Wisconsin Electric
A WISCONSIN ENERGY COMPANY

Wisconsin Electric
231 W. Michigan
P.O. Box 2046
Milwaukee, WI 53201-2046
Phone 414 221-2345

March 15, 2001

Ms. Jennifer Huffman, P.G.
Hydrogeologist
Remediation and Redevelopment Program
Wisconsin Department of Natural Resources
3369 W. Brewster Street
Appleton, WI 54914-1602

RE: Appleton MGP Site (BRRTS ID #02-45-000042)

Dear Ms. Huffman:

Please find enclosed a copy of "*MGP Site Remedial Alternatives Analysis Report*" dated March 15, 2001 that was prepared by STS Consultants Ltd. This report was requested by you during our meeting on November 2, 2000, and was discussed in my letter to you of December 1, 2000. We have outlined a variety of remediation scenarios for both contaminated soil and groundwater that may be applicable for the Appleton MGP site. Although a number of specific technologies are described in the report, it is likely that a combination of the methodologies described will be used at the Appleton site.

Since our meeting, we have met with representatives of the Appleton Redevelopment Authority, the Appleton Economic Development Office, and other interested parties regarding the future use of the land following remediation. The status of the property is currently under consideration for a variety of uses and has been the subject of specific resolutions and recommendations by various city governmental officials. We believe that it is critical to integrate the final land use into the overall remediation design. We will continue to work with the City and with DNR as we work prepare a Remediation Design Report for the property.

We are also working with the Electric Power Research Institute and URS Corporation on laboratory and engineering studies of a permeable reactive wall that might be used along the river for passive long-term groundwater treatment. Although this technique has only been used for a couple of MGP sites, we believe it may hold some promise for the Appleton site.

Please call me at 414-221-2156 if you have any questions regarding the report.

Sincerely,

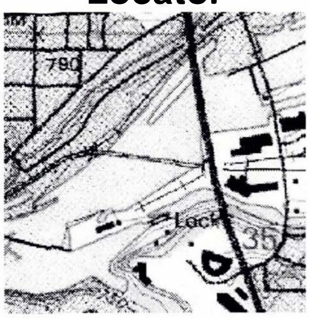
Jim

James W. Lingle
Principal Environmental Chemist

enclosure

cc: Terry Bergman
Susan Murawski – STS Consultants Ltd. (w/o enclosure)
Susan Martin (w/o enclosure)

Locator



Other Imagery:

USGS Topo Map
01 Jul 1986

HomeAdvisor Links:

- Homes for sale in 54911
- Homes for sale in 54915
- Schools, Crime and Demographics for 54911
- Schools, Crime and Demographics for 54915

USGS Stream Gauge:

FOX RIVER AT APPLETON (AVM), WI

Encarta Articles:

- ★ Appleton

Appleton, Wisconsin, United States 01 May 1992

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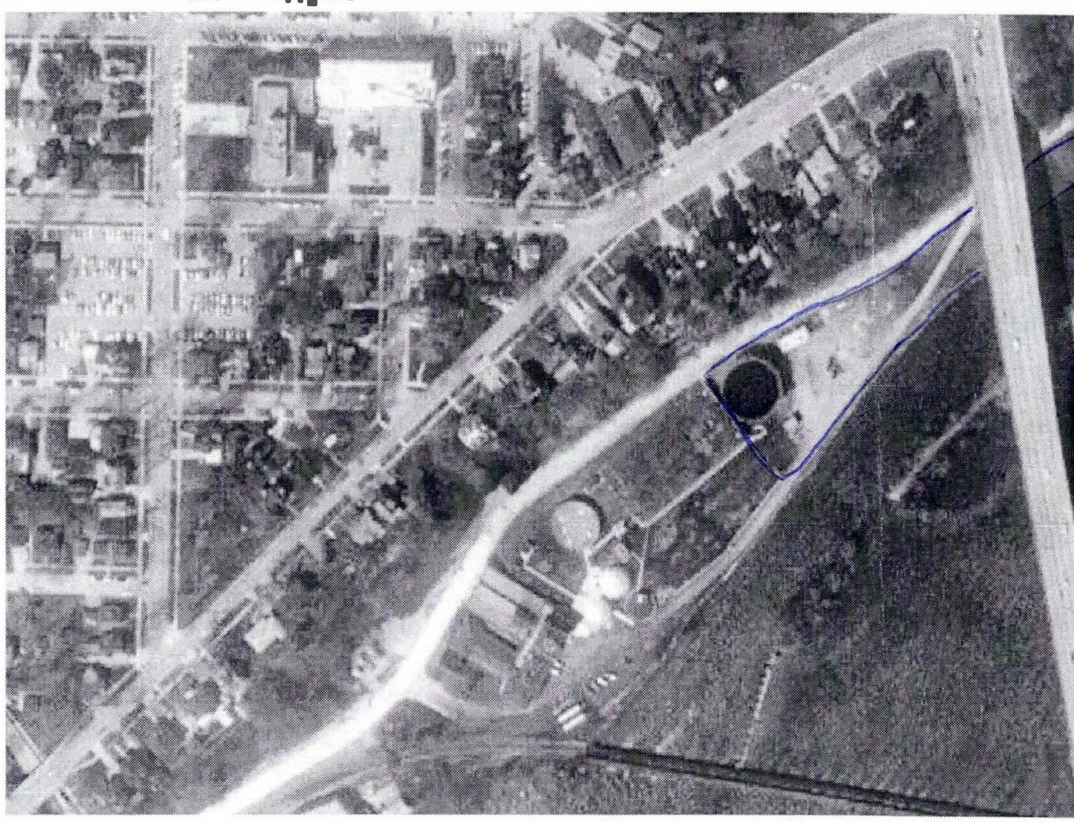

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Image courtesy of the US Geological Survey.

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Encarta Articles:
☆ Appleton

Appleton, Wisconsin, United States 01 May 1992

Zoom 2m

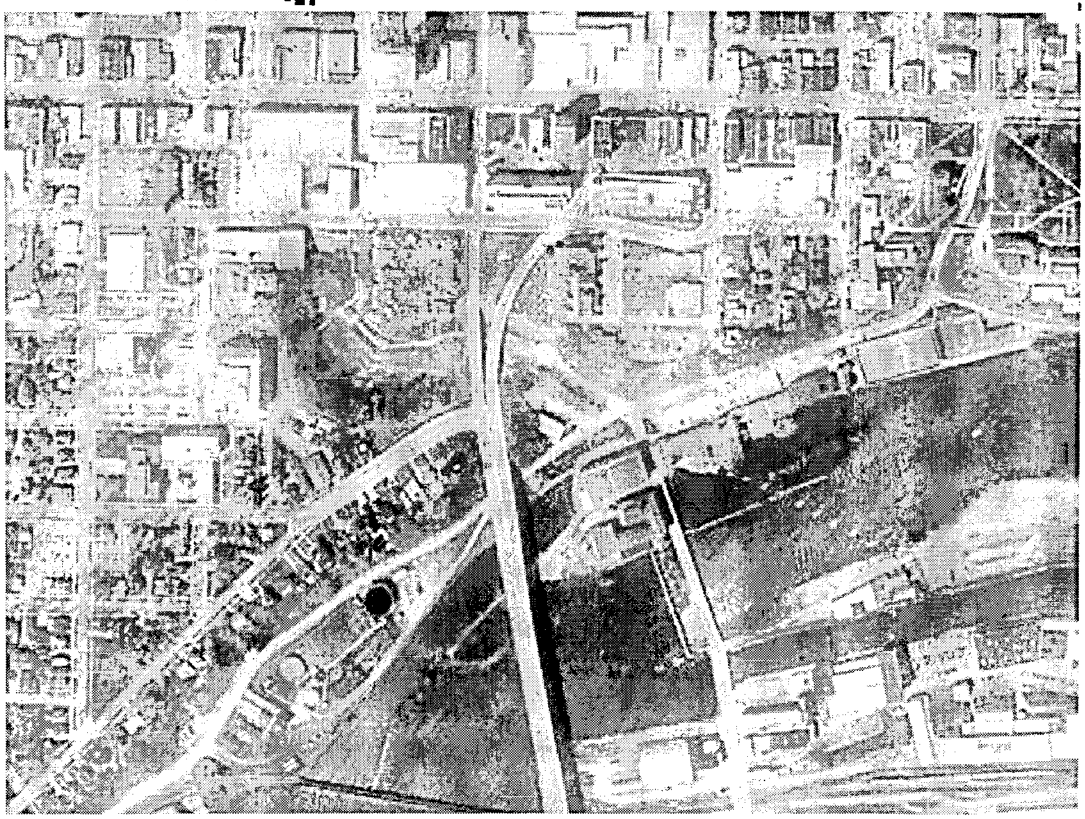

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Image courtesy of the US Geological Survey.

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R E P O R T

Wisconsin Electric Power Company

333 West Everett Street

Milwaukee, Wisconsin 53203

MGP Site Remedial Alternatives Analysis Report

Wisconsin Electric Power Company

Appleton City (Coal Tar)
02-45-000042

Former Manufactured Gas Plant
Appleton, Wisconisn

3/20/01

STS Project No. 84741XG

March 15, 2001

STS

STS Consultants, Ltd.
Solutions through Science & Engineering

March 15, 2001

Mr. Jim Lingle
Wisconsin Electric Power Company
333 West Everett Street
Milwaukee, WI 53203

Re: Appleton MGP Site Remedial Alternatives Analysis Report -- STS Project No. 84741XG

Dear Mr. Lingle:

STS Consultants, Ltd. (STS) is pleased to present the attached draft report of the Remedial Alternatives Analysis for the former Manufactured Gas Plant site in Appleton, Wisconsin. The report was prepared in general conformance with the requirements of NR722, WAC. The NR712.07 certifications for this report follow the cover letter.

We have enjoyed working with you on this project. If you have any questions regarding the report, please contact us.

Respectfully,

STS CONSULTANTS LTD.

Suzanne M. Murawski, P.E.
Senior Project Engineer

Jeanne M. Tarvin, PG, CPG
Principal Hydrogeologist

Attachments

11425 West Lake Park Drive • Milwaukee, WI 53224-3025 • (414) 359-3030 • (414) 359-0822 Fax

"I, Suzanne M. Murawski, certify that I am a registered professional engineer in the State of Wisconsin, registered in accordance with the requirements of ch. A-E4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR700 to 726, Wis. Adm. Code."

Suzanne M. Murawski ______________________ 3/15/01 ______________________

Signature, title and P.E. number P.E. Seal | Date

WISCONSIN PROFESSIONAL ENGINEER
Suzanne M. Murawski
E30239
Milwaukee, WI

"I, Jeanne M. Tarvin, certify that I am a hydrogeologist as that term is defined in s.NR712.03(1), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR700 to 726, Wis. Adm. Code."

Jeanne M. Tarvin ______________________ 3/15/01 ______________________

Signature and title | Date

TABLE OF CONTENTS

EXECUTIVE SUMMARY

A remedial alternatives analysis has been completed in general accordance with NR722 of the Wisconsin Administrative Code for the former Manufactured Gas Plant (MGP) site located at 337 West Water Street in Appleton, Wisconsin. On behalf of Wisconsin Electric Power Company (WE), STS Consultants, Ltd. prepared this report to present the remedial options that continue to be evaluated for the site.

Based on the site investigation conducted in 1995 and 1996, coal tar affected soils were observed within the unsaturated soil and extend below the groundwater table. The highest concentration of impacts was observed in the area south of the former gas holders and within the former MGP plant area. Affected soil extends to the river and decreases in concentration toward the west (water filtration plant) and east (railroad bridge). Residual soil impacts were observed in West Water Street during previous utility work in the roadway; however, the street appears to define the northern extent of affected soil.

Benzene, ethylbenzene, toluene and xylene (BETX) compounds and styrene were detected in the groundwater above NR140 Enforcement Standards. Several polynuclear aromatic hydrocarbons (PAH) parameters were observed in the soil, but corresponding elevated PAH concentrations were not detected in the groundwater. With the exception of naphthalene, no other PAHs were consistently detected in the groundwater above NR140 Enforcement Standards. As such, over the past 40 years, the only contaminants in the soil that have leached to the groundwater are the more volatile BETX compounds and naphthalene, not the insoluble PAH compounds.

Besides BETX, styrene and naphthalene, iron cyanide was also detected in the soil and groundwater. Iron cyanide is a by-product of the MGP operations.

Groundwater impacts were present in the former area of the MGP plant and gas holders, with the highest concentration of impacts within the former plant area. Groundwater impacts appeared to be defined by West Water Street (upgradient from the site) and to extend downgradient to the Fox River. Groundwater impacts diminished rapidly toward the water filtration plant reservoirs to the west and the railroad bridge to the east.

Several remedial alternatives are available to remediate or manage the site. The feasibility and applicability of each remediation method is continuing to be evaluated based on the final end use of the property. Potential remediation alternatives include capping the site, varying degrees of excavation of affected soil, solidification, bioremediation, groundwater controls and/or engineering controls. Any one or a combination of these methods could be employed at the site. Selection of a remedial option will involve reviewing the feasibility of the

approach, considering the City of Appleton's objectives for future site use and possibly conducting laboratory or field tests, or research to evaluate actual site applicability.

Final soil cleanup standards that are protective of groundwater and direct contact will be developed during evaluation or upon selection of a final site remedy. These levels may be based on numerical soil cleanup standards, or on a permanent engineering control such that the contamination does not pose a threat to public health and the environment.

The evaluation of remedial alternatives depends on cooperation with the City of Appleton to develop a remedial approach that is beneficial to both parties. WE intends to work closely with the City and WDNR while developing the remedial alternative most suitable for the site. The selected approach will be reviewed and approved by the WDNR as part of the Design Report process.

1

ONE

FORMER MANUFACTURED GAS PLANT (MGP)
REMEDIAL ALTERNATIVES ANALYSIS REPORT
APPLETON, WISCONSIN

1.0 REMEDIAL ALTERNATIVES ANALYSIS OVERVIEW

1.1 Introduction

STS Consultants, Ltd. (STS) has been retained by Wisconsin Electric (WE) to prepare this Remedial Alternatives Analysis (RAA) to present the current status of remedial options being evaluated for the former MGP site located in Appleton, Wisconsin. This report has been prepared in general accordance with chapter NR722 of the Wisconsin Administrative Code (WAC).

The site is currently owned by WE and used by the City of Appleton Water Filtration Plant (Plant). A new water filtration plant is being constructed on Manitowoc Road in Appleton. Therefore, the current site location will be eventually abandoned and the City will redevelop the Plant and former MGP property. The final end use of both properties, however, has not been determined by the City. The selected remedial option will depend on the final end use of the properties. The objective of this RAA is to present a summary of the work completed to date and present the remedial options that have been considered for the site and are being further evaluated.

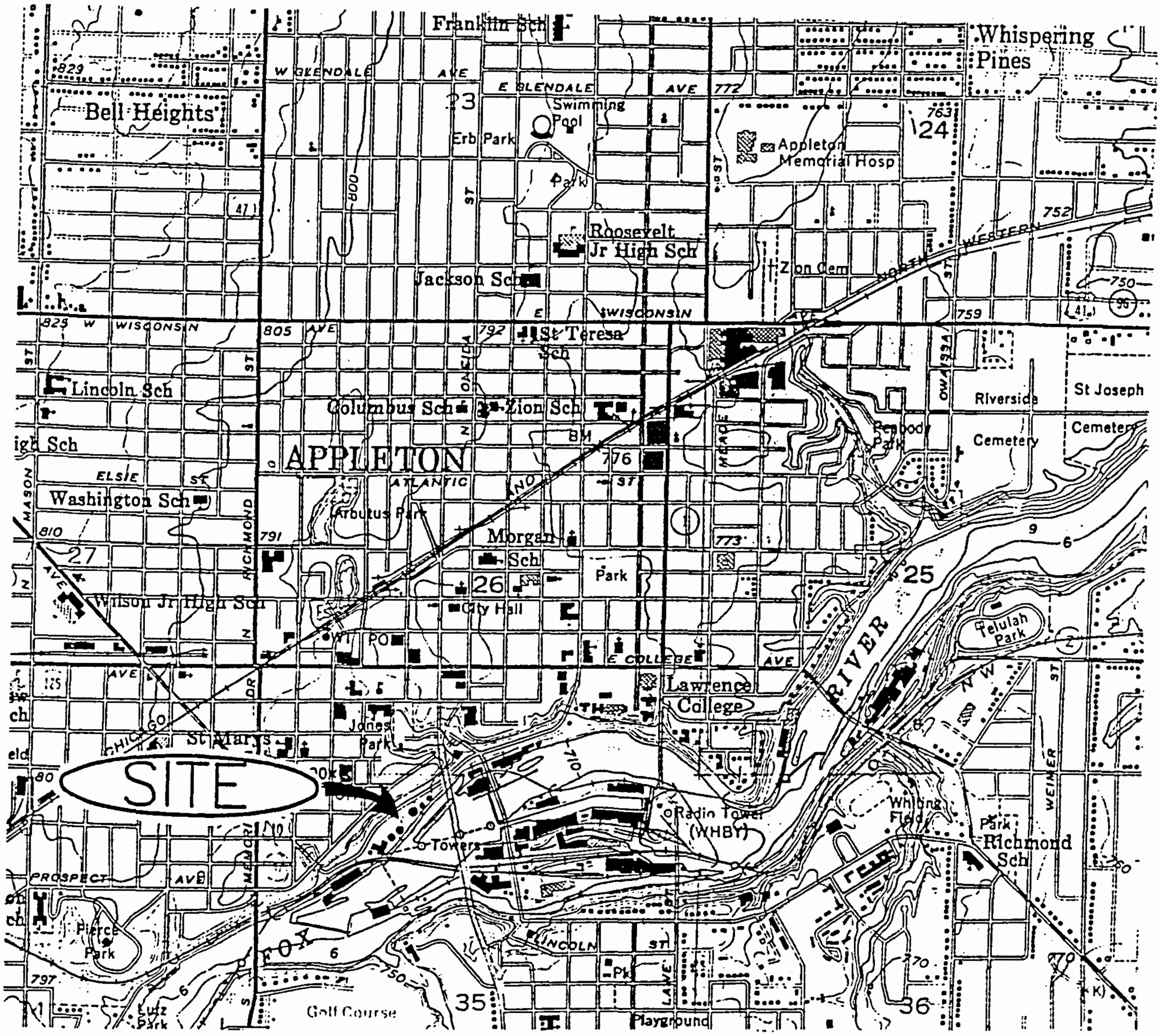
1.2 Project Description

The MGP site address is 337 West Water Street in Appleton, Wisconsin. The site is located in the NE 1/4 of the NW 1/4 of Section 35, T21N, R17E in Outagamie County, Wisconsin. The Appleton Plant produced gas by coal carbonization using retorts and oil gas from approximately 1867 to 1953 based on Sanborn Fire Insurance Maps and internal WE information. A site location diagram is presented as Figure 1.

The project managers/site contacts include the following individuals:

- Responsible Parties:
  Mr. James Lingle
  Wisconsin Electric Power Company
  333 West Everett Street
  P.O. Box 2046
  Milwaukee, WI 53203
  414/221-2156

  Mr. Art Covi
  Wisconsin Gas
  5400 N. Green Bay Avenue
  Milwaukee, WI 53209
  414/540-5763



SOURCE: USGS TOPOGRAPHIC MAP, APPLETON QUADRANGLE

STS Consultants Ltd.
Consulting Engineers

SITE LOCATION DIAGRAM
MGP SITE INVESTIGATION
337 WEST WATER STREET
APPLETON, WISCONSIN

DRAWN BY	LMc	2-27-96
CHECKED BY	SMM	2-27-96
APPROVED BY	JMT	2-27-96
CADFILE 847030002	SCALE 1"=2000'	
STS PROJECT NO. 84703XB	FIGURE NO. 1	

- Consultant: Ms. Jeanne Tarvin and Ms. Suzanne Murawski
  STS Consultants, Ltd.
  11425 West Lake Park Drive
  Milwaukee, WI 53224
  414/359-3030

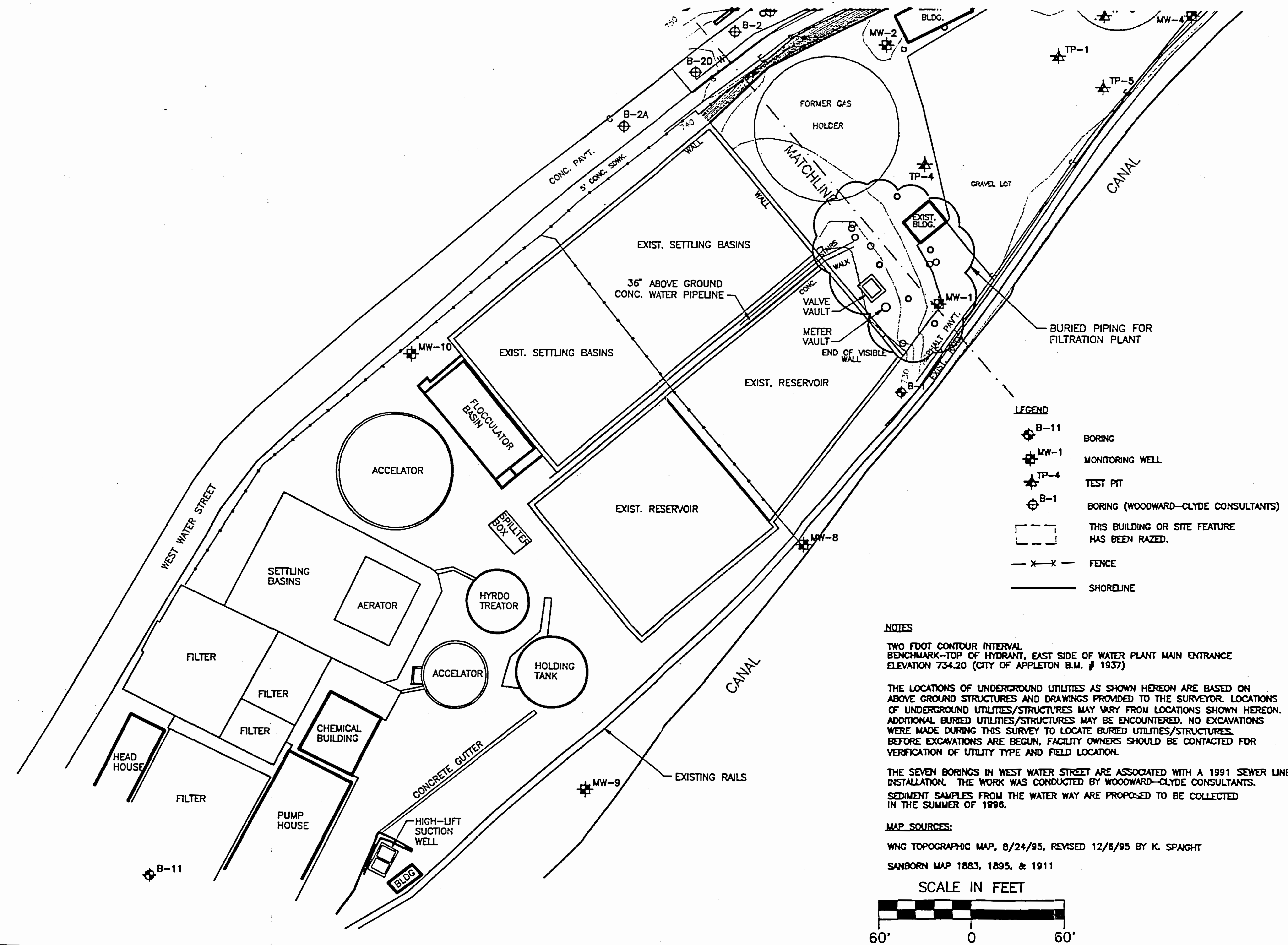
1.3 Site History

The Appleton MGP site history is documented in a collection of historical maps, photographs, site observations and anecdotal resources. The available information was reviewed by STS to develop this site history section. A general layout of historical and existing site features is provided in Figures 2 and 3.

According to WE personnel, the property for the gas plant site was purchased in 1867, developed into a MGP site shortly thereafter and sold in 1954 after the MGP operations ceased. Based on Sanborn Map descriptions and other information, the Plant produced gas using coal-carbonization retorts with purification of the gas using lime and iron oxide. A water gas process was installed in 1945. The Plant had a coal storage area on the east side, an oil house to the south along the shoreline and near the railroad tracks, and gas holders on the west side of the Plant.

Several structures were located on the gas plant site. The 1883 Sanborn Map shows a rectangular shaped building (30 feet wide by 111 feet long) that was used as the gas plant with one gas holder (50 feet in diameter) located to the west and a rectangular shaped oil house (10 feet wide by 50 feet long) positioned south and parallel to the river. The Custom Carding and Dye House was located to the east of the plant. By 1895, the Gas Plant size increased with expansion to the south toward the river. The neighboring Carding and Dye House was being used as a cooper shop. The 1911 Sanborn Map shows another gas holder to the west, doubling of the Gas Plant size with expansion to the south, and the addition of a large coal storage area to the east, where the previous cooper shop was located. One of the cooper shop buildings remained on-site but it was vacant in 1911. A third gas holder was constructed on-site further to the west of the 2 other gas holders, sometime after 1911. This gas holder was not razed and remains on the property today on the east side of the water plant filtration reservoirs. This third gas holder is referred to in the remainder of the report as the former gas holder or largest gas holder on the west side of the property.

The Gas Plant building was observed in a 1971 aerial photograph but was razed by 1980 based on an April 1980 aerial photograph. According to a water filtration plant representative, the former MGP building was used by Peerless Paint prior to its demolition in the late 1970's.



LEGEND

- B-11 BORING
- MW-1 MONITORING WELL
- TP-4 TEST PIT
- B-1 BORING (WOODWARD-CLYDE CONSULTANTS)
- THIS BUILDING OR SITE FEATURE HAS BEEN RAZED.
- FENCE
- SHORELINE

NOTES

TWO FOOT CONTOUR INTERVAL
BENCHMARK-TOP OF HYDRANT, EAST SIDE OF WATER PLANT MAIN ENTRANCE
ELEVATION 734.20 (CITY OF APPLETON B.M. # 1937)

THE LOCATIONS OF UNDERGROUND UTILITIES AS SHOWN HEREON ARE BASED ON ABOVE GROUND STRUCTURES AND DRAWINGS PROVIDED TO THE SURVEYOR. LOCATIONS OF UNDERGROUND UTILITIES/STRUCTURES MAY VARY FROM LOCATIONS SHOWN HEREON. ADDITIONAL BURIED UTILITIES/STRUCTURES MAY BE ENCOUNTERED. NO EXCAVATIONS WERE MADE DURING THIS SURVEY TO LOCATE BURIED UTILITIES/STRUCTURES. BEFORE EXCAVATIONS ARE BEGUN, FACILITY OWNERS SHOULD BE CONTACTED FOR VERIFICATION OF UTILITY TYPE AND FIELD LOCATION.

THE SEVEN BORINGS IN WEST WATER STREET ARE ASSOCIATED WITH A 1991 SEWER LINE INSTALLATION. THE WORK WAS CONDUCTED BY WOODWARD-CLYDE CONSULTANTS.

SEDIMENT SAMPLES FROM THE WATER WAY ARE PROPOSED TO BE COLLECTED IN THE SUMMER OF 1996.

MAP SOURCES:

WNG TOPOGRAPHIC MAP, 8/24/95, REVISED 12/6/95 BY K. SPAIGHT

SANBORN MAP 1883, 1895, & 1911

DRAWN BY	JM\LMc\RP	DATE	8-9-96
CHECKED BY	SMM	DATE	8-9-96
APPROVED BY	X	DATE	8-9-96
CADFILE	..\PROJECTS\84703\XB\G5Z002 XREF=		

BORING, MONITORING WELL AND TEST PIT LOCATION DIAGRAM

APPLETON WATER TREATMENT PLANT AREA
APPLETON, WISCONSIN

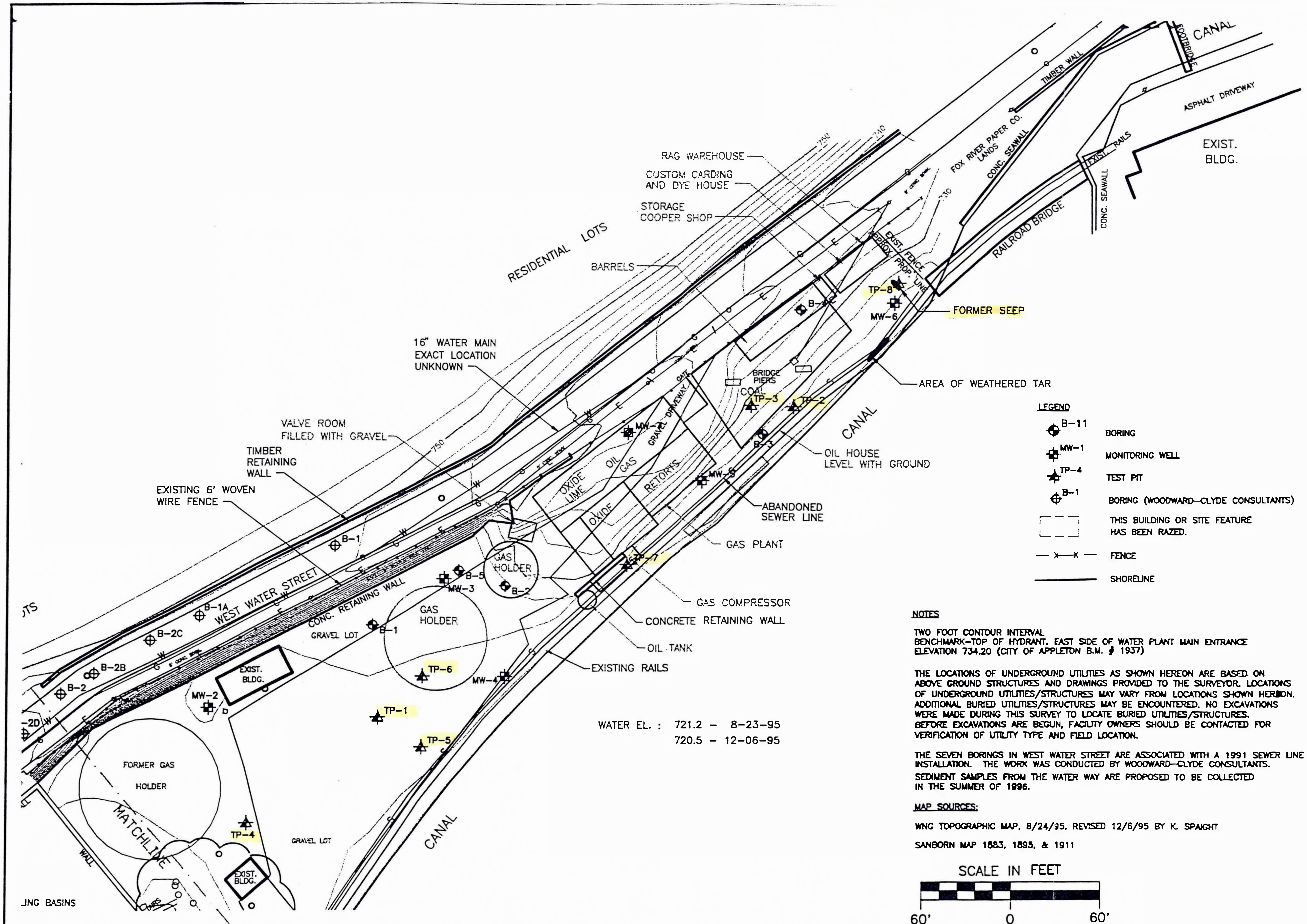
STS Consultants Ltd.
Consulting Engineers

STS PROJECT NO. 84703XB

STS PROJECT FILE G5Z002

SCALE AS SHOWN

FIGURE NO 2



NOTES

TWO FOOT CONTOUR INTERVAL
BENCHMARK–TOP OF HYDRANT, EAST SIDE OF WATER PLANT MAIN ENTRANCE
ELEVATION 734.20 (CITY OF APPLETON B.M. # 1937)

THE LOCATIONS OF UNDERGROUND UTILITIES AS SHOWN HEREON ARE BASED ON ABOVE GROUND STRUCTURES AND DRAWINGS PROVIDED TO THE SURVEYOR. LOCATIONS OF UNDERGROUND UTILITIES/STRUCTURES MAY VARY FROM LOCATIONS SHOWN HEREON. ADDITIONAL BURIED UTILITIES/STRUCTURES MAY BE ENCOUNTERED. NO EXCAVATIONS WERE MADE DURING THIS SURVEY TO LOCATE BURIED UTILITIES/STRUCTURES. BEFORE EXCAVATIONS ARE BEGUN, FACILITY OWNERS SHOULD BE CONTACTED FOR VERIFICATION OF UTILITY TYPE AND FIELD LOCATION.

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MAP SOURCES:

WNG TOPOGRAPHIC MAP, 8/24/95, REVISED 12/6/95 BY K. SPAIGHT

SANBORN MAP 1883, 1895, & 1911

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BORING, MONITORING WELL AND TEST PIT LOCATION DIAGRAM

FORMER MANUFACTURED GAS PLANT
APPLETON, WISCONSIN

STS Consultants Ltd.
Consulting Engineers

STS PROJECT NO. 84703XB

STS PROJECT FILE G5Z003

SCALE AS SHOWN

FIGURE NO. 3

A review of city directories showed that the subject site address is listed as the Gas Plant until 1966 after which it was listed as Peerless Paint Manufacturing Company from 1971 to 1975.

The Skyline Bridge was constructed over a portion of the area of the former Plant in the 1980's. Bridge abutment foundations now stand in the former Plant footprint.

1.4 Summary of Previous Investigations

STS conducted a preliminary exploration of the site on July 24, 1995 to evaluate the depth to bedrock to prepare a site investigation work plan and to respond to an area of weathered tar that was slowly seeping from the ground. In addition, a subsurface investigation was completed by WE in 1991 in conjunction with installation of a sewer along West Water Street. The following subsections include a discussion of these previous investigations. STS conducted a Site Investigation in 1995 and 1996 in general accordance with NR716.15. The results of this investigation are presented in Section 2.0 Summary of Site Investigation Findings.

1.4.1 Seep Identification and Action

The source of the seep appeared to be a small mass of tar near the ground surface approximately 30 feet north of the river's edge. No drums were observed buried below the ground surface in the area of the seep. A concrete foundation wall was present. The approximate locations of the two seep areas which are referred to as "areas of weathered tar," and "former seep" are shown on Figure 3. The visible portion of the tar seep was excavated using a backhoe in 1995. Tarry soil was placed in three 55-gallon drums. Only the tarry material on the surface was placed in the drums. The extent of tarry material at a deeper depth was evaluated during the site investigation. The drummed tar was disposed of off site. where?

1.4.2 Preliminary Depth to Bedrock Investigation

Three test pits were excavated by STS in 1995 to a maximum depth of 14.5 feet bgs (the reach of the backhoe) to determine the depth to bedrock. The approximate test pit locations are shown on Figure 3. Based on the field observations, the depth to bedrock or more dense soil was determined to be below 11 feet bgs in the former Plant area and 14.5 feet on the west side of the property. No soil samples were collected for field screening or analytical testing during the preliminary investigation since the purpose of the preliminary exploration was to confirm that bedrock was at a shallow depth across the site. The drummed soil was disposed of off site. Evaluation of the site was completed during the NR716, WAC site investigation. where?

1.4.3 1991 Subsurface Investigation in Water Street

The subsurface investigation in Water Street in 1991 was associated with the installation of a sewer within the street right-of-way. Several borings were advanced by others to characterize soil conditions within the excavation limits that would require special excavation and disposal work. Seven of the borings advanced in Water Street were located near the former MGP operations. The boring locations are shown on Figures 2 and 3.

Each boring drilled through a brown or red-brown clay. These borings are directly north of the largest gas holder used in the former MGP operations. No water was encountered in the borings.

A total of 1145 tons of coal tar impacted soil was hauled from the Water Street sewer line near the large gas holder. An additional 413 tons of coal tar impacted soil was hauled from Water Street east of the Oneida Skyline Bridge. The extent of affected soil in Water Street was excavated in 1991 based on visual observations, odors and PID screening.

S T S C O N S U L T A N T S , L T D .

TWO

2.0 SUMMARY OF SITE INVESTIGATION FINDINGS

2.1 Overview of Site Investigation

A site investigation was conducted in accordance with NR716.15 of the Wisconsin Administrative Code for the former MGP site in Appleton, Wisconsin. The site investigation was performed to characterize the magnitude and extent of affected soil and impacted groundwater from the former MGP operations. The results and conclusions of the site investigation work are presented in a Site Investigation report dated May 1996. The investigation results were presented to the Wisconsin Department of Natural Resources (WDNR) for review and comment.

The site investigation work consisted of advancing borings and converting some borings into groundwater monitoring wells. Test pits were excavated to evaluate subsurface conditions. Soil and groundwater samples were collected and tested to evaluate environmental impacts.

Coal tar affected soils were observed within the unsaturated soil below the gravel and fill soil cover and extend below the groundwater table. The highest concentration of impacts in the soils and groundwater were observed in the area south of the former gas holders and within the former MGP plant area. Affected soil and groundwater extends to the river and decreases in concentration toward the west near the water filtration plant and east toward the railroad bridge.

Laboratory analysis showed that soil impacts were due to elevated benzene, ethylbenzene, toluene and xylene (BETX); ferric ferrocyanide; styrene; and various coal tar related polynuclear aromatic hydrocarbons (PAHs), in particular naphthalene. The BETX compounds, styrene and ferric ferrocyanide were observed in the groundwater above NR140 Enforcement Standards. PAH concentrations observed in soil were not detected at elevated concentrations in the groundwater with the exception of naphthalene.

A summary of the site investigation findings is presented in this section.

2.2 Physiographical, Geological and Hydrogeological Setting

2.2.1 Physical Site Description/Constraints

The MGP site is located within the flats of the Fox River basin in Appleton, Wisconsin. The site is bordered by a canal of the Fox River to the south, West Water Street to the north, the existing City of Appleton Water Filtration Plant to the west and a continuation of the water channel to the east. The canal wraps around the site from the south to the east and continues east of the site. The footprint of the former MGP facility is vacant except for a bridge abutment to the Skyline Bridge. The largest gas holder from the former MGP operations remains on the property and is positioned on the west side of the property. The gas holder was going to be used as a carbon contact tank for the water filtration plant during 1968, but inadequate plumbing prevented its conversion to a contact tank. To the west of the gas holder is the water filtration plant buildings.

The site consists of the low lying flats area along the Fox River (approximately 5 feet above the river level), including the former MGP site and the existing water filtration plant, and a higher area to the north which includes West Water Street followed by a steep embankment and an even higher land surface area to the north that includes a residential neighborhood. Two retaining walls exist just north of the site that result in a terraced site, with retaining walls on the south and north sides of West Water Street. The construction of the walls is unknown in term of their foundation and drainage behind the walls.

The former area of the MPG plant was filled with soil to the elevation of West Water Street to create an access road to the plant. Bridge piers for the Oneida Street bridge are located in the center of the former MGP footprint. The former area of the two small gas holders is a gravel lot.

Historical maps show the area of the water filtration plant, reservoirs and largest former gas holder as part of the Fox River suggesting that this area was filled to create the present "flats". The type of fill was investigated as part of the Site Investigation.

2.2.2 Summary of Geologic Conditions

The geologic information from borings and test pits indicates that the site is generally underlain by approximately 3 to 14 feet of fill. Till deposits (3 to 19 feet thick) are found below the fill. Relatively thin (1 to 3 feet thick) lenses of lacustrine and glaciofluvial material have also been observed within or underlying the till. Cobbles and boulders of the underlying bedrock are found within the fill and till. The thickness of large cobbles and boulders has been observed to be 10 to 15 feet thick in boring B-5 and difficult to excavate through. More competent, fine-grained dolomite bedrock was encountered at approximately 24 feet below the ground surface at boring location B-5.

The soil profile consists of one to two feet of topsoil or gravel underlain by 3 to 14 feet of fill material consisting of silt, sand and clay mixed with remnants of old buildings (glass, metal pieces, wood, wood drums, concrete, etc.). The fill layer is typically oily and black in color with a petroleum based odor. Below the fill is silty clay or silty clay mixed with cobbles and boulders (bouldery till). The silty clay layer is discontinuous and in some places has thin fissures of black oily material. Where the clay layer doesn't exist, fill material is present. The clay layer is thickest along the northern portion of the site; and, in general it thins near the river primarily on the western half of the site. Below the clay layer on the eastern one-third of the site is a glaciofluvial layer. Below the clay layer or fill is bouldery till approximately 10 feet thick. The bouldery till layer is intermixed with silty clay. More competent bedrock is present at approximately 24 feet based on one boring completed in the rock. Cross sections of the site are shown as Figures 4 through 10. The cross section locations are shown on Plan Sheet 1.

2.2.3 Summary of Hydrogeologic Conditions

Hydrogeologic conditions were evaluated by reviewing water level elevations and hydraulic conductivity data from in-situ permeability testing. Water levels were measured in the monitoring wells following completion and again on November 14 and December 13, 1995. STS installed three additional wells MW-8, MW-9 and MW-10 on the western part of the site in 1996 to evaluate the impacts to groundwater, if any, in that area. Hydraulic conductivity and calculated gradient data were reviewed to estimate the groundwater flow velocity and contaminant transport beneath the site.

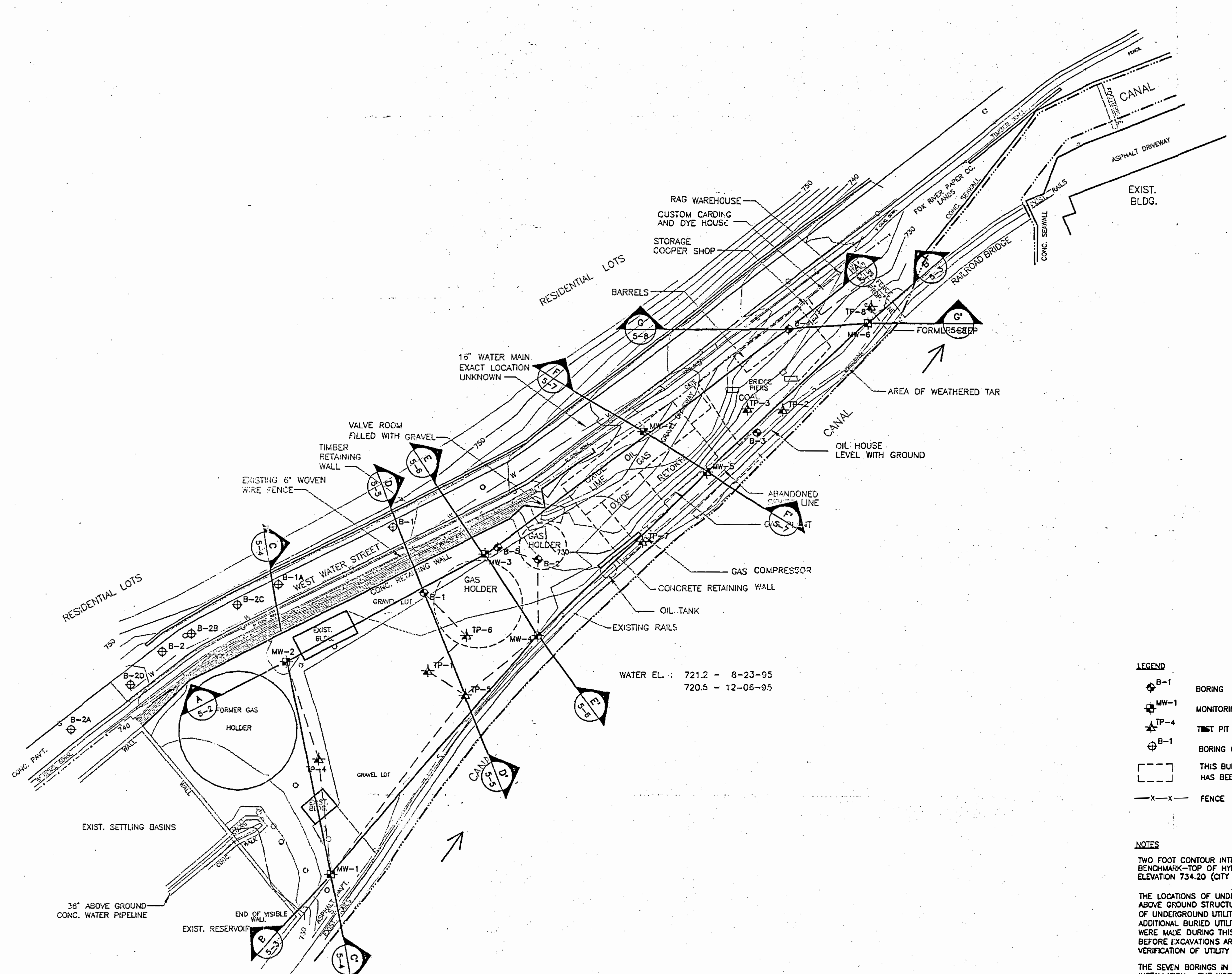
The depth to groundwater in the groundwater table monitoring wells ranges from approximately 3 feet bgs (MW-3) to 18 feet bgs (MW-7) based on the water level information collected to date. This depth to water may fluctuate significantly in the southern portion of the site (i.e. adjacent to the River) as the water levels in the Fox River fluctuate.

The groundwater elevation at MW-3 appears to be elevated compared to the groundwater elevations observed at the other wells. Due to the close proximity of the concrete retaining wall and the change of ground surface elevation from the bottom of this wall to West Water Street, it appears that the groundwater at this location (MW-3) is likely influenced by a larger water table head on the other side of the wall and/or a drainage system behind the wall.

Groundwater elevations on November 14, 1995, December 13, 1995 and July 15, 1996 were used to develop groundwater contour maps. The principle direction of flow is to the southeast towards the Fox River. This water table flow direction is consistent with shallow regional flow which is generally towards the Fox River. The groundwater contour maps from July 15, 1996 are included as Figures 11 and 12.

Horizontal gradients measured between the water table wells are variable across the site and range from approximately 0.043-foot/foot on the central portion of the site to 0.0042-foot/foot on the western portion of the site. The site's average horizontal gradient, calculated from water levels measured November 14, 1995, is 0.025-foot/foot.

In-situ hydraulic conductivity tests were performed in monitoring wells during November, 1995. The horizontal hydraulic conductivity in the fill and till soil ranges from 8.1×10^{-4} to 2.1×10^{-6} cm/sec, whereas the hydraulic conductivity in the till/glaciofluvial soil is approximately 2.5×10^{-6}. The geometric mean of the horizontal hydraulic conductivities for groundwater monitoring wells MW-1 through MW-6 is 2.8×10^{-5} cm/sec.



LEGEND

- BORING
- MONITORING WELL
- TEST PIT
- BORING (WOODWARD-CLYDE CONSULTANTS)
- THIS BUILDING OR SITE FEATURE HAS BEEN RAZED.
- —X—X— FENCE

NOTES

TWO FOOT CONTOUR INTERVAL
BENCHMARK–TOP OF HYDRANT, EAST SIDE OF WATER PLANT MAIN ENTRANCE
ELEVATION 734.20 (CITY OF APPLETON B.M. #1937)

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THE SEVEN BORINGS IN WEST WATER STREET ARE ASSOCIATED WITH A 1991 SEWER LINE INSTALLATION. THE WORK WAS CONDUCTED BY WOODWARD-CLYDE CONSULTANTS.

SEDIMENT SAMPLES FROM THE WATER WAY ARE PROPOSED TO BE COLLECTED IN THE SUMMER OF 1996.

MAP SOURCES:

WNG TOPOGRAPHIC MAP, 8/24/95, REVISED 12/6/95 BY K. SPAIGHT

SANBORN MAP 1883, 1895, & 1911

SCALE IN FEET
40' 0 40'

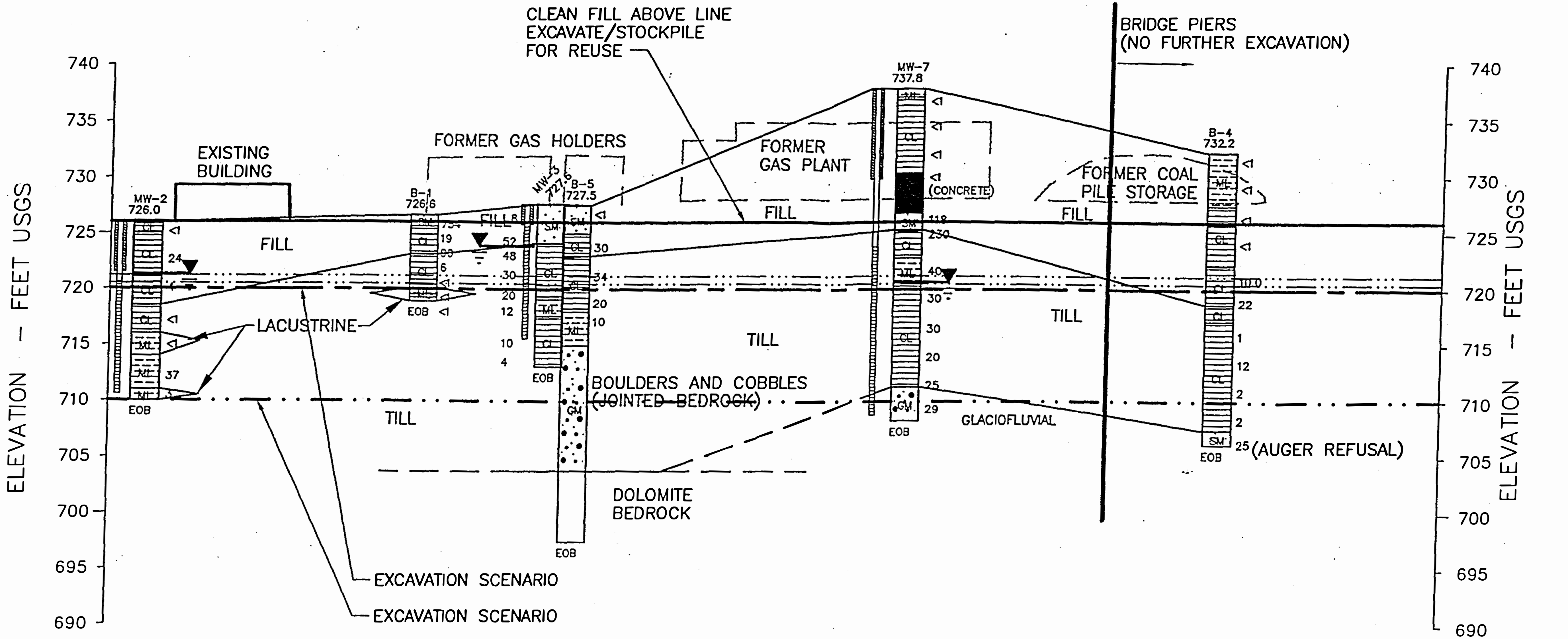
DRAWN BY	JMI\ LMC	DATE	4-9-96
CHECKED BY	SMM	DATE	4-9-96
APPROVED BY	JMT	DATE	4-9-96
CADFILE	..\PROJECTS\84703\ XB\Z3.DWG XREF=EXSTDASE		

CROSS-SECTION INDEX

FORMER MANUFACTURED GAS PLANT
APPLETON, WISCONSIN

STS Consultants Ltd.
Consulting Engineers

STS PROJECT NUMBER	84703XB
STS DRAWING NUM	
SCALE	AS SHOWN
SHEET NUMBER	1



CROSS-SECTION A-A'

A 2

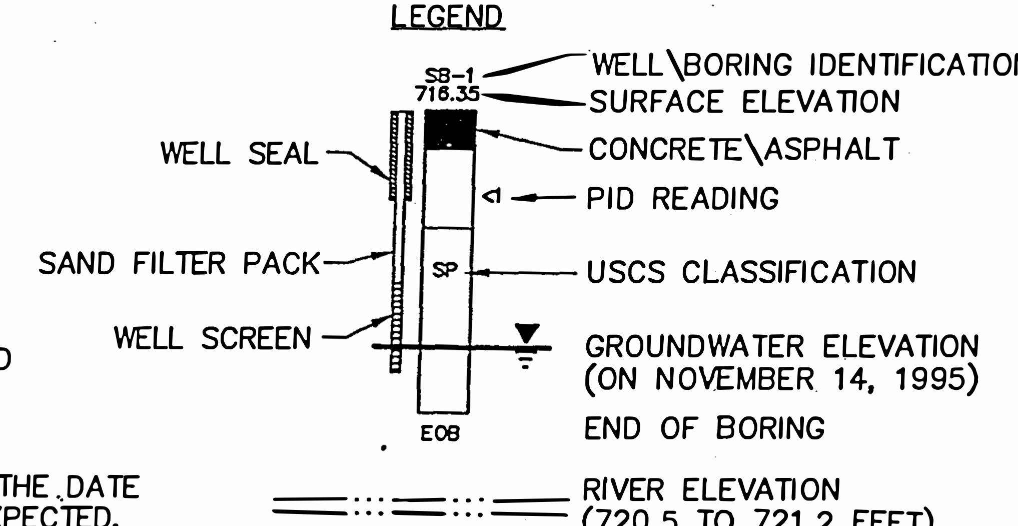
SCALE: HORIZ. 1"=50'
VERT. 1"=10'

NOTE:

SOIL CONDITIONS DESCRIBED HEREIN ARE VALID AT THE BORING LOCATIONS ONLY. HORIZONTAL PROJECTIONS ARE INTERPOLATED AND REPRESENT ONLY APPROXIMATIONS OF ACTUAL SOIL CONDITIONS.

THE GROUNDWATER LEVELS ARE UNIQUE TO THE DATE SAMPLED. SEASONAL FLUCTUATIONS ARE EXPECTED.

LEGEND



DRAWN BY	LMc/JMI	DATE 2-13-97
CHECKED BY	TWW	DATE 2-13-97
APPROVED BY	SMM	DATE 2-13-97
CADFILE	..\PROJECTS\84703\XD\G503D002.DWG XREF=NONE	

CROSS-SECTION A-A'

FORMER MANUFACTURED GAS PLANT
APPLETON, WISCONSIN

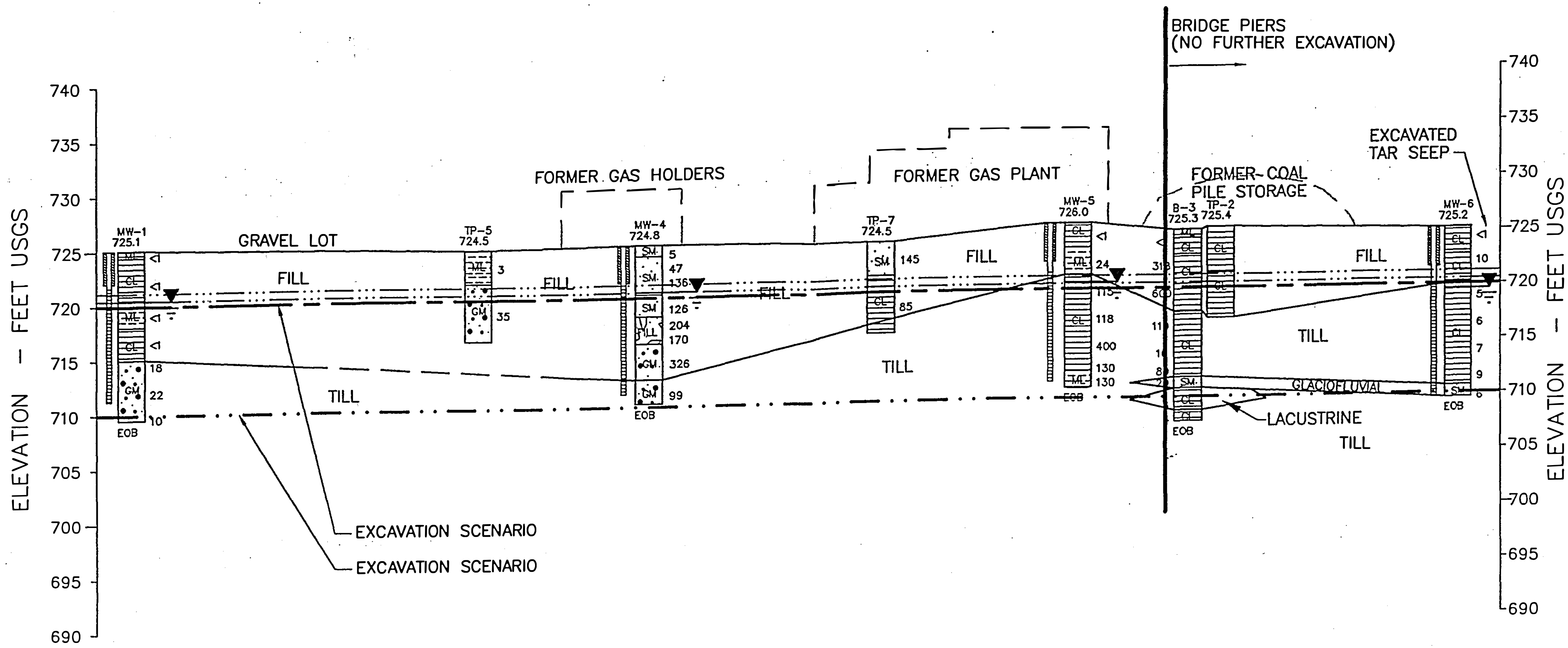
STS Consultants Ltd.
Consulting Engineers

STS PROJECT NO. 84703XD

STS PROJECT FILE

SCALE AS SHOWN

FIGURE NO. 4



B
3
CROSS-SECTION B-B'

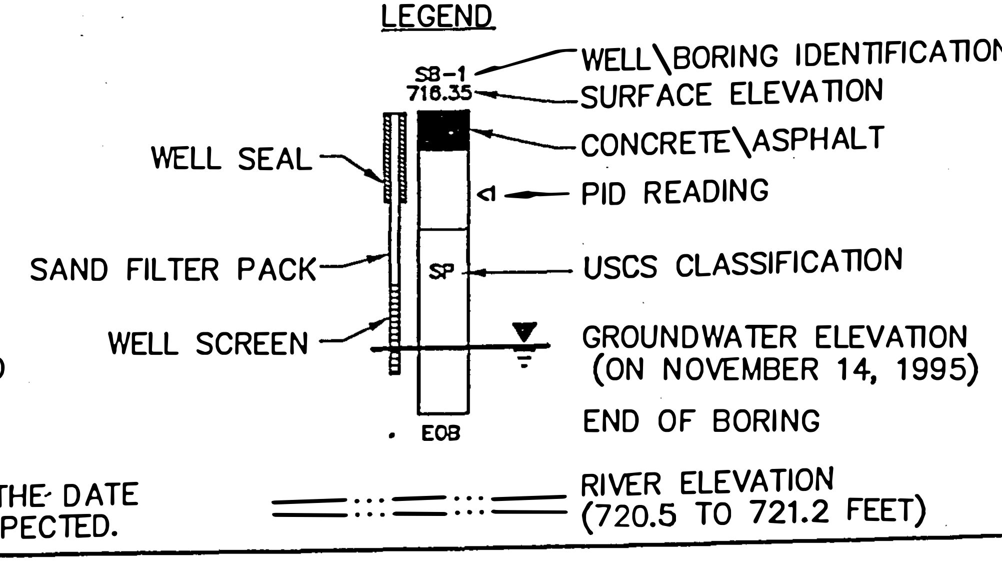
SCALE: HORIZ. 1"=50'
VERT. 1"=10'

NOTE:

SOIL CONDITIONS DESCRIBED HEREIN ARE VALID AT THE BORING LOCATIONS ONLY. HORIZONTAL PROJECTIONS ARE INTERPOLATED AND REPRESENT ONLY APPROXIMATIONS OF ACTUAL SOIL CONDITIONS.

THE GROUNDWATER LEVELS ARE UNIQUE TO THE DATE SAMPLED. SEASONAL FLUCTUATIONS ARE EXPECTED.

LEGEND

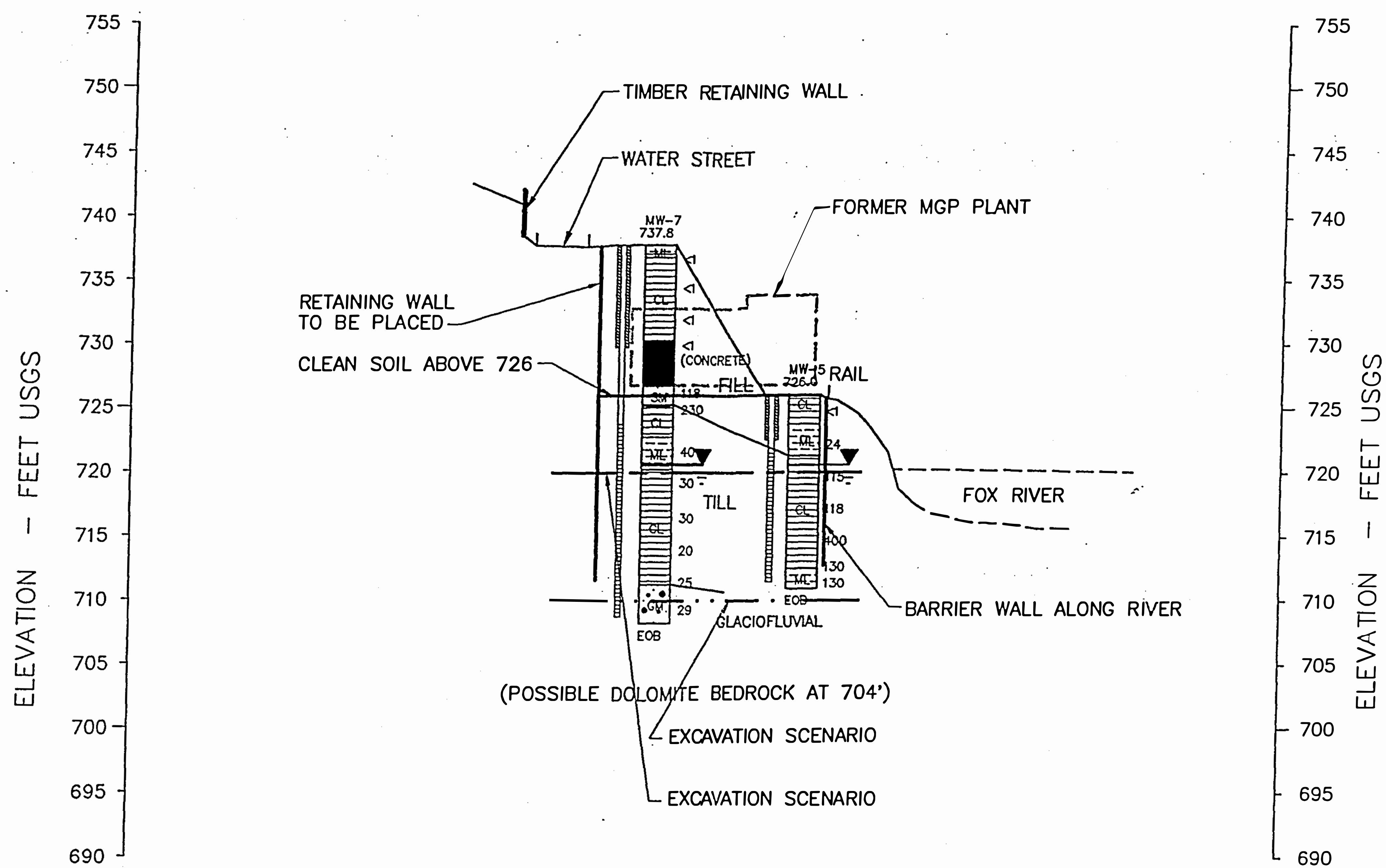


DRAWN BY LMc/JMI	DATE 2-13-97	
CHECKED BY TWW	DATE 2-13-97	
APPROVED BY SMM	DATE 2-13-97	
CADFILE ..\PROJECTS\84703\XD\G503D002.DWG XREF=NONE		

CROSS-SECTION B-B'
FORMER MANUFACTURED GAS PLANT
APPLETON, WISCONSIN

STS Consultants Ltd.
Consulting Engineers

STS PROJECT NO. 84703XD
STS PROJECT FILE
SCALE AS SHOWN
FIGURE NO. 5

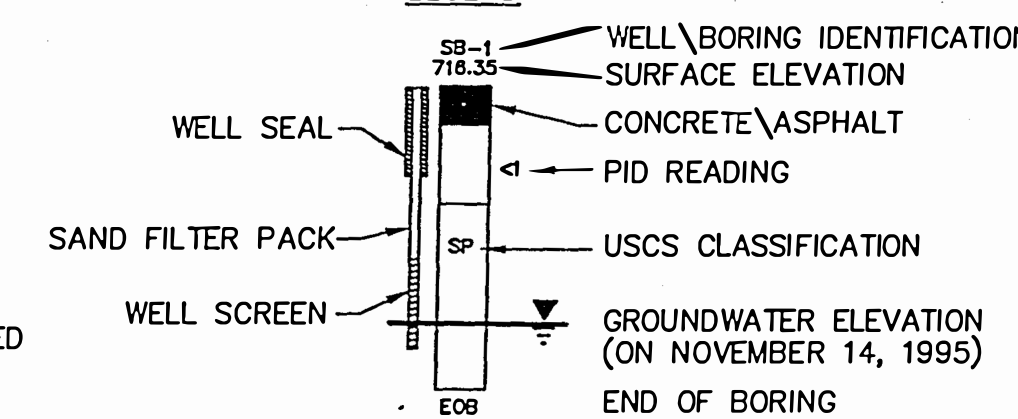


CROSS-SECTION C-C'

C / 4

SCALE: HORIZ. 1"=50'
VERT. 1"=10'

LEGEND



NOTE:

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THE GROUNDWATER LEVELS ARE UNIQUE TO THE DATE SAMPLED. SEASONAL FLUCTUATIONS ARE EXPECTED.

DRAWN BY	LMc/JMI	DATE	2-13-97
CHECKED BY	SMM	DATE	2-13-97
APPROVED BY	SMM	DATE	2-13-97
CADFILE	..\PROJECTS\84703\XD\G503D004.DWG XREF=NONE		

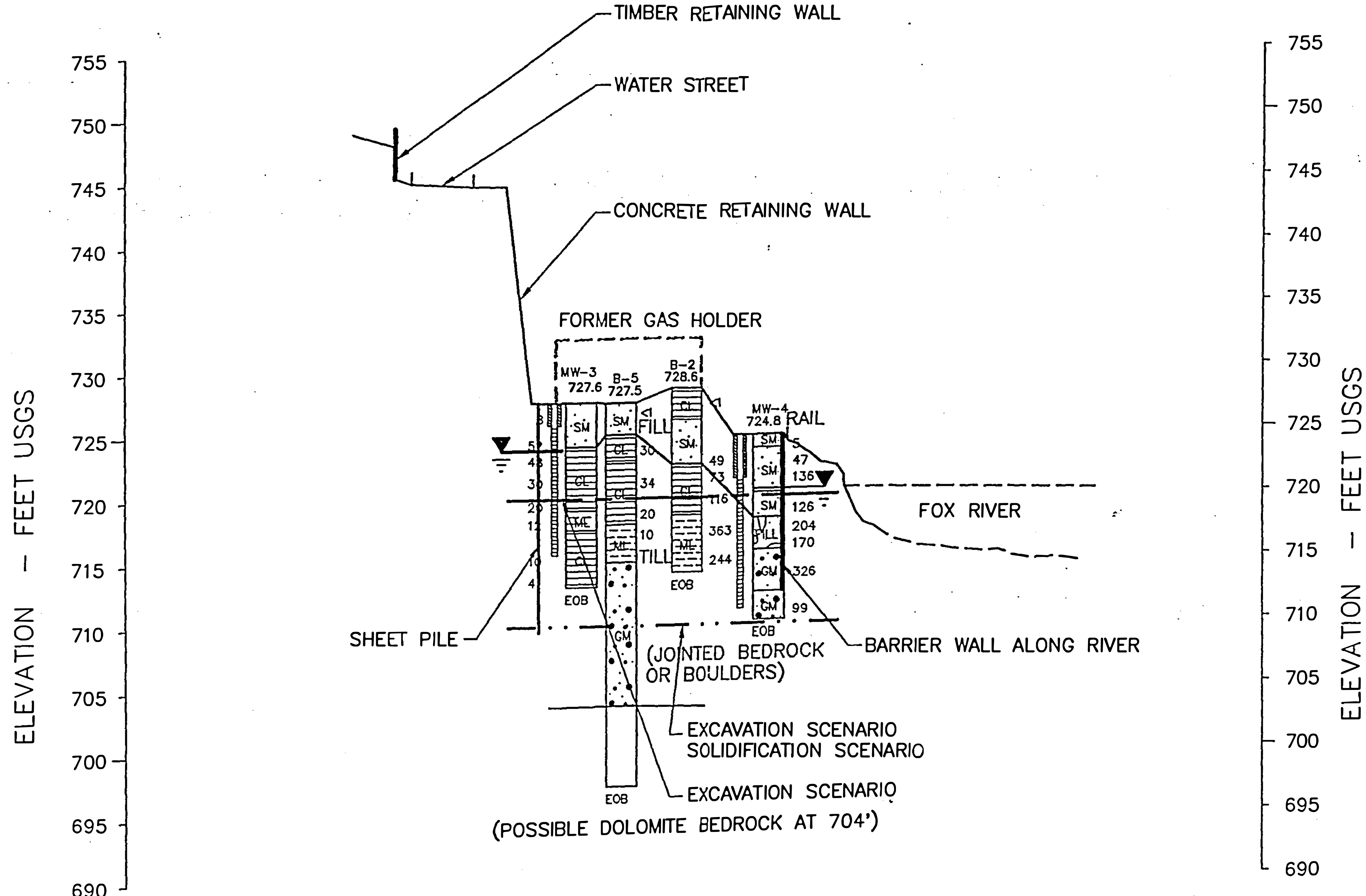
CROSS-SECTION C-C'
FORMER MANUFACTURED GAS PLANT
APPLETON, WISCONSIN

STS Consultants Ltd.
Consulting Engineers

STS PROJECT NO. 84703XD
STS PROJECT FILE

SCALE AS SHOWN

FIGURE NO. 6

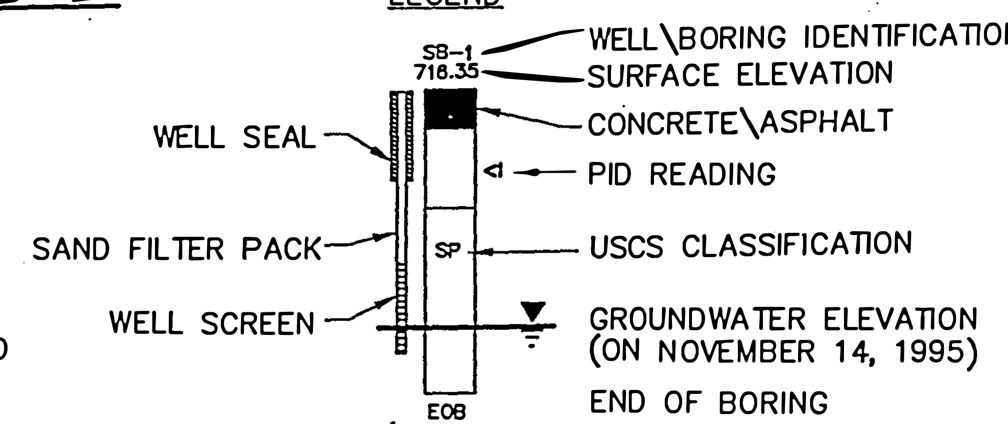


CROSS-SECTION D-D'

D / 5

SCALE: HORIZ. 1"=50'
VERT. 1"=10'

LEGEND



NOTE:

SOIL CONDITIONS DESCRIBED HEREIN ARE VALID AT THE BORING LOCATIONS ONLY. HORIZONTAL PROJECTIONS ARE INTERPOLATED AND REPRESENT ONLY APPROXIMATIONS OF ACTUAL SOIL CONDITIONS.

THE GROUNDWATER LEVELS ARE UNIQUE TO THE DATE SAMPLED. SEASONAL FLUCTUATIONS ARE EXPECTED.

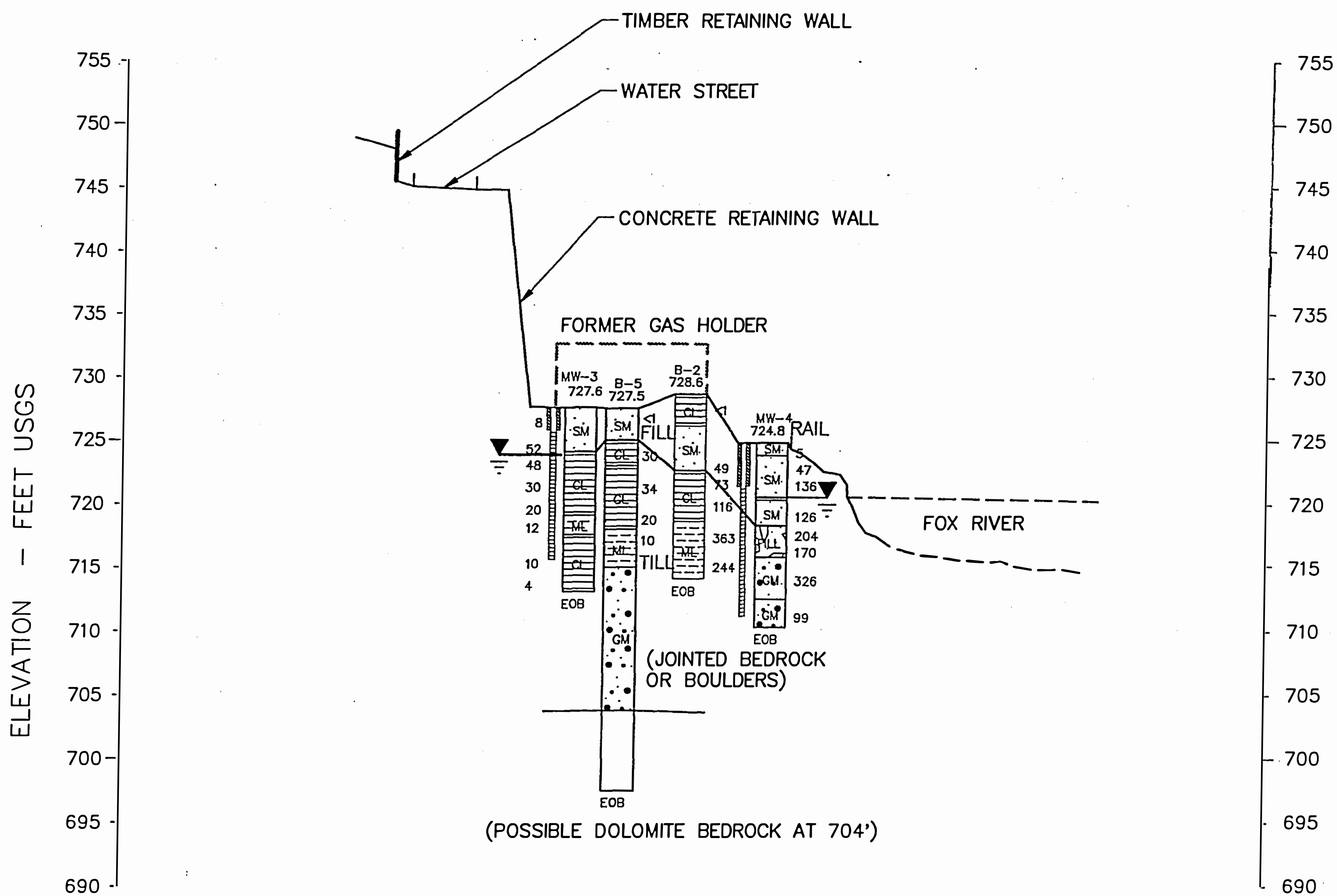
DRAWN BY	LMc/JMI	DATE	2-13-97
CHECKED BY	SMM	DATE	2-13-97
APPROVED BY	SMM	DATE	2-13-97
CADFILE	:\PROJECTS\84703\XD\G503D004.DWG XREF=NONF		

CROSS-SECTION D-D'
FORMER MANUFACTURED GAS PLANT
APPLETON, WISCONSIN

STS Consultants Ltd.
Consulting Engineers

STS PROJECT NO. 84703XD
STS PROJECT FILE
SCALE AS SHOWN
FIGURE NO. 7

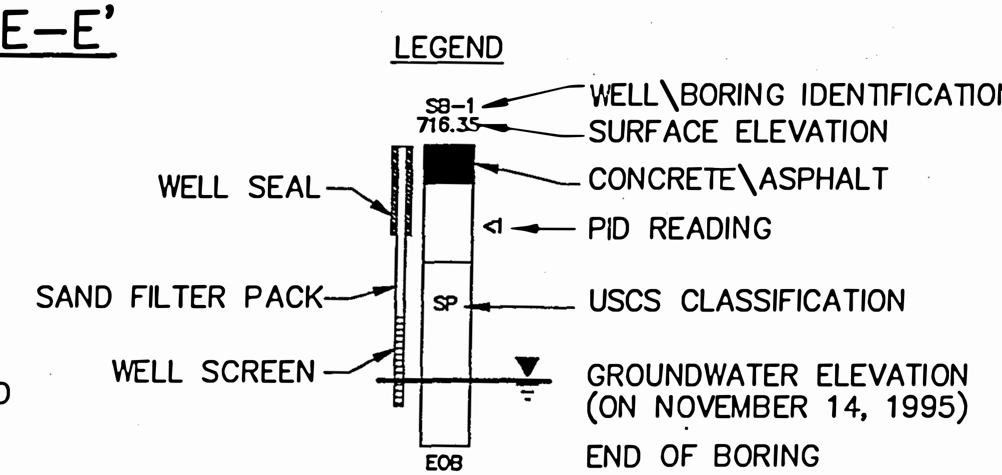
PROJECT[redacted]84703\XD\G503D004 Thu Feb 13 14:48:31 1997 STS CONSULTANTS LTD., MILWAUKEE, WISCONSIN



CROSS-SECTION E-E'

E 5-6

SCALE: HORIZ. 1"=50'
VERT. 1"=10'



NOTE:

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THE GROUNDWATER LEVELS ARE UNIQUE TO THE DATE SAMPLED. SEASONAL FLUCTUATIONS ARE EXPECTED.

DRAWN BY	LMc/JMI	DATE	4-4-96
CHECKED BY	GJB	DATE	4-4-96
APPROVED BY	SMM	DATE	4-4-96
CADFILE	:\PROJECTS\84703\XB\EESEC.DWG XREF=NONE		

CROSS-SECTION E-E'
FORMER MANUFACTURED GAS PLANT
APPLETON, WISCONSIN

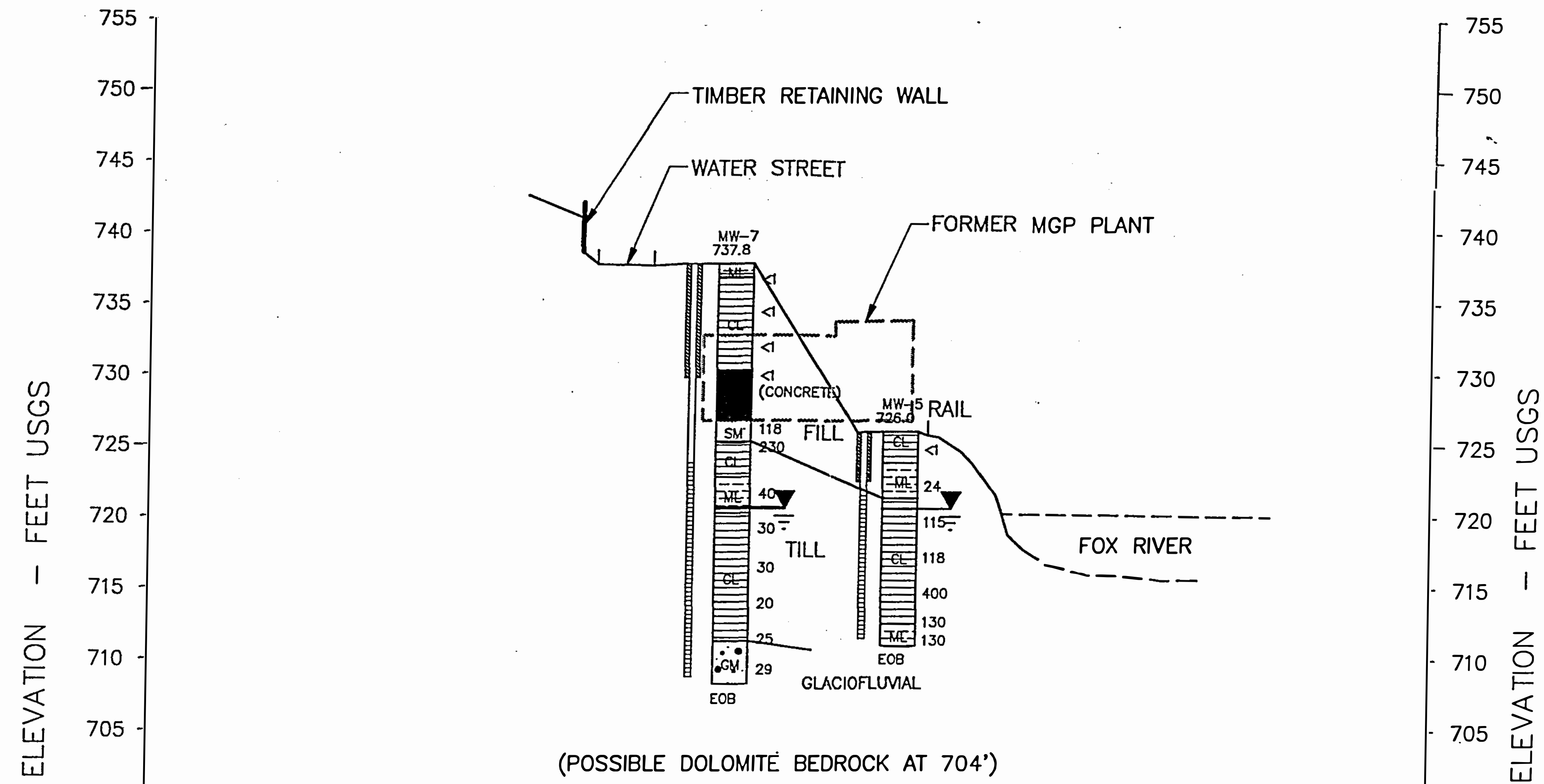
STS Consultants Ltd.
Consulting Engineers

STS PROJECT NO. 84703XB

STS PROJECT FILE

SCALE AS SHOWN

FIGURE NO. 8

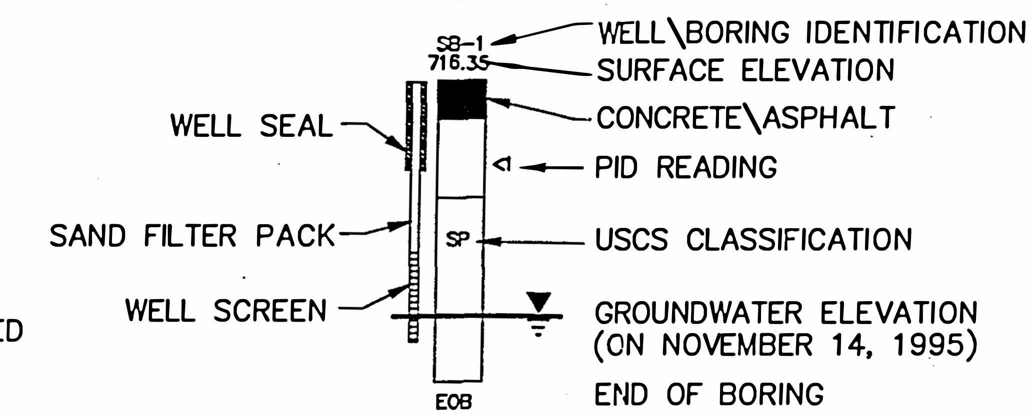


F
5-7

CROSS-SECTION F-F'

SCALE: HORIZ. 1"=50'
VERT. 1"=10'

LEGEND



NOTE:

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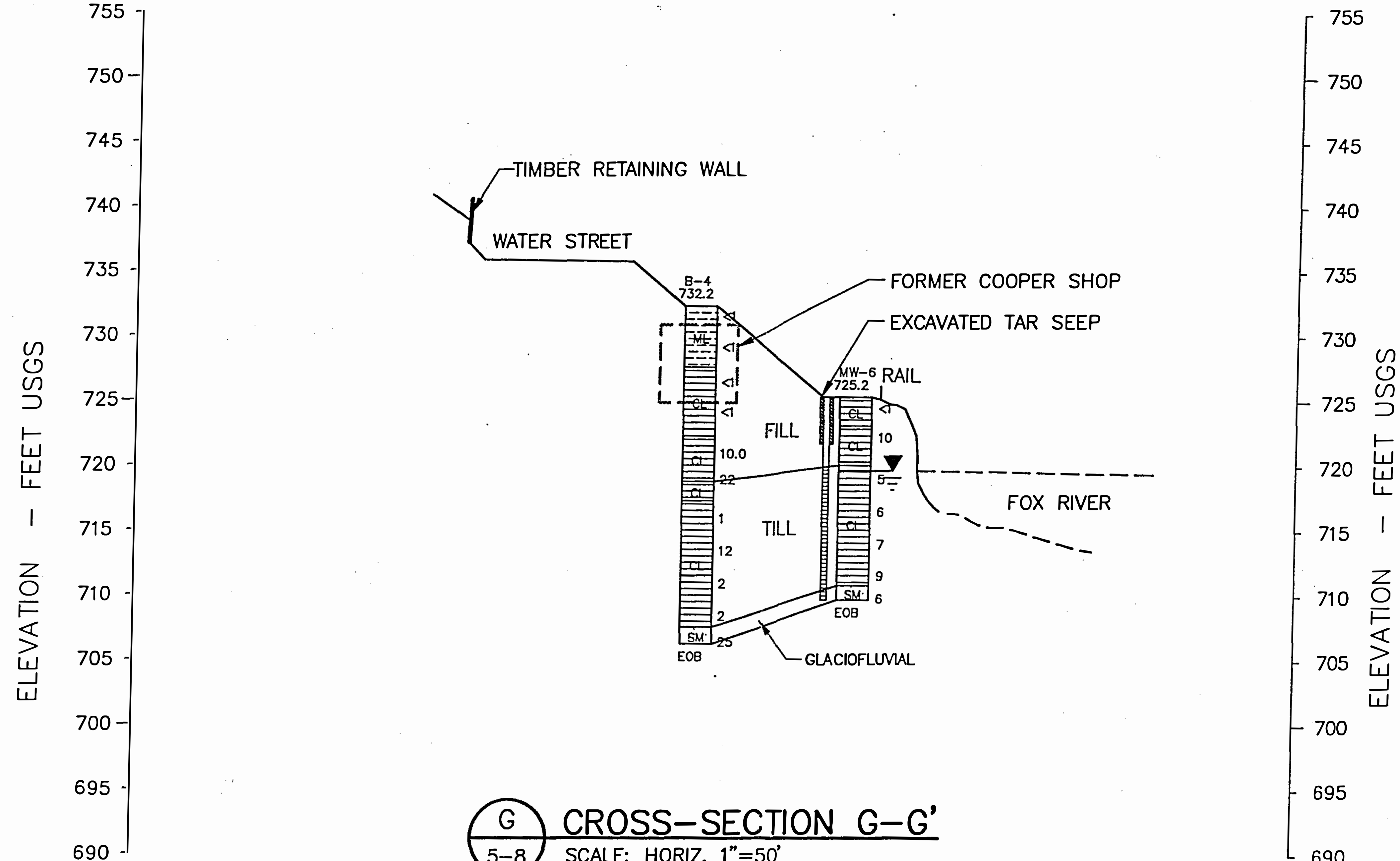
THE GROUNDWATER LEVELS ARE UNIQUE TO THE DATE SAMPLED. SEASONAL FLUCTUATIONS ARE EXPECTED.

DRAWN BY	LMc/JMI	DATE	4-4-96
CHECKED BY	GJB	DATE	4-4-96
APPROVED BY	SMM	DATE	4-4-96
CADFILE	:\PROJECTS\84703\XB\EESEC.DWG XREF=NONE		

CROSS-SECTION F-F'
FORMER MANUFACTURED GAS PLANT
APPLETON, WISCONSIN

STS Consultants Ltd.
Consulting Engineers

STS PROJECT NO. 84703XB
STS PROJECT FILE
SCALE AS SHOWN
FIGURE NO. 9

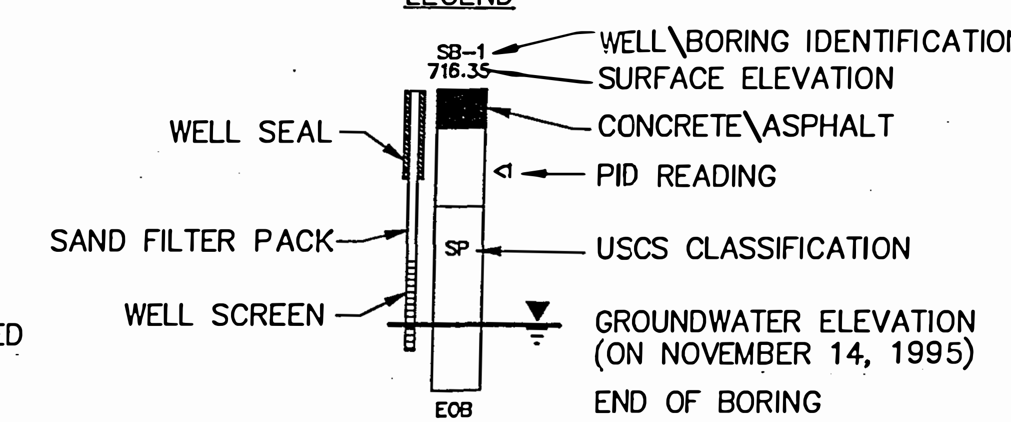


CROSS-SECTION G-G'

G 5-8

SCALE: HORIZ. 1"=50'
VERT. 1"=10'

LEGEND



NOTE:

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THE GROUNDWATER LEVELS ARE UNIQUE TO THE DATE SAMPLED. SEASONAL FLUCTUATIONS ARE EXPECTED.

DRAWN BY	LMc/JMI	DATE	4-4-96
CHECKED BY	GJB	DATE	4-4-96
APPROVED BY	SMM	DATE	4-4-96
CADFILE	:\PROJECTS\84703\XB\EESEC.DWG XREF=NONE		

CROSS-SECTION G-G'
FORMER MANUFACTURED GAS PLANT
APPLETON, WISCONSIN

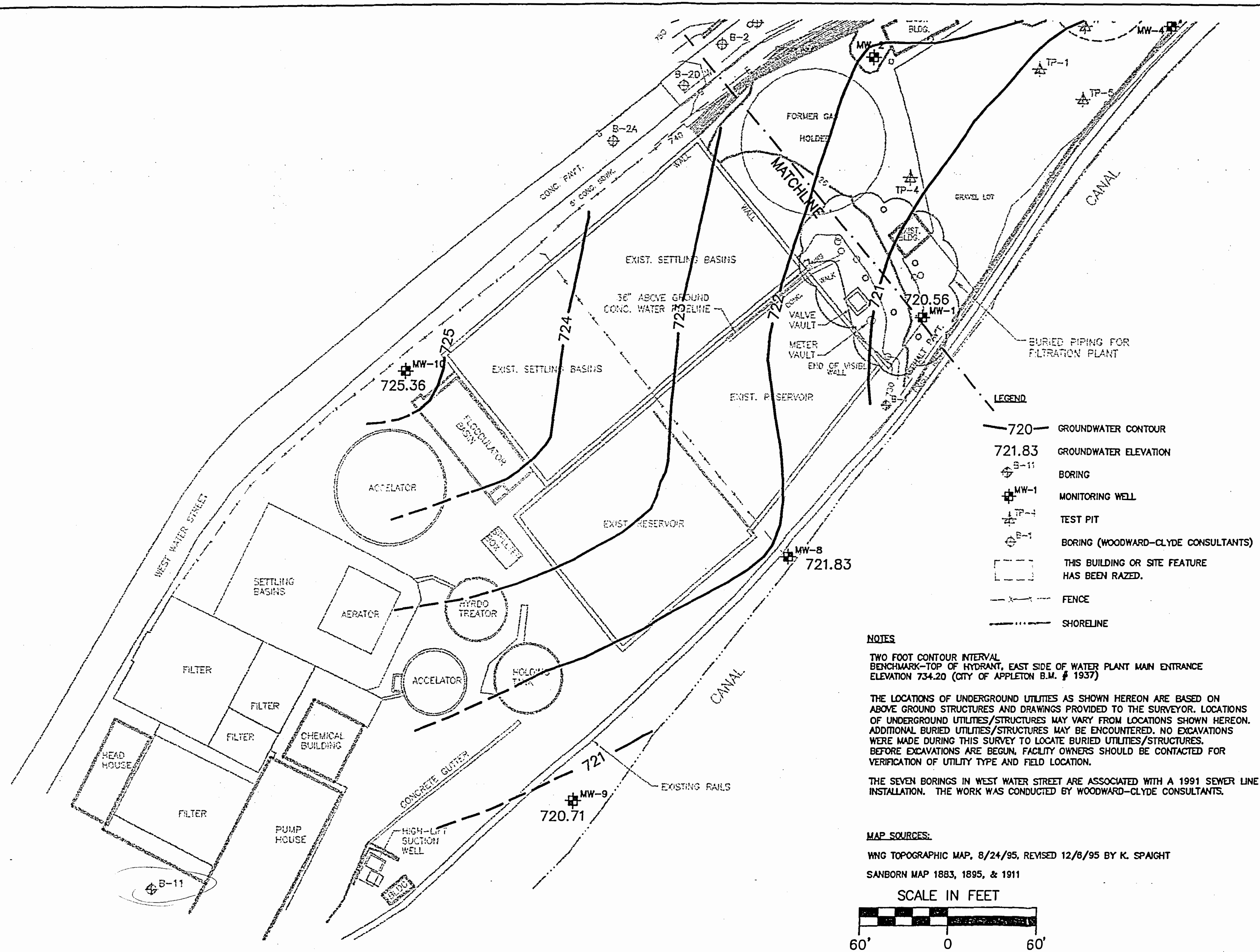
STS Consultants Ltd.
Consulting Engineers

STS PROJECT NO. 84703XB

STS PROJECT FILE

SCALE AS SHOWN

FIGURE NO. 10



NOTES

TWO FOOT CONTOUR INTERVAL
BENCHMARK-TOP OF HYDRANT, EAST SIDE OF WATER PLANT MAIN ENTRANCE
ELEVATION 734.20 (CITY OF APPLETON B.M. # 1937)

THE LOCATIONS OF UNDERGROUND UTILITIES AS SHOWN HEREON ARE BASED ON ABOVE GROUND STRUCTURES AND DRAWINGS PROVIDED TO THE SURVEYOR. LOCATIONS OF UNDERGROUND UTILITIES/STRUCTURES MAY VARY FROM LOCATIONS SHOWN HEREON. ADDITIONAL BURIED UTILITIES/STRUCTURES MAY BE ENCOUNTERED. NO EXCAVATIONS WERE MADE DURING THIS SURVEY TO LOCATE BURIED UTILITIES/STRUCTURES. BEFORE EXCAVATIONS ARE BEGUN, FACILITY OWNERS SHOULD BE CONTACTED FOR VERIFICATION OF UTILITY TYPE AND FIELD LOCATION.

THE SEVEN BORINGS IN WEST WATER STREET ARE ASSOCIATED WITH A 1991 SEWER LINE INSTALLATION. THE WORK WAS CONDUCTED BY WOODWARD-CLYDE CONSULTANTS.

MAP SOURCES:

WNG TOPOGRAPHIC MAP, 8/24/95, REVISED 12/6/95 BY K. SPAIGHT

SANBORN MAP 1883, 1895, & 1911

DRAWN BY	JMI\LMc\RP	DATE 3-5-97
CHECKED BY	SMM	DATE 3-5-97
APPROVED BY	JMT	DATE 3-5-97
CADFILE	::\PROJECTS\84703\XD\G503D009.DWG XREF=X5EXSTBS	

JULY 1996 GROUNDWATER FLOW DIAGRAM FORMER MANUFACTURED GAS PLANT APPLETON, WISCONSIN

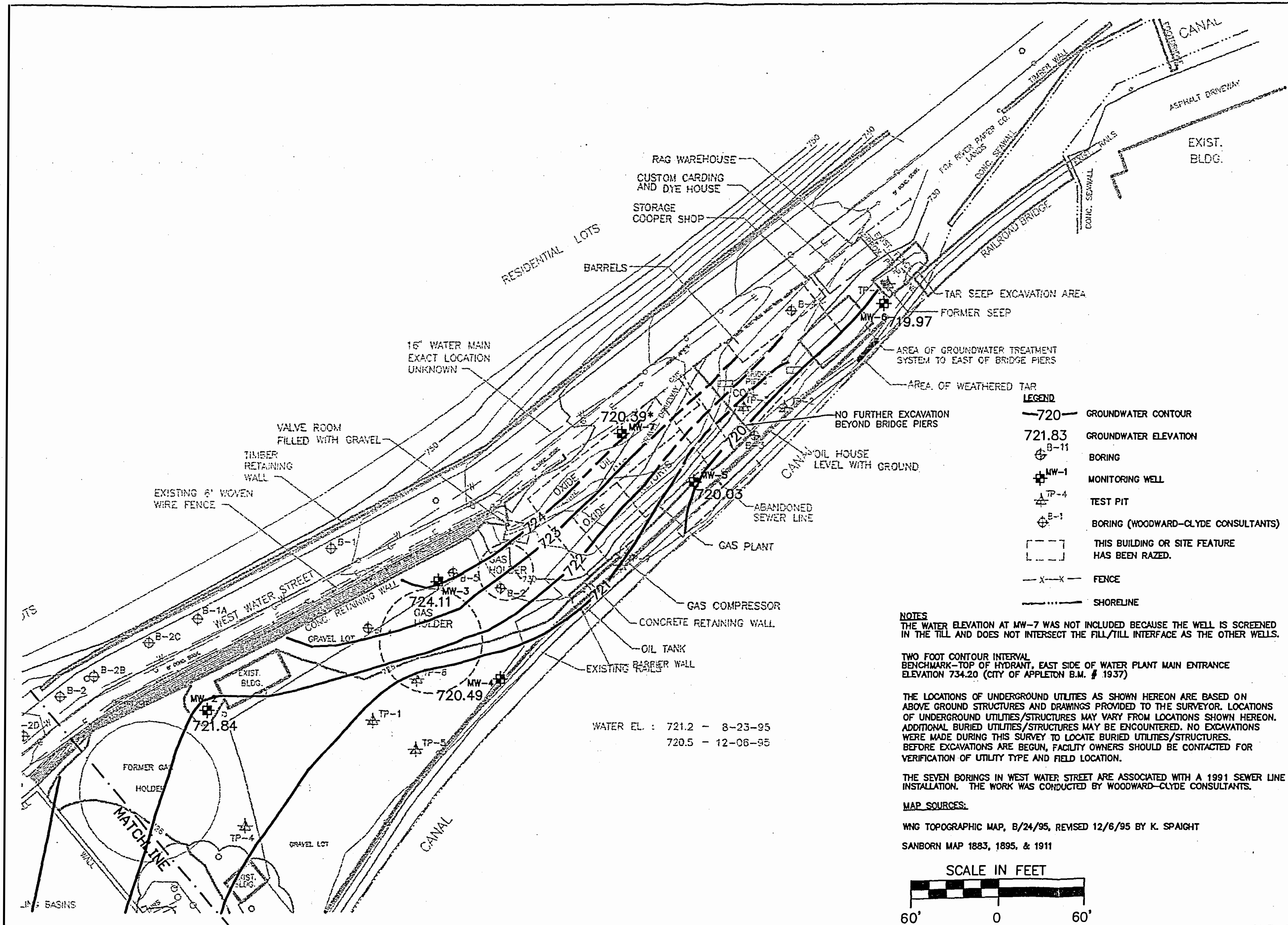
STS Consultants Ltd.
Consulting Engineers

STS PROJECT NO. 84703XD

STS PROJECT FILE

SCALE AS SHOWN

FIGURE NO 11



LEGEND

—720—	GROUNDWATER CONTOUR
721.83	GROUNDWATER ELEVATION
B-11	BORING
MW-1	MONITORING WELL
TP-4	TEST PIT
B-1	BORING (WOODWARD-CLYDE CONSULTANTS)
[ ]	THIS BUILDING OR SITE FEATURE HAS BEEN RAZED.
—x—x—	FENCE
——···——	SHORELINE

NOTES

THE WATER ELEVATION AT MW-7 WAS NOT INCLUDED BECAUSE THE WELL IS SCREENED IN THE TILL AND DOES NOT INTERSECT THE FILL/TILL INTERFACE AS THE OTHER WELLS.

TWO FOOT CONTOUR INTERVAL
BENCHMARK–TOP OF HYDRANT, EAST SIDE OF WATER PLANT MAIN ENTRANCE
ELEVATION 734.20 (CITY OF APPLETON B.M. # 1937)

THE LOCATIONS OF UNDERGROUND UTILITIES AS SHOWN HEREON ARE BASED ON ABOVE GROUND STRUCTURES AND DRAWINGS PROVIDED TO THE SURVEYOR. LOCATIONS OF UNDERGROUND UTILITIES/STRUCTURES MAY VARY FROM LOCATIONS SHOWN HEREON. ADDITIONAL BURIED UTILITIES/STRUCTURES MAY BE ENCOUNTERED. NO EXCAVATIONS WERE MADE DURING THIS SURVEY TO LOCATE BURIED UTILITIES/STRUCTURES. BEFORE EXCAVATIONS ARE BEGUN, FACILITY OWNERS SHOULD BE CONTACTED FOR VERIFICATION OF UTILITY TYPE AND FIELD LOCATION.

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MAP SOURCES:

WNG TOPOGRAPHIC MAP, 8/24/95, REVISED 12/6/95 BY K. SPAIGHT

SANBORN MAP 1883, 1895, & 1911

SCALE IN FEET

60' 0 60'

DRAWN BY JMI\LMc\RP	DATE 3-5-97
CHECKED BY SMM	DATE 3-5-97
APPROVED BY JMT	DATE 3-5-97
CADFILE :: \PROJECTS\84703\XD\GS03D010.DWG X REF=X5EXST8S	

JULY 1996 GROUNDWATER FLOW DIAGRAM
FORMER MANUFACTURED GAS PLANT
APPLETON, WISCONSIN

STS Consultants Ltd.
Consulting Engineers

STS PROJECT NO. 84703XD

STS PROJECT FILE

SCALE AS SHOWN

FIGURE NO. 12

The average estimated linear horizontal groundwater flow velocity in the fill/glacial till is approximately 2.6 feet/year. Slightly higher groundwater flow velocities are expected in the central and western portions of the site due to the larger horizontal gradients observed there, while lower groundwater flow velocities are anticipated for the site's eastern portion.

Groundwater seeped into several of the test pits during excavation; whereas some test pits along the river's edge were dry to depths below the elevation of the river. The infiltration rate of water into the excavations depended upon the presence and continuity of silty clay in the excavations.

2.3 Summary of Soil and Groundwater Results

2.3.1 Summary of Soil Quality

The following conclusions are drawn from the field observations and soil analytical data:

- The heaviest impacts to soil appear to be in the areas of the former MGP plant footprint and along the south side of the three former gas holders, in particular south of the largest gas holder. The soil impacts are generally just below the ground surface and extend vertically to the groundwater table. Soil impacts are suspected below the groundwater table due to elevated PID readings and visual observations.

- Coal tar stained soil was observed at the water table at several locations. Elevated VOC, PAH, cyanide, and phenols in the soil matrix were associated with occurrences of coal tar stained soil.

- Elevated total cyanide concentrations were associated with the occurrence of blue wood chips or staining, especially in the area of the former MGP plant. Most of the total cyanide is likely in the complexed and stable ferric ferrocyanide form since weak acid dissociable and cyanide amenable to chlorination were generally low or non-detectable.

- Elevated PAH concentrations were associated with the presence of cinders, coal tar, or oily material. The pattern of elevated cyanide and BETX mimicked the pattern of elevated PAH concentrations.

- A population of indigenous hydrocarbon-degrading microbes have developed in the site soils. The microbial population and available nutrients are sufficient to support bioremediation; however, augmentation of the nutrients would increase the rate of bioremediation.

- Site-specific groundwater protective RCLs were exceeded for several compounds: styrene; benzene; toluene; ethylbenzene; xylenes; acetone; methylene chloride; 2-butanone; phenol; 1,1,2,2-tetrachloroethane; 1,1,2-trichloroethane; and naphthalene. The greater exceedances occurred in the area of the former MGP plant and south of the existing large gas holder.

- Concentrations of the PAHs benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene exceeded their preliminary RCLs for direct contact in one or more samples. The areas of highest concentration of these PAHs and others were near the former locations of the MGP plant and the larger gas holder.

- At this time, exposure due to direct contact is considered minimal because the majority of the site is covered with overburden soil. Several contaminants have been shown to exceed the site-specific groundwater RCLs, but only cyanide, 1,2-dichloroethane, BETX, styrene, and naphthalene exceeded a NR140 Groundwater ES. The affected soil has been in-place since at least 1956.

- Elevated VOCs have been detected in the soil. The BETX and styrene compounds are the VOCs of concern since they were detected most frequently and at the highest concentrations. Elevated VOC levels are observed in the area of the former MGP plant and gas holders. No consistent correlation between locations of BETX and other VOCs was noted. The VOCs other than BETX may have originated from more recent site use by a paint manufacturing facility.

- Impacts from the former MPG plant were observed in the soil. A layer of visibly coal tar impacted soil varying in thickness from two to 15 feet is present across the site. The affected soil extends to the south near the Fox River and tapers off to the north near West Water Street. Soil impacts extend to the west near the reservoir tanks and east to the railroad bridge. Soil impacts extend below the groundwater table.

- Elevated PAH concentrations were associated with the presence of cinders, coal tar or oily residue. While PAH concentrations were detected above direct contact RCLs, the PAH affected soil is below a soil cover or structures on-site and does not pose a direct contact risk to receptors. With the exception of naphthalene, no other PAHs were consistently detected in the groundwater above NR140 ESs.

- Complex iron cyanide species such as ferric ferrocyanide are present in the soil across the site. The highest impacts are in the former area of the MGP plant and on the south side of the three former gas holders. Phenols are also present in the soil.

- Typically, elevated VOC concentrations across the site in the soil coincide with elevated PAH concentrations and higher concentrations of cyanides and phenols.
- Bedrock was cored in one location. The weathered bedrock did not have obvious signs of impacts. No staining or black coloring was observed. More competent bedrock at depth, below the cobble and boulder till layer also did not have visual signs of contamination.

2.3.2 Groundwater Quality Summary

Four rounds of groundwater samples were collected by WEPCo personnel between 1995 and 1997. Groundwater samples were tested for cyanides, VOCs, total phenols, semivolatile organic compounds (SVOCs), total dissolved solids (TDS), carbonate, bicarbonate, total organic carbon (TOC), chloride, sulfate, calcium, iron, lead, magnesium, potassium, sodium, nitrate plus nitrite, total kjeldahl nitrogen (TKN), and phosphorus. The list of SVOCs included phenols, polynuclear aromatic hydrocarbons (PAH), phthalates, and amines (pesticides and PCBs were not analyzed). Results of laboratory analyses are summarized on Tables 1 and 2. The most recent round of groundwater sampling was conducted in March 2001. The groundwater results will be submitted under separate cover once the laboratory analytical data is available.

Table 1
Appleton MGP Site
Analytical Results - Groundwater
STS Project No. 84703XB

	NR140 PAL	NR140 ES	MW-1 11/15/95	MW-1 12/13/95	MW-1 9/10/97	MW-2 11/15/95	MW-2 12/13/95	MW-2 9/9/97	MW-3 11/15/95	MW-3 12/13/95	MW-3 9/10/97
Weak Acid Dissociable Cyanide, ug/L	(1)	(1)	63.8	53.0	4.2	341	370	110	127	53.0	43.0
Total Cyanide, ug/L	40	200	399	317	200	2700	2450	1100	477	430	420
Amenable Cyanide, ug/L	(1)	(1)	399	317	160	630	2440	720	262	430	240
Carbonate, mg/L	—	—	<20.0	<20.0	<1.0	<20.0	<20.0	<1.0	<20.0	<20.0	<1.0
Bicarbonate, mg/L	—	—	872	206	670	683	144	660	866	158	440
Total Organic Carbon, mg/L	(2)	(2)	12.2	18.7	17	18.6	27.1	21	13.4	21.6	16.0
Chloride mg/L	125	250	47.4	46.6	80	92.2	89.1	130	177	199	140
Nitrate/Nitrite as N, mg/L	2	10	<0.04	<0.05	0.05(Y)	<0.04	<0.05	0.32	0.388	<0.05	0.11
Total Kjeldahl Nitrogen, mg/L	—	—	7.0	8.1	8.2	7.0	9.5	5.1	<0.23	5.0	6.0
Total Phenol, ug/L	1200	6000	22	16	<8.5	7.3	6.7	<8.5	6.4	24	43
Total Phosphorus mg/L	(2)	(2)	0.0129(Y)	0.207	1.2	<0.01	0.038	1.3	0.0241	1.462	0.14(Y)
Total Sulfate, mg/L	125	250	198	78.3	130	730	339	290	205	314	210
Total Dissolved Solids, mg/L	(2)	(2)	940	937	1100	1540	1660	1600	540	1180	1200
Calcium, mg/L	(2)	(2)	227	187	190	370	311	270	239	225	150
Iron, mg/L	0.15	0.3	3.18	3.8	12	1.73	1.92	17	1.07	1.26	0.67
Lead, mg/L	0.0015	0.015	0.001	0.0011(Y)	<3.0	<0.001	<0.001	<.003	0.002	0.0017(Y)	<.003
Magnesium mg/L	(2)	(2)	82.3	72.9	64	105	90.2	69	97.3	87.5	48
Potassium mg/L	(2)	(2)	11.8	9.42	13	12.9	10.8	15	11.4	9.90	8.80
Sodium, mg/L	(2)	(2)	40.0	27.5	39	74.9	66.8	74	104	74.7	61.0

	MW-4 11/14/95	MW-4 12/12/95	MW-4 DUP 12/12/95	% RPD	MW-4 9/9/97	MW-5 11/15/95	MW-5 DUP 11/15/95	% RPD	MW-5 12/13/95	MW-5 9/10/97	MW-6 11/15/95	MW-6 12/13/95	MW-6 9/10/97
Weak Acid Dissociable Cyanide, ug/L	35.3	106	119	11.6	12	74.1	43.2	52.7	40.6	10	38	36.2	7.4
Total Cyanide, ug/L	22.5	14.7	9.96	38.4	960	389	376	3.4	352	270	268	237	270
Amenable Cyanide, ug/L	<2.5	<62.5	<62.5	0	<140(X)	<2.50	<2.5	0	<250	<2.4(X)	268	237	66
Carbonate, mg/L	<20.0	<20.0	<20.0	0	<1	<20.0	<20	0	<20.0	<1.0	<20.0	<20.0	<1.0
Bicarbonate, mg/L	1490	329	330	0.3	1000	896	872	2.7	226	900	913	215	590
Total Organic Carbon, mg/L	45.6	53.4	56.8	6.2	46	80.8	97.6	18.8	66.9	72	38.1	40.7	13
Chloride mg/L	166	172	157	9.1	160	130	133	2.3	148	210	264	252	180
Nitrate/Nitrite as N, mg/L	0.0708	<0.05	<0.05	0	0.056	<0.04	<0.04	0	<0.05	0.049(Y)	0.0770	<0.05	0.045(Y)
Total Kjeldahl Nitrogen, mg/L	34	32	32	0	38	160	160	0	140	170	6.0	11	21
Total Phenol, ug/L	660	570	520	9.2	540	20000	2500	155	17000	11000	15	12	25(Y)
Total Phosphorus mg/L	1.21	0.753	0.593	23.8	0.86	0.529	0.321	48.9	0.215	1.3	0.0819	0.024	62
Total Sulfate, mg/L	234	244	198	20.8	280	149	162	8.4	121	120	189	314	110
Total Dissolved Solids, mg/L	700	1620	1650	1.8	1800	540	720	28.6	833	1,100	1,360	1,550	1,200
Calcium, mg/L	309	266	272	2.2	270	49.0	52.9	7.6	54.3	89	289	264	170
Iron, mg/L	1.48	1.09	1.07	1.9	2.4	0.378	0.698	59.5	0.375	1.1	1.79	3.38	14
Lead, mg/L	<0.001	<0.001	<0.001	0	<0.003	<0.001	<0.001	0	<0.001	<0.003	0.0021	0.0011(Y)	<0.003
Magnesium mg/L	136	124	125	0.8	120	50.5	54.7	8	69.9	92	110	101	57
Potassium mg/L	10.1	9.11	8.97	1.5	9.9	7.84	8.03	2.4	7.77	11	10.3	14.3	18
Sodium, mg/L	107	96.9	95.6	1.4	94	75.9	79.5	4.6	95.2	120	79.3	73.8	68

	MW-7 11/15/95	MW-7 12/13/95	MW-7 9/10/97	MW-8 7/15/96	MW-8 9/9/97	MW-9 7/15/96	MW-9 9/9/97	MW-10 7/15/96	MW-10 9/10/97
Weak Acid Dissociable Cyanide, ug/L	52	40.3	10	2.5	2.5(Y)	<2.5	1.6(Y)	<2.5	5.1
Total Cyanide, ug/L	409	472	280	51.4	23	8.39	4.7	19.6	6.1
Amenable Cyanide, ug/L	409	472	190	51.4	<1.3	8.39	<24(X)	19.6	<14(X)
Carbonate, mg/L	<20.0	<20.0	<1.0	NAD	40	NAD	<1.0	NAD	<1.0
Bicarbonate, mg/L	669	163	760	397	350	421	320	136	330
Total Organic Carbon, mg/L	19.5	21.8	13	88.8	4.8	18.1	3.6	3.91	4.4
Chloride mg/L	119	130	290	52.5	20	191	130	70.5	15
Nitrate/Nitrite as N, mg/L	<0.04	<0.05	0.048(Y)	<0.05	0.049(Y)	<0.05	0.047(Y)	0.85	0.049(Y)
Total Kjeldahl Nitrogen, mg/L	27	29	3.4	NA	1.4	NA	1.2	NA	0.98
Total Phenol, ug/L	340	290	170	<5	<8.5	<5	<8.5	<5	32
Total Phosphorus mg/L	0.0979	0.093	.17(Y)	NA	0.2(Y)	NA	0.84	NA	0.17(Y)
Total Sulfate, mg/L	19.4	169	190	126	51	88.5	130	45.2	110
Total Dissolved Solids, mg/L	480	696	1800	702	500	885	800	289	590
Calcium, mg/L	99.4	101	160	112.8	100	121.9	110	36.1	110
Iron, mg/L	0.406	1.01	1.4	0.224	0.46	5.08	5.8	0.172	4.5
Lead, mg/L	<0.001	<0.001	<0.003	<0.001	<0.003	<0.001	<0.003	<0.001	<0.003
Magnesium mg/L	72.8	76.3	150	36.1	30	45.1	39	15.1	37
Potassium mg/L	6.56	6.19	21	8.2	8.2	2.73	3.8	4.39	6.7
Sodium, mg/L	49.5	36.4	130	27.9	29	58.2	76	8.24	9.9

Notes:
(1) = See PAL and ES for Total Cyanide.
(2) = Site-specific PAL may be developed in accordance with NR140, WAC.
– = No PAL or ES
Y = Reported concentration is below the limit of quantitation.
X = Matrix interference adjustment
NA = Not Analyzed.
Sample QC-1 from 11/15/95 is a duplicate sample of MW-5.
Sample QC-1 from 12/12/95 is a duplicate sample of MW-4. The duplicate samples were collected for quality control purposes.
RPD = Relative percent difference.
Phenol concentration determined using colorimetric method in "Standard Methods for the Examination of Water and Wastewater" 14th Edition.
ND = Not detected above laboratory detection limit

TABLE 2
APPLETON MGP SITE
ANALYTICAL RESULTS - GROUNDWATER
VOLATILE AND SEMI-VOLATILE ORGANIC COMPOUNDS
Units In ug/L Unless Otherwise Specified
STS Project No. 84703XB

	NR140		Sample Number												
	PAL	ES	MW-1			MW-2			MW-3			MW-4		MW-4 DUP	% RPD
Date Sampled			11/15/95	12/13/95	9/10/97	11/15/95	12/13/95	9/9/97	11/15/95	12/13/95	9/10/97	11/15/95	12/12/95	12/12/95	
VOCs															
Methylene Chloride	0.5	5	<1.3	<1.3	<0.42	<1.3	<1.3	<0.42	<1.3	<1.3	<4.2	<1.3	<65.0	<65	0
Acetone	200	1000	<7.4	<7.4	<3.3	<7.4	<7.4	3.7(Y)	<7.4	<7.4	73(B)	61	<370	<370	0
Carbon Disulfide	---	---	<0.5	<0.5	0.97(Y)	<0.5	<0.5	<0.45	<0.5	<0.5	<4.5	3.6	<25	<25	0
Chloroform	0.6	6	<0.3	<0.3	<0.50	<1.3	<0.3	<0.5	0.7(Y)	0.4(Y)	<5.0	<0.3	<15	<15	0
1,2-Dichloroethane	0.5	5	<0.5	<0.5	<1.0	<7.4	<0.5	<0.47	<0.5	<0.5	<4.7	92	<25	<25	0
2-Butanone	90	460	<1.1	<1.1	<2.3	<0.5	<1.1	<2.3	<1.1	<1.1	<23	20	<55	<55	0
Benzene	0.5	5	40	31	34	3.9	14	39	200	520	940	5,400	4,500	4,600	2.2
Toluene	68.6	343	3.5	2.3	1.9	0.5(U,Y)	0.6(Y)	0.53	5.8	10	50	3,100	2,800	2,700	3.6
Ethylbenzene	140	700	19	8.2	12	1.4	1.4	1.1(Y)	9.2	31	210	720	670	640	4.6
Styrene	10	100	<0.3	<0.3	<0.23	<0.3	<0.3	0.24(Y)	1.1	<0.3	<2.3	62	<15.0	<15	0
Total Xylenes	124	620	22.0	21	12	3.3	<1.2	1.0(Y)	44	140	860	2,800	3200	3,300	3.1
SVOCs															
Phenol	1200	6000	<1.1	<1.1	<0.53	<1.1	<1.1	<0.51	<1.1	5.4	<5.3	7.9	<1.1	9.8	159.6
2-Methylphenol	---	---	<0.7	<0.7	<1.0	<0.7	<0.7	<0.99	<0.7	<0.7	<9.8	<0.7	<0.7	<0.7	0
4-Methylphenol	---	---	<3.0	<3.0	<0.97	<3.0	<3.0	<0.93	<3.0	<3.0	<9.8	190	190	190	0
2,4-Dimethylphenol	---	---	<2.7	<2.7	<1.1	<2.7	<2.7	<1.1	<2.7	<2.7	<11	420(E)	150	150	0
Naphthalene	8	40	200	7.2	21.0	10	5.6	<2.1	<0.5	70	3700	10,000	10000	9,700	3.0
2-Methylnaphthalene	---	---	38	12	<2.0	<0.8	<0.8	<1.9	<0.8	1.2(Y)	180	950	970	930	4.2
Acenaphthylene	---	---	41	30	13	4.2	4.5	<1.5	<0.6	1.0(Y)	<16	110	79	71	10.7
Acenaphthene	---	---	75	68	41	<8.5	<8.5	3.4(Y)	<8.5	<8.5	39(Y)	67	64	59	8.1
Dibenzofuran	---	---	7.6	7	3.9(Y)	<1.2	1.6(Y)	<1.7	<1.2	<1.2	<18	18	16	16	0
Fluorene	80	400	37	35	14	1.8(Y)	1.7(Y)	<1.6	<1.0	<1.0	<17	44	31	32	3.2
Phenanthrene	---	---	33	26	24	<1.1	<1.1	<0.73	<1.1	<1.1	25	59	55	52	5.6
Anthracene	---	---	7	8.0	6.1	<1.1	<1.1	<1.2	<1.1	<1.1	<12	12	11	9.6	13.6
Carbazole	---	---	1.6(Y)	<1.3	1.3(Y)	<1.3	<1.3	<0.98	<1.3	<1.3	25(Y)	12	10	11	9.5
Fluoranthene	---	---	<2.0	2.2(Y)	<.96	<2.0	<2.0	<0.92	<2.0	<2.0	<9.7	4.7(Y)	5.5(Y)	5.2(Y)	5.6
Pyrene	---	---	2.2(Y)	2.6(Y)	3.7	<1.6	<1.6	<0.69	<1.6	<1.6	<7.3	6.8	7.6	5.2(Y)	37.5
Benzo(a)Anthracene	---	---	<1.5	<1.5	<0.63	<1.5	<1.5	<0.60	<1.5	<1.5	<6.3	<1.5	<1.5	<1.5	0
Chrysene	---	---	<1.0	<1.0	<0.48	<1.0	<1.0	<0.46	<1.0	<1.0	<4.9	<1.0	<1.0	<1.0	0
Bis(2-Ethylhexyl)Phthalate	0.6	6	3.3(Y)	<2.1	<1.3	<2.1	<2.1	<1.3	<2.1	<2.1	<13	12	5.0(Y)	2.5(Y)	66.7
Benzo(b)Fluoranthene	---	---	<0.9	<0.9	<2.4	<0.9	<0.9	<2.3	<0.9	<0.9	<24	<0.9	<0.9	<0.9	0
Benzo(a)Pyrene	0.02	0.2	<0.8	<0.8	<1.4	<0.8	<0.8	<1.4	<0.8	<0.8	<14	<0.8	1.1(Y)	<0.8	31.6
Ideno(1,2,3-cd)Pyrene	---	---	<1.3	<1.3	<2.3	<1.3	<1.3	<2.2	<1.3	<1.3	<23	<1.3	<1.3	<1.3	0
Benzo(g,h,i)Perylene	---	---	<1.0	<1.0	<2.1	<1.0	<1.0	<2.0	<1.0	<1.0	<21	<1.0	<1.0	<1.0	0
2-Nitrophenol	---	---	<1.0	<1.0	<0.89	<1.0	<1.0	<0.85	<1.0	6.5	<9.0	<1.0	<1.0	<1.0	0

	MW-4	MW-5	MW-5 DUP	% RPD	MW-5		MW-6			MW-7			MW-8		MW-9	MW-10		MW-11
Date Sampled	9/9/97	11/15/95	11/15/95		12/13/95	9/10/97	11/15/95	12/13/95	9/10/97	11/15/95	12/13/95	9/10/97	7/15/96	9/9/97	9/9/97	7/15/96	9/10/97	7/15/96
VOCs																		
Methylene Chloride	<21	<1.3	<260.0	0	<260	<84	<1.3	<1.3	<0.5	<65.0	<65.0	<8.4	<1.0	<0.42	<0.42	<1.0	<0.42	<1.0
Acetone	370(B)	92	<1480.0	0	<1480	1300(Y)	330	<7.4	3.5(B)	<370.0	<370.0	96(B)	<1.4	<3.3	<3.3	<1.4	<3.3	<1.4
Carbon Disulfide	<22	0.8(Y)	<98.0	0	<100	<90	<0.5	<0.5	<0.45	<24.5	<25.0	<9.0	<0.5	<0.45	<0.45	<0.5	<0.45	<0.5
Chloroform	<25	<0.3	<60.0	0	<60	<100	<0.3	<0.3	<0.5	<15.0	<15.0	<10	<0.8	<0.5	<0.5	<0.8	<0.5	11
1,2-Dichloroethane	<23	<0.5	<100.0	0	<100	<94	<0.5	<0.5	<0.47	<25.0	<25.0	<9.4	<0.8	<0.47	<0.47	<0.8	<0.47	<0.8
2-Butanone	<120	30	<220.0	0	<220	<470	4.5	<1.1	<2.3	<55.0	<55.0	<47	<1.2	<2.3	<2.3	<1.2	<2.3	<1.2
Benzene	4,900	23,000	31,000	29.6	17,000	11,000	70	75	130	5,400	4,400	1,800	<0.5	<0.4	<0.4	<0.5	<0.4	<1.2
Toluene	3,100	9,400	11,000	15.7	6,600	4,300	4.3	2.5	0.63(Y)	580	360	960	<0.8	<0.32	<0.32	<0.8	<0.32	<0.5
Ethylbenzene	880	920	1,200	26.4	750	680	20	9.9	48	1,900	1,400	730	<0.5	<0.4	<0.4	<0.5	<0.4	<0.5
Styrene	<12	1,900	2,000	5.1	730	380	0.9(Y)	<0.3	<0.23	30	<15.0	26	<0.6	<0.23	<0.23	<0.6	<0.23	<0.5
Total Xylenes	3,500	3,000	3,400	12.5	2,700	2,100	42	50	2.8(Y)	1,800	1,800	1,100	<2.6	<1.0	<1.0	<2.6	<1.0	<0.6
SVOCs																		
Phenol	<5.2	3,900	4,000	2.5	2,200	780	<1.1	<1.1	<.53	13	<1.1	< 11	<0.7	<0.52	<0.52	<0.7	<0.53	<1.1
2-Methylphenol	77	4,100	4300	4.8	2,600	1,800	<0.7	<0.7	<1.0	<0.7	<0.7	<21	<3.0	<1.0	<1.0	<3.0	<1.0	<0.7
4-Methylphenol	170	6,500	6900	6	3.700	1,900	<3.0	<3.0	<0.98	41	39	<19	<2.7	<0.95	<0.95	<2.7	<0.98	<3.0
2,4-Dimethylphenol	130	4,700	5100	8.2	3.300	2,500	<2.7	<2.7	<1.1	290(E)	58	<22	<0.5	<0.97	<1.1	<0.5	<1.1	<2.7
Naphthalene	10,000	12,000	13,000	8	8,900	7,100	150	4.2	17	9,900	9,000	6,100	<0.8	<2.2	<2.2	<0.8	<2.2	<0.5
2-Methylnaphthalene	620	880	990	11.8	650	440	37	<0.8	<2.0	1,100	1,100	840	<0.6	<1.9	<1.9	<0.6	<2.0	<0.8
Acenaphthylene	55	92	87	5.6	58	<30	1.7(Y)	0.8(Y)	<1.6	2,100	32	160	<8.5	<1.5	<1.5	<8.5	<1.6	<0.6
Acenaphthene	62	72	69	4.2	52	74(Y)	46	17.8(Y)	6.4	180	160	270	<1.2	<1.4	<1.4	<1.2	<1.4	<8.5
Dibenzofuran	<17	54	54	0	39	79(Y)	16	6.3	7.9	23	21	38(Y)	<1.0	<1.7	<1.7	<1.0	<1.8	<1.2
Fluorene	<16	68	65	4.5	45	<32	16	5.1	2.1(Y)	65	60	110	<1.1	<1.6	<1.6	<1.1	<1.7	<1.0
Phenanthrene	57	76	74	2.7	70	170	6.1	<1.1	3.4	63	64	390	<1.1	<0.74	<0.74	<1.1	<0.77	<1.1
Anthracene	<12	17	16	6.1	15	<24	2.6(Y)	<1.1	<1.2	11	13	99	<1.3	<1.2	<1.2	<1.3	<1.2	<1.1
Carbazole	16(Y)	120	120	0	110	94	3.9(Y)	2.1(Y)	5.5	53	40	55(Y)	<2.0	<1.0	<1.0	<2.0	<1.0	<1.3
Fluoranthene	<9.4	9.1	8.6	5.6	8.5	<19	3.8(Y)	<2.0	<0.97	3.8(Y)	3.6(Y)	<19	<1.6	<0.94	<0.94	<1.6	<0.97	<2.0
Pyrene	<7.1	6.8	6.8	0	5.7	<14	3.0(Y)	<1.6	1.4(Y)	4.4(Y)	4.3(Y)	110	<1.5	<0.71	<0.71	<1.5	<0.73	<1.6
Benzo(a)Anthracene	<6.1	<1.5	<1.5	0	<1.5	<12	<1.5	<1.5	<0.63	<1.5	<1.5	<13	<1.0	<0.61	<0.61	<1.0	<0.63	<1.5
Chrysene	<4.7	<1.0	<1.0	0	<1.0	<9.5	<1.0	<1.0	<0.49	<1.0	<1.0	<9.7	2.5(BY)	<0.47	<0.47	8.5(B)	<0.49	<1.0
Bis(2-Ethylhexyl)Phthalate	<13	<2.1	<2.1	0	<2.1	<26	<2.1	<2.1	<1.3	<2.1	<2.1	<26	<0.9	<1.3	<1.3	<0.9	<1.3	<2.1
Benzo(b)Fluoranthene	<24	<0.9	<0.9	0	<0.9	<47	<0.9	<0.9	<2.4	<0.9	<0.9	<48	<0.8	<2.4	<2.4	<0.8	<2.4	<0.9
Benzo(a)Pyrene	<14	<0.8	<0.8	0	<0.8	<28	<0.8	<0.8	<1.4	<0.8	<0.8	<29	<1.3	<1.4	<1.4	<0.8	<1.4	<0.8
Ideno(1,2,3-cd)Pyrene	<23	<1.3	<1.3	0	<1.3	<45	<1.3	<1.3	<2.3	<1.3	<1.3	<46	<1.0	<2.3	<2.3	<1.3	<2.3	<1.3
Benzo(g,h,i)Perylene	<20	<1.0	<1.0	0	<1.0	<41	<1.0	<1.0	<2.1	<1.0	<1.0	<42	<1.0	<2.0	<2.0	<1.0	<2.1	<1.0
2-Nitrophenol	<8.7	<1.0	<1.0	0	<1.0	<17	<1.0	<1.0	<0.9	<1.0	<1.0	<18	<1.0	<0.87	<0.87	<1.0	<0.90	<1.0

Notes:

--- = No PAL or ES
Y = Reported concentration is below the limit of quantitation.
B = Compound present in the associated blank.
NA = Not Analyzed.
E = Concentration exceeds the calibration range, therefore, this value is an estimate.
U = Data may reflect impacts from post-sampling contamination.
QC-1 = Sample QC-1 from 11/15/95 is a duplicate sample of MW-5.
Sample QC-1 from 12/12/95 is a duplicate sample of MW-4. The duplicate samples were collected for quality control purposes.
RPD = Relative percent difference.
A diluted sample from MW-6 (12/13/95) was reanalyzed outside the holding time of the sample. The second analysis reported naphthalene at 130 µg/l and 2-methylnaphthalene at 27 µg/l. The remaining parameters were comparable.
Phenols concentration determined using GC/MS Method 8270 of SW-846.

The conclusions drawn from evaluation of the groundwater quality data are as follows:

- The most significant groundwater impacts were observed in the vicinity of the former MGP plant and MGP structures, i.e. former location of the two smaller gas holders. A pattern of elevated PAH, BETX, and cyanide concentrations exists in the area of the former plant and two smaller gas holders. The PAH concentration in the groundwater extends toward the larger gas holder to the west.

- The most significant VOC impacts in groundwater are due to benzene, and to a lesser extent toluene, xylenes, and ethylbenzene. Benzene concentrations were highest at MW-4, MW-5 and MW-7 in the area of the former MGP plant and downgradient of the two smaller gas holders. ES exceedances in these three wells were observed for the BETX parameters, styrene and 1,2-dichloroethane.

- Several SVOCs were detected in groundwater at the site, the most notable being PAH compounds. PAHs are known contaminants at MGP sites and several PAHs, particularly naphthalene, were detected in the groundwater. Naphthalene was detected above the ES at six of the seven monitoring well locations and exceeded the PAL at the seventh monitoring well. Benzo(a)pyrene was detected above its ES at well MW-4. Fluorene was not detected above its PAL at any sampling location. PAH contaminants were observed in the area particularly downgradient of the former MGP structures.

- The PAH concentrations in groundwater were not as elevated as the PAH concentrations in the soil reflecting the hydrophobic nature of most PAH parameters.

- Cyanide was detected in samples from all wells, however, the cyanide concentration only slightly exceeded the ES at all locations except MW-4 where the ES was not exceeded. Most of the cyanide detected in groundwater at wells MW-1, MW-2, MW-3, MW-6, and MW-7 was amenable cyanide. In general, 20 percent or less of the total cyanide detected was weak acid dissociable.

- Nutrient levels at most well locations are not present at the optimum ratios or in sufficient concentration to support bioremediation without augmentation.

- Iron concentrations exceeded the ES at each of the wells during both sampling rounds. The elevated iron concentrations are considered background conditions.

- Concentrations of iron, calcium, TDS, sulfates, and carbonates indicate that the groundwater will have a tendency to form incrustations on the well screen or within piping runs if a groundwater extraction and treatment system is implemented. Sulfate and chloride concentrations are naturally high in the groundwater.

- Stiff diagrams showed similarities between the shallow groundwater present in the area of the former MGP plant compared to the groundwater outside of this area. The similarity may be due to wells MW-5 and MW-7 in the former plant area being completely screened in the till deposits and/or affected by the degree of contamination in this area. The diagrams did not show a difference between the upgradient and downgradient groundwater on-site.

Sediment probing was conducted in November 2000 as part of an Interim Action Investigation. The results were summarized in a December 1, 2000 letter to the WDNR. No sediment discussion is presented in this report.

Biological Remediation Parameters

- Bioremediation studies were completed to evaluate the potential for intrinsic or natural bioremediation. Nutrients and bacteria colonies are present but not in abundance. Augmentation of both as well as oxygen supplementation would be necessary to use bioremediation as an effective remediation technology.

Residual Contaminant Levels

- Soil impacts were elevated near the former location of the MGP plant and gas holders above levels protective of groundwater for BETX compounds, styrene, acetone, methylene chloride, 2-butanone, phenol, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane and naphthalene. Since the site ceased operation in 1956, groundwater quality in the monitoring wells represents the leaching potential of these soils. Only BETX, styrene, 1,2-dichloroethane and naphthalene were consistently detected above their respective NR140 ESs.

- Soil contaminant levels that are based on direct contact were exceeded for several of the PAH parameters but not the VOCs. The affected soil is currently covered limiting the potential for exposure to these parameters. The highest potential for exposure would be to workers during remediation where soil would be excavated. The area with the highest concentration of PAH parameters is at the former location of the MGP plant and three gas holders.

- The PAH parameters that exceed RCLs for direct contact include benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene and indeno(1,2,3-cd)pyrene.

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THREE

3

3.0 APPLICABLE ENVIRONMENTAL STANDARDS

3.1 Soils

NR720, WAC was developed to provide regulatory procedures for establishing soil cleanup standards for the remediation of soil contamination which result in the restoration of the environment to the extent practicable, minimize harmful effects to the air, lands and waters of the state and are protective of public health, safety and welfare, and the environment.

Site-specific RCLs were developed for the site using the procedures outlined in NR720 WAC to be 1) protective of groundwater and 2) protective of human health by direct contact. The more restrictive of these two RCLs was then considered in the evaluation of the soil data. The RCLs were developed to understand which contaminants are of concern and to draw conclusions concerning the extent of these contaminants. The RCLs were not developed as soil cleanup goals since soil remedial goals need to consider the future site usage which has not yet been determined, the remedial action being implemented and possibly performance-based goals rather than RCL's for each compound detected. Performance-based soil standards may be appropriate depending upon the future site usage and the remedial aternative selected.

3.2 Groundwater

NR140 WAC specifies groundwater quality standards for the State of Wisconsin for substances detected in, or having a reasonable probability of entering the groundwater resources of the state. These PAL and ES standards were used as reference in discussions of the site groundwater investigation results. At sites where ES's have been exceeded, NR140.26 WAC specified a range of responses which may be required by the WDNR. NR140.28 WAC specifies criteria for granting exemptions in certain cases where a PAL or ES has been exceeded. One of these criteria states that the department may grant an exemption when a PAL or ES is exceeded if it is determined that compliance which the standard is either not technically or economically feasible. Since PALs and ESs are exceeded at this site for certain parameters, Chapter NR140 WAC is an appropriate consideration for this site.

Revisions to chs. NR722, NR724, NR726 and NR140 allow for case closure where groundwater remediation initiatives have reached their limit of effectiveness (treatment conducted to the extent practicable) but groundwater contamination still exists above NR140 ESs. As long as the source of the contamination has been satisfactorily addressed and there is no additional chemical release to groundwater that would violate ch. NR140, natural attenuation may be used to attain NR140 groundwater standards (i.e. sites may be closed out by using natural attenuation as the final remedy for groundwater). Monitoring for natural attenuation may continue until NR140 standards are met or until there is a request that the site be closed out with a well restriction.

3.3 Sediments

Sediments were not observed along the river edge during the sediment probing activities. It is possible, however, that pockets of sediments may be present in the river or near bridge supports. Potential soil impacts and applicable response actions will be addressed as a separate submittal.

3.4 Surface Water

Minimal discharge to surface water is anticipated at the site as part of a remedial action. Surface water will be controlled during any site activities to eliminate the amount of sediments leaving the site. The WDNR surface water regulations and associated permits will be addressed as part of the selected remedial option.

3.5 Air

NR400 address air quality requirements. During any type of remedial activities, air monitoring measures will be implemented. These air monitoring measures will be presented to the Department of Health and Human Services. If remedial technologies are implemented that involve air discharges, NR400 WAC regulations will be followed.

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FOUR

4.0 INITIAL SCREENING OF REMEDIAL OPTIONS

4.1 Presentation of Remedial Options

Soil is affected at the former MPG site from the past operations and from demolition of the structures. The affected soil intersects the water table and has affected groundwater quality. The greatest soil and groundwater impacts are in the former location of the MGP plant and three gas holders. The extent of impacts has been defined. Horizontal impacts extend downgradient to the river and are defined to the west, north and east by diminishing impacts to soil and groundwater. The limits of impacts appear to extend to the filtration plant reservoirs (west), Water Street (north) and railroad bridge (east).

The soil concentrations of BETX and PAH compounds as well as phenols exceed some of the residual contaminant levels (RCLs) that are protective of groundwater or are based on direct contact. In addition, NR140 ESs for BETX, naphthalene, styrene and cyanide were exceeded in several wells. In accordance with NR700, these elevated soil and groundwater concentrations require a response action.

The soil remediation approaches presented in this document include varying degrees of excavation, solidification, capping, bioremediation, phytoremediation and chemical oxidation. Soils requiring excavation could be landfilled, thermally treated, or biologically treated. Groundwater remediation approaches are evaluated to minimize affected groundwater from migrating to the river. Groundwater extraction could be implemented with discharge directly to the local sanitary sewer and waste water treatment plant (WWTP), or pretreated on site before being pumped to the WWTP. These groundwater control measures could include some type of wall along the river's edge to assist in collecting the groundwater. Another on-site treatment option includes creating a "funnel" to direct affected groundwater toward a "gate" that has an in-situ passive "reactive" treatment medium to remove contaminants before the water discharges to the river. A trench filled with the treatment medium could be constructed to create a "reactive wall" along the river edge. Other in-situ treatment technologies for groundwater include injection with oxygen releasing compounds (ORC) and/or biosparging. Also, depending upon the degree of excavation, natural attenuation may be an effective remedy.

The soil and groundwater remediation approaches are presented. The purpose of separating them is to identify applicable technologies for each media separately. However, a final remedy will include a combination of both soil and groundwater remedies. Remedial scenarios will be evaluated further based on the final end use of the property. The feasibility and applicability of each remediation option continues to be evaluated for the site.

The objectives of the soil remedial options are to:

- reduce the continuous leaching of contamination to the groundwater
- eliminate the potential for direct contact
- reduce or eliminate the risk to receptors
- reduce impacted soil on site that exceed cleanup goals

The objectives of the groundwater remedial options are to:

- minimize discharge of affected groundwater to the river;
- allow for groundwater treatment or monitoring while developing the site; and
- provide for cost effective long term O&M.

In addition, tar has been identified during the Site Investigation on the rip rap along the shore and in one area below the ground surface. The final remedial action would also include removal or containment of the tar.

The remedial options for soil, groundwater and tar are summarized on the following tables. The options have been evaluated using the criteria established in NR722.07(4). These criteria included evaluation of each remedy based on the following points:

Long Term Effectiveness
- Direct contact with affected soil.
- Groundwater leaching source eliminated.
- Applicability to all contaminants.
- Need for institutional controls.
- Potential to discharge to the river.

Short Term Effectiveness
- Direct contact exposure during implementation.
- Potential to discharge to the river.

Implementability
- Ease of implementation/limitations (structural).
- Conventional/proven technology vs. innovative/unproved.
- Regulatory acceptance.
- Limits/coincides with site development.
- Requires long term O&M/gradient control.

Restoration Time Frame

- Time frame to achieve direct contact exposure control.
- Time frame for meeting groundwater standards.
- Means of measuring restoration time frame.

Cost

- Cost to study option, design, construct and monitor.

EVALUATION OF REMEDIAL OPTIONS FOR IMPACTED SOILS
APPLETON MGP SITE
APPLETON, WISCONSIN

ALTERNATIVE	TECHNICAL FEASIBILITY				ECONOMIC FEASIBILITY
	Long Term Effectiveness	Short Term Effectiveness	Implementability	Restoration Time Frame	
Source Materials & Soils					
No Action	Direct contact would require institutional control. Does not address continuing groundwater source. Requires deed restriction.	Avoids direct contact exposure potential during active remedy.	Easy to implement. Low regulatory acceptance. May limit future site use.	Likely never achieve direct contact regulatory limits. Will be continuing source to groundwater. Requires long term groundwater monitoring.	Low Cost
Site Cap	Will need to maintain cover to limit direct contact exposure. Will reduce infiltration and continued leaching from vadose zone to groundwater. Remaining source in saturated zone. Likely require deed restrictions.	Minimal direct contact exposure during implementation.	Easy to implement. Moderate regulatory acceptance due to continuing groundwater source. Low disruption for site. May limit future site development options due to inability to compromise cap.	Immediate direct contact control - will require long-term maintenance of cap. Will reduce infiltration of surface water and reduce leaching to groundwater. Requires groundwater monitoring to evaluate performance.	Low Cost
Excavation - "Hot Spot" Only: Includes area of former buildings and holders. **Landfill disposal or off-site biological treatment.**	Direct contact exposure reduced. Still may require institutional control or site cap for remaining soil. Significantly reduces groundwater source potential - but may still require groundwater remedy. Likely requires deed restriction.	Direct contact exposure during excavation. Immediate removal of soil with greatest exposure potential and greatest groundwater source potential.	Excavation relatively simple due to shallow depths and limited "hot spot" extent. Some potential limitations due to stability of soils along Water Street and near bridge piers. Likely regulatory acceptance. May limit future site development. Moderate disruption to site (odor control)	Quick removal of highest contaminant source. Site work could last up to 6 months. Will reduce timeframe for meeting groundwater standards. Rely on natural attenuation for ultimately reaching standards. Groundwater monitoring required.	Low Cost
Excavation - To Water Table Only: Thermal treatment, landfill disposal or off-site biological treatment.	Eliminates direct contact exposure to water table (I.e. approx. 10 ft). Clean backfill provides barrier. Eliminates continuing groundwater source in vadose zone. Likely requires deed restriction.	Direct contact exposure during excavation. Immediate removal of soil with greatest exposure potential and greatest groundwater source potential.	Excavation relatively simple due to shallow depths and extent of impacts defined. Some potential limitations due to stability of soils along Water Street and near bridge piers, and potential infiltration from river. High regulatory acceptance. Does not limit future site development. High disruption to site (odor control).	Immediate elimination of direct contact exposure. Site work could last from 6 months to 1 year. Should significantly reduce timeframe for meeting groundwater standards. Rely on natural attenuation for ultimately reaching standards. Groundwater monitoring required.	Moderate Cost
Excavation - To Bedrock: Thermal treatment, landfill disposal or off-site biological treatment.	Eliminates direct contact exposure. Eliminates continuing groundwater source. Possibly not require deed restriction.	Increased direct contact exposure during excavation.	Difficult to excavate below water table due to river infiltration, stability of existing retaining wall, stability of soils near Water street, and stability of soils near bridge piers. High regulatory acceptance. Does not limit future site development. High disruption to site (odor control).	Immediate elimination of direct contact exposure. Site work could last from 6 months to 1 year. Should significantly reduce timeframe for meeting groundwater standards. Rely on natural attenuation for ultimately reaching standards.	High Cost
Phytoremediation	Reduce direct contact exposure by vegetative cover. Potential to reduce groundwater source - most effective on moderately impacted soils. May require deed restriction. May be effective for groundwater control.	Low exposure potential during implementation.	Easy to implement. Few limitations. Newer technology - on going research with promising potential. May be used in conjunction with another soil option.	Potential short-term reduction indirect contact exposure. Overall restoration time frame likely moderate.	Moderate Cost

EVALUATION OF REMEDIAL OPTIONS FOR IMPACTED SOILS
APPLETON MGP SITE
APPLETON, WISCONSIN

ALTERNATIVE	TECHNICAL FEASIBILITY				ECONOMIC FEASIBILITY
	Long Term Effectiveness	Short Term Effectiveness	Implementability	Restoration Time Frame	
In-Situ bioremediation	Direct contact exposure may still exist - may require institutional or engineering control. Reduced groundwater source potential. Effective for lower weight hydrocarbons and possibly effective for higher weight hydrocarbons. Ineffective for inorganic constituents. Low clean up levels may not be possible. Likely requires deed restrictions.	Limits short term exposure potential during implementation.	Difficult to apply uniformly without removing underground structures. Need to evaluate leaching potential of other compounds. Potential limitations due to structural stability of soils near retention wall, bridge piers and along Water Street. Moderate regulatory acceptance. Site development may be limited due to stability of soils.	Direct contact exposure remains. Should reduce timeframe for meeting groundwater standards. Requires groundwater monitoring to evaluate performance.	Moderate Cost
Chemical Oxidation	Direct contact exposure may still exist - may require institutional or engineering control. Reduce groundwater source.	Relatively rapid results. Limited exposure during implementation.	Potential limitations due to subsurface structures/conduits. Relatively new technology - ongoing research. May require multiple applications.	Relatively short-term, within weeks to few months. Groundwater monitoring may be required.	Moderate Cost
Solidification	Direct contact exposure may still exist - may require institutional or engineering control. Minimizes leaching potential to groundwater. Likely require deed restriction. May cause leaching of other compounds.	Direct contact exposure during implementation. Need to get a homogeneous mixture to reduce pockets of unsolidified soils.	Difficult to mix soils without first removing foundations and other fill. Moderate regulatory acceptance. May not get close to river. Soil bulking a problem for excess soil. May limit future site development with structures.	Reduction of direct contact exposure. Requires groundwater monitoring. Should reduce timeframe to meet groundwater standards.	Moderate Cost

K:\PROJECTS\84741\Xg\[Appleton MGP Table-SMM.xls]soil

EVALUATION OF REMEDIAL OPTIONS FOR GROUNDWATER
APPLETON MGP SITE
APPLETON, WISCONSIN

ALTERNATIVE	TECHNICAL FEASIBILITY				ECONOMIC FEASIBILITY
	Long Term Effectiveness	Short Term Effectiveness	Implementability	Restoration Time Frame	
Groundwater					
No Action	Not Applicable.	Not Applicable.	Low regulatory acceptance.	May never achieve regulatory standards without some form of source control/soil remedy.	Low Cost
Natural Attenuation	Likely to take long time frame to meet standards without source control. Could be effective option with source control. Discharge of plume to river will continue. May not be effective for all contaminants.	Discharge of plume to river will continue.	Easy to implement. Perform natural attenuation monitoring. Will require groundwater use restriction/GIS listing.	Likely long-term without source control.	Low Cost
Extraction and Treatment/Disposal: May include wells or trench. May include treatment or possible discharge to sanitary sewer without treatment.	Likely to take long time frame to meet standards without source control. Likely effective option with source control. Likely contain plume and minimize discharge to river. Effective for all contaminants.	Discharge of plume to river should be minimized in short term.	Generally routine construction, with some limitations for both trench and wells due to nature of fill, proximity to river, and shallow depth to bedrock. Long-term operation and maintenance of system.	Likely attain significant reduction in concentration in short term if source control is performed.	High Cost
Oxygen Releasing Compound (ORC)	Potential to meet standards in relatively short time frame. Should be combined with source control. Will minimize discharge to river. May not be effective for all contaminants.	Standards may be met in short term. Discharge of plume to river should be minimized in short term.	May be potential delivery limitations due to nature of geologic materials.	Potential short term time frame.	Moderate Cost
Reactive Wall with funnel and gate system	Potentially effective technology, but still innovative. Should eliminate discharge of contaminants to river.	Discharge of plume to river should be minimized in short term.	Innovative technology. May have construction and maintenance limitations. Would require in-depth feasibility study.	Would minimize discharge of plume to river immediately. Reduction of groundwater concentrations would occur in short term at wall and is dependent on natural groundwater flow rate and flushing.	Moderate Cost
Reactive Wall	Potentially effective technology, but still innovative. Should eliminate discharge of plume to river.	Discharge of plume to river should be minimized in short term.	Innovative technology. May have construction and maintenance limitations. Would require in-depth feasibility study.	Would minimize discharge of plume to river immediately. Reduction of groundwater concentrations would occur in short term at wall and is dependent on natural groundwater flow rate and flushing.	Moderate Cost
Bio Sparging	Potential to meet standards in relatively short period of time. Potential for short circuiting to limit effectiveness.	Could mobilize contaminants.	Generally routine construction, but may be limitations due to nature of fill, proximity to river, and shallow depth to bedrock.	Potentially long-term.	Moderate Cost
Tar Recovery					
Excavation: Includes excavation of tar along shoreline.	Complete removal of tar.	Complete removal of tar.	Need to excavate in the dry by damming river along shoreline. Will need to replace shoreline.	Immediate removal of tar.	Low Cost
Migration Barrier: Options include HDPE wall, sheet pile wall or cement/bentonite wall with tar wells for recovery.	Tar migration to river is eliminated. Tar not likely completely recovered.	Tar migration to river eliminated immediately.	Need to evaluate geotechnical properties of site to place wall and collect tar.	Collection mechanism for tar and limit its migration to river. Monitor tar wells for presence of tar.	Moderate Cost

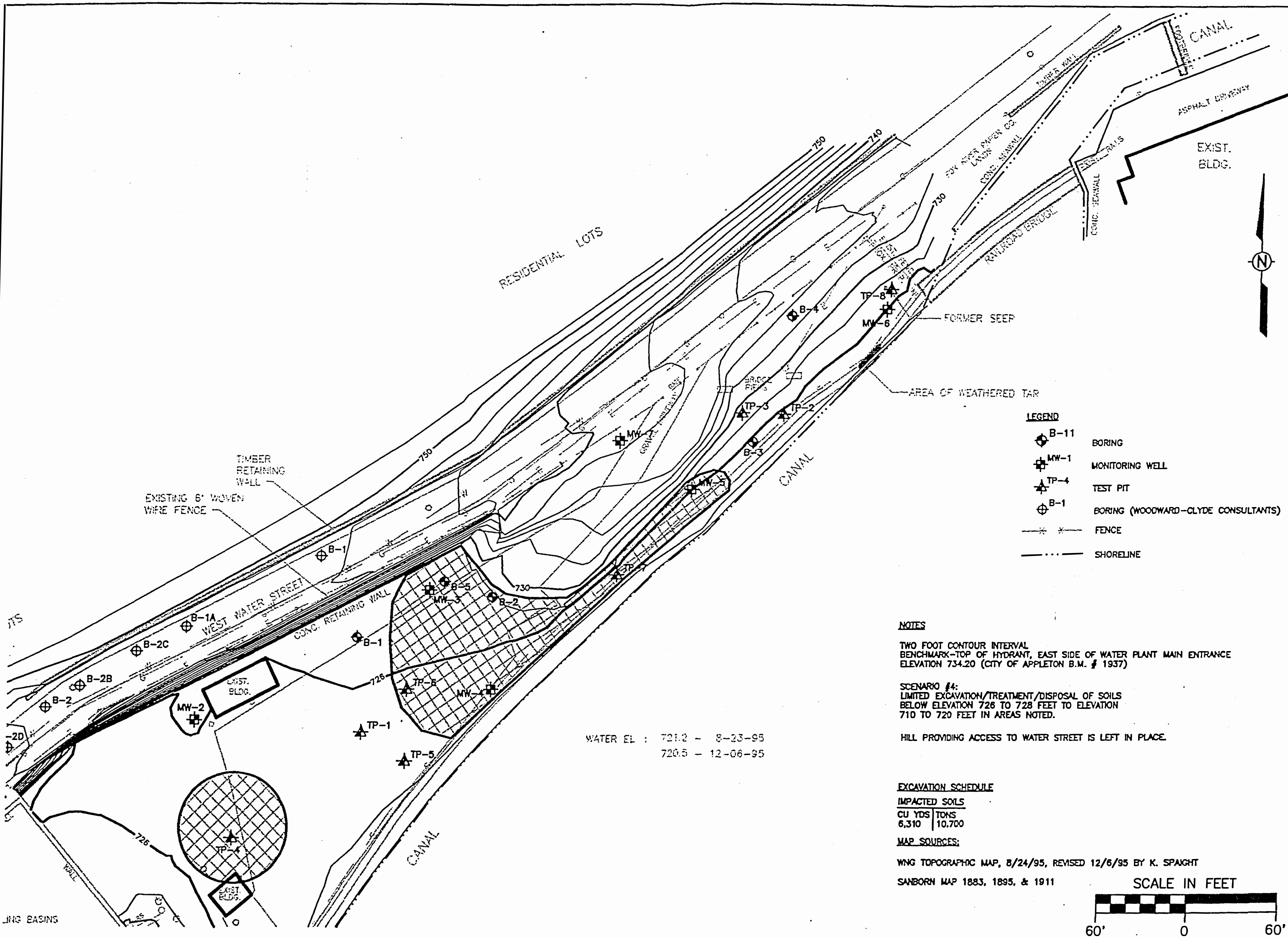
4.2 Soil Remedial Options

The soil remedial options identified include no action, excavation, solidification, in-situ bioremediation, capping of the affected area, phytoremediation and chemical oxidation. The degree of soil excavation varies from excavating as much contaminated soil on site as possible (i.e. excavating to bedrock below water table), excavating to the water table, or excavating only the most highly impacted areas or "hot spots". The potential depth of excavation are shown on the cross sections as Figures 4 through 10. The areas of potential "hot spot" removals are shown on Figures 13 and 14. The excavated material under any of the excavation scenarios could then be thermally treated, landfilled or biologically treated off site. The volume of soil treated by solidification, in-situ bioremediation or chemical oxidation may also vary. Based on the final end use of the site and the groundwater remedial option selected, an impermeable cover (i.e. cap) could be placed over the site without any excavation, solidification or in-situ treatment. Phytoremediation is a potential effective option for moderately contaminated soils and may be used in conjunction with other options.

Additional evaluation of the soil remedial options was completed by meeting with contractors or contacting them by phone to discuss the site. STS met with Layne, a soil reinforcement contractor to discuss potential options for placing an impermeable wall along the river, excavating below the groundwater table, and constructing a retaining wall along Water Street. Significant engineering efforts are needed to effectively complete any of these options. Currently, WE is working with a chemical oxidation contractor associated with remediation at another MGP site. The applicability of this technology is still under investigation as the chemical oxidation application process has not reached completion. Laboratory and pilot studies would need to be conducted to further evaluate the solidification option. Thermal treatment contractors have been contacted regarding the possibility of thermally treating the soil. Thermal treatment is moisture dependent and will require an off-site location to operate the equipment and stockpile soil. WE is looking into possible off-site locations. In-situ bioremediation involves injecting and/or mixing a proprietary substance into the soil to enhance biodegradation of the contaminants. Once again, a pilot study would need to be conducted to evaluate the effectiveness of this option. Any selected treatment option will require that a pilot test be conducted to determine the effectiveness of the selected remedial option.

4.3 Tar Remedial Options

For each of the soil scenarios, the tar seep on the east side of the property and the material coated with tar along the shoreline will be excavated. A new shoreline protection wall will need to be constructed once the existing rip-rap is removed. This limited action is common to all scenarios.



NOTES

TWO FOOT CONTOUR INTERVAL
BENCHMARK-TOP OF HYDRANT, EAST SIDE OF WATER PLANT MAIN ENTRANCE
ELEVATION 734.20 (CITY OF APPLETON B.M. # 1937)

SCENARIO #4:
LIMITED EXCAVATION/TREATMENT/DISPOSAL OF SOILS
BELOW ELEVATION 726 TO 728 FEET TO ELEVATION
710 TO 720 FEET IN AREAS NOTED.

HILL PROVIDING ACCESS TO WATER STREET IS LEFT IN PLACE.

EXCAVATION SCHEDULE

IMPACTED SOILS

CU YDS	TONS
6,310	10,700

MAP SOURCES:

WNG TOPOGRAPHIC MAP, 8/24/95, REVISED 12/6/95 BY K. SPAIGHT

SANBORN MAP 1883, 1895, & 1911

DRAWN BY	JMI\LMc\RP	DATE	2-18-97
CHECKED BY	SMM	DATE	2-18-97
APPROVED BY	JMT	DATE	2-18-97
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LIMITED HOT SPOT
FORMER MANUFACTURED GAS PLANT
APPLETON, WISCONSIN

STS Consultants Ltd.
Consulting Engineers

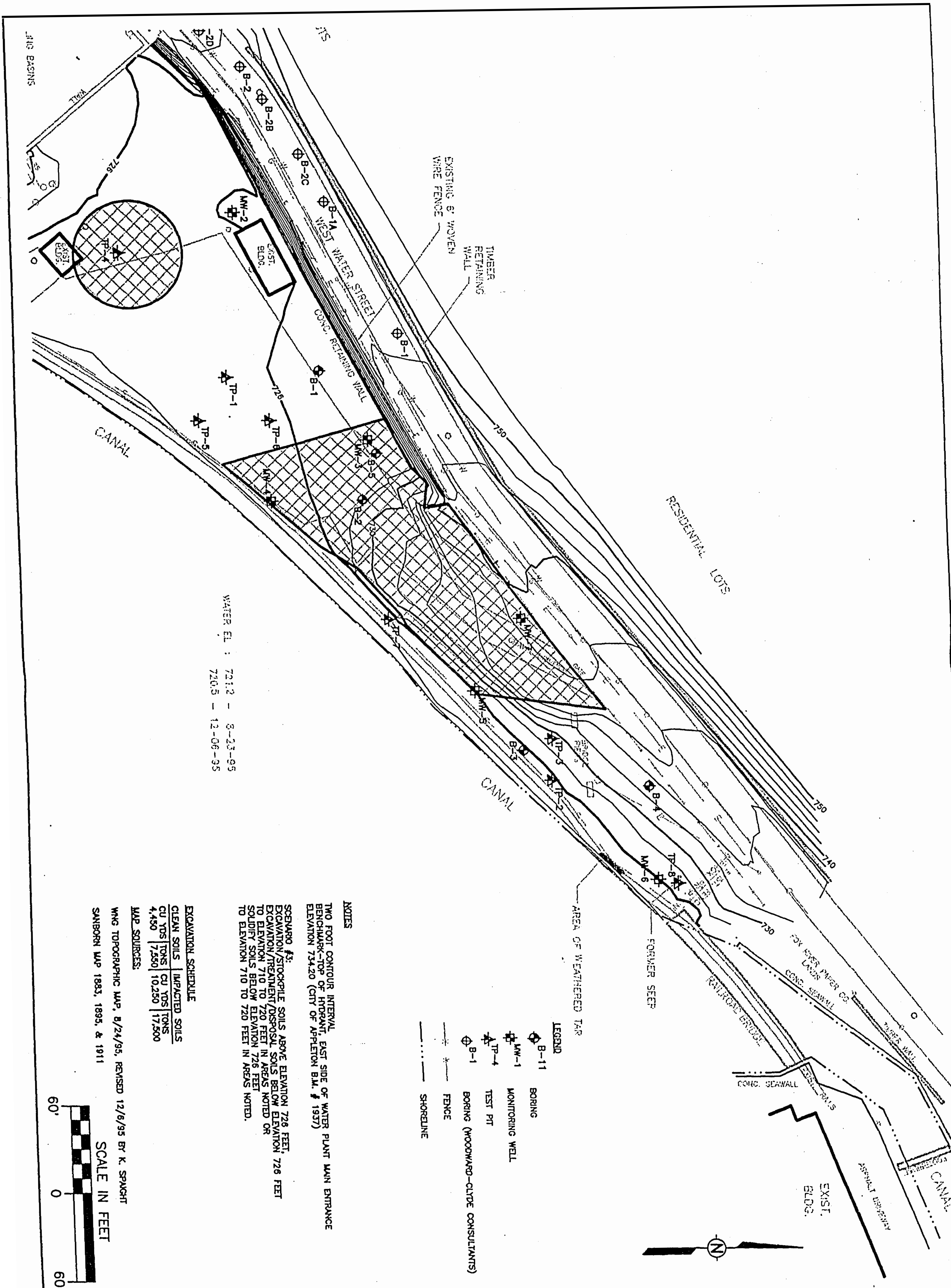
STS PROJECT NO. 84703XD

STS PROJECT FILE

SCALE AS SHOWN

FIGURE NO. 14

[redacted]



STS Consultants Ltd. Consulting Engineers	HOT SPOT REMOVAL FORMER MANUFACTURED GAS PLANT APPLETON, WISCONSIN	DRAWN BY JMI\LMc\RP	DATE 2-18-97
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STS PROJECT FILE		APPROVED BY JMT	DATE 2-18-97
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FIGURE NO 13			

4.4 Groundwater Remedial Options

Given the proximity of the river, some type of barrier or flow-through treatment wall could be installed to meet the groundwater remedial objectives. The barrier wall could be a cement/bentonite wall, sheet pile or a geomembrane flow through wall. Groundwater may also be treated using a reactive wall with or without a funnel and gate system. Additional discussion with barrier wall contractors is necessary to evaluate the installation feasibility of these walls at the Appleton MGP site. Pilot studies may be needed to evaluate the effectiveness of the wall to impede and/or treat groundwater movement. Whichever wall is selected, it can be coupled with groundwater monitoring to evaluate the effectiveness of soil treatment. Groundwater may also be treated using a reactive wall with or without a funnel and gate system. Further evaluation of this treatment technology is necessary for the Appleton MGP site. The approximate location of a wall is shown on Figure 15.

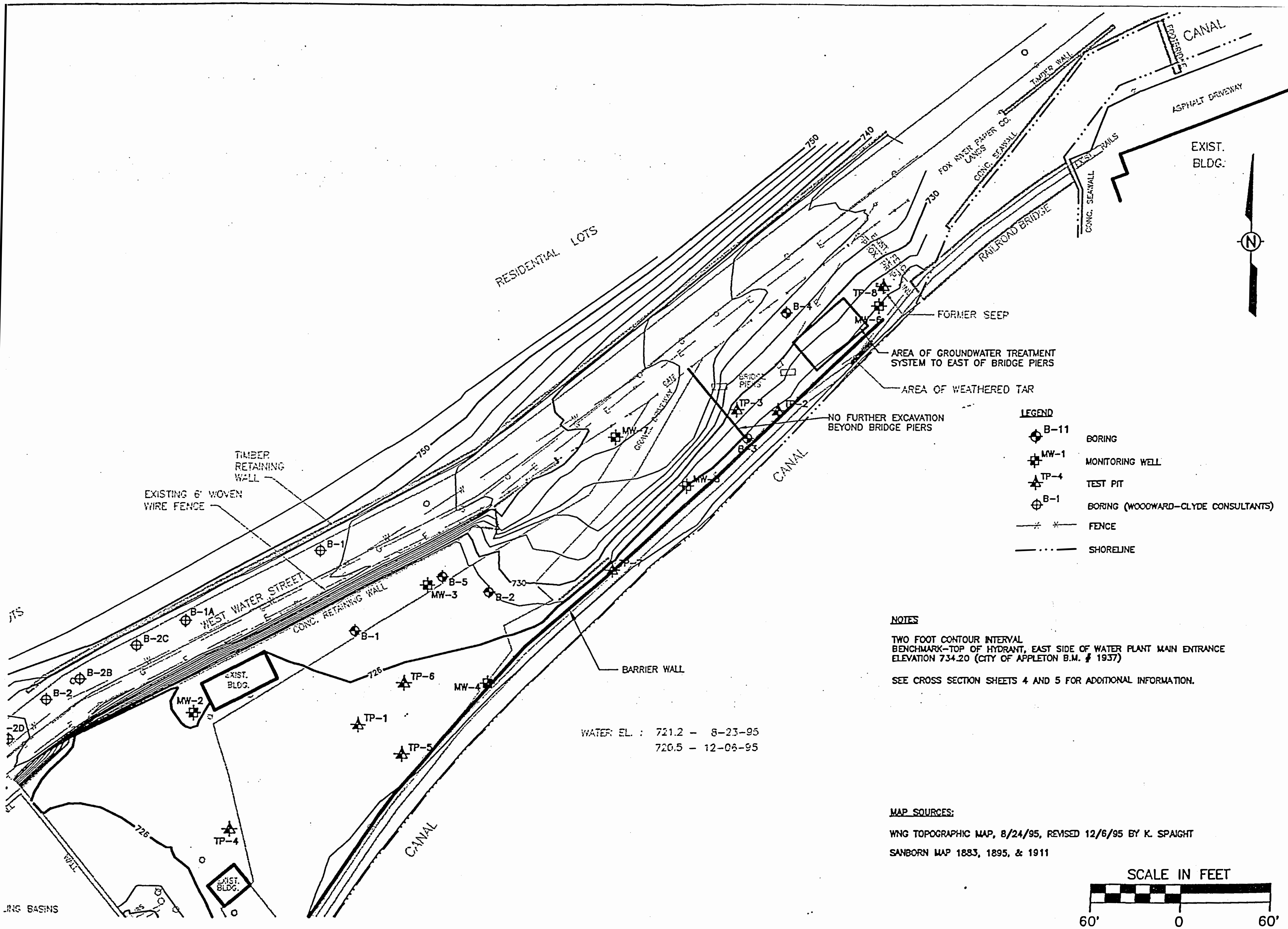
Other groundwater treatment options that require further evaluation are oxygen releasing compounds (ORC) and bio-sparging. These technologies could be used as a polishing step for residual groundwater impacts after a soil remedial technology is applied. Bio-sparging has been used at other MGP sites and has proven to be effective, especially for treating BTEX compound. Its application to the Appleton MGP site would require further evaluation. WE is currently supporting an effort by URS and the Electric Power Research Institute (EPRI) who are studying conceptual designs of permeable reactive walls. The results of this study have not been finalized.

Depending upon the soil remedy selected, groundwater remediation by natural attenuation may be feasible. The use of natural attenuation for groundwater remediation will be dependent on final use.

4.5 Site Constraints

An area of clean fill soil exists on the western portion of the site to provide vehicle access to Water Street. No retaining structure exists where the soil is located. If the clean soil is removed during soil remedial actions, a retaining structure will need to be constructed to support Water Street and the utilities under this street. It has been assumed that one of the sidewalls for the proposed filtered water reservoir could be used as the retaining structure.

The City of Appleton is currently constructing a new water filtration plant along Manitowoc Road. The new plant should be operational by July 2001. The existing plant on the Appleton MGP site is scheduled to be taken out of operation one year later, in the Summer of 2002. The final disposition of the existing water filtration plant is unknown. The City may leave the structures in place or demolish the buildings and reservoirs. The manor in which the water filtration plant site is left after the plant is no longer operational will also drive the remedial option selected for the Appleton MGP site.



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CHECKED BY SMM DATE 2-13-97

APPROVED BY JMT DATE 2-13-97

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GROUNDWATER REMEDIAL SCENARIOS
FORMER MANUFACTURED GAS PLANT
APPLETON, WISCONSIN

STS Consultants Ltd.
Consulting Engineers

STS PROJECT NO. 84703XD

STS PROJECT FILE

SCALE AS SHOWN

FIGURE NO. 15

The close proximity of the river presents a remedial design obstacle that will need to be addressed in the design process. Any type of excavation could encounter a significant amount of water infiltration. Dewatering of the site may be required unless some type of barrier wall is constructed along the river. The shallow bedrock and fill soils along the river will require further study of the structural stability of the selected wall type.

The foundations from the former MGP buildings remain on the site. The foundations could limit the effectiveness of selected remedial technologies. Any type of soil mixing or injection of materials could be limited by the presence of the buried foundations. Further location of the building foundations may be required for a selected remedial technology.

4.6 Final End Use Considerations

The City of Appleton is considering several options for development of the site. The future development options include a park, high-density residential living, an amphitheater, and an aquarium. It is unknown at this time how the site will be developed. However, the final end use of the site will drive the remediation scenario for soil and groundwater. A park-like setting may allow for capping the site with groundwater migration control, whereas development of residential living spaces may require excavation of as much impacted soil as possible with groundwater monitoring for natural attenuation of the remaining soils. The City of Appleton will be involved in the selected remedial approach.

The evaluation of remedial alternatives depends on cooperation with the City of Appleton to develop a remedial approach that is beneficial to both parties. WE intends to work closely with the City and WDNR while developing the remedial alternative most suitable for the site. No single technology will be applied to the site. The final remedy will be a logical combination of technologies with input from the City and WDNR. The selected approach will be reviewed and approved by the WDNR as part of the Design Report process.