were properly abandoned to prevent potential contaminant migration downward through the borehole. Each abandoned borehole was grouted to grade with cement bentonite grout. Soil cuttings generated during the drilling of all soil borings were contained in New York State Department of Transportation (NYSDOT) approved 55-gallon drums. The drums were labeled and transported to the staging area (within the former scale house building).

Table 2-2

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
SUBSURFACE SOIL SAMPLING
GRAB SAMPLE DESCRIPTION

Sample Identification	Sample Depth (in feet bgs)	Description
SB-23E	8-10	Landfill Debris
SB-24L	22-24	Native Overburden
SB-25J	18-20	Landfill Debris
SB-26H	14-16	Landfill Debris
SB-27F	10-12	Landfill Debris
SB-28H	14-16	Landfill Debris
SB-30J	18-20	Landfill Debris
SB-31K	20-22	Base of Landfill Debris
SB-32I	16-18	Landfill Debris
SB-33H	14-16	Landfill Debris
SB-34E	8-10	Hydraulic Sand Fill, Sand Fill II
SB-35E	8-10	Hydraulic Sand Fill
SB-36G	12-14	Hydraulic Sand Fill
SB-37H	14-16	Landfill Debris
SB-38I	16-18	Landfill Debris
SB-39J	18-20	Landfill Debris
SB-40J	18-20	Industrial Fill
SB-41G	14-16	Hydraulic Fill I
SB-42L	22-24	Sand Fill I, with Wood
SB-43L	22-24	Native Overburden
SB-44K	20-22	Hydraulic Fill II
SB-45H	14-16	Sand Fill II
SB-46H	14-16	Industrial Fill
SB-47J	18-20	Hydraulic Fill I
SB-48F	10-12	Sand Fill II
SB-49J	18-20	Hydraulic Fill I
SB-50I	16-18	Hydraulic Fill I
SB-51F	10-12	Industrial Fill
SB-52F	10-12	Sand Fill II and Hydraulic Fill I
SB-53H	14-16	Hydraulic Fill I
SB-54I	16-18	Landfill Debris
SB-55K	20-22	Landfill Debris
SB-56J	18-20	Landfill Debris
SB-57G	12-14	Sand Fill II
SB-58H	14-16	Landfill Debris
SB-59G	12-14	Landfill Debris

Table 2-2 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
SUBSURFACE SOIL SAMPLING
GRAB SAMPLE DESCRIPTION

Sample Identification	Sample Depth (in feet bgs)	Description
SB-60K	20-22	Base of Landfill Debris
SB-61I	16-18	Landfill Debris
SB-62L	22-24	Landfill Debris
SB-63M	24-26	Landfill Debris
SB-64I	16-18	Landfill Debris
SB-65K	20-22	Hydraulic Fill I
SB-66G	12-14	Hydraulic Fill I
SB-67K	20-22	Landfill Debris
SB-68F	10-12	Hydraulic Fill I
SB-69G	12-14	Hydraulic Fill I
SB-70H	14-16	Hydraulic Fill I
SB-71H	14-16	Hydraulic Fill II
SB-72I	16-18	Hydraulic Fill II
SB-72J	18-20	Hydraulic Fill II
SB-73F	10-12	Sand Fill II
SB-73H	14-16	Sand Fill II
SB-74G	12-14	Industrial Fill
SB-77	5-7	Landfill Debris
SB-78	5-7	Landfill Debris
SB-79H	14-16	Hydraulic Fill II
SB-80H	14-16	Hydraulic Fill II
SB-81K	20-22	Hydraulic Fill I
SB-82H	14-16	Hydraulic Fill II
SB-83H	14-16	Hydraulic Fill II
SB-84H	14-16	Hydraulic Fill II
PZ-7F	10-12	Landfill Debris
PZ-8H	14-16	Native Overburden - Olive Silt Clay
PZ-9F*	12-14	Landfill Debris
PZ-10F	10-12	Hydraulic Fill I

*Sample erroneously labeled F; should be G.

Note: Detailed descriptions of these fill units are contained in Section 3.2- Geology and the individual boring logs (Appendix C).

Table 2-3

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
SUBSURFACE SOIL SAMPLES COLLECTED FOR
VOLATILE ORGANIC ANALYSIS

Sample Identification	Sample Depth (in feet bgs)	PID Readings
SB-27E	8-10	60
SB-31G	12-14	54
SB-52I	16-18	16
SB-56M	24-26	16.9
SB-59I	16-18	257
SB-61H	14-16	30
SB-62L	22-24	120
SB-64G	12-14	100
SB-65J	18-20	35.4
SB-66H	14-16	5
SB-67J	18-20	175
SB-69I	16-18	19
SB-73G	12-14	110
SB-73H	14-16	125
SB-81K	20-22	0*
SB-82F	10-12	25
PZ-7F	10-12	12.7
PZ-7J	18-20	10

*Previous split spoon sample exhibited PID reading of 45.

2.5.2 Test Pit Excavation and Sampling

A total of three test pits (TP-1, TP-2 and TP-3) were constructed on August 29, 1994 directly east of the Radio Tower. Test pit locations are depicted in Figure 2-3. Because of high levels of nitrobenzene previously detected in subsurface soils collected from this area and the possible presence of buried drums, all test pit work was conducted in Level B personal protection equipment. Air monitoring was continuously performed during the test pit excavations and ambient air samples were also collected (see Section 2.7). Six test pits were planned to be constructed in this area to a depth of approximately 10 feet bgs. However, groundwater was encountered at 4 to 5 feet bgs making excavation below 4 feet difficult. Therefore, due to limited information that could be obtained from the test pit program, only three test pits were constructed, and it was decided that information on this area would be obtained from the boring program.

All field personnel involved with the test pit excavation were equipped with full Level B personal protection. Butyl barricade suits were donned for protection against possible contact with nitrobenzene, including butyl gloves and full face respirators. An area was set up for all Level B control equipment, including oxygen supply tanks in the upwind direction of soil disturbances and housed in a four-wheel drive vehicle. All Level B work was fully supervised by the D&B Health and Safety Officer at all times. Specific health and safety procedures involved with the test pit excavations were followed and are detailed in Section 7.0 of the Buffalo Outer Harbor Site Work Plan.

All three test pits were constructed with a CASE 850 track mounted backhoe with a bucket reach of 20 feet. Soil from the top 1 to 2 feet of the excavation was removed and placed separately. One soil sample was collected from each test pit. The selection of the sample was based on visual characteristics and PID/FID measurements. Samples were obtained from the backhoe bucket immediately after retrieval. A summary of test pit dimensions, highest PID/FID readings and samples is provided below:

Test Pit Number	Dimension	Highest PID/FID Reading (ppm)	Sample Interval (in feet bgs)
TP-1	3' x 15' x 6'	0.0/0.2	5-6'
TP-2	3' x 29' x 10'	0.0/1.3	4-5'
TP-3	3' x 20' x 12'	0.0/0.2	5-6'

Samples were also screened with a Victoreen V190 Geiger counter, however, no readings measured during test pit excavation were greater than background (1-20 uR/hr). Each sample was to be analyzed for full TCL +30 and TCLP parameters, however, due to the low PID/FID readings and the lack of visual contamination, a decision was made not to analyze the samples.

Following test pit excavation and sampling, each test pit was backfilled with the excavated soil and waste material in reverse order of removal. Final backfill and grading was performed with the soil removed from the surface of the test pit area. All pertinent sampling information was recorded by the field geologists on Test Pit Logs. These Test Pit Logs are included in Appendix C with the Boring Logs.

2.6 Piezometer and Monitoring Well Program

The following sections describe the monitoring well and piezometer installation program which was undertaken during the Phase I RI. The primary purpose of the installation of the piezometers and monitoring wells at the Buffalo Outer Harbor Site was to obtain and evaluate groundwater quality and hydrogeologic data.

2.6.1 Piezometer Locations

Five water table piezometers (PZ-1 through PZ-5) were installed off-site (directly east of the site along Fuhrmann Boulevard) to define shallow groundwater flow patterns in the vicinity of the site. Seven water table piezometers (PZ-6 through PZ-12) were installed on-site following a mid-field program evaluation of groundwater elevation data collected from the new off-site piezometers, existing groundwater monitoring wells and four staff gauges installed for the remedial investigation (see Figure 2-3). The locations of these piezometers were selected to increase the density of groundwater elevation measurement points in select on-site areas to enhance interpretation of the shallow flow regime. Piezometer locations are illustrated on Figure 2-3.

2.6.2 Piezometer Installation and Construction

All piezometers were constructed utilizing the hollow stem auger drilling method with 4¼-inch I.D. augers and 1½-inch ID Schedule 40 PVC. The well screen used in the construction of PZ-1 through PZ-5 was 0.010-inch slot Schedule 40 PVC and ranged from 12 to 15 feet in length. Piezometers PZ-6 through PZ-12 were constructed with 15-foot sections of screen.

The screened interval of each piezometer was backfilled with native material. While it was proposed in the Work Plan that the piezometers to be screened with 5 feet above the water table to allow for seasonal variation in groundwater elevations, shallow groundwater conditions encountered in many areas of the site made it difficult to maintain the planned separation distance. Piezometer screens were set a minimum of 5 feet below ground surface to prevent contamination of the screened interval by the cement surface seal.

All piezometers were completed with 1½-inch diameter Schedule 40 PVC flush threaded riser pipe with approximately 2 feet of stick up above ground surface. A 4-inch diameter steel surface casing (5 feet long) with locking cover and cement surface seal were installed around the completed piezometers. A weep hole was drilled near the base of the steel casing at each piezometer. Boring Logs and Well Construction Diagrams are provided in Appendix C and E, respectively.

2.6.3 Piezometer Depths

The piezometers were installed at an average depth of 20 feet bgs. All piezometers are screened in the fill material and across the water table. The piezometer construction details are summarized on Table 2-4.

2.6.4 Monitoring Well Locations

A total of 20 groundwater monitoring wells were installed during the Remedial Investigation (see Figure 2-3). This included installation of three bedrock wells (GW-4C, 5C and 6C), eight intermediate wells (GW-3B, 4B, 5B, 6B, 10B, 12B, 15B and 18B) screened in the native overburden, and nine shallow monitoring wells (GW-11A, 13, 14, 16, 17, 18A, 19, 20 and 21) screened across the water table within the fill material. The two proposed off-site well clusters were not installed because no shallow upgradient areas were identified off-site and were substituted with piezometers (PZ-6 through PZ-12). Monitoring well GW-17 was installed as a replacement for GW-7 which was properly abandoned during this monitoring well program. The location of the newly installed monitoring wells and the previously installed monitoring wells is provided on Figure 2-3.

2.6.5 Monitoring Well Installation and Construction

Deep Monitoring Wells

Three bedrock monitoring wells (GW-4C, 5C, and 6C) were constructed in the Onondaga Limestone as "open hole" wells (no screens were installed in the bedrock) to establish water quality and hydrogeologic parameters in the bedrock.

Table 2-4

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
DESCRIPTION OF NEWLY INSTALLED
MONITORING WELLS AND PIEZOMETERS

Well/ Piezometer Number	Description (Unit Screened)	Total Depth of Well (feet bgs)*	Groundwater Sampling Point	Soil Sampling Interval
GW-3B	Native overburden: Gray-black sand and gravel. loose, wet	36.0	B	Continuous
GW-4B	Native overburden: intermittent dark gray clay and brown sand, some gravel. wet	26.3	B	2 split spoons in screen zone
GW-4C	Bedrock: (open hole) gray fossiliferous limestone	80.3	C	Continuous
GW-5B	Native overburden: gray silt and clay (occas. red clay and lam. of sand)	59.6	B	2 split spoons in screen zone
GW-5C	Bedrock: (open hole) gray fossiliferous limestone	79.3	C	Continuous
GW-6B	Native overburden: red-brown clay, green fine sand, gravel, wet	30.2	B	Continuous (continuous to 34' bgs)
GW-6C	Bedrock: (open hole) gray fossiliferous limestone	83.5	C	0 to 34' bgs no sampling Continuous from 34'-64' bgs
GW-10B	Native overburden: pink clay (some silt and sand), very moist-wet	34.0	B	Continuous
GW-11A	Fill: dark gray sand, some silt	19.5	A	2 split spoons in screen zone

Table 2-4 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
DESCRIPTION OF NEWLY INSTALLED
MONITORING WELLS AND PIEZOMETERS

Well/ Piezometer Number	Description (Unit Screened)	Total Depth of Well (feet bgs)*	Groundwater Sampling Point	Soil Sampling Interval
GW-12B	Native overburden: salt and pepper sand and gravel, wet	42.1	B	Continuous
GW-13	Fill: tan and gray sand, some clay, wet	17.8	A	Continuous
GW-14	Fill: brown and gray sand, gravel, brick, gastro pods, tr. cinders	20.0	A	Continuous
GW-15B	Native overburden: dark green clay and silt, and red-brown silt and clay, little gravel	31.4	B	Continuous
GW-16	Fill: brown silt, slag, wood, and green-brown silt and clay	20.2	A	Continuous
GW-17	Fill: olive gray fine sand, silt, gravel	17.6	A	2 split spoons in screen zone
GW-18A	Fill: black silt, green fine sand, red-brown clay, strong odor, brick, gravel	19.7	A	Continuous
GW-18B	Native overburden: gray-black, fine to medium sand, silt and clay	28.5	B	Continuous
GW-19	Fill: gray-brown-black silt, trace gravel, trace sand, trace brick and waste	16	A	Continuous

Table 2-4 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
DESCRIPTION OF NEWLY INSTALLED
MONITORING WELLS AND PIEZOMETERS

Well/ Piezometer Number	Description (Unit Screened)	Total Depth of Well (feet bgs)*	Groundwater Sampling Point	Soil Sampling Interval
GW-20	Fill: gray-brown sand and silt, weed, brick, concrete, gravel	16	A	Continuous
GW-21	Fill: gray silt, fine sand, black organic matter	16	A	Continuous
PZ-1	Fill: brown-black sand, gravel, brick	14.7	A	No sampling
PZ-2	Fill: brown-black sand, gravel, brick	14.5	A	No sampling
PZ-3	Fill: brown silt and sand, little gravel	14.5	A	No sampling
PZ-4	Fill: brown silt, some gravel, red brick, ceramic chips	14.4	A	No sampling
PZ-5	Fill: black silt and sand, tr. gravel	14.3	A	No sampling
PZ-6	Fill: gray sand, silt and dark gray clay, brick, wood, gravel	19.8	A	Continuous
PZ-7	Fill: S&P sand, black silt, wood, gravel, cinder, glass, concrete	19.5	A	5' intervals
PZ-8	Fill: S&P sand grading to green gray silt and clay	19.7	A	Continuous

Table 2-4 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
DESCRIPTION OF NEWLY INSTALLED
MONITORING WELLS AND PIEZOMETERS

Well/ Piezometer Number	Description (Unit Screened)	Total Depth of Well (feet bgs)*	Groundwater Sampling Point	Soil Sampling Interval
PZ-9	Fill: brown-black sand, silt, brick, glass, slag, wood, clay	20.1	A	Continuous
PZ-10	Fill: red-brown clay, coal, cinder, wood, slag, sand, gravel	19.9	A	Continuous
PZ-11	Fill: Black-white sand, silt, gravel, cinder, clay, slag	20.1	A	5' intervals
PZ-12	Fill: red-black, sand, gravel, ash, brick, cinder, slag, silt	18.9	A	Continuous

Notes:
A - Water table (fill)
B - Piezometric surface (native overburden)
C - Bedrock
bgs - below ground surface

*Total depth rounded to the nearest 0.1'.

The bedrock monitoring well boreholes were drilled with a Mobile B-61 Drill Rig utilizing the spin casing method with 6-inch flush joint steel casing. The 6-inch casing was advanced with an attached diamond impregnated drive shoe. After the drill rig was mobilized and set up, 6¼-inch ID hollow stem augers (HSA) were advanced to a depth of 10 feet bgs. A 10-foot section of 8-inch ID temporary steel casing was set in the borehole with a 2-foot section of bentonite grout set to grade to seal the casing. The 6-inch drill casing was installed through this outer casing which supported the discharge pipe for collection and containment of drill water. Potable water was continually pumped through (inside) the steel casing during casing advancement for borehole flushing and removal of the formation cuttings.

The use of the spin casing technique and the installation of temporary casing provided excellent control of running sands (sands and fine gravels) which were present at certain locations and intervals. Drilling continued until refusal was encountered at the bedrock surface. The depth to bedrock was encountered at 60.5 feet bgs in GW-4C, 65.5 feet bgs in GW-5C and 62 feet bgs in GW-6C. Bedrock coring commenced at the top of rock with an NQ-2 diamond bit corer to approximately 5 feet below the top of rock. The core hole was then reamed out with a 5 7/8-inch roller bit to a 6-inch ID hole forming the rock socket. This drilling method was modified slightly during the installation of GW-6C. As a time saving step, a 5-inch reaming shoe was used simultaneously with the diamond bit core barrel during bedrock drilling to eliminate the need to use a roller bit. During construction of each well, the new 4-inch PVC riser pipe was plugged with a PVC plug, loaded with potable water (to facilitate lowering) and lowered into the 5-foot rock socket. The casing was then sealed with cement-bentonite grout. The cement-bentonite grout was pressure pumped into the rock socket prior to the installation of the casing to ensure proper installation. Once in place in the socket, the casing was secured to prevent shifting and the 6-inch spin casing was removed as the borehole was backfilled with pressure pumped cement-bentonite grout. The grout was pumped to within 3.5 feet of the ground surface. The hole was left undisturbed for greater than 12 hours in order to facilitate grout curing. The following day, coring commenced with the NQ-2 corer until the well produced water. GW-4C and GW-5C were then reamed to 4-inch diameter. A bail down test was conducted to ensure that each new well was capable of producing water.

Six-inch protective steel casings, extending no more than 2.5 feet above the ground surface and 2.5 feet bgs, were set and locked. The steel casing was set in a minimum 2 feet by 2 feet by 2 feet thick concrete pad constructed at the ground surface. The pads were constructed with a surface that slopes radially away from the protective casing. Weep holes were constructed in the base of the protective casings to allow for drainage. Well Construction Diagrams for the deep monitoring wells can be found in Appendix E.

Intermediate Monitoring Wells

Seven intermediate depth monitoring wells (GW-3B, 4B, 5B, 6B, 10B, 12B, 15B and 18B) were installed during the Phase I/Phase II RI to determine water quality in the native overburden and measure hydrogeologic parameters. The wells were installed with a Mobile B-61 Drill Rig and 4¼-inch hollow stem augers. The intermediate depth monitoring wells were constructed with 2-inch ID 0.006-inch slot, Schedule 40 PVC well screen and Schedule 40 PVC riser pipe. In the construction of GW-3B, a coarser 0.010-inch slot screen was used due to the coarser formation material encountered. Ten foot well screens were used at GW-3B, 5B, 10B, 12B and 15B, however five and six foot well screens were used at GW-6B, GW-4B and GW-18B, respectively, due to differing lithologies at those locations. A clean Number N00 grade silica sand pack (and Number 0 grade at GW-3B) was tremied in place to a depth of 2 feet above the top of the well screen and no more than 6 inches below the base of the screen. The sand pack grain size was selected based on the slot size of the well screen.

A 2-foot thick bentonite slurry seal was pressure pumped above the sand pack. The remaining annular space above the sand pack was filled with cement-bentonite grout. The cement-bentonite grout was pressure pumped into the annular space by the tremie method from the top of the sand pack to within 3.5 feet of the ground surface. Construction of the protective casing and concrete pad was conducted in the same manner as the bedrock monitoring wells, however, 6-inch thick protective casing was used. Well Completion Logs for the intermediate depth wells can be found in Appendix E.

Shallow Monitoring Wells

Nine shallow monitoring wells (GW-11A, GW-13, GW-14, GW-16, GW-17, GW-18A, GW-19, GW-20 and GW-21) were installed with a Mobile B-61 Drill Rig. The wells were constructed with 2-inch diameter, 0.006-inch slot, Schedule 40 PVC well screens and Schedule 40 PVC risers. These wells were set approximately 10 feet below the water table. A clean Number N00 grade silica pack was tremied in place to a depth of 2 feet above the top of the well screen and no more than 6 inches below the base of the screen. Construction of the shallow monitoring wells, including protective casings, were conducted in the same manner as the intermediate monitoring wells.

At the completion of all the shallow, intermediate and deep monitoring wells, a vented PVC cap was placed on the riser pipe and the wells were labeled with the appropriate well number. The existing on-site wells and wells installed as part of this investigation were secured with keyed alike waterproof padlocks.

All drill cuttings generated during the construction of all shallow, intermediate and deep monitoring wells were contained in NYSDOT approved 55-gallon drums. The drums were transported to the drum staging area on-site and stored in the former scale house.

2.6.6 Monitoring Well Depths

Each monitoring well cluster consists of either two or three individual monitoring wells screened at different lithologic units (A-shallow, B-intermediate and C-deep) at the same location. These monitoring well clusters were designed to define the hydraulic connection between the upper fill unit (shallow), the underlying native overburden unit (intermediate) and the Onondaga Limestone bedrock (deep).

The total depths of the wells installed during this investigation may have varied from the planned depths due to differences in the expected depth to water, thickness of fill, geologic characteristics of the native overburden, or general site-specific problems with drilling. The monitoring well construction details for all installed during the Phase I/Phase II RI are summarized in Table 2-5.

The three deep monitoring wells were installed at each cluster location, ranging in depth from approximately 79-83 feet bgs. GW-4C was constructed to approximately 80.3 feet bgs. GW-5C and GW-6C were constructed to 79.3 feet bgs and 83.5 feet bgs, respectively.

The intermediate monitoring wells were installed ranging in depth from approximately 26.3 feet bgs in GW-4B to 59.6 feet bgs in GW-5B. All intermediate monitoring wells penetrate the upper fill unit and are screened completely within the native overburden.

The shallow monitoring wells were installed at an average depth of approximately 20 feet bgs. The range in total depths of the shallow wells is 16 feet bgs at GW-19 to 20 feet bgs at GW-14.

2.6.7 Monitoring Well Development

All monitoring wells were to be developed by pumping and surging the well screen interval until the turbidity of the groundwater achieved a reading of 50 nephelometric turbidity units (NTUs) or less. Development was initiated with bailing to remove fine grain sediments from the well bottom. A Grundfos RediFlo-2 2-inch diameter submersible pump was used with dedicated polyethylene tubing, suction pump from the CME-55 and/or hand operated Brainard-Kilman manual pump was used to develop the monitoring wells. The pumps removed the fine sand and silt from the well casing, annulus (sand pack), and surrounding formation which tends to increase the well yield and ensure better development. Water quality measurements, including pH, specific conductivity, temperature, salinity, percent dissolved oxygen, and turbidity, were taken at specified pumping volume intervals (approximately each well volume) to monitor stabilization of these field

Table 2-5

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
SUMMARY OF NEWLY INSTALLED MONITORING WELL AND PIEZOMETER CONSTRUCTION DETAILS

Well/Piezometer Number	Total Depth of Well (feet below grade)	Elevation of Ground (feet relative to IGLD)	Top of PVC Casing (feet relative to IGLD)	Elevation of Screen Interval (feet relative to IGLD)
GW-3B	36.0	582.8	585.3	546.8-556.8
GW-4B	26.3	582.2	584.7	555.9-561.2
GW-4C	80.3	583.2	585.2	502.9-518.0
GW-5B	59.6	585.4	587.3	525.8-535.8
GW-5C	79.3	585.6	587.6	506.3-515.5
GW-6B	30.2	583.9	585.8	553.7-558.9
GW-6C	83.5	583.0	585.6	499.5-509.4
GW-10B	34.0	581.2	583.8	547.2-557.2
GW-11A	19.5	583.0	584.7	563.5-578.5
GW-12B	42.1	583.8	586.3	541.7-551.7
GW-13	17.8	583.3	585.7	565.5-578.5
GW-14	20.0	584.1	586.8	564.1-579.1
GW-15B	31.4	581.3	584.0	549.9-555.9
GW-16	20.2	583.2	585.5	563.0-578.0
GW-17	17.6	579.0	581.5	561.4-573.4
GW-18A	19.7	584.2	586.1	564.5-579.5
GW-18B	28.5	584.7	586.8	556.2-561.2
GW-19	16.0	584.2	586.4	568.2-578.2
GW-20	16.0	585.3	587.3	569.3-579.3
GW-21	16.0	584.0	586.0	568.0-578.0
PZ-1	14.7	582.5	585.4	567.8-580.8
PZ-2	14.5	580.9	583.9	566.4-579.4
PZ-3	14.5	582.1	585.3	567.6-580.6
PZ-4	14.4	583.7	586.6	569.3-582.3
PZ-5	14.3	585.2	587.5	570.9-583.9
PZ-6	19.8	585.2	587.8	565.4-580.4
PZ-7	19.5	587.4	589.8	567.9-582.9
PZ-8	19.7	585.6	587.6	565.9-580.9
PZ-9	20.1	585.6	587.9	565.5-580.5
PZ-10	19.9	586.7	589.1	566.8-581.8
PZ-11	20.1	585.3	587.3	565.2-580.2
PZ-12	18.9	583.4	586.1	564.5-579.5

parameters during development. Development continued until the field parameters stabilized for three consecutive readings within 10 percent variability or less.

Yield varied considerably among the new groundwater monitoring wells. In general, the higher yielding wells cleaned up the best with resultant turbidities below 50 NTUs. The lowest yielding wells, where repeated development attempts had to be made (due to complete evacuation of well bore within one well volume), were the least successful in cleaning up. This was due to the low yielding formation material which had a high percentage of fine grained material. In addition, the flushing action of development on the screen and surrounding formation was reduced due to lower volumes of water removed from these wells. Final turbidities of the newly installed wells following development are provided in Table 2-6. During development, water was collected in DOT-approved 55-gallon ring-top drums. Following completion, all development water excluding water from wells installed in the Radio Tower Area was transported to a shallow pit excavated southeast of SB-42 and discharged to the pit.

2.6.8 Borehole/Monitoring Well and Piezometer Logging

All borehole monitoring well split spoon samples were logged and documented by a geologist in accordance with the procedures outlined in Section 6.10.5 of the Work Plan. Notes were kept in both bound field books and on Boring Log and Well Construction Logs following procedures outlined in Section 6.10.6 of the Work Plan. Well Construction Diagrams and Boring Logs are provided in Appendices E and C, respectively. The Modified Burmeister Classification System was used to describe soil samples recovered from the split spoons. Daily Field Activity Reports were completed to document drilling activities (or any other field activities) undertaken as part of this investigation.

Table 2-6

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
FINAL MONITORING WELL DEVELOPMENT TURBIDITIES

Well Location	Final Turbidity (NTUs)	Development Date
GW-3B	25	10/4/94
GW-4B	100	9/28/94
GW-4C	101	9/28/94, 9/30/94, 10/4/94, 10/5/94, 10/7/94
GW-5B	73	9/29/94
GW-5C	15	9/29/94
GW-6B	7	9/26/94
GW-6C	26	10/3/94, 10/5/94, 10/7/94
GW-10B	>999	10/5/94, 10/6/94, 10/7/94, 10/10/94
GW-11A	44	9/29/94, 10/3/94, 10/4/94
GW-12B	14	9/30/94
GW-13	44.1	10/3/94
GW-14	4	10/3/94
GW-15	36.4	10/5/94
GW-16	>200	10/4/94, 10/7/94
GW-17	312	9/30/94
GW-18A	35	10/6/94
GW-18B	16	6/27/95
GW-19	>999	6/27/95
GW-20	46	6/27/95
GW-21	180	6/27/95

2.6.9 Groundwater Level Measurements

Stabilized groundwater level measurements were obtained from each of the 16 newly installed monitoring wells and the 14 existing monitoring wells on eight occasions during the Phase I field investigation. Stabilized groundwater level measurements were obtained from each of the 20 newly installed monitoring wells and the 14 existing monitoring wells on one occasion during the Phase II field investigation. The static water levels were measured to the nearest one-hundredth (0.01) foot using a Solinst electronic water level indicator. All static water levels were taken from a presurveyed reference point on the top of the PVC well casing. The electronic water level indicator was properly decontaminated between use in each well.

The frequency of static water level rounds (monitoring rounds) during the Phase I RI increased as the monitoring well and piezometer installations progressed. Table 2-7 represents static water levels collected on October 20, 1994, which were used to construct groundwater contour maps to determine local flow conditions. Table 2-8 represents static water levels collected during the Phase II investigation on June 28, 1995. The remainder of the groundwater elevation measurements are presented in Appendix F.

2.6.10 Groundwater Sampling

Phase I RI

Groundwater samples were collected from each of the 14 existing and 16 newly installed monitoring wells (including on-site piezometer PZ-12) to characterize the current groundwater quality and to aid in the determination of any release of contamination due to past activities at the site. The interpretation of groundwater sampling results will enable current groundwater quality characterization for each of the three distinctive geologic units on-site (fill, native overburden and bedrock). The groundwater samples were collected between October 10 and 20, 1994, and each groundwater sample was analyzed for TCL +30 parameters.

Table 2-7

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
GROUNDWATER AND SURFACE WATER ELEVATION MEASUREMENTS
FOR OCTOBER 20, 1994

Well, Piezometer, and Staff Gauge Designation	PVC Riser Elevation* (feet)	Depth to Water From Riser (feet)	Groundwater Elevation* (feet)
GW-1	592.37	20.10	572.27
GW-2A	589.41	13.20	576.21
GW-3A	585.67	12.21	573.46
GW-4A	585.56	9.81	575.75
GW-5A	587.72	15.08	572.64
GW-6A	586.26	8.72	577.54
GW-8A	584.46	9.41	575.05
GW-9	587.27	14.62	572.65
GW-10A	583.07	5.85	577.22
GW-11A	584.65	9.93	574.72
GW-13	585.70	7.99	577.71
GW-14	586.75	12.58	574.17
GW-15B	583.96	12.38	571.58
GW-16	585.47	11.07	574.40
GW-17	581.48	7.31	574.17
GW-18A	586.09	10.48	575.61
SG-1	Bolt top 575.08	3.35	571.73
SG-2	Filed notch 574.17	2.51	571.66
SG-3	Nail top 583.37	11.65	571.72
SG-4	Nail top 577.74	6.60	571.14
PZ-1	585.35	11.64	573.71
PZ-2	583.93	10.81	573.12
PZ-3	585.28	9.68	575.60
PZ-4	586.64	11.87	574.77
PZ-5	587.52	14.39	573.13
PZ-6	587.78	9.20	578.58
PZ-7	589.84	15.96	573.88
PZ-8	587.59	9.91	577.68
PZ-9	587.88	11.76	576.12
PZ-10	589.13	10.85	578.28
PZ-11	587.29	13.05	574.24
PZ-12	586.13	11.59	574.54

Notes: All water table wells are screened in the fill unit.
All depth to water measurements were collected within a 5-hour period on October 20, 1994.
MW-7 was abandoned during the Phase I RI and replaced with MW-17 on September 6, 1994.
0.65 inches of rain was recorded on the previous day (October 19, 1994).

NA - Not applicable

*Elevations are tied into and reported in relation to the International Great Lakes Datum (IGLD) of 1955.

Table 2-7 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
GROUNDWATER AND SURFACE WATER ELEVATION MEASUREMENTS
FOR OCTOBER 20, 1994

Well, Piezometer, and Staff Gauge Designation	PVC Riser Elevation* (feet)	Depth to Water From Riser (feet)	Groundwater Elevation* (feet)
GW-2B**	588.88	15.99	572.89
GW-3B	585.26	12.03	573.23
GW-4B	584.71	9.81	574.9
GW-5B	587.32	15.79	571.53
GW-6B	585.75	12.23	573.52
GW-8B	584.62	13.41	571.21
GW-10B	583.76	10.81	572.95
GW-12B	586.33	14.92	571.41

Notes: All intermediate depth monitoring wells are screened in the native overburden interval.
All depth to water measurements were collected within a 4-hour period on October 20, 1994.

*Elevations are tied into and reported in relation to the International Great Lakes Datum (IGLD) of 1955.

** GW-2B is mislabeled as GW-2C in the field. Groundwater elevation data has been corrected in the field notebooks. Survey data contained in Appendix G has been hand corrected.

Table 2-7 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
GROUNDWATER AND SURFACE WATER ELEVATION MEASUREMENTS
FOR OCTOBER 20, 1994

Well, Piezometer, and Staff Gauge Designation	PVC Riser Elevation* (feet)	Depth to Water From Riser (feet)	Groundwater Elevation* (feet)
GW-2C**	589.12	17.80	571.32
GW-4C	585.19	13.40	571.79
GW-5C	587.60	16.26	571.34
GW-6C	585.56	14.07	571.49
GW-8C	584.35	14.00	570.35

Notes: All deep bedrock monitoring wells measure potentiometric head within the Onondaga limestone bedrock unit.
All depth to water measurements were collected within a 5-hour period on October 20, 1994.

*Elevations are tied into and reported in relation to the International Great Lakes Datum (IGLD) of 1955.

** GW-2C is mislabeled as GW-2B in the field. Groundwater elevation data has been corrected in the field notebooks. Survey data contained in Appendix G has been hand corrected.

Table 2-8

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
GROUNDWATER AND SURFACE WATER ELEVATION MEASUREMENTS
FOR WATER TABLE WELLS
FOR JUNE 28, 1995

Well, Piezometer, and Staff Gauge Designation	PVC Riser Elevation* (feet)	Depth to Water From Riser (feet)	Groundwater Elevation* (feet)
GW-1	592.37	19.85	572.52
GW-2A	589.41	11.75	577.66
GW-3A	585.67	11.89	573.78
GW-4A	585.56	9.19	576.37
GW-5A	587.72	14.83	572.89
GW-6A	586.26	9.01	577.25
GW-8A	584.46	10.05	574.41
GW-9	587.27	13.82	573.45
GW-10A	583.07	6.17	576.90
GW-11A	584.65	9.31	575.34
GW-13	585.70	8.48	577.22
GW-14	586.75	12.42	574.33
GW-15B	583.96	12.21	571.75
GW-16	585.47	10.80	574.67
GW-17	581.48	7.56	573.92
GW-18A	586.09	9.83	576.26
GW-19	586.35	12.28	574.07
GW-20	587.34	11.96	575.38
GW-21	585.95	7.10	578.85
SG-1	Bolt top 575.08	6.75	568.33
SG-2	Filed notch 574.17	3.01	571.16
SG-3	Nail top 583.37	12.08	571.29
SG-4	Nail top 577.74	6.44	571.30
PZ-1	585.35	11.75	573.60
PZ-2	583.93	10.53	573.40
PZ-3	585.28	9.16	576.12
PZ-4	586.64	11.30	575.34
PZ-5	587.52	14.11	573.41
PZ-6	587.78	9.76	578.02
PZ-7	589.84	--	--**
PZ-8	587.59	10.19	577.40
PZ-9	587.88	14.85*	573.03***
PZ-10	589.13	10.66	578.47
PZ-11	587.29	12.42	574.87
PZ-12	586.13	11.03	575.10

Notes: All water table wells are screened in the fill unit.
All depth to water measurements were collected within a 8-hour period on June 28, 1995.
MW-7 was abandoned during the Phase I RI and replaced with MW-17 on September 6, 1994.

NA - Not applicable

*Elevations are tied into and reported in relation to the International Great Lakes Datum (IGLD) of 1955.

**Well clogged with iron bacteria. Unable to obtain water level.

***Protective casing disturbed; integrity of piezometer potentially compromised.

Table 2-8 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
GROUNDWATER AND SURFACE WATER ELEVATION MEASUREMENTS
FOR NATIVE OVERBURDEN WELLS
FOR JUNE 28, 1995

Well, Piezometer, and Staff Gauge Designation	PVC Riser Elevation* (feet)	Depth to Water From Riser (feet)	Groundwater Elevation* (feet)
GW-2B**	588.88	15.71	573.17
GW-3B	585.26	11.71	573.55
GW-4B	584.71	9.30	575.41
GW-5B	587.32	15.69	571.63
GW-6B	585.75	11.95	573.8
GW-8B	584.62	13.63	570.99
GW-10B	583.76	10.74	573.02
GW-12B	586.33	14.55	571.78
GW-18B	586.76	12.62	574.14

Notes: All intermediate depth monitoring wells are screened in the native overburden interval.
All depth to water measurements were collected within a 8-hour period on June 28, 1995.

*Elevations are tied into and reported in relation to the International Great Lakes Datum (IGLD) of 1955.

** GW-2B is mislabeled as GW-2C in the field. Groundwater elevation data has been corrected in the field notebooks. Survey data contained in Appendix G has been hand corrected.

Table 2-8 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
GROUNDWATER AND SURFACE WATER ELEVATION MEASUREMENTS
FOR BEDROCK WELLS
FOR JUNE 28, 1995

Well, Piezometer, and Staff Gauge Designation	PVC Riser Elevation* (feet)	Depth to Water From Riser (feet)	Groundwater Elevation* (feet)
GW-2C**	589.12	17.10	572.02
GW-4C	585.19	13.50	571.69
GW-5C	587.60	16.20	571.40
GW-6C	585.56	13.97	571.59
GW-8C	584.35	13.80	570.55

Notes: All deep bedrock monitoring wells measure potentiometric head within the Onondaga limestone bedrock unit.
All depth to water measurements were collected within a 8-hour period on June 28, 1995.

*Elevations are tied into and reported in relation to the International Great Lakes Datum (IGLD) of 1955.

** GW-2C is mislabeled as GW-2B in the field. Groundwater elevation data has been corrected in the field notebooks. Survey data contained in Appendix G has been hand corrected.

The monitoring wells and PZ-12 were sampled by first measuring the depth to the water in order to calculate the well volume necessary for purging.

The 30 monitoring wells and piezometer-PZ-12 were then purged a minimum of three to five well volumes using either a Grundfos RediFlo-2 2-inch submersible pump or a disposable bailer. The number of well volumes purged were a function of stabilization of the field parameters pH, temperature and conductivity. The field parameters were measured using either a Horiba U-10 water quality checker (for pH, temperature, conductivity, salinity, percent dissolved oxygen and turbidity) or an ICM 51601 (for same parameters as Horiba U-10 except salinity and turbidity). Turbidity was measured with either a HACH or H.F. Scientific turbidimeter or Horiba U-10 water quality checker. In cases where the turbidity failed to drop below 50 NTUs, the collection of metals fraction of the sample was postponed to allow for suspended sediment to settle out of the water column. In these cases, the collection of the metals sample occurred within 24 hours of the initial purging event.

All groundwater samples were collected using dedicated disposable polyethylene bailers in the following order: TCL volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides/PCBs, metals and cyanide. The groundwater was poured directly into the appropriate laboratory supplied sample jars and stored in a cooler on ice. Purge water was contained in 55-gallon drums and disposed of on-site at the discharge pit southeast of SB-42.

During purging and sampling at monitoring well GW-4C and piezometer PZ-12, a turbidity level below 50 NTUs was not attainable within a 24-hour period after well purging. Therefore, two samples were collected, one for dissolved metals and one for total metals. The dissolved samples were filtered in the field through a 0.45-micron filter prior to submittal to the laboratory. The sample collected for total metals analysis was not filtered.

Appropriate QA/QC samples were collected to meet the minimum Data Quality Requirements outlined in Section 6.0 of the Work Plan. Trip blank samples accompanied all laboratory sample coolers in which the TCL VOC samples were placed. Six trip blank samples were analyzed for VOCs, or one trip blank per shipment.

Phase II RI

Based upon the results of the Phase II investigation groundwater samples were collected from 15 monitoring wells GW-1, GW-2A, GW-3A, GW-5A, GW-8A, GW-8B, GW-8C, GW-9, GW-16, GW-17, GW-18A, GW-18B, GW-19, GW-20 and GW-21. Groundwater samples were collected from these wells in order to clarify discrepancies between historical and recent groundwater sampling results and further define the extent of documented groundwater contamination.

Groundwater samples were collected between June 19, 1995 and July 7, 1995. Each sample was analyzed for SVOCs, metals and cyanide. Groundwater samples collected from the five wells in the Radio Tower Area (GW-18A, GW-18B, GW-19, GW-20 and GW-21) were also analyzed for VOCs. Duplicate samples were collected from GW-3A, GW-9, GW-18A and GW-21. All samples were analyzed by Energy and Environmental Engineering, Inc. and duplicate samples were analyzed by Nytest Environmental, Inc.

The monitoring wells were sampled by first measuring the depth to water in order to calculate the well volume necessary for purging. The monitoring wells were purged a minimum of three to five well volumes using a disposable bailer. Sampling procedures were conducted using the same procedures discussed above for the Phase I RI.

Due to concerns regarding the influence of turbidity levels on the levels of metals detected in groundwater samples collected from GW-3A and GW-9 during the Phase I RI, a decision was made to collect both a total and dissolved sample from this well to be analyzed for metals. The dissolved sample was placed in an unpreserved bottle and filtered in the laboratory. The sample collected for total metals analysis was placed in a preserved bottle and was not filtered.

As discussed above all appropriate QA/QC samples were collected. Trip blanks accompanied all laboratory sample coolers in which VOC samples were placed. A total of four trip blank samples were analyzed for VOCs during the Phase II RI.

2.6.11 In Situ Hydraulic Conductivity Testing

In situ hydraulic conductivity tests (slug tests) were conducted on 13 of the 16 monitoring wells installed during the Phase I RI. Slug tests were conducted on five shallow water wells: GW-11A, 13, 14, 16 and 18A; six intermediate depth wells GW-3B, 4B, 5B, 10B, 12B and 15B; and two bedrock wells GW-4C and 5C. The wells selected for slug tests were considered to be representative of all on-site monitoring wells (for each of the three depth intervals). Each monitoring well that was slug tested had been previously developed.

Slug tests provide data used to calculate the hydraulic conductivity of the formation in the vicinity of the well screen. Rising head and falling head slug tests were performed on each monitoring well and the data analyzed by the Bouwer and Rice Method (1976, 1989).

The slug tests (falling and rising head) utilized a 1½-inch diameter variable length PVC slug (weighted with metal insert). A Hermit Model 1000 data logger and pressure transducer were used to measure and record groundwater elevation changes during the test. An IBM-compatible laptop computer was used in conjunction with the Hermit data logger for data storage.

Static water levels were measured with a decontaminated electronic water level meter at each monitoring well before any instruments were inserted. The pressure transducer was then lowered below the static water level, secured and allowed to equilibrate. The falling head tests were performed first (before rising head tests) by inserting the decontaminated PVC slug below the static water level as quickly and smoothly as possible (and fully penetrating). The data logger was started immediately prior to the installation of the slug at time t=0. The infiltration rate, measured and recorded by data logger, are accurate to the nearest 0.001 feet of water level depth and 0.001 seconds of elapsed time. The rising head tests were performed after the falling head tests once the static water level had returned within 90% of the original equilibrium level.

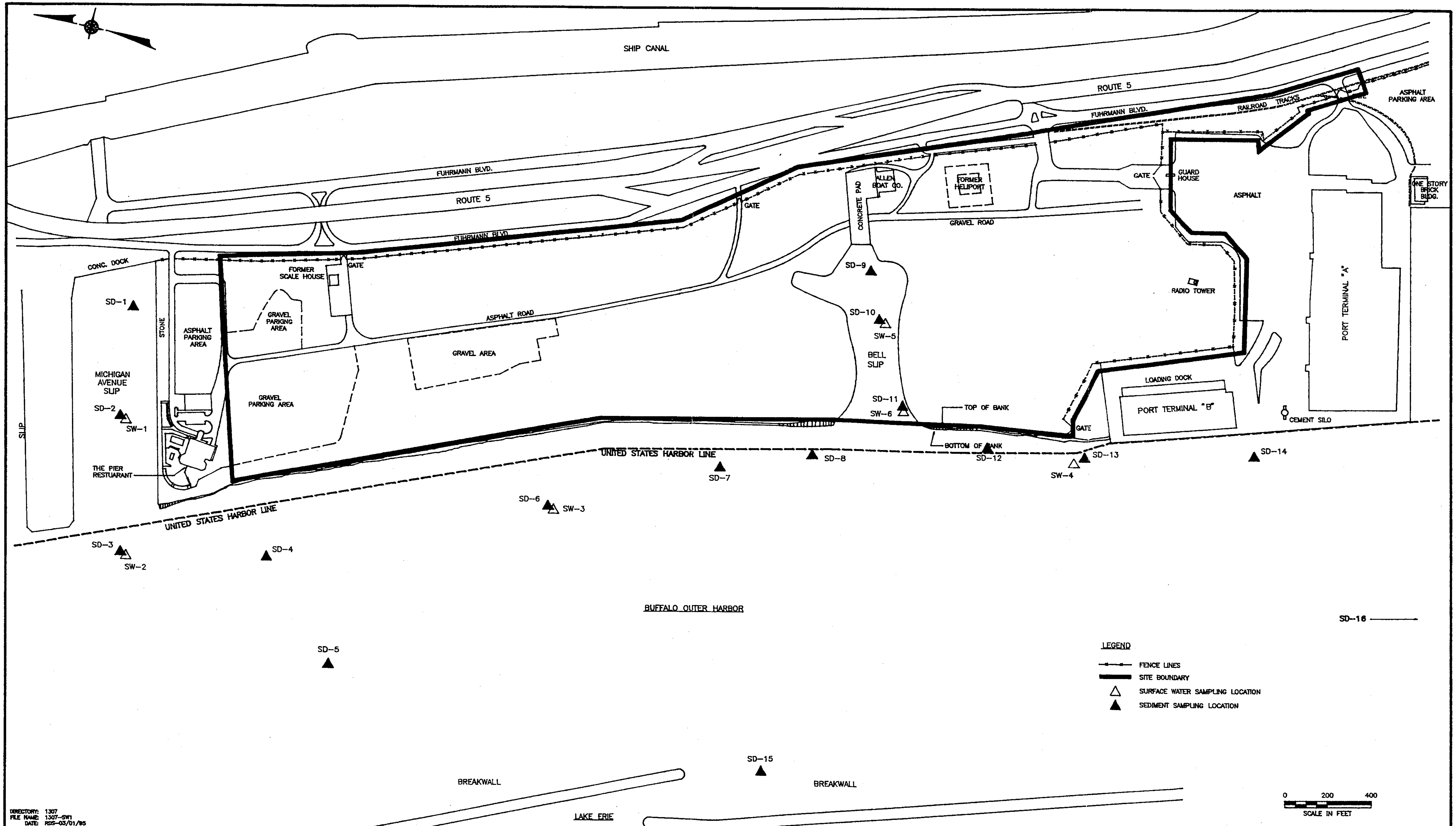
Hydraulic conductivity values derived from the slug tests will be supplemented from grain size distribution curves from samples collected at each well location (or one from each well cluster). Hydraulic conductivities will be estimated by relationship described by Hazen (1892) and further defined by Shepherd (1989). In situ hydraulic conductivity testing results are provided in Appendix H.

2.7 Surface Water Sampling

A total of six surface water samples were collected as part of this investigation (see Figure 2-4). One surface water sample was collected from the Michigan Avenue Slip (MA SW-1), two samples were collected from the Bell Slip (BS-SW-5 and 6), and three samples were collected from the Buffalo Outer Harbor (OH-SW-2, 3 and 4). Seven surface water samples were planned, however, only six samples were collected and analyzed. The location of surface water sample SW-4 in the Work Plan was moved to SW-7 and SW-7 sample was eliminated. These samples were collected 0 to 6 inches below the water surface. Each sample was analyzed for full TCL +30 parameters (including TCL VOCs) and hardness. Sample Information Records are provided in Appendix A.

2.8 Surface Water Sediment Sampling

A total of 16 surface water sediment samples were collected as part of this investigation (see Figure 2-4). Two samples were collected from the Michigan Avenue Slip (MA-SD-1 and 2), three samples were collected from the Bell Slip (BS-SD-9, 10, and 11), and nine samples were collected from the Buffalo Outer Harbor (OH-SD-3 through 8, and 12 through 14), including two background samples (OH-SD-15 and 16). Fifteen samples were originally planned, however, one additional sample (OH-SD-16) was collected from the Outer Harbor. This sample was collected at the same location as a US Army Corps of Engineer Sampling Station. These samples were collected 0 to 6



DIRECTORY: 1307
FILE NAME: 1307-SW1
DATE: RDS-03/01/95

NO.	DATE	REVISION	INT.

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DVIRKA AND BARTILUCCI
CONSULTING ENGINEERS

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

SURFACE WATER AND SURFACE WATER SEDIMENT SAMPLING LOCATION

PROJECT NO. 1307
DATE: MARCH 1995
SCALE: 1"=200'

FIGURE 2-4

inches below the surface of the sediment by using a ponar sampler after the surface water samples were collected. Each sample was analyzed for full TCL +30 parameters, total organic carbon (TOC) and grain size analysis. Each sample was analyzed for pH, Eh and hydrogen sulfide (H_2S) in the field. The results of the field analysis are presented on Sample Information Logs in Appendix A.

2.9 Ambient Air Sampling

Due to the concern regarding elevated levels of nitrobenzene, other semi-volatile compounds, and volatile organic compounds in the ambient air as a result of the findings of previous investigation activities in the vicinity of the Radio Tower, a total of 10 ambient air samples were collected during the installation of biased soil borings in this area. Ambient air sampling was originally planned to be performed during the test pit excavations, however, since the test pit program was reduced in scope, the ambient air samples were collected during soil boring construction.

The first five ambient air samples were collected on August 30, 1994, during the first two biased soil borings in the Radio Tower area (SB-65 and SB-66). One tenax tube was attached to the chest area of the field geologist representing the breathing zone (OSHA requirement) over the split spoon sampling work area (AA-01), one sample was collected five feet downwind of borehole SB-65 (AA-02), and two other samples were collected 3 feet from the soil cutting drums at each boring location (AA-03 and AA-04). In addition, one field blank sample was collected for QA/QC requirements (AA-05).

Due to a concern regarding elevated levels of nitrobenzene in the ambient air in the area of the Radio Tower, it was decided to collect additional air samples. On September 19 and 20, 1994, soil boring and ambient air sampling continued in the Radio Tower area. On September 19, 1994, three composite ambient air samples were collected during the installation of soil borings SB-68 and SB-70. Two of the samples (01 and 02) were attached to the chest area of the field geologist representing the breathing zone above the sample collection area and the remaining sample was a field blank for QA/QC (03). On September 20, 1994, two composite ambient air samples were collected during the installation of soil borings SB-69 and SB-71. Both of these samples (04 and 05) were breathing sampling zone samples (OSHA requirement) as described above.

The ambient air samples were collected by purging air at a specified constant rate through the tenax tube sample columns with a Gillian air pump compositing the air sample for the duration of the specific work event. The procedure for air sampling is outlined in Section 6.7.11 of the Work Plan in accordance with Method TO1. All ambient air samples were analyzed for TCL VOCs and nitrobenzene.

Ambient air samples collected on August 30, 1994, were analyzed with one week turnaround. Ambient air samples collected on September 19 and 20, 1994, were analyzed within 24 hours. Results of the air samples are provided in Section 4.2.8 of this report.

2.10 Air Monitoring and Radiation Screening

Ambient air monitoring was performed throughout the Phase I/Phase II RI field investigation activities. A Foxboro Century 128 OVA flame ionization detector (FID) and/or a Photovac Microtip photoionization detector (PID) was used to detect total organic vapors during borehole construction, groundwater sampling, test pit excavation, and surface soil sampling activities. A Victoreen V190 Geiger counter was utilized for screening radiation (alpha, beta and gamma emissions). A Mini Ram digital dust indicator was also used throughout the field investigation in order to detect the levels of respirable dust particulates in the air. In addition, a Neotronics EXOTOX Portable Multi-gas Monitor Model #40 was utilized during borehole drilling to monitor for percent lower explosive limit (% LEL) and a Simms anemometer was used to measure wind speed.

Air monitoring was performed during the field investigation to establish ambient air conditions during field activities on-site and to monitor off-site piezometer and surface soil sampling locations. The primary purpose for air monitoring was for the protection of the workers' health and safety and to collect information regarding the presence of organic vapors at the point of sample collection. The air monitoring results are provided in Section 4.2.9 of this report.

2.11 Surveying and Mapping

All soil boring, monitoring well, piezometer and staff gauge locations were surveyed for horizontal and vertical reference. The land elevation of the site was tied into the International Great Lakes Datum (IGLD) dated 1955 obtained from the U.S. Coast Guard Station located approximately one-half mile north of the site. Vertical elevations of the monitoring well casings and piezometers allowed calculation of groundwater elevations (with depth to water measurements) for developing groundwater contour maps of the site (and off-site in the vicinity of the upgradient piezometers). Survey data for this field program is provided in Appendix G.

2.12 Health and Safety Program

Prior to performance of the Phase I RI field program and as part of the project Work Plan, a Health and Safety Plan was prepared in order to establish occupational health and safety requirements, responsibilities and procedures to protect workers during the field investigation at the Buffalo Outer Harbor Site. An addendum to this Work Plan was prepared as part of the Work Plan Amendment for the Phase II RI. The requirements for worker health and safety were based on the following:

- The Standard Operating Safety Guides. US Environmental Protection Agency (EPA), Office of Emergency and Remedial Response;
- The Occupational Health and Safety Administration (OSHA) Regulations, 29 CFR Parts 1019.120 and 1926;
- NYSDEC Division of Hazardous Waste Remediations Technical and Administrative Memorandums 4016 and 4031;
- Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH, OSHA, USCG and EPA;

- Health and Safety Procedures for Hazardous Waste Sites. Dvirka and Bartilucci Consulting Engineers; and

- Superfund Amendments and Reauthorization Act (SARA), Title I, Section 126.

Activities associated with the Phase I/Phase II RI were performed in accordance with this Health and Safety Plan. A detailed description of the Health and Safety Plan is contained in the Work Plan.

2.13 Quality Assurance/Quality Control Program

As part of the remedial investigation and project Work Plan, a Quality Assurance and Quality Control (QA/QC) Plan was prepared which developed and described the detailed sample collection and analytical procedures to be used to ensure high quality, valid data. The QA/QC analytical samples collected during the Phase I/Phase II RI are representative of all the sample locations to assure quality control for the soil, surface water, air, sediment and groundwater characterization of this site. The results of these samples will enable data evaluation for accuracy and provide support for the feasibility study and development of a remediation plan for the site. This QA/QC Plan included detailed descriptions of the following:

- Data Quality Objectives and Scope
- Data Usage
- Monitoring Network Design and Rationale
- Monitoring Parameters
- Data Quality Requirements and Assessment
- Sampling Procedures
- Decontamination Procedures
- Laboratory Sample Custody Procedures

- Field Management Documentation
- Calibration Procedures and Preventive Maintenance
- Performance of Field Audits
- Control and Disposal of Contaminated Material
- Documentation, Data Reduction and Reporting
- Data Validation
- Performance and System Audits
- Corrective Action
- Trip Blanks
- Field Blanks
- Matrix Spikes/Matrix Spike Duplicates and Spiked Blanks
- Method Blanks/Holding Blanks
- Field Management Forms
- NYSDEC Sample Identification, Preparation and Analysis Summary Forms
- Data Quality Requirements and Assessments

Work undertaken during the Phase I/Phase II RI was performed in accordance with the procedures outlined in the QA/QC Plan contained in the project Work Plan.

2.14 Data Validation

NYTEST Environmental, Inc., which is a New York State Department of Health (NYSDOH) Environmental Laboratory Approved Program (ELAP) certified laboratory meeting requirements for performing sample analysis according to NYSDEC 12/91 Analytical Services

Protocols (ASP), was utilized to perform the analyses for the soil samples (surface and subsurface) obtained during the Phase I/Phase II RI. Nytest also analyzed the duplicate groundwater samples collected during the Phase II RI and analyzed the initial ambient air samples collected on August 30, 1994. Ecology and Environment, Inc. (E&E) was utilized for analysis of the remaining ambient air samples, and Energy and Environmental Engineering, Inc. (E3I) was utilized for all groundwater, surface water and surface water sediment analyses. Both E&E and E3I laboratories are also NYSDOH ELAP certified for performing environmental analysis according to NYSDEC 12/91 ASP. Summary documentation regarding data validation was completed by the laboratory using NYSDEC forms (Contract Laboratory Sample Information Sheets) and submitted with the data package as required in the Work Plan.

Section 3

3.0 PHYSICAL AND ECOLOGICAL CHARACTERISTICS OF THE STUDY AREA

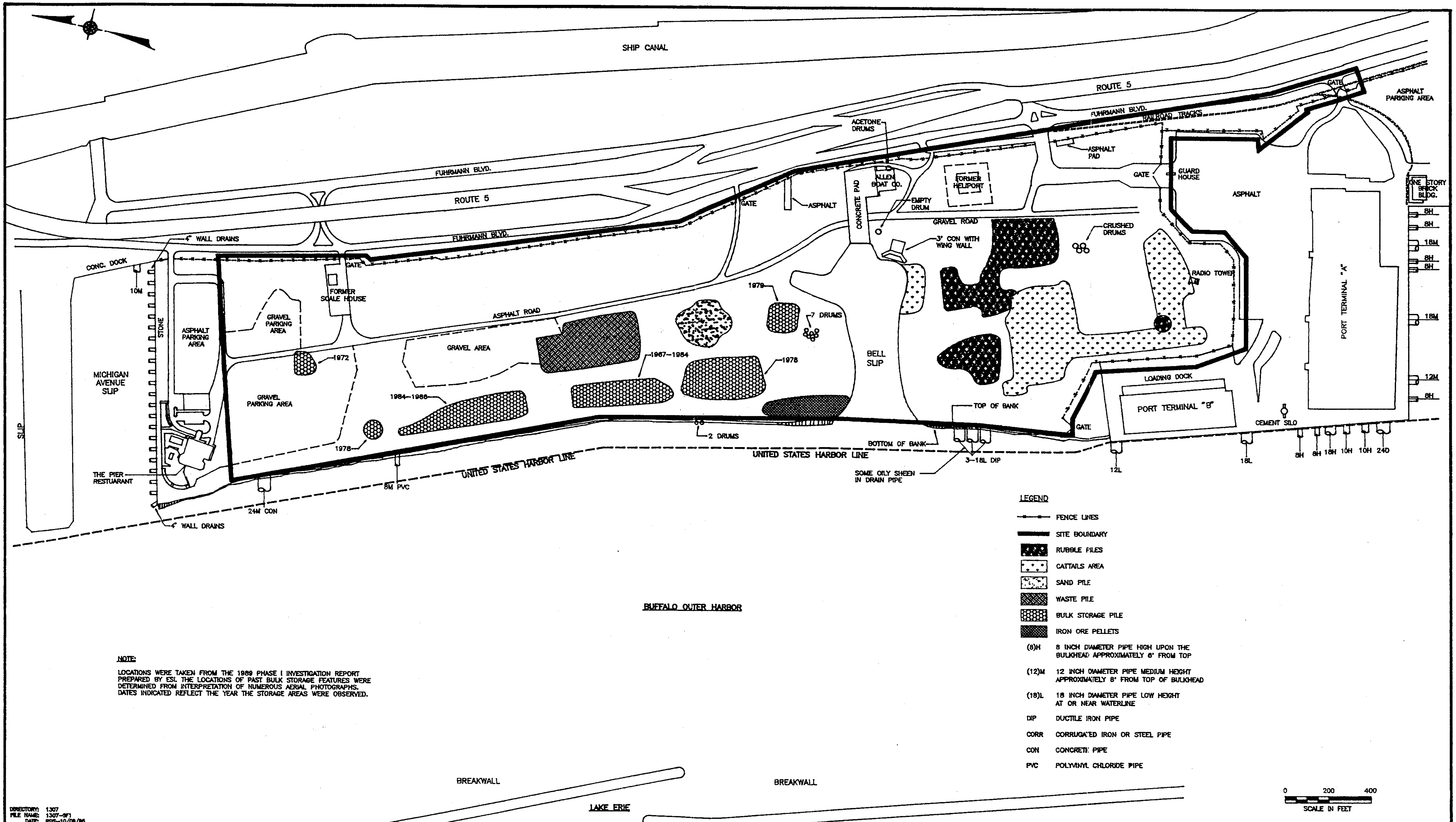
3.1 Surface Features

The Buffalo Outer Harbor Site is characterized by relatively flat topography and is predominantly vacant. The only on-site structures include buildings associated with the Allen Boat Company and a small metal building which was a scale house for the former Fuhrmann Avenue landfill. Gravel parking areas associated with The Pier restaurant are located at the north end of the site. An asphalt/gravel road traverses the site north-south. Three other asphalt areas are on the site: north of the Allen Boat Company; the former heliport located south of the Allen Boat Company; and directly south of the main entrance gate on the southern portion of the site. Major surface features have been delineated and are shown on a surface features map (see Figure 3-1).

Flowing surface water was not observed on-site during the course of the investigation, however, rills were observed along the top of the shore line banks leading into the Buffalo Outer Harbor indicating that overland flow to the Outer Harbor is occurring during precipitation events. During the Phase I RI, little precipitation was recorded. The few observations that were made, however, indicated that precipitation generally lies upon the ground and seeps directly through the ground surface. A major on-site surface water feature is the Bell Slip located in the central portion of the site.

Vegetation is varied over the site. It consists predominantly of weeds and grasses with some localized areas of cattail growth and few trees. There are areas which have stressed or limited vegetation. These are notably associated with the former bulk material storage areas on the northern portion of the site. See Section 3.4 for a more detailed discussion of site vegetation.

Portions of the site have distinct areas of debris disposal consisting of piles of trash (desks, chairs, household garbage, tires, etc.), asphalt, soil from off-site excavation, and construction and demolition debris. The entire Outer Harbor shoreline from the end of the bulkhead north of Terminal B, along the Bell Slip and north to The Pier restaurant is lined with concrete, asphalt,



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DVIRKA AND BARTILUCCI
CONSULTING ENGINEERS

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

SURFACE FEATURES AND DRAIN PIPE LOCATION MAP

PROJECT NO. 1307
DATE MARCH 1995
SCALE 1"=200'

FIGURE 3–1

heavy lumber and reinforced steel. A pile of miscellaneous debris was noted west of the baseline road (Waste Pile) on the northern portion of the site consisting of school desks, plaster board, dirt and concrete. A large area covered by slag is located midway between the Bell Slip and the north end of the site along the top of the bank above the Outer Harbor. Several large rubble piles of construction and demolition debris are located south of the Bell Slip and west of the baseline road. A dirt road running northwest-southwest in this area is lined with wooden pallets, concrete and asphalt debris, timber and construction debris. In the 1989 Phase II Investigation, Empire Soils Investigations, Inc. (ESI) reported finding foundry sand east of Terminal B, although this was not observed during the Phase I/Phase II RI.

Evidence of former bulk material storage on-site was identified over a large area which was confirmed through the review of aerial photographs. Iron ore pellets, sand and coke were identified on the surface of the site. In the 1989 Phase II Investigation, coal and gypsum were identified as possible bulk storage items as well.

During the Phase I RI, a series of pipes were located discharging to the Outer Harbor from the site. However, due to dry conditions experienced on-site throughout the Phase I field investigation, no significant discharges were observed from any of the locations. Pipes in the bulkheading of the Michigan Avenue Slip, Port Terminal B Building and Port Terminal A Slip are shown on Figure 3-1. These pipes probably prevent a buildup of water pressure behind the bulkhead by allowing groundwater to drain freely through it. Four pipelines were identified along the shore which may drain storm water from the site. One 24-inch concrete pipe was located just south of The Pier restaurant.

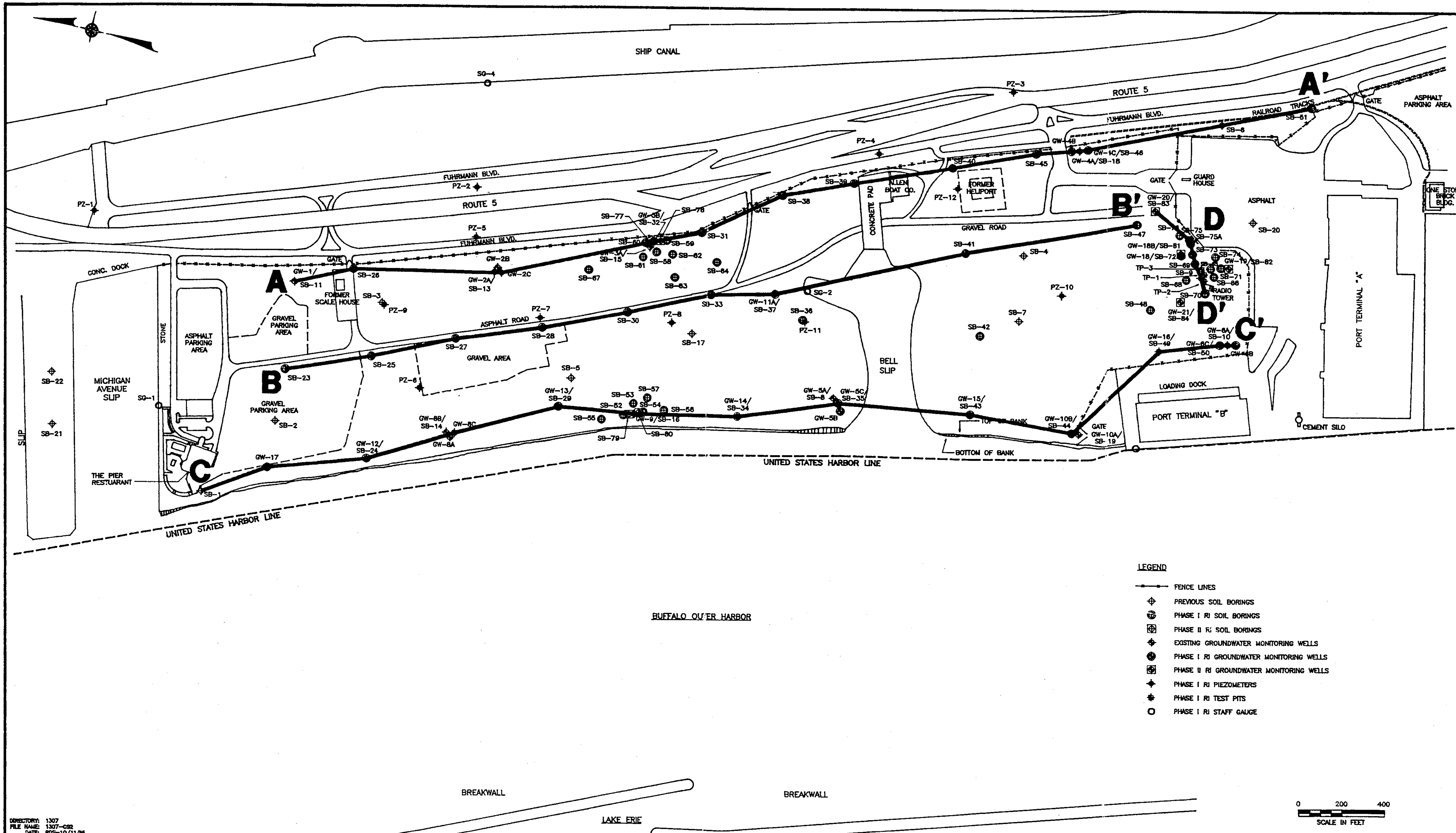
In the 1989 Phase II Investigation Report, it was reported that the pipe is part of the storm drainage system for the southern side of the restaurant parking and roadway areas. Farther south along the shore, an 8-inch PVC pipe was found extending from the bank onto the shore at an awkward angle possibly caused by dislocation. The 1989 Phase II Investigation Report suggested that this pipe may be related to storm water drainage from the area of the former scalehouse. Within the Bell Slip, a 3-foot diameter concrete pipe outfall with wing walls was identified. Plans for construction of the guardhouse and parking lot expansion provided by the NFTA indicate that storm water from those areas is directed to this outfall. Lastly, three 18-inch ductile iron pipes were identified south of the Bell Slip along the Outer Harbor shoreline. It is not clear what area of the site these pipes drain.

Miscellaneous 55-gallon drums were identified scattered over the entire site. Empty drums were found along the Outer Harbor shore line north of the Bell Slip, north of the Bell Slip shore, east of the Bell Slip and north of the Radio Tower area. Full and partially full drums labeled acetone and mineral spirits with dispensing spouts were found east of the Allen Boat Company which belong to the Boat Company.

3.2 Site Geology

The site is underlain by fill material, native Holocene deposits of Lake Erie, lacustrine, ice contact and till deposits of glacial origin and competent limestone bedrock. Three north-south trending cross sections have been constructed of the on-site stratigraphic column from information obtained during the Phase I RI. Boring data obtained from the Phase II Investigation (November 1991) and Geotechnical Investigation (July 1987), both of which were conducted by ESI has been used to supplement data collected during the Phase I RI. In addition, one cross section has been constructed depicting the fill unit encountered on the southern portion of site in the Radio Tower area. The location of all cross sections constructed are shown on Figure 3-2.

The discussion of site geology has been organized into three subsections addressing fill material, native unconsolidated deposits and bedrock. All information used in preparation of this section was either obtained from data gathered during the Phase I/Phase II RI or from boring logs available from previous investigations conducted at the site. A brief discussion of regional geology is contained in Section 1.3.8 of this report.



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BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

LOCATION OF CROSS SECTIONS

PROJECT NO. 1307
DATE MARCH 1995
SCALE 1"=200'

FIGURE 3-2

3.2.1 Fill Material

Fill material was encountered in all soil borings installed as part of the Phase I and Phase II RI. Consistent with site history, the fill materials were deposited directly upon Holocene Lake Erie shore and near shore deposits. Fill thickness on site ranges from about 16 feet at SB-75 to a maximum of 35 feet at GW-2C.

As a result of the RI, five major fill types have been identified on-site: landfill deposits, hydraulic fill (silt and clay matrix), sand fill (sand matrix), construction fill and industrial fill consisting of slag, ash, coal and cinder. Some of the fill identified on-site is a combination of two or more of the fill types described above. On the southern portion of the site, for example, coarse material such as concrete and lumber was encountered in certain areas within the hydraulic fill. On the southern portion of the site, industrial fill was also found in combination with sand fill, as well as in combination with hydraulic fill. Due to the potential physical and chemical heterogeneity of these materials, the combination units have been identified as separate fill units on-site. All together, eight fill units have been encountered, identified and mapped as part of the RI. A description of each fill type follows.

Fill Type

1. Clean Sand - Medium well sorted sand found on the ground surface or near surface on the northern portion of the site. May have remained on-site as a remnant of past bulk storage activities.

2. Sand Fill I - Fine-medium subrounded sand matrix with little-some silt, little-some fine-coarse subrounded-subangular gravel, with varying amounts of crushed concrete, brick fragments, broken glass, trace clay, organic roots and grass. Blow counts were low to high and ranged from 1 to 50 blows per 6 inches of penetration. Sand Fill I was predominately dry to damp.

3. Sand Fill II - Gray-red-brown-black fine coarse sand, trace-some gravel, little silt, trace clay, with varying amounts of black cinders, green-red slag, wood, iron ore pellets, lime, brick and concrete fragments. Blow counts ranged from 1 to 48 blows per 6 inches of penetration.

4. Hydraulic Fill I - Brown-red and gray-green-black fine–medium sand and angular-flat gravel. The hydraulic fill exhibited slightly plastic and soft characteristics and occasionally contained trace shells and roots. Generally the blow counts were low, ranging from the weight of drill rods (WOR) to 5 blows per 6 inches of penetration.

5. Hydraulic Fill II - Predominately brown-red-black-gray silt and clay with trace-little amounts of glass, wood, concrete, red brick, green slag and cinder. The blow counts on average ranged from 1 to 8 blows per 6 inches of penetration.

6. Hydraulic Sand Fill - Brown-gray fine-medium sand and silt, little-some medium-coarse gravel, laminations of organic material and trace brick fragments. Blow counts ranged from 2 to 46 blows per 6 inches of penetration.

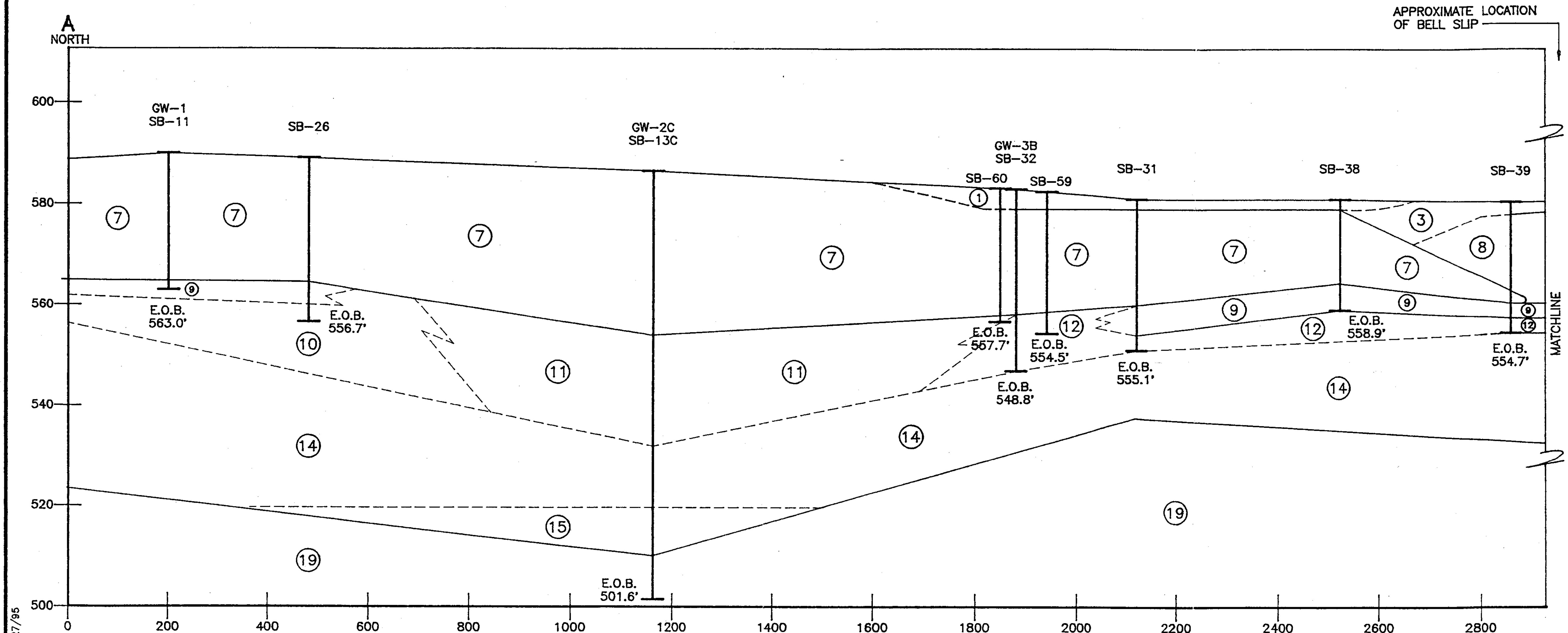
7. Landfill Debris - Black-brown silt, clay and fine-coarse sand matrix that may contain trace and any of the following materials of black-red-gray slag, black cinders, white-yellow-tan-black ash, coal, black foundry sand, brick, yellow brick, decomposed wood, plastic, rubber, concrete, paper, metal (copper, tin, aluminum), roof and ceramic tile, caulk, cardboard, fine-coarse subangular gravel and trace organic material. Blow counts are low to moderate and generally ranged from 1 to 20 blows per 6 inches of penetration.

8. Industrial Fill - Brown-black-orange-red fine-medium sand and brown-orange-yellow ash (cohesive and stiff), trace silt and fine gravel mixed with varying amounts of green-pale gray-white slag, trace cinder, red brick and decomposed wood. Blow counts ranged from 1 to 21 blows per 6 inches of penetration.

The site history indicates that deposition of the fill material on the Buffalo Outer Harbor Site occurred in a shore and near shore environment. As expected, many fill units were observed to exhibit a relatively high lateral continuity in the north-south direction as compared to the east-west direction. This distribution pattern is consistent with their deposition along a westward advancing shoreline. The three major cross sections constructed for the site illustrate these relationships well (Figures 3-3 through 3-8).

North of the Bell Slip

The most prominent and distinctive fill unit found at the site is in the area of the former municipal landfill. Landfill Debris deposits are found in Sections A-A' (see Figures 3-3 and 3-4) and B-B' (see Figures 3-5 and 3-6) on the northern portion of the site. On A-A' the landfill extends from SB-26 located near the metal building (former scale house) southward to SB-39 located north



VERTICAL SCALE: 1" = 20'
HORIZONTAL SCALE: 1" = 200'

(1) CLEAN SAND
(3) SAND FILL II
(7) LANDFILL DEBRIS
(8) INDUSTRIAL FILL
(9) GRAY-GREEN-BROWN FINE SAND, LITTLE-AND SILT, TRACE-LITTLE GRAVEL, ORGANIC MATERIAL, SHELLS, ROOTS
(10) GRAY-GREEN SILTY CLAY, SHELLS
(11) RED-BROWN CLAY AND SILT, SOME SAND, TRACE GRAVEL
(12) GREY-BLACK FINE-COARSE SAND, SOME FINE-COARSE GRAVEL, (ROUNDED SHALE GRAVEL)
(14) RED-BROWN SILT AND CLAY
(15) RED-BROWN, FINE-MEDIUM SAND AND SILT, TRACE GRAVEL
(19) ONONDAGA LIMESTONE - GRAY, COARSE, FOSSILIFEROUS

NOTE: ELEVATION OF BASE OF BORING IN FEET RELATIVE TO IGLD.

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BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

GEOLOGIC CROSS SECTION A-A' (NORTH)

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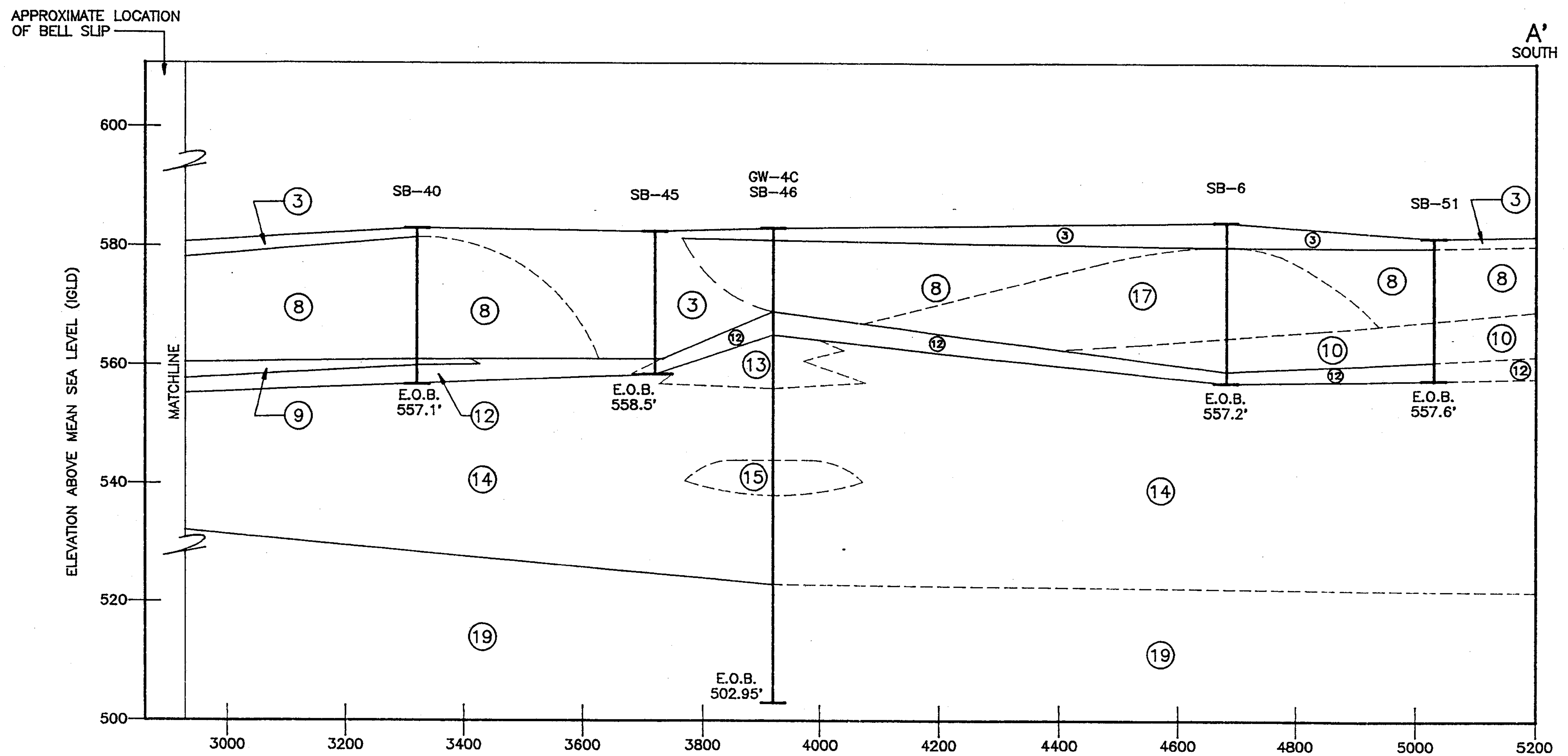
FIGURE 3-3



VERTICAL SCALE: 1" = 20'
HORIZONTAL SCALE: 1" = 200'

(3) SAND FILL II

(8) INDUSTRIAL FILL

(9) GRAY-GREEN-BROWN FINE SAND, LITTLE-AND SILT, TRACE-LITTLE GRAVEL, ORGANIC MATERIAL, SHELLS, ROOTS

(10) GREY-GREEN OR BLACK SILTY CLAY, SHELLS

(12) GREY-BLACK FINE-COARSE SAND SOME FINE-COARSE GRAVEL (ROUNDED SHALE GRAVEL)

(13) DARK GRAY CLAY, ALTERNATING WITH LAMINATIONS OF BROWN-GREY FINE-COARSE SAND, TRACE GRAVEL

(14) RED-BROWN SILT AND CLAY

(17) OLIVE GREEN-GREY FINE-COARSE SAND, SOME SILT

(15) RED-BROWN, FINE-MEDIUM SAND AND SILT, TRACE GRAVEL

(19) ONONDAGA LIMESTONE - GRAY, COARSE, FOSSILIFEROUS

NOTE: ELEVATION OF BASE OF BORING IN FEET RELATIVE TO IGLD.

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BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

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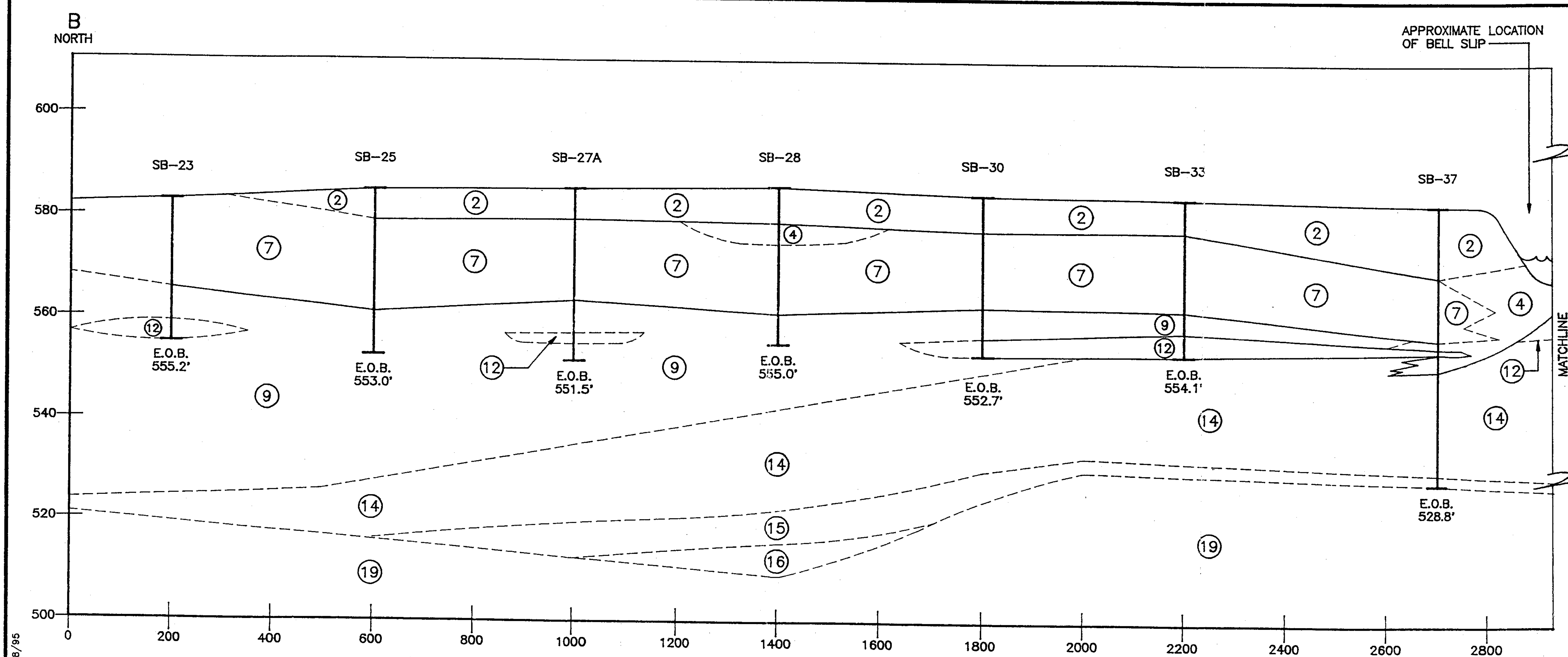
GEOLOGIC CROSS SECTION A-A' (SOUTH)

FIGURE 3-4



VERTICAL SCALE: 1" = 20'
HORIZONTAL SCALE: 1" = 200'

- (2) SAND FILL I
- (4) HYDRAULIC FILL I
- (7) LANDFILL DEBRIS
- (9) GRAY-GREEN-BROWN FINE SAND, LITTLE-AND SILT, TRACE-LITTLE GRAVEL, ORGANIC MATERIAL, SHELLS, ROOTS
- (12) GREY-BLACK FINE-COARSE SAND, SOME FINE-COARSE GRAVEL, (ROUNDED SHALE GRAVEL)
- (14) RED-BROWN SILT AND CLAY
- (15) RED-BROWN, FINE-MEDIUM SAND AND SILT, TRACE GRAVEL
- (16) GREY SILT AND FINE-COARSE SAND, OCCASIONAL CLAY, TRACE GRAVEL; COBBLES MAY BE PRESENT (VERY DENSE)
- (19) ONONDAGA LIMESTONE – GRAY, COARSE, FOSSILIFEROUS

NOTE: ELEVATION OF BASE OF BORING IN FEET RELATIVE TO IGLD.

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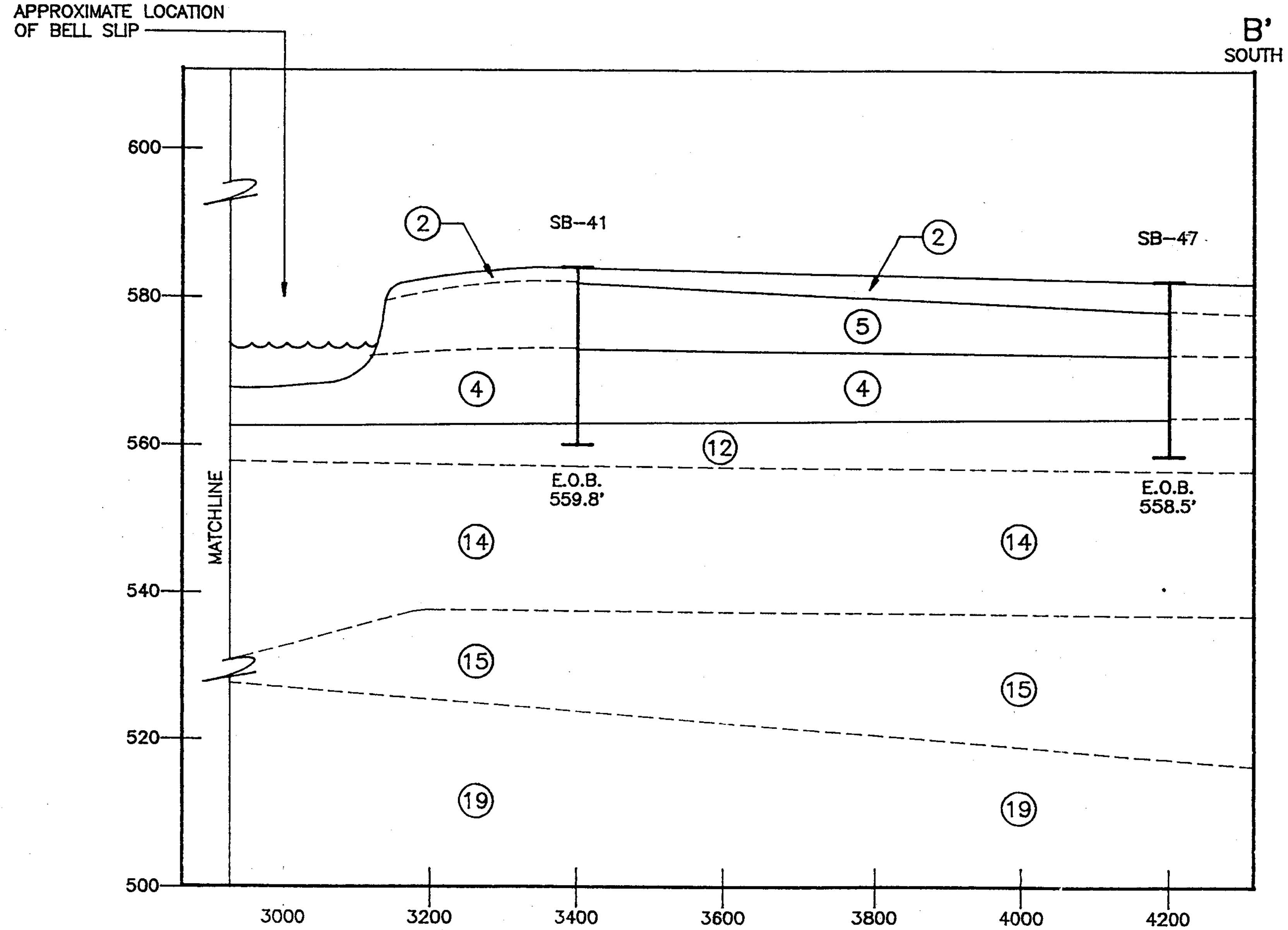
BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

GEOLOGIC CROSS SECTION B–B' (NORTH)

FIGURE 3–5



VERTICAL SCALE: 1" = 20'
HORIZONTAL SCALE: 1" = 200'

(2) SAND FILL I

(4) HYDRAULIC FILL I

(5) HYDRAULIC FILL II

(12) GREY-BLACK FINE-COARSE SAND, SOME FINE-COARSE GRAVEL, (ROUNDED SHALE GRAVEL)

(14) RED-BROWN SILT AND CLAY

(15) RED-BROWN, FINE-MEDIUM SAND AND SILT, TRACE GRAVEL

(19) ONONDAGA LIMESTONE- GREY, COARSE, FOSSILIFEROUS

NOTE: ELEVATION OF BASE OF BORING IN FEET RELATIVE TO IGLD.

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BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

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GEOLOGIC CROSS SECTION B-B' (SOUTH)

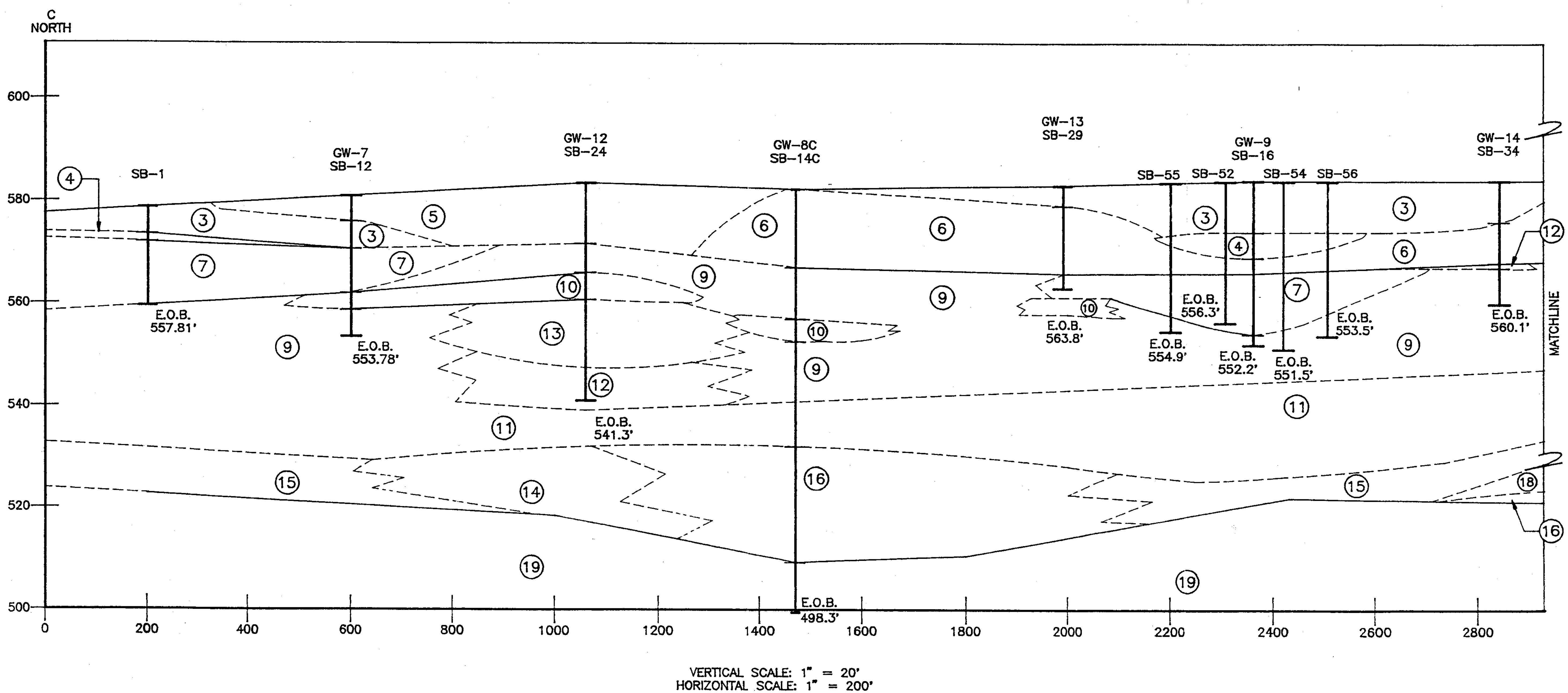
FIGURE 3-6

of the Allen Boat Company. Along the fringes of the landfill, the deposit is found in combination with sand and silt, reflecting its mixing with the modern shore deposits. The landfill unit is approximately 20 feet thick in the north and 15 feet thick in the south. The maximum observed thickness of 24.5 feet was observed at SB-26 where landfill material extends to the land surface.

Overlying the landfill unit is a thin veneer of Clean Sand which is well sorted and absent of debris in the vicinity of SB-32, SB-31 and SB-38, and combined with other materials (most commonly slag, brick and concrete fragments) elsewhere.

Section B-B', which traverses the central portion of the site, also illustrates the predominance of the Landfill Debris in the northern part of the site. This unit was observed extending from SB-23 in the north to SB-37 (GW-11A) just north of the Bell Slip. Overlying the Landfill Debris is the Sand Fill I unit which ranges between 5 and 10 feet in thickness in this area.

Section C-C' (see Figures 3-7 and 3-8) runs along the western boundary of the site parallel to the Outer Harbor shoreline. Within this section, the largest variety of fill units have been encountered. Fill similar to that found in the landfill, in that it may contain cinders, organics, clay, brick, glass, slag and is black in color, has been identified in borings SB-1, SB-12 (GW-7), SB-55, SB-52, SB-16 (GW-9), SB-54 and SB-56. The difference between the deposits is the lower percentage of Landfill Debris materials (i.e., cinders, organics, brick, etc.) found in the deposits along Section C-C'. These deposits, found in the two areas around GW-7 and GW-9, exhibit a greater percentage of sand than samples collected from the landfill itself. An absence of the typical landfill fill in SB-2, located midway between SB-23 and SB-12 (GW-7), indicates that the deposit is discontinuous in this area. An absence of the typical landfill fill in SB-53 and SB-57, located between the western borings flanking SB-16 (GW-9) and SB-30, indicates that the deposit is discontinuous in this area as well. The landfill deposits have been interpreted as extending less than 200 feet westward beyond Section B-B', based upon an absence of the Landfill Debris at SB-17 and PZ-8 locations and only 2 feet of the material found in PZ-6.



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(3) SAND FILL II

(4) HYDRAULIC FILL I

(5) HYDRAULIC FILL II

(6) HYDRAULIC SAND FILL

(7) LANDFILL DEBRIS

(9) GRAY-GREEN-BROWN FINE SAND, LITTLE-AND SILT, TRACE-LITTLE GRAVEL, ORGANIC MATERIAL, SHELLS, ROOTS

(10) GREY-GREEN OR BLACK SILTY CLAY, SHELLS

(11) RED-BROWN CLAY AND SILT, SOME SAND, TRACE GRAVEL

(12) GREY-BLACK FINE-COARSE SAND, SOME FINE-COARSE GRAVEL, (ROUNDED SHALE GRAVEL)

(13) DARK GREY CLAY, ALTERNATING WITH LAMINATIONS OF BROWN-GREY FINE-COARSE SAND, TRACE GRAVEL

(14) RED-BROWN SILT AND CLAY

(15) RED-BROWN, FINE-MEDIUM SAND AND SILT, TRACE GRAVEL

(16) GREY SILT AND FINE-COARSE SAND, OCCASIONAL CLAY, TRACE GRAVEL; COBBLES MAY BE PRESENT (VERY DENSE)

(18) BLACK, WHITE, BROWN, FINE-COARSE SAND

(19) ONONDAGA LIMESTONE - GRAY, COARSE, FOSSILIFEROUS

NOTE: ELEVATION OF BASE OF BORING IN FEET RELATIVE TO IGLD.

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

GEOLOGIC CROSS SECTION C-C' (NORTH)

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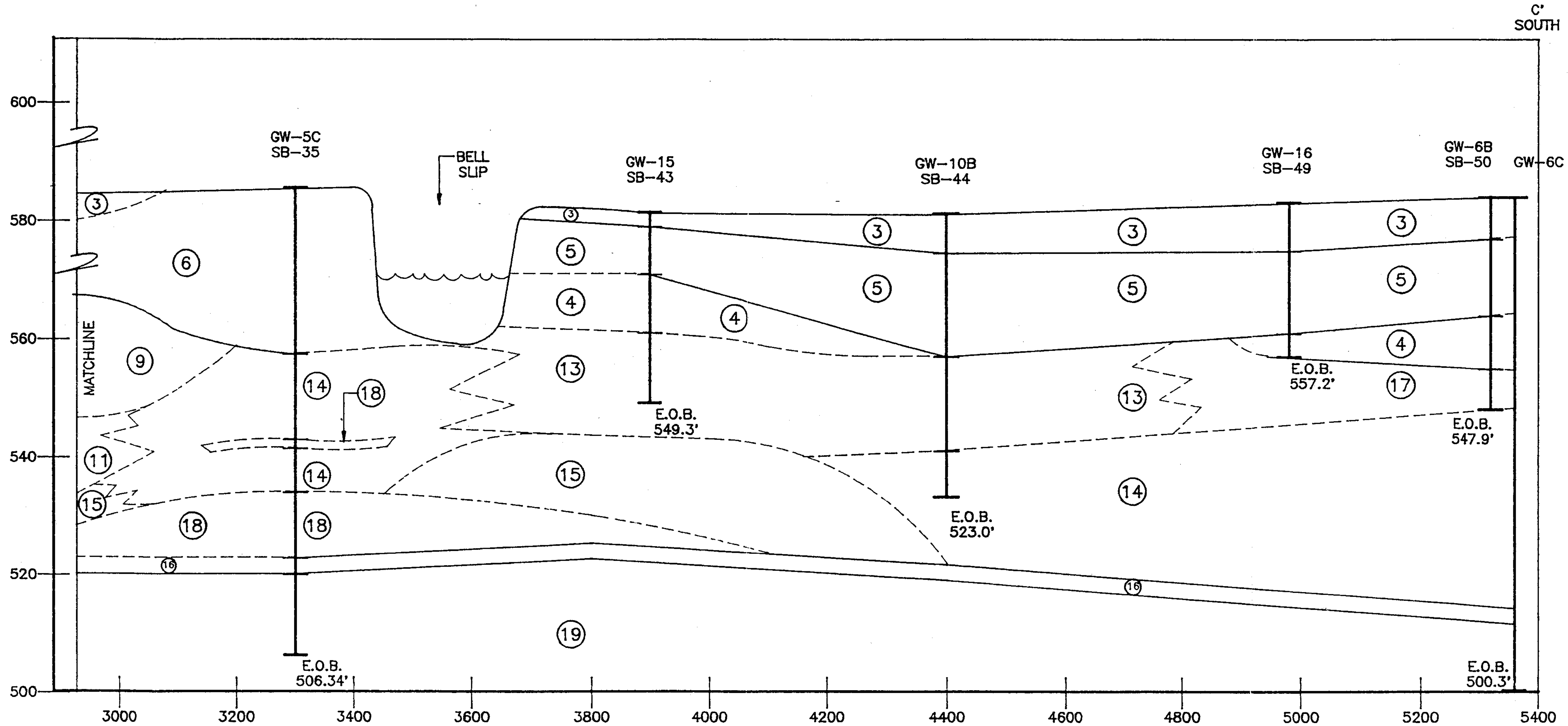
FIGURE 3-7



VERTICAL SCALE: 1" = 20'
HORIZONTAL SCALE: 1" = 200'

(3) SAND FILL II

(4) HYDRAULIC FILL I

(5) HYDRAULIC FILL II

(6) HYDRAULIC SAND FILL

(9) GRAY–GREEN–BROWN FINE SAND, LITTLE–AND SILT, TRACE–LITTLE GRAVEL, ORGANIC MATERIAL, SHELLS, ROOTS

(11) RED–BROWN CLAY AND SILT, SOME SAND, TRACE GRAVEL

(13) DARK GREY CLAY, ALTERNATING WITH LAMINATIONS OF BROWN–GREY FINE – MEDIUM–COARSE SAND, TRACE GRAVEL

(14) RED–BROWN SILT AND CLAY

(15) RED–BROWN, FINE–MEDIUM SAND AND SILT, TRACE GRAVEL

(16) GREY SILT AND FINE–COARSE SAND, OCCASIONAL CLAY, TRACE GRAVEL; COBBLES MAY BE PRESENT (VERY DENSE)

(17) OLIVE GREEN–GREY FINE TO COARSE SAND, SOME SILT

(18) BLACK, WHITE, BROWN, FINE TO COARSE SAND

(19) ONONDAGA LIMESTONE – GRAY, COARSE, FOSSILIFEROUS

NOTE: ELEVATION OF BASE OF BORING IN FEET RELATIVE TO IGLD.

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BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

GEOLOGIC CROSS SECTION C–C' (SOUTH)

FIGURE 3–8

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Other fill materials observed on the northern portion of the site include Hydraulic Sand Fill, Hydraulic Fill I, Hydraulic Fill II, Sand Fill I and Sand Fill II.

Hydraulic Fills I and II are soft silt and clay fills which appear to have been placed on-site as part of the dredge and fill operations known to have occurred in the area. Low blow counts, an absence of structure in the sediments and their distribution pattern (limited to west of the B-B' section) suggest rapid mechanical placement (i.e., hydraulic dredging) of soft bottom sediments on-site.

The Hydraulic Sand Fill observed solely in Section C-C' in SB-14C (GW-8C), SB-29 (GW-13), SB-34 (GW-14) and SB-31 (GW-5C) also appears to have been placed by mechanical means. This unit is predominantly a sand with little-some medium-coarse gravel which makes it more coarse than the hydraulic fill nearby. It was deposited adjacent to and at similar elevations as Sand Fill II and Hydraulic Fill II found in SB-24 (GW-12) and SB-12 (GW-7), indicating that the period of deposition is similar. The northern dike (north-south), known to protect the western boundary of the site from Lake Erie after construction, would have slowed or prevented normal lacustrine shore processes from depositing material in this area. Additionally, laminations of black organic material (individual grains are light in weight and irregularly shaped) could be expected to form following pumping of the material on-site due to the rapid settling out of the accompanying sand size particles in the quiet environment.

Sand Fills I and II were found predominantly at the ground surface covering the northern portion of the site. The one exception to this was at SB-12 (GW-7), where Sand Fill II was identified beneath approximately 5 feet of Hydraulic Fill II. These deposits do not exhibit structure, but appear to have been deposited on-site in combination with other fill from a land based source. Both of these deposits contain additional materials inconsistent with a modern channel, shore or bottom sediment deposit, and therefore, are not deposits which can be solely attributed to dredge and fill activities. These include: concrete, glass, brick, foundry sand, slag and iron ore pellets.

South of the Bell Slip

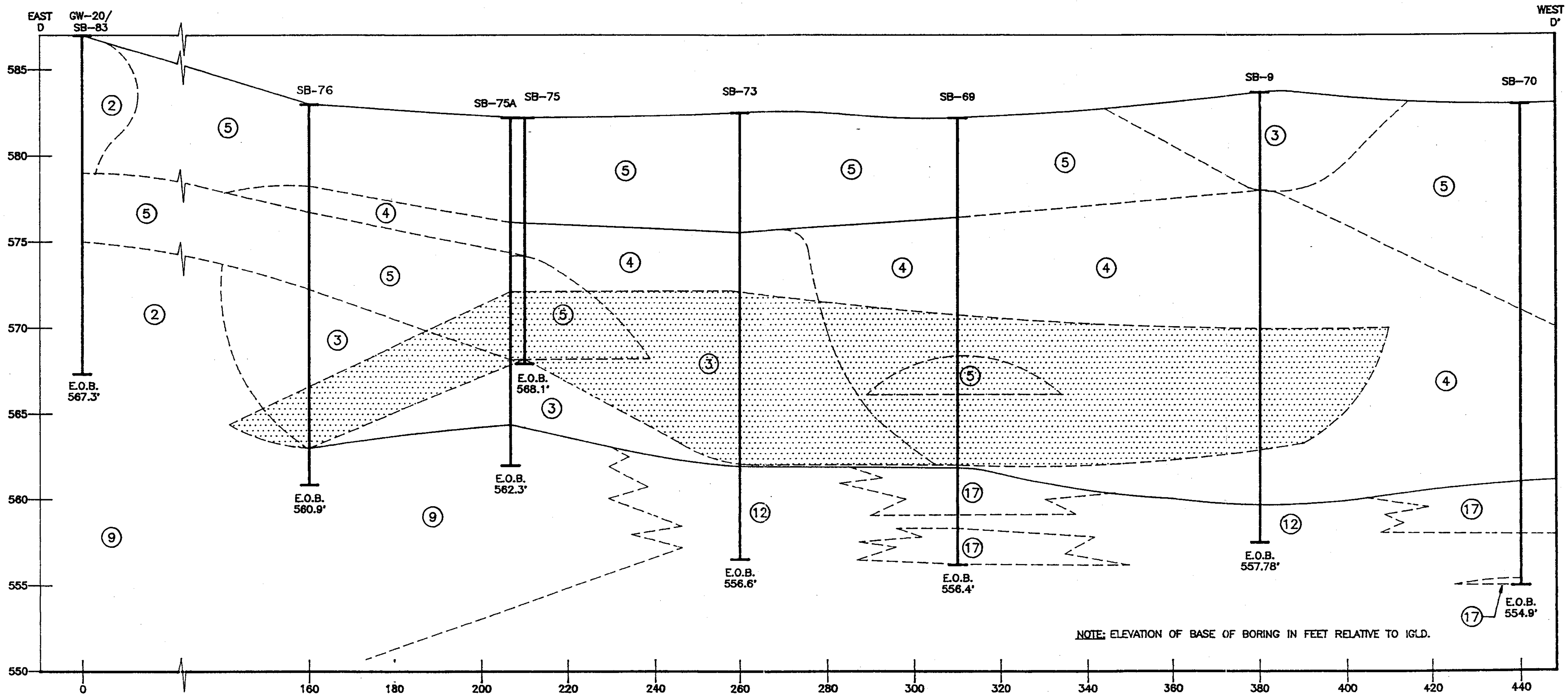
The southern portion of the site can be divided into two distinct fill areas, one east of the asphalt/dirt roadway and the other to the west. To the east along Section A-A', the significant fill feature is the Industrial Fill which is present in SB-39, SB-40, SB-46 (GW-4C) and SB-51. This highly heterogeneous material is approximately 14 feet thick. It consists of multicolored foundry sand (red, black, orange, white), pale green slag, yellow brick and multicolored cohesive dense, damp layers of unconsolidated material made up of silt and clay sized particles. This fine-grained material has been identified as ash and/or flue dust and varies in color from white, pink, orange, red and gray to black.

On the southern portion of the site west of the baseline road (Section B-B'), two hydraulic fills were encountered overlying the native material. Directly overlying the native overburden is Hydraulic Fill I, consisting of reddish brown silty clay. The overlying fill is Hydraulic Fill II, a combination fill consisting of reddish brown to gray silty clay, trace fine-coarse gravel and brick fragments, crushed concrete, wood and green-black slag. Along Section B-B' the clays and silts of Hydraulic Fill I make a bed of approximately 10 feet.

At the ground surface along Sections A-A' and B-B', extends a thin veneer of silty soil with roots and grass underlain by Sand Fill II comprising fine-medium sand with brick, concrete, wood and green slag.

Along Section C-C', Hydraulic Fill I was encountered in all borings except SB-44 (GW-10B) where Hydraulic Fill II was encountered directly overlying the native overburden. The Hydraulic Fill I ranged in thickness from 10 to 14 feet at SB-43 (GW-15) and SB-49 (GW-16), respectively.

Hydraulic Fill I lies directly above the native overburden in SB-69, SB-9 and SB-70 shown in Section D-D' (see Figure 3-9) in the Radio Tower area where it reaches a maximum thickness of 18 feet in SB-9. In SB-75 and SB-73, however, Sand Fill II overlies the native overburden. This



(2) SAND FILL I

(3) SAND FILL II

(4) HYDRAULIC FILL I

(5) HYDRAULIC FILL II

(9) GRAY-GREEN-BROWN FINE SAND, LITTLE-AND SILT, TRACE-LITTLE GRAVEL, ORGANIC MATERIAL, SHELLS, ROOTS

(12) GREY-BLACK, FINE-COARSE SAND, SOME FINE-COARSE GRAVEL, (ROUNDED SHALE GRAVEL)

(17) OLIVE GREEN-GREY, FINE-COARSE SAND, SOME SILT

[dotted pattern] STAINED SOILS AND SOILS EXHIBITING ELEVATED CONCENTRATIONS OF TOTAL VOLATILE ORGANIC COMPOUNDS DETECTED DURING SCREENING OF SOIL SAMPLES COLLECTED FROM SPLIT SPOON SAMPLES.

VERTICAL SCALE 1" = 6.5'
HORIZONTAL SCALE: 1" = 25'

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BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

GEOLOGIC CROSS SECTION D-D'

Dvirka and Bartilucci
Consulting Engineers
A Division of William F. Cosulich Associates, P.C.

FIGURE 3-9

unit may be continuous with the Sand Fill II shown in Section A-A' at SB-46 (GW-4C), SB-6 and SB-51. Extension of this unit onto the southeastern edge of the Radio Tower area as a manmade shoreline deposit is consistent with historical records which show water in this area.

Hydraulic Fill II overlies Hydraulic Fill I along Section B-B' and in the vicinity of SB-43 (GW-15) on Section C-C'. It overlies both the Sand Fill II and Hydraulic Fill I in Section D-D'. This unit is very similar to the Hydraulic Fill I except that it contains trace to little amounts of the following components: glass, wood, concrete, red brick slag and/or cinder.

Deposits encountered extending to the ground surface on the southern portion of the site are Sand Fill I along Section B-B'. Along A-A', C-C' and in the vicinity of SB-9 in the Radio Tower area, Sand Fill II is encountered at the ground surface.

In addition to identification of fill types, areas of observed soil staining have been delineated in the Radio Tower Area (Section D-D'). The staining varied from a black discoloration of otherwise brown-tan Sand Fill II and red-brown Hydraulic Fill I to observed black oily product both in the sample and outside the split spoon with a pearly sheen. Typically, where the product was found, the staining of soil particles would extend 2 to 5 feet above and below the product. Staining in this area was often accompanied by a distinctive mothball or shoe polish odor. Black oily product and/or gray-black to black staining was observed in the following soil borings in the Radio Tower Area during the Phase I RI: SB-65, SB-66, SB-69, SB-72, SB-73, SB-74, SB-75 and SB-76.

3.2.2 Native Unconsolidated Deposits

The top of native overburden was encountered on-site generally at elevations between 565 and 560 feet above mean sea level (msl) International Great Lakes Datum (IGLD). Thickness of the native deposits range between approximately 30 and 50 feet. Both modern Lake Erie shore and near shore deposits, as well as deposits of glacial origin have been found on-site. Interpretation of the native overburden was accomplished through the review of boring logs generated during the

Phase I/Phase II RI, 1989 Phase II Investigation and the Geotechnical Investigation conducted by ESI.

The modern near shore deposits consist of gray silty sands and red silty clays. Shore deposits have been interpreted as brown and gray fine-coarse sands with various amounts of subrounded gravel, olive green sand with shells, and black-gray-white (salt and pepper) fine to coarse sand. The distribution of these deposits are shown on Sections A-A', B-B' and C-C'.

Underlying the modern Lake Erie shore and near shore deposits are glacio-lacustrine deposits. Limited deposits of ice contact sands and till have been identified on-site as well. The most significant of the glacial deposits is the red brown lacustrine clay which underlies large portions of Sections A-A' and B-B'. This unit has exhibited a thickness of greater than 30 feet in many locations. Soil boring SB-24 (GW-8C) along Section C-C' is unique in that the lacustrine clay deposit was not encountered. Instead, gray fine to coarse sand with a percentage of silt ranging from 20 to 50 percent was encountered down to the top of rock.

3.2.3 Bedrock

Bedrock was encountered on-site at an elevation ranging from 520 to 501 feet above msl (IGLD). Bedrock on-site is the highly competent and coarse gray fossiliferous Onondaga Limestone. One void infilled with sand was encountered during coring at GW-6C. It was encountered about 2.8 feet below the surface of the rock and extended about 5 inches. No voids were encountered at any of the other locations and the Rock Quality Designation (RQD) percentage exceeded 90% in the other holes (70% in the upper 3.8 feet at GW-6C).

3.3 Site Hydrogeology

The three dimensional flow system beneath the site has been established through analysis of permeability data and groundwater elevation data collected from existing monitoring wells, as well as those installed during the Phase I/Phase II RI.

Permeability data for the on-site formations include: calculation of bulk permeabilities from grain size analysis of split spoon samples from well screen intervals and in situ hydraulic conductivity testing (slug testing) results for 13 of the new monitoring wells and three existing monitoring wells.

Groundwater elevation data collected on October 20, 1994 and on June 28, 1995, has been utilized in the preparation of this discussion. These measurements are presented in Tables 2-7 and 2-8. All calculations have been made for the fill unit, the native overburden and the shallow bedrock. Where appropriate, calculations of permeability for the various fill units encountered have been used to illustrate the heterogeneous nature of these materials and its effect on groundwater flow.

The following sections present the permeability data gathered for the site, groundwater flow patterns, groundwater velocity calculations and calculations of daily discharge to the Outer Harbor of groundwater from the site.

3.3.1 Permeability

Slug tests were performed at 13 of the 16 monitoring wells installed during the Phase I RI, including five wells screened in the fill, six wells screened in the native overburden and two bedrock wells. The results of the slug tests are shown in Table 3-1. The graphical solutions and field forms are presented in Appendix H.

In addition to the slug tests, 13 soil samples were collected from within the screened intervals of the monitoring wells. Bulk hydraulic conductivity using the Hazen method for sieve analysis results was calculated for each sample. Results of the calculation are presented in Table 3-2. Results of the grain size analyses are presented in Appendix D.

Table 3-1

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
COMPARISON OF PERMEABILITY VALUES OBTAINED FOR THE FILL, NATIVE OVERBURDEN AND BEDROCK

Monitoring Well	Hazen Method K (cm/sec)	Bouwer-Rice Rising Head Test K (cm/sec)	Bouwer-Rice Falling Head Test K (cm/sec)	Screened Interval* (Depth)	Screened Unit
Fill					
GW-3A	--	--	8.3×10^{-5}**	7-17	Landfill Debris
GW-7***	--	--	1.25×10^{-5}**	7-17	Sand Fill I
GW-10A	--	--	5.8×10^{-5}**	5-15	Hydraulic Fill II
GW-11A	2.2×10^{-4}	2.78×10^{-5}	4.43×10^{-5}	5-20	Sand Fill I
GW-13	1.1×10^{-4}	3.16×10^{-5}	9.78×10^{-5}	5-18	Hydraulic Sand Fill
GW-14	2.8×10^{-3}	3.34×10^{-4}	4.70×10^{-4}	5-20	Hydraulic Sand Fill
GW-16	NA	2.74×10^{-5}	1.25×10^{-3}	5-20	Hydraulic Fill I
GW-17	3.1×10^{-4}	--	--	6-18	Landfill Debris
GW-18A	NA	7.16×10^{-5}	8.78×10^{-5}	5-20	Hydraulic Fill I

Table 3-1 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
COMPARISON OF PERMEABILITY VALUES OBTAINED FOR THE FILL, NATIVE OVERBURDEN AND BEDROCK

Monitoring Well	Hazen Method K (cm/sec)	Bouwer-Rice Rising Head Test K (cm/sec)	Bouwer-Rice Falling Head Test K (cm/sec)	Screened Interval* (Depth)	Screened Unit
Native Overburden					
GW-3B	4.2×10^{-2}	9.08×10^{-4}	9.08×10^{-4}	26-36	Fine medium-coarse sand and gravel
GW-4B	8.9×10^{-4}	3.72×10^{-3}	3.75×10^{-3}	21-26	Fine-medium sand, some gravel
GW-5B	1.4×10^{-2}	1.02×10^{-3}	2.05×10^{-3}	50-60	Fine medium-coarse sand
GW-10B	NA	1.19×10^{-4}	5.10×10^{-5}	24-34	Clay, some silt, 4" layers
GW-12B	1.4×10^{-3}	1.71×10^{-4}	1.98×10^{-4}	32-42	Fine to coarse sand, some silt
GW-15B	NA	2.59×10^{-4}	2.52×10^{-4}	25-31	Fine to medium sand, alternating with clay
Bedrock					
GW-4C	--	4.36×10^{-5}	8.77×10^{-5}	65-80	Onondaga Limestone
GW-5C	--	3.50×10^{-3}	2.94×10^{-3}	70-79	Onondaga Limestone

*To nearest foot.
**Slug test value obtained from Phase II Investigation Report.
***Abandoned during Phase I RI/FS.
NA - D_{10} particle size not available for calculation; see Table 3-2.
--: Permeability calculations by grain size not applicable for bedrock wells.

Table 3-2

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
HYDRAULIC CONDUCTIVITY VALUES FROM SOIL SAMPLES COLLECTED IN THE SCREENED INTERVALS OF GROUNDWATER MONITORING WELLS USING THE HAZEN EQUATION

Monitoring Well	Sample/Depth (feet)	D_{10} (cm)	D_{60} (cm)	Cu	K (cm/sec)
GW-3B	32-34	0.02283	0.176	7.7	4.2×10^{-2}
GW-4B	24-26	0.00334	0.542	162.2	8.9×10^{-4}
GW-5B	52-54	0.01180	0.067	5.7	1.4×10^{-2}
GW-6B	28-30	0.00054	0.075	140.0	2.3×10^{-5}
GW-10B	32-34	NA	0.010	NA	*
GW-11A	10-12	0.00148	0.008	5.4	2.2×10^{-4}
GW-12B	32-34	0.00422	0.111	26.3	1.4×10^{-3}
GW-13	12-14	0.00167	0.0055	3.3	1.1×10^{-4}
GW-14	14-16	0.00531	0.026	5.0	2.8×10^{-3}
GW-15B	26-28	NA	0.010	NA	*
GW-16	16-18	NA	0.025	NA	*
GW-17	8-10	0.00177	0.017	9.3	3.1×10^{-4}
GW-18A	8-10	NA	NA	NA	*

Notes:

NA - Data not available.

* Hydraulic conductivity value could not be calculated. Hydrometer test unable to achieve full particle settlement. Therefore, D_{10} particle size value not available.

D_{10} - The grain size that is 10 percent finer by weight.

D_{60} - The grain size that is 60 percent finer by weight.

Cu - Uniformity Coefficient, $Cu = D_{60}/D_{10}$ (Fetter, 1988, p. 67).

Sample calculation for K using the Hazen equation:

GW-3B

$D_{10} = 0.02283$ cm

C = 100 for medium sand well sorted to coarse sand poorly sorted (GW-5B, GW-11A, GW-14 and GW-17). C=80 for fine sand with appreciable fines (GW-3B, GW-4B, GW-6B, GW-12B) except GW-13 for which C=40 was used.

C is a dimensionless unit.

$K = C(D_{10})^2$

$K = 80 \times (0.02283 \text{ cm})^2$

$K = 4.2 \times 10^{-2}$ cm/sec

Fill

The following fill units were screened by the shallow wells installed during the Phase I RI: Sand Fill I, Hydraulic Sand Fill and Hydraulic Fill I. Additionally, permeability testing was conducted previously on wells screened in the Landfill Debris and Hydraulic Fill I units.

The hydraulic conductivity values obtained for the fill units from slug testing of shallow wells have been calculated for both rising and falling head test. However, the falling head test is considered to be valid only for a fully saturated screen condition. Since this is not the case in water table wells, the rising head test results will be primarily discussed here. The falling head results, however, are useful to compare gross recovery characteristics for the wells.

Hydraulic conductivity values for the fill unit derived from the rising head tests (bail tests) range from a low of 2.74×10^{-5} cm/s measured in the Hydraulic Fill I (GW-16) to a high of 3.34×10^{-4} cm/s in the Hydraulic Sand Fill (GW-14).

Hydraulic conductivities for the fill units obtained from the grain size analysis results are available for the Sand Fill I and Hydraulic Sand Fill only. The Hazen equation uses the effective grain size, D_{10} (size corresponding to the 10 percent line on the grain size curve) of a sample to estimate hydraulic conductivity. For the samples from wells with screened intervals in the Hydraulic Fill I (GW-16 and GW-18A), the hydrometer portion of the test was terminated when 0.0025 mm size particles dropped out of suspension in accordance with the test procedure. At GW-16, greater than 20 percent of the sample (D_{20}) and at GW-18A greater than 30 percent of the sample is smaller in particle size than 0.0025 mm, precluding determination of a D_{10} value.

The Hazen equation is a method for determining hydraulic conductivity from grain size analysis. Originally developed for use with sandy materials, its accuracy becomes lower with decreased sample grain size and poorer sorting. The degree of sorting (Uniformity Coefficient [Cu]) has been calculated for the grain size samples and is presented in Table 3-2. A Cu of less than 4 is considered to be well sorted. If the Cu is greater than 6, it is poorly sorted. The only sample considered to be well sorted is GW-13 (12-14'). The particle size of sand ranges from 0.00625 to 0.2 cm. Many of the samples consist of fine sand and finer material which also limits of usefulness of the equation.

The hydraulic conductivity obtained for the Sand Fill (GW-11A) is one order of magnitude higher than results obtained with the slug tests. Similarly, hydraulic conductivities obtained for the Hydraulic Sand Fill were also one order of magnitude higher than those obtained by the slug test method.

In addition to poor sorting which limits the usefulness of the D_{10} values and fine grained samples overall, a hydraulic conductivity value estimated from one sample from within the screened interval of a well can be expected to vary from a value derived from a slug test run along the entire length of the saturated section in the screened interval. Variations in formation material along the length of the screen are to some degree averaged out during a slug test. Based upon these considerations, a consistent difference in hydraulic conductivity values of one order of magnitude between the two methods for the wells screened in fill is considered to be reasonable and in fairly good agreement.

During the 1989 Phase II Investigation, limited slug testing was conducted and reported. Hydraulic conductivity values for the Landfill Debris have been derived from GW-3A (8.3×10^{-5} cm/s), for the Sand Fill I from GW-7 (1.25×10^{-5} cm/s) and for the Hydraulic Fill I from GW-10A (5.8×10^{-5} cm/s). The value for Sand Fill I is comparable to the value obtained during this investigation. The documentation supporting these values has been included in Appendix H.

Native Overburden

The following overburden units were screened by the intermediate depth wells installed during the Phase I RI: alternating clay, silt and gravel (GW-15B); fine to coarse sand and medium gravel (GW-12B); coarse sandy till (GW-5B); fine-coarse sand and gravel (GW-3B);

and sand, some gravel (GW-4B). Well GW-6B, which is screened 27 to 32 feet below ground surface is screened within fine to medium sand with varying amounts of flat gravel.

Monitoring well GW-18B was installed in the Phase II RI and screened alternating clay, silt and gravel.

The slug test results for the intermediate depth wells are presented in Table 3-1. Excellent correlation between the rising and falling head tests exists for all wells tested with one exception. At GW-10B, the falling head test results are almost one order of magnitude lower than the rising head test results. This well is screened across a unit of alternating clay, sand and silt. The heterogeneity of the material may have caused the difference in the results.

Hydraulic conductivities obtained from the slug test data range from 1.71×10^{-4} cm/s at GW-12B to 3.75×10^{-3} cm/s at GW-4B.

Hydraulic conductivities derived from grain size analysis results fluctuate around values derived from the slug test data by one to two orders of magnitude. Variations in conductivities calculated using the Hazen equation and slug test results are most likely caused by the presence of silt, clay and gravel within the screened intervals making them much more heterogeneous than any single sample submitted for grain size analysis.

<u>Bedrock</u>

The shallow Onondaga Limestone encountered on-site is very competent. Slug tests were performed at GW-4C and GW-5C which were both installed during the Phase I RI. Well GW-6C, which was also installed during the Phase I RI, behaved similarly to GW-4C during development and sampling by bailing dry and requiring 24 to 36 hours to recharge. Well GW-5C produces water in large quantities.

Excellent correlation between the rising and falling head tests were achieved for both wells. The hydraulic conductivity ranges from a high at GW-5C of 3.5 x 10^{-3} cm/s (rising head test) to a low at GW-4C of 8.77 x 10^{-5} cm/s (falling head test).

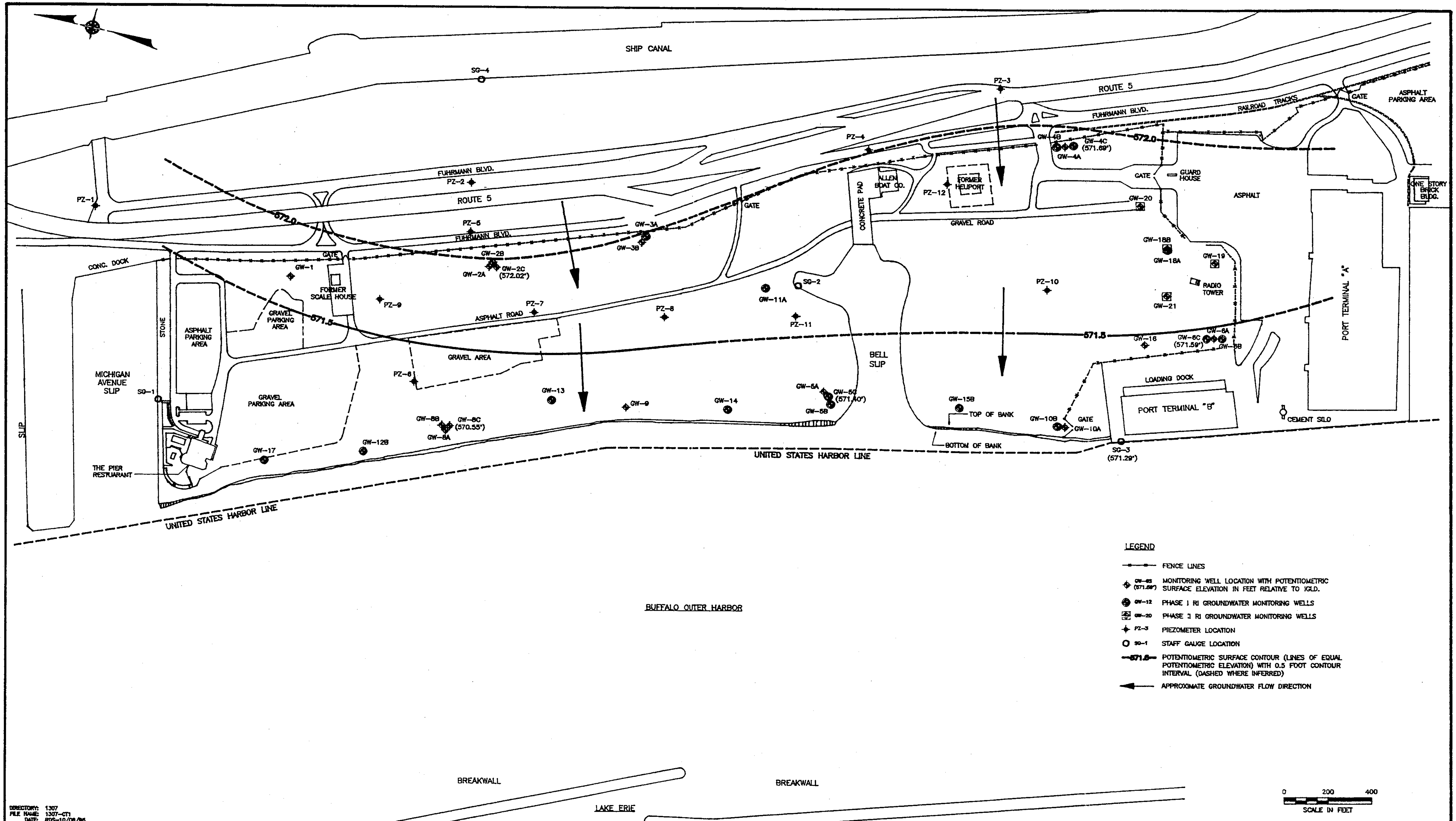
3.3.2 Groundwater Flow Patterns

Groundwater elevation data has been collected at the site several times throughout the Phase I RI field program. During the early phases of the Phase I RI, water levels were collected from existing wells and newly constructed wells (often undeveloped). Groundwater elevation data was collected from the entire network, including newly developed wells on several occasions during the Phase I RI and once during the Phase II RI. Groundwater elevation data is presented in Table 2-7 for October 20, 1994 and on Table 2-8 for June 28, 1995. The remainder of the data is contained in Appendix F.

Groundwater contour maps have been generated for the site from groundwater elevation data collected on October 20, 1994 and June 28, 1995. Water table and bedrock potentiometric surface maps have been prepared for groundwater elevations recorded on each date. The October 1994 maps are presented as Figures 3-10 and 3-11. The June 1995 maps are presented as Figures 3-12 and 3-13.

Fill (Water Table)

The water table was encountered within the fill unit across the site. During the Phase I RI, the depth to groundwater was the greatest at GW-1 (17.73 feet below ground surface) and the most shallow at GW-10A (3.78 feet below ground surface). Depth to groundwater north of the Bell Slip varied from 17.73 feet (GW-1) to 4.83 feet (GW-17) below ground surface. Similar results were observed during the Phase II RI where again depth to groundwater was the greatest at GW-1 and the most shallow at GW-10A. In general, depth to water decreases north to south along the eastern boundary of the site and increases north to south along the Outer Harbor shore.



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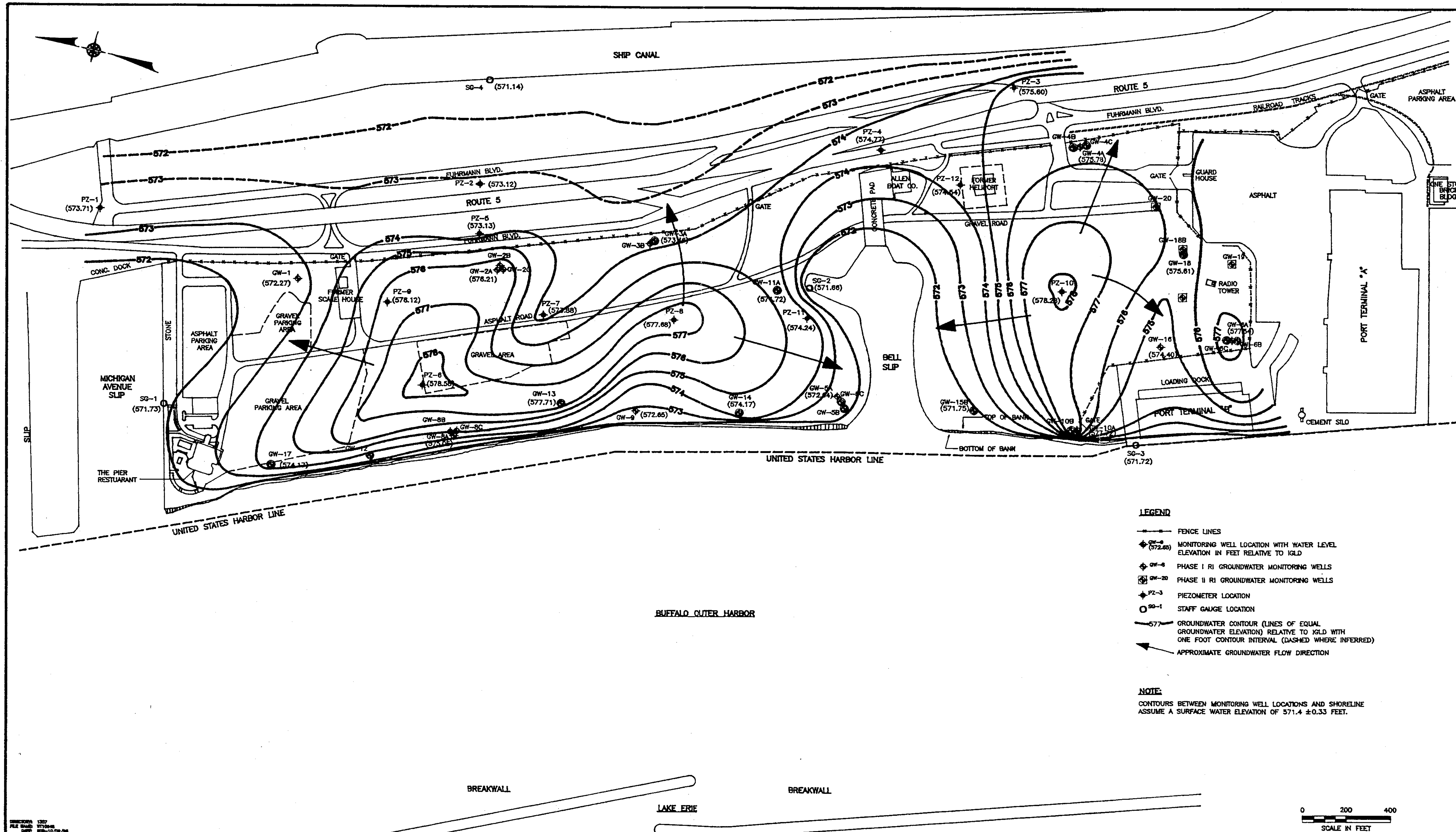
DVIRKA AND BARTILUCCI
CONSULTING ENGINEERS

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

CONTOUR MAP OF THE POTENTIOMETRIC SURFACE FOR SHALLOW BEDROCK
JUNE 28, 1995

PROJECT NO. 1307
DATE: OCT. 1995
SCALE: 1"=200'

FIGURE 3-13



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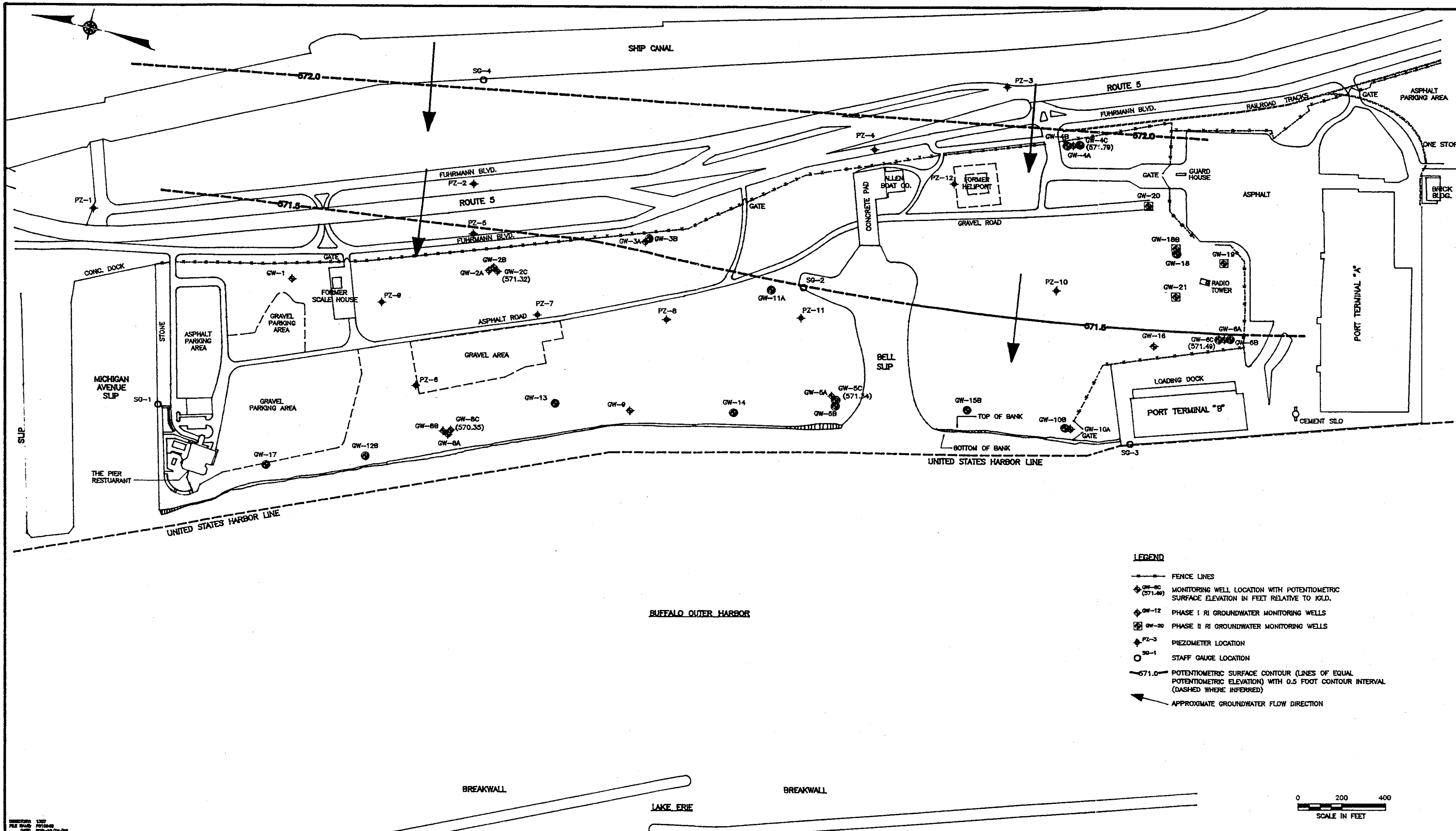
BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

WATER TABLE CONTOUR MAP (SHALLOW WELL)
OCTOBER 20, 1994

PROJECT NO. 1307
DATE: OCT. 1995
SCALE: 1"=200'

FIGURE 3-10



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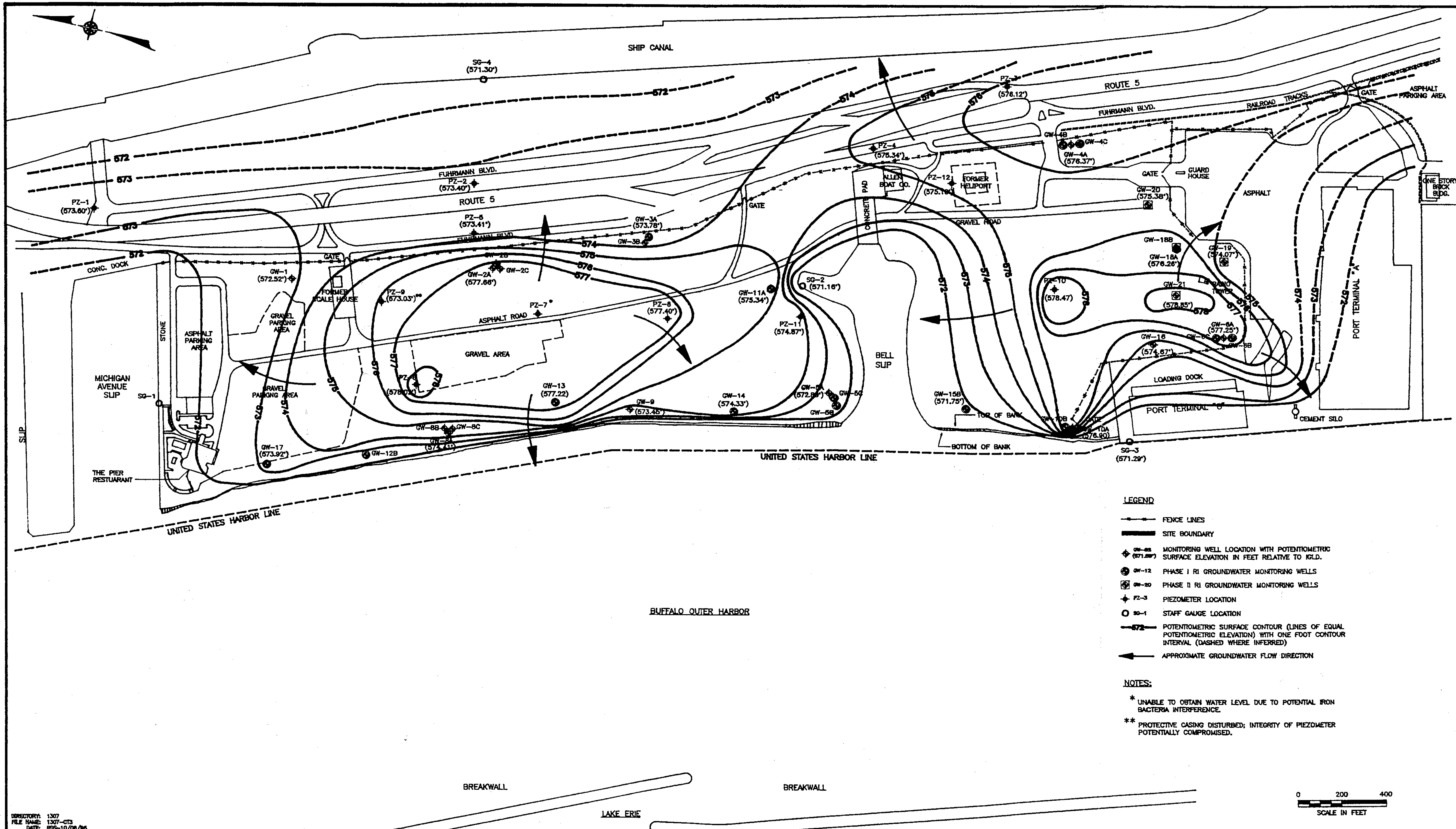
BUFFALO, NEW YORK

CONTOUR MAP OF THE POTENTIOMETRIC SURFACE FOR SHALLOW BEDROCK
OCTOBER 20, 1994

1307
JUNE 1994
1"=200'

FIGURE 3-11



LEGEND

- FENCE LINES
- SITE BOUNDARY
- GW-5B (571.89') MONITORING WELL LOCATION WITH POTENTIOMETRIC SURFACE ELEVATION IN FEET RELATIVE TO IGLD.
- GW-12 PHASE I RI GROUNDWATER MONITORING WELLS
- GW-20 PHASE II RI GROUNDWATER MONITORING WELLS
- PZ-3 PIEZOMETER LOCATION
- SG-1 STAFF GAUGE LOCATION
- 572 POTENTIOMETRIC SURFACE CONTOUR (LINES OF EQUAL POTENTIOMETRIC ELEVATION) WITH ONE FOOT CONTOUR INTERVAL (DASHED WHERE INFERRED)
- APPROXIMATE GROUNDWATER FLOW DIRECTION

NOTES:

* UNABLE TO OBTAIN WATER LEVEL DUE TO POTENTIAL IRON BACTERIA INTERFERENCE.

** PROTECTIVE CASING DISTURBED; INTEGRITY OF PIEZOMETER POTENTIALLY COMPROMISED.

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CONSULTING ENGINEERS

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

WATER TABLE CONTOUR MAP (SHALLOW WELL)
JUNE 28, 1995

PROJECT NO. 1307
DATE: OCT. 1995
SCALE: 1"=200'

FIGURE 3-12

South of the Bell Slip, depth to groundwater varied from 8.86 feet (PZ-12) to 3.78 feet (GW-10A) below ground surface during the Phase I RI and from 10.13 feet (GW-19) to 4.1 feet (GW-10A).

Groundwater flow direction on-site has generally been found to be radial, flowing toward surface water from the central areas of the site. A groundwater divide has been interpreted to be running roughly parallel to the eastern boundary of the site. Shallow groundwater east of the divide flows toward the ship canal and west of the divide flows toward the nearest surface water boundary (Michigan Avenue Slip, Outer Harbor, Bell Slip and Terminal A Slip). The horizontal hydraulic gradient varies considerably depending upon proximity to the shore, permeability of the underlying fill unit and density of measurement points. Groundwater has been found to flow under an average hydraulic gradient of 2×10^{-2} feet of head loss per horizontal foot (mean of five measurements).

Average groundwater flow velocities have been calculated for the various fill units identified on-site and screened by water table wells. Data from the Phase I RI from slug tests and hydraulic gradient measurements in the vicinity of the wells have been used in the calculations. The results are presented in Table 3-3. Average flow velocities range from a low of 4×10^{-7} cm/s (0.4 ft/year) as measured at GW-18A in the Hydraulic Fill to a high of 3.3×10^{-5} cm/s (34 ft/year) measured at GW-14 in the Hydraulic Sand Fill.

Bedrock (Deep Potentiometric Surface)

A contour map of the potentiometric surface within the shallow bedrock is presented as Figure 3-11 and Figure 3-13. Groundwater within the bedrock has been found to flow in a northwesterly direction (consistent with regional flow) toward the Outer Harbor. It flows under an average hydraulic gradient of 4×10^{-4} feet of head loss per horizontal foot of drawdown on the southern portion of the site and 1.2×10^{-3} feet of head loss per horizontal foot of drawdown on the northern portion of the site.

Table 3-3

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
AVERAGE FLOW VELOCITIES BY
HYDROSTRATIGRAPHIC UNIT

Well	Average Flow Velocity V (cm/s)	Average Flow Velocity V (ft/day)	Unit
Fill			
GW-11A	1.4×10^{-6}	4×10^{-3}	Sand Fill I
GW-13	3.1×10^{-6}	8.8×10^{-3}	Hydraulic Sand Fill
GW-14	3.3×10^{-5}	9.3×10^{-2}	Hydraulic Sand Fill
GW-16	5.9×10^{-7}	1.7×10^{-3}	Hydraulic Fill I
GW-18A	4×10^{-7}	1.1×10^{-3}	Hydraulic Fill I
GW-3A	3×10^{-6}	8.5×10^{-3}	Landfill Debris
GW-7	1.1×10^{-6}	3.1×10^{-3}	Landfill Debris
GW-10A	1.1×10^{-5}	3.1×10^{-2}	Hydraulic Fill II
GW-17*	2.8×10^{-5}	7.9×10^{-2}	Landfill
Native Overburden			
GW-3B	4.5×10^{-6}	1.3×10^{-2}	Sand and gravel
GW-4B	1.7×10^{-5}	4.8×10^{-2}	Sand, some gravel
GW-5B	1.7×10^{-5}	4.8×10^{-2}	Coarse sand (till)
GW-10B	3.8×10^{-8}	1.1×10^{-4}	Alt. clay, silt and gravel
GW-12B	7.9×10^{-7}	2.2×10^{-3}	Fine-coarse sand, medium gravel
GW-15B	2.4×10^{-6}	6.8×10^{-3}	Alt. clay, silt and gravel
Bedrock			
GW-4C	7×10^{-7}	2×10^{-3}	Onondaga Limestone
GW-5C	1.3×10^{-5}	3.7×10^{-2}	Onondaga Limestone

*Hazen method of hydraulic conductivity calculation only.

Average flow velocity within the bedrock has been calculated based upon slug test data from GW-4C and GW-5C to be 7 x 10^{-7} cm/s (0.73 ft/yr) and 1.3 x 10^{-5} cm/s (14 ft/yr), respectively.

Vertical Flow

Groundwater elevation data for eight rounds of measurements during the Phase I RI (September 1, 1994 through October 28, 1994) show that the predominant component of flow on-site is horizontal. The vertical component is much smaller, but has been consistently observed downwards through the fill into the native overburden, as well as through the upper portion of the overburden into the shallow bedrock.

The existence of the downward component of flow, however, does not necessarily mean that large quantities of water and potentially contaminated groundwater are recharging to the overburden and bedrock beneath the site. Regional hydrogeology indicates that downward flow this close to the Lake Erie shoreline is negligible due to the large volume of groundwater discharging to the lake along the shore.

Quantification of the downward flow velocities between the various hydrostratigraphic units on-site requires measured values or knowledgeable estimates of their anisotropy. The most effective way to obtain this information would be to perform a pumping test on-site. Should additional definition of vertical extent or potential extent of groundwater contamination be necessary, a pumping test could be designed to more fully evaluate the water bearing characteristics of the hydrostratigraphic units on-site at that time.

3.3.3 Discharge to Buffalo Outer Harbor

To aid in the evaluation of the need for remedial alternatives for the site, an effort has been made to calculate the daily discharge of potentially contaminated groundwater to the Buffalo Outer Harbor from the saturated fill unit on-site.

All groundwater recharging to the west of the shallow flow system groundwater divide on-site discharges to the Outer Harbor both beneath and beyond the shoreline. No seeps were observed along the shoreline during the RI field investigation. In the area of the Bell Slip, discharge would be expected to flow beneath the shoreline and upward through the base of the slip bed. Within the Michigan Avenue and Port Terminal A Slips, groundwater is expected to discharge to the Outer Harbor through the piping system along the wooden bulkheads, beneath the wall of the bulkheads and upward through the bottom sediment within the slips. The approximate location and diameter of the pipes are shown on Figure 3-1 (Surface Features Map). Estimated discharge of 16,000 gallons per day (gpd) to the Outer Harbor has been calculated for water passing through the fill unit along the shoreline, within the Bell Slip, along the southern wall of the Michigan Avenue Slip and along the northern wall of the Port Terminal A Slip.

The area of each saturated fill unit along Section C-C' was obtained by planimeter and discharge through that section was calculated using the average flow velocity developed for each unit. Where velocities were unknown, a known velocity for a unit displaying similar permeability characteristics was used. All independent discharges were summed, then divided by the total saturated area along Section C-C' to obtain a value of average discharge per unit area of fill.

Within the Bell Slip, Michigan Avenue Slip and Port Terminal A Slip, little to no data exists on fill type or thickness and saturated thickness. Estimates of fill thickness and saturated thickness were made for the Michigan Avenue Slip using data from SB-1 and GW-17, for the Bell Slip using GW-11, GW-5A and GW-5B, and for the Port Terminal A Slip using GW-6A and GW-6B. From this information, the area of the discharge faces were obtained and discharge values were calculated using the average discharge value per unit area established for Section C-C'.

3.4 Ecology

The terrestrial and aquatic ecology at the Buffalo Outer Harbor Site and adjacent areas is assessed in this section. This habitat-based assessment conforms to the Step 1 Habitat Assessment

Effort Guidelines presented in the NYSDEC document, entitled "Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites," dated June 18, 1991. The purpose of this assessment is to describe the existing ecology at the site, including a site-specific description of major habitat types and associated fish and wildlife populations, as well as, the identification of any significant on-site ecological resources. Overall, since the entire site was created a result of land reclamation and filling activities, the entire site can be considered disturbed lands. However, for the current conditions, the habitats presently existing at the site have been ascertained and are discussed.

The information contained in this assessment was obtained during the Phase I RI aquatic sampling program and site walkover, and is supplemented with data from outside sources, including the U.S. Army Corps of Engineers (USACOE), NYSDEC, the Erie County Department of Environment and Planning and the United States Fish and Wildlife Service (USFWS).

3.4.1 Major Habitat Types

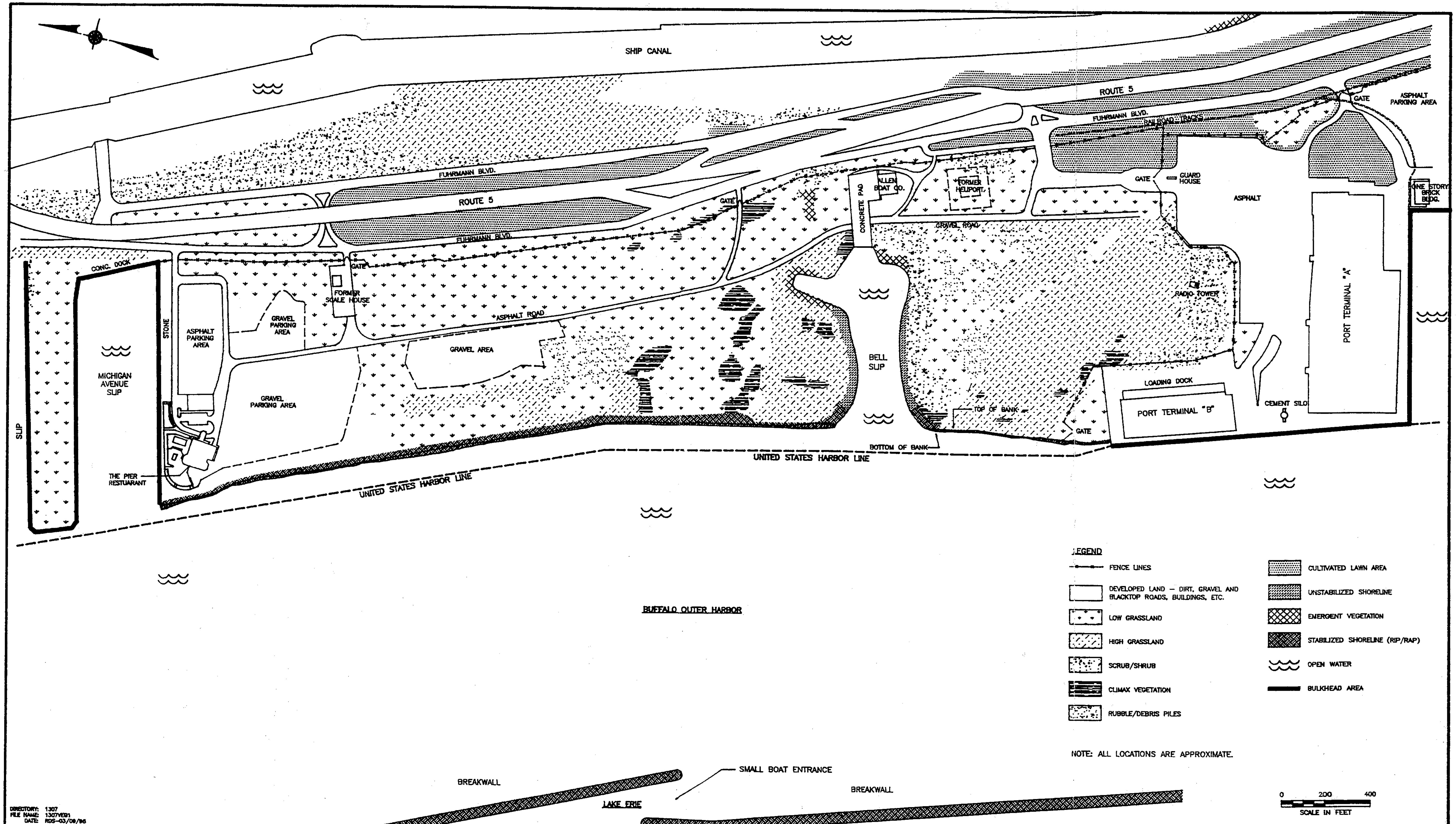
The Buffalo Outer Harbor Site is located in the Erie-Niagara basin, bordering Lake Erie to the west and the Michigan Avenue Slip to the north. The topography in the vicinity of the site is generally flat. The average elevation of the site is approximately 580 feet above mean sea level, which is approximately 10 feet above Lake Erie. Land surrounding the site is primarily industrial.

Past activities on the site included the land disposal of dredged spoils from the harbor and disposal of construction and demolition debris. The entire site was at one time an open water area. The majority of the site is currently reclaimed land comprised of open grassland vegetation that has become established in upland areas. Emergent wetland vegetation is also present along the periphery of the Bell Slip at approximately the center of the site. The majority of the site is upland area. The shoreline along the Outer Harbor area is heavily stabilized with large riprap which, for the most part, does not support vegetation.

Major plant associations or communities identified on-site include:

- Developed Lands: Consisting of buildings (Pier Restaurant, Allen Boat Company and Niagara Frontier Transportation Authority (NFTA) port facilities and warehouses, dirt and blacktop roadways, and gravel and paved parking areas);
- Low Grassland Habitat: Uncultivated areas characterized by typical upland grasses and wildflowers which have a maximum height of approximately 2-3 feet;
- High Grassland Habitat: Uncultivated areas characterized by upland grasses and Giant Reed Grass habitat with some sporadic scrub-shrub growth. These areas are typically comprised of vegetation approximately 4-6 feet high.
- Cultivated Lawn Areas: Typified by rye and fescue grasses which are periodically mowed;
- Emergent Wetland Habitat: Low-lying areas adjacent to open water areas typified by hydrophilic emergent wetland species;
- Open Water Habitat: Open water habitat on the site includes the Outer Harbor (Lake Erie), the Michigan Avenue Slip and the Bell Slip. The Bell Slip will be discussed separately below as a littoral zone habitat;
- Climax Vegetation Habitat: Areas characterized by stands of mature trees and shrubs of varying density;
- Scrub-Shrub Areas: Characterized by mature and mid sized hardwoods; and
- Debris Pile Habitat: Typified by visible rubble mounds partially covered by vegetation.

Figure 3-14 illustrates the approximate location of each community expressed as the dominant vegetative cover type. The major communities found within ½ mile of the site are described below. A listing of the plant species encountered during site walkovers is presented in Table 3-4.



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DVIRKA AND BARTILUCCI
CONSULTING ENGINEERS

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

VEGETATIVE COVER TYPE MAP

PROJECT NO. 1307
DATE MARCH 1995
SCALE 1"=200'

FIGURE 3–14

Table 3-4

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
PLANT SPECIES INHABITING THE SITE*

Achillea millefolium	Yarrow, Milfoil
Aethusa cynapium	Fools Parsley
Allanthus sp.	Tree-Of-Heaven
Ambrosia artemisiifolia elatior	Common Ragweed
Ambrosia trifida	Giant Ragweed
Apocynum sibiricum	Indian Hemp
Arctium minus	Common Burdock
Artemisia vulgaris	Mugwort
Asclepias syriaca	Common Milkweed
Aster junciformis	Rush Aster
Aster novae-angliae	New England Aster
Aster patens	Late Purple Aster
Barbarea vulgaris	Yellow Rocket
Brassica nigra	Black Mustard
Brassica polylepis	Tickseed Sunflower
Calamagrostis canadensis	Blue Joint Grass
Camelina microcarpa	Small-Fruited False Flax
Carduus nutans	Nodding Thistle
Carex crinita	Fringed Sedges
Carex cristatella	Crested Sedge
Carex spp.	Sedges
Caltha sp.	Buttercup
Cerastium arvense	Field Chickweed
Chaenorrhinum sp.	Snapdragon
Chrysanthemum leucanthemum	Ox-Eye Daisy
Chrysopis sp.	Golden Aster
Cichorium intybus	Chickory
Cirsium arvense	Field Thistle
Cirsium vulgare	Bull Thistle
Clethra alninfolia	Sweet Pepper Bush
Convolvulus arvensis	Field Bindweed
Convolvulus sepium	Hedge Bindweed
Coronilla spp.	Vetch

*Based upon site walkovers conducted during September 19 through September 23, 1994.

Table 3-4 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
PLANT SPECIES INHABITING THE SITE*

Cuscuta sp.	Dodder
Dactylis glomerata	Orchard Grass
Daucus carota	Wild Carot, Queen Anne's Lace
Dipsacus sylvestris	Common Teasel
Echium vulgare	Viper's Bugloss
Elodea nuttallii	Slender Waterweed
Equisetum arvense	Horsetail
Erigeron annuus	Annual Fleabane
Erigeron philadelphicus	Marsh Fleabane
Eupatorium spp.	Joe Pye Weed
Eupatorium perfoliatum	Common Boneset
Festuca spp.	Fescues
Fraxinus pennsylvanica	Green Ash
Geum spp.	Avens
Helianthus annuus	Garden Sunflower
Heracleum maximum	Cow Parsnip
Hypericum perforatum	Common St. John's Wort
Impatiens carpensis	Orange Jewelweed
Iris sp.	Iris
Ipomoea purpurea	Common Morning Glory
Juncus effusus	Common Rush
Juncus spp.	Rushes
Knautia spp.	Teasel
Leersia oryzoides	Rice Cut Grass
Lepidium virginicum	Common Peppercress
Linaria vulgaris	Butter-And-Eggs
Lolium perenne	Perennial Rye Grass
Lonicera spp.	Honeysuckle
Lychnis alba	White Campion
Lycopus americanus	Common Water Horehound
Melilotus officinalis	Yellow Sweet-Clover
Myriophyllum exalbescens	Spiked Water Milfoil
Nepeta cataria	Catnip
Oenothera biennis	Common Evening Primrose
Oxalis spp.	Sorrel
Parthenocissus spp.	Creeper

Table 3-4 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
PLANT SPECIES INHABITING THE SITE*

Pastinaca sativa	Wild Parsnip
Picea spp.	Blue Spruce
Phalaris arundinacea	Reed Canary Grass
Phleum pratense	Timothy
Phragmites spp.	Common Reed
Phytolacca americana	Pokeweed
Plantago manor	Common Plantain
Poa compressa	Canada Blue Grass
Polygonum spp.	Smart Weed
Populus deltoides	Eastern Cottonwood
Populus tremuloides	Quaking Aspen
Potentilla anserina	Silver Weed
Potentilla sp.	Cinquefoil
Ptilimnium capillaceum	Mock Bishops Weed
Ranunculus sp.	Spearwort
Rhamnus cathartica	Common Buckthorn
Rhamnus frangula	Glossy Buckthorn
Rhus copallina	Winged Sumac
Rhus typina	Staghorn Sumac
Rumex crispus	Curly Dock
Sabatia spp.	Marsh Pink
Salix nigra	Black Willow
Sambucus canadensis	Elderberry
Saponaria officinalis	Soapwort
Scirpus spp.	Rushes
Scirpus validus creber	Great Bulrush
Silphium integrifolium	Rosin Weed
Solanum nigrum	Common Nightshade
Solidago altissima	Tall Goldenrod
Solidago canadensis	Canada Goldenrod
Solidago odora	Sweet Goldenrod
Sonchus spp.	Cow Thistle
Sonchus oleraceus	Common Sow Thistle
Sphenopholis intermedia	Slender Wedge Grass
Stellaria media	Common Chick Weed
Taraxacum officinale	Dandelion

Table 3-4 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
PLANT SPECIES INHABITING THE SITE*

Typha angustifolia	Narrow-Leaved Cattail
Typha latifolia	Broad-Leaved Cattail
Ulmus rubra	Slippery Elm
Urtica procera	Tall Nettle
Verbascum thapsus	Common Mullein
Verbena hastata	Blue Vervain
Vernonia noveboracensis	New York Iron Weed
Vicia cracca	Cow Vetch
Viburnum spp.	Arrow Wood
Viola spp.	Violets

Developed Land

Developed lands are considered to be those areas which exhibit outward signs of use including dirt, gravel and paved roadways, parking areas and buildings. Developed lands support plant species, such as grasses and weeds that can reproduce quickly and colonize small areas between disturbances. Such plants include clover (Trifolium spp.) and Chicory (Cichorium intybus).

Low Grassland Habitat

Grassland areas exist over portions of the center of the site that were disturbed by past land disposal activities and have been abandoned. These disturbed lands support typical upland grasses and wildflowers, and are found in between many areas of the site. Species identified in the grassland habitat areas include crabgrasses (Digitaria spp.) and goldenrods (Soldago spp.).

High Grassland Habitat

High grassland habitat includes those grassland areas which have been allowed to grow for at least two or more seasons. These areas may contain vegetation similar to low grassland areas, as well as taller varieties. Typically, vegetation in these areas range in height from 4 to 6 feet. These areas typically provide for increased cover for terrestrial animals for foraging and breeding.

Cultivated Lawn Areas

These areas are found in areas bordering Fuhrmann Boulevard to the east and areas bordering the Buffalo Skyway. These areas contain typical cultivated grasses which are periodically maintained.

Emergent Wetland Habitat

Emergent habitats are sporadically found in low-lying areas of the site which tend to retain moisture. These areas include sections of the Bell Slip and a small low lying natural drainage area north of the Allen Boat yard. These habitats provide for emergent wetland plant species, such as soft rush (Juncus effusus), bull rush (Scirpus Sp.), milkweed (Asciepias syriaca) and giant reed (Phragmites australis).

Open Water Habitat

Along the Outer Harbor shoreline and at the Michigan Avenue Slip (at the north of the site), deep 22-30 feet deep dredged channel areas exist. These areas do not support extensive aquatic vegetation and are considered separate and distinct from the Bell Slip. The Bell Slip area in contrast is shallow (6-8 feet in depth) and supports extensive aquatic vegetation, such as waterweed watermilfoil and curly pond weed.

Debris Pile Habitat

Debris pile habitats are considered separate from other areas on this site since the material in these areas has allowed them to form a unique habitat. These areas, most likely used for disposal of construction and demolition materials, are predominately concrete rubble covered by vegetation as evidenced by visible mounds several feet in elevation. Although visually unattractive, these areas tend to provide cover and suitable habitat for burrowing animals and reptiles.

Climax Vegetation

Sporadically throughout the site, climax vegetation occurs which is characterized by stands of mature trees and some low scrub of sparse density. Areas of climax vegetation on the site are located north of the Bell Slip and in areas surrounding the Radio Tower (near the south of the site). The woody overstory includes eastern cottonwood (Populus deltoides) and willows (Salix spp.). Staghorn sumac (Rhus typhina) characterizes the medium density shrubs in these areas, with more dense growth near the Radio Tower area.

Scrub-Shrub

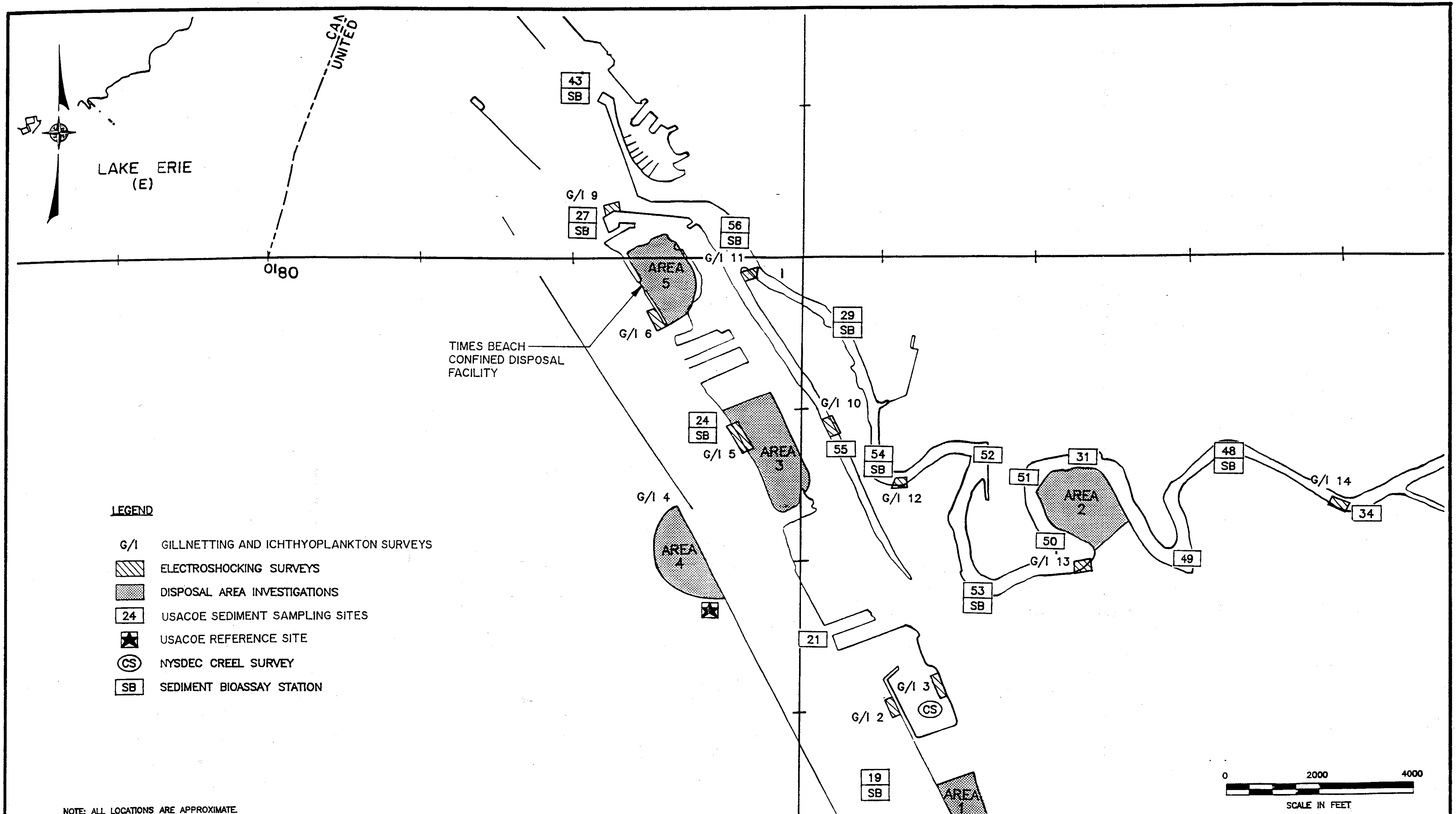
Typically found near climax vegetation, these areas are comprised of woody varieties, such as sumacs (Rhus spp.) and tree of heaven (Allanthus spp.) of moderate density and height.

3.4.2 Open Water Systems

The open water areas surrounding the site have been extensively studied. Studies conducted or supported by the USACOE for dredging activities in the Outer Harbor have included investigations at the Times Beach Upland Confined Disposal Facility north of the site (designated as Disposal Area 5), the area south of the Small Boat Harbor channel in Lake Erie (designated as Disposal Area 4), as well as sediment collections adjacent to the site in the navigable channel and work on the Buffalo Outer Harbor Site proper (designated as Disposal Area 3).

The above efforts have included work performed by the U.S. Fish and Wildlife Service, NYSDEC, State University of New York at Brockport, the Buffalo River Citizens Committee and the Great Lakes Fishery Commission. A map presenting the approximate locations of survey areas near the site are presented in Figure 3-15.

Open water systems associated with the site include Lake Erie to the west. No tributaries exist on the site. The Buffalo River Ship Canal is east of the Buffalo Skyway. A number of ponded



BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

LOCATION OF PREVIOUS SAMPLING SITES

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FIGURE 3–15

areas exist south of the site within the Tifft Farm Nature Preserve. The Bell Slip, given its function as a shallow vegetated embayment, is discussed separately. Figure 3-16 illustrates the location of these systems and their corresponding NYSDEC index number.

The reach of the site along the Outer Harbor is approximately 4,500 feet long. Bank heights are approximately 8-12 feet high and are steep. The river bottom material along portions of the shoreline is comprised of miscellaneous riprap, concrete rubble, bricks and marble. This material extends 10-20 feet offshore, whereupon the water depth drops to 20-30 feet.

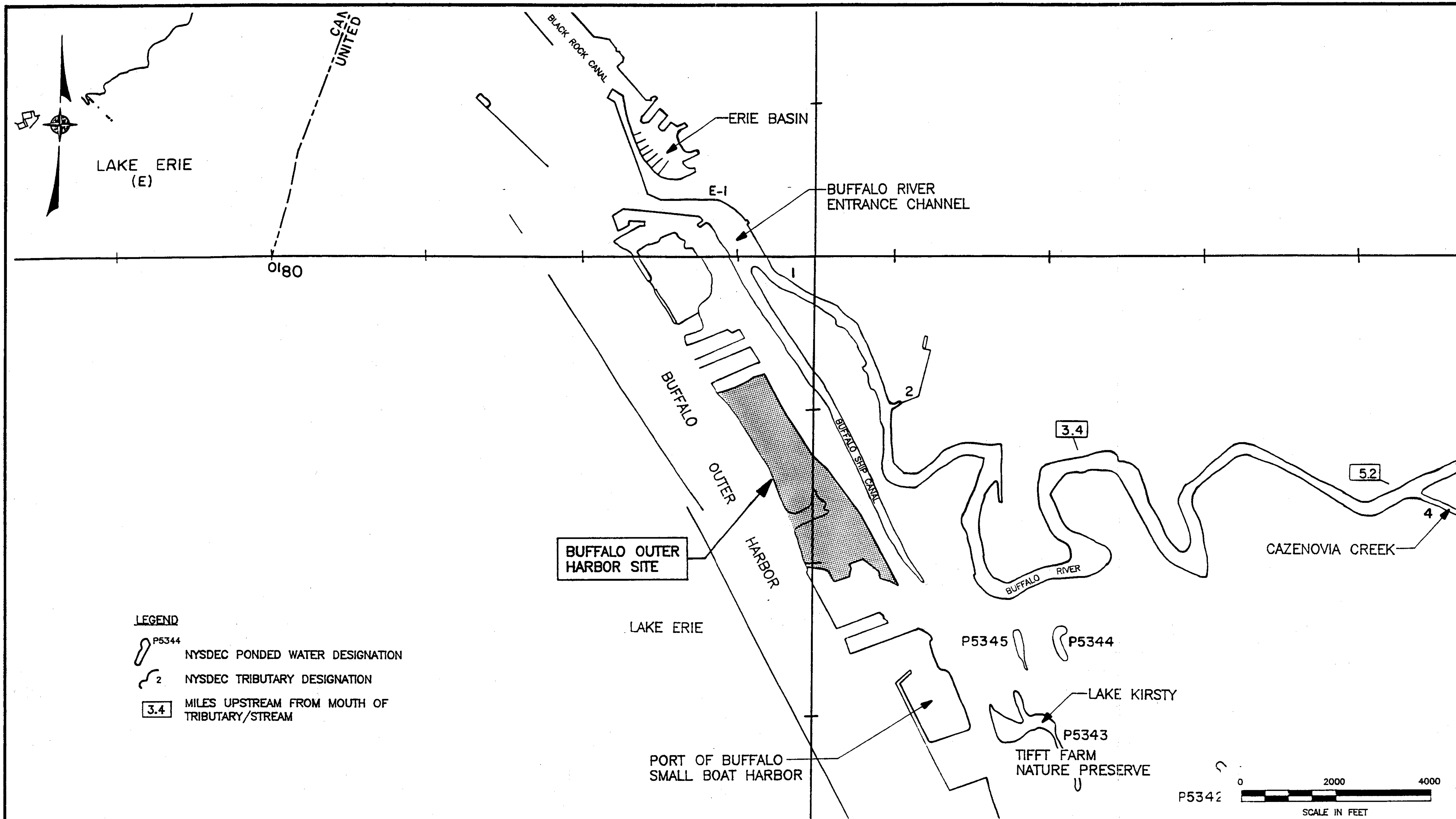
During the investigation, the water was relatively clear, having low turbidity and high light penetration (secchi values ranged from 14 to 19 feet deep).

Littoral Zone Areas

Although an open water area, the Bell Slip is considered as a separate habitat type for this assessment. The shallow nature of the area (6-8 feet), combined with the extensive growth of aquatic macrophytic vegetation, provide for an enhanced use of this area by waterfowl, fish and recreational users. The Bell Slip contains aquatic plants, such as waterweed (Elodea nutalli), curly pond weed (Potamogeton crispus) and watermilfoil (Myriophyllum spp.) in significant amounts. The invertebrates encountered included a freshwater snail (Campeloma spp.) and zebra mussel (Dreissena polymorpha).

Benthic Invertebrates

A 1977 benthic study of Buffalo Outer Harbor performed by the State University College at the Buffalo Great Lakes Laboratory indicated that the freshwater invertebrate family Chironomidae (midges) were the most diverse group followed by Tubificidae (aquatic worms) and Gastropoda (snails). The most frequently occurring species was the snail (Valvata tricarinata). Other species found were the sludge worm (Limnodrilus hoffmeisteri), (Pisidium spp.), and bloodworm (Procladius spp.). These data and previous work performed by the Great Lakes Laboratory in 1975



BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

TRIBUTARY MAP

Dvirka and Bartilucci
Consulting Engineers
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FIGURE 3–16

indicated that there were no rare or endangered species present. However, there were some species which were uncommon to eastern Lake Erie. In general, the surveys found a benthic community typical for the existing depths and sediment types within the harbor (Great Lakes Laboratory, 1979). A 1981 - 1982 biological survey of Buffalo Outer Harbor and the Buffalo River revealed 26 different species of benthic invertebrates, including snails, clams, and aquatic worms (Makarewicz, et al., 1982). A 1983 biological survey of Buffalo Harbor identified a variety of aquatic worms, scuds, caddisflies, copepods, midge larvae, blackflies, snails and clams (USFWS, 1984). During the present investigation, the dredged channel areas adjacent to the site did not reveal any macroscopic invertebrates and little aquatic vegetation in those sediment samples collected from the Outer Harbor or Michigan Avenue Slip.

Sediment Contaminant Studies

The sediments within Buffalo Outer Harbor have exceeded contaminant levels established by the USEPA and USACOE for open lake disposal. Therefore, the USACOE has designated upland confined disposal locations around the harbor for placement of maintenance dredging spoils. The present spoil disposal area is located west of Stony Point adjacent to the south entrance channel.

Under contract to the USACOE, Aqua Tech Environmental Consultants (1989) performed a sediment analysis of Buffalo Outer Harbor. This work was performed to support ongoing maintenance dredging of the navigable channel. The typical maintenance dredging project depth adjacent to the site is 27 feet. The work included water quality parameters, sediment quality and sediment bioassay (96 hour LC50) for Fathead minnow (Pimephales promelas), (Hexagenia limbata) and the water flea (Daphnia magna). The stations closest to the Buffalo Outer Harbor Site were USACOE Stations 24 and 21. The sediment samples collected for the Phase I RI were located coincident with these two sample locations (OHSD5 and OHSD16, respectively), and were collected with a similar sampling device (petite ponar grab). Coincident with the sediment samples collected for the USACOE bioassay study, samples were analyzed for volatile and semi-volatile organic contaminants, polychlorinated biphenyls (PCBs), pesticides, metals and conventional pollutants. This sediment characterization for the USACOE study is presented on Table 3-5 and the bioassay data is presented on Table 3-6 for the three sites closest to the Buffalo Outer Harbor Site. The aquatic sediment results from the Phase I RI is presented in Section 4.2.7 of this document. Figure 3-15 illustrates the approximate USACOE sampling locations.

3.4.3 Wetlands

Wetlands 12.4 acres or greater in size are regulated by the NYSDEC under Article 24 of the Environmental Conservation Law. Wetland acreage less than 12.4 acres is regulated by the Federal Government (U.S. Army Corps of Engineers). According to National Wetlands Inventory Mapping, a small intermittent ponded water wetland (POWZx) exists south of the Bell Slip. This wetland was not confirmed during the September 1994 habitat survey. However, the area could become prominent during wet periods. The remainder of the site is considered uplands. Figure 3-17 indicates the location of protected wetlands within the vicinity of the site.

Wetlands BU-15 and BU-7 are NYSDEC regulated wetlands located south of the site within the confines of the Tifft Farm Nature Preserve. North of the site, within the Times Beach Confined Disposal Facility, exists wetland BU-3 which was created via dredge spoil disposal. Small patches of undesignated areas within the Bell Slip support emergent vegetation which continues sporadically to the east along a natural drainage swale (north of the Allen Boat Company yard).

3.4.4 Mammals

Evidence of the presence of various mammals was found on-site during the Phase I RI field program. This was particularly evident by the presence of two partially consumed bird carcasses. An eastern cottontail (Sylvilagus floridanus) was observed on-site, and has been confirmed by previous USACOE studies site as well. Muskrats (Ondatra zibethicus) were seen in and around the Bell Slip during the field program. Raccoons (Procyon lotor) and Meadow voles (Microtus pennsylvanicus) were noted on-site by sign.

Table 3-5

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
BULK CHEMICAL ANALYSES FOR SELECTED
USACOE SEDIMENT SAMPLING STATIONS
(all data in mg/kg)*

Analytes	Site Number 19	21	24	27
VOLATILE ORGANICS				
Acrolein	<0.100	<0.100	<0.100	<0.100
Acrylonitrile	<0.100	<0.100	<0.100	<0.100
Benzene	<0.005	<0.005	<0.005	<0.005
Bromoform	<0.010	<0.010	<0.010	<0.010
Carbon Tetrachloride	<0.005	<0.005	<0.005	<0.005
Chlorobenzene	<0.005	<0.005	<0.005	0.119
Chlorodibromomethane	<0.050	<0.050	<0.050	<0.050
Chloroethane	<0.050	<0.050	<0.050	<0.050
2-Chloroethyl Vinyl Ether	<0.010	<0.010	<0.010	<0.010
Chloroform	<0.005	<0.005	<0.005	<0.005
Dichlorobromomethane	<0.005	<0.005	<0.005	<0.005
Dichlorodifluoromethane	<0.050	<0.050	<0.050	<0.050
1,1-Dichloroethane	<0.010	<0.010	<0.010	<0.010
1,2-Dichloroethane	<0.010	<0.010	<0.010	<0.010
1,1-Dichloroethane	<0.010	<0.010	<0.010	<0.010
1,2-Dichloropropane	<0.010	<0.010	<0.010	<0.010
cis-1,3-Dichloropropene	<0.010	<0.010	<0.010	<0.010
trans-1,3-Dichloropropene	<0.005	<0.005	<0.005	<0.005
Ethyl Benzene	<0.005	<0.005	<0.005	<0.005
Methyl Bromide	<0.005	<0.005	<0.005	<0.005
Methyl Chloride	<0.005	<0.005	<0.005	<0.005
Methylene Chloride	<0.050	<0.050	<0.050	<0.050
1,1,2,2-Tetrachloroethane	<0.050	<0.050	<0.050	<0.050
Tetrachloroethene	<0.005	<0.005	<0.005	<0.005
Toluene	<0.010	<0.010	<0.010	<0.010
cis-1,2-Dichloroethene	<0.005	<0.005	<0.005	<0.005
trans-1,2-Dichloroethene	<0.005	<0.005	<0.005	<0.005
1,1,1-Trichloroethane	<0.005	<0.005	<0.005	<0.005
1,1,2-Trichloroethane	<0.005	<0.005	<0.005	<0.005
Trichloroethene	<0.005	<0.005	<0.005	<0.005
Trichlorofluoromethane	<0.020	<0.020	<0.020	<0.020

Table 3-5 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
BULK CHEMICAL ANALYSES FOR SELECTED
USACOE SEDIMENT SAMPLING STATIONS
(all data in mg/kg)*

	Site Number			
Analytes	**19**	**21**	**24**	**27**
VOLATILE ORGANICS				
Vinyl Chloride	<0.050	<0.050	<0.050	<0.050
Total Xylenes	<0.010	<0.010	<0.010	0.037
1,3-Dichlorobenzene	<0.005	<0.005	<0.005	0.107
Other Volatile Hydrocarbons*	0.578	1.62	<0.050	3.12
POLYNUCLEAR AROMATIC HYDROCARBONS				
Acenaphthene	<0.20	<0.20	<0.20	<0.20
Acenaphthylene	<0.20	<0.20	<0.20	<0.20
Anthracene	0.26	0.40	0.22	0.22
Benzo(a)Anthracene	0.90	1.00	0.74	0.83
Benzo(a)Phrene	1.11	1.26	1.01	1.09
Benzo(b)Fluoranthene	1.72	2.04	1.80	1.91
Benzo(ghi)Perylene	0.53	0.43	0.54	0.48
Benzo(k)Fluoranthene	<0.20	<0.20	<0.20	<0.20
Chrysene	0.82	0.95	0.82	0.94
Debenzo(a,h)Anthracene	0.40	<0.40	<0.40	<0.40
Fluoranthene	1.89	2.37	1.72	1.86
Fluorene	<0.30	<0.30	0.30	<0.30
Indeno(1,2,3-cd)Pyrene	0.58	0.52	0.56	0.58
Naphthalene	0.49	<0.30	0.38	<0.30
Phenanthrene	0.97	1.72	0.84	0.74
Pyrene	0.87	1.52	0.86	0.98

Table 3-5 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
BULK CHEMICAL ANALYSES FOR SELECTED
USACOE SEDIMENT SAMPLING STATIONS
(all data in mg/kg)*

Analytes	Site Number 19	21	24	27
PESTICIDES/PCBs				
Aldrin	<0.02	<0.02	<0.02	<0.02
alpha-BHC	<0.02	<0.02	<0.02	<0.02
beta-BHC	<0.02	<0.02	<0.02	<0.02
gamma-BHC	<0.02	<0.02	<0.02	<0.02
delta-BHC	<0.02	<0.02	<0.02	<0.02
Chlordane	<0.10	<0.10	<0.10	<0.10
4,4'-DDD	<0.02	<0.02	<0.02	<0.02
4,4'-DDE	<0.03	<0.03	<0.03	<0.03
4,4'-DDT	<0.03	<0.03	<0.03	<0.03
Dieldrin	<0.02	<0.02	<0.02	<0.02
Endosulfan I	<0.03	<0.03	<0.03	<0.03
Endosulfan II	<0.03	<0.03	<0.03	<0.03
Endosulfan Sulfate	<0.03	<0.03	<0.03	<0.03
Endrin	<0.05	<0.05	<0.05	<0.05
Endrin Aldehyde	<0.05	<0.05	<0.05	<0.05
Heptachlor	<0.03	<0.03	<0.03	<0.03
Heptachlor Epoxide	<0.03	<0.03	<0.03	<0.09
Toxaphene	<0.10	<0.10	<0.10	<0.10
PCB-1016	<0.10	<0.10	<0.10	<0.10
PCB-1221	<0.10	<0.10	<0.10	<0.10
PCB-1232	<0.10	<0.10	<0.10	<0.10
PCB-1242	<0.10	<0.10	<0.10	<0.10
PCB-1248	<0.10	<0.10	<0.10	<0.10
PCB-1254	<0.10	<0.10	<0.10	<0.10
PCB-1260	<0.10	<0.10	<0.10	<0.10

Table 3-5 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
BULK CHEMICAL ANALYSES FOR SELECTED
USACOE SEDIMENT SAMPLING STATIONS
(all data in mg/kg)*

	Site Number			
Analytes	19	21	24	27
METALS				
Arsenic, Total, As	13	11	8	9
Barium, Total, Ba	65	53	49	76
Cadmium, Total, Cd	0.6	0.5	<0.6	0.5
Chromium, Total, Cr	36	29	20	21
Copper, Total, Cu	35	30	38	45
Iron, Total, Fe	32400	50600	22200	27400
Lead, Total, Pb	33	37	52	64
Manganese, Total, Mn	1400	1000	560	505
Mercury, Total, Hg	0.26	0.18	0.15	0.50
Nickel, Total, Ni	29	24	20	27
Residue, Total (Ts), %	47.9	49.5	53.0	52.7
Selenium, Total, Se	<2	<2	<2	<2
Silver, Total, Ag	<0.6	<0.5	<0.6	<0.5
Sodium, Total, Na	470	770	1200	455
Zinc, Total, Zn	170	210	150	190
Specific Gravity	1.4	1.51	1.58	1.57
Carbon, Total Organic	1700	1500	170	1000

*Source: Aqua Tech Environmental Consultants, 1989.

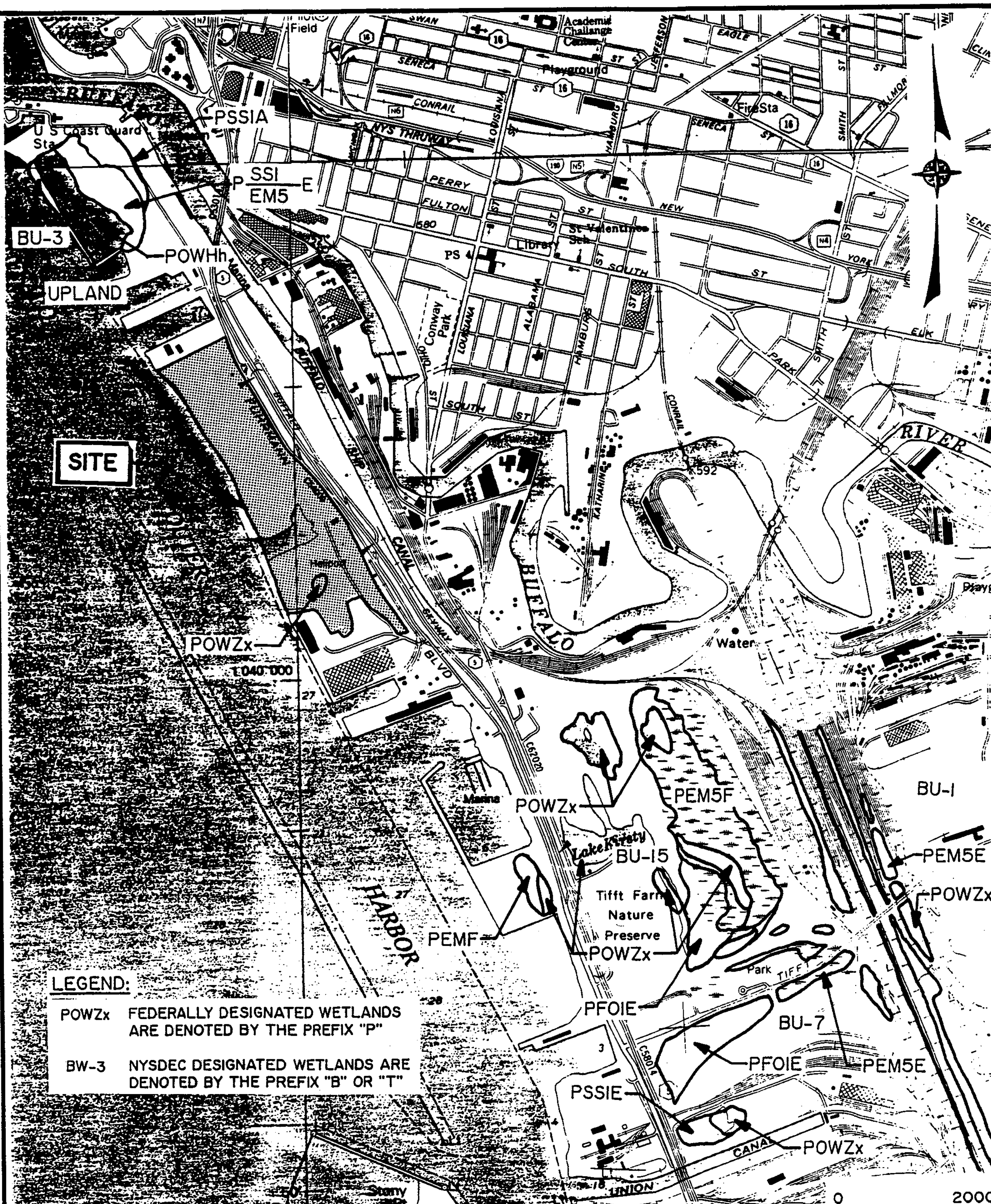
Table 3-6

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
SEDIMENT BIOASSAY RESULTS FOR USACOE
SITES 27, 24 AND 21*

Organism	Site #	% Mortality	Remarks
Pimephales promelias	19	0%	All sites classified as non-polluted.
	24	0%	All sites classified as non-polluted.
	27	0%	All sites classified as non-polluted.
Hexagenia limbata	19	18.3%	Sites classified as moderately polluted.
	24	21.6%	Sites classified as moderately polluted.
	27	21.6%	Sites classified as moderately polluted.
Daphnia magna	19	8.8%	Classified as non-polluted.
	24	17.8%	Classified as moderately polluted.
	27	18.8%	Classified as moderately polluted.

* Data as reported in Aqua Tech Environmental Consultants, Inc., 1989. The analyses of sediments from Buffalo Harbor Contract #DACW 49-88 D-005 Technical Report to USACOE Buffalo District.

All data is based upon three replicate 96-hour sediment bioassay tests for each organism group.



LEGEND:

POWZx	FEDERALLY DESIGNATED WETLANDS ARE DENOTED BY THE PREFIX "P"
BW-3	NYSDEC DESIGNATED WETLANDS ARE DENOTED BY THE PREFIX "B" OR "T"

SOURCE: NATIONAL WETLAND INVENTORY MAPPING AND NYSDEC WETLAND MAPPING, BUFFALO SE QUADRANGLE

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

LOCATION OF REGULATED WETLANDS

Dvirka and Bartilucci
Consulting Engineers
A Division of William F. Cosulich Associates, P.C.

FIGURE 3–17

3.4.5 Birds

The Buffalo Outer Harbor area is an important habitat for migratory waterfowl. The site hosts a number of common species of birds which typically frequent disturbed lands and mature tree stands. Observed during field surveys were numerous black capped chickadees (Parus atricapillus) and a single northern oriole (Icterus galbulla) in the mixed wooded areas of the site. Several hawks (Buteo spp.) were observed on more than one occasion circling high above the site, apparently hunting for prey. These birds did not descend and the species could not be positively identified. NYSDEC Division of Fish and Wildlife, however, has confirmed the presence of red tailed hawk (Buteo jamaicensis), and the birds observed during the Phase I RI could be of the same variety. The area within the Bell Slip provides a suitable foraging area for mallards. Small forage fishes provide prey for great blue heron (Ardea herodias) and egrets (Egretta spp.) and (Bubulus spp.) which were seen during the field survey.

In addition, many species of birds found in Erie County can be presumed to frequent the site. Table 3-7 contains the bird listing found during the site survey, supplemented by background reports for the Times Beach area.

The area is an important winter habitat for ducks, including greater scaup (Aythya marila), canvasback (A. Valisineria), common merganser (Mergus merganser), red-breasted merganser (Mergus serrator), oldsquaw (Clanqula hymalis) and common goldeneye (Bucephala clanqula). NYSDEC collected adult male common goldeneye near their time of arrival on wintering grounds of the Upper Niagara River (November to December) and just prior to their spring migration (February to March) to identify and measure organochlorine contaminants in fat tissues (Foley and Batcheller, 1988).

The accumulation of persistent compounds in ducks is considered a concern since humans consuming waterfowl from the harbor area are exposed to contaminants. The objectives of the NYSDEC study were to compare changes in contaminant concentrations in birds from their winter migration.

Table 3-7

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
BIRDS RECORDED AT THE TIMES BEACH DISPOSAL SITE*

Common Name	Scientific Name	Confirmed +
Pied-billed Grebe	Podilym bus piduceos	
Double-crested Heron	Phalacrocorax auritus	
Great Blue Heron	Ardea herodias	+
Green Heron	Butoridas virescens	
Great Egret	Casmerodius albus	
Black-crowned Night Heron	Nycticorax nycticorax	
Whistling Swan	Olor columbianus	
Canada Goose	Branta canadensis	+
Brant	Branta bernicla	+
Egyptian Goose	Alopochen aeoyptiacus	
Mallard	Anas platyrhynchos	+
Black Duck	Anas rubripes	
Gadwall	Anas strepera	
Pintail	Anas acuta	
American Green-winged Teal	Anas crecca	
Blue-winged Teal	Anas discors	
Cinnamon Teal	Anas cyanoptera	
American Wigeon	Anas americana	
Shoveler	Anas clypeata	
Wood Duck	Aix sponsa	
Redhead	Aythya americana	
Ring-necked Duck	Aythya collaris	
Canvasback	Aythya valisineria	+
Greater Scaup	Aythya marila	+
Lesser Scaup	Aythya affinis	
Common Goldeneye	Bucephala clangula	
Bufflehead	Bucephala albeola	
Oldsquaw	Clangula hyemalis	
Surf Scoter	Melanitta persoicillata	
Ruddy Duck	Oxyura jamaicensis	
Hooded Merganser	Lophodytes cucullatus	
Red-breasted Merganser	Mergus serrator	
Sharp-shinned Hawk	Accipiter striatus	
Red-tailed Hawk	Buter beicalis	
Marsh Hawk	Circus cyaneus	+
American Kestrel	Falco soarverius	+

Table 3-7 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
BIRDS RECORDED AT THE TIMES BEACH DISPOSAL SITE*

Common Name	Scientific Name	Confirmed +
Ring-necked Pheasant	Phasianus colchicus	+
Sora	Porzana carolina	
Common Gallinule	Gallinula chloropus	+
American Coot	Fulica americana	
Semipalmated Plover	Charadrius semipalmatus	
Killdeer	Charadrius vociferus	+
American Golden Plover	Pluvialis dominica	
Black-bellied Plover	Pluvialis squatarola	
Ruddy Turnstone	Arenaria interpres	
Common Snipe	Capella gallinago	
Whimbrel	Numenius phaeopus	
Spotted Sandpiper	Actitis macularia	
Solitary Sandpiper	Tringa solitaria	
Willet	Catoptrophorus semipalmatus	
Greater Yellowlegs	Tringa melanoleucus	
Lesser Yellowlegs	Tringa flavipes	+
Red Knot	Calidris canutus	
Pectoral Sandpiper	Calidris melanotos	
White-rumped Sandpiper	Calidris fuscicollis	
Baird's Sandpiper	Calidris bairdii	
Least Sandpiper	Calidris minutilla	
Dunlin	Calidris alpina	
Semipalmated Sandpiper	Calidris pusillus	
Western Sandpiper	Calidris mauri	
Sanderling	Calidris alba	
Short-billed Dowitcher	Limnodromus griseus	
Long-billed Dowicher	Limnodromus scolopaceus	
Stilt Sandpiper	Micropalama himantopus	
Marbled Godwit	Limosa fedoa	
Hudsonian Godwit	Limosa haemastica	
Ruff	Philomachus pugnax	
American Avocet	Recurvirostra americana	
Wilson's Phalarope	Steganopus tricolor	
Parasitic Jaeger	Steganopus parasiticus	
Glaucous Gull	Larus hyperboreus	
Iceland Gull	Larus glaucoides	

Table 3-7 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
BIRDS RECORDED AT THE TIMES BEACH DISPOSAL SITE*

Common Name	Scientific Name	Confirmed +
Great Black-backed Gull	Larus marinus	+
Herring Gull	Larus argontatus	+
Ring-billed Gull	Larus delawarensis	
Black-headed Gull	Larus ridibundus	
Laughing Gull	Larus atricilla	+
Franklin's Gull	Larus pioixcan	
Bonaparte's Gull	Larus philadelphia	+
Little Gull	Larus minutus	
Forster's Tern	Sterna forsteri	
Common Tern	Sterna hirundo	+
Caspian Tern	Hydroprogne caspia	
Black Tern	Chlidonia nigar	
Rock Dove	Columba livia	+
Mourning Dove	Zenaida macroura	+
Snowy Owl	Nyctea scandiaca	
Common Nighthawk	Chordeiles minor	+
Chimney Swift	Chaetura pelagica	+
Belted Kingfisher	Megaceryle alcyon	
Common Flicker	Colaptes auratus	+
Red-headed Woodpecker	Melanerpes erythrocephalus	
Yellow-bellied Sapsucker	Syhyragilus varius	
Downy Woodpecker	Dendrocopos pubascens	
Eastern Kingbird	Tyrannus tyrannus	
Willow Flycatcher	Empidonax trailii	+
Least Flycatcher	Empidonax minimus	
Horned Lark	Eremophila alpestris	
Tree Swallow	Iridoprocne bicolor	
Bank Swallow	Riparia riparia	+
Rough-winged Swallow	Stelgidoptaryx ruficollis	
Barn Swallow	Hirundo rustica	+
Purple Martin	Progne subis	
Blue Jay	Cyanocitta cristata	+
Common Crow	Corvus brachyrhynchos	+
Black-capped Chickadess	Parus atricapillus	
White-breasted Nuthatch	Sitta carolinensis	
Red-breasted Nuthatch	Sitta canadensis	

Table 3-7 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
BIRDS RECORDED AT THE TIMES BEACH DISPOSAL SITE*

Common Name	Scientific Name	Confirmed +
House Wren	Troglodytes aedon	+
Carolina Wren	Thryothorus ludovicianus	
Long-billed Marsh Wren	Telmatodytes palustris	
Gray Catbird	Dumetella carolinensis	
Brown Thrasher	Toxostoma rufum	
American Robin	Turdus migratorius	+
Hermit Thrush	Catharus guttatus	
Swainson's Thrush	Catharus ustulatus	
Veery	Catharus fucescens	
Blue-gray Gnatcatcher	Polioptila caerulea	
Golden-crowned Kinglet	Regulus satrapa	
Ruby-crowned Kinglet	Regulus calendula	
Water Pipit	Anthus spinoletta	
Cedar Waxwing	Bombycilla cedrorum	+
Loggerhead Shrike	Lanius ludovicianus	
Starling	Sturnus vulgaris	+
Red-eyed Vireo	Vireo olivaceus	
Philadelphia Vireo	Vireo philadelphicus	
Warbling Vireo	Vereo gilvus	
Black-and-white Warbler	Mniotilta varia	
Blue-winged Warbler	Vermivora pinus	
Tennessee Warbler	Vermivora peregrina	
Orange-crowned Warbler	Vermivora celata	
Nashville Warbler	Vermivora ruficapilla	
Parula Warbler	Parula americana	
Yellow Warbler	Dendroica petechia	
Magnolia Warbler	Dendroica magnolia	
Cape May Warbler	Dendroica tigrina	
Black-throated Blue Warbler	Dendroica caerulescens	
Yellow-rumped Warbler	Dendroica coronata	
Black-throated Green Warbler	Dendroica virens	
Blackburnian Warbler	Dendroica fusca	
Chestnut-sided Warble	Dendroica pensylvanica	
Bay-breasted Warbler	Dendroica castanea	
Blackpoll Warbler	Dendroica striata	
Prairie Warbler	Dendroica discolor	

Table 3- 7 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
BIRDS RECORDED AT THE TIMES BEACH DISPOSAL SITE*

Common Name	Scientific Name	Confirmed +
Palm Warbler	Dendroica palmarum	
Ovenbird	Seiurus aurocapillus	
Northern Waterthrush	Seiurus noveboracensis	
Common Yellowthroat	Geothlypis trichas	
Wilson's Warbler	Wilsonia pusilla	
Canada Warbler	Wilsonia canadensis	
American Redstart	Setophaga ruticilla	
House Sparrow	Passer domesticus	+
Bobolink	Dolichonyx oryzivorus	
Eastern Meadowlark	Sturnella maona	
Red-winged Blackbird	Agelaius phoeniceus	+
Rusty Blackbird	Euphagus carolinus	
Common Grackle	Quiscalus quiscula	
Brown-headed Cowbird	Molothrus ater	
Scarlet Tanager	Piranga olivacea	
Cardinal	Cardinalis cardinalis	
Rose-breasted Grosbeak	Pheucticus ludovicianus	
Indigo Bunting	Passerina cyanea	
Purple Finch	Caroodacus purpureus	
American Goldfinch	Spinus tristis	
Rufous-sided Towhee	Pipilo erythrophthalmus	
Savannah Sparrow	Passerculus sandwichensis	
Dark-eyed Dunco	Dunco hyemalis	
Chipping Sparrow	Spizella passerina	+
Field Sparrow	Spizella pusilla	+
White-crowned Sparrow	Zonotrichia leucophrys	
White-throated Sparrow	Zonotrichia albicollis	
Lincoln's Sparrow	Melospiza lincolnii	
Swamp Sparrow	Melospiza georgiana	+
Song Sparrow	Melospiza melodia	

Source:

* Buffalo Ornithological Society Survey. Birds recorded in the vicinity of Times Beach Dike Disposal Area No. 2. Data from 1972 to 1990.

\+ Confirmed on-site during September, 1994 Habitat Survey.

Residues of organochlorine chemicals were found in fat tissues of all adult birds. PCBs increased from a mean of 19.8 to 34.6 ppm between the winter and spring periods, respectively. Residues of DDT detected in adult birds collected in the winter period ranged from 0.01 ppm to 0.52 ppm, while concentrations in the spring period ranged from 0.06 ppm to 1.27 ppm. All organochlorine residues were higher in the spring period than the winter period, except oxy chlordane and mirex, which did not change. Prey species were assumed to be the source of contaminants (Foley and Batcheller, 1988).

It should be noted that population changes were observed during these periods and are most likely attributable to severe ice conditions on Lake Erie and Lake Ontario. Therefore, there was no way to be sure that birds taken for the spring sample were present in early winter. As a result, contaminant data may represent birds using Lake Erie, the Niagara River and Lake Ontario. In any case, environmentally persistent organochlorine compounds appear to increase in birds wintering in the Lake Erie-Niagara River-Lake Ontario system.

3.4.6 Fishes

The Buffalo Harbor area supports a diverse fishery with a dominance of resident warm water species. A trans-seasonal survey conducted in 1982 revealed the presence of seasonal lake residents and harbor/river residents. Cold water species from Lake Erie dominate the area in April - May followed by a transition to warm water varieties in May - June (Makarewicz, et al 1982, USFWS 1984).

The Buffalo Outer Harbor area supports a high quality fishery for Muskellunge (Esox masquinongy) and bait fishing for primarily Emerald shiners (Notropis antherinoides). The Small Boat Harbor supports a substantial ice fishing activity. Since the mid 1980's, the NYSDEC regularly stocks rainbow trout into the harbor at the NFTA pier or the Small Boat Harbor. Fishermen were noted in the Bell Slip on-site during the September 1994 field investigation.

A listing of the fishes found within the Buffalo Outer Harbor area are presented on Table 3-8.

3.4.7 Reptiles and Amphibians

The site contains habitat which may support a number of reptiles and amphibians. The upland areas on-site provide suitable habitat for a number of snake species, including common garter snake (Thamnophis sirtalis) and possibly eastern ribbon snake (Thamnophis saurit). Anurans that utilize these habitats include American toad (Bufo americanus) and green frog (Rana clamitans).

3.4.8 Rare Species and Critical Habitats

Based upon a review by the Significant Habitat Unit of NYSDEC and the New York Natural Heritage Program Files, the project site is within 3 miles of the following rare species areas: (1) Small Skull-Cap (Scutellaria parvula var. leonardii), (2) Pink Wintergreen (Pyrola asarifolia), (3) Woodland Bluegrass (Poa sylvestris), (4) Calamint (Calamintha arkansana), (5) Nodding Rattlesnake-Root (Prenanthes crepidinea), and (6) Common Tern (Sterna hirundo nesting area). Small Skull-Cap is rare with a poor occurrence. The next four plant species are unprotected and have historic occurrences. The Common Tern is threatened.

The site is also within 3 miles of five significant habitats: (1) Tifft Farm Nature Preserve, (2) Port of Buffalo Small Boat Harbor, (3) Times Beach Diked Disposal Site, (4) North Buffalo Harbor and (5) Donnelley's Pier (North Breakwater) Gull and Tern Colonies. These five areas are briefly discussed below.

Tifft Farm Nature Preserve

Tifft Farm Nature Preserve is located approximately 3 miles south of downtown Buffalo, within the City limits, in Erie County. The preserve is located adjacent to the Small Boat Harbor,

Table 3- 8

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
FISH SPECIES OF THE BUFFALO OUTER HARBOR AREA

Family	Common Name	Scientific Name
Petromizontidae	Sea lamprey	Petromyzon marinus
Clupeidae	Alewife	Alosa pseudoharengus
Clupeidae	Gizzard Shad	Dorosoma cepedianum
Salmonidae	Chinook salmon	Oncorhynchus tshawytscha
Salmonidae	Rainbow trout	Oncorhynchus mykiss
Salmonidae	Brown trout	Salmo trutta
Salmonidae	Lake trout	Salvelinus namaycush
Salmonidae	Lake whitefish	Coregonus clupeaformis
Osmeridae	Smelt	Osmerus mordax
Esocidae	Northern pike	Esox lucius
Esocidae	Muskellunge	Esox masquinongy
Cyprinidae	Goldfish	Carassius auratus
Cyprinidae	Carp-goldfish hybrid	none
Cyprinidae	Carp	Cyprinus carpio
Cyrpinidae	Hornyhead chub	Nocomis biguttatus
Cyrpinidae	River chub	Nocomis micropogon
Cyrpinidae	Golden shiner	Notemigonus crysoleucas
Cyrpinidae	Emerald shiner	Notropis atherinoides
Cyrpinidae	Common shiner	Notropis cornutus
Cyrpinidae	Spottail shiner	Notropis hudsonius
Cyrpinidae	Bluntnose minnow	Pimephales notatus
Cyrpinidae	Creek chub	Semotilus atromaculatus
Catostomidae	Quillback sucker	Carpiodes cyprinus
Catostomidae	White sucker	Catostomus commersoni
Catostomidae	Shorthead redhorse	Moxostoma macrolepidotum
Ictaluridae	Black bullhead	Ictalurus melas
Ictaluridae	Brown bullhead	Ictalurus nebulosus
Ictaluridae	Stonecat	Noturus flavus

Table 3-8 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
FISH SPECIES OF THE BUFFALO OUTER HARBOR AREA

Family	Common Name	Scientific Name
Anguillidae	American eel	Anguilla rostrata
Cyprinodontidae	Banded killifish	Fundulus diaphanus
Percopsidae	Trout perch	Percopsis omiscomaycus
Percichthyidae	White perch	Morone americana
Percichthyidae	White bass	Morone chrysops
Centrarchidae	Rock bass	Ambloplites rupestris
Centrarchidae	Pumpkinseed	Lepomis gibbosus
Centrarchidae	Bluegill	Lepomis macrochirus
Centrarchidae	Smallmouth bass	Micropterus dolomieui
Centrarchidae	Largemouth bass	Micropterus salmoides
Centrarchidae	Black crappie	Poxomis nigromaculatus
Percidae	Yellow perch	Perca flavescens
Percidae	Walleye	Stizostedion vitreum
Percidae	Logperch	Percina caprodes
Percidae	Johnny darter	Etheostoma nigrum
Sciaenidae	Freshwater drum	Aplodinotus grunniens
Cottidae	Slimy sculpin	Cottus cognatus

Sources: Makariowicz, Dilcher, Haynes & Shump 1982.
NYSDEC Personal Communication, USFWS 1984. USACOE 1994.

bounded roughly by Fuhrmann Boulevard to the west, and railroad right-of-ways to the north, east, and south. Tifft Farm is a 264-acre nature preserve and environmental education center owned by the City of Buffalo and operated jointly by the City and the Buffalo Museum of Science. This area contains a diversity of fish and wildlife habitats, including an approximate 75-acre cattail marsh, small freshwater ponds and old canal remnants, old fields (partly covering a former solid waste transfer site), forested wetland and shrub-sapling stages of succession. The land area surrounding Tifft Farm is dominated by active and vacant industrial facilities and railroad properties. The Tifft Farm Nature Preserve is the largest contiguous fish and wildlife habitat area within the City of Buffalo. Of special importance is the relatively undisturbed wetland area, which is the largest of its kind along the Lake Erie coastline. The preserve is inhabited by a diversity of fish and wildlife species that is unusual in this coastal region, especially within the urban area. A full complement of wetland wildlife species occurs in and around the marshes at Tifft Farm. Tifft Farm also contains a population of burrowing crayfish, one of only three known localities for this species in New York State.

The largest of the freshwater ponds is directly connected to Lake Erie via a culvert under Fuhrmann Boulevard to the Small Boat Harbor. Consequently, many warm water fish species occur in the area.

Port of Buffalo Small Boat Harbor

The Small Boat Harbor is located on the shoreline of Lake Erie in the City of Buffalo (approximately three miles south of downtown Buffalo). The fish and wildlife habitat is an approximate 165 acre, shallow (generally less than 12 feet deep below mean low water), embayment of Lake Erie. This area is sheltered from prevailing winds and wave action by a two mile long rock breakwall, which enhances sediment deposition and growth of submerged aquatic macrophytes, such as watermilfoil, wild celery and pondweeds. Substrates vary from a mixture of sand, gravel and cobble in some nearshore areas, to a dark brown gelatinous type sediment (gyttja). Most of the Small Boat Harbor has been subjected to considerable human disturbance, which has played a major role in the development of existing habitat conditions. The harbor is bordered on three sides by rip-rap, concrete bulkheads and gravel-cobble beach. The fourth side (westerly) is open to the Outer Harbor, with an approximate 30-foot deep dredged navigation channel. Heavily used small craft harbor facilities, with docks, launching ramps and protective jetties, exist in the center of this area.

The Small Boat Harbor is the only sizable shallow water embayment on Lake Erie in Erie County. Despite human disturbances, it is one of the most important fish and wildlife habitat areas in the Buffalo metropolitan region, because it provides substantial protection from wave action for fish, wildlife and aquatic vegetation. Consequently, the harbor supports a highly productive and diverse littoral community, with concentrations of many fish and wildlife species occurring in the area.

Studies of the Small Boat Harbor have demonstrated that this is a diverse and productive fisheries habitat. The major adult fishes found in the area were pumpkinseed, yellow perch and brown bullhead, along with largemouth bass, muskellunge, carp and freshwater drum. Icthyoplankton sampling revealed substantial reproduction by centrarchids, shiners and yellow perch. Carp and freshwater drum may also enter the area to spawn. By mid-summer, the Small Boat Harbor is an ideal habitat for centrarchids and bullheads as macrophytes fill the embayment. The Small Boat Harbor is the largest, most obvious nursery area for numerous harbor and lake species on the Erie County shoreline. In addition, the harbor supports a productive macrobenthic community, dominated by snails and clams. Submerged, rooted macrophytes and their associated invertebrates and fish provide valuable food resources for many species of waterfowl and other migratory birds. The Small Boat Harbor attracts concentrations of these birds during Spring and Fall migrations (March-April and September-November, respectively), with some remaining until the harbor freezes over in early to mid-Winter. The most abundant birds observed during these periods are the diving ducks, including canvasback, scaups, mergansers, common goldeneye and scoters, along with mallard, black duck, canada goose, loons, grebes and gulls. Hundreds of these birds are regularly found in the area during late Fall, with the greatest numbers occurring when open waters on Lake Erie are rough. Prior to ice-up, the Small Boat Harbor serves as a refuge and feeding area for some of the larger concentrations of waterfowl that occur in North Buffalo Harbor.

During the Summer months, ring-billed gull, herring gull and common tern may feed in the area, but the extent of their use has not been documented.

The abundant fish and wildlife populations in the Small Boat Harbor attract a considerable amount of human use of the area. The harbor provides high quality recreational fishing opportunities throughout the year. Anglers from throughout the Buffalo metropolitan area are attracted to the diverse warm water fisheries, and ice fishing is popular. The concentrations of birds which utilize the Small Boat Harbor, and the availability of good public access and vantage points, makes this a popular birdwatching site in Erie County during waterfowl migration periods.

Times Beach Diked Disposal Site

Times Beach Diked Disposal Site is located within the City of Buffalo, approximately 1 mile south-southwest of downtown and approximately ½ mile north of the Buffalo Outer Harbor Site. The fish and wildlife habitat is a partially filled, diked, dredge spoil disposal area, located just south of the Buffalo River on the shore of Lake Erie. This approximate 55-acre area is owned by the City of Buffalo and is leased to the U.S. Army Corps of Engineers for dredged material disposal. The site was constructed and partially filled during the early to mid-1970's, when it served as the primary disposal site for silt dredged from the Buffalo River, Buffalo Harbor, Black Rock Canal and Tonawanda Harbor areas. The area was originally planned to be filled to 8 feet above mean low water, but since the late 1970's, has been set aside as a wildlife preserve. The lakeward side of the area is surrounded by porous stone dikes, allowing water depths within the site to vary with lake levels. Times Beach contains several distinct physical zones, including: a deep water zone up to about 6 feet in depth, with submerged aquatic plants; a gradually sloping shallow water zone with emergent marsh vegetation; and an upland zone containing tall herbs, grasses and stands of variously sized trees and shrubs. The upland portion of the habitat is bordered by the U.S. Coast Guard base, a marina, abandoned industrial developments, an ice boom storage area and port facilities.

Times Beach Diked Disposal Site is one of the few sizeable wetland areas along the New York shoreline of Lake Erie. Although the area is man-made and only recently created, it has become an important fish and wildlife habitat. The variety of ecological communities at Times Beach attracts a diversity of species that is unusual in this coastal region, especially within the Buffalo metropolitan area. The site lies on an important flyway for migratory birds, a key factor enhancing its potential for wildlife. Its location at the eastern end of Lake Erie and dike-protected water area make it a focal point for water-oriented birds moving eastward along the north and south shores of the lake.

North Buffalo Harbor/Donnelly's Pier

North Buffalo Harbor is located in the northeast corner of Lake Erie at the head of the Niagara River, in the City of Buffalo, Erie County. The fish and wildlife habitat is an approximate 800 acre area of open water within the lake and upper river channel extending roughly from the mouth of the Buffalo River north to the Peace Bridge. Water depths vary from less than 6 feet over several small reefs to over 20 feet below mean low water. The U.S. Army Corps of Engineers maintains several breakwaters within this area, including: Bird Island Pier, a 1½--mile long stone dike which parallels the shoreline and protects the Black Rock Canal; Donnelly's Wall, a ½ mile long concrete wall and lighthouse located northwest of the Buffalo River mouth; and, the North End Light Breakwater, a 500-foot long concrete wall located due west of the Buffalo River. Also located in North Buffalo Harbor are the water supply intakes for the City of Buffalo and Erie County. The North Buffalo Harbor fish and wildlife habitat is bordered to the east by the Black Rock Canal with the adjacent land area heavily developed for urban residential, commercial, industrial and recreational uses. Immediately west of the area are the Canadian waters of Lake Erie.

North Buffalo Harbor is generally representative of an older urban waterfront environment. Fish and wildlife habitats in the harbor area have been lost or degraded as a result of land development, dredging, storm protection projects, discharges of domestic and industrial wastes, and inflow of polluted upland runoff. However, the area continues to support valuable fish and wildlife resources.

One of only three major nesting concentrations of gulls and terns in western New York State occurs in North Buffalo Harbor. Donnelly's Pier and the North End Light Breakwater have served as nesting sites for common terns since at least the 1940's, and for ring-billed gulls and herring gulls since at least 1964. In 1983, there were approximately 420 tern nests, 1,000 ring-billed gull nests and 100 herring gull nests among these two locations. A third colony, containing over 60 common tern nests, was also found in 1983, on an abandoned lighthouse near Middle Reefs. The concrete surfaces of these structures have deteriorated so that crevices, cracks and depressions provide a substrate for nests of these species. A sand and gravel bar located at the north end of Donnelly's Pier also provides suitable nesting habitat. A critical feature of these harbor structures is their isolation from mammalian predators.

The open waters of North Buffalo Harbor are important feeding areas for the tern population nesting in this area and for some of the largest concentrations of wintering waterfowl in the Lake Erie coastal region. Mid-winter aerial surveys of waterfowl abundance for the 10-year period 1976 - 1985, indicate average concentrations of approximately 6,500 birds in the harbor each year (14,120 in peak year), including approximately 5,100 common and red-breasted mergansers (13,025 in peak year), 750 scaup (4,210 in peak year) and 500 common goldeneye (2,000 in peak year), along with lesser numbers of canvasback, black duck and mallard. Waterfowl use of the area during Winter is influenced by the extent of ice cover each year. Concentrations of many waterfowl species, along with loons, grebes, gulls and terns, occur in North Buffalo Harbor during Spring and Fall migrations (March-April and October-November, respectively). However, waterfowl hunting is not allowed within this area.

North Buffalo Harbor supports a fishery of regional significance. Although no critical spawning or nursery areas have been documented in the area, a relatively diverse and productive fish community attracts recreational anglers from throughout the Buffalo metropolitan area. Predominant fish species occurring in the harbor include rock bass, white bass, smallmouth bass, yellow perch, walleye, northern pike, muskellunge, brown trout, rainbow trout and coho salmon. Among the most popular fishing spots are near Donnelly's Pier and the "fish market," located just outside of the southern portion of Bird Island Pier.

3.4.9 Biological Associations Found in the Project Vicinity

The area surrounding the Buffalo Outer Harbor Site is predominantly developed (industrial). Extending from the site in a ½ mile radius results in open water to the west, developed land to the north and east, small open areas to the east and developed (industrial) areas to the south. Figure 3-18 illustrates the area surrounding the site. Table 3-9 presents the associations between common animals and vegetation covertypes within the site.

3.4.10 Observations of Stress Potentially Related to Site Contaminants

Since the site has been created essentially as filled land, the substrate types are mixed and consist of rubble, debris, dredge spoil and other remnants of filling activity (most notably iron pellets which abound on-site possibly from previous milling operations by surrounding industry).

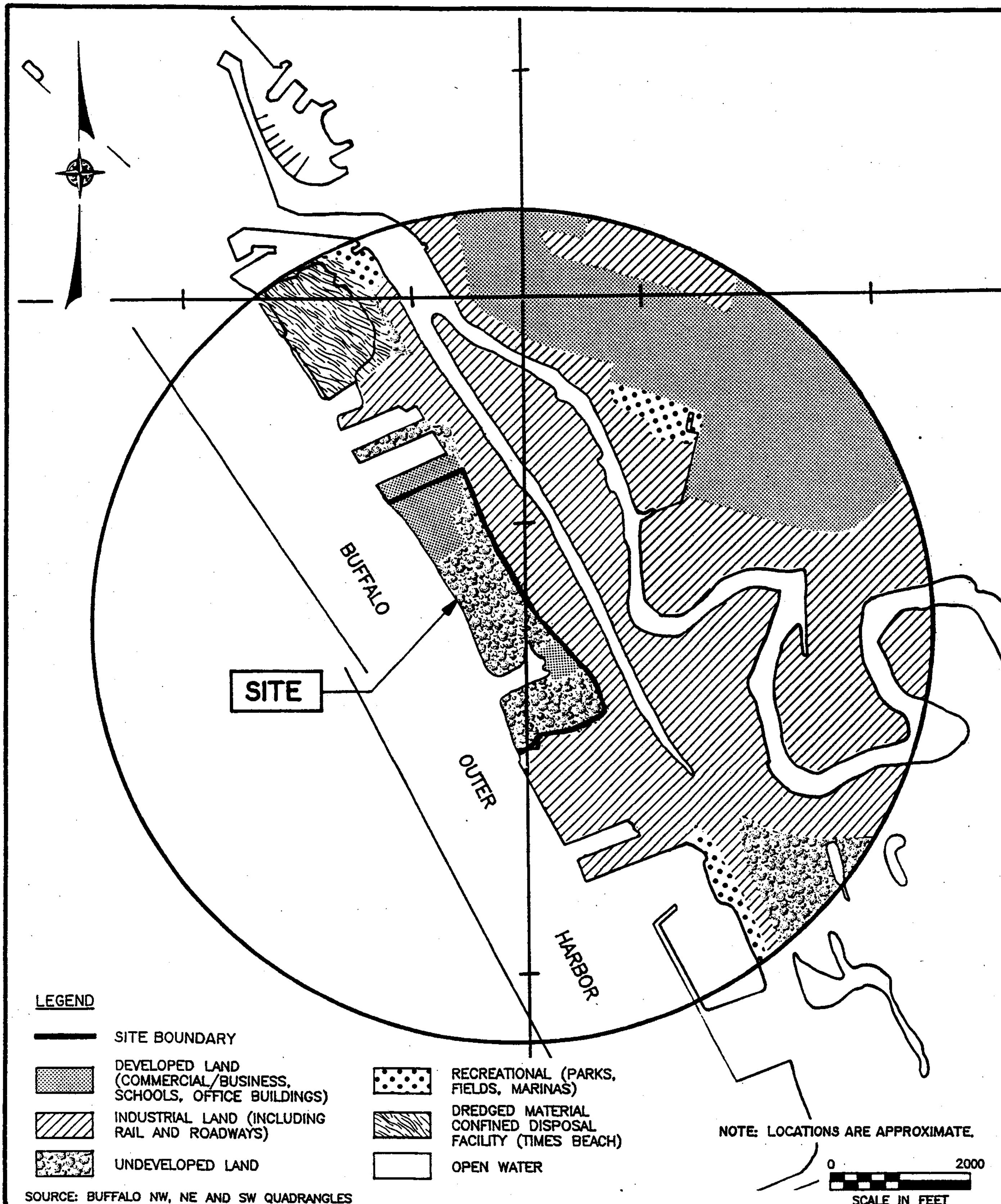
No obvious seepages or liquid wastes were noted on-site. Two fish kills have been reported by NYSDEC in the period 1969-1993 in the vicinity of the site. These include the following:

- December 30, 1991 - Thousands of grizzard shad were observed dead in the Outer Harbor area.
- July 12, 1993 - Twelve bass (species unknown) ranging in size from 6-14 inches in length were reported dead at the Michigan Avenue Boat Slip adjacent to the Pier Restaurant.

The causes of the above mortalities are unknown.

Fish Contaminant Studies

Over 215 hazardous waste disposal sites were identified in Erie and Niagara Counties, of which 164 were used by major industries along the river. Comparisons of concentrations of chemicals in Lake Erie and Lake Ontario were made by the Niagara River Toxics Committee (NRTC, 1984). Twenty-four chemicals were shown to exist at higher concentrations at the Lake



BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

Dvirka and Bartilucci
Consulting Engineers
A Division of William F. Cosulich Associates, P.C.

0.5 MILE VICINITY MAP

FIGURE 3–18

Table 3-9

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
ANIMAL AND VEGETATIVE COVERTYPES*
WITHIN THE BUFFALO OUTER HARBOR SITE

Type	Developed Land	Low Grasslands	High Grasslands	Open Water	Littoral Zone	Lawn Areas	Debris Pile	Scrub/ Shrub	Climax Veget.
Queen Anne's Lace		X							
Clover		X							
Goldenrods		X	X						
Rye Grass		X	X			X			
Fescues		X				X			
Reed Grass			X						
Cattails					X				
Cottonwoods								X	X
Sumacs								X	X
Alder									X
Willow								X	X
Garter Snake		X	X				X		
Toads		X	X				X		
Green Frog		X	X			X	X		
Snails					X				
Zebra Mussel				X	X				
Fishes				X	X				
Waterfowl				X	X	X			
Raptors	X	X	X		X			X	X
Wading Birds				X	X				
Passerines	X	X	X					X	

*Animal and plant lists refer to most abundant types only.

Ontario end of the Niagara River than the Lake Erie end, thus suggesting that the Niagara River is the source of these chemicals.

The New York State Department of Environmental Conservation collected fish from the Niagara River for analysis of chemical constituents in 1984. This data indicates PCB concentrations from 0.18 ug/g to 2.99 ug/g on the upper River, while lower river locations had concentrations from 0.60 ug/g to 5.29 ug/g. Concentrations above trace amounts were also found for the pesticides DDT and chlordane. Little data exists for fish contaminants adjacent to the Buffalo Outer Harbor Site. Therefore, the degree to which the site has contributed to the accummulated contaminants found cannot be determined.

As reported in the NYSDEC Draft Niagara River Remedial Action Plan (March 1993), Lake Erie has been purported to cause use impairments in the Niagara River (and presumably the Buffalo Harbor area) associated with a number of contaminants, including PCBs, mirex, chlordane, dioxin, dibenzofuran, DDT, PDE, dieldrin, metals and cyanide. Although the levels of contaminants encountered are very variable, NYSDEC sampling data show that PCBs exceeded the Food and Drug Administration tolerance level in carp taken from the Buffalo River and Harbor area in 1984, and have issued an advisory not to eat carp from these areas.

Brown bullhead catfish caught in the Buffalo River (upstream of the site) have been determined to have a high prevalence of liver and skin tumors. The evidence suggests that the incidence of these tumors is well above levels expected from natural causes. Related laboratory studies have shown that Buffalo River sediments have induced tumors to healthy fishes.

3.4.11 Habitat Values of Vegetative Zones Within the Project Site

The assessment of habitat value provides for assessments of primary functions, such as food chain production, specialized habitat and hydrologic interaction. As part of the analysis, cultural values concerning recreation, aesthetics or other special features must be taken into consideration.

The information gathered during the Phase I Remedial Investigation can provide for a hierarchy of habitat values for the cover types found at the Buffalo Outer Harbor Site. It should be noted that this approach is highly subjective. Those functions assumed to be valuable in relative efficiency or importance are ranked as 3 (high), 2 (moderate) or 1 (low). Specific factors and brief descriptions which were utilized in the habitat value analysis of the qualitative evaluation are as follows:

- Nutrient Transport Function - Transport of nutrients in detrital-based food chains is strongly dependent on the hydrologic characteristics of the particular ecosystem. For example, wetlands located in lower lying areas export more detrital material than do the higher marsh areas infrequently affected by creek/river overflow. Similarly, detrital transport in riverine systems is dependent on the river flow regime, especially during periods of peak discharge. In contrast, very little detrital material is exported from isolated ponds and marshes, except during periods of episodic overflow resulting from exceptionally high precipitation.

- Food Chain Support - This function refers to the secondary productivity values of consumer species that a particular ecosystem can support. Secondary productivity is an overall measure of the efficiency of the habitat in terms of available nutrients to higher trophic levels.

- Hydroperiod - This factor refers to the frequency of inundation either by river flow runoff or direct precipitation. Areas of good hydrologic linkage help maintain a regular interchange of nutrients and other materials necessary to support diverse flora and fauna.

- Elevational Location - From the above, it is apparent that hydrologic relationships will progressively deteriorate as the depth of flooding decreases. The weakest hydrologic linkages exist in those areas physically isolated from other areas in the system.

- Cultural Evaluation - This particular factor is difficult to assess in specific detail because of the number of socio-economic considerations which may be involved. Hence, the evaluation in relation to local residential, commercial or industrial development is largely left to the professional judgement of the field personnel on a specific case-by-case basis.

- Recreation - Recreation is a vital personal and social need which provides opportunity for self-expression, physical exercise and a change of pace from normal or routine activities. Outdoor recreation is a major leisure activity and is growing in national importance with a trend towards a higher standard of living. A significant portion of the total recreational output is water based or water related. As such, greater weight is given to those types of habitats.

- Socio-Economic - This factor pertains to benefits which can be attributed directly to renewable resources, recreational enjoyment or other features associated with a particular habitat.

- Aesthetics - Selected types of habitats are distinctive landscape features which can please the aesthetic sense through the intrinsic appreciation of natural beauty. Wetlands or any other type of natural landscape can also be offensive, if their features have been adversely modified by incompatible human activities. Aesthetic value can be largely determined by the degree of visual diversity and contrast between the physical elements, such as landforms, water bodies, vegetation types and land use types.

- Food Chain Production - This factor determines the growth of vegetation in a habitat and influences the populations and secondary productivity of animals that feed on the plants, or that feed at high tropic levels in the community.

- Primary Productivity- Primary productivity is a measure of the stored food potential of the vegetation in excess of that used by the plants in metabolism. This determination provides an overall measure of the energy input directly available to the consumer species. It should be noted that the possible range of productivity values, both within and between particular environments, is extremely variable and dependent on a number of local conditions.

- Water Purification Factor - Through a variety of physical, biological and chemical processes, some habitats function to naturally purify water by removing organic and mineral particulate matter from runoff and/or rivers and streams. For example, wetlands may be significant in minimizing some of the harmful effects of pollutants introduced into natural ecological systems by the activities of man. Thus, wetlands, especially when part of riverine or estuarine systems, can be an integral part of water quality and pollution control objectives.

Based upon the above factors and given the frequency of coverage of the respective habitat types at the site, a qualitative analysis of the habitat value of the vegetative communities is presented on Table 3-10. Based upon these results, those habitats in descending order from high to low value are as follows:

- Littoral Zone (Shallow Water);
- Open Water (Navigable Channels);
- High Grassland;
- Low Grassland/Climax Vegetation;

Table 3-10

BUFFALO OUTER HARBOR SITE

PHASE I/PHASE II REMEDIAL INVESTIGATION

QUALITATIVE HABITAT VALUES[a]

HABITAT TYPE

Type	Developed Land	Low Grasslands	High Grasslands	Open Water	Littoral Zone	Lawn Areas	Debris Pile	Scrub-Shrub	Climax Vegetation
Food Chain Production	1	2	2	3	3	1	1	2	2
Primary Productivity	1	2	3	3	3	1	2	2	3
Nutrient Transport	1	2	2	3	3	1	1	2	2
Food Chain Support (i.e., Nesting)	1	2	3	3	3	1	1	2	2
Hydroperiod	1	2	2	3	3	1	1	1	1
Elevational Location	1	2	2	3	3	1	1	1	1
Cultural Evaluation	2	1	1	3	3	2	1	1	2
Recreation	1	1	1	2	3	1	1	1	1
Socio-Economic	2	1	1	3	3	1	1	1	1
Aesthetics	2	1	1	3	3	1	1	1	2
Water Purification	1	2	2	2	3	1	1	1	1
TOTALS	14	18	20	31	33	13	12	15	18

(a) Scoring as follows:

3 - High Value
2 - Moderate Value
1 - Low Value

- Scrub-Shrub Areas;
- Developed Land;
- Lawn Areas; and
- Debris Piles.

Section 4

4.0 NATURE AND EXTENT OF CONTAMINATION

The purpose of this section is to provide a discussion of the results of the field investigation and sample analytical results, and the nature and extent of contamination found at the Buffalo Outer Harbor Site during the Phase I and the Phase II Remedial Investigations.

4.1 Identification of Standards, Criteria and Guidelines

This section provides a presentation of the standards, criteria and guidelines which were used to determine the significance of the analytical results and the potential threat to human health and the environment.

4.1.1 Surface and Subsurface Soil

For review and interpretation of the soil analytical results, individual elements and groups of compounds have been identified as contaminants of concern for the Buffalo Outer Harbor Site. The contaminants of concern (based upon toxicity characteristics and elevated concentrations found at the site) are volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), carcinogenic PAHs (CaPAHs), nitrobenzene, polychlorinated biphenyls (PCBs) and select metals comprising antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc. Elevated levels of pesticides and cyanide were not detected in either surface or subsurface soil at the site.

Screening levels for the contaminants of concern have been identified based upon review of applicable guidance documents, such as New York State Department of Environmental Conservation (NYSDEC) Technical and Administrative Guidance Memorandum (TAGM) : Determination of Soil Cleanup Objectives and Cleanup Levels (January, 1994); screening and cleanup levels utilized for various sites located in New York State with similar contaminants of concern; discussions with NYSDEC and New York State Department of Health (NYSDOH); and screening/cleanup levels developed and used by other states, including Massachusetts and New Jersey.

To further develop appropriate screening levels associated with the contaminants found at the Buffalo Outer Harbor Site, the results from the analysis of the off-site surface soil samples collected as part of this investigation were utilized to assist in selection of background contaminant concentrations. These screening levels are utilized as the basis for the Qualitative Health Risk and Environmental Assessment. The assessment identifies specific exposure pathways and receptors that may be subject to unacceptable risk. The results of the risk assessment may further define/refine the screening levels utilized in this document and will potentially allow for the selection of remediation guidelines and measures, if required. It should be noted that exceedances of the screening levels do not mean that remediation is necessary, but rather, that the contaminant concentrations are elevated sufficiently to warrant concern and evaluation. The purpose of establishing screening levels is to provide a basis with which to identify areas and matrices of concern that may require some form of remediation, including limited or restricted access and/or use.

Table 4-1 lists the composition of the groups of contaminants of concern applicable to the site. The screening levels utilized for evaluation of the soil analytical results obtained during this investigation are presented below.

Contaminant	Screening Level
Total VOCs	10 mg/kg
Total SVOCs	500 mg/kg
Total PAHs	100 mg/kg
Total CaPAHs	10 mg/kg
Total PCBs	1 mg/kg (surface) 10 mg/kg (subsurface)
Nitrobenzene	1 mg/kg
Antimony	20 mg/kg

Table 4-1

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
CATEGORIES OF COMPOUNDS OF CONCERN

Volatile Organic Compounds (VOCs)

Chloromethane
Bromomethane
Vinyl chloride
Chloroethane
Methylene chloride
2-Propanone
Carbon disulfide
1,1-Dichloroethene
1,1-Dichloroethane
1,2-Dichloroethene (total)
Chloroform
1,2-Dichloroethane
2-Butanone
1,1,1-Trichloroethane
Carbon tetrachloride
Vinyl acetate
Bromodichloromethane
1,2-Dichloropropene
cis-3-Dichloropropene
Trichloroethene
Dibromochloromethane
1,1,2-Trichloroethane
Benzene
trans-3-Dichloropropene
Bromoform
4-Methyl-2-pentanone
2-Hexanone
Tetrachloroethene
1,1,2,2-Tetrachloroethane
Toluene
Chlorobenzene
Ethylbenzene
Styrene
Xylene (total)

Table 4-1 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
CATEGORIES OF COMPOUNDS OF CONCERN

Polycyclic Aromatic Hydrocarbons (PAHs)

Naphthalene
Acenaphthylene
Acenaphthene
Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Benzo(a)anthracene
Chrysene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(a)pyrene
Indeno(1,2,3-cd)pyrene
Dibenzo(a,h)anthracene
Benzo(g,h,i)perylene

Carcinogenic Polycyclic Aromatic Hydrocarbons (CaPAHs)

Benzo(a)anthracene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(a)pyrene
Chrysene
Indeno(1,2,3-cd)pyrene
Dibenzo(a,h)anthracene

Table 4-1 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
CATEGORIES OF COMPOUNDS OF CONCERN

Polychlorinated Biphenyls (PCBs)

Aroclor-1016
Aroclor-1221
Aroclor-1232
Aroclor-1242
Aroclor-1248
Aroclor-1254
Aroclor-1260

Metals

Antimony
Arsenic
Cadmium
Chromium
Copper
Lead
Mercury
Nickel
Zinc

Arsenic	20 mg/kg
Cadmium	10 mg/kg
Chromium	100 mg/kg
Copper	200 mg/kg
Lead	500 mg/kg
Mercury	10 mg/kg
Nickel	40 mg/kg
Zinc	500 mg/kg

Polycyclic aromatic hydrocarbons is a subgroup of a larger class of compounds comprising semivolatile organic compounds or base neutral/acid extractables. Since most of the compounds in the semivolatile group were detected at low concentrations or not detected at all at the site, it was determined to establish subcategories of this group to provide more pertinent evaluation of the data.

4.1.2 Sediment

For review and interpretation of surface water sediment results, screening levels for the Buffalo Outer Harbor Site were developed based upon the NYSDEC Division of Fish and Wildlife Technical Guidance for Screening Contaminated Sediment - November, 1993. This criteria is based on the total organic carbon present in the sample. The screening levels were developed utilizing the most conservative total organic carbon values detected in the sediment samples analyzed as part of this investigation. The lowest value for total organic carbon detected in the sediment samples collected was 14,000 mg/kg. The levels utilized for the discussion of the sediment results will be the Aquatic Chronic Toxicity Criteria which are presented on Table 4-2.

TABLE 4-2
BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
SEDIMENT CRITERIA
VOLATILE ORGANICS

VOLATILE ORGANICS	TOC	AQUATIC ACUTE TOXICITY CRITERION ug/gOC	AQUATIC ACUTE TOXICITY LEVEL ug/kg	AQUATIC CHRONIC TOXICITY CRITERION ug/gOC	AQUATIC CHRONIC TOXICITY LEVEL ug/kg	HUMAN HEALTH TOXICITY CRITERION ug/gOC	HUMAN HEALTH TOXICITY LEVEL ug/kg	WILDLIFE TOXICITY CRITERION ug/gOC	WILDLIFE TOXICITY LEVEL ug/kg
Chloromethane	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Bromomethane	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Vinyl Chloride	14	- - -	- - -	- - -	- - -	0.07	0.98	- - -	- - -
Chloroethane	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Methylene Chloride	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Acetone	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Carbon Disulfide	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
1,1-Dichloroethene	14	- - -	- - -	- - -	- - -	0.02	0.28	- - -	- - -
1,1-Dichloroethane	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
1,2-Dichloroethene (total)	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Chloroform	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
1,2-Dichloroethane	14	- - -	- - -	- - -	- - -	0.7	9.8	- - -	- - -
2-Butanone	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
1,1,1-Trichloroethane	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Carbon Tetrachloride	14	- - -	- - -	- - -	- - -	0.6	8.4	- - -	- - -
Bromodichloromethane	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
1,2-Dichloropropane	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
cis-1,3-Dichloropropene	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Trichloroethene	14	- - -	- - -	- - -	- - -	2.0	28	- - -	- - -
Dibromochloromethane	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
1,1,2-Trichloroethane	14	- - -	- - -	- - -	- - -	0.6	8.4	- - -	- - -
Benzene	14	- - -	- - -	- - -	- - -	0.6	8.4	- - -	- - -
Trans-1,3-Dichloropropene	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Bromoform	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
4-Methyl-2-Pentanone	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
2-Hexanone	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Tetrachloroethene	14	- - -	- - -	- - -	- - -	0.8	11.2	- - -	- - -
1,1,2,2-Tetrachloroethane	14	- - -	- - -	- - -	- - -	0.3	4.2	- - -	- - -
Toluene	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Chlorobenzene	14	3.5	49	- - -	- - -	- - -	- - -	- - -	- - -
Ethylbenzene	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Styrene	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Total Xylenes	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -

QUALIFIERS:
- - -: No criterion available for compound

TABLE 4-2 (continued)
BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
SEDIMENT CRITERIA
SEMIVOLATILE ORGANICS

		AQUATIC ACUTE TOXICITY CRITERION	AQUATIC ACUTE TOXICITY LEVEL	AQUATIC CHRONIC TOXICITY CRITERION	AQUATIC CHRONIC TOXICITY LEVEL	HUMAN HEALTH TOXICITY CRITERION	HUMAN HEALTH TOXICITY LEVEL	WILDLIFE TOXICITY CRITERION	WILDLIFE TOXICITY LEVEL
SEMIVOLATILE ORGANIC COMPOUNDS	TOC	ug/gOC	ug/kg	ug/gOC	ug/kg	ug/gOC	ug/kg	ug/gOC	ug/kg
Phenol	14	---	---	0.6	8.4	---	---	---	---
bis(2-Chloroethyl)ether	14	---	---	---	---	0.03	0.42	---	---
2-Chlorophenol	14	---	---	---	---	---	---	---	---
1,3-Dichlorobenzene	14	120	1680	12	168	---	---	---	---
1,4-Dichlorobenzene	14	120	1680	12	168	---	---	---	---
1,2-Dichlorobenzene	14	120	1680	12	168	---	---	---	---
2-Methylphenol	14	---	---	---	---	---	---	---	---
2,2'-oxybis(1-chloropropane)	14	---	---	---	---	---	---	---	---
4-Methylphenol	14	---	---	---	---	---	---	---	---
N-Nitroso-di-n-propylamine	14	---	---	---	---	---	---	---	---
Hexachloroethane	14	---	---	---	---	---	---	---	---
Nitrobenzene	14	---	---	---	---	---	---	---	---
Isophorone	14	---	---	---	---	---	---	---	---
2-Nitrophenol	14	---	---	---	---	---	---	---	---
2,4-Dimethylphenol	14	---	---	---	---	---	---	---	---
bis(2-Chloroethoxy)methane	14	---	---	---	---	---	---	---	---
2,4-Dichlorophenol	14	---	---	---	---	---	---	---	---
1,2,4-Trichlorobenzene	14	50	700	91	1274	---	---	---	---
Naphthalene	14	---	---	---	---	---	---	---	---
4-Chloroaniline	14	---	---	---	---	---	---	---	---
Hexachlorobutadiene	14	---	---	---	---	---	---	---	---
4-Chloro-3-methylphenol	14	---	---	---	---	---	---	---	---
2-Methylnaphthalene	14	---	---	---	---	---	---	---	---
Hexachlorocyclopentadiene	14	44	616	4.4	61.6	---	---	---	---
2,4,6-Trichlorophenol	14	---	---	---	---	---	---	---	---
2,4,5-Trichlorophenol	14	---	---	---	---	---	---	---	---
2-Chloronaphthalene	14	---	---	---	---	---	---	---	---
2-Nitroaniline	14	---	---	---	---	---	---	---	---
Dimethylphthalate	14	---	---	---	---	---	---	---	---
Acenaphthylene	14	---	---	---	---	---	---	---	---
2,6-Dinitrotoluene	14	---	---	---	---	---	---	---	---
3-Nitroaniline	14	---	---	---	---	---	---	---	---
Acenaphthene	14	---	---	140	1960	---	---	---	---
2,4-Dinitrophenol	14	---	---	---	---	---	---	---	---
4-Nitrophenol	14	---	---	---	---	---	---	---	---

TABLE 4-2 (continued)
BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
SEDIMENT CRITERIA
SEMIVOLATILE ORGANICS

		AQUATIC ACUTE TOXICITY CRITERION	AQUATIC ACUTE TOXICITY LEVEL	AQUATIC CHRONIC TOXICITY CRITERION	AQUATIC CHRONIC TOXICITY LEVEL	HUMAN HEALTH TOXICITY CRITERION	HUMAN HEALTH TOXICITY LEVEL	WILDLIFE TOXICITY CRITERION	WILDLIFE TOXICITY LEVEL
SEMIVOLATILE ORGANIC COMPOUNDS	TOC	ug/gOC	ug/kg	ug/gOC	ug/kg	ug/gOC	ug/kg	ug/gOC	ug/kg
Dibenzofuran	14	---	---	---	---	---	---	---	---
2,4-Dinitrotoluene	14	---	---	---	---	---	---	---	---
Diethylphthalate	14	---	---	---	---	---	---	---	---
4-Chlorophenyl-phenylether	14	---	---	---	---	---	---	---	---
Fluorene	14	---	---	---	---	---	---	---	---
4-Nitroaniline	14	---	---	---	---	---	---	---	---
4,6-Dinitro-2-methylphenol	14	---	---	---	---	---	---	---	---
N-Nitrosodiphenylamine	14	---	---	---	---	---	---	---	---
4-Bromophenyl-phenylether	14	---	---	---	---	---	---	---	---
Hexachlorobenzene	14	9081	127134	5570	77980	0.15	2.1	12	168
Pentachlorophenol	14	100	1400	40	560	---	---	---	---
Phenanthrene	14	---	---	120	1680	---	---	---	---
Anthracene	14	---	---	---	---	---	---	---	---
Carbazole	14	---	---	---	---	---	---	---	---
Di-n-butylphthalate	14	---	---	---	---	---	---	---	---
Fluoranthene	14	---	---	---	---	---	---	---	---
Pyrene	14	---	---	---	---	---	---	---	---
Butylbenzylphthalate	14	---	---	---	---	---	---	---	---
3-3'-Dichlorobenzidine	14	---	---	---	---	---	---	---	---
Benzo (a) anthracene	14	---	---	---	---	1.3	18.2	---	---
Chrysene	14	---	---	---	---	1.3	18.2	---	---
bis(2-Ethylhexyl)phthalate	14	199.5	2793	---	---	---	---	---	---
Di-n-octylphthalate	14	---	---	---	---	---	---	---	---
Benzo(b)flouranthene	14	---	---	---	---	1.3	18.2	---	---
Benzo(k)flouranthene	14	---	---	---	---	1.3	18.2	---	---
Benzo(a)pyrene	14	---	---	---	---	1.3	18.2	---	---
Indeno(1,2,3-cd)pyrene	14	---	---	---	---	1.3	18.2	---	---
Dibenz(a,h)anthracene	14	---	---	---	---	---	---	---	---
Benzo(g,h,i)perylene	14	---	---	---	---	---	---	---	---

QUALIFIERS:
---: No criterion available for compound

TABLE 4-2 (continued)
BUFFALO OUTER HARBOR SITE
PHASE I/PHASEII REMEDIAL INVESTIGATION
SEDIMENT CRITERIA
PESTICIDE/PCBs

PESTICIDE/PCBs	TOC	AQUATIC ACUTE TOXICITY CRITERION ug/gOC	AQUATIC ACUTE TOXICITY LEVEL ug/kg	AQUATIC CHRONIC TOXICITY CRITERION ug/gOC	AQUATIC CHRONIC TOXICITY LEVEL ug/kg	HUMAN HEALTH TOXICITY CRITERION ug/gOC	HUMAN HEALTH TOXICITY LEVEL ug/kg	WILDLIFE TOXICITY CRITERION ug/gOC	WILDLIFE TOXICITY LEVEL ug/kg
alpha-BHC	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
beta-BHC	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
delta-BHC	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
gamma-BHC (Lindane)	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Heptachlor	14	13.1	183.4	0.1	1.4	0.0008	0.0112	0.03	0.42
Aldrin	14	- - -	- - -	- - -	- - -	0.1	1.40	0.77	10.78
Heptachlor epoxide	14	13.1	183.4	0.1	1.4	0.0008	0.0112	0.03	0.42
Endosulfan I	14	0.78	10.92	0.03	0.42	- - -	- - -	- - -	- - -
Dieldrin	14	- - -	- - -	- - -	- - -	0.1	1.40	0.77	10.78
4,4'-DDE	14	1100	15400	- - -	- - -	0.01	0.14	1	14.00
Endrin	14	- - -	- - -	4.0	56	0.0532	0.7448	0.8	11.20
Endosulfan II	14	0.78	10.92	0.03	0.42	- - -	- - -	- - -	- - -
4,4'-DDD	14	1100	15400	- - -	- - -	0.01	0.14	1	14.00
Endosulfan sulfate	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
4,4'-DDT	14	1100	15400	1.0	14	0.01	0.14	1.0	14.00
Methoxychlor	14	0.60	8.40	- - -	- - -	- - -	- - -	- - -	- - -
Endrin ketone	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Endrin aldehyde	14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
alpha-Chlordane	14	1.4 +	19.6	0.03	0.42	0.001	0.014	0.006	0.084
gamma-Chlordane	14	1.4 +	19.6	0.03	0.42	0.001	0.014	0.006	0.084
Toxaphene	14	3.2	44.80	0.01	0.14	0.02	0.28	- - -	- - -
Aroclor-1016	14	2760.8	38651.2	19.3	270.2	0.008	0.112	1.4	19.6
Aroclor-1221	14	2760.8	38651.2	19.3	270.2	0.008	0.112	1.4	19.6
Aroclor-1232	14	2760.8	38651.2	19.3	270.2	0.008	0.112	1.4	19.6
Aroclor-1242	14	2760.8	38651.2	19.3	270.2	0.008	0.112	1.4	19.6
Aroclor-1248	14	2760.8	38651.2	19.3	270.2	0.008	0.112	1.4	19.6
Aroclor-1254	14	2760.8	38651.2	19.3	270.2	0.008	0.112	1.4	19.6
Aroclor-1260	14	2760.8	38651.2	19.3	270.2	0.008	0.112	1.4	19.6

QUALIFIERS:
- - -: No criterion available for compound
+: Guidance references chlordane

TABLE 4-2 (continued)
BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
SEDIMENT CRITERIA
INORGANIC CONSTITUENTS

	LOWEST	SEVERE
	EFFECT LEVEL	EFFECT LEVEL
INORGANIC CONSTITUENT	ug/g	ug/g
Aluminum	- - -	- - -
Antimony	2.0	25.0
Arsenic	6	33
Barium	- - -	- - -
Beryllium	- - -	- - -
Cadmium	0.6	9
Calcium	- - -	- - -
Chromium	26	110
Cobalt	- - -	- - -
Copper	16	110
Iron *	2	4
Lead	31	110
Magnesium	- - -	- - -
Manganese	460	1100
Mercury	0.15	1.3
Nickel	16	50
Potassium	- - -	- - -
Selenium	- - -	- - -
Silver	1.0	2.2
Sodium	- - -	- - -
Thallium	- - -	- - -
Vanadium	- - -	- - -
Zinc	120	270
Cyanide	- - -	- - -

QUALIFIERS
- - -: No criterion available for compound
*: Values are in percent (%)

4.1.3 Groundwater and Surface Water

For the review and interpretation of groundwater analytical results, the screening levels for the Buffalo Outer Harbor Site are obtained from the NYSDEC Technical and Operational Guidance Series (TOGS) - Ambient Water Quality Standards and Guidance Values dated October 1993. The NYSDEC TOGS tabulated water quality standards (ST) and guidance values (GV) provide ambient pollutant concentrations developed to protect New York State groundwater and refers to their best classified usage. Analytical results obtained for groundwater samples are compared to Class GA groundwater standards.

As discussed in Section 1.0, Lake Erie is Classified as a Class A Special International Water, however, the Buffalo Outer Harbor is classified as a Class B surface water. Therefore, the results from the surface water samples obtained from the Buffalo Outer Harbor Site are compared to Class B surface water standards and guidance values.

4.2 Results of Site Characterization

4.2.1 Surficial Soil

A total of 112 on-site composite surface soil and five off-site individual surface soil samples were collected at the Buffalo Outer Harbor Site during the Phase I RI. Ten additional surface soil samples were collected as part of the Phase II RI. Each on-site composite sample was analyzed for Target Compound List (TCL) SVOCs, pesticides/PCBs (P/PCBs), metals and cyanide. Eight of the on-site samples were also analyzed for VOCs as a result of total organic vapor screening in the field exceeding 10 ppm. Each of the off-site samples was analyzed for full TCL+30 parameters. The tabulated analytical results for the soil samples compared to the screening levels are provided in Appendix I.

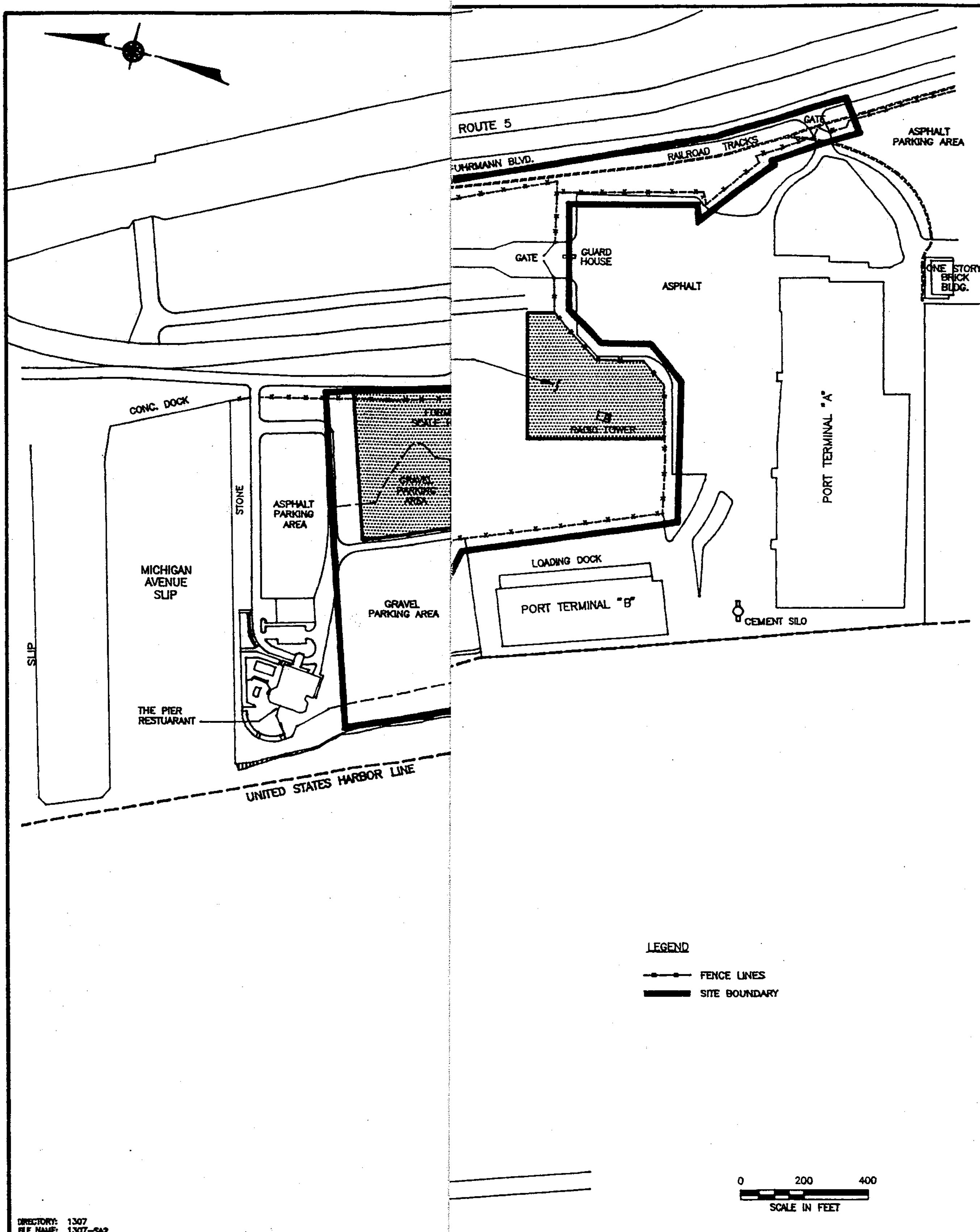
Levels of contaminants detected above the screening levels and the associated sample locations are presented on Figure 4-1. The discussion of the results is presented with respect to the areas in which they were collected (see Figure 4-2). These areas were delineated based upon the degree of soil contamination found at the site, as well as physical features, such as the asphalt roadway, Bell Slip, etc. The areas delineated comprise the following:

- Radio Tower Area
- Area South of the Bell Slip (excluding the Radio Tower Area)
- Area North of the Bell Slip (excluding the area contiguous to The Pier restaurant gravel parking lot)
- Eastern Parking Area for The Pier restaurant

In general, none of the surface soil samples collected exhibited the presence of total VOCs above the screening criteria. Although the eight on-site surface soils collected for VOC analysis exhibited elevated readings on the photoionization detector (PID) (greater than 10 ppm) in the field, none of the laboratory analytical results exceeded 10 mg/kg. Only samples SS-43A (located north of the Bell Slip along the asphalt road) and SS-117D (located in the vicinity of the Radio Tower) exhibited detectable levels of VOCs that were not attributed to blank contamination. In addition, although elevated levels of CaPAHs were detected, none of the surface soil samples exhibited elevated levels of total PAHs or total SVOCs above the screening criteria. As a result, the contaminants of concern in the surface soil at the site comprise carcinogenic PAHs, PCBs and metals.

Radio Tower Area

Eight composite surface soil samples (SS-106 through SS-108, SS-113 through SS-115, SS-118 and SS-119) were collected in the Radio Tower area. Five of the eight samples collected from this area exhibited at least one contaminant above the screening criteria. None of the samples within this area exhibited elevated levels of CaPAHs.



DIRECTORY: 1307
FILE NAME: 1307-SA2
DATE: RDS-110/13/95

NO.	DATE	REVISION

SITE AREAS

PROJECT NO. 1307

DATE MARCH 1995

SCALE 1"=200'

FIGURE 4-2

Four samples located in the Radio Tower area exhibited elevated levels of lead with the highest level detected at 777 mg/kg. Five of the samples collected in this area exhibited elevated levels of zinc with the highest level detected at 2,350 mg/kg. Four samples in the vicinity of the Radio Tower exhibited levels of total PCBs (Aroclor 1254 and Aroclor 1260) above the screening criteria. The highest level detected in this area was 8.2 mg/kg at SS-114.

Area South of the Bell Slip

Forty-three composite samples (SS-73 through SS-105, SS-109 through SS-112, SS-116, SS-117, SS-120, SS-121, SS-123 and SS-124), not associated with the Radio Tower Area, were collected south of the Bell Slip. A total of 20 of the 43 samples collected from this area exhibited levels of one or more contaminants above the screening criteria.

Eleven samples south of the Bell Slip exceeded the screening level for CaPAHs. The highest level of CaPAHs detected on-site was detected in the vicinity of the Allen Boat Company at SS-74 which exhibited the presence of total CaPAHs at 80 mg/kg.

Several of the samples (13 of the 43) also indicated the presence of elevated levels of metals including lead, zinc, copper, cadmium and arsenic. Two samples (SS-120 and SS-123) collected along the rail spur adjacent to Fuhrmann Boulevard exhibited elevated levels of arsenic at 25 mg/kg and 1,301 mg/kg, respectively.

Area North of the Bell Slip

Fifty seven composite samples were collected north of the Bell Slip, excluding the area contiguous to the gravel parking area for The Pier restaurant. These samples included SS-1, SS-2, SS-11 through SS-72 and SS-131 through SS-140 with the exception of SS-23, SS-28, SS-33, SS-48, SS-52 and SS-58 which were not collected due to surface obstructions such as stockpiled sand or gravel parking areas. SS-15 is included in the discussion for the Eastern Parking Area. Of the 57 samples collected, only 9 samples exhibited levels of contaminants above the screening criteria.

Three samples exhibited elevated levels of zinc and four samples exhibited levels of CaPAHs above the screening criteria, but below 20 mg/kg. One sample exhibited significantly elevated levels of copper (29,500 mg/kg at SS-35). Although the source of this elevated level cannot be determined, it is possible that a piece of copper wire from the electrical transformer located just east of the sample could be the cause of this result.

One sample, SS-29, located in the center of the site exhibited elevated levels of lead, zinc and CaPAHs. This sample was collected in a vegetated area of the site and was not described as stained or discolored.

Eastern Parking Area for The Pier Restaurant

A total of 14 samples (SS-6, SS-7, SS-8, SS-15 and SS-131 through SS-140) were collected from this area. One additional sample proposed to be collected in this area, SS-5, was not collected during the Phase I RI due to the presence of a gravel parking lot for The Pier restaurant. Due to the presence of elevated levels of contaminants surrounding the Eastern Parking Area, samples were collected in the gravel parking area during the Phase II RI.

Nine of the 14 samples collected from this area exhibited elevated levels of one or more contaminant. SS-8 collected north of the Bell Slip, exhibited the highest level of PCBs detected on-site at 12 mg/kg. SS-137 also exhibited elevated levels of PCBs at 4.9 mg/kg. None of the other samples collected from this area exhibited elevated levels of PCBs. Since only two samples exhibited elevated levels of PCBs, the extent of this contamination appears to be localized.

Four samples (SS-7, SS-8, SS-137 and SS-140) also exhibited elevated levels of copper, lead and zinc. The highest level of lead detected on-site was 14,000 mg/kg at SS-140, which was located just east of the former scale house. Due to the proximity to the fenceline, this sample was a composite sample of three points. The sample node collected just east of the former scale house was located in an area where four partially filled and opened "Heavy Duty Motor Oil" containers were located. Although no readings were obtained on the PID, the soil was observed to be visually stained. The extremely elevated levels of zinc and lead could be possibly attributed to the discharge of these, likely used, motor oils onto the surface soil. This area of contamination is not believed to be extensive, nor is it considered representative of surface soil quality in this area of the site.

SS-7 also indicated elevated levels of several other metals including arsenic, cadmium, copper, nickel and zinc. Several other samples including SS-6, SS-137 and SS-139, also collected from this area, exhibited levels of lead above the screening criteria.

Only three samples collected from this area, SS-7, SS-15 and SS-132, exhibited elevated levels of CaPAHs. Levels were only slightly above the screening level ranging from 10.2 mg/kg to 14.8 mg/kg.

Composite sample ESI-SS-1 was collected in the vicinity of the gravel parking area by Empire Soils Investigation (ESI) in 1989 and analyzed for TCL+30 parameters. Results of the analysis of these samples indicated low levels of PAHs (less than 2 mg/kg). No pesticides or PCBs were detected and acetone (a likely laboratory contaminant) was the only VOC detected in the ESI sample. In addition, no metals were detected above the screening levels in this sample.

Off-site (Background)

Of the five off-site samples collected, none of the samples exhibited elevated levels of VOCs or pesticides/PCBs. Two of the samples (SS-128 and SS-129) exhibited elevated levels of CaPAHs (14.6 and 32 mg/kg, respectively). These samples also exhibited elevated levels of lead at 522 and 1,600 mg/kg, respectively. The median level of CaPAHs detected was 5.3 mg/kg and the median level of lead detected was 357 mg/kg.

Based upon the results of the analysis of the on-site surface soil samples it appears that surface soil in the vicinity of the Radio Tower, the Allen Boat Company and the area contiguous to the gravel parking area exhibit elevated levels of the contaminants of concern. A large percentage (85%) of the samples collected in the Area North of the Bell Slip do not exhibit elevated levels of contaminants. Excluding the gravel parking area, the surface soil in the Area North of the Bell Slip does not appear to be significantly contaminated. The Area South of the Bell Slip, excluding the Radio Tower Area, may require remediation based upon future use of this area.

4.2.2 Subsurface Soil

One hundred twenty two subsurface soil samples were collected as part of the Phase I/Phase II investigation. One hundred and seventeen samples were collected during construction of the soil borings and monitoring well boreholes, and five samples were collected during installation of piezometers PZ-7 through PZ-10. Fifty-three of the samples were composite shallow subsurface samples (collected from 0 to 8 feet), 63 samples were grab/discrete samples below 8 feet and six samples were grab/discrete samples collected between 0 and 8 feet.

Each of the 110 samples collected during the Phase I investigation was analyzed for SVOCs, pesticides/ PCBs, metals and cyanide. All eight of the samples collected from the Radio Tower Area during the Phase II RI were analyzed for SVOCs, PCBs, metals and cyanide. The four remaining samples collected during the Phase II RI were analyzed for total lead, copper and zinc, and Toxicity Characteristics Leaching Procedure (TCLP) lead, copper and zinc. Twenty grab samples (18 from the Phase I RI and 2 from the Phase II RI) exhibiting greater than 10 ppm total organic vapors on the PID/FID were also collected and analyzed for VOCs. Two samples from the Radio Tower area were also analyzed for TCLP constituents.

The tabulated results for the analysis of these samples were compared to the screening levels and are presented in Appendix I. Similar to the discussion for the surface soil samples, the results of the subsurface soil samples will be discussed for the site areas described above. Samples exceeding the screening levels are presented on Figure 4-3.

	GW-3A	GW-3AF*	GW-3ADUP	GW-3AFDUP*
BENZO (a) ANTHRACENE	4	NA	--	NA
CHRYSENE	4	NA	--	NA
BENZO (b) FLUORANTHENE	3	NA	--	NA
BENZO (k) FLUORANTHENE	2	NA	--	NA
BENZO (a) PYRENE	4	NA	--	NA
INDENO (1,2,3-cd) PYRENE	2	NA	--	NA
IRON	35,900	3860	38,800	1850
LEAD	410	--	473	--
MAGNESIUM	44,800	40,400	47,700	49,000
MANGANESE	349	68.8	393	302
THALLIUM	7.2	--	--	--
SODIUM	154,000	133,000	156,000	167,000
BARIUM	--	--	1090	--

GW-1	
CHRYSENE	0.6
THALLIUM	6.3
IRON	15,900
LEAD	500
MAGNESIUM	49,900
MANGANESE	354
SODIUM	213,000

	GW-2A
IRON	9720
MANGANESE	952

GW-20	
PHENOL	7
IRON	639
MANGANESE	119,000

	GW-18A	GW-18ADUP	GW-18B
BENZENE	8	9	2
CHLOROBENZENE	95	100	--
1,3 DICHLOROBENZENE	150	150	--
1,4 DICHLOROBENZENE	33	--	--
1,2 DICHLOROBENZENE	140	150	--
1,2,4 TRICHLOROBENZENE	27	--	--
NAPTHALENE	890	--	--
4-CHLOROANILINE	1400	3600	790
ANTIMONY	189	231	--
IRON	4090	3330	1150
MAGNESIUM	80,500	92,600	142,000
MANGANESE	243	281	31.6
SODIUM	58,800	47,300	135,000
THALLIUM	--	5.0	15.1

	GW-21	GW-21DUP
IRON	834	333
MANGANESE	10.7	--

GW-19	
PHENOL	6
ARSENIC	159
IRON	2490
LEAD	28.4
MAGNESIUM	54,200
MANGANESE	35
SODIUM	245,000

GW-16	
IRON	4580
MAGNESIUM	78,600
MANGANESE	429
SODIUM	67,700

	GW-8A	GW-8B	GW-8C
ANTIMONY	--	26.7	--
CYANIDE	715	--	--
IRON	25,200	943	2860
MAGNESIUM	157,000	270,000	106,000
MANGANESE	2090	489	117
SODIUM	29,420,000	28,940,000	8,732,000

	GW-5A
IRON	6740
MAGNESIUM	35,900
MANGANESE	609

GW-17	
CYANIDE	892
IRON	619
MAGNESIUM	45,600
MANGANESE	115
SODIUM	198,000

	GW-9	GW-9F*	GW-9DUP	GW-9F*DUP
IRON	4580	4140	7260	482
MANGANESE	73	93.6	248	77.7
SODIUM	2,027,000	2,410,000	714,000	2,490,000

LEGEND

GW-16	
IRON	4580
MAGNESIUM	78,600
MANGANESE	429
SODIUM	67,700

SAMPLE LOCATION

CONSTITUENT CONCENTRATION IN ug/l

NO EXCEEDANCES

FENCE LINES

SITE BOUNDARY

MONITORING WELL LOCATION

PIEZOMETER LOCATION

PHASE II RI GROUNDWATER MONITORING WELLS

NOTE:
ALL RESULTS COMPARED TO NYSDEC CLASS GA GROUNDWATER STANDARDS.

* RESULTS REPRESENT DISSOLVED METALS ANALYSIS

DUP – RESULTS REPRESENT DUPLICATE ANALYSIS CONDUCTED BY A SECOND INDEPENDENT LABORATORY

DIRECTORY: 1307
FILE NAME: PH2GWRES
DATE: RDS-12/19/95

NO.	DATE	REVISION	INT.

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DVIRKA AND BARTILUCCI
CONSULTING ENGINEERS

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

PHASE II GROUNDWATER SAMPLING RESULTS

PROJECT NO. 1307

DATE: OCT. 1995

SCALE: 1"=200'

FIGURE 4-5

Radio Tower Area

Eleven biased soil borings were completed in the Radio Tower Area (SB-65 through SB-76, excluding SB-67) during the Phase I RI. Nine composite and 11 grab samples were collected from these borings. No samples were collected for analysis from SB-75 and SB-76, but the soils were logged for physical characteristics by the on-site geologist. Two grab samples were collected from both SB-72 and SB-73. Four additional borings (SB-81 through SB-84) were installed and eight grab samples were collected as part of the Phase II RI. The locations of these samples were selected based upon the elevated levels of nitrobenzene detected in one soil boring (SB-9) constructed in this area by ESI in 1989.

Of the nine composite samples collected from 0 to 8 feet, only two of the samples exhibited levels of contaminants above the screening criteria. SB-72 exhibited the presence of lead at 615 mg/kg and SB-74 exhibited the presence of antimony at 29.4 mg/kg.

Four of the samples collected during the Phase II RI in this area were collected from 0 to 2 feet. Three of the samples exhibited levels of contaminants above the screening criteria. SB-82 exhibited the presence of PAHs at 387 mg/kg and CaPAHs at 112 mg/kg. SB-81 exhibited the presence of CaPAHs at 10.5 mg/kg. SB-84 exhibited the presence of metals, including cadmium, lead and zinc, at elevated levels.

The results of the VOC analysis indicated two samples within the Radio Tower Area with elevated levels of VOCs, including benzene, chlorobenzene, toluene and ethylbenzene. These two samples were grab samples collected from SB-73. The sample collected from 14 to 16 feet exhibited levels of total VOCs of 351 mg/kg and the sample collected from 12 to 14 feet from this boring exhibited the presence of total VOCs of 287 mg/kg. Elevated levels of VOCs were detected in the duplicate sample analyzed by ESI from SB-9.

SB-73 also exhibited levels of nitrobenzene at 10 to 12 feet and 14 to 16 feet at 41 and 13,000 mg/kg, respectively. Elevated levels of nitrobenzene were also detected in the two samples collected from SB-72. Elevated levels of nitrobenzene were detected in samples collected from 16 to 18 feet and 18 to 20 feet at 4 and 48 mg/kg, respectively. Nitrobenzene was also detected in SB-66 at a depth of 12 to 14 feet at 6.9 mg/kg. This sample also exhibited the presence of 4-chloroaniline at 49 mg/kg. None of the samples collected during the Phase II RI exhibited elevated levels of nitrobenzene, however, 4-chloroaniline was detected in SB-81 at 30 mg/kg from 20 to 22 feet. As discussed in the following sections, elevated levels of 4-chloroaniline were detected in groundwater samples collected from this area.

The levels of nitrobenzene detected are consistent with the results of a sample previously collected in this area. SB-9 collected by ESI at 14 to 16 feet indicated the presence of nitrobenzene at 1,571 mg/kg (818 mg/kg in the duplicate sample). This sample also exhibited elevated levels of total SVOCs and PAHs.

Elevated levels of total PAHs and total SVOCs were detected in SB-73 at 14 to 16 feet. Elevated levels of CaPAHs were detected in SB-83 at 14 to 16 feet. None of the remaining deep samples collected from this area indicated the presence of elevated levels of PAHs, CaPAHs or SVOCs.

None of the samples collected in the Radio Tower Area indicated the presence of elevated levels of PCBs above the screening criteria. Low levels of pesticides were detected in this area (less than 1 mg/kg), except for the sample collected from 14-16 feet in SB-73. This sample exhibited the presence of endrin at 26 mg/kg. Although delta - BHC was detected in this sample, it was qualified as nondetect due to interference on the column. SB-9 did not exhibit the presence of any detectable levels of pesticides.

Several samples collected from this area exhibited elevated levels of metals. Of particular interest is that the borings which exhibited elevated levels of nitrobenzene (SB-72 and SB-73) also exhibited elevated levels of antimony. Two samples collected from SB-72 indicated the presence of antimony at 94 and 27 mg/kg at 16 to 18 and 18 to 20 feet, respectively, and samples collected from SB-73 indicated the presence of antimony at 268 and 5,470 mg/kg at 10 to 12 and

14 to 16 feet, respectively. SB-9 indicated the presence of antimony at 89.9 mg/kg (205 mg/kg in the duplicate).

Elevated levels of other metals, including chromium (2 out of 28 samples), copper (1 out of 28), cadmium (1 out of 28), lead (4 out of 28) , nickel (1 out of 28) and zinc (2 out of 28) were also detected in this area.

In addition to the TCL VOCs, SVOCs, P/PCBs and metals analysis conducted in this area, two samples (SB-69G and SB-73H) were collected for Toxicity Characteristic Leaching Procedure (TCLP) analysis. The results of this analysis are presented in Table 4-3. As shown, sample SB-73H indicated the presence of 2,4 dinitrotoluene and nitrobenzene at levels substantially greater than the TCLP maximum allowable levels as determined by United States Environmental Protection Agency (USEPA). As shown, SB-69G did not exhibit the presence of any of the TCLP parameters above the maximum allowable level.

Remaining Area South of the Bell Slip

Twelve borings, SB-40 through SB-51, not associated with the Radio Tower Area, were constructed south of the Bell Slip. A total of 24 subsurface soil samples, including 12 composite (0-8 feet) and 12 grab samples, were collected from these borings. In addition, one subsurface soil sample was collected during installation of piezometer PZ-10. Each of the samples was analyzed for SVOCs, P/PCBs, metals and cyanide. No samples collected from this area were analyzed for VOCs because total organic vapor screening did not exceed 10 ppm. Fourteen of the 25 subsurface soil samples collected from this area exhibited levels of contaminants above the screening criteria. Eight of these samples were the composite samples collected from 0 to 8 feet.

The results from the analysis of the samples indicated elevated levels of CaPAHs in eight of the 25 samples. Levels ranged from nondetect to 31 mg/kg in SB-46 at 14 to 16 feet. SB-46 also exhibited elevated levels of total PAHs at 104 mg/kg. This sample was collected during the

TABLE 4-3
BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
SUBSURFACE SOIL SAMPLE RESULTS
TCLP CONSTITUENTS

SAMPLE ID	SB - 69 G	SB - 73 H	MAXIMUM ALLOWABLE
DATE OF COLLECTION	09/20/94	09/22/94	LEVEL
TCLP CONSTITUENTS	(ug/l)	(ug/l)	(ug/l)
Benzene	U	70	500
Carbon Tetrachloride	U	U	500
Chlordane	U	U	30
Chlorobenzene	10 J	800	100000
Chloroform	U	U	6000
o-Cresol	U	U	200000
m-Cresol	U	U	200000
p-Cresol	U	U	200000
Cresol	U	U	200000
2,4-D	U	U	10000
1,4-Dichlorobenzene	U	U	7500
1,2-Dichloroethane	U	U	500
1,1-Dichloroethylene	U	U	700
2,4-Dinitrotoluene	U	610 E**	130
Endrin	U	U	20
Heptachlor(and its epoxide)	U	U	8
Hexachlorobenzene	U	U	130
Hexachloro-1,3-butadiene	U	U	500
Hexchloroethane	U	U	3000
Lindane	U	U	400
Methoxychlor	U	U	10000
Methyl ethyl ketone	U	U	200000
Nitrobenzene	U	91000 D*	2000
Pentachlorophenol	U	U	100000
Pyridine	U	U	5000
Tetrachloroethylene	U	U	700
Toxaphene	U	U	500
Trichloroethylene	U	U	500
2,4,5-Trichlorophenol	U	U	400000
2,4,6-Trichlorophenol	U	U	2000
2,4,5-TP (Silvex)	U	2	1000
Vinyl chloride	U	U	200
Arsenic	U	U	5000
Barium	1088.76	463.33	100000
Cadmium	U	U	1000
Chromium	U	19.95	5000
Lead	U	51.86	5000
Mercury	0.269	0.283	200
Selenium	U	U	1000
Silver	U	U	5000

QUALIFIERS
U: compound analyzed for but not detected
B: constituent found above the IDL but below the CRDL
D*: Result taken from the diluted run. Compound exceeded the calibration range in the initial analysis.
E**: Result is estimated. Exceeded calibration range but not detected in diluted run.

installation of GW-4C and was described as industrial fill consisting of multicolored foundry sand, pale green slag and yellow brick.

None of the samples collected exhibited levels of PCBs above the screening criteria. Elevated levels of lead were detected in four of the 25 samples with the highest level detected at 2,200 mg/kg in SB-40 at 18 to 20 feet. This sample was also characterized as industrial fill. Elevated levels of other metals were also detected in SB-40 at that depth, including antimony, copper, nickel and zinc. SB-43 at 22 to 24 feet in the native overburden exhibited a slightly elevated level of arsenic at 21 mg/kg. The composite shallow sample collected from 0 to 8 feet in SB-45 also exhibited elevated levels of metals including lead, nickel and zinc.

Samples collected from SB-42, SB-49, SB-50 and PZ-10 did not exhibit any contaminants above the screening levels. In addition, three samples collected by ESI from SB-4, SB-6 and SB-7 also did not exhibit any contaminants above the screening levels. The majority of the subsurface in this area has been characterized as containing a substantial amount of construction and demolition debris and sediment spoil from the dredging of the Buffalo Outer Harbor.

SB-18 was constructed by ESI during the installation of GW-4A. One sample was collected from this boring from 5 to 7 feet and a duplicate analysis was also run on the sample. The original sample did not exhibit elevated levels of any of the contaminants of concern, however, the duplicate analysis indicated the presence of arsenic, copper, lead and zinc at levels above the screening criteria. Lead was detected in this sample at 586 mg/kg. In 1991, GeoEnvironmental of New York (GZA), at the request of NFTA, reconstructed SB-18 and collected a sample from 5 to 7 feet for EPTOX lead analysis. The result of this analysis indicated the presence of EPTOX lead at 0.062 mg/l which is below the regulatory limit.

Area North of the Bell Slip

The Area North of the Bell Slip is subdivided into three sections in order to address the biased borings constructed in the vicinity of GW-3 and GW-9. The Area North of the Bell Slip, exclusive of the areas surrounding GW-3 and GW-9, will include SB-23 through SB-39, excluding SB-31 and SB-32, and PZ-7 through PZ-9.

Thirty-three samples were collected from this area and analyzed for SVOCs, P/PCBs, metals and cyanide. Fifteen of the samples were composite samples collected from 0 to 8 feet and 18 were grab samples. Of the 33 samples collected, 17 samples exhibited levels of one or more of the contaminants of concern above the screening criteria.

None of the samples collected from this area were analyzed for VOCs. The results of the analysis indicated the presence of elevated levels of CaPAHs in five of the 33 samples collected. None of the samples exhibited elevated levels of PAHs or SVOCs. The highest level of CaPAHs detected in this area was 21 mg/kg. The elevated levels were detected sporadically throughout the area and were not limited to one particular fill unit.

None of the samples collected from this area indicated the presence of elevated levels of PCBs or pesticides. The results of the metals analysis indicated the presence of elevated levels of several metals, including lead in 8 of the 33 samples collected. Several of the samples that exhibited elevated levels of lead also exhibited elevated levels of other metals including copper, arsenic, nickel and zinc.

ESI installed nine borings North of the Bell Slip, excluding the areas surrounding GW-3 and GW-9. Five of the borings were not associated with the installation of monitoring wells (SB-1 through SB-3, SB-5 and SB-17) and four borings were associated with the installation of the monitoring wells (SB-11 through SB-14). One sample was collected from each of the borings and analyzed for TCL+30 parameters. Four of the nine borings (SB-1, SB-2, SB-5 and SB-17) did not exhibit elevated levels of the contaminants of concern. Each of the remaining borings indicated the presence of elevated levels of one of the following metals: lead, mercury, cadmium, copper, nickel, arsenic, antimony or zinc. (See Figure 4-3.)

A soil sample collected from 15 to 17 feet from SB-13 constructed during the installation of GW-2A, exhibited the presence of lead at 586 mg/kg. In 1991, GZA reconstructed SB-13 and collected a sample form 15 to 17 feet for EPTOX lead analysis. The results of the analysis indicated the presence of EPTOX lead at 14.3 mg/l. This sample exceeded the EPTOX criteria for lead of 5 mg/l. In addition to this sample, GZA also collected a sample from SB-11 at 5 to 7 feet for EPTOX lead. During ESI's investigation 2,460 mg/kg (1,100 mg/kg in the duplicate analysis) of total lead was detected in the soil. GZA's EPTOX analysis indicated the presence of 2.12 mg/l EPTOX lead which is below the regulatory limit.

Area Surrounding GW-3

In order to address elevated levels of PAHs and lead detected in groundwater samples collected from GW-3 during the investigation conducted by ESI, a total of eight biased borings were constructed during the Phase I RI in this area (SB-58 through SB-64 and SB-67). In addition to these biased borings, SB-32 was constructed as part of installation of GW-3B and SB-31 was an unbiased boring constructed in this area. A total of 20 samples were collected during the Phase I RI from this area and analyzed for TCL SVOCs, P/PCBs, metals and cyanide. Twelve of the 20 samples collected from this area exhibited elevated levels of contaminants above the screening criteria. The majority of the samples collected from this area were collected within the material characterized as landfill debris.

Two samples collected from this area were analyzed for VOCs. Neither sample indicated the presence of VOCs greater than 1 mg/kg (screening level of 10 mg/kg). The results of the SVOC analysis indicated that four of the 20 samples exhibited the presence of elevated levels of CaPAHs above the screening criteria with the highest level detected in SB-58 at 14 to 16 feet at 37 mg/kg. This sample also exhibited the presence of total PAHs above the criteria at 102 mg/kg.

Only low levels of PCBs were detected in this area. However, several samples exhibited elevated levels of metals. The composite sample collected from 0 to 8 feet from SB-31 exhibited elevated levels of antimony, arsenic, copper, lead, nickel and zinc. A total of 10 out of the 20 samples collected from this area exhibited elevated levels of lead with the highest level detected at 2,800 mg/kg in SB-62 at 22 to 24 feet. Screening level exceedances of antimony, arsenic, copper, nickel and zinc also occurred in this area.

ESI collected one sample from 5 to 7 feet during construction of SB-15. This sample exhibited elevated levels of CaPAHs, lead, mercury and zinc. Lead was detected at 5,530 mg/kg. In 1991, GZA revisited SB-15 and collected a sample from SB-15 at 5 to 7 feet. This sample was analyzed for EPTOX lead. The results of this analysis indicated the presence of EPTOX lead at 59.4 mg/l. This level is greater than the regulatory level for EPTOX lead (5 mg/l).

The results of the Phase I RI from this area were not consistent with the results of the sampling conducted by ESI. Although elevated levels of lead were detected in this area, the levels were not as high as the levels detected by ESI. Due to concerns regarding the level of EPTOX lead previously collected in this area, two additional borings were constructed and two samples collected as part of the Phase II RI. Each sample was collected from 5 to 7 feet and analyzed for copper, lead and zinc and TCLP copper, lead and zinc.

Both samples indicated the presence of elevated levels of total copper, lead and zinc. Although elevated, these levels of lead were not as high as the levels detected previously in this area (931 mg/kg in SB-77 and 781 mg/kg in SB-78 versus 5,530 mg/kg in SB-15). One of the samples, SB-77, exceeded the regulatory levels for TCLP lead at 8.4 mg/l.

Area Surrounding GW-9

A total of six biased borings (SB-52 through SB-57) were constructed in this area during the Phase I RI in order to address elevated levels of lead detected in GW-9 during the investigation conducted by ESI. Twelve samples were collected from this area and analyzed for

SVOCs, pesticides/PCBs, metals and cyanide. Three of the twelve samples collected from this area exhibited elevated levels of the contaminants of concern.

No samples collected from this area were analyzed for VOCs. The results of the SVOC analysis indicated elevated levels of CaPAHs in the deep samples collected from three of the borings (SB-54, SB-55 and SB-56). The highest level detected was 38 mg/kg in SB-55. The samples ranged in depth from 16 to 22 feet. All three of these samples were collected in the fill material described as landfill debris.

None of the samples collected exhibited elevated levels of PCBs. However, three of the deep samples collected during the Phase I RI did exhibit elevated levels of metals including lead, zinc, copper, nickel and arsenic. The highest level of lead detected was 1,190 mg/kg in SB-55.

ESI collected one sample during installation of GW-9 (SB-16). This sample was collected from 25 to 27 feet. Elevated levels of CaPAHs and metals, including copper, lead, and zinc, were detected in this sample. Total lead in this sample was detected at 3,120 mg/kg. GZA also collected a sample from this location and depth for EPTOX analysis. The results of this analysis indicated 0.141 mg/l for EPTOX lead.

Concern with regard to the elevated levels of lead detected in a groundwater sample collected from GW-9 by ESI required the installation of two additional borings (SB-79 and SB-80) in this area during the Phase II RI. One sample was collected from each boring and analyzed for total copper, lead and zinc and TCLP copper, lead and zinc. Each sample was collected from a depth of 14 to 16 feet which is within the screened interval of GW-9. Elevated levels of total lead, copper and zinc were detected in these samples, however, neither sample exhibited the presence of TCLP lead, copper or zinc above the regulatory levels.

Based upon the results of the subsurface soil sampling conducted during the Phase I/Phase II Remedial Investigation elevated levels of metals and CaPAHs were found in the subsurface soil samples collected in the areas described as receiving landfill debris. Previous concerns regarding exceedences of EPTOX lead criteria in the vicinity of GW-3 have been confirmed as a result of the Phase II RI. Some of the materials disposed of in this area, if removed off-site, would be considered characteristically hazardous. This area, described as containing landfill debris, extends to the asphalt roadway in the vicinity of the former scale house and is believed to be part of the Fuhrmann Boulevard Landfill which reportedly received incinerator ash. Slightly elevated levels of CaPAHs were also found in the shallow subsurface at sporadic locations across the site. However, these levels are not considered to be significant and are not believed to be associated with a particular fill unit.

The area surrounding GW-9 exhibited elevated levels of contamination in the subsurface soil including CaPAHs and metals, comprising arsenic, antimony and copper. The levels detected in the subsurface soil are similar to what was previously documented in this area. Neither historical or recent subsurface soil samples collected from this area exhibited levels of metals above EPTOX or TCLP regulatory limits. A discussion regarding the impact of this contamination on the groundwater quality in this area is provided below.

Subsurface soil contamination at depths greater than 8 feet appears to be of significant concern in the Radio Tower Area. Significantly elevated levels of nitrobenzene and antimony in the subsurface soil at depths between 10 to 20 feet, warrant specific consideration. The total volume of contaminated material is estimated to be at least 15,000 cubic yards. A sample collected from this area exceeded TCLP criteria and therefore, if removed off-site, at least a portion of this material would be considered characteristically hazardous. As discussed below, this contamination appears to be leaching to the groundwater and it appears that additional information may need to be obtained to determine the extent and migration of this contamination in the groundwater.

4.2.3 Groundwater

During the Phase I RI, groundwater samples were collected from 29 monitoring wells and one piezometer (PZ-12) at the Buffalo Outer Harbor Site. The locations of the monitoring wells and piezometer are shown on Figure 2-3. Each sample was analyzed for TCL + 30 parameters. During the Phase II RI, groundwater samples were collected from 11 existing monitoring wells (GW-1, GW-2A, GW-3A, GW-5A, GW-8A, GW-8B, GW-8C, GW-9, GW-16, GW-17, GW-18A) and four newly installed wells (GW-18B, GW-19, GW-20 and GW-21). Duplicate samples were collected from GW-3A, GW-9, GW-18A and GW-21. Each sample was analyzed for TCL semivolatile organics and metals. The samples collected from the five monitoring wells in the Radio Tower Area (G-18A, GW-18B, GW-19, GW-20 and GW-21) were also analyzed for TCL volatile organics. All Phase II RI samples were analyzed by Energy and Environmental Engineering, Inc. and duplicate samples were analyzed by NYTEST Environmental, Inc. As discussed above, the results of the analyses have been compared to the NYSDEC Class GA groundwater standards and guidelines. Results of the sample analysis are discussed below, and the data tables comparing the results to the standards and guidelines are provided in Appendix I. Figures 4-4 and 4-5 present the results of the groundwater samples which exhibited levels of contaminants above the groundwater standards/guidelines for the Phase I and Phase II RI sampling, respectively.

The volatile organic analyses conducted during the Phase I RI indicated the presence of VOCs above the NYSDEC standards/guidelines in 5 of the 29 wells sampled. No volatile organic compounds were detected above the standards/guidelines in PZ-12. Four of the wells (GW-2B, GW-3A, GW-4A and GW-8C) exhibited the presence of one VOC above the standard/guideline at relatively low levels. GW-4A exhibited the presence of chloroform at 15 ug/l. Chloroform was detected in this well at 11 ug/l (12 ug/l in the duplicate sample) during the 1989 sampling event. A low level of chloroform (0.8 ug/l) was detected the deep well in this cluster.

During the Phase I RI, GW-18A, which is in the Radio Tower Area, exhibited the presence of three VOC compounds above the standards/guidelines with benzene at 15 ug/l, toluene at 7 ug/l and chlorobenzene at 170 ug/l. The results of the analysis of the sample collected from this well during the Phase II RI and the duplicate analysis conducted both yielded similar results. Only one other sample collected from this area during the Phase II RI exhibited the presence of VOCs above the groundwater standards. This sample was collected from GW-

LEGEND

FENCE LINES

SITE BOUNDARY

SS-96 COMPOSITE SAMPLE OF FOUR NODAL POINTS

SCREENING CRITERIA	mg/kg
TOTAL VOCs	10 mg/kg
TOTAL SVOCs	500 mg/kg
TOTAL PAHs	100 mg/kg
TOTAL CARCINOGENIC PAHs (CAPAHS)	10 mg/kg
TOTAL PCBs	1 mg/kg
NITROBENZENE	1 mg/kg
ANTIMONY	20 mg/kg
ARSENIC	20 mg/kg
CADMIUM	10 mg/kg
CHROMIUM	100 mg/kg
COPPER	200 mg/kg
LEAD	500 mg/kg
MERCURY	10 mg/kg
NICKEL	40 mg/kg
ZINC	500 mg/kg

NOTE:

SS-131 THROUGH SS-140 WERE COLLECTED AS PART OF THE PHASE II REMEDIAL INVESTIGATION.

NOTE: ALL CONCENTRATIONS IN mg/kg.

DIRECTORY: 1307
FILE NAME: SSRESLT2
DATE: RDS-08/09/95

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DVIRKA AND BARTILUCCI
CONSULTING ENGINEERS

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

SURFACE SOIL SAMPLING RESULTS

PROJECT NO. 1307

DATE: AUG. 1995

SCALE: 1"=200'

FIGURE 4-1

GW-1	
IRON	12,700
LEAD	45.4
MAGNESIUM	42,500
MANGANESE	344
SODIUM	155,000

	GW-2A	GW-2B	GW-2C
IRON	8100	5910	---
MAGNESIUM	---	---	149,000
MANGANESE	1030	176	---
SODIUM	---	266,000	3,769,000
CHLOROMETHANE	---	10	---

	GW-3A	GW-3B
BENZO (a) ANTHRACENE	4	---
CHRYSENE	3	---
BENZO (b) FLUORANTHENE	3	---
BENZO (k) FLUORANTHENE	3	---
BENZO (a) PYRENE	3	---
INDENO (1,2,3-cd) PYRENE	0.6	---
TRICHLOROETHENE	6	---
IRON	25,600	2940
LEAD	170	---
MAGNESIUM	50,300	---
MANGANESE	191	129
SODIUM	285,000	230,000
ZINC	---	349

PZ-12*	
IRON	4580
MAGNESIUM	35,600
MANGANESE	573
SODIUM	50,100

	GW-4A	GW-4B	GW-4C	GW-4C*
IRON	326	1580	---	---
MANGANESE	105	175	---	---
SODIUM	---	---	719,000	676,000
CHLOROFORM	15	---	---	---

GW-18	
BENZENE	15
TOLUENE	7
CHLOROBENZENE	170
1,3 DICHLOROBENZENE	100
1,4 DICHLOROBENZENE	26
1,2 DICHLOROBENZENE	91
NAPTHALENE	370
4-CHLOROANILINE	2400
4,4-DDD	0.069
ANTIMONY	244
IRON	2930
MAGNESIUM	75,100
MANGANESE	233
SODIUM	45,800

GW-11A	
IRON	5140
MANGANESE	1400

GW-13	
HEPTACHLOR EPOXIDE	0.026
DIELDRIN	0.032
IRON	1580
MANGANESE	363
SODIUM	10,443,000
CYANIDE	259

GW-15	
4,4-DDD	0.02
4,4-DDT	0.046
ARSENIC	95
IRON	20,800
MAGNESIUM	37,100
MANGANESE	405
SODIUM	65,600

	GW-6A	GW-6B	GW-6C
ARSENIC	---	63.2	---
IRON	1790	15,500	1650
MAGNESIUM	39,400	---	---
MANGANESE	711	206	5.2
SODIUM	23,300	74,500	580,000

GW-9	
IRON	4560
MANGANESE	76.8
SODIUM	3,451,000

GW-14	
IRON	5660
MANGANESE	745

	GW-5A	GW-5B	GW-5C
IRON	7710	---	1930
MAGNESIUM	36,800	---	181,000
MANGANESE	711	---	74
SODIUM	---	42,600	751,000

	GW-10A	GW-10B
4,4-DDT	---	0.039
ENDRIN	---	0.024
ARSENIC	27.4	---
IRON	---	259
MANGANESE	---	201
SODIUM	25,600	64,000

GW-16	
IRON	1030
MAGNESIUM	36,200
MANGANESE	495
SODIUM	59,800

GW-17	
ENDRIN	0.018
IRON	3110
MAGNESIUM	54,500
MANGANESE	431
SODIUM	7,170,000

	GW-8A	GW-8B	GW-8C
ANTIMONY	124	111	77.1
BARIUM	---	4050	---
IRON	37,000	42,100	4480
MAGNESIUM	262,000	304,000	141,000
MANGANESE	3230	4530	162
SODIUM	29,481,000	15,436,000	8,662,000
TRICHLOROETHENE	---	---	7

GW-12	
beta-BHC	0.011
BARIUM	1260
IRON	4710
MAGNESIUM	45,100
MANGANESE	173
SODIUM	729,000

LEGEND

SAMPLE LOCATION

	GW-10A	GW-10B
4,4-DDT	-	0.039
ENDRIN	-	0.024
ARSENIC	27.4	-
SODIUM	25,600	64,000

CONSTITUENT CONCENTRATION IN ug/l

-- NO EXCEEDANCES

FENCE LINES

SITE BOUNDARY

MONITORING WELL LOCATION

PIEZOMETER LOCATION

NOTE:
ALL RESULTS COMPARED TO NYSDEC CLASS GA GROUNDWATER STANDARDS.

* RESULTS REPRESENT DISSOLVED METALS ANALYSIS

DIRECTORY: 1307
FILE NAME: GWRSLTS
DATE: ROS-12/19/95

NO.	DATE	REVISION	INT.

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DVIRKA AND BARTILUCCI
CONSULTING ENGINEERS

BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

PHASE I GROUNDWATER SAMPLING RESULTS

PROJECT NO. 1307

DATE: MARCH 1995

SCALE: 1"=200'

FIGURE 4-4

18B which is the intermediate well constructed adjacent to GW-18A. Benzene was detected in this well at 2 ug/l.

Review of the analysis for the SVOC samples collected during the Phase I RI resulted in the identification of only 2 of the 29 wells, GW-3A and GW-18A, with levels of SVOCs above the standards/guidelines. Review of the analysis for the SVOCs samples collected during the Phase II RI resulted in the identification of 6 of the 15 wells, GW-1, GW-3A, GW-18A, GW-18B, GW-19 and GW-20, with levels of SVOCs above the standards/guidelines. GW-3A exhibited the presence of several PAHs above the guidance value during the Phase I and Phase II RI sampling events. A sample collected from this well during the Phase II Investigation in 1989 also indicated the presence of several SVOCs above the current groundwater standards/ guidelines. However, the levels detected in 1989 were significantly higher than the levels detected during the RI investigations. Levels of PAHs exceeding the guidance values ranged from 6 ug/l to 250 ug/l in 1989 and from 0.6 ug/l to 4 ug/l during the Phase I and Phase II RI. A duplicate sample collected from this well during the Phase II RI did not indicate the presence of any PAHs above the standards/guidelines.

Results of the analysis of the groundwater sample collected from GW-18A during the Phase I RI indicated the presence of dichlorobenzene (217 ug/l - total of all three targeted isomers including 1,2-, 1,3- and 1,4-dichlorobenzene), naphthalene (370 ug/l) and 4-chloroaniline (2,400 ug/l) above the standards/guidance values for these compounds. 4-Chloroaniline was not observed in the soil samples collected during construction of this well, however, it was detected at elevated levels in other borings constructed in the Radio Tower Area. As discussed in Section 4.2.2, significantly elevated levels of nitrobenzene were detected in the subsurface soil at this location. Nitrobenzene is used for the manufacturing of aniline in soaps and shoe polishes. The levels of 4-chloroaniline, dichlorobenzene and naphthalene found in the groundwater at this location are attributable to this contaminated fill material.

Elevated levels of dichlorobenzene were detected in GW-18A during the Phase II RI (including the duplicate sample from this well). 1,2,4-Trichlorobenzene, naphthalene and 4-

chloroaniline were also detected in a sample analyzed by E3I. Duplicate analysis did not indicate the presence of 1,2,4-trichlorobenzene or naphthalene, but did indicate higher levels of 4-chloroaniline. The sample collected from the intermediate well in this cluster indicated the presence of 4-chloroaniline above the standard. No other SVOCs were detected above the standard/guideline in this intermediate well.

Samples collected from GW-19 and GW-20 exhibited the presence of phenol above the standard at 6 ug/l and 7 ug/l, respectively. Phenol was not detected in any of the soil samples collected from this area. Although slightly above the groundwater standard, these levels do not appear to be significant.

A slightly elevated level of chrysene was detected in GW-1 (0.6 ug/l) during the Phase II RI. Chrysene was not detected in the sample collected from this well during the Phase I RI. However, elevated levels of PAHs were detected in GW-1 during the 1989 sampling event, with the highest level detected of benzo(b)fluoranthene at 62 ug/l. Several other wells, including GW-2A, GW-5, GW-7 and a duplicate sample collected from GW-9, also exhibited elevated levels of SVOCs, particularly PAHs, during the 1989 sampling event.

The results of the pesticide/PCB analysis conducted on the well samples during the Phase I RI indicated six of the 29 wells sampled exhibited levels of pesticides above the standard. None of the wells indicated the presence of detectable levels of PCBs. Although elevated levels of pesticides were detected in the groundwater, the levels do not appear to be substantially elevated. None of the wells sampled in 1989 exhibited the presence of detectable levels of pesticides/PCBs. No pesticide/PCB analysis was conducted during the Phase II RI.

The results of the inorganic analysis conducted during the Phase I and Phase II RI indicated the presence of several inorganic constituents above the standards/guidelines. Due to elevated turbidity levels (>50 NTUs), two samples (GW-4C and PZ-12) were filtered during the Phase I RI and the samples were analyzed for both total metals (unfiltered) and dissolved metals (filtered). Similarly, during the Phase II RI, two samples (GW-3A and GW-9) were filtered and the samples were analyzed for both total metals (unfiltered) and dissolved metals (filtered).

During the Phase I RI, iron was detected above the standard in 25 of the 29 wells sampled and in PZ-12, and sodium was detected above the standard in 23 of the 29 wells sampled and PZ-12. Elevated levels of magnesium were detected in 14 of the 29 wells and PZ-12, and manganese was detected at levels above the guidance value in 26 of the 29 wells and PZ-12. During the Phase II RI, iron was detected above the standard in 15 of the 15 wells sampled (including duplicate and filtered analysis), and sodium was detected in 12 of the 15 wells sampled. Elevated levels of magnesium were detected in 11 of the 15 wells, and manganese was detected at levels above the guidance value in 15 of the 15 wells. Elevated levels of iron, magnesium, manganese and sodium were detected above the standards and guidelines in several samples collected during the 1989 Phase II Investigation. Elevated levels of iron, magnesium, manganese and sodium in groundwater are often associated with landfill leachate.

Antimony was detected in four wells and arsenic was detected in three wells above the standard or guidance value during the Phase I RI. Antimony was detected above the guidance value in each of the wells in cluster GW-8. Antimony was only detected above the guidance value in GW-8B during the Phase II RI sampling. Previous results from the samples collected from these wells by ESI in 1989 did not indicate the presence of antimony. However, the detection limit during the 1989 sampling for antimony was 710 ug/l, which is more than 200 times greater than the current guidance value of 3 ug/l. Antimony was also detected in GW-18A in the Radio Tower Area during the Phase I RI and Phase II RI sampling events. Although arsenic was detected in three wells (GW-6B, GW-10A and GW-15) during the Phase I RI at levels above the standard of 25 ug/l, samples collected during the 1989 Phase II Investigation indicated arsenic was only detected at levels above the guidance value in one of the three wells (GW-10). Arsenic was detected above the guidance value in only one well during the Phase II RI in GW-19 at 159 ug/l.

Of the remaining constituents sampled, lead was detected above the guidance value in two wells (GW-1 and GW-3A) during the Phase I RI and zinc was detected above the guidance value in one well (GW-3B) during the Phase I RI. Previously in the 1989 Phase II Investigation, lead was detected in 10 of the 14 wells sampled at levels above the standard and zinc was detected in 7 of the 14 wells above the standard. One of the wells, GW-9, indicated the presence of lead at 8,780 ug/l. Due to the elevated levels of lead detected in the samples, ESI requested that 13 of the groundwater samples be filtered and analyzed for dissolved lead. The result of the analysis indicated 5 of the 13 wells still indicated the presence of lead above the groundwater standard of 25 ug/l, including GW-9 at 65 ug/l. GZA collected a sample from GW-9 in 1991 and analyzed the sample for EPTOX lead. The result of this analysis indicated the presence of lead at 36 ug/l. Elevated levels of lead and zinc are often found in groundwater impacted by landfill leachate or municipal incinerator ash.

During the Phase II RI, samples were collected from GW-3A and GW-9 and analyzed for total metals (unfiltered) and dissolved metals (filtered). In addition, duplicate analysis was performed on each of these samples. The unfiltered sample and duplicate unfiltered sample collected from GW-3A exhibited elevated levels of lead (410 ug/l and 473 ug/l, respectively). The filtered sample and duplicate analysis exhibited nondetectable levels of lead..

The results of the metals analysis from GW-9 did not exhibit elevated levels of lead in either the filtered or unfiltered analysis. The only constituents detected above the groundwater standards/guidelines for GW-9 were iron, manganese and sodium.

During the Phase I RI, cyanide was detected above the standard in only one well GW-13 at 259 ug/l. In 1989, cyanide was detected at extremely elevated levels in GW-7 at 3,350 ug/l. As discussed above, GW-7 was replaced by GW-17. GW-17 did not exhibit elevated levels of cyanide during the Phase I RI, however, it was detected at elevated levels during the Phase II RI at 892 ug/l. In addition, cyanide was detected at elevated levels in GW-8A at 715 ug/l during the Phase II RI. GW-17 was installed in material described as landfill debris which included material such as brick, glass, rubber and slag. No elevated levels of cyanide were detected in the subsurface soil during any of the investigations. However, there was a great deal of matrix interference and many of the cyanide samples were rejected.

Information provided in the 1989 Phase II Investigation Report indicated 5 of the 14 samples (GW-2B, GW-5, GW-6A, GW-8B and GW-9) exhibited levels of turbidity above 50 NTUs at the time of sample collection. A comparison of the turbidity found during the Phase II Investigation and the levels found during the Phase I and Phase II RI are presented in Table 4-4. As shown, the comparison of the turbidity levels is fairly consistent except for GW-1. Much higher levels of turbidity were encountered in this well during the Phase II RI. This may account for the higher levels of metals and PAHs detected in this sample during the most recent round of sampling. As discussed above, although several of the wells exhibited total lead levels greater than the standard during the 1989 sampling, five of the wells sampled during the RI still indicated dissolved lead levels greater than the standard. Therefore, the elevated levels of metals detected in the samples previously do not appear to be associated with elevated turbidity levels.

Based upon the results obtained during the Phase I and Phase II RI, it does not appear that groundwater at the site, exclusive of the non-heavy metals (iron, magnesium, manganese and sodium) is significantly contaminated except for the Radio Tower Area. Low levels of PAHs detected in GW-3A are likely a result of leaching of the contaminated subsurface soil to the groundwater. However, the contamination appears to be localized in extent.

Significantly elevated levels of contamination found in GW-18A and GW-18B appear to be a result of leaching of contamination from the contaminated soil in this area to the groundwater. Groundwater flow direction appears to be to the southeast, away from the Outer Harbor. Downgradient monitoring wells do not appear to be impacted by this contamination, therefore the contamination does not appear to be readily migrating.

Table 4-4

BUFFALO OUTER HARBOR SITE
PHASE I AND II REMEDIAL INVESTIGATION
COMPARISON OF TURBIDITY LEVELS

Well	Turbidity (8/89) NTUs	Turbidity (9/94) NTUs	Turbidity (1/95) NTUs
GW-1	6.5	5	42
GW-2A	24	28	30
GW-2B	150	40	NS
GW-2C	15	7	NS
GW-3A	10	55	*
GW-4A	10	45	NS
GW-5A	140	32	30
GW-6A	97	43	NS
GW-7/ GW-17	14	31	35
GW-8A	21	48	19
GW-8B	80	30	18
GW-8C	9.1	36	11
GW-9	56	28	*
GW-10A	32	10	NS

NS - Not sampled

*Sample filtered and total and dissolved metals analyzed.

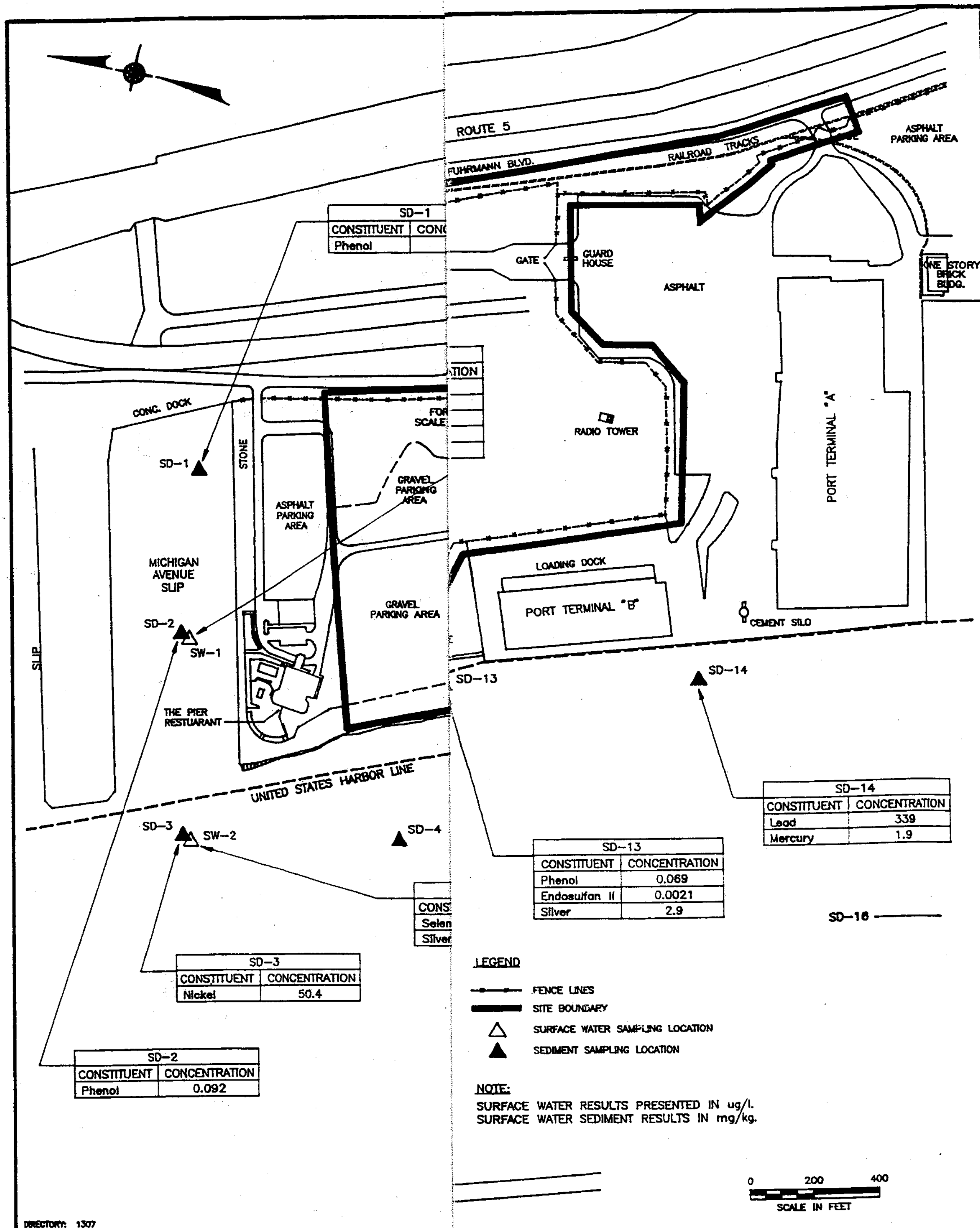
As discussed in Section 3.3, it is estimated that the discharge of water to the Outer Harbor passing through the fill unit along the shoreline (including the Bell Slip and Michigan Avenue Slip) is approximately 16,000 gallons per day or about 6 gallons per day per foot of shoreline. Based upon this estimated discharge, a loading to the Outer Harbor could be calculated for contaminants of concern at the site. However, excluding sodium, magnesium, manganese and iron, no other constituent was detected consistently above screening levels in the fill material. In addition, as discussed in the following sections, none of the contaminants detected in the groundwater at elevated levels were detected in any of the surface water or surface water sediment samples. Therefore, a detailed assessment of contaminant loadings to the Outer Harbor does not appear to be warranted at this time. This is discussed in greater detail in Section 4.2.6.

4.2.4 Surface Water

Six surface water samples were collected as part of the Phase I RI. The samples were collected from the Michigan Avenue Slip (SW-1), the Bell Slip (SW-5 and SW-6) and the Outer Harbor (SW-2, SW-3 and SW-4). Each sample was analyzed for TCL+30 parameters and the results of the analysis were compared to Class B Surface Water Standards for the propagation of fish or wildlife consumption of fish (Type A). For compounds that also have standards for Type H (B), human consumption of fish, the standard is also listed on the tables. The results of the analysis have been compared to the standards, and exceedances of the standards are presented on Figure 4-6. Tables presenting the results and comparison to standards are provided in Appendix I. The results of the analyses are discussed below.

Only one sample, SW-4, exhibited the presence of any VOCs. Tetrachloroethene was detected above the detection limit at 2 ug/l. In addition, trichloroethene was detected in this sample at 1 ug/l and total xylenes were detected at 1 ug/l. None of these compounds exceeded the surface water standards/guidelines.

SW-1 was the only sample that exhibited SVOCs above the detection limit with bis(2-ethylhexyl)phthalate at 2 ug/l. No P/PCBs were detected in any of the samples analyzed.



SD-1	
CONSTITUENT	CONC
Phenol	

SD-2	
CONSTITUENT	CONCENTRATION
Phenol	0.092

SD-3	
CONSTITUENT	CONCENTRATION
Nickel	50.4

CONS	
Selen	
Silver	

SD-13	
CONSTITUENT	CONCENTRATION
Phenol	0.069
Endosulfan II	0.0021
Silver	2.9

SD-14	
CONSTITUENT	CONCENTRATION
Lead	339
Mercury	1.9

LEGEND

- FENCE LINES
- SITE BOUNDARY
- △ SURFACE WATER SAMPLING LOCATION
- ▲ SEDIMENT SAMPLING LOCATION

NOTE:
SURFACE WATER RESULTS PRESENTED IN ug/l.
SURFACE WATER SEDIMENT RESULTS IN mg/kg.

DIRECTORY: 1307
FILE NAME: SW1-RES
DATE: RDS-03/02/95

NO.	DATE	REVISION	INT.

E WATER AND SURFACE WATER
DIMENT SAMPLING RESULTS

PROJECT NO. 1307
DATE MARCH 1995
SCALE 1" =200'

FIGURE 4-6

The results of the metals analysis indicated elevated levels of aluminum in three of the samples and two of the samples indicated the presence of elevated levels of selenium and silver. Although these samples indicated the presence of these metals above the standards, these levels are not considered excessively elevated and do not appear to be attributable to site contamination since they were not found at elevated levels in site soils.

4.2.5 Surface Water Sediment

Sixteen sediment samples were collected from the Michigan Avenue Slip (SD-1 and SD-2), the Bell Slip (SD-9, SD-10 and SD-11) and the Outer Harbor (SD-3 through 8, and SD-12 through 14) during the Phase I RI. Two background samples at the entrances to the breakwater were also collected (SD-15 and SD-16). Two of the samples, SD-5 and SD-16, were collected at coincident locations with United States Army Corps of Engineers (USACOE) Sampling Stations. Historical data from the USACOE on sediment quality at these sampling locations is provided Section 3.4. All of the samples collected during the Phase I RI were analyzed for TCL+30 parameters.

As discussed in Section 4.1, the results of the sediment analysis are compared to the Aquatic Chronic Toxicity Criteria presented in the NYSDEC Division of Fish and Wildlife Technical Guidance for Screening Contaminated Sediment - November 1993, and the exceedances of the criteria are presented in Figure 4-6. Results of all the analyses are presented in tables in Appendix I.

There are no applicable screening criteria for VOCs, and therefore, there are no exceedances for VOCs in the sediment. The results of the analysis did, however, indicate the presence of low levels of acetone and 2-butanone which could be attributable to laboratory contamination.

The results of the SVOC analysis indicate the presence of phenol above the sediment criteria in 4 of the 16 samples with the highest level detected in SD-1 at 130 ug/kg. In addition, SD-9 indicated the presence of phenanthrene above the criteria at a level of 5,100 ug/kg. Each of the samples exhibited the presence of PAHs in the sediment, however, there are no applicable criteria for the PAHs detected. No SVOCs were detected above the criteria in SD-15, however, the levels of PAHs were consistent with the other samples collected and actually indicated the second highest level of total PAHs of any of the sediment samples. Levels of pesticides above the criteria were detected in several of the samples. Six of the 16 samples indicated the presence of one or more pesticides above the sediment criteria. As shown on Figure 4-6, the majority of these samples are located towards the southern portion of the site.

The results of the sediment VOC analysis performed for samples collected from the Outer Harbor by the USACOE, and as presented in Section 3.4, were analyzed at elevated detection limits, and therefore, also did not indicated the presence of detectable levels of VOCs. The results of the SVOC analysis also indicated the presence of elevated levels of PAHs. Pesticides/PCBs were also analyzed at elevated detection limits, ranging from 20 to 50 ug/kg, and as a result, a comparable evaluation to the levels of pesticides in the sediment detected during the Phase I RI is not possible.

The results of the metals analysis were compared to the Lowest and Severe Effect Level Sediment Criteria. According to the guidance, "a sediment is considered contaminated if either criterion is exceeded. If both criteria are exceeded, the sediment is considered to be severely impacted. If only the Lowest Effect Level criterion is exceeded, the impact is considered moderate." Each of the sediment samples collected exceeded the Lowest Effect Level Criteria for almost all the metals with criteria. Several of the samples also exceeded the Severe Effect Level (SEL) Criteria. Two samples located in the Bell Slip, SD-9 and SD-11, exceeded the SEL for zinc. SD-9 also exceeded the SEL for copper and lead. Three samples located in the Outer Harbor exceeded the SEL criteria, including SD-3 for nickel, SD-13 for silver and SD-14 for mercury and lead. SD-7 collected from the Outer Harbor exceeded the SEL for iron and manganese. SD-15 and SD-16 did not exhibit the presence of any metals above the criteria.

As shown in Section 3.4, the two samples (site number 21 and 24) collected at coincident sampling locations as SD-5 and SD-16, respectively, indicated similar levels of metals in the sediment. These sampling locations indicated the presence of several samples with metals greater than the Lowest Effect Level. However, none of the metals exceeded the SEL. Similarly, none of the metals exceeded the SEL in samples collected at SD-5 or SD-16 locations.

Based upon the results of the sediment analysis, the elevated levels of zinc detected in the Bell Slip may be attributed to runoff from the site. A few surface soil samples collected in the vicinity of the Bell Slip indicated the presence of elevated levels of zinc, and zinc, as well as copper and lead, may also be found in paint used to paint the boats at the Allen Boat Company. Elevated levels of nickel and silver detected in SD-3 and SD-13, respectively, do not appear to be attributable to the site, since only one of the surface soil samples exhibited elevated levels of nickel and none of the surface soil samples or groundwater samples collected exhibited elevated levels of nickel or silver.

4.2.6 Loadings to the Outer Harbor

As discussed in Section 3.3, it is estimated that the discharge of water to the Outer Harbor passing through the fill unit along the shoreline (including the Bell Slip and Michigan Avenue Slip) is 16,000 gallons per day. The absence of groundwater seeps along the shore line suggests that groundwater discharge occurs largely through lateral flow through the lake bottom. Due to the varied nature of contaminants and contaminant sources found on the site it is very difficult to trace the migration of contaminants to a discharge location in or near the Outer Harbor. In order to evaluate the impact groundwater from the site is having on the Outer Harbor the following factors need to be considered:

- The source and location of the contaminants in the fill material.
- Specific groundwater flow paths including discharge points at the lake bottom, and
- The mobility of the contaminants.

Although the investigation conducted at the Buffalo Outer Harbor Site has evaluated groundwater flow direction in the fill material and has identified several different types of fill material, the specific flow directions through the non-homogeneous fill material can not be evaluated. In addition, although in several cases the impact a particular fill unit may have on groundwater quality can be evaluated based upon soil chemical analysis and groundwater chemical analysis, this is not always the case. Therefore, strict utilization of groundwater discharge and chemical concentrations to calculate loadings would not be an appropriate evaluation.

As an example, although GW-3A has exhibited elevated levels of PAHs in the groundwater samples collected from this well, it is difficult to evaluate the fate of these chemicals as they migrate in the groundwater. It would not be appropriate to assume that these chemicals migrated towards and discharge to the Outer Harbor. Particularly, since downgradient monitoring wells located along the shoreline of the Outer Harbor do not indicate the presence of these chemicals at elevated levels. In addition, none of the surface water or sediment samples collected from the Outer Harbor indicate the presence of these chemicals at elevated levels.

Similarly, although elevated levels of cyanide were detected in the groundwater samples from GW-17 and GW-8A, it is also not possible to determine the fate of the cyanide in the subsurface. Differences in the results obtained from these wells between the 1989, 1994 and 1995 sampling events make it difficult to evaluate the real concentration of cyanide in the groundwater on a continuous basis. Since the actual "source" of this contamination can not be attributed to a particular fill unit on the site, an accurate evaluation of the loading to the Outer Harbor cannot be made.

Therefore, based upon the results of the groundwater, surface water and surface water sediment analysis, it does not appear as though groundwater discharge to the Outer Harbor has significantly impacted the quality of the surface water or sediment of the Outer Harbor. There are several other sources that may be impacting the surface water and sediment quality at and adjacent to the site, including storm water runoff discharges, overland flow discharges, industrial discharges and other contaminated sites along the lake and river shoreline. A more detailed discussion of these impacts is provided in Section 5.0.

4.2.7 Air

Ten ambient air samples were collected and analyzed during construction of soil borings in the vicinity of the Radio Tower during the Phase I RI. Seven of the samples were analyzed for VOCs and nitrobenzene in order to address concern regarding exposure to nitrobenzene while conducting the subsurface investigation in this area. Due to an error in the laboratory, three of the samples were not analyzed for nitrobenzene. The results of the analysis are presented in Table 4-5. Although several volatile organic compounds were detected, none of the compounds detected exceeded the Occupational and Safety and Health Administration (OSHA) limits for air contaminants, time weighted averages (TWA) as per 29 CFR 1910.1000.

During drilling at SB-24 (GW-12) on September 7, 1994, greater than 1,000 ppm of total organic vapors were detected with the FID from a soil/splitspoon sample collected at a depth of 20 feet. This depth corresponds to the saturated zone (groundwater was encountered at a depth of approximately six feet). The corresponding EXOTOX reading was 42% LEL with the oxygen level in the normal range. Drilling was temporarily stopped and potable water pumped in the augers to reduce the vapors. No VOC sample was collected from this interval since the PID reading was less than 10 ppm indicating that the elevated OVA reading may have been attributable to methane gas.

Although the majority of total organic vapor readings obtained did not exceed background, several elevated readings were measured during construction of the soil borings in the fill material. Elevated PID and FID total organic vapor readings above 10 ppm were detected at a total of 48 locations during the Phase I RI and two locations during the Phase II RI. Information on the levels detected are provided in the boring logs presented in Appendix C.

During the collection of surface soil samples, 10 elevated total organic vapor readings were measured ranging from 10.4 ppm at SS-54C and SS-77C, to 159 ppm at SS-73B. Elevated total

TABLE 4-5
BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
AIR SAMPLING RESULTS
VOLATILE ORGANICS

SAMPLE IDENTIFICATION	A - 1	A - 2	A - 3	A - 4	A - 5	CONTRACT REQUIRED DETECTION LIMIT	OSHA TWA
DATE OF COLLECTION	09/19/94	09/19/94	09/19/94	09/20/94	09/20/94		
DILUTION FACTOR	1	1	1	1	1		
VOLATILE ORGANICS	(ug/m3)	(ug/m3)	(ug/m3)	(ug/m3)	(ug/m3)	(ug/m3)	(ug/m3)
Chloromethane	2.2	3.3	0.5 J	1.8 B	0.7 JB	10	105,000
Bromomethane	U	U	U	U	U	10	20,000
Vinyl Chloride	U	U	U	U	U	10	2,600
Chloroethane	U	0.4 J	U	U	U	10	---
Methylene Chloride	U	0.3 J	0.3 J	1.0 B	0.4 JB	10	175,000
Acetone	24 B	36 B	4.5 B	13 B	8.3 B	10	18,000,000
Trichlorofluoromethane	0.3 J	0.3 J	U	1.9	0.6	10	---
Carbon Disulfide	3.3	7.0	U	0.5 B	0.3 JB	10	12,000
1,1-Dichloroethene	0.8	1.2	U	0.2 J	U	10	4,000
1,1-Dichloroethane	U	U	U	U	U	10	400,000
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	10	790,000
trans-1,2-Dichloroethene	U	U	U	U	U	10	790,000
Chloroform	0.2 J	U	U	0.3 J	U	10	9,780
1,2-Dichloroethane	U	U	U	U	U	10	---
2-Butanone	3.8	5.4	1.3 U	3.5	2.5	10	590,000
1,1,1-Trichloroethane	0.6	U	U	1.1	0.6	10	1,900,000
Carbon Tetrachloride	0.4 J	0.2 J	U	1.0	0.5	10	12,600
Vinyl Acetate	U	U	U	U	U	10	30,000
Bromodichloromethane	U	U	U	U	U	10	---
1,2-Dichloropropane	U	U	U	U	U	10	350,000
trans-1,3-Dichloropropene	U	U	U	U	U	10	5,000
cis-1,3-Dichloropropene	U	U	U	U	U	10	5,000
Trichloroethene	0.1 J	U	U	U	U	10	270,000
Dibromochloromethane	U	U	U	U	U	10	---
1,1,2-Trichloroethane	U	U	U	U	U	10	45,000
Benzene	1.8	0.6	U	2.5	1.3	10	3,250
2-Chloroethylvinylether	U	U	U	NA	NA	10	---
Bromoform	U	U	U	U	U	10	5,000
4-Methyl-2-Pentanone	U	U	U	U	U	10	---
2-Hexanone	U	U	U	U	U	10	20,000
Tetrachloroethene	0.2 J	U	U	0.4 J	0.1 J	10	170,000
1,1,2,2-Tetrachloroethane	U	U	U	U	U	10	7,000
Toluene	3.9	0.8	0.1 J	25	22	10	375,000
Chlorobenzene	U	U	U	U	0.3 J	10	350,000
Ethylbenzene	0.8	0.2 J	U	1.3	0.5	10	435,000
Styrene	0.2 J	0.1 J	U	0.2 J	2.0	10	215,000
Total Xylenes	4.2	0.9	U	7.4	2.7	10	435,000
Nitrobenzene	NA	NA	NA	U	2.4 J	10	5,000
TOTAL VOCs	46.8	56.7	6.7	61.1	42.8		

QUALIFIERS
U: Compound analyzed for but not detected
B: Compound found in the blank as well as the sample
J: Estimated value
NA: Not analyzed

NOTES
---: Standard not available

TABLE 4-5 (continued)
BUFFALO OUTER HARBOR SITE
PHASE I/PHASE II REMEDIAL INVESTIGATION
AIR SAMPLING RESULTS
VOLATILE ORGANICS

SAMPLE IDENTIFICATION	01	02	03	04	05		
SAMPLE LOCATION	SB-65	SB-65(5' DOWNWIND)	SB-65 (3" FROM CUTTINGS)	SB-66	BLANK		
DATE OF COLLECTION	8/30/94	8/30/94	8/30/94	8/30/94	8/30/94		
VOLUME COLLECTED	15.2 L	18.6 L	18.6 L	25.8 L	NA		
DILUTION FACTOR	1	1	1	1	1		
VOLATILE ORGANICS	(ug/m3)	(ug/m3)	(ug/m3)	(ug/m3)	(ng)	CONTRACT REQUIRED DETECTION LIMIT (ng)	OSHA TWA (ug/m3)
Chloroform	4.4	U	0.97	1.9	U	10	9,780
1,2-Dichloroethane	U	U	U	U	U	10	---
1,1,1-Trichloroethane	U	U	4.5	U	42	10	1,900,000
Carbon Tetrachloride	0.7	0.75	0.81	0.54	U	10	12,600
1,2-Dichloropropane	U	U	U	U	U	10	350,000
1,3-Dichloropropane	U	U	U	U	U	10	---
Trichloroethylene	1.7	U	6.2	U	U	10	270,000
Benzene	31	4.6	7.1	U	74	10	3,250
Bromoform	U	U	U	U	U	10	5,000
Ethylene Dibromide	U	U	U	U	U	40	---
Tetrachloroethylene	1.1	U	0.54	U	U	10	170,000
n-Heptane	U	U	U	U	U	10	1,600,000
1-Heptene	U	U	U	U	U	50	---
Toluene	113	18.5	62	60	200	10	375,000
Chlorobenzene	0.9	U	U	0.73	U	10	350,000
Ethylbenzene	22	3.2	10.8	6.2	21	10	435,000
Bromobenzene	U	U	U	U	U	50	---
Xylenes	101	11.8	33	19	48	10	435,000
Cumene	U	U	U	U	U	10	245,000
Nitrobenzene	350	11.3	16.2	5	U	50	5,000
TOTAL VOCs	625.8	50.15	142.12	93.37	385		

QUALIFIERS
U: Compound analyzed for but not detected
NA: Not Applicable
---: Standard not available

NOTE: To convert the CRDL from ng to ug/m3 divide by the volume of air collected for each sample organic vapor readings from the surface soil locations and corresponding analyses performed are presented in Section 2.4. Although the PID readings indicated elevated levels of organic vapor, the analytical results showed low (<1ppm) or non detect concentrations.

4.3 Data Validation/Usability

Phase I Investigation

Many of the samples collected during the Phase I RI field investigation at the Buffalo Outer Harbor Site were analyzed for the NYSDEC 12/91 Analytical Services Protocol (ASP) Target Compound List (TCL) +30 parameters. A majority of the subsurface soil samples and surface soil samples did not require analysis of the volatile organic portion of the TCL +30 list, because field screening did not indicate total volatile organic vapors greater than 10 ppm as specified in the project Work Plan.

Samples were analyzed in accordance with NYSDEC 12/91 ASP Superfund requirements. All data packages were validated in accordance with NYSDEC 12/91 ASP and USEPA 3/90 SOW requirements at 100% by Enviroscience, Inc. a subcontractor to Dvirka and Bartilucci Consulting Engineers. Table 4-6 presented at the end of this section, summarizes the findings of the data validation and the qualifiers that were applied to each sample.

In general, all analyses were contractually compliant with the ASP. As per NYSDEC, field blanks were not required to be collected during this field investigation, because dedicated, disposable equipment, for the most part, was used to collect the samples. Major issues that were found during the validation process are discussed below by analytical fraction.

Volatile Organic Compounds

Some samples required reanalysis due to surrogate recoveries being outside Quality Control (QC) limits and/or compound concentrations exceeding the calibration range. The results which are considered the "best" set, that is most compliant, should be used for environmental assessment and are summarized in Table 4-6.

In sample GW-18A, three unknown dichlorobenzenes were identified as Tentatively Identified Compounds (TICs) for the VOC analysis, as a result the TICs were rejected since they are target compounds and were detected on the semivolatile organic compound list.

Semivolatile Organics Compounds

Several samples required reanalysis and/or re-extraction due to surrogates being outside QC limits and/or due to matrix interferences. Many of the re-extractions were performed outside of holding time and the data was not available at the time of validation. When the reanalysis/re-extraction data was received, the results were compared to those in the original/initial analysis. Since results were comparable, the results from the initial analysis were considered the "best" set to use for environmental assessment due to holding time exceedances for the reanalysis. The "best" set of data for each sample which should be used for assessment is summarized in Table 4-6.

Sample SB-71Z was initially run under a non-compliant continuing calibration. It was rerun 17 days outside of the 40-day holding time and, since some analytes dissipated, the initial results should be utilized for environmental assessment.

The original extracts for SB-23Z, SB-40Z, SS-74Z, SS-75Z, SS-76Z, SB-24Z, SS-86Z, SS-85Z, SS-75ZDL, SS-74DL, SB-24L and SB-45Z were lost during the gel permeation column (GPC) cleanup procedure and were re-extracted outside of the 7-day holding time. All results have been qualified as estimated, but deemed usable for environmental assessment.

Sample SB-45H was reanalyzed at a secondary dilution, SB45HDL, but the diluted run was outside of the 12-hour tune criteria, therefore the undiluted results should be used for environmental assessment.

Pesticides/PCBs

Due to the nature of the soil matrix and presence of PCBs, many of the pesticide results have been qualified as non-detected due to the aroclor (PCB) pattern. That is, the peaks for the PCB pattern fell within the retention time window for some pesticide compounds. The samples which are affected have note #45 listed in the summary table. Also, the data tables have been qualified using a "Y" for the compounds affected.

Based upon validation criteria, all compounds which had a difference between the two column concentrations of greater than 90% have been qualified as rejected by the validator. These results were qualified with an "R" on the data tables. The validator (Enviroscience) stated that sample SB-41G seems to have a pattern for Aroclor-1248, but it was not reported by the laboratory. As a result, all analytical data were qualified as estimated. SB-47Z had matrix spike compound contamination and was re-extracted.

SS-59Z and SS-51Z were reanalyzed at secondary dilutions due to the high levels of alpha and gamma chlordane present. Results from the diluted runs, suffix "DL," should be utilized for environmental assessment.

Sample SD-10 was run on two separate instruments instead of running the sample on one instrument with dual columns, however, the data was not affected.

Samples SS-61Z and SS-62Z were extracted outside of holding time, since the first extract was lost during cleanup. All results have been qualified as estimated.

Metals

All metals analysis was performed in accordance with 12/91 NYSDEC ASP requirements. Data has been qualified based on QC limits being exceeded, however, matrix interference was proven since post-digest QC was in accordance with requirements.

The copper results for samples contained in sample delivery group (SDG) Buff 10 (see Table 4-6) were rejected due to a high spike recovery, but the post-digest spike recovery was within limits hence demonstrating matrix interference. As a result, the data is contractually compliant.

Copper and chromium results for samples in group SDG Buff 3 were rejected due to high spike recoveries. Matrix interference was proven by the post-digest spike. As a result, data estimated was possibly biased high.

Cyanide

Based on validation criteria, most soil cyanide results have been rejected due to a 0% spike recovery. The laboratory performed a post-digest spike on the samples and obtained recoveries within QC limits, hence demonstrating matrix interference. As a result, no further action was required by the laboratory. From the user's standpoint, the cyanide results for soil are qualified as estimated, possibly biased low with possible false negatives being reported. These results should be used with caution. The samples affected are qualified with a #2 on Table 4-6 under the metals column.

Toxicity Characteristic Leaching Procedure (TCLP)

The TCLP extractions were performed outside of holding times, since the request to do this analysis was made after the samples were collected and the holding times were already exceeded. Data is considered valid and useable for environmental assessment.

Total Organic Carbon (TOC)

Five sediment samples, SD-15, SD-10, SD-11, SD-9 and SD-16, were analyzed for total organic carbon outside of the 26-day holding time. Results have been qualified as estimated.

No other problems were found with the sample results. All data is deemed usable with the qualifiers as noted in Table 4-6. Copies of the complete validation reports prepared by Enviroscience are available upon request.

<u>Phase II Remedial Investigation</u>

Most of the samples collected during the Phase II RI field investigation at the Buffalo Outer Harbor Site were analyzed for select fractions of the NYSDEC 12/91 ASP TCL +30 parameters.

Samples were analyzed in accordance with NYSDEC 12/91 ASP Superfund requirements. All data packages were validated in accordance with NYSDEC 12/91 ASP and USEPA 3/90 SOW requirements at 100% by Enviroscience, Inc., a subcontractor to Dvirka and Bartilucci Consulting Engineers. Table 4-7, presented at the end of this section, summarizes the findings of the validation process and the qualifiers that were applied to each sample.

In general, all analyses were contractually compliant with the ASP. As per NYSDEC, field blanks were not required to be collected during this field investigation because disposable sampling equipment was used to collect samples. Issues that were found during the validation process are discussed below by analytical fraction.

<u>Volatile Organic Compounds</u>

In both the soil and groundwater, if methylene chloride was detected in a sample, it was qualified as non-detect since it was also found in the associated method blank.

<u>Semivolatile Organic Compounds</u>

Many soil samples required reanalysis at a secondary dilution due to compound concentrations exceeding the instrument calibration range in the initial run. The results considered the "best" set, that which is most compliant, is summarized in Table 4-7. In most cases, the data from the diluted run should be used for environmental assessment.

Several samples required reanalysis and/or reextractions due to surrogate recoveries and/or internal standard area counts being outside QC limits. The "best" set of data, that which is most compliant, is summarized in Table 4-7 and should be used for environmental assessment.

PCBs

PCBs were qualified as estimated due to the percent difference in concentrations between the two columns being greater than 25%. The data is possibly biased low, since the lower concentration was reported, as required in the ASP.

Metals

Four soil samples, SB77, SB78, SB79 and SB80, were analyzed for select total metals, as well as TCLP Metals.

The cyanide results for the soil boring (prefix SB) samples listed in Sample Delivery Group (SDG) Buff1 have been rejected due to 0% spike recovery. However, a post digest spike was analyzed and recoveries were within QC limits, hence indicating matrix interference.

Aluminum and iron results have been rejected for all groundwater samples in group SDG BHGW1 due to spike recoveries being below 30%.

Two samples, BHGW3A and BHGW9, were analyzed for both total and dissolved metals. Copper, lead and manganese were rejected in sample BHGW9 and BHGW9 DISS since the dissolved results were five times greater than the total results.

In the surface soil samples SS131Z through SS140Z, the chromium results have been rejected since the spike recovery was less than 10%.

Selenium results have been rejected in samples BHGW21, BHGW3A, BHGW3A DISS, BHGW9A and BHGW9A DISS due to a 0% spike recovery.

Table 4-6

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: BUFF 1

SB25Z	Subsurface Soil	NA	OK	OK[45]	OK [1,2]
SB25J	Subsurface Soil	NA	OK	OK[45]	OK [1,2]
SB27Z	Subsurface Soil	NA	OK	OK[30]	OK [1,2]
SB27E	Subsurface Soil	OK [3,4]	NA	NA	NA
SB27F	Subsurface Soil	NA	OK	OK[46,47,32,38]	OK [1,2]
SB28Z	Subsurface Soil	NA	OK	OK[45]	OK [1,2]
SB28H	Subsurface Soil	NA	OK	OK[48]	OK [1,2]
SB35Z	Subsurface Soil	NA	OK	OK[31]	OK [1,2]
SB35E	Subsurface Soil	NA	OK	OK[49]	OK [1,2]
SB30Z	Subsurface Soil	NA	OK	OK	OK [1,2]
SB30J	Subsurface Soil	NA	OK	OK[28,31,32]	OK [1,2]
SB33Z	Subsurface Soil	NA	OK	OK[45]	OK [1,2]
SB33H	Subsurface Soil	NA	OK	OK	OK [1,2]
SB36Z	Subsurface Soil	NA	OK	OK	OK [1,2]
SB36G	Subsurface Soil	NA	OK	OK	OK [1,2]
SB52Z	Subsurface Soil	NA	OK	OK	OK [1,2]
SB52F	Subsurface Soil	NA	OK	OK	OK [1,2]
SB52I	Subsurface Soil	OK	NA	NA	NA
SB54Z	Subsurface Soil	NA	OK	OK[49]	OK [1,2]
SS6Z	Surface Soil	NA	OK	OK[27]	OK [1,2]
SS17Z	Surface Soil	NA	OK	OK[31,43,44]	OK [1,2]

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: BUFF 2

Sample					
SB54I	Subsurface Soil	NA	OK	OK	OK[6, 2]
SB53Z	Subsurface Soil	NA	OK	OK	OK[6, 2]
SB53H	Subsurface Soil	NA	OK	OK	OK[6, 2]
SB55Z	Subsurface Soil	NA	OK	OK	OK[6, 2]
SB55K	Subsurface Soil	NA	OK	OK	OK[6, 7, 2]
SB56Z	Subsurface Soil	NA	OK	OK	OK[6, 2]
SB56J	Subsurface Soil	NA	OK[9]	OK	OK[6, 2]
SB56M	Subsurface Soil	OK[18, 8]	NA	NA	NA
SS83Z	Surface Soil	NA	OK	OK	OK[6, 2]
SS97Z	Surface Soil	NA	OK	OK[45]	OK[6, 2]
SS97C	Surface Soil	OK[18]	NA	NA	NA
SS100Z	Surface Soil	NA	OK	OK[45]	OK[6, 2]
SS101Z	Surface Soil	NA	OK	OK[45]	OK[6, 2]
SS102Z	Surface Soil	NA	OK[9]	OK[45]	OK[6, 2]
SS103Z	Surface Soil	NA	OK[9]	OK[45]	OK[6, 2]
SS106Z	Surface Soil	NA	OK	OK[45]	OK[6, 2]
SS107Z	Surface Soil	NA	OK	OK[45]	OK[6, 2]
SS108Z	Surface Soil	NA	OK	OK[45]	OK[6, 2]
SS109Z	Surface Soil	NA	OK	OK[45]	OK[6, 2]
SS113Z	Surface Soil	NA	OK	OK	OK[6, 2]
SS114Z	Surface Soil	NA	OK	OK	OK[6, 2]
SS115Z	Surface Soil	NA	OK	OK[45]	OK[6, 2]

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: BUFF 3

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SB26Z	Subsurface Soil	NA	OK[9]	OK	OK [10,11,12,13,14,15,2]
SB26H	Subsurface Soil	NA	OK	OK	OK [10,11,12,13,14,2]
SB31Z	Subsurface Soil	NA	OK	OK	OK [10,11,12,13,14,,2]
SB31G	Subsurface Soil	OK [3,17]	NA	NA	NA
SB31K	Subsurface Soil	NA	OK	OK	OK [10,11,12,13,14,15,2]
SB38Z	Subsurface Soil	NA	OK[34]	OK	OK [10,11,12,13,14,15,2]
SB38I	Subsurface Soil	NA	OK [34]	OK[30]	OK [10,11,12,13,14,15,16,2]
SB57Z	Subsurface Soil	NA	OK[34]	OK[30]	OK [10,11,12,13,14,2]
SB57G	Subsurface Soil	NA	OK	OK	OK [10,11,12,13,14,2]
SB46Z	Subsurface Soil	NA	OK	OK	OK [10,11,12,13,14,2]
SB46H	Subsurface Soil	NA	OK	OK	OK [10,11,12,13,14,2]
SB58Z	Subsurface Soil	NA	OK[35]	OK[32]	OK [10,11,12,13,14,2]
SB58H	Subsurface Soil	NA	OK	OK[31,27]	OK [10,11,12,13,14,2]
SS95Z	Surface Soil	NA	OK	OK[32]	OK [10,11,12,13,14,2]
SS104Z	Surface Soil	NA	OK	OK	OK [10,11,12,13,14,2]
SS105Z	Surface Soil	NA	OK[34]	OK[26,33]	OK [10,11,12,13,14,15,2]
SS116Z	Surface Soil	NA	OK[34]	OK[30]	OK [10,11,12,13,14,2]
SS117Z	Surface Soil	NA	OK[34]	OK[30]	OK [10,11,12,13,14,2]
SS117D	Surface Soil	OK [3]	NA	NA	NA
SS118Z	Surface Soil	NA	OK	OK	OK [10,11,12,13,14,2]
SS119Z	Surface Soil	NA	OK[35]	OK[30,26,32,31]	OK [10,11,12,13,14,2]

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: BUFF 4

[redacted]					
SB37Z	Subsurface Soil	NA	OK	OK	OK[2,36,37]
SB37H	Subsurface Soil	NA	OK[35]	OK	OK[2,36,37]
SB61Z	Subsurface Soil	NA	OK	OK[26,27]	OK[2,36,37]
SB61I	Subsurface Soil	NA	OK	OK[28]	OK[2,36]
SB61H	Subsurface Soil	OK[3]	NA	NA	NA
SB62Z	Subsurface Soil	NA	OK	OK	OK[2,36,37]
SB62L	Subsurface Soil	OK[3,20]	OK	OK	OK[2, 26,37]
SB63Z	Subsurface Soil	NA	OK	OK	OK[2,36,37]
SB63M	Subsurface Soil	NA	OK	OK	OK[2,36]
SB64Z	Subsurface Soil	NA	OK	OK	OK[2,36,37]
SB64I	Subsurface Soil	NA	OK	OK[28]	OK[2,36]
SB64G	Subsurface Soil	OK[17, 3]	NA	NA	NA
SB66Z	Subsurface Soil	NA	OK	OK[26]	OK[2,36,37]
SB66G	Surface Soil	NA	OK[9]	OK[29,28]	OK[2,36,37]
SB66H	Surface Soil	OK[3,17,9]	NA	NA	NA
SS60Z	Surface Soil	NA	OK	OK	OK[2,36,37]
SS68Z	Surface Soil	NA	OK	OK	OK[2,36]
SS69Z	Surface Soil	NA	OK	OK[26]	OK[2,36,37]
SS70Z	Surface Soil	NA	OK	OK	OK[2,36,37]
SS70A	Surface Soil	OK	NA	NA	NA
SS71Z	Surface Soil	NA	OK	OK[26]	OK[2,36]
SS72Z	Surface Soil	NA	OK[35]	OK[27]	OK[2,36,37]
SS88Z	Surface Soil	NA	OK	OK	OK[2,36]
SS98Z	Surface Soil	NA	OK	OK[26]	OK[2,36]

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: BUFF 6

SB59Z	Subsurface Soil	NA	OK	OK	OK[2,21,22,23]
SB59G	Subsurface Soil	NA	OK	OK[41]	OK[2,21,22,23]
SB59I	Subsurface Soil	OK [18]	NA	NA	NA
SB60Z	Subsurface Soil	NA	OK[24]	OK[39]	OK[2,21,22,23]
SB60K	Subsurface Soil	NA	OK[24]	OK	OK[2,21,22,23]
SB65Z	Subsurface Soil	NA	OK[24]	OK[26]	OK[2,21,22,23]
SB65K	Subsurface Soil	NA	OK[24]	OK	OK[2,21,22,23]
SB65J	Subsurface Soil	OK[18]	NA	NA	NA
SS55Z	Surface Soil	NA	OK[24]	OK	OK[2,21,22,23]
SS56Z	Surface Soil	NA	OK	OK	OK[2,21,22,23]
SS61Z	Surface Soil	NA	OK	OK[26,27,42]	OK[2,21,22,23]
SS62Z	Surface Soil	NA	OK[24]	OK[32]	OK[2,21,22,23]
SS63Z	Surface Soil	NA	OK	OK[32,26]	OK[2,21,22,23]
SS64Z	Surface Soil	NA	OK	OK[26]	OK[2,21,23]
SS65Z	Surface Soil	NA	OK[24]	OK	OK[2,21,22,23]
SS66Z	Surface Soil	NA	OK[24]	OK[26]	OK[2,21,22,23]
SS67Z	Surface Soil	NA	OK[24]	OK	OK[2,21,23]
SS80Z	Surface Soil	NA	OK[24]	OK	OK[2,21,22,23]
SS81Z	Surface Soil	NA	OK[24,25]	OK	OK[2,21,22,23]
SS82Z	Surface Soil	NA	OK	OK[38,39]	OK[2,21,22,23]
SS84Z	Surface Soil	NA	OK[24]	OK[40]	OK[2,21,22,23]
SS87Z	Surface Soil	NA	OK[24]	OK[32,26,42]	OK[2,21,22,23]

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: BUFF 7

SB39Z	Subsurface Soil	NA	OK[24]	OK[49,67]	OK[2,55]
SB39J	Subsurface Soil	NA	OK	OK	OK[2,55]
SB67Z	Subsurface Soil	NA	OK[34]	OK[49]	OK[2,55]
SB67K	Subsurface Soil	NA	OK	OK	OK[2,55]
SB67J	Subsurface Soil	OK[17,3]	NA	NA	NA
SB24Z	Subsurface Soil	NA	OK[56]	OK[65]	OK[2,55]
SB24L	Subsurface Soil	NA	OK	OK[49]	OK[2,55]
SS99Z	Surface Soil	NA	OK[34]	OK[73,65,67]	OK[2,55]
SS79Z	Surface Soil	NA	OK	OK[46,65]	OK[2,55]
SS78Z	Surface Soil	NA	OK[34]	OK	OK[2,55]
SS110Z	Surface Soil	NA	OK[34,70]	OK[60,65,45]	OK[2,55]
SS111Z	Surface Soil	NA	OK[34,70]	OK[65,72]	OK[2,55]
SS77Z	Surface Soil	NA	OK[34,70]	OK[39,45,65]	OK[2,55]
SS77D	Surface Soil	OK[3]	NA	NA	NA
SS54Z	Surface Soil	NA	OK[34,70]	OK[49]	OK[2,55]
SS54C	Surface Soil	OK[3]	NA	NA	NA
SS46Z	Surface Soil	NA	OK[34,70]	OK[65]	OK[2,55]
SS53Z	Surface Soil	NA	OK[34,70]	OK[65]	OK[2,55]
SS74Z	Surface Soil	NA	OK[56,9]	OK[43,65,33,45]	OK[2,55]
SS75Z	Surface Soil	NA	OK[56,9]	OK[41,65]	OK[2,55]
SS76Z	Surface Soil	NA	OK[56]	OK[38]	OK[2,55]
SS85Z	Surface Soil	NA	OK[56]	OK[49,73]	OK[2,55]
SS86Z	Surface Soil	NA	OK[56]	OK[49,33]	OK[2,55]

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: BUFF 8

SS85B	Surface Soil	OK [18]	NA	NA	NA
SS73B	Surface Soil	OK [19, 3]	NA	NA	NA
SS43A	Surface Soil	OK [18]	NA	NA	NA

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: BUFF 9

SB23Z	Subsurface Soil	NA	OK[56]	OK[56,32,60]	OK[2,58,59]
SB23E	Subsurface Soil	NA	OK[5,35]	OK[56,28]	OK[2,58,59]
SB40Z	Subsurface Soil	NA	OK[56]	OK[56,27]	OK[2,58,59]
SB40J	Subsurface Soil	NA	OK	OK[40,27]	OK[2,58,59]
SB41Z	Subsurface Soil	NA	OK[20]	OK	OK[2,58,59]
SB41G	Subsurface Soil	NA	OK	OK[61]	OK[2,57,59]
SB45Z	Subsurface Soil	NA	OK[56]	OK[56,31,27,32]	OK[2,58,59]
SB45H	Subsurface Soil	NA	OK[20]	OK[44]	OK[2,58,59]
SB47Z	Subsurface Soil	NA	OK	OK[40,46]	OK[2,57,59]
SB47J	Subsurface Soil	NA	OK	OK	OK[2,57,59]
SB51Z	Subsurface Soil	NA	OK[20]	OK[56,39,47,60,64,65,27]	OK[2,58,59]
SB51F	Subsurface Soil	NA	OK[9,5,35]	OK[41,44,63]	OK[2,58,59]
SS44Z	Surface Soil	NA	OK	OK[56,49]	OK[2,58,59]
SS51Z	Surface Soil	NA	OK	OK[56,9]	OK[2,59]
SS57Z	Surface Soil	NA	OK	OK[56,32]	OK[2,58,59]
SS59Z	Surface Soil	NA	OK	OK[56,9]	OK[2,58,59]
SS73Z	Surface Soil	NA	OK	OK[56,31,28]	OK[2,58,59]
SS90Z	Surface Soil	NA	OK	OK[56,33,65]	OK[2,58,59]
SS91Z	Surface Soil	NA	OK	OK[56,66,33,65,67]	OK[2,58,59]
SS92Z	Surface Soil	NA	OK	OK[56,66,33,65]	OK[2,58,59]

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: BUFF 10

SB29Z	Subsurface Soil	NA	OK	OK	OK[2,54,22]
SB32Z	Subsurface Soil	NA	OK	OK	OK[2,54,22]
SB32I	Subsurface Soil	NA	OK	OK[39]	OK[2,54,22]
SB34Z	Subsurface Soil	NA	OK	OK[65]	OK[2,54,22]
SB42Z	Subsurface Soil	NA	OK[5,35]	OK[45,68]	OK[2,54,22]
SB42L	Subsurface Soil	NA	OK	OK[67,61]	OK[2,54,22]
SB48Z	Subsurface Soil	NA	OK	OK[68,69,60,38]	OK[2,54,22]
SB48F	Subsurface Soil	NA	OK	OK[65,67]	OK[2,54]
SS35Z	Surface Soil	NA	OK	OK[45,65]	OK[2,54,22]
SS36Z	Surface Soil	NA	OK	OK[65,67]	OK[2,54,22]
SS37Z	Surface Soil	NA	OK	OK[65,67]	OK[2,54]
SS43Z	Surface Soil	NA	OK	OK[65]	OK[2,54,22]
SS45Z	Surface Soil	NA	OK	OK[67]	OK[2,54]
SS47Z	Surface Soil	NA	OK	OK[65,67]	OK[2,54,22]
SS49Z	Surface Soil	NA	OK	OK[65,67]	OK[2,54,22]
SS50Z	Surface Soil	NA	OK	OK	OK[2,54]
SS89Z	Surface Soil	NA	OK	OK[67,31]	OK[2,54,22]
SS93Z	Surface Soil	NA	OK	OK[71,44,65]	OK[2,54,22]
SS94Z	Surface Soil	NA	OK	OK[65,44]	OK[2,54,22]
SS96Z	Surface Soil	NA	OK	OK[65,45]	OK[2,54,22]

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: BUFF 11

[redacted]					
SB34E	Subsurface Soil	NA	OK	OK	OK[92,94]
SB43Z	Subsurface Soil	NA	OK[95]	OK (lost during extraction)	OK[92,94]
SB43L	Subsurface Soil	NA	OK	OK	OK[92,93,94]
SB44Z	Subsurface Soil	NA	OK[95,96]	OK[51]	OK[92,94]
SB44K	Subsurface Soil	NA	OK[95]	OK[69,31,27,65,26]	OK[92,93,94]
SB50Z	Subsurface Soil	NA	OK	OK[65]	OK[92,93,94]
SB50I	Subsurface Soil	NA	OK[95]	OK	OK[92,93,94]
SS24Z	Surface Soil	NA	OK[95,25,90,8]	OK[78,28,33,65]	OK[92,93,94]
SS25Z	Surface Soil	NA	OK[95,25,90]	OK[56,65,26]	OK[92,94]
SS26Z	Surface Soil	NA	OK[96]	OK[65,71]	OK[92,94]
SS27Z	Surface Soil	NA	OK[96]	OK[65,27]	OK[92,93,94]
SS30Z	Surface Soil	NA	OK[95,96]	OK	OK[92,93,94]
SS31Z	Surface Soil	NA	OK[95]	OK[71,33,38]	OK[92,93,94]
SS32Z	Surface Soil	NA	OK[8]	OK	OK[92,93,94]
SS34Z	Surface Soil	NA	OK[96]	OK[49]	OK[92,93,94]
SS38Z	Surface Soil	NA	OK	OK[71,26]	OK[92,93,94]
SS39Z	Surface Soil	NA	OK	OK[31]	OK[92,94]
SS40Z	Surface Soil	NA	OK[8]	OK	OK[92,93,94]
SS41Z	Surface Soil	NA	OK[95,96]	OK[32]	OK[92,93,94]
SS42Z	Surface Soil	NA	OK[8]	OK[71]	OK[92,94]

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: BUFF 12

SB49Z	Subsurface Soil	NA	OK	OK[71,40,60,45]	OK[84,85]
SB49J	Subsurface Soil	NA	OK[5]	OK	OK[84,85]
PZ9F	Subsurface Soil	NA	OK	OK	OK[84,85]
SS2Z	Surface Soil	NA	OK	OK[65,45]	OK[84,85]
SS7Z	Surface Soil	NA	OK	OK[31,60,39,27,38,32,45]	OK[84,85]
SS8Z	Surface Soil	NA	OK	OK[43,40,65,38,45,80]	OK[84,85]
SS11Z	Surface Soil	NA	OK	OK[45,26,33]	OK[84,85]
SS12Z	Surface Soil	NA	OK	OK[33,45,65]	OK[84,85]
SS13Z	Surface Soil	NA	OK	OK[51,79]	OK[84,85]
SS14Z	Surface Soil	NA	OK	OK[51,79]	OK[84,85]
SS15Z	Surface Soil	NA	OK	OK[31,27,45,26,32]	OK[84,85]
SS16Z	Surface Soil	NA	OK	OK[33,26]	OK[84,85]
SS18Z	Surface Soil	NA	OK	OK[79,51,38]	OK[84,85]
SS19Z	Surface Soil	NA	OK	OK[31,45,65]	OK[84,85]
SS20Z	Surface Soil	NA	OK	OK[45,65,27]	OK[84,85]
SS21Z	Surface Soil	NA	OK	OK[65]	OK[84,85]
SS22Z	Surface Soil	NA	OK	OK[79,31]	OK[84,85]
SS29Z	Surface Soil	NA	OK	OK[79,38,33,51]	OK[84,85]
SS112Z	Surface Soil	NA	OK	OK[30,45,27,26,65]	OK[84,85]

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: BUFF 13

SB68Z	Subsurface Soil	NA	OK	OK[45,60]	OK
SB68F	Subsurface Soil	NA	OK	OK	OK
SB69Z	Subsurface Soil	NA	OK	OK[26,27]	OK
SB69G	Subsurface Soil	NA	OK	OK[32,47]	OK
SB70Z	Subsurface Soil	NA	OK	OK[26]	OK
SB70H	Subsurface Soil	NA	OK[90]	OK	OK
SB71Z	Subsurface Soil	NA	OK[91]	OK	OK
SB71H	Subsurface Soil	NA	OK	OK[32]	OK
SS1Z	Surface Soil	NA	OK	OK[26]	OK
SS120Z	Surface Soil	NA	OK	OK[32]	OK
SS121Z	Surface Soil	NA	OK	OK[32]	OK
SS123Z	Surface Soil	NA	OK	OK[32,27]	OK
SS124Z	Surface Soil	NA	OK	OK[32,27]	OK

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: BUFF 14

SB69I	Subsurface Soil	OK[3,17]	NA	NA	NA
SB72Z	Subsurface Soil	NA	OK	OK[5,35]	OK[2,86,87]
SB72I	Subsurface Soil	NA	OK[9]	OK[5,35]	OK[2,86,87]
SB72J	Subsurface Soil	NA	OK[9]	OK[5,35]	OK[2,86,87]
SB73Z	Subsurface Soil	NA	OK	OK[5,35]	OK[2,86,87]
SB73F	Subsurface Soil	NA	OK[9]	OK[40,73,51,89]	OK[2,86,87]
SB73H	Subsurface Soil	OK[3,17,81]	OK[9]	OK[89,39,32,51]	OK[2,86,87]
SB73G	Subsurface Soil	OK[3,17]	NA	NA	NA
SB74Z	Subsurface Soil	NA	OK	OK[5,35]	OK[2,86,87]
SB74G	Subsurface Soil	NA	OK	OK[60,28,41]	OK[2,86,87]
PZ7F	Subsurface Soil	OK[3,17]	OK[90,5]	OK[45,60,51]	OK[2,86,87]
PZ7J	Subsurface Soil	OK[3,17]	NA	NA	NA
PZ8Z	Subsurface Soil	NA	OK	OK[5,35]	OK[2,86,87]
PZ8H	Subsurface Soil	NA	OK[96,35]	OK[49]	OK[2,86,87]
PZ10F	Subsurface Soil	NA	OK[96]	OK	OK[2,86,87]
SS125	Surface Soil	OK[3]	OK	OK[41,65]	OK[2,86,87]
SS126	Surface Soil	OK[3]	OK	OK	OK[2,86,87]
SS127	Surface Soil	OK[3,17,70]	OK[96]	OK[5,35,45]	OK[2,86,87]
SS128	Surface Soil	OK[3,17]	OK[96]	OK[26,45,27,44]	OK[2,86,87]
SS129	Surface Soil	OK[3,17]	OK	OK[88,28,40,31,60,26,47]	OK[2,86,87]

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: BUFF 15

SB69J	Subsurface Soil	OK	OK	OK	OK
SB73H	Subsurface Soil	OK	OK[35,9]	OK	OK

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: BSSW5

MASW1	Surface Water	OK[3]	OK[24]	OK	OK[53]
BSSW5	Surface Water	OK[50, 3]	OK[24]	OK	OK[52]
BSSW6	Surface Water	OK[3]	OK[24]	OK	OK[52]
OHSW2	Surface Water	OK[3]	OK[24]	OK	OK[52,53]
OHSW3	Surface Water	OK[3]	OK[24]	OK[51]	OK[52]
OHSW4	Surface Water	OK[50, 3]	OK[24]	OK	OK[52]
TB	Trip Blank	OK[50]	NA	NA	NA

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: BSSDIO

MASD1	Sediment	OK[3,50]	OK	OK[77,5,31,60,40,48,44, 27,47,65,45]	OK[82,83]
MASD2	Sediment	OK[3,17]	OK	OK[31,60,39,28,33,47,45]	OK[82,83]
OHSD3	Sediment	OK[3,17]	OK	OK[45,71,60,47]	OK[82,83]
OHSD4	Sediment	OK[3,17]	OK	OK[45,31,40,33,47]	OK[82,83]
OHSD5	Sediment	OK[3]	OK	OK[71,74,60,28,47,33]	OK[82,83]
OHSD6	Sediment	OK[3]	OK	OK[60,39,28,51,45]	OK[82,83]
OHSD7	Sediment	OK[3,17]	OK	OK[60,39,51,27,45]	OK[82,83]
OHSD8	Sediment	OK[3]	OK	OK	OK[82,83]
OHSD12	Sediment	OK[3,17]	OK	OK[60,28,47,33,63,75,45]	OK[82,83]
OHSD13	Sediment	OK[3]	OK	OK[45,40,44,33,32]	OK[82,83]
OHSD14	Sediment	OK[3,17]	OK	OK[45,28,33]	OK[82,83]
OHSD15	Sediment	OK[3,17]	OK	OK[44,40,43,47,27]	OK[83]
OHSD16	Sediment	OK[3]	OK	OK[43]	OK[82,83]
BSSD10	Sediment	OK[3,17]	OK[34]	OK[45,43,51,28,74]	OK[83]
BSSD11	Sediment	OK[3]	OK[34,8,5]	OK[60,40,45,44,47,33,65]	OK[83]
BSSD9	Sediment	OK	OK	OK[31,32,33,45]	OK[82,83]

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: GW 10A

GW1	Groundwater	OK[50]	OK[24]	OK	OK[22]
GW6A	Groundwater	OK[18]	OK	OK	OK
GW6B	Groundwater	OK[18]	OK	OK	OK
GW6C	Groundwater	OK[50]	OK	OK	OK
GW10A	Groundwater	OK[3]	OK	OK	OK
GW10B	Groundwater	OK	OK[24]	OK[27,44]	OK
GW11A	Groundwater	OK	OK	OK	OK
GW15	Groundwater	OK[3]	OK[24]	OK[101,73,47]	OK
GW16	Groundwater	OK[18]	OK[24]	OK[28]	OK
GW18	Groundwater	OK[3]	OK	OK[102]	OK
PZ12	Groundwater	OK[3]	OK[24]	OK	OK
PZ12F	Groundwater	NA	NA	NA	OK[22]
TB 10/17	Groundwater	OK	NA	NA	NA
TB 10/13	Groundwater	OK	NA	NA	NA

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: GW 12

GW2A	Groundwater	OK[3,50]	OK[24]	OK	OK[99,100]
GW2B	Groundwater	OK[3,50]	OK[24]	OK	OK[99,100]
GW2C	Groundwater	OK[3,50]	OK[24]	OK	OK[14,99]
GW3A	Groundwater	OK	OK[24]	OK	OK[99]
GW3B	Groundwater	OK[3]	OK[24]	OK	OK[14,99,100]
GW4A	Groundwater	OK[3]	OK[24]	OK	OK[99]
GW4B	Groundwater	OK[3]	OK[24,34]	OK	OK[99,100]
GW4C	Groundwater	OK[3]	OK[24]	OK[97]	OK[14,99,100]
GW5A	Groundwater	OK[3]	OK[24]	OK	OK[99]
GW5B	Groundwater	OK[3]	OK[24]	OK	OK[99,100]
GW5C	Groundwater	OK[50,3]	OK[24]	OK	OK[14,99,100]
GW8A	Groundwater	OK[3,50]	OK[24]	OK	OK[98,99,100,86]
GW8B	Groundwater	OK[3]	OK[24,34]	OK	OK[98,99,100]
GW8C	Groundwater	OK[3]	OK[24,34]	OK	OK[98,99]
GW9	Groundwater	OK[3,50]	OK[24]	OK	OK[14,99]
GW12	Groundwater	OK[3]	OK[24]	OK[31]	OK[14,99]
GW13	Groundwater	OK[3]	OK[24]	OK[40]	OK[98,99,101,16]
GW14	Groundwater	OK	OK[24]	OK	OK[14,99]
GW17	Groundwater	OK[50]	OK[24]	OK	OK[14,99]
TB10111	Groundwater	OK[3]	OK	OK	OK
TB10113	Groundwater	OK[3]	OK	OK	OK
TB10114	Groundwater	OK[3]	OK	OK	OK

Table 4-6 (continued)

BUFFALO OUTER HARBOR SITE
PHASE I REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

OK - Data is 100% contractually compliant, no qualifiers required.

OK, # - Data is contractually compliant, but qualified (see # below for further explanation).

No, # - Data is not 100% contractually compliant, data is qualified (see # below for explanation of usability).

#	Comment
1.	Silver results have been qualified as estimated possibly biased low due to a spike recovery of 66.1%.
2.	All cyanide results have been rejected due to a 0% spike recovery.
3.	Methylene chloride has been qualified as non-detect due to method blank contamination. The sample concentration was less than five times the concentration found in the method blank.
4.	The sample required reanalysis due to the recovery of the system monitoring compound (SMC), BFB, being above QC limits. Based upon the SMC recoveries the results from the reanalysis, suffix "Re", is considered the best set and should be used for environmental assessment.
5.	Sample required re-extraction/reanalysis due to very low surrogate recoveries.
6.	Copper and cadmium results are qualified as estimated, possibly biased low due to low spiking recoveries, 71.8 and 67.7 respectively.
7.	Selenium is qualified as estimated due to MSA correlation coefficient.
8.	Reanalysis was required due to internal standard area counts being outside of QC limits. The initial results should be used for environmental assessment.

Table 4-6 (continued)

9. Sample was reanalyzed at a secondary dilution due to compound concentrations exceeding the instrument calibration range. The results from the reanalysis, suffix "DL" should be used for environmental assessment.

10. Antimony and silver results have been qualified as estimated due to CRI results outside QC limits. Zinc is qualified as estimated due to the serial dilution.

11. Cadmium results were qualified as estimated due to CRI results.

12. Copper and chromium results have been qualified as "R" rejected since the spike recoveries were above 200%.

13. Barium and manganese results have been qualified as estimated possibly biased high due to spiking recoveries between 126 and 200%.

14. Thallium results have been flagged estimated possibly biased low due to spiking recoveries between 10 and 74%.

15. Selenium results have been qualified as estimated possibly biased high due to a high spike recovery.

16. Arsenic has been qualified as estimated due to the correlation coefficient for MSA being <0.995.

17. Acetone and 2-Butanone have been qualified as non detect, since the sample concentrations were less than five times the concentrations found in the associated method blank.

18. Methylene chloride and acetone have been qualified as non-detect since the sample concentrations were less than five times the concentration found in the associated method blank.

19. Sample required reanalysis (suffix "Re") due to a system monitoring compound (Toluene-d8) recovery being above QC limits and all three internal standard area counts being below QC limits. The reanalysis data, should be utilized for environmental assessment.

20. Sample was reanalyzed at a secondary dilution due to compound concentrations exceeding the instrument calibration range. The results from the initial analysis should be utilized for environmental assessment.

21. Antimony, beryllium and silver results have been qualified as estimated due to the CRI recoveries.

22. Lead result has been qualified as estimated possibly biased high due to high spike recovery.

Table 4-6 (continued)

23. Copper result has been qualified as estimated possibly biased high due to high spike recovery. Selenium result has been qualified as estimated possibly biased low due to a low spike recovery.

24. Di-n-butylphthalate has been qualified as non-detect since it was also detected in the method blank and the sample concentration was less than five times that of the blank.

25. Two surrogate recoveries outside QC limits. All results have been qualified as estimated.

26. Aroclor 1260 has been qualified as estimated due to the % difference between the concentrations from each column being >25%.

27. Concentration of 4-4 DDT has been qualified as estimated due to the % difference between the primary and confirmation column being >25%.

28. Results for Endosulfan II have been qualified as rejected since the % difference between the columns was >90%. Data is usable but flagged estimated.

29. Results for Delta BHC and 4,4'DDD have been rejected due to % difference between columns being >90%. Endrin has been qualified as estimated since % difference was between 25% - 50%.

30. All positive results as well as non-detects have been qualified as estimated due to surrogate recoveries being below QC limits. Since the limits are advisory no action was required to be taken by the laboratory.

31. Results for Dieldrin have been qualified as "R" rejected due to the % difference between the two GC column concentrations being >90%.

32. Endrin aldehyde has been qualified as "R", rejected, due to the % difference between the two GC column concentrations being >90%.

33. The result for 4,4-DDT has been qualified as "R", rejected, due to the % difference between the two GC column concentrations being >90%.

34. Bis (2 ethylhexyl) phthalate has been qualified as non-detect since the sample concentration was less than five times the concentration found in the associated method blank.

35. All non-detects have been qualified as "R" rejected and all positive results were estimated due to low, <10%, recoveries of surrogate compounds.

36. Cadmium has been qualified as estimated due to a % difference of >100% between the duplicate and sample.

Table 4-6 (continued)

37. Barium results have been qualified as estimated due to CRI % recoveries between 121% and 150%.

38. Alpha and/or gamma chlordane has been qualified as "R", rejected, due to the % difference between the two column concentrations being >90%.

39. Endrin has been qualified as estimated since the % difference between the two columns was >25%.

40. Endrin has been qualified as "R", rejected, since the % difference between the two column concentrations was >90%.

41. Endrin Ketone has been qualified as estimated since the % difference between the two column concentrations was >25%.

42. Sample required reanalysis due to matrix interferences. Reanalysis data suffix "RE" should be utilized for environmental assessment.

43. 4,4-DDE has been qualified "R", rejected, since the % difference between the two column concentrations was >90%.

44. Endosulfan II has been qualified as estimated since the % difference between the two column concentrations was >25%.

45. Pesticide results are qualified as estimated due to the Aroclor present in the sample. Presence most likely caused by Aroclor pattern.

46. Heptachlor has been qualified as "R" rejected due to the % difference in concentrations between the two columns being >90%.

47. 4,4-DDD has been qualified as estimated since the % difference between the two column concentrations was >25%.

48. Aldrin and gamma chlordane have been flagged as estimated due to the % difference between the two column concentrations being >25%.

49. Endrin aldehyde has been qualified as estimated due to the % difference between the two column concentrations being >25%.

50. Acetone has been qualified as non-detect since the sample concentration was less than five times the concentration found in the associated method blank.

51. Result for 4-DDD has been qualified as "R" rejected due to the % difference between the two column concentrations being >90%.

Table 4-6 (continued)

52. Mercury, arsenic, chromium and lead have been qualified as estimated possibly biased high due to high % recoveries.

53. Mercury and selenium are qualified as estimated, possibly biased high due to high CRA/CRI recovery.

54. The copper result has been rejected due to a high spike recovery (360.8%).

55. Cadmium, copper, manganese, nickel and silver have been qualified as estimated due to spike recoveries being outside QC limits. Antimony has been qualified as estimated, possibly biased high due to CRI recoveries being >120%. Arsenic and selenium have been qualified as estimated due to the laboratory control sample (LCS) recovery being outside of QC limits. Aluminum and iron have been qualified as estimated due to serial dilution recoveries being above 10% RSD, indicating possible matrix interferences.

56. Sample extracted outside of seven-day holding time. Data qualified as estimated and useable for environmental assessment.

57. Antimony has been qualified as estimated due to the CRI recovery being greater than 120%.

58. Silver and cadmium results have been qualified as estimated due to CRI recoveries being greater than 120%.

59. Arsenic and selenium have been qualified as estimated, possibly biased low due to LCS recoveries being less than 85%. Manganese has been qualified as estimated possibly biased high due to a high spike recovery, >125%.

60. 4,4-DDE has been qualified as estimated, due to % difference between the two column concentrations being greater than 25%.

61. Aroclor-1248 was not reported by the laboratory but the pattern seems to be present.

62. Heptachlor has been qualified as estimated, due to the % difference between the two column concentrations being greater than 25%.

63. Alpha chlordane has been qualified as estimated since the % difference between the two column concentrations were greater than 25%.

64. Endosulfan sulfate has been qualified as estimated due to the % difference between the two column concentrations being greater than 25%.

65. Endrin aldehyde has been qualified as "R", rejected, since the % difference between the two column concentrations is greater than 90%.

Table 4-6 (continued)

66. Endosulfan sulfate has been qualified as "R", rejected, due to the % difference between the two column concentrations being >90%.

67. Aroclor 1260 seems to be present in the sample but not reported by the laboratory.

68. Aroclor 1248 has been qualified as estimated due to % difference between the two column concentrations being >25%.

69. Heptachlor expoxide has been qualified as "R" rejected due to the % difference between the two column concentrations being >90%.

70. Reanalysis was required due to internal standard area counts being outside QC limits. The results from the reanalysis, suffix "Re," should be utilized for environmental assessment.

71. Dieldrin has been qualified as estimated due to the % difference between the two column concentrations being >25%.

72. Methoxychlor has been qualified as estimated due to % difference between the two column concentrations being >25%.

73. Aldrin has been qualified as "R", rejected, due to % difference between the two column concentrations being >90%.

74. Gamma BHC has been qualified as "R", rejected, since the % difference between the two column concentrations were >90%.

75. Gamma chlordane has been qualified as estimated due to a % difference between column concentrations being >25%.

76. Aroclor 1254 and Aroclor 1260 have been qualified as "R", rejected, due to the % difference between the two column concentrations being >90%.

77. Sample required re-extraction, suffix "Re", for low surrogate recoveries. The results for the reextract should be used for environmental assessment.

78. Heptachlor expoxide has been qualified as estimated due to a % difference between the two columns being >25%.

79. Endosulfan II has been qualified as "R", rejected, due to the column concentrations having a % difference greater than 90%.

80. Sample re-analyzed at a secondary dilution due to the presence of Aroclor 1254. Use the result from the diluted run for Aroclor 1254.

Table 4-6 (continued)

81. Ethylbenzene qualified as "R", rejected due to a problem with peak integration and considered an incorrect identification.

82. All results qualified as estimated since the % solids was less than 50%.

83. Lead has been qualified as estimated due to the recovery of the LCS being outside QC limits. Antimony, copper and manganese have been qualified as estimated, possibly biased low due to low spike recoveries.

84. Copper and zinc have been qualified as "R", rejected, due to a spike recovery of <10%. Appears to be due to matrix interference.

85. Antimony, arsenic, chromium, lead, selenium and silver results have been qualified as estimated, possibly biased low due to low spike recoveries.

86. Arsenic, selenium and silver have been qualified as estimated, possibly biased low due to low spike recoveries.

87. Calcium, copper, manganese and zinc have been qualified as estimated due to serial dilution results >10%.

88. Results qualified as estimated, possibly biased high due to high surrogate recoveries.

89. Sample was reanalyzed at a dilution due to the presence of delta-BHC. Use the result from the diluted run, suffix "DL," for delta-BHC.

90. All non-detect acid compounds have been qualified as rejected and all hits were qualified as estimated due to an acid surrogate recovery of <10%.

91. Sample was reanalyzed outside of the 40-day holding time. Results from the initial run should be used for environmental assessment.

92. Cyanide results have been qualified as estimated due to a spike recovery slightly below QC limits.

93. Lead results have been qualified as "R", rejected, due to a spike recovery >200%.

94. Copper results have been qualified as "R", rejected, due to a spike recovery >200%.

95. Naphthalene has been qualified as non-detect since the sample concentration was less than five times the concentration found in the blank.

96. Sample required reanalysis due to internal standard area counts being outside QC limits. The results from the reanalysis, suffix "Re," should be used for environmental assessment.

Table 4-7

BUFFALO OUTER HARBOR SITE
PHASE II REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: PHASE II - BUFF 1

Sample ID	Matrix	VOA	BNA	Pest/PCB	Metals
SB8202	Subsurface Soil	NA	OK	OK[6]	OK[7,8,9]
SB8210	Subsurface Soil	OK[1]	NA	NA	NA
SB8214	Subsurface Soil	NA	OK[2]	OK	OK[7,8,9]
SB8302	Subsurface Soil	NA	OK[2]	OK	OK[7,8,9]
SB8314	Subsurface Soil	NA	OK[2]	OK[5]	OK[7,8,9]
SB8402	Subsurface Soil	NA	OK	OK	OK[7,8,9]
SS8414	Subsurface Soil	NA	OK	OK	OK[7,8,9]
SS131Z	Surface Soil	NA	OK	OK[4]	OK[22,23,24]
SS132Z	Surface Soil	NA	OK[2]	OK[4,6]	OK[22,23,24]
SS133Z	Surface Soil	NA	OK[3]	OK[4,6]	OK[22,23,24]
SS134Z	Surface Soil	NA	OK	OK[4]	OK[22,23,24]
SS135Z	Surface Soil	NA	OK[3]	OK[5]	OK[22,23,24]
SS136Z	Surface Soil	NA	OK	OK[4]	OK[22,23,24]
SS137Z	Surface Soil	NA	OK[2]	OK[2]	OK[22,23,24]
SS138Z	Surface Soil	NA	OK	OK[4,5]	OK[22,23,24]
SS139Z	Surface Soil	NA	OK[2]	OK[4]	OK[22,23,24]
SS140Z	Surface Soil	NA	OK[2]	OK[4]	OK[22,23,24]

Table 4-6 (continued)

97. Endrin ketone has been qualified as "R", rejected, since the % difference between the two columns was >90%.

98. Thallium results were rejected due to a spike recovery <10%.

99. Mercury has been qualified as estimated, possibly biased low due to a low spike recovery.

100. Selenium results have been qualified as estimated, possibly biased low due to a low spike recovery.

101 4-DDE and alpha chlordane have been qualified as "R", rejected, due to blank contamination.

102. The following compounds were qualified as "R", rejected, since the % difference between the two columns was >90%: Delta BHC, aldrin, endosulfan II, endosulfan sulfate and endrin ketone.

Table 4-7 (continued)

BUFFALO OUTER HARBOR SITE
PHASE II REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: PHASE II - BUFF 2

Sample ID	Matrix	VOA	BNA	Pest/PCB	Metals
SB77	Subsurface Soil	NA	NA	NA	OK[11,13,14]
SB78	Subsurface Soil	NA	NA	NA	OK[11,13,14]
SB79	Subsurface Soil	NA	NA	NA	OK[11,12,13,14]
SB80	Subsurface Soil	NA	NA	NA	OK[11,12,13,14]
SB81 0-2'	Subsurface Soil	NA	OK[10,21]	OK	OK[24,25]
SB81 20-22'	Subsurface Soil	OK[1]	OK[2]	OK[4]	OK[24,25]

Table 4-7 (continued)

BUFFALO OUTER HARBOR SITE
PHASE II REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: PHASE II - BUFF 3

Sample ID	Matrix	VOA	BNA	Pest/PCB	Metals
BHGW3A	Groundwater	NA	OK	NA	NA
BHGW9	Groundwater	NA	OK	NA	NA
BHGW18A	Groundwater	OK[1]	OK[28]	NA	OK[19]
TRIP1	Trip Blank	OK	NA	NA	NA

Table 4-7 (continued)

BUFFALO OUTER HARBOR SITE
PHASE II REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: PHASE II - BUFF 4

Sample ID	Matrix	VOA	BNA	Pest/PCB	Metals
BHGW21	Groundwater	OK	OK	NA	OK[26,27]
BHGW9	Groundwater	NA	NA	NA	OK[26,27]*
BHGW3A	Groundwater	NA	NA	NA	OK[26,27]*

*Sample was analyzed for both total and dissolved metals.

Table 4-7 (continued)

BUFFALO OUTER HARBOR SITE
PHASE II REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

SDG: PHASE II - BHGW1

Sample ID	Matrix	VOA	BNA	Pest/PCB	Metals
BHGW2A	Groundwater	NA	OK[20]	NA	OK[15,16,17,19]
BHGW3A	Groundwater	NA	OK	NA	OK*[15,16,17,19]
BHGW5A	Groundwater	NA	OK[20]	NA	OK[15,16,17,19]
BHGW8A	Groundwater	NA	OK[20]	NA	OK[15,16,17,19]
BHGW8C	Groundwater	NA	OK[20]	NA	OK[15,16,17,19]
BHGW16	Groundwater	NA	OK[20]	NA	OK[15,16,17,19]
BHGW17	Groundwater	NA	OK[20]	NA	OK[15,16,17,19]
BHGW18A	Groundwater	OK	OK	NA	OK[15,16,17,19]
BHGW18B	Groundwater	OK	OK	NA	OK[15,16,17,19]
BHGW19	Groundwater	OK	OK	NA	OK[15,16,17,19]
BHGW20	Groundwater	OK	OK	NA	OK[15,16,17,19]
BHGW21	Groundwater	OK	OK	NA	OK[15,16,17,19]
BHGW9	Groundwater	NA	OK	NA	OK[15,16,17,18,19]*
BHGW1	Groundwater	NA	OK[20]	NA	OK[15,16,17,19]
BHGW8B	Groundwater	NA	OK[20]	NA	OK[15,16,17,19]

*Both total and dissolved metals were analyzed for.

Table 4-7 (continued)

BUFFALO OUTER HARBOR SITE
PHASE II REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

OK - Data is 100% contractually compliant, no qualifiers required.

OK, # - Data is contractually compliant, but qualified (see # below for further explanation).

No, # - Data is not 100% contractually compliant, data is qualified (see # below for explanation of usability).

NA - Not Analyzed

#	Comment
1.	Methylene chloride has been qualified as non-detect since it was also found in the method blank.
2.	Sample was analyzed at a secondary dilution due to compound concentrations exceeding the instrument calibration range in the initial run. The results from the diluted run, suffix "DL" should be used for environmental assessment.
3.	Sample was reanalyzed due to one internal standard area count being outside QC limits. Results from the reanalysis, suffix "RE" should be used for environmental assessment.
4.	All Aroclor results were qualified as estimated due to surrogate recoveries being outside QC limits.
5.	The result for Aroclor-1254 was qualified as estimated since the % difference between the two column concentrations was >25%.
6.	The result for Aroclor-1260 has been qualified as estimated since the % difference between the two column concentrations was >25%.
7.	All cyanide results have been rejected due to a 0% spike recovery.
8.	Antimony, selenium and silver results have been qualified as estimated, possibly biased low, due to spike recoveries <75%.

Table 4-7 (continued)

BUFFALO OUTER HARBOR SITE
PHASE II REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

9. Calcium and chromium results have been qualified as estimated due to a >10% difference in serial dilution results.

10. Sample required reextraction/reanalysis due to 7 of 8 surrogate recoveries falling below QC limits with one of the recoveries being 0%.

11. Samples were analyzed for Toxicity Characteristic Leaching Procedure (TCLP) Metals, as well as select total metals.

12. Chromium and selenium results have been qualified as estimated, possible biased low, due to % recovery being <80%.

13. Lead and barium have been qualified as estimated due to high RPD's in the duplicate.

14. Mercury has been qualified as estimated, possibly biased high, due to spike recovery >125%.

15. Aluminum and iron results have been rejected due to spike recovery being <30%.

16. Antimony, mercury, cyanide and lead have been qualified as estimated, possible biased low, due to spike recoveries <75%.

17. Arsenic, sodium and potassium results have been qualified as estimated due to duplicate recoveries.

18. Copper, lead and manganese results have been rejected since the dissolved results were more than 50% higher than the total result.

19. Zinc has been qualified as estimated due to high percent recovery in the CRI standard.

20. Phthalate results have been qualified as non-detect due to blank contamination.

21. Sample was reextracted outside of holding time.

22. Antimony, cadmium, copper, silver and zinc results have been qualified as estimated, possibly biased low, due to low spike recoveries.

23. Calcium has been qualified as estimated due to serial dilution recoveries.

24. Chromium results have been rejected due to a spike recovery of <10%.

Table 4-7 (continued)

BUFFALO OUTER HARBOR SITE
PHASE II REMEDIAL INVESTIGATION
CONTRACTUAL COMPLIANCE SUMMARY
(12/91 NYSDEC ASP)

25. Aluminum, cadmium, copper, silver and zinc have been qualified as estimated, possibly biased low, due to low spike recoveries.

26. Antimony, iron, lead and silver results have been qualified as estimated due to QC recoveries being outside limits.

27. Selenium results have been rejected due to a spike recovery of 0%.

28. All results qualified as estimated based on non-compliant surrogate recoveries.

Section 5

5.0 CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations presented in this section are based upon previously collected data and information, together with the chemical results and physical information obtained during the Phase I and Phase II Remedial Investigations conducted for the Buffalo Outer Harbor Site.

As discussed in Section 4.0, for purposes of developing a remediation plan for the site, the Buffalo Outer Harbor Site has been subdivided into a number of areas. The primary areas comprise the Area South of the Bell Slip and the Area North of the Bell Slip. Each of these areas has been subdivided further based on the nature of waste and degree of contamination found at the site, primarily as a result of the findings of the remedial investigation. The subdivided areas of the site are described below, together with the general degree of contamination (primarily soil contamination) found within each area.

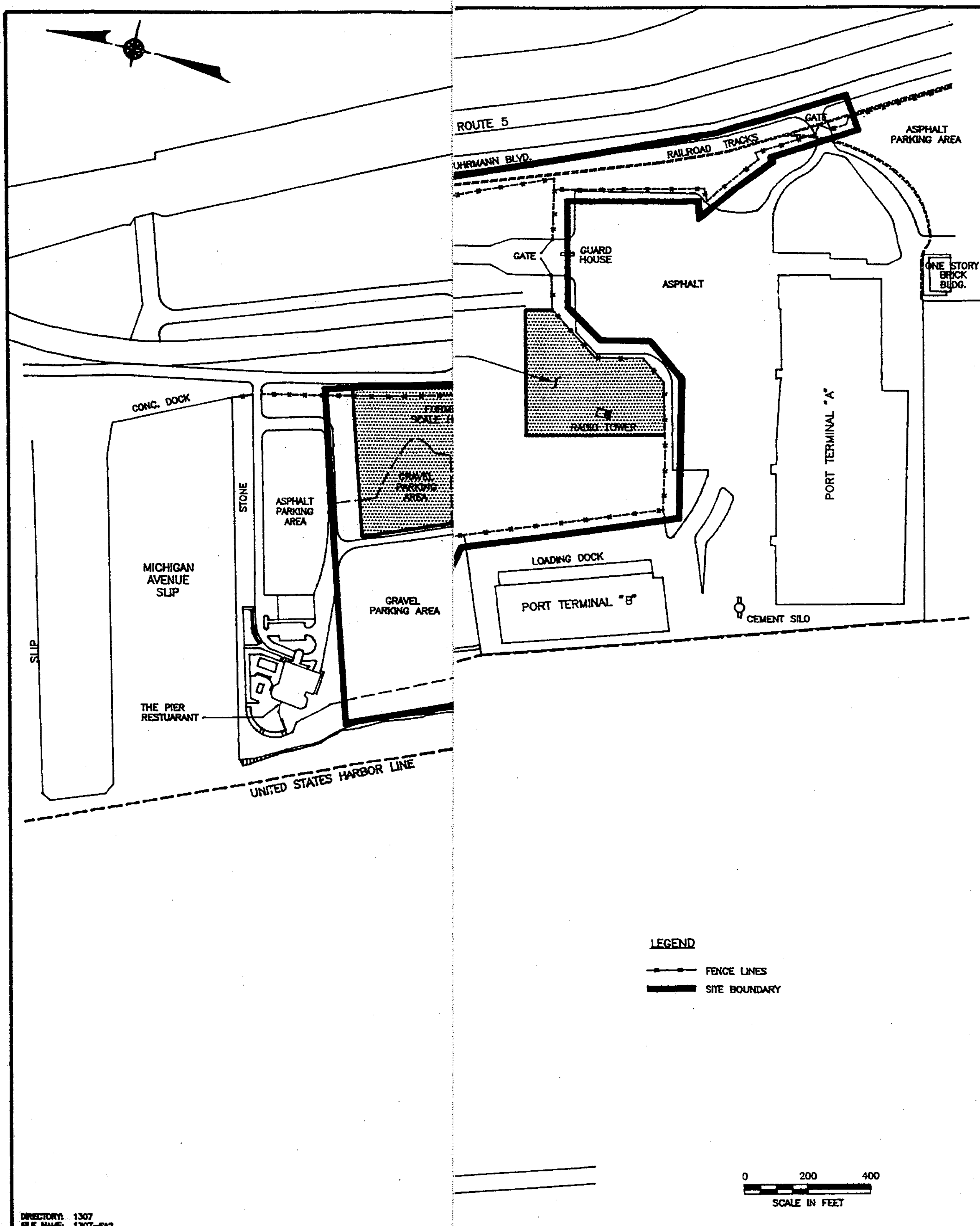
Area South of the Bell Slip

- Radio Tower Area (highly contaminated)
- Remaining Area South of the Bell Slip (moderately contaminated)

Area North of the Bell Slip

- Eastern Gravel Parking Area for The Pier restaurant (moderately contaminated)
- Area East of the Asphalt Road (moderately contaminated)
- Area West of the Asphalt Road (slightly contaminated)

The delineation of these areas is illustrated in Figure 5-1.



DIRECTORY: 1307
FILE NAME: 1307-SA2
DATE: RDS-110/13/96

NO.	DATE	REVISION

SITE AREAS

PROJECT NO. 1307

DATE MARCH 1995

SCALE 1"=200'

FIGURE 5-1

In addition to the nature and degree of contamination found at the Buffalo Outer Harbor Site, thedegree of remediation required to protect human health and the environment at the site is a function of the current and future use of the site. These factors include potential receptors who are presently or will be in the future exposed to contamination at the site (e.g., children, elderly, adult residents, adult workers, etc.), routes of exposure (e.g., ingestion, inhalation, dermal contact) and migration pathways (e.g., vapor, dust, surface runoff, infiltration to groundwater, etc.).

In order to provide guidance and maximum flexibility for future utilization of the Buffalo Outer Harbor Site, potential future land uses of the site have been defined (e.g., residential, recreational, commercial, etc.) and recommendations for remediation, on a preliminary basis, have been developed for each category of land use. Table 5-1 provides a summary of the contamination found at the site, the screening levels used to determine if the contaminants found are a potential concern, and preliminary recommendations for remediation based on the particular area of the site and possible use of the property.

The following presents a summary discussion of the findings and the conclusions of the remedial investigation together with preliminary recommendations for remediation. These preliminary findings, conclusions and recommendations will be further refined based upon the results of the qualitative risk assessment and feasibility study.

5.1 Conclusions and Recommendations

5.1.1 Area North of the Bell Slip

As shown in Figure 5-1, the Area North of the Bell Slip has be subdivided into three subareas, comprising the areas east and west of the asphalt roadway, and the eastern gravel parking area for The Pier restaurant. The following presents a discussion of the findings, conclusions and recommendations for each of the subareas.

5-1
BUFFALO OUTER HARBOR
LAND USE AND REMEDIATION MATRIX

SITE AREAS	MATRIX	TOTAL NO. OF EXCEEDANCES	CONTAMINANT SUMMARY: CONTAMINANT	HIGHEST LEVELS (3)	AVERAGE LEVELS	NO. OF EXCEEDANCES	SCREENING LEVELS	LAND USE AND POTENTIAL REMEDIAL ALTERNATIVES: RESIDENTIAL	RECREATIONAL	COMMERCIAL/INDUSTRIAL
West of Asphalt Road (continued)	Deep Subsurface soil (8 to 20 feet)	10 out of 20 samples above the screening level	CaPAHs	38 mg/kg	9.1 mg/kg	5 out of 18	10 mg/kg	No Action	No Action	No Action
			Lead	2850 mg/kg	643 mg/kg	8 out of 20	500 mg/kg			
			Antimony	89 mg/kg	19.4 mg/kg	2 out of 18	20 mg/kg			
			Copper	12900 mg/kg	802 mg/kg	10 out of 20	200 mg/kg			
			Chromium	569 mg/kg	66 mg/kg	2 out of 18	100 mg/kg			
			Arsenic	57.8 mg/kg	16.2 mg/kg	5 out of 18	20 mg/kg			
			Cadmium	32.6 mg/kg	4.8 mg/kg	2 out of 18	10 mg/kg			
			Nickel	747 mg/kg	75 mg/kg	4 out of 18	40 mg/kg			
			Zinc	5290 mg/kg	923 mg/kg	10 out of 20	500 mg/kg			
	Groundwater (depth to groundwater ranges from 5 to 15 feet)	6 out of 12 samples above the screening level for the Phase I investigation (2)	Antimony	124 ug/l (Phase I)	--	--	3 ug/l	No Action	No Action	No Action
			Barium	4050 ug/l (Phase I)	--	--	25 ug/l			
			Trichloroethene	7 ug/l (Phase I)	--	--	1000 ug/l			
			Cyanide	892 ug/l (Phase II)	--	--	5 ug/l			
		3 out of 6 samples above the screening level for the Phase II investigation (2)	Dieldrin	0.032 ug/l (Phase I)	--	--	100 ug/l			
			Endrin	0.018 ug/l (Phase I)	--	--	Non detect			
			Heptachlor Epoxide	0.026 ug/l (Phase I)	--	--	Non detect			
			Beta BHC	0.011 ug/l (Phase I)	--	--	Non detect			
East of Asphalt Road	Surface soil (0 to 6 inches)	4 out of 23 samples above the screening level	CaPAHs	18 mg/kg	2.2 mg/kg	1 out of 23	10 mg/kg	Removal (0-2 feet) (1) (8) or Treatment	Removal (0-2 feet) (1) or Soil Cover (2 feet) or Pavement/Structure Cap	No Action
			Copper	29,500 mg/kg	62 mg/kg (5)	1 out of 23	200 mg/kg			
			Zinc	874 mg/kg	205 mg/kg	2 out of 23	500 mg/kg			
	Shallow Subsurface soil (6 inches to 8 feet)	8 out of 15 samples above the screening level	CaPAHs	17 mg/kg	2.7 mg/kg	1 out of 13	10 mg/kg	Removal (2-8 feet) (1) or Treatment	No Action	No Action
			Antimony	37 mg/kg	16.7 mg/kg	2 out of 13	20 mg/kg			
			Arsenic	34 mg/kg	10.6 mg/kg	3 out of 13	20 mg/kg			
			Lead	1200 mg/kg	389 mg/kg	8 out of 15	500 mg/kg			
			Copper	1460 mg/kg	673 mg/kg	6 out of 15	200 mg/kg			
			Nickel	48.1 mg/kg	19.2 mg/kg	2 out of 13	40 mg/kg			
			Zinc	4230 mg/kg	968 mg/kg	6 out of 15	500 mg/kg			
	Deep Subsurface soil (8 to 20 feet)	12 out of 15 samples above the screening level	CaPAHs	38 mg/kg	9.1 mg/kg	3 out of 15	10 mg/kg	Removal (8-20 feet) (1) or Treatment	No Action	No Action
			Arsenic	412 mg/kg	41.7 mg/kg	6 out of 15	20 mg/kg			
			Antimony	1170 mg/kg	133 mg/kg	8 out of 15	20 mg/kg			
			Cadmium	27 mg/kg	6.4 mg/kg	4 out of 15	10 mg/kg			
			Chromium	343 mg/kg	58 mg/kg	2 out of 15	100 mg/kg			
			Copper	1560 mg/kg	432 mg/kg	6 out of 15	200 mg/kg			
			Lead	4860 mg/kg	1185 mg/kg	10 out of 15	500 mg/kg			
			Nickel	141 mg/kg	38 mg/kg	4 out of 15	40 mg/kg			
			Zinc	4330 mg/kg	1036 mg/kg	7 out of 15	500 mg/kg			
	Groundwater (depth to groundwater 10 feet)	3 out of 5 samples above the screening level for the Phase I investigation (2)	VOCs	Low levels of VOCs (Less than 10 ug/l Phase I)	--	--	Various Class GA groundwater standards/guidelines	No Action	No Action	No Action
			PAHs	Low levels of PAHs (less than 5 ug/l Phase I and Phase II)	--	--				
		1 out of 2 samples above the screening level for the Phase II investigation (2)	Zinc	349 ug/l (Phase I)	--	--	300 ug/l			
			Lead	410 ug/l (Phase II unfiltered)	--	--	25 ug/l			
			Thallium	7.2 ug/l (Phase II unfiltered)	--	--	4 ug/l			
			Barium	1090 ug/l (Phase II unfiltered)	--	--	1000 ug/l			
Eastern Gravel Parking Area	Surface soil (0 to 6 inches)	8 out of 14 samples above the screening level	PCBs	12 mg/kg	1.3 mg/kg	2 out of 14	1 mg/kg	Removal (0-2 feet) (1) (8)	Removal (0-2 feet)* or Soil Cover (2 feet) or Pavement/Structure Cap	Removal (0-2 feet)* or Soil Cover (2 feet) or Pavement/Structure Cap
			CaPAHs	14.8 mg/kg	6.1 mg/kg	3 out of 14	10 mg/kg			
			Arsenic	21.3 mg/kg	8.6 mg/kg	1 out of 14	20 mg/kg			
			Cadmium	323 mg/kg	25.9 mg/kg	2 out of 14	10 mg/kg			
			Chromium	113 mg/kg	32 mg/kg	1 out of 14	100 mg/kg			
			Lead	14,000 mg/kg	623 mg/kg (6)	[illegible] out of 14	500 mg/kg			
			Nickel	62.8 mg/kg	19.4 mg/kg	1 out of 14	40 mg/kg			
			Zinc	29800 mg/kg	[illegible] mg/kg (7)	5 out of 14	500 mg/kg			
	Groundwater (depth to groundwater 17 feet)	1 out of 1 sample above the screening level for the Phase I and Phase II investigation(2)	Chrysene	0.6 ug/l (Phase II)	--	--	0.002 ug/l	No Action	No Action	No Action
			Lead	500 ug/l (Phase II)	--	--	25 ug/l			
			Thallium	6.3 ug/l (Phase II)	--	--	4 ug/l			

NOTES:
(1) Removal includes replacement with clean soil
(2) Does not include exceedances for iron, manganese, magnesium or sodium
(3) Highest level encountered during the Phase I and II Investigation
(4) Does not include 1301 mg/kg (detected in only one sample) in average. Average with 1301 mg/kg is 38 mg/kg
(5) Does not include 29500 mg/kg (detected in only one sample) in average. Average with 29500 mg/kg is 1342 mg/kg
(6) Does not include 14000 mg/kg (detected in only one sample) in average. Average with 14000 mg/kg is 1485 mg/kg
(7)Does not include 29800 mg/kg (detected in only one sample) in average. Average with 29800 mg/kg is 3007 mg/kg
(8) Removal of the soil in this area is recommended due to the presence of the former Furhmann Boulevard Landfill in this area.

SHADING
:Average level exceeds screening level.
:Number of exceedances exceeds 30 %.

BUFFALO OUTER HARBOR
LAND USE AND REMEDIATION MATRIX

SITE AREAS	MATRIX	TOTAL NO. OF EXCEEDANCES	CONTAMINANT	HIGHEST LEVELS (3)	AVERAGE LEVELS	NO. OF EXCEEDANCES	SCREENING LEVELS	RESIDENTIAL	RECREATIONAL	COMMERCIAL/INDUSTRIAL
		CONTAMINANT SUMMARY						LAND USE AND POTENTIAL REMEDIAL ALTERNATIVES		
SOUTH OF BELL SLIP Radio Tower Area	Surface soil (0 to 6 inches)	5 out of 8 samples above the screening level	PCBs	8.2 mg/kg	2.4 mg/kg	4 out of 8	1 mg/kg	Removal (0-2 feet) (1) or Treatment	Removal (0-2 feet)* or Soil Cover (2 feet) or Pavement/Structure Cap	Removal (0-2 feet)* or Soil Cover (2 feet) or Pavement/Structure Cap
			Cadmium	12 mg/kg	5.8 mg/kg	1 out of 8	10 mg/kg			
			Lead	777 mg/kg	390 mg/kg	4 out of 8	500 mg/kg			
			Zinc	2350 mg/kg	1164 mg/kg	5 out of 8	500 mg/kg			
			Nickel	47.9 mg/kg	24.6 mg/kg	1 out of 8	40 mg/kg			
	Shallow Subsurface soil (6 inches to 8 feet)	5 out of 13 samples above the screening level	CaPAHs	112 mg/kg	13.2 mg/kg	2 out of 13	10 mg/kg	Removal (2-8 feet) (1) or Treatment	No Action	No Action
			Lead	1170 mg/kg	314 mg/kg	2 out of 13	500 mg/kg			
			Antimony	29 mg/kg	11.5 mg/kg	1 out of 13	20 mg/kg			
	Deep Subsurface soil (8 to 20 feet)	7 out of 15 samples above the screening level	Total VOCs	351 mg/kg	32.7 mg/kg	2 out of 7	10 mg/kg	Removal (8-20 feet) (1) or Treatment	Removal (8-20 feet)* or Treatment or Containment	Removal (8-20 feet)* or Treatment or Containment
			Nitrobenzene	13,000 mg/kg	79.4 mg/kg	6 out of 15	1 mg/kg			
			PAHs	5600 mg/kg	406 mg/kg	2 out of 15	100 mg/kg			
			CaPAHs	16 mg/kg	2.9 mg/kg	1 out of 15	10 mg/kg			
			Antimony	5470 mg/kg	433 mg/kg	8 out of 15	20 mg/kg			
			Lead	1720 mg/kg	296 mg/kg	2 out of 15	500 mg/kg			
			Chromium	2820 mg/kg	218 mg/kg	2 out of 15	100 mg/kg			
			Nickel	123 mg/kg	23 mg/kg	1 out of 15	40 mg/kg			
			Copper	1480 mg/kg	140 mg/kg	1 out of 15	200 mg/kg			
			Zinc	1290 mg/kg	253 mg/kg	1 out of 15	500 mg/kg			
			TCLP Nitrobenzene	91 mg/l	--	1 out of 2	2 mg/l			
			TCLP 2,4 - Dinitrotoluene	0.6 mg/l	--	1 out of 2	0.3 mg/l			
	Groundwater (depth to groundwater 8 feet)	1 out of 1 samples above the screening level for the Phase I investigation (2) 3 out of 5 samples above the screening level for the Phase II investigation (2)	Benzene	15 ug/l (Phase I)	--	--	0.7 ug/l	Monitoring	Monitoring	Monitoring
			Toluene	7 ug/l (Phase I)	--	--	5 ug/l			
			Chlorobenzene	170 ug/l (Phase I)	--	--	5 ug/l			
			1,3 Dichlorobenzene	150 ug/l (Phase II)	--	--	5 ug/l			
			1,4 Dichlorobenzene	33 ug/l (Phase II)	--	--	4.7 ug/l			
			1,2 Dichlorobenzene	150 ug/l (Phase II)	--	--	4.7 ug/l			
			Napthalene	890 ug/l (Phase I)	--	--	10 ug/l			
			4-Chloroaniline	3600 ug/l (Phase II)	--	--	5 ug/l			
			Antimony	244 ug/l (Phase I)	--	--	3 ug/l			
			Lead	28.4 ug/l (Phase II)	--	--	25 ug/l			
			Arsenic	159 ug/l (Phase II)	--	--	25 ug/l			
Remaining Area	Surface soil (0 to 6 inches)	20 out of 43 samples above the screening level	CaPAHs	80 mg/kg	10 mg/kg	11 out of 43	10 mg/kg	Removal (0-2 feet) (1) or Soil Cover (2 feet) or Pavement/Structure Cap	Removal (0-2 feet)* or Soil Cover (2 feet) or Pavement/Structure Cap	Removal (0-2 feet)* or Soil Cover (2 feet) or Pavement/Structure Cap or No Action
			Arsenic	1301 mg/kg	8 mg/kg (4)	2 out of 43	20 mg/kg			
			Zinc	3080 mg/kg	414 mg/kg	8 out of 43	500 mg/kg			
			Lead	834 mg/kg	220 mg/kg	4 out of 43	500 mg/kg			
			Cadmium	27 mg/kg	2.7 mg/kg	1 out of 43	10 mg/kg			
			Chromium	133 mg/kg	29 mg/kg	2 out of 43	100 mg/kg			
			Copper	456 mg/kg	81 mg/kg	3 out of 43	200 mg/kg			
	Shallow Subsurface soil (6 inches to 8 feet)	8 out of 12 samples above the screening level	CaPAHs	16 mg/kg	5.7 mg/kg	4 out of 12	10 mg/kg	Removal (2-4 feet) (1)	No Action	No Action
			Arsenic	36 mg/kg	8.7 mg/kg	1 out of 12	20 mg/kg			
			Lead	1260 mg/kg	345 mg/kg	2 out of 12	500 mg/kg			
			Nickel	63 mg/kg	24 mg/kg	1 out of 12	40 mg/kg			
			Zinc	834 mg/kg	372 mg/kg	4 out of 12	500 mg/kg			
	Deep Subsurface soil (8 to 20 feet)	6 out of 13 samples above the screening level	CaPAHs	31 mg/kg	9.6 mg/kg	4 out of 13	10 mg/kg	No Action	No Action	No Action
			PAHs	104 mg/kg	25.8 mg/kg	1 out of 13	100 mg/kg			
			Lead	2200 mg/kg	283 mg/kg	2 out of 13	500 mg/kg			
			Antimony	74 mg/kg	19 mg/kg	1 out of 13	20 mg/kg			
			Arsenic	21.4 mg/kg	7.8 mg/kg	1 out of 13	20 mg/kg			
			Copper	247 mg/kg	43 mg/kg	1 out of 13	200 mg/kg			
			Nickel	53 mg/kg	23 mg/kg	1 out of 13	40 mg/kg			
			Zinc	1880 mg/kg	317 mg/kg	1 out of 13	500 mg/kg			
	Groundwater (depth to groundwater 8 feet)	5 out of 11 samples above the screening level for the Phase I investigation (2) 0 out of 1 samples above the screening level for the Phase II investigation (2)	Chloroform	15 ug/l (Phase I)	--	--	7 ug/l	No Action	No Action	No Action
			Endrin	0.024 ug/l (Phase I)	--	--	Non-detect			
			4,4 - DDT	0.039 ug/l (Phase I)	--	--	Non-detect			
			4,4 - DDD	0.069 ug/l (Phase I)	--	--	Non-detect			
			Arsenic	95 ug/l (Phase I)	--	--	25 ug/l			
NORTH OF BELL SLIP West of Asphalt Road	Surface soil (0 to 6 inches)	4 out of 34 samples above the screening level	CaPAHs	18 mg/kg	3.6 mg/kg	3 out of 34	10 mg/kg	Removal (0-2 feet) (1) or Soil Cover (2 feet) or Pavement/Structure Cap or No Action	Removal (0-2 feet) (1) or Soil Cover (2 feet) or Pavement/Structure Cap or No Action	No Action
			Lead	815 mg/kg	157 mg/kg	2 out of 34	500 mg/kg			
			Zinc	671 mg/kg	151 mg/kg	1 out of 34	500 mg/kg			
	Shallow Subsurface soil (6 inches to 8 feet)	6 out of 19 samples above the screening level	CaPAHs	18.4 mg/kg	3.8 mg/kg	3 out of 19	10 mg/kg	No Action	No Action	No Action
			Lead	1160 mg/kg	173 mg/kg	1 out of 19	500 mg/kg			
			Copper	753 mg/kg	123 mg/kg	2 out of 19	200 mg/kg			
			Nickel	55.6 mg/kg	15.4 mg/kg	1 out of 19	40 mg/kg			
			Zinc	1010 mg/kg	190 mg/kg	1 out of 19	500 mg/kg			

West of the Asphalt Road

The area west of the asphalt road has been characterized as an area filled with primarily dredged sediment spoils from the Buffalo Outer Harbor. As summarized in Table 5-1, only a few surface soil samples (0 to 6 inches) from this area (4 out of 34) indicated the presence of slightly elevated levels of contaminants, such as carcinogenic polycyclic aromatic hydrocarbons (CaPAHs) and metals, including lead and zinc, and only a few shallow subsurface soil samples (6 out of 19) collected from 6 inches to 8 feet exceeded the screening criteria for CaPAHs and metals. Although elevated levels of metals and CaPAHs were detected in several deep samples, groundwater from this area does not appear to be impacted by the contamination. No sample analyzed for EP Toxicity and Toxicity Characteristics Leaching Procedure (TCLP) analysis from this area exceeded the regulatory levels. As a result of these findings, the surface and shallow subsurface soils, as well as the deep subsurface soils (8 to 20 feet) in this area can be characterized as not being significantly contaminated. Based on these results, as presented in Table 5-1, depending upon the future use of the property, limited remediation of the surficial soil, such as select removal, soil cover or capping with pavement or building structures, will be considered for this area.

East of the Asphalt Road

Similar to the area west of the asphalt road, only a few samples (4 out of 23) collected from the surface soil in this area exceeded the screening criteria. Based on these results, the surface soil in this portion of the site is not significantly contaminated. However, elevated levels of CaPAHs and metals, including lead, zinc, copper, arsenic and chromium, were detected in a fairly high number (20 out of 30) of subsurface soil samples collected in this area. As discussed in Section 4.0, the elevated levels of these contaminants are likely attributable to waste/incinerator ash disposal at the former Fuhrmann Boulevard Landfill located in this area. Two subsurface soil samples collected from this area by GZA GeoEnvironmental in 1991 exceeded the EP Toxicity criteria for lead. One additional soil sample collected from this area as part of the Phase II RI exceeded the TCLP criteria for lead. As a result of these findings, although the surface soil in this area is not highly contaminated, because of the elevated levels of metals in the subsurface soil, future use of the site in this area may require restrictions or more significant remediation if unrestricted (residential) use is proposed.

Eastern Gravel Parking Area of The Pier Restaurant

Elevated levels of metals, CaPAHs and polychlorinated biphenyls (PCBs) were detected in 8 out of 14 surface soil samples collected in this area. The extent of the elevated levels of these contaminants appears to extend from the former scale house to within 200 feet of the site boundary. These elevated levels could be attributed to waste disposal at the former Fuhrmann Boulevard Landfill or material utilized for construction of the parking area. Extremely elevated levels of lead and zinc (14,000 mg/kg and 29,800 mg/kg, respectively) detected in one sample adjacent to the eastern fenceline may be the result of recent dumping.

Although surface soil quality in this area appears to have higher levels of contaminants than the areas east or west of the asphalt roadway, subsurface soil chemical quality in this area appears to be consistent with that detected in the areas east (2 to 20 feet) and west (8 to 20 feet) of the asphalt roadway. As a result of these findings, it is likely that this area under any land use scenario will require some type of remediation, including removal, soil cover or a pavement/structure cap.

5.1.2 Area South of the Bell Slip

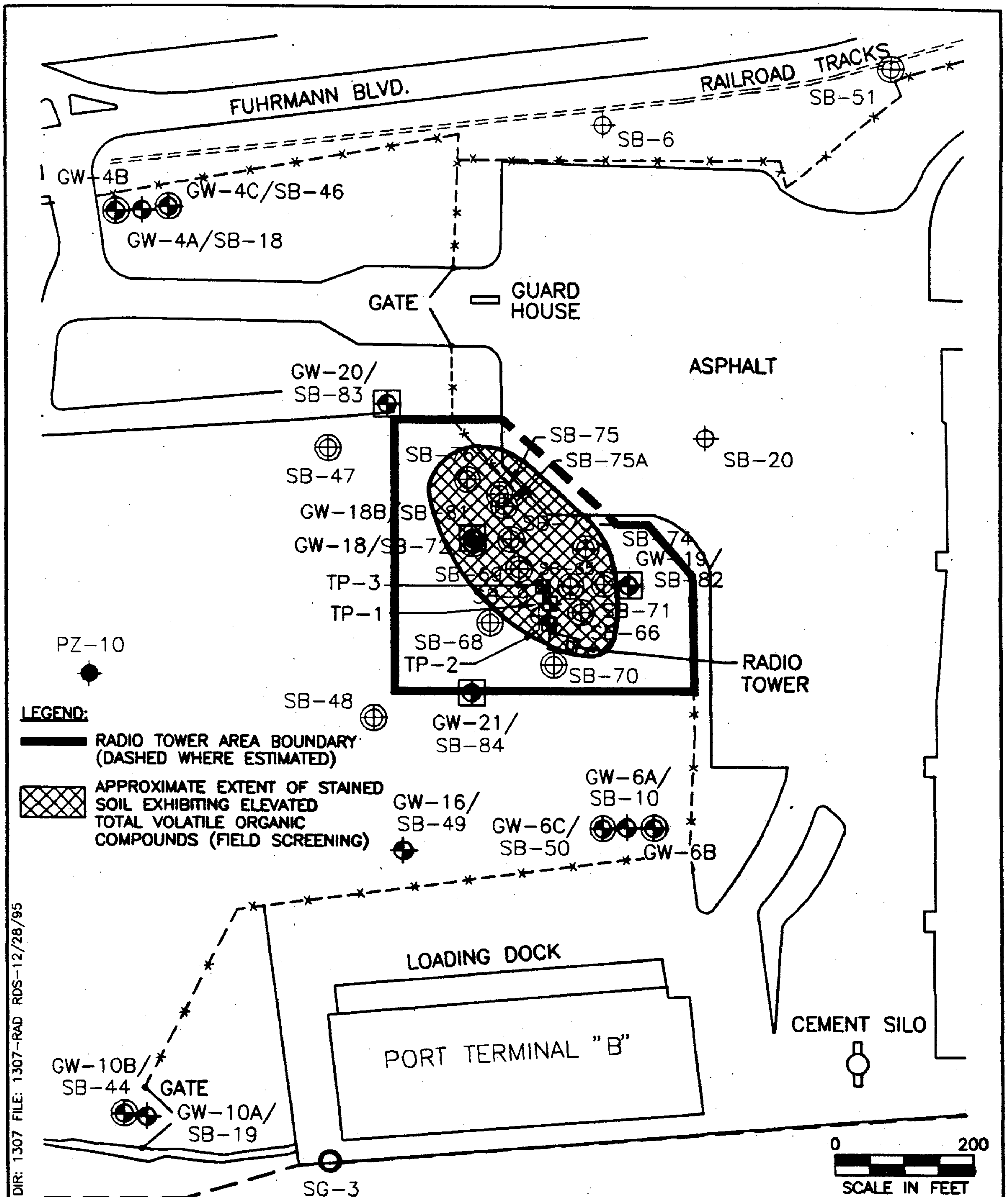
As described above, the area south of the Bell Slip has been divided into two separate subareas, the Radio Tower Area and the remaining area excluding the Radio Tower Area (see Figure 5-1). The following discussion provides the findings, conclusions and preliminary recommendations for each of the areas.

Radio Tower Area

Based on samples collected from this area, significantly elevated levels of contaminants have been detected in the surface soil, subsurface soil and groundwater. The toxic nature and extremely elevated levels of nitrobenzene (as high as 13,000 mg/kg) and antimony (as high as 5,470 mg/kg) detected in the subsurface soil 10 to 20 feet below ground surface and the levels of 4-chloroaniline (as high as 3,600 ug/l) detected in the groundwater warrant specific concern and consideration. Based on TCLP results, if these contaminated soils were removed for off-site treatment or disposal, they would be classified as a hazardous waste. Although elevated levels of volatile organic compounds (VOCs) and semi volatile organic compounds (SVOCs) have been detected in the groundwater, the contamination does not appear to be migrating readily toward the Buffalo Outer Harbor, and therefore not impacting the Outer Harbor.

The area of stained soils in the subsurface exhibiting elevated levels of total volatile organic compounds (TVOCs) based on vapor monitoring performed during drilling, is shown on Figure 5-2. Laboratory analysis of soils collected from these borings confirm that elevated levels of VOCs are present in the Radio Tower Area. Levels of benzene plus related constituents (benzene plus toluene, chlorobenzene and ethylbenzene, as high as 351 mg/kg) were found in subsurface soils at depths of 10 to 20 feet below ground surface.

The elevated levels of VOCs, plus the high levels of nitrobenzene, antimony and 4-chloroaniline, demonstrate that significant contamination is present at depth in the Radio Tower Area. As a result of these findings, soil in this area may require significant remediation, including removal, containment or treatment, before any future use of the site in order to ensure protection of human health and the environment. However, remediation of groundwater may not be required.



BUFFALO OUTER HARBOR
BUFFALO, NEW YORK

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Consulting Engineers
A Division of William F. Cosulich Associates, P.C.

RADIO TOWER AREA

FIGURE 5-2

Remaining Area

Elevated levels of CaPAHs and metals, including arsenic, lead and zinc, were detected in about one-half of the surface (20 out of 43) and subsurface soil samples (14 out of 25) collected in this area. As a result of these findings, remediation will most likely be required in this area. The extent of remediation will depend on the future use of the property. As shown on Table 5-1, the elevated levels of contaminants may warrant remediation, such as removal of the surface soil, and a portion of subsurface soil if the property were to be utilized for residential use. However, if the property were to be used for commercial/industrial purposes in the future, remediation such as placement of soil cover or pavement/structure cap would likely be appropriate.

5.1.3 Groundwater

Based upon the results of groundwater sampling conducted during the Phase I and Phase II Remedial Investigations, excluding groundwater in the Radio Tower Area, it does not appear that groundwater at the site is significantly contaminated beneath the Buffalo Outer Harbor Site. Low levels of metals and PAHs just above Class GA groundwater standards/guidelines were detected in select wells on-site, however, the contamination appears to be localized in extent and does not appear to be impacting surface water or sediment quality in the Outer Harbor. The elevated levels of sodium, manganese, magnesium and iron may be attributed to waste disposal at the former Fuhrmann Boulevard Landfill or general/background groundwater quality in the vicinity of the site.

The results of the shallow groundwater samples collected from the Radio Tower Area indicate the presence of significantly elevated levels of 4-chloroaniline and other VOCs and SVOCs, as well as antimony in one shallow well in this area. The intermediate well also exhibited elevated levels of 4-chloroaniline. Downgradient monitoring wells are not exhibiting elevated levels of these contaminants and the contamination does not appear to be migrating toward the Buffalo Outer Harbor. Therefore remediation of groundwater is not required. However, because of significant contamination in the Radio Tower Area, long-term groundwater monitoring will be necessary in this area.

5.1.4 Surface Water

The results of the samples collected from the Outer Harbor, Bell Slip and Michigan Avenue Slip do not indicate that surface water in the vicinity of the Buffalo Outer Harbor Site is being impacted by the site. Only three metals (aluminum, selenium and silver) were detected above the Class B surface water standards. These metals were not detected at elevated levels on-site, and therefore, are not attributed to site contamination.

5.1.5 Surface Water Sediment

Elevated levels of zinc were detected in two of the three sediment samples collected from the Bell Slip. These levels may be attributed to runoff from the site an/or activities at the Allen Boat Company. Elevated levels of contaminants were not detected elsewhere in the sediment samples in the vicinity of the Buffalo Outer Harbor Site except for pesticides which were detected in nearly all of the sediment samples collected in the Outer Harbor and the Michigan and Bell Slips, including the background sample collected at the entrance at the breakwater; however, pesticides were not detected in elevated levels at the site. As a result, pesticide contamination in the sediments is attributed to other sources and remediation of the sediments is not required.

Section 6

6.0 REFERENCES

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