RETEC

PRELIMINARY FEASIBILITY STUDY REPORT
FORMER THIRD WARD MANUFACTURED GAS PLANT SITE
MILWAUKEE, WISCONSIN

Prepared For:

WISCONSIN GAS COMPANY
Milwaukee, Wisconsin

Prepared By:

REMEDIATION TECHNOLOGIES, INC.
St. Paul, Minnesota

RETEC Project No. 3-0887-900

JULY 1994

ERR/ERP
FID # 241496530

WISCONSIN GAS
A WICOR COMPANY

Wisconsin Gas Company
626 East Wisconsin Avenue
Milwaukee, WI 53202
(414) 291-7000

August 1, 1994

Ms. Margaret Graefe
Wisconsin Department of Natural Resources
4041 North Richards Street
Milwaukee, Wisconsin 53212

Dear Ms. Graefe:

Enclosed please find two copies of the document "Preliminary Feasibility Study Report, Former Third Ward Manufactured Gas Plant Site, Milwaukee, Wisconsin" dated July, 1994 for the site located in the area of North Milwaukee Street and East Menomonee Street. The enclosed Preliminary Feasibility Study Report identifies the compounds and media of potential concern, the appropriate existing standards and the appropriate remedial action objectives. In addition, the Report preliminarily discusses appropriate response actions and the process for establishing standards with the WDNR for media in which standards are currently undefined. Based on this Preliminary Feasibility Study Report, a Final Feasibility Study will be prepared which will screen the preliminary response actions identified in this Report and assemble alternatives for WDNR concurrence and implementation.

The Preliminary Feasibility Study Report also disclosed that after the Wisconsin Gas Company completed the "Phase III ESI Report - Former Third Ward MGP Site" dated April, 1993, the Wisconsin Gas Company entered into a 10 year lease for the block bounded by North Jefferson Street, East Corcoran Street, North Milwaukee Street and East Menomonee Street located within the former Third Ward MGP Site. The lease was entered as a part of a settlement of litigation with a property owner who alleged that the Wisconsin Gas Company was responsible for the presence of contamination caused by former MGP operations at the Site. This lease enables the Wisconsin Gas Company to proceed as may be required by law with investigation and remediation of contamination associated with the former Third Ward MGP operations and reported in the Phase III ESI Report.

Because of the technical complexity of this Site and the nature of Site impacts, Wisconsin Gas Company believes it is appropriate at this time to meet with the WDNR staff to identify the final remedy selection process and to develop appropriate remedial standards.

A representative of the Wisconsin Gas Company will contact the WDNR to set up a meeting in the near future. Please feel free to call me at 291-7000, Ext. 5463 with any questions or comments. Thank you for your attention and assistance in this matter.

Very truly yours,

Art Covi /3ß

Art Covi, PE
Research Engineer
Wisconsin Gas Company
5400 N. Green Bay Avenue
Milwaukee, Wisconsin 53209

ATTACHMENT

c: Mr. Ronald W. Kazmierczak (w/o attachment)

PRELIMINARY FEASIBILITY STUDY REPORT
FORMER THIRD WARD MANUFACTURED GAS PLANT SITE
MILWAUKEE, WISCONSIN

Prepared For:

WISCONSIN GAS COMPANY
Milwaukee, Wisconsin

Prepared By:

REMEDIATION TECHNOLOGIES, INC.

RETEC Project No. 3-0887-900

Prepared by: M J Salisbury

Reviewed by: ______

JULY 1994

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Background

This Preliminary Feasibility Study Report (Preliminary FS Report) has been prepared by Remediation Technologies, Inc. (RETEC) on behalf of Wisconsin Gas Company for the former Third Ward Manufactured Gas Plant (MGP) site located in Milwaukee, Wisconsin (Site). Figures 1-1 and 1-2 show the location of the Site.

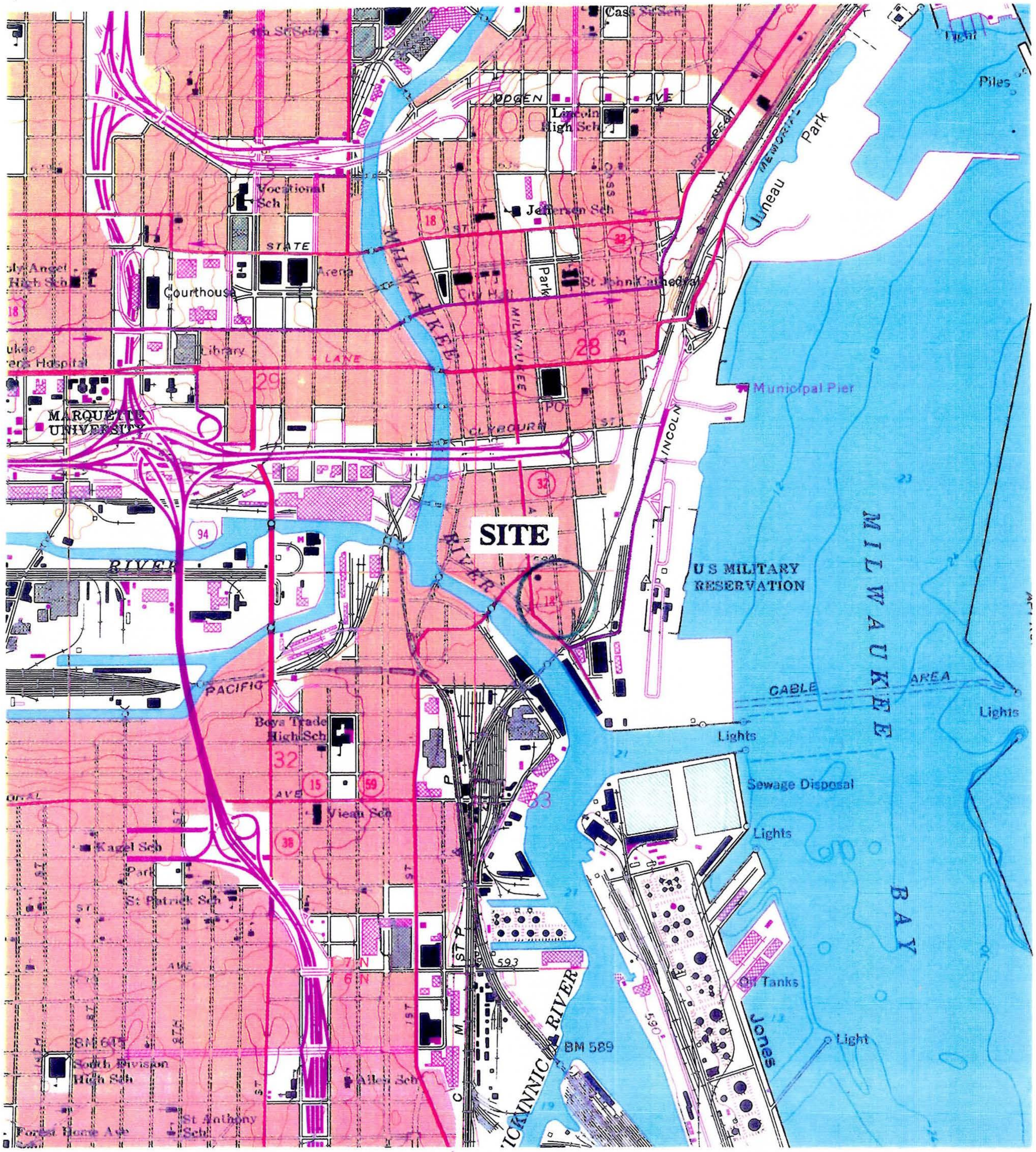
The Preliminary FS Report is based on the findings of a Phase III Environmental Site Investigation of the Site (Phase III ESI), conducted by RETEC during 1992 and 1993, as presented in the document, Phase III Environmental Site Investigation Report, Former Third Ward Manufactured Gas Plant Site, April 1993 (Phase III ESI Report). The Phase III ESI Report contains information regarding the Site including: the setting, the history, previous environmental assessments, geology and hydrogeology, sources and potential sources of impacts, and nature and extent of impacted media. The Phase III ESI Report was submitted to the Wisconsin Department of Natural Resources (WDNR) in April 1993. A supplement to the Phase III ESI, consisting of the document, Addendum No. 1 Phase III Environmental Site Investigation Report, Former Third Ward Manufactured Gas Plant Site, River Sediment Sampling Report, June 1994 (River Sediment Sampling Report), has been prepared to provide the results of a river sediment sampling program which was completed in the Milwaukee River adjacent to the Site during September and October 1993.

The Preliminary FS Report is based upon specific information pertaining to the Site and RETEC's experience in evaluating and implementing remedial technologies at MGP sites located throughout the United States.

The objectives of this report include the following:

- identify the compounds and media of potential concern;
- identify appropriate existing standards;
- identify appropriate remedial action objectives;
- preliminarily discuss appropriate response actions; and

REI IEC



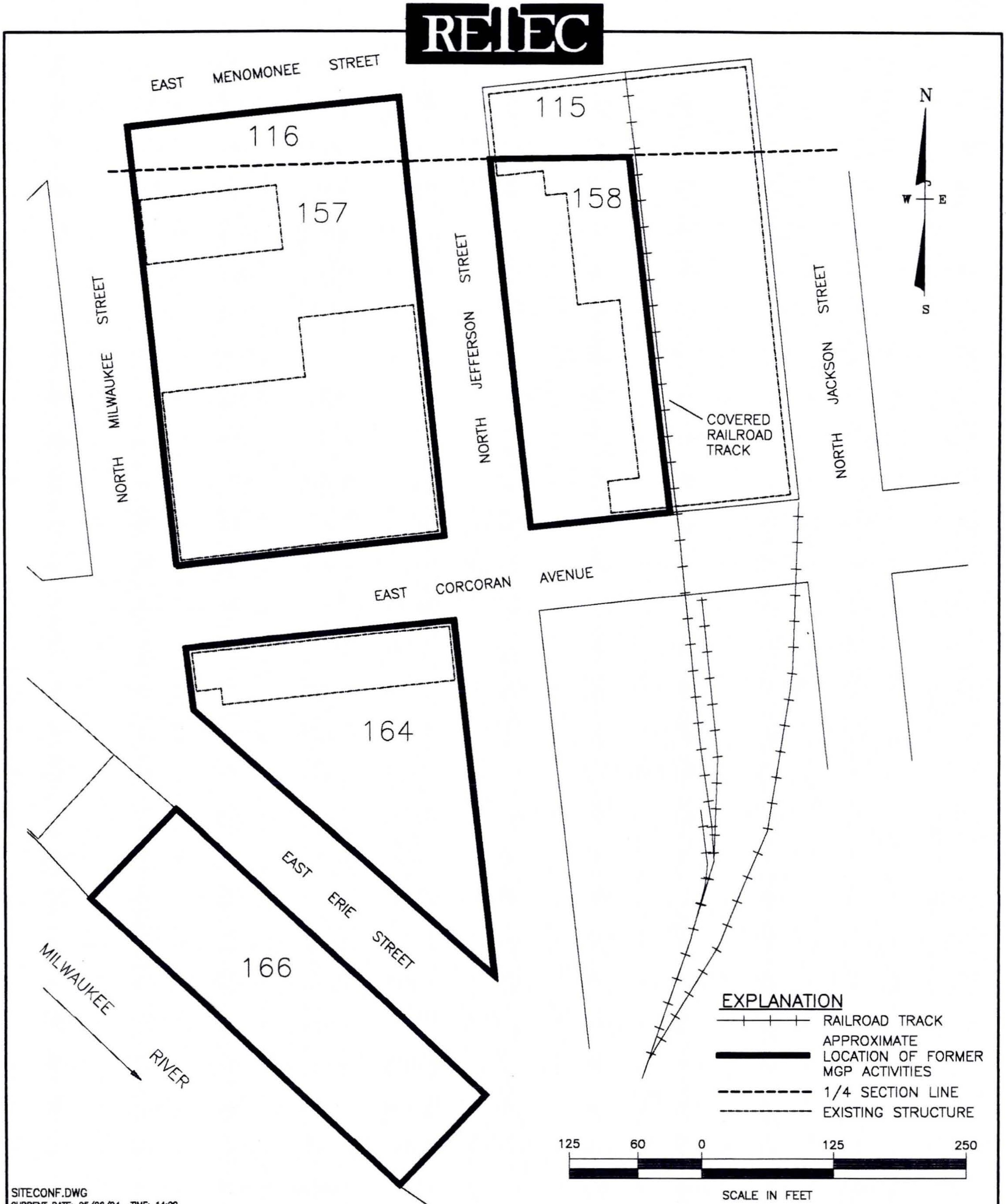
SOURCE: MILWAUKEE 7-1/2 MINUTE TOPOGRAPHIC QUADRANGLE

SCALE 1 inch = 2,000 feet

N

THIRD WARD MGP SITE
SITE LOCATION MAP

FIGURE 1-1



CURRENT SITE CONFIGURATION
THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

FIGURE 1–2

- discuss the process for establishing standards with the Wisconsin Department of Natural Resources (WDNR) in which standards are currently undefined.

Based on this report, a final feasibility study will be prepared which screens the preliminary response actions identified herein and assembles alternatives for WDNR concurrence and implementation.

1.2 Abbreviated Operational History

Gas was made at the former Third Ward MGP from the 1850s to the 1950s. The methods used to manufacture gas evolved during the life of the plant and involved three different gas manufacturing processes. MGP operations were conducted on land comprising an area of approximately 5.5 acres as shown on Figure 1-2. The Site consists of three distinct parcels of land, as shown on Figure 1-2, which includes portions or all of Blocks 116, 157, 158, 164 and 166. All of the land on which the MGP was formerly located was sold to other parties after the decommissioning and demolition of the MGP was completed in 1959. The Phase III ESI Report contains additional information regarding the history of the Site.

After completing the Phase III ESI Report dated April 1993, the Wisconsin Gas Company entered into a 10 year lease for property bounded by North Jefferson Street, East Corcoran Avenue, North Milwaukee Street and East Menomonee Street located within the former Third Ward MGP Site. The lease was entered as part of a settlement of litigation with a property owner who alleged that the Wisconsin Gas Company was responsible for the presence of impacts caused by former MGP operations at the Site. This lease enables the Wisconsin Gas Company to proceed as may be required by law with investigation and remediation of impacts associated with the former Third Ward MGP operations as reported in the Phase III ESI Report.

Three different MGP processes were used at the Site during the period of gas manufacturing. The three MGP processes consisted of coal carbonization (CC), carburetted water gas (CWG) and oil gas (OG). The original gas manufacturing process was coal carbonization, which produced coal gas from a coal feedstock. In the late 1800s, a carburetted water gas (CWG) process was installed. The coal gas and CWG processes operated from the late 1800s until at least 1938. The MGP operations were completely converted to a CWG plant by 1910. The CWG process utilized a carbon feedstock, generally coke, to produce "Blue gas". The "Blue gas" was carburetted using lighter oils such as naphtha in the early days, to heavier crude oils in the 1930s. During the later years of operation, an OG process was installed at the

Site and various types of fuel oil were utilized as feedstocks for the OG operations. By 1932, a crude oil storage tank had been constructed on the Site indicating a change in feedstock to crude oil.

In conjunction with the changes in gas manufacturing processes and feedstocks, came changes in the by-products, residuals, and wastes produced by the processes. Each process produced a tar residual and wastewater. Characteristics of the tars produced varied and were dependent on the process and, to some degree, the type of carburetion oil used in the process. Table 1-1 provides a summary of selected former MGP structures including gas holders, large tanks and other subsurface structures which were identified during the Phase III ESI to have been present at the Site during its use as an MGP. Figure 1-3 shows the location of these structures. The gas holders at the former Third Ward MGP were constructed partially below grade containing a water seal.

Demolition of the MGP began in December 1957 and was completed in October 1959. During the demolition, a total of 816,000 gallons of gas oil were removed from storage tanks and 1,640 tons of scrap metal was removed from the Site. Based upon records reviewed during the preparation of the Phase III ESI, during the demolition the city Building Inspector required the removal of all wood chips and timber cribbing which had been placed in one of the gas holders and purifier boxes.

The land use at the Site after the decommissioning of the MGP includes a variety of commercial and industrial activities. During the period after the decommissioning of the MGP, underground storage tanks (USTs) were installed by the land owners and tenants of the Site in support of their operations. Table 1-2 provides a summary of underground and aboveground tanks which were identified during the Phase III ESI.

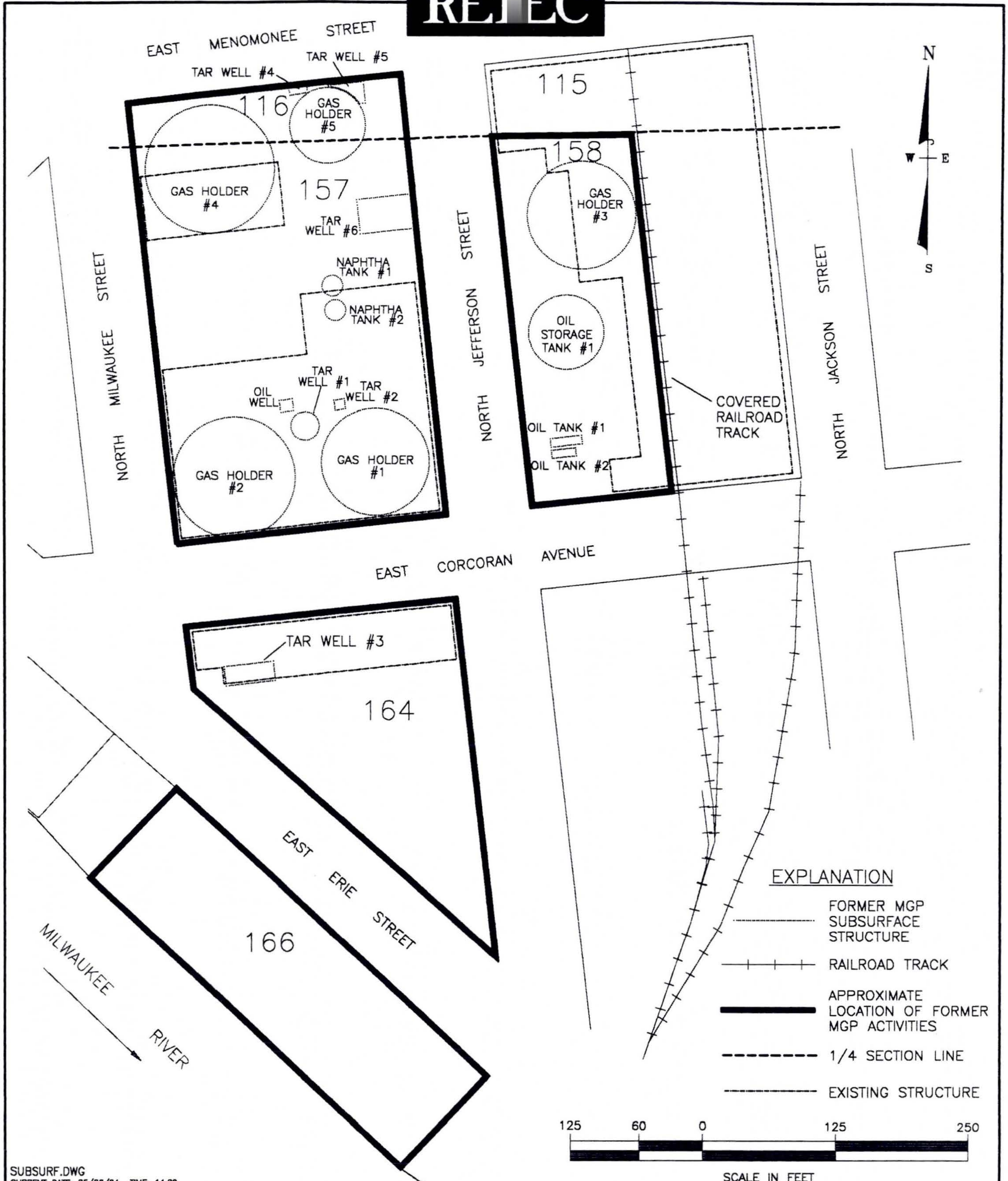
1.3 Existing Environmental Conditions

Structures associated with the former MGP, as well as post- or non-MGP structures, have been identified to exist at the Site through a review and compilation of historical Site information and the completion of the subsurface drilling program. Organic chemical compounds, consisting of Polycyclic Aromatic Hydrocarbons (PAHs), certain Volatile Organic Compounds (VOCs) and groups of organic compounds represented by Gasoline Range Organics (GRO) and Diesel Range Organics (DRO) analyses, have been detected in soil, groundwater and sediment samples collected at the Site. Non-Aqueous Phase Liquids (NAPLs) consisting of Dense NAPLs

TABLE 1-1
DIMENSIONS OF SELECTED SUBSURFACE STRUCTURES
FORMER THIRD WARD MGP SITE

Location	Structure	Approximate Dates Of Operation	Capacity	Areal Dimension (feet)	Estimated Depth (feet)
BLOCK 116	Holder #4	1893-1959	850,000 ft^3	117(a)	20
	Holder #5 Converted to: - Tar Storage	1893-1951 1953-1958	103,000 ft^3 400,000 gal.	65 --	15 --
	Tar Well (Jefferson and Menomonee)	1910-1957	unknown	6x15	unknown
	Tar Well (Jefferson and Menomonee)	1910-1957	unknown	30x20x37	unknown
BLOCK 157	Holder #1	1857-1958	360,000 ft^3	85	20
	Holder #2	1868-1910	180,000 ft^3	108	20
	Tar Well	1868-1894	unknown	19	unknown
	Tar Well	1868-1894	unknown	12	unknown
	Oil Well	1910-1957	unknown	13x13	unknown
	Tar Well	1953-1957	unknown	50x31	unknown
BLOCK 158	Holder #3 Converted to: - Oil Tank #2	1873-1910 1925-1958	157,000 ft^3 850,000/1,200,000 gal.	100	20 14/20
	Drip Water Tank Converted to: - Oil Storage Tank #1	1892-1910 1910-1958	407,000 gal.	120	15
	Naphtha tanks (2) Converted to: - Drip Wells	1894-1910 1910-?	unknown	19	unknown
	Oil tank (Corcoran and Jefferson)	1910-1953	8,000 gal.	10	Horizontal tank
	Oil tank (Corcoran and Jefferson)	1910-1953	6,400 gal.	10	Horizontal tank
BLOCK 164	Tar Vault/Well	1884-1910	unknown	75x20	unknown

(a) Single numerical dimension denotes diameter of circular structure



SUBSURFACE MGP STRUCTURES
THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

FIGURE 1-3

TABLE 1-2
POST- OR NON-MGP UNDERGROUND AND ABOVEGROUND STORAGE TANKS
FORMER THIRD WARD SITE

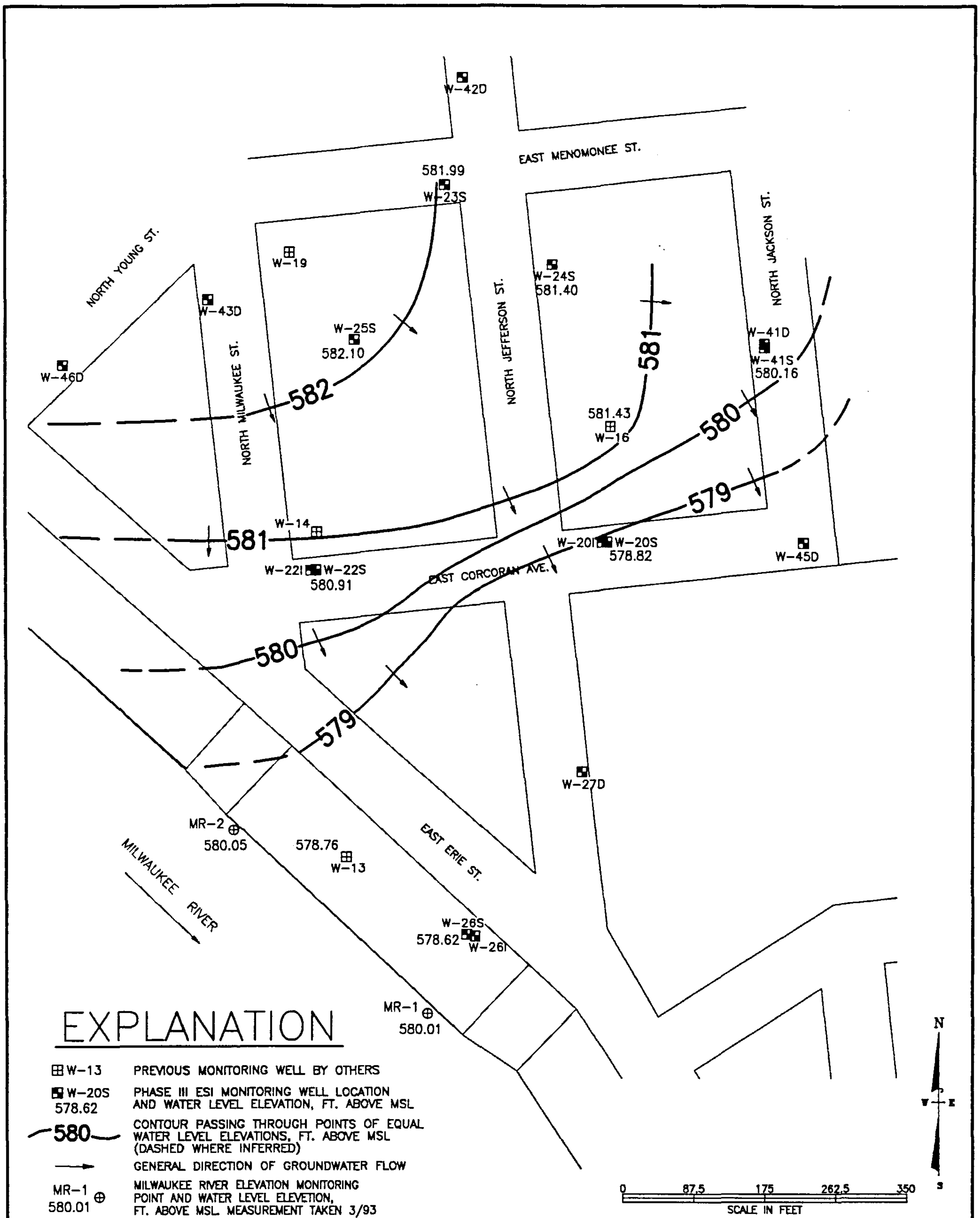
Location	Structure	Approximate Date Installed	Date Removed	Capacity (Gallons)	Present Land Owner	Activity Status
Block 115	Fuel Oil Above Ground Tanks (4)	~1910	Unknown	Unknown	City of Milwaukee	Removed
Block 116	Gasoline UST	1969	October 1991	10,000	Peters=Johnson Investment Company	Removed
Block 157	Diesel UST	1969	Unknown	2,000	Peters=Johnson Investment Company	Unknown
	Waste Oil UST	~1963	In-place	500	Peters=Johnson Investment Company	Inactive: contains liquids and sludge
	Gasoline UST	1962	In-place	10,000	Peters=Johnson Investment Company	Inactive
	Above Ground Tank	Unknown	In-place	275	Peters=Johnson Investment Company	Unknown
Block 158	Gasoline UST	1967	In-place	Unknown	City of Milwaukee	Inactive
	Diesel UST	1967	In-place	Unknown	City of Milwaukee	Inactive
Block 164	Gasoline UST	1962	In-place	1,000	Four Separate Parties	Unknown

(DNAPLs) and Light NAPLs (LNAPLs) have been observed in soil and groundwater. Metals which have been detected in soil and groundwater samples do not indicate that impacts exist at the Site as a result of these constituents. Cyanide was detected, but with a distribution which indicates that impacts resulting from cyanide are isolated to discrete areas of the Site. The organic chemical compounds detected at the Site are present in several media. Organic chemical compounds consisting of PAHs, VOCs, and groups of organic compounds as represented by GRO and DRO analyses are:

- adsorbed to soils above and below the water table;
- adsorbed to river sediments;
- contained in NAPLs, including LNAPLs and DNAPLs, above and below the water table; and
- dissolved in groundwater.

Based on the data collected during the Phase III ESI from monitoring wells installed at the Site, and on regional hydrogeological information, the overall pattern of groundwater flow has generally been defined. Figures 1-4, 1-5 and 1-6 show the groundwater flow patterns at the Site based upon work completed during the Phase III ESI. The groundwater flow shown on Figures 1-4, 1-5 and 1-6 identify flow in the shallow, intermediate and deep zones, respectively, as identified in the Phase III ESI Report. The groundwater at the Site flows in response to hydraulic gradients that have both horizontal and vertical components. The movement of any particular particle of water from a position near the water table surface would initially be southeastward. As the particle of water moves in that direction, it would likely move deeper into the shallow aquifer, along a gently curving flowpath. As distance increases, the water would move downward to a depth at which it would be influenced to a greater degree by the lower potentiometric heads in the bedrock. Shallow groundwater near the river is influenced by the elevation of the river. Increases in the surface of the river elevation may affect shallow groundwater flow near the river. The Phase III ESI Report contains a complete description of the groundwater hydrology at the Site.

As groundwater flows through impacted soils, or soils containing DNAPL or LNAPL, soluble organic chemical compounds dissolve into the groundwater. The dissolved fraction is contained in the flowing groundwater, which redistributes the organic compounds. This redistribution process is controlled by the movement of the groundwater as well as by such processes as attenuation, physical degradation, chemical degradation, microbial degradation and dispersion.

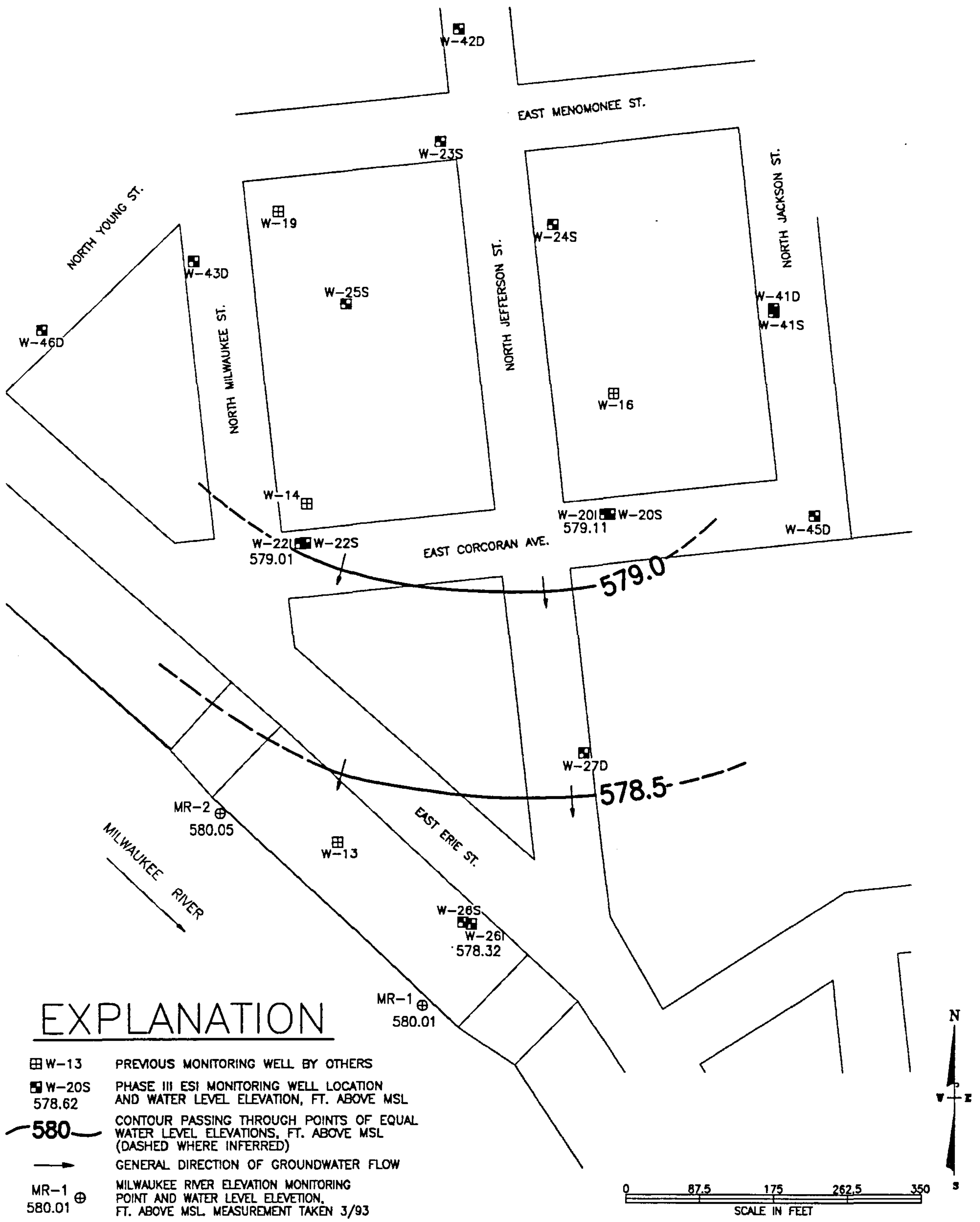


ELEVATIONS OF WATER LEVELS IN SHALLOW WELLS 11/11/92
FORMER THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

RETEC
REMEDIATION TECHNOLOGIES INC

DRAWN BY	DATE	CHECKED BY	DATE	SCALE	DRAWING NUMBER	REV
R.K.K.	7/94			1"=175'	FIGURE 1-4	

887_CONT..DWG



EXPLANATION

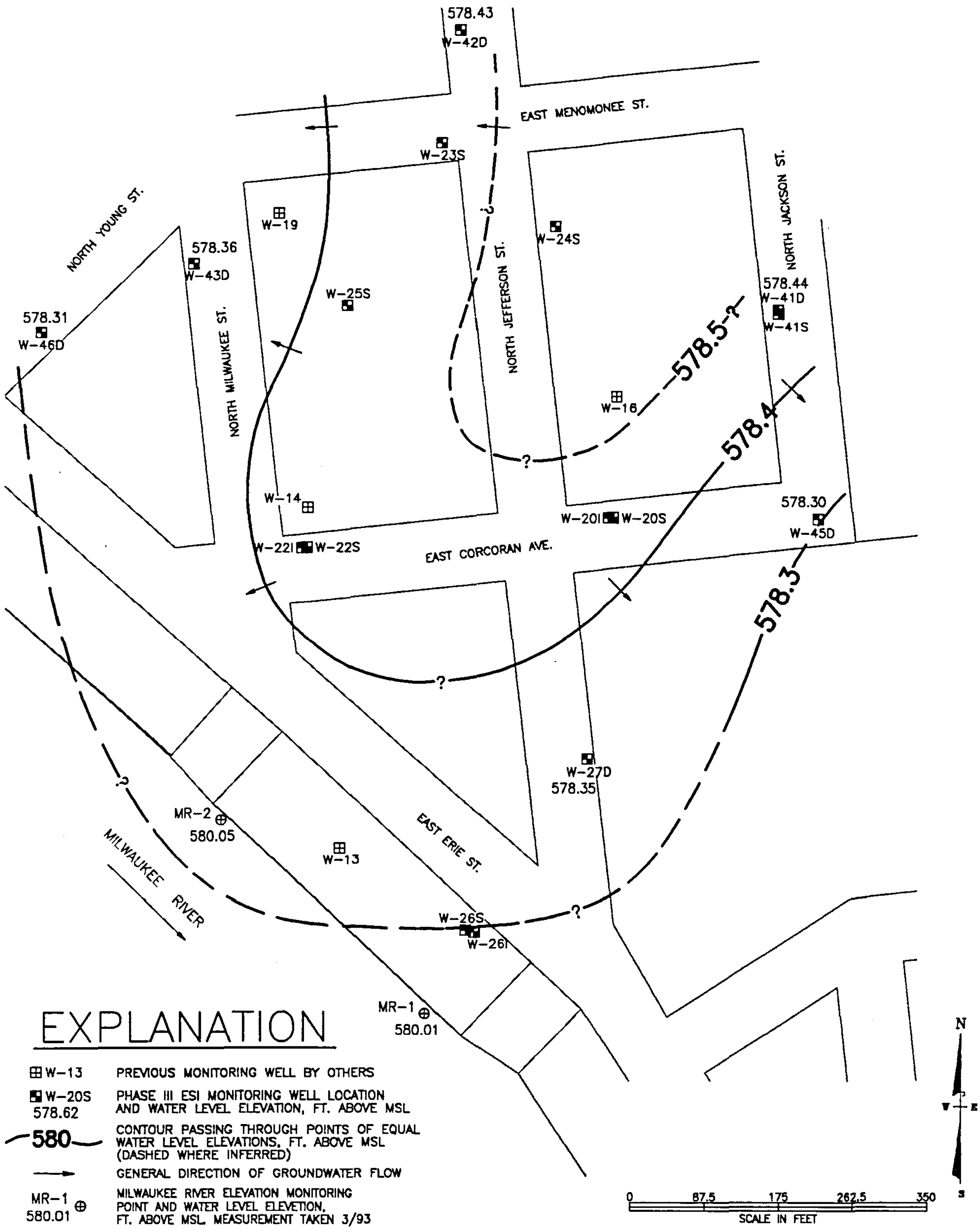
W-13	PREVIOUS MONITORING WELL BY OTHERS
W-20S 578.62	PHASE III ESI MONITORING WELL LOCATION AND WATER LEVEL ELEVATION, FT. ABOVE MSL
580	CONTOUR PASSING THROUGH POINTS OF EQUAL WATER LEVEL ELEVATIONS, FT. ABOVE MSL (DASHED WHERE INFERRED)
→	GENERAL DIRECTION OF GROUNDWATER FLOW
MR-1 580.01	MILWAUKEE RIVER ELEVATION MONITORING POINT AND WATER LEVEL ELEVETION, FT. ABOVE MSL. MEASUREMENT TAKEN 3/93

887_CONT..DWG

ELEVATION OF WATER LEVELS IN INTERMEDIATE WELLS 11/11/92
FORMER THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

RETEC
REMEDIATION TECHNOLOGIES INC

DRAWN BY	DATE	CHECKED BY	DATE	SCALE	DRAWING NUMBER	REV
R.K.K.	7/94			1"=175'	FIGURE 1-5	



EXPLANATION

W-13	PREVIOUS MONITORING WELL BY OTHERS
W-20S 578.62	PHASE III ESI MONITORING WELL LOCATION AND WATER LEVEL ELEVATION, FT. ABOVE MSL
580	CONTOUR PASSING THROUGH POINTS OF EQUAL WATER LEVEL ELEVATIONS, FT. ABOVE MSL (DASHED WHERE INFERRED)
→	GENERAL DIRECTION OF GROUNDWATER FLOW
MR-1 580.01	MILWAUKEE RIVER ELEVATION MONITORING POINT AND WATER LEVEL ELEVETION, FT. ABOVE MSL. MEASUREMENT TAKEN 3/93

ELEVATION OF WATER LEVELS IN DEEP WELLS 11/11/92
FORMER THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

RETEC
REMEDIATION TECHNOLOGIES INC

DRAWN BY	DATE	CHECKED BY	DATE	SCALE	DRAWING NUMBER	REV
R.K.K.	7/94			1"=175'	FIGURE 1-6	

887_CONT..DWG

The movement of NAPLs within the environment varies and depends on the density of the NAPL. LNAPLs are less dense than water and will generally float on the surface of the water table. Movement of LNAPLs will be controlled largely by the gradient of the water tablesurface and will flow from areas of higher water table elevation to areas of lower water table elevation. The movement of DNAPLs differs from that of LNAPLs because DNAPLs are more dense than water. DNAPLs will move downward through the unsaturated and saturated zones until contacting a confining unit. In geologic environments which are characterized by laterally discontinuous horizons of sands, silts and clays, DNAPLs will have a tendency to move downward through the coarser granular sediments (i.e., sands and silts), then laterally along the surface of finer grained sediments (i.e., clays and silty clays). An alternating pattern of downward and lateral movement of DNAPL can continue until contacting the surface of a laterally continuous confining unit. DNAPLs have a tendency to move along the surface of a lower permeability confining unit in the direction of declining topographic elevation and may also collect in depressions on the surface of the confining unit.

A highly plastic clay (i.e., Lower Zone) exists at the Site at depths ranging from approximately 30 to 40 feet below the ground surface. Based upon observations made during the drilling program conducted during the Phase III ESI and the results of the laboratory analyses of soil samples collected from within the Lower Zone, it appears that the clay unit acts as a confining unit with respect to the downward migration of DNAPL.

Other factors which may influence the movement of both LNAPLs and DNAPLs are the presence of subsurface utility piping conduits and cables and the presence of foundations. The construction of utility trenches and foundations typically results in the placement of backfill materials which may be coarser than native soils. This may result in preferential flowpaths for groundwater as well as NAPLs. These preferential flowpaths can influence the lateral migration of NAPLs.

Groundwater samples collected from monitoring wells which are located upgradient/cross-gradient of known former MGP operations had measurable concentrations of both PAHs and VOCs (i.e., monitoring wells W-23S and W-42D). Based on these results, it is possible that upgradient/cross-gradient sources of impacts, not related to the former MGP, exist off site.

Based upon the laboratory analytical results, it appears that benzene and naphthalene have migrated up to several hundred feet downgradient of the source areas. It is possible that detectable benzene and naphthalene have not migrated further in groundwater due to natural processes of attenuation, physical degradation, chemical degradation, microbial degradation and dispersion. Lake and river levels, which affect groundwater flow, may also have influenced the migration of compounds such as naphthalene and benzene. The extent of dissolved benzene and naphthalene in groundwater has not been completely delineated with the existing network of monitoring wells.

2.0 DEVELOPMENT AND PRESENTATION OF REMEDIAL ACTION OBJECTIVES

Remedial action objectives are site-specific goals for protecting public health and the environment. Developing the remedial action objectives for a site is important to the identification of remedial action alternatives and the screening of technologies. The process of developing remedial action objectives includes: identifying chemicals of interest, designating impacted media and potential receptors and exposure pathways, and identifying compliance requirements contained in applicable regulatory standards. The remedial action objectives which have been developed for this Preliminary FS Report are presented at the end of this section.

2.1 Chemicals of Interest

Previous investigations conducted at the Site and knowledge of the former process operations conducted at the Site have resulted in the identification of a set of chemicals of interest. The chemicals of interest at the Site fall into three categories:

- semi-volatile organic compounds consisting of 16 PAHs;
- volatile organic compounds (VOCs) consisting of 8 alkyl-substituted benzene compounds; and
- an inorganic compound, cyanide.

Table 2-1 lists the chemicals of interest for the Site and provides certain physical and chemical properties of the chemicals of interest which will be useful during later stages of the FS and remedial action selection process.

2.2 Media Designation and Potential Receptors and Exposure Pathways

Based on the results of the Phase III ESI, the following four media at the Site may be impacted by one or more of the chemicals of interest listed in Table 2-1, pending definition of appropriate remedial goals:

- subsurface structures;

REIIEC

TABLE 2–1
CHEMICALS OF INTEREST
PHYSICAL AND CHEMICAL PROPERTIES
FORMER THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

Chemicals of Interest	Molecular Weight (g/mol)	Vapor Pressure (mm Hg)	Water Solubility (mg/L)	Henry's Law Constant (atm x m^3/mol)	Specific Density	Log K_{OW}	Log K_{OC}
Polycyclic Aromatic Hydrocarbons							
Acenapthene	154	1.55×10^{-3}@25°C	3.47	1.5×10^{-4}	1.0242	3.92	1.25
Acenaphthylene	152	2.9×10^{-2}@20°C	3.93	2.8×10^{-4}	0.8988	4.07	3.68
Anthracene	178	1.95×10^{-4}@25°C	4.5×10^{-2}	1.4×10^{-3}	1.283	4.45	4.27
Benzo(a)anthracene	228	2.20×10^{-8}@20°C	1.0×10^{-2}	6.6×10^{-7}	1.274	5.61	6.14
Benzo(b)fluoranthene	252	5.00×10^{-7}@20°C	1.40×10^{-2}	1.19×10^{-5}	NA	6.57	5.74
Benzo(k)fluoranthene	252	9.59×10^{-11}@25°C	5.5×10^{-4}	1.04×10^{-3}	NA	6.85	6.64
Benzo(g,h,i)perylene	276	1.04×10^{-10}@25°C	2.6×10^{-4}	1.48×10^{-7}	1.00	7.10	6.26
Benzo(a)pyrene	252	5.49×10^{-9}@25°C	3.00×10^{-3}	1.55×10^{-6}	.351	6.04	6.29
Chrysene	228	6.30×10^{-9}@25°C	1.80×10^{-3}	1.05×10^{-6}	1.274	5.60	5.39
Dibenzo(a,h)anthracene	278	~ 10^{-10}@20°C	5×10^{-4}	7.33×10^{-9}	1.282	6.36	6.22
Fluoranthene	202	1.0×10^{-2}@20°C	2.06×10^{-1}	1.69×10^{-2}	1.252	5.22	4.62
Fluorene	166	1.64×10^{-4}@33.3°C	1.69	2.1×10^{-4}	1.203	4.12	3.70
Indeno(1,2,3–cd)pyrene	276	1.00×10^{-10}@25°C	6.2×10^{-2}	1.00×10^{-10}	NA	7.70	7.49
Naphthalene	128	5.4×10^{-2}@20°C	31.7	4.6×10^{-4}	1.162	3.36	3.11
Phenanthrene	178	6.80×10^{-4}@25°C	1.18	3.9×10^{-5}	0.9800	4.57	3.72
Pyrene	202	6.85×10^{-7}@25°C	1.3×10^{-2}	1.09×10^{-5}	1.271	4.88	4.66
Volatile Organic Compounds							
Benzene	78	75@20°C	1.8×10^{3}	5.48×10^{-3}	0.8765	2.13	1.69
Toluene	92	22@20°C	5.24×10^{2}	6.7×10^{-3}	0.867	2.65	2.06
Ethylbenzene	106	12@30°C	1.87×10^{2}	6.6×10^{-3}	0.8670	3.13	1.98
Xylene (o–, m–, and p–)	106	10@25.9°C	1.98×10^{2}	7.04×10^{-3}	0.8802	2.95	2.11
1,2,4–Trimethylbenzene	120	2.03@25°C	57	6.19×10^{-3}	1.14	3.65	NA
1,3,5–Trimethylbenzene	120	2.42@25°C	97	9.57×10^{-4}	1.16	3.42	2.85
Inorganic Compound							
Cyanide	26	– –	– –	– –	– –	– –	– –

Notes:

NA Not Available

– – Not Applicable

References:

Mackay, D., Shiu, W.Y., and Ma, K.C., 1992, *Illustrated Handbook of Physical–Chemicals Properties and Environmental Fate for Organic Chemicals,* Volumes I and II, Lewis Publisher, Inc., Chelsea, Michigan.

Montgomery, J.H. and Welkom, L.M., 1990, *Groundwater Chemicals Desk Reference,* Lewis Publisher, Inc., Chelsea, Michigan.

Zamuda, C. et al, 1986, *Superfund Public Health Evaluation Manual EPA/540/1–86/060 (Owser Directive 9285.4–1),* Office of Emergency and Remedial Response, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

- soil;
- groundwater; and
- river sediments.

The following subsections describe the four media listed above and potential receptors and exposure pathways associated with each medium.

2.2.1 Subsurface Structures

Historical records and subsurface investigations indicate that portions of structures associated with both former MGP operations and post or non-MGP operations are present in the subsurface at the Site. Existing subsurface structures, the contents of these existing subsurface structures, if any, and impacted soil located immediately outside of the structures are included in this media designation. The contents of the structures may include soil, debris, NAPLs, and water.

Potential receptors of chemicals of interest from subsurface structures include soil above and below the water table, groundwater, and the vapors above the subsurface structures. Unsaturated materials within the structures may leach chemicals of interest into the water present within the structures as a result of precipitation events. Impacted water within a structure could potentially migrate from the structure and impact groundwater and soil below the water table located outside of the structure. Vapor emissions may also occur if volatile organic compounds desorb and migrate upward through the soil matrix.

Potential exposure pathways include direct contact with impacted soil, debris, groundwater, and NAPL as well as inhalation of vapors. Direct contact with the contents of subsurface structures could only occur if on-site workers excavated in the areas of these structures. Direct contact with soil, debris, NAPL or water could occur as a result of excavation. Inhalation of impacted vapors by on-site workers, or others, is also a potential exposure pathway.

2.2.2 Impacted Soil

The impacted soil media designation consists of impacted soil in the unsaturated zone above the groundwater table and the upper two feet of impacted soil below the groundwater table. The groundwater table at the Site is located at depths varying from approximately 4 to 7 feet below the ground surface.

Potential receptors of chemicals of interest from impacted soil include groundwater and vapors above impacted soil. Unsaturated soil above the water table may leach chemicals of interest into the groundwater. Chemicals of interest may also desorb from impacted saturated zone soil and into the groundwater. Vapor emissions may occur if volatile organic compounds desorb from soil and migrate upward through the soil matrix.

Potential exposure pathways include direct contact with impacted soil and inhalation of vapors. Direct contact with impacted soil could only occur if on-site workers excavated in locations where impacted soil was present. Inhalation of vapors by on-site workers, or others, is also a potential exposure pathway.

2.2.3 Impacted Groundwater

The impacted groundwater media designation includes impacted groundwater extending vertically from the surface of the water table to the clay layer that exists at an average depth of approximately 30 to 40 feet below ground surface at the Site. The groundwater table at the Site varies from 4 to 7 feet below the ground surface. NAPLs have also been found at and below the water table at the Site and are included in this media designation. The NAPLs include DNAPLs and LNAPLs. DNAPLs have been found at the surface of the clay layer at approximately 17 to 29 feet below ground surface at monitoring well W-43D. LNAPLs have been found on the water table surface at monitoring well W-16.

Potential receptors of chemicals of interest from groundwater include surface water, off-site groundwater, and soil below the water table. Chemicals of interest could potentially migrate to the river through groundwater transport. Groundwater is also flowing off site, and chemicals of interest could potentially migrate off site through groundwater transport. Soil above the water table may be affected by impacted groundwater due to fluctuations (i.e., rising) in the water table elevation. Soil below the water table could be impacted by flowing groundwater as a result of the partitioning of the chemicals of interest from the groundwater to the soil matrix.

Potential receptors of chemicals of interest from DNAPLs include soil below the water table and groundwater. DNAPLs could impact soils as they migrate downward toward an impermeable layer or along an impermeable layer. Chemicals of interest could also diffuse from the DNAPL into groundwater. Potential receptors of chemicals of interest from LNAPLs include soil below the water table and groundwater as well as soil above the water table. LNAPLs floating on the water table may rise and fall with the water table and chemicals of interest in contact with soil particles may adhere to those soil particles and remain below the water table. When the water table falls, chemicals of interest in contact with soil particles may adhere to those soil particles and remain above the water table. Chemicals of interest from LNAPLs may also diffuse from the LNAPL phase to the groundwater.

Potential exposure pathways include direct contact with groundwater and NAPLs. Direct contact with groundwater and NAPLs could occur when on-site workers perform subsurface work at depths greater than or equal to the depth of the groundwater table, approximately 4 to 7 feet below the ground surface. Direct contact with groundwater and NAPLs may also occur if wells are advanced into the subsurface and groundwater is withdrawn by pumping. The city of Milwaukee has a potable water system which utilizes water from Lake Michigan. This system is used to supply drinking water to residents and businesses in the city, including the Third Ward.

2.2.4 Impacted Sediments

Based on the results presented in the River Sediment Sampling Report, certain sediments in the Milwaukee River, located at the southwest portion of the Site, have been found to contain chemicals of interest. The impacted sediments medium designation includes the sediment particles, water below the river bed extending downward to the clay layer which is located approximately 30 to 40 feet below the water surface, and DNAPLs which were observed in certain sediment borings as noted in the River Sediment Sampling Report.

A potential receptor of chemicals of interest from impacted sediments is surface water. Chemicals of interest could potentially migrate from the river sediments into the surface water above the river bed.

Potential exposure pathways include direct contact with impacted sediment particles, water, and DNAPLs. Direct contact would be limited to when on-site workers are dredging the river bed in the area where impacted sediments have been found or performing underwater work which involves contact with the river sediments. Based on information collected during the River Sediment Sampling Report, the dredging operations conducted for the river channel maintenance is not conducted in the areas where the impacted sediments were found to be present.

2.3 Applicable Standards

Soil quality standards have been proposed by the WDNR in the form of draft rules that may become part of NR 720. NR 720 has not been promulgated, and the proposed soil quality standards are not presently a part of the WDNR regulations. Soil cleanup goals will be set through use of a soil organic leaching model. A soil cleanup goal can be set such that chemicals of interest would not leach to groundwater. The soil leaching model would factor in processes such as sorption, biodegradation, and time of travel. Soil with concentrations of chemicals of interest above the soil cleanup goal, as identified through use of the soil organic leaching model or other WDNR approved approach, would be managed according to the selected alternative. Soil with concentrations below the soil cleanup goal would remain in place, or, if removed to access soil requiring management, be used to backfill the excavation.

Current Wisconsin standards for groundwater are addressed in the March 1994 revisions of NR 140. Groundwater standards only exist for the following chemicals of interest at the Site: benzo(a)pyrene, naphthalene, benzene, toluene, ethylbenzene, and xylenes. The enforcement standards for these chemicals of interest as provided in NR 140 are shown in Table 2-2.

Current Wisconsin surface water quality criteria are addressed in the February 1989 version of NR 105. NR 105 states that, "substances may not be present in surface waters at concentrations which adversely affect public health or welfare, present or prospective uses of surface waters for public or private water supplies, or the protection or propagation of fish or other aquatic life or wild or domestic animal life." The definitions of certain applicable terms are defined in NR 105.

Wisconsin does not have universal sediment cleanup standards. A methodology to obtain site-specific sediment cleanup standards, or Sediment Quality Criteria (SQC) for PAHs in sediments, is addressed in two WDNR guidance documents, consisting of:

- WDNR Background Document on Assessing Ecological Impacts and Threats from Contaminated Sediments, October 1992 (WDNR Background Document); and
- WDNR Guidance for Assessing Ecological Impacts and Threats from Contaminated Sediments, October 1992 (WDNR Guidance Document).

TABLE 2-2
WISCONSIN PUBLIC HEALTH GROUNDWATER QUALITY STANDARDS
(NR 140)

CHEMICAL OF INTEREST	ENFORCEMENT STANDARD (1) (μg/l)
Benzene	5
Benzo(a)pyrene	0.003
Cyanide	200
Ethylbenzene	700
Naphthalene	40
Toluene	343
Xylene (o-, m-, and p-)	620

(1) NR 140 (Revised March 1994)

The WDNR currently recommends that an ecological impact study, as outlined in the WDNR Guidance Document and the WDNR Background Document, be performed to set SQC for a site where sediments have been impacted. An ecological impact study involves the examination of potential adverse effects that the impacted sediments might have on the different trophic levels, from benthic organisms to mammals.

The SQC for PAHs have not been developed for impacted sediments adjacent to the Third Ward Site. Additional effort will be required to develop the SQC for the Site. Input will be required from the WDNR to determine whether there is a need to develop SQC for the Site.

2.4 Remedial Action Objectives

The previous subsections presented the basis for development of remedial action objectives for each of the four designated media the Site. Table 2-3 lists the medium-specific remedial action objectives for the Site.

TABLE 2-3
REMEDIAL ACTION OBJECTIVES
FORMER THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

MEDIUM	REMEDIAL ACTION OBJECTIVE
Subsurface Structures	a. Reduce the potential for migration of chemicals of interest from subsurface structures to groundwater which results in the exceedance of applicable groundwater quality enforcement standards at the point(s) of standards application. b. Control the potential for direct contact with chemicals of interest in subsurface structures.
Impacted Soil	a. Reduce the potential for migration of chemicals of interest from soil to groundwater which results in the exceedance of applicable groundwater quality enforcement standards at the point(s) of standards application. b. Control the potential for direct contact with chemicals of interest in soil.
Impacted Groundwater	a. Reduce the potential for migration of chemicals of interest in groundwater which results in the exceedance of applicable groundwater quality enforcement standards at the point(s) of standards application. b. Reduce the potential for migration of chemicals of interest from groundwater to surface water which results in the exceedance of applicable surface water quality standards.
Impacted River Sediments	a. Reduce the potential for migration of chemicals of interest from river sediments to surface water consistent with the SQC developed for the Site.

3.0 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

3.1 Identification of Remedial Alternatives

RETEC performed a screening of a wide array of remedial technologies and process options. The technology screening was performed on a medium-specific basis to develop a list of technologies which could be combined to form a set of medium-specific remedial alternatives. The four media of interest are subsurface structures, impacted soil, impacted groundwater, and impacted river sediments. During the screening of the remedial technologies and process options, each process option was either retained or eliminated based on the evaluation of two criteria:

- effectiveness; and
- implementability.

A set of medium-specific remedial alternatives has been developed from the list of medium-specific remedial technologies and process options which were retained. Tables 3-1, 3-2, 3-3, and 3-4 outline the medium-specific remedial alternatives. Three medium-specific remedial alternatives were developed for subsurface structures: ALT SS1, ALT SS1, and ALT SS3. Three medium-specific remedial alternatives were developed for impacted soil: ALT SOIL1, ALT SOIL2, and ALT SOIL3. Four medium-specific remedial alternatives were developed for impacted groundwater: ALT GW1, ALT GW2, ALT GW3, and ALT GW4. Four medium-specific remedial alternatives were developed for impacted river sediments: ALT SED1, ALT SED2, ALT SED3, and ALT SED4. The process options which are checked in the column for the particular medium-specific remedial alternatives are possible process options for that remedial alternative (i.e., Tables 3-1, 3-2, 3-3, and 3-4).

Using the medium-specific remedial alternatives as building blocks, site-wide remedial alternatives have been developed as presented in Section 3.1. Section 3.2 provides detailed descriptions of the site-wide remedial alternatives, and Section 3.3 provides a screening of the site-wide remedial alternatives based on Wisconsin Draft Rules, NR 722.

TABLE 3-1
REMEDIAL ALTERNTATIVES
SUBSURFACE STRUCTURES
FORMER THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	ALT SS1 NO ACTION/ MONITORING	ALT SS2 CONTAINMENT	ALT SS3 REMOVAL AND *EX SITU* TREATMENT
No Action	None	None	No action.	✓		
Institutional Controls	Access Restriction	Deed Restriction	Attaching use restrictions or warnings on deeds for property containing impacted media.	✓	✓	✓
		Fencing	Construction of a perimeter barrier to prevent outside contact with impacted media.	✓	✓	✓
		Buried Utility Notification	Provide written notification to utility companies with warnings about potentially impacted areas.	✓	✓	✓
Monitoring	Groundwater and Air Monitoring	Groundwater Monitoring Wells	Collection of groundwater and/or surface water samples to monitor affected or potentially affected areas.	✓	✓	✓
		Air Monitoring System	Collection of air samples to monitor affected or potentially affected areas.	✓	✓	✓
Containment	Horizontal Containment	Cap/Cover	A cap/cover consisting of clay, synthetic membrane, or other impermeable material placed over an impacted area to prevent migration of chemicals of interest to other media due to water percolation.		✓	
Removal	Dismantling	Dismantling	Use of mechanical equipment to demolish large structures, making its components amendable to processing and/or handling.			✓
	Excavation	Excavation	Removal of soil, debris, and/or NAPL from the ground by means of mechanical equipment for *ex situ* treatment, storage, or disposal.			✓
Disposal	Permitted Landfill	Permitted Landfill	Removal and transport of wastes to the site of an existing secure landfill, and placement and compaction within that facility.			✓
Treatment	Decontamination	Decontamination	Pressure cleaning or other method to remove impacted surface materials from structures and debris prior to handling or disposal.			✓

RETEC

TABLE 3-1 (PAGE 2 OF 2)
REMEDIAL ALTERNATIVES
SUBSURFACE STRUCTURES
FORMER THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	ALT SS1 NO ACTION/ MONITORING	ALT SS2 CONTAINMENT	ALT SS3 REMOVAL AND *EX SITU* TREATMENT
	Ex Situ Physical/Chemical	Screening	Separation of fine solids from coarse solids by running all solids through a sieve.			✓
		Stabilization	Technique to alter characteristics or prevent the migration of chemicals of interest by addition of chemical or physical complexing agents.			✓
	Ex Situ Thermal	Incineration	High temperature oxidation of organics in any one of a number of incineration units including, but not limited to, fluidized bed/circulating bed combustion, infrared, or rotary kiln.			✓
		Thermal Decomposition	Thermal decomposition at high termperature in a direct-fired rotary aggregate dryer-type unit.			✓
Resource Recovery	Reuse	Direct Fuel Use	High temperature oxidation of organic wastes as a supplemental fuel in a boiler or industrial furnace.			✓
		Use as Feedstock (Asphalt Plants, Brick Mfg., or Cement Kilns)	Recovery, pretreatment, if needed, and transport of waste materials and impacted soils for addition as supplemental material in asphalt batch plants or cement kilns.			✓

TABLE 3-2
REMEDIAL ALTERNATIVES
IMPACTED SOIL
FORMER THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	ALT SOIL1 NO ACTION/ MONITORING	ALT SOIL2 CONTAINMENT	ALT SOIL3 REMOVAL AND *EX SITU* TREATMENT
No Action	None	None	No action.	✓		
Institutional Controls	Access Restriction	Deed Restriction	Attaching use restrictions or warnings on deeds for property containing impacted media.	✓	✓	✓
		Fencing	Construction of perimeter barrier to prevent outside contact with impacted media.	✓	✓	✓
		Buried Utility Notification	Provide written notification to utility companies with warnings about potentially impacted areas.	✓	✓	✓
Monitoring	Groundwater and Air Monitoring	Groundwater Monitoring Wells	Collection of groundwater and/or surface water samples to monitor affected or potentially affected areas.	✓	✓	✓
		Air Monitoring System	Collection of air samples to monitor affected or potentially affected areas.	✓	✓	✓
Containment	Horizontal Containment	Cap/Cover	A cap/cover consisting of clay, synthetic membrane, or other impermeable material placed over an impacted area to prevent migration of chemicals of interest to other media due to water percolation.		✓	
Removal	Excavation	Excavation	Removal of soil, debris, and/or NAPL from the ground by means of mechanical equipment for *ex situ* treatment, storage, or disposal.			✓
Disposal	Permitted Landfill	Permitted Landfill	Removal and transport of wastes to the site of an existing secure landfill, and placement and compaction within that facility.			✓
Treatment	*Ex Situ* Physical/Chemical	Screening	Separation of fine solids from coarse solids by running all solids through a sieve.			✓
		Stabilization	Technique to alter characteristics or prevent the migration of chemicals of interest by addition of chemical or physical complexing agents.			✓

TABLE 3-2 (PAGE 2 OF 2)
REMEDIAL ALTERNATIVES
IMPACTED SOIL
FORMER THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	ALT SOIL1 NO ACTION/ MONITORING	ALT SOIL2 CONTAINMENT	ALT SOIL3 REMOVAL AND *EX SITU* TREATMENT
Treatment (continued)	*Ex Situ* Thermal	Incineration	High temperature oxidation of organics in any one of a number of incineration units including, but not limited to, fluidized bed/circulating bed combustion, infrared, or rotary kiln.			✓
		Thermal Decomposition	Thermal decomposition at high temperature in a direct-fired rotary aggregate dryer-type unit.			✓
Resource Recovery	Reuse	Use as Feedstock (Asphalt Plants, Brick Mfg., or Cement Kilns)	Recovery, pretreatment, if needed, and transport of waste materials and impacted soils for addition as supplemental material in asphalt batch plants or cement kilns.			✓

TABLE 3-3
REMEDIAL ALTERNATIVES
IMPACTED GROUNDWATER
FORMER THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	ALT GW1 NO ACTION/ MONITORING	ALT GW2 *IN SITU* TREATMENT	ALT GW3 GROUNDWATER REMOVAL AND *EX SITU* TREATMENT	ALT GW4 SUBSURFACE FLUSHING AND *IN SITU* TREATMENT
No Action	None	None	No action.	✓			
Institutional Controls	Access Restriction	Deed Restriction	Attaching use restrictions or warnings on deeds for property containing impacted media.	✓	✓	✓	✓
		Ordinance Restriction	Establish local ordinance to restrict drilling in or using the impacted aquifer.	✓	✓	✓	✓
		Buried Utility Notification	Provide written notification to utility companies with warnings about potentially impacted areas.	✓	✓	✓	✓
Monitoring	Groundwater and Air Monitoring	Groundwater Monitoring Wells	Collection of groundwater and/or surface water samples to monitor affected or potentially affected areas.	✓	✓	✓	✓
		Air Monitoring System	Collection of air samples to monitor affected or potentially affected areas.	✓	✓	✓	✓
Containment	Vertical Containment	Hydraulic Containment	Pumping wells are used to create a hydraulic gradient for containing a groundwater contaminant plume.			✓	✓
Removal	Subsurface Flushing	Subsurface Flushing	Water containing additives and/or heat is circulated through impacted subsurface zone to recover NAPL.				✓
Disposal	Disposal of Waters	NPDES Discharge to Surface Water or POTW Discharge	Discharge of treated or untreated groundwater to a receiving body of water (NPDES) or to the local publicly owned treatment works (POTW).			✓	✓

TABLE 3-3 (PAGE 2 OF 3)
REMEDIAL ALTERNATIVES
IMPACTED GROUNDWATER
FORMER THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	ALT GW1 NO ACTION/ MONITORING	ALT GW2 *IN SITU* TREATMENT	ALT GW3 GROUNDWATER REMOVAL AND *EX SITU* TREATMENT	ALT GW4 SUBSURFACE FLUSHING AND *IN SITU* TREATMENT
Treatment	*Ex Situ* Biological	Fixed Bed	Degradation of chemicals of interest by microorganisms attached to a fixed media.			✓	✓
		Fluidized Bed	Buildup of an active biomass on a suspended bed of particles to treat wastewaters			✓	✓
	Ex Situ Physical/Chemical	Carbon Adsorption	Adsorption of selected dissolved chemicals of interest on the surface of activated carbon, an inert, highly porous material.			✓	✓
		Chemical Coagulation/Floc-culation	Agglomeration of small, non-settling suspended particles into larger, more settleable particles by adding a flocculating agent.			✓	✓
		Chemical Oxidation	Process by which oxidizing agents decompose organic and inorganic chemicals of interest to CO_2, H_2O and innocuous salts.			✓	✓
		Dissolved Air Flotation	Removal of solids by attachment to microbubbles released upon depressurization of the water.			✓	✓
		Filtration	Removal of suspended solids by passing water through a porous material.			✓	✓
		Gravity Separation	Separation of fluids or suspended solids due to differences in specific gravity (may be enhanced in water or wastewater by chemical coagulation/flocculation.			✓	✓

RETEC

TABLE 3-3 (PAGE 3 OF 3)
REMEDIAL ALTERNATIVES
IMPACTED GROUNDWATER
FORMER THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	ALT GW1 NO ACTION/ MONITORING	ALT GW2 *IN SITU* TREATMENT	ALT GW3 GROUNDWATER REMOVAL AND *EX SITU* TREATMENT	ALT GW4 SUBSURFACE FLUSHING AND *IN SITU* TREATMENT
Treatment (continued)		Neutralization	Use of acid/alkaline steams to meet discharge requirements, results in precipitation of certain constituents, or controls a desired chemical reaction.			✓	✓
		Precipitation	Alteration of ionic equilibrium to produce insoluble precipitates that can be removed by sedimentation/ filtration.			✓	✓
	In Situ Biological	Groundwater Aeration	Increasing the oxygen concentration in groundwater by injecting a source of oxygen such as air, pure oxygen, or hydrogen peroxide. Addition of nutrients and/or microbes may be necessary.		✓		✓

TABLE 3-4
REMEDIAL ALTERNATIVES
IMPACTED RIVER SEDIMENTS
FORMER THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	ALT SED1 NO ACTION/ MONITORING	ALT SED2 *IN SITU* STABILIZATION	ALT SED3 *IN SITU* TREATMENT	ALT SED4 REMOVAL AND *EX SITU* TREATMENT
No Action	None	None	No Action.	✓			
Institutional Controls	Access Restriction	Buried Utility Notification	Provide written notification to utility companies with warnings about potentially impacted areas.	✓	✓	✓	✓
Monitoring	Surface Water Monitoring	Surface Water Monitoring	Collection of surface water samples to monitor affected or potentially affected areas.	✓	✓	✓	✓
Containment	Vertical Containment	Impermeable Flexible Barrier	Impermeable flexible barrier such as HDPE is mounted in a rigid frame and driven into the sediments forming a vertical synthetic barrier to control the migration of chemicals of interest.		✓	✓	✓
		Sheet Piles	Long, thin sheeting is hammered into the ground forming a vertical metal barrier to control the migration of chemicals of interest.		✓	✓	✓
Removal	Dredging	Conventional	Performed in-stream, a barge equipped with mechanical equipment such as backhoes, clamshells, crane-mounted draglines or bucket loaders are used to remove sediments.				✓
		Hydraulic	Performed in-stream, a cutting and/or suction apparatus is used to collect contaminated sediments, which are then collected and drawn through a floating pipeline to a temporary storage facility on land.				✓
	Excavation	Excavation	Removal of sediments and/or NAPL by means of mechanical equipment for *ex situ* treatment, storage, or disposal.				✓

TABLE 3-4 (PAGE 2 OF 2)
REMEDIAL ALTERNATIVES
IMPACTED RIVER SEDIMENTS
FORMER THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	ALT SED1 NO ACTION/ MONITORING	ALT SED2 *IN SITU* STABILIZATION	ALT SED3 *IN SITU* TREATMENT	ALT SED4 REMOVAL AND *EX SITU* TREATMENT
Disposal	Permitted Landfill	Permitted Landfill	Removal and transport of wastes to the site of an existing secure landfill, and placement and compaction within that facility.				✓
Treatment	*Ex Situ* Biological	Liquid/Solid Bioslurry	Enhanced biodegradation by increasing the mass transfer of organics into the aqueous phase.				✓
	Ex Situ Physical/ Chemical	Centrifigation	Liquids and solids are separated by application of a centrifugal force to the fluid in the confines of a vessel. Analogous to sedimentation, but the applied force is several thousand times greater.				✓
		Filtration	Physical removal of suspended solids from water by passing it through a porous media.				✓
		Stabilization	Technique to alter characteristics or prevent the migration of chemicals of interest by addition of chemical or physical complexing agents.				✓
	In Situ Biological	Liquid/Solid Bioslurry	Enhances biodegradation by increasing the mass transfer of organics into the aqueous phase.			✓	
	In Situ Physical/Chemical	Stabilization	Technique to alter characteristics or prevent migration of chemicals of interest by addition of chemical or physical complexing agents.		✓		

3.2 Development of Alternatives

Ten site-wide remedial alternatives were developed by combining the medium-specific remedial alternatives identified in Tables 3-1 through 3-4. The site-wide remedial alternatives are summarized in Table 3-5, and are named ALT-1, ALT-2, ALT-3, ALT-4, ALT-5, ALT-6, ALT-7, ALT-8, ALT-9 and ALT-10.

The site-wide remedial alternatives are broadly described as follows:

- ALT-1: no action/monitoring;
- ALT-2: containment;
- ALT-3: removal and *ex situ* treatment of structures and soil, *in situ* biological treatment of groundwater, and no action on river sediments;
- ALT-4: removal and *ex situ* treatment of structures and soil, *in situ* biological treatment of groundwater, and *in situ* stabilization of river sediments;
- ALT-5: removal and *ex situ* treatment of structures and soil, *in situ* biological treatment of groundwater, and *in situ* biological treatment of river sediments;
- ALT-6: removal and *ex situ* treatment of structures and soil, *in situ* biological treatment of groundwater, and removal and *ex situ* treatment of river sediments;
- ALT-7: removal and *ex situ* treatment of structures and soil, *in situ* biological treatment of groundwater plus removal of DNAPL by flushing, and no action on river sediments;
- ALT-8: removal and *ex situ* treatment of structures and soil, *in situ* biological treatment of groundwater plus removal of DNAPL by flushing, and *in situ* stabilization of river sediments;
- ALT-9: removal and *ex situ* treatment of structures and soil, *in situ* biological treatment of groundwater plus removal of DNAPL by flushing, and *in situ* biological treatment of river sediments; and

TABLE 3-5
SITE-WIDE REMEDIAL ALTERNATIVES
FORMER THIRD WARD MGP SITE
MILWAUKEE, WISCONSIN

SITE-WIDE ALTERNATIVE	MEDIUM-SPECIFIC ALTERNATIVES			
	SUBSURFACE STRUCTURES	IMPACTED SOIL	IMPACTED GROUNDWATER	IMPACTED RIVER SEDIMENTS
ALT-1: No Action/Monitoring	No Action	No Action	No Action/Monitoring	No Action/Monitoring
ALT-2: Containment	Capping	Capping	Hydraulic Containment and *Ex situ* Treatment	No Action/Monitoring
ALT-3: Structure and Soil Removal, *in situ* Biological Treatment of Groundwater, and No Action on River Sediments	Removal and *Ex situ* Treatment	Removal and *Ex situ* Treatment	*In situ* Biological Treatment	No Action/Monitoring
ALT-4: Structure and Soil Removal, *in situ* Biological Treatment of Groundwater, and *in situ* Stabilization of River Sediments	Removal and *Ex situ* Treatment	Removal and *Ex situ* Treatment	*In situ* Biological Treatment	*In situ* Stabilization
ALT-5: Structure and Soil Removal, *in situ* Biological Treatment of Groundwater, and *in situ* Biological Treatment of River Sediments	Removal and *Ex situ* Treatment	Removal and *Ex situ* Treatment	*In situ* Biological Treatment	*In situ* Biological Treatment by Slurry
ALT-6: Structure and Soil Removal, *in situ* Biological Treatment of Groundwater, and *ex situ* Treatment of River Sediments	Removal and *Ex situ* Treatment	Removal and *Ex situ* Treatment	*In situ* Biological Treatment	Removal by Dredging and *Ex situ* Treatment
ALT-7: Structure and Soil Removal, *in situ* Biological Treatment of Groundwater plus DNAPL Removal by Flushing, and No Action on River Sediments	Removal and *Ex situ* Treatment	Removal and *Ex situ* Treatment	*In situ* Biological Treatment and DNAPL Removal by Flushing	No Action/Monitoring
ALT-8: Structure and Soil Removal, *in situ* Biological Treatment of Groundwater plus DNAPL Removal by Flushing, and *in situ* Stabilization of River Sediments	Removal and *Ex situ* Treatment	Removal and *Ex situ* Treatment	*In situ* Biological Treatment and DNAPL Removal by Flushing	*In situ* Stabilization
ALT-9: Structure and Soil Removal, *in situ* Biological Treatment of Groundwater plus DNAPL Removal by Flushing, and *in situ* Biological Treatment of River Sediments	Removal and *Ex situ* Treatment	Removal and *Ex situ* Treatment	*In situ* Biological Treatment and DNAPL Removal by Flushing	*In situ* Biological Treatment by Slurry
ALT-10: Structure and Soil Removal, *in situ* Biological Treatment of Groundwater plus DNAPL Removal by Flushing, and *ex situ* Treatment of River Sediments	Removal and *Ex situ* Treatment	Removal and *Ex situ* Treatment	*In situ* Biological Treatment and DNAPL Removal by Flushing	Removal by Dredging and *Ex situ* Treatment

above or at watertable

including tar layers

- ALT-10: removal and *ex situ* treatment of structures and soil, *in situ* biological treatment of groundwater and plus removal of DNAPL by flushing, and removal and *ex situ* treatment of river sediments.

In Table 3-5, the term, *Ex situ* Treatment denotes the potential use of a set of treatment and resource recovery remedial technologies or process options. The following describes how the term *Ex situ* Treatment is applied for each media:

- *Ex situ* Treatment of Subsurface Structures - this includes reuse and/or one or more of the following treatments: decontamination, screening, stabilization, incineration, thermal decomposition, and reuse.

- *Ex situ* Treatment of Impacted Soil - this includes reuse and/or one or more of the following treatments: screening, stabilization, incineration, thermal decomposition, and reuse.

- *Ex situ* Treatment of Impacted Groundwater - this includes one or more of the following treatments: fixed or fluidized bed, carbon adsorption, chemical coagulation/flocculation, chemical oxidation, dissolved air flotation, filtration, gravity separation, neutralization, and precipitation.

- *Ex situ* Treatment of Impacted River Sediments - this includes one or more of the following treatments: liquid/solid bioslurry, centrifugation, filtration, and stabilization.

These *Ex situ* Treatment options have not specifically been selected at this point in the FS process, because inadequate information is available to assess the effectiveness of one of these process options versus another. Every alternative option also includes institutional controls such as deed restrictions, fences, buried utility notification and groundwater, air, and/or surface water monitoring.

3.3 Description of Alternatives

This section is divided into ten subsections, each of which describe in detail one of the (i.e., institutional controls and monitoring) site-wide remedial alternatives. To avoid repetition, certain process options (i.e., institutional controls and monitoring) which are common to all site-wide remedial alternatives are described here first, and then mentioned by name in the remedial alternative descriptions.

Institutional Controls:

Deed Restriction/Ordinance Restriction: Each site-wide alternative includes amending the property deeds by adding warnings and/or restrictions for invasive construction activities such as excavation, demolition or disturbance of a cap (e.g., asphalt pavement), and drilling. These restrictions will also stipulate limitations on groundwater usage. Maintenance requirements will also be identified for any cap structure constructed on the Site.

Fencing: Each Site-wide alternative includes construction of a fence around the perimeter of work areas during any excavation or removal activities to prevent unauthorized entry. Fencing will also be placed around process equipment and treatment systems to secure these areas from unauthorized access.

Buried Utility Notification: Each site-wide alternative includes a provision for written notification of all local utilities about potentially impacted areas. This warning would include detailed descriptions of the type of potential impacts and would identify potentially impacted areas.

Monitoring:

Long-Term Groundwater, Air and Surface Water Monitoring: Groundwater, air, and/or surface water monitoring would, as appropriate, be a component of all site-wide alternatives. The monitoring will include regularly scheduled collection of groundwater, air, and/or surface water samples for laboratory analysis for chemicals of interest. Monitoring will also include water level measurements to ascertain the direction of groundwater flow.

ALT-1: No Action/Monitoring

Site-wide remedial alternative ALT-1 involves implementation of institutional controls and monitoring only. The specific actions were described previously.

ALT-2: Containment

Site-wide remedial alternative ALT-2 involves implementation of institutional controls and monitoring as described previously, combined with the following for each of the media:

Subsurface Structures and Contents: This remedial alternative for subsurface structures includes placement of a cap/cover. The cap/cover constructed over the impacted structures would minimize potential future migration of chemicals of interest from the unsaturated zone to the water table.

Soil: This remedial alternative for soil includes placement of a cap/cover. The cap/cover constructed over impacted soil would minimize potential future migration of chemicals of interest from the unsaturated zone to the water table.

Groundwater: This remedial alternative for groundwater includes hydraulic containment and DNAPL removal using recovery wells with treatment and disposal of recovered water. Pumping wells would be used to create a hydraulic gradient such that impacted groundwater would be captured and treated. Recovery wells would also be installed to recover DNAPL. Pumped groundwater would be treated with one or more treatment processes before discharge.

Sediments: This remedial alternative for sediments includes no action except for surface water monitoring.

ALT-3: Structure and Soil Removal, *in situ* Biological Treatment of Groundwater, and No Action on River Sediments

Site-wide remedial alternative ALT-3 involves implementation of institutional controls and monitoring as described previously, combined with the following for each of the media:

Subsurface Structures and Contents: This remedial alternative for subsurface structures includes removal, treatment, and disposal of materials within the structures. The structure walls and bottoms would be demolished, decontaminated, and disposed of, as needed. The resulting excavation would be backfilled with clean fill.

Soil: This remedial alternative for soil includes removal, treatment, and disposal of impacted soils. The resulting excavation would be backfilled with clean fill.

Groundwater: This remedial alternative for groundwater includes *in situ* bioremediation. Bioremediation would increase the oxygen and the nutrient content of the groundwater to stimulate aerobic degradation of the chemicals of interest by indigenous microorganisms. If an appropriate indigenous microbial population does not exist at the Site, suitable microbes could be introduced.

Sediments: This remedial alternative for sediments includes no action except for surface water monitoring.

ALT-4: Structure and Soil Removal, *in situ* Biological Treatment of Groundwater, and *in situ* Stabilization of River Sediments

Site-wide remedial alternative ALT-4 involves implementation of institutional controls and monitoring as described previously, combined with the following for each of the media:

Subsurface Structures and Contents: This remedial alternative for subsurface structures includes removal, treatment, and disposal of materials within the structures. The structure walls and bottoms would be demolished, decontaminated, and disposed of, as needed. The resulting excavation would be backfilled with clean fill.

Soil: This remedial alternative for soil includes removal, treatment, and disposal of impacted soils. The resulting excavation would be backfilled with clean fill.

Groundwater: This remedial alternative for groundwater includes *in situ* bioremediation. Bioremediation would increase the oxygen and the nutrient content of the groundwater to stimulate aerobic degradation of the chemicals of interest by indigenous microorganisms. If an appropriate indigenous microbial population does not exist at the Site, suitable microbes could be introduced.

Sediments: This remedial alternative for sediments includes the *in situ* stabilization of the river sediments. A temporary vertical barrier would be constructed to minimize the short term migration potential of the chemicals of interest to the surrounding surface water.

ALT-5: Structure and Soil Removal, *in situ* Biological Treatment of Groundwater, and *in situ* Biological Treatment of River Sediments

Site-wide remedial alternative ALT-5 involves implementation of institutional controls and monitoring as described previously, combined with the following for each of the media:

Subsurface Structures and Contents: This remedial alternative for subsurface structures includes removal, treatment, and disposal of materials within the structures. The structure walls and bottoms would be demolished, decontaminated, and disposed of, as needed. The resulting excavation would be backfilled with clean fill.

Soil: This remedial alternative for soil includes removal, treatment, and disposal of impacted soils. The resulting excavation would be backfilled with clean fill.

Groundwater: This remedial alternative for groundwater includes *in situ* bioremediation. Bioremediation would increase the oxygen and the nutrient content of the groundwater to stimulate aerobic degradation of the chemicals of interest by indigenous microorganisms. If an appropriate indigenous microbial population does not exist at the Site, suitable microbes could be introduced.

Sediments: This remedial alternative for sediments includes implementation of an *in-situ* liquid/slurry bioslurry system to biologically treat the sediments. A vertical barrier would be constructed around the periphery of the treatment area to prevent the chemicals of interest from migrating to surface water.

ALT-6: Structure and Soil Removal, *in situ* Biological Treatment of Groundwater, and *ex situ* Treatment of River Sediments

Site-wide remedial alternative ALT-6 involves implementation of institutional controls and monitoring as described previously, combined with the following for each of the media:

Subsurface Structures and Contents: This remedial alternative for subsurface structures includes removal, treatment, and disposal of materials within the structures. The structure walls and bottoms would be demolished, decontaminated, and disposed of, as needed. The resulting excavation would be backfilled with clean fill.

Soil: This remedial alternative for soil includes removal, treatment, and disposal of impacted soils. The resulting excavation would be backfilled with clean fill.

Groundwater: This remedial alternative for groundwater includes *in situ* bioremediation. Bioremediation would increase the oxygen and the nutrient content of the groundwater to stimulate aerobic degradation of the chemicals of interest by indigenous microorganisms. If an appropriate indigenous microbial population does not exist at the Site, suitable microbes could be introduced.

Sediments: This remedial alternative for sediments includes removal of impacted sediments via dredging and dewatering, treatment, and off-site disposal of the dredged sediments. A vertical barrier would be constructed to minimize the migration of chemicals of interest to surface water during the dredging.

ALT-7: Structure and Soil Removal, *in situ* Biological Treatment of Groundwater plus DNAPL Removal by Flushing, and No Action on River Sediments

Site-wide remedial alternative ALT-7 involves implementation of institutional controls and monitoring as described previously, combined with the following for each of the media:

Subsurface Structures and Contents: This remedial alternative for subsurface structures includes removal, treatment, and disposal of materials within the structures. The structure walls and bottoms would be demolished, decontaminated, and disposed of, as needed. The resulting excavation would be backfilled with clean fill.

Soil: This remedial alternative for soil includes removal, treatment, and disposal of impacted soils. The resulting excavation would be backfilled with clean fill.

Groundwater: This remedial alternative for groundwater includes hydraulic containment, *in situ* bioremediation and DNAPL removal using flushing with water treatment and disposal. Bioremediation includes increasing the oxygen and the nutrient content of the groundwater to stimulate aerobic degradation of the chemicals of interest by indigenous microorganisms. If an appropriate indigenous microbial population does not exist at the Site, suitable microbes could be introduced. Flushing of DNAPL would be accomplished by circulating hot water, or water with additives, through areas which contain DNAPL. Pumped groundwater may be treated with one or more treatment processes before being discharged.

Sediments: This remedial alternative for sediments includes no action except for surface water monitoring.

ALT-8: Structure and Soil Removal, *in situ* Biological Treatment of Groundwater plus DNAPL Removal by Flushing, and *in situ* Stabilization of River Sediments

Site-wide remedial alternative ALT-8 involves implementation of institutional controls and monitoring as described previously, combined with the following for each of the media:

Subsurface Structures and Contents: This remedial alternative for subsurface structures includes removal, treatment, and disposal of materials within the structures. The structure walls and bottoms would be demolished, decontaminated, and disposed of, as needed. The resulting excavation would be backfilled with clean fill.

Soil: This remedial alternative for soil includes removal, treatment, and disposal of impacted soils. The resulting excavation would be backfilled with clean fill.

Groundwater: This remedial alternative for groundwater includes hydraulic containment, *in situ* bioremediation and DNAPL removal using flushing coupled with water treatment and disposal. Bioremediation includes increasing the oxygen and the nutrient content of the groundwater to stimulate aerobic degradation of the chemicals of interest by indigenous microorganisms. If an appropriate indigenous microbial population does not exist at the Site, suitable microbes could be introduced. Flushing of DNAPL would be accomplished by circulating hot water, or water with additives, through areas which contain DNAPL. Pumped groundwater may be treated with one or more treatment processes before being discharged.

Sediments: This remedial alternative for sediments includes the *in situ* stabilization of the river sediments. A temporary vertical barrier would be constructed to minimize the short term migration potential of the chemicals of interest to the surrounding surface water.

ALT-9: Structure and Soil Removal, *in situ* Biological Treatment of Groundwater plus DNAPL Removal by Flushing, and *in situ* Biological Treatment of River Sediments

Site-wide remedial alternative ALT-9 involves implementation of institutional controls and monitoring as described previously, combined with the following for each of the media:

Subsurface Structures and Contents: This remedial alternative for subsurface structures includes removal, treatment, and disposal of materials within the structures. The structure walls and bottoms would be demolished, decontaminated, and disposed of, as needed. The resulting excavation would be backfilled with clean fill.

Soil: This remedial alternative for soil includes removal, treatment, and disposal of impacted soils. The resulting excavation would be backfilled with clean fill.

Groundwater: This remedial alternative for groundwater includes hydraulic containment, *in situ* bioremediation and DNAPL removal using flushing coupled with water treatment and disposal. Bioremediation includes increasing the oxygen and the nutrient content of the groundwater to stimulate aerobic degradation of the chemicals of interest by indigenous microorganisms. If an appropriate indigenous microbial population does not exist at the Site, suitable microbes could be introduced. Flushing of DNAPL would be accomplished by circulating hot water, or water with additives, through areas which contain DNAPL. Pumped groundwater may be treated with one or more treatment processes before being discharged.

Sediments: This remedial alternative for sediments includes implementation of an *in-situ* liquid/slurry bioslurry system to biologically treat the sediments. A vertical barrier would be constructed around the periphery of the treatment area to prevent the chemicals of interest from migrating to surface water.

ALT-10: Structure and Soil Removal, *in situ* Biological Treatment of Groundwater plus DNAPL Removal by Flushing, and *ex situ* Treatment of River Sediments

Site-wide remedial alternative ALT-10 involves implementation of institutional controls and monitoring as described previously, combined with the following for each of the media:

Subsurface Structures and Contents: This remedial alternative for subsurface structures includes removal, treatment, and disposal of materials within the structures. The structure walls and bottoms would be demolished, decontaminated, and disposed of, as needed. The resulting excavation would be backfilled with clean fill.

Soil: This remedial alternative for soil includes removal, treatment, and disposal of impacted soils. The resulting excavation would be backfilled with clean fill.

Groundwater: This remedial alternative for groundwater includes hydraulic containment, *in situ* bioremediation and DNAPL removal using flushing coupled with water treatment and disposal. Bioremediation includes increasing the oxygen and the nutrient content of the groundwater to stimulate aerobic degradation of the chemicals of interest by indigenous microorganisms. If an appropriate indigenous microbial population does not exist at the Site, suitable microbes could be introduced. Flushing of DNAPL would be accomplished by circulating hot water, or water with additives, through areas which contain DNAPL. Pumped groundwater may be treated with one or more treatment processes before being discharged.

Sediments: This remedial alternative for sediments includes removal of impacted sediments via dredging and dewatering, treatment, and off-site disposal of the dredged sediments. A vertical barrier would be constructed to minimize the migration of chemicals of interest to surface water during the dredging.

4.0 SUMMARY AND RECOMMENDATIONS

As described in Section 3.0, a total of 14 medium-specific remedial alternatives were developed for impacted soil, impacted groundwater, and impacted river sediments based on the identification and screening of remedial action technology types and process options. The medium-specific alternatives were then combined to obtain 10 site-wide remedial alternatives that address each of the four media at the Site. The final feasibility study for the site will address further screening of these, and possibly other alternatives identified herein, based on remedial action goals to be identified in conjunction with WDNR. Remedial action goals which need to be established in order to further screen and select a final remedy or remedies for the Site which include the following:

- Sediments: sediment quality criteria and the process for determining these criteria need to be established for the Milwaukee River channel.

- Soil: Soil quality goals need to be established for the Site. These goals may be a combination of NR 720 standards for applicable compounds, standards to be proposed for compounds not currently identified in NR 720 or performance standards with alternative concentrations which meet the remedial action objectives. Standards to be proposed or performance standards would likely require further evaluation through a combination of unsaturated zone modeling and/or risk assessment.

- Groundwater: Remediation of groundwater at this Site may ultimately require *in situ* treatment technologies involving injection of compounds in the subsurface. The regulatory feasibility of this option needs to be addressed in order to conduct final screening of alternatives for this media. Alternate concentrations and/or performance standard for containment of impacted groundwater may also be more appropriate for remedial goals.

The process by which these remedial goals will be established is contained in proposed NR 720 and NR 722. Due to the technical complexity of the Site and the nature of Site impacts, it is appropriate at this time to meet with WDNR to identify the final remedy selection process and to develop appropriate remedial standards. Based on the above discussions with WDNR, additional data collection needs and further evaluation of existing Site data can also be conducted which will support the remedy selection process. Such data collection needs might include, for example, the following:

- treatability studies to evaluate supplements for *in situ* biodegradation and/or treatment of extracted groundwater;

- pilot testing of soil treatment alternatives and/or DNAPL extraction and treatment; and

- further delineation of the extent of impacted media in selected areas.

It is anticipated that proposed NR 720 and NR 722 will be further in the process of final promulgation at the time WDNR deems it appropriate to discuss the above issues.