Natural Resource Technology, Inc.

N R T

PHASE II REMEDIAL WORK PLAN
CAMPMARINA AND CENTER AVENUE RIGHT-OF-WAY

FORMER COAL GAS FACILITY
SHEBOYGAN, WISCONSIN

Project No: 1313

Prepared For:

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April 17, 2000

Spiros L. Fafalios, P.E.
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"I, Spiros L. Fafalios, hereby certify that I am a registered professional engineer in the State of Wisconsin, registered in accordance with the requirements of ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, 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. NR 700 to 726, Wis. Adm. Code."

Roy E. Wittenberg, P.E.
Project Manager

"I, Roy E. Wittenberg, hereby certify that I am a registered professional engineer in the State of Wisconsin, registered in accordance with the requirements of ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, 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. NR 700 to 726, Wis. Adm. Code."

TABLE OF CONTENTS

FIGURES

APPENDICES

DESIGN DRAWINGS

1 INTRODUCTION

1.1 Overview

Presented in this document is a Phase II Operable Unit (OU) Remedial Design/Remedial Action (RD/RA) Work Plan for Wisconsin Public Service Corporations (WPS's) former coal gas facility located at Campmarina in Sheboygan, Wisconsin (Figure 1). This Phase II Work Plan was prepared in substantive conformance with the May 7, 1999 Feasibility Study (FS) as approved by the Wisconsin Department of Natural Resources (WDNR) on October 27, 1999 and the March 5, 1991 Contract between WPS, the City of Sheboygan and the Wisconsin Department of Natural Resources (WDNR). General requirements are outlined under task 13, RD/RA Project Plans and task 14, Remedial Design. In accordance with the Contract task requirements, the Phase II Work Plan incorporates applicable and appropriate WDNR requirements under NR 718 and 724 as well as guidance provided by the United States Environmental Protection Agency's (U.S. EPA's) document "*Superfund Remedial Design and Remedial Action Guidance*", OSWER Directive 9355-0-4A, dated June 1986, as appropriate.

The former coal gas facility is located on what is now known as Campmarina. Campmarina is located directly along the Sheboygan River and was a designated recreational vehicle parking area and boat launch. MGP affected soil and groundwater has been identified on both Campmarina and onan adjacent property to the south known as the Center Avenue right-of-way. Proposed remedial activities in this work plan address both these locations as one comprehensive site ("site"). City of Sheboygan redevelopment plans for Campmarina include a neighborhood park, river walk and condominiums. The right-of-way property is part of an adjacent development that includes condominiums and a river walk.

Proposed redevelopment plans by the City of Sheboygan for Campmarina and the Center Avenue right-of-way that consist of a neighborhood park and river walk are components of a broader scope called the Water Street Neighborhood Redevelopment Plan. Other components of the

development plan include eliminating Water Street as part of the neighborhood park development and expansion of the condominium development from the Pennsylvania Bridge to the Center Avenue right-of-way. Construction of the park and the river walk is currently slated for mid to late 2000.

Remedial actions for Campmarina and the Center Avenue right-of-way will be implemented in two phases. Division into two phases reflects a restructuring of the submittals from what is requested in the March 5, 1991 Contract to better meet site specific conditions and current scheduling requests from the City. Two separate OU RD/RA work plans instead of one comprehensive document will be submitted to address each phase.

Requirements for conducting the Phase I activities are presented in the February 2, 2000, *Remedial Work Plan, Phase I Excavation and Grading* previously forwarded to the WDNR. Phase I site activities will consist of the excavation, site grading, material management and off-site thermal treatment or disposal of MGP affected soil and debris. Thermal treatment of MGP affected soil and debris will be accomplished using a mobile thermal treatment unit to be stationed at WPS's Wildwood Avenue facility in Sheboygan, Wisconsin (Figure 1).

Phase II activities will consist of installing a vertical sheet pile wall around affected portions of Campmarina and the right-of-way, constructing a low permeability geosynthetic cap, backfilling the site to pre-existing grades and installing a flexible delivery and extraction system for low flow biosparging. Following completion of these activities the site will be turned over to the City of Sheboygan for construction of the planned neighborhood park and river walk. This Phase II Work Plan provides a technical overview for the design and implementation of these activities and addresses key Contract task elements including the basis for design, pilot testing, construction quality assurance (CQA) objectives, permitting and scheduling for remedial implementation. Phase II design plans and specifications are being prepared for bidding, and contract administration and will be forwarded to the WDNR under separate cover.

1.2 General Site Information

Campmarina and the Center Avenue right-of-way encompass approximately 2.6 acres and are bounded on the north by New York Avenue, on the east by North Water Street, on the west by the Sheboygan River and on the south by currently vacant property.

Key project principals and personnel are listed below:

Site Owner:	City of Sheboygan 807 Center Avenue Sheboygan, WI 53081 Contact: Mr. Bob Peterson (920) 459-3380
Former MGP Operator:	Wisconsin Public Service Corporation 700 North Adams Street, P. O. Box 19002 Green Bay, WI 54307-9002 Contact: Ms. Connie Lawniczak (920) 433-1140
Site Location:	732 North Water Street Sheboygan , Wisconsin Sheboygan County NW ¼, SW ¼, Section 23, T15N, R23E Refer to Figure 1
Consultant:	Natural Resource Technology, Inc. (NRT) 23713 West Paul Road Pewaukee, WI 53072 Contact: Mr. Roy E. Wittenberg (262) 523-9000

Key WPS personnel that will be involved in the implementation includes Ms. Connie Lawniczak and Mr. Dale Wiley. Ms. Lawniczak will serve as the Project Director and Mr. Wiley will serve as Construction Manager for WPS. Key NRT personnel involved in the implementation of remedial actions at the Campmarina site includes Mr. Roy Wittenberg P.E., Ms. Laurie Parsons P.E., Mr. Spiros Fafalios P.E., Mr. Chris Robb and Mr. Dan Plovnick. Mr. Wittenberg will serve as the

Project Manager, Mr. Fafalios and Mr. Robb will serve as Project Engineers and Mr. Plovnik will serve as the field engineer. Ms. Parsons will provide support as Senior Review Engineer.

1.3 Phase II Remedial Action Objectives and Design Criteria

Phase II remedial action objectives (RAOs) for the site are summarized below:

- Reduce the potential for direct contact exposure to MGP residuals;
- Prevent leaching and run-off of MGP residuals at the site into the river and river sediment;
- Prevent leaching of MGP residuals to groundwater; and,
- Reduce migration of dissolved phase MGP residuals in groundwater to the river.

Design criteria identified for the selected remedy consisting of full source area encapsulation with low flow biosparging includes the following:

- Minimization of intrusive remedial action below the water table where phase separated MGP residuals were identified;
- Minimization of disturbance to MGP affected river sediment;
- Long-term effectiveness, performance and chemical compatibility of remedy components with MGP residuals;
- Capital costs for installation and long term operation and maintenance costs;
- Maximization of beneficial reuse of excavated site materials;
- Constructability given site specific conditions and limitations;
- Compatibility with design and construction requirements for the neighborhood park and the river walk; and;
- Ability to gradually reduce quantity and toxicity of MGP residuals over time.

1.4 Design Approach

The approach to meet the established RAOs and design criteria includes the following key elements:

- Vertical Barrier Technology Evaluation: Several demonstrated conventional barrier technologies were evaluated with respect to the design criteria for the site that included sealed steel sheet pile, high density polyethylene (HDPE) sheet pile and soil cement and cement-bentonite slurry walls. The results and recommendations of this evaluation are presented in this work plan.

- Engineered Cap Technology Evaluation: Two different capping approaches were evaluated that included conventional clay and geosynthetic cap. The results of this evaluation and design recommendations are included in this work plan.

- Design parameters for hydraulic control and drainage: Design parameters will be confirmed for surface water management and containment zone hydraulic controls.

- Pilot Testing for Low Flow Biosparging: A Pilot test will be conducted to finalize detailed design parameters for low flow biosparging. Pilot test requirements are provided in a March 30, 2000 *Pilot Test Work Plan* previously forwarded to the WDNR and included as Appendix C to this Work Plan.

- Key-In Depth Evaluation for the Vertical Barrier Wall: The vertical barrier wall will be keyed-in to a low permeability clay layer that is serving as an aquitard for vertical migration of MGP residuals. Requirements are included for six additional key-in depth borings along the proposed alignment for the barrier to finalize barrier depth and key-in thickness. These additional key depth borings will supplement the existing geotechnical data.

- Mass Balance Evaluation for Reuse of Treated and Untreated Excavated Materials: Estimates of the quantities of treated and untreated material that can be reused as backfill over the proposed engineered cap prior to construction of the park will be developed to provide a basis for material management and reuse.

- Structural and Stability Evaluation: A structural and stability evaluation will be conducted to confirm acceptable factors of safety for the engineered cap components and backfill.

- Amendment of Thermally Treated Material for Beneficial Reuse: Recommendations for amending thermally treated material for reuse will be developed to support future landscaping for review and approval by the City of Sheboygan.

Each of these design elements is discussed in the following sections.

2 VERTICAL BARRIER WALL

2.1 Basis for Design

A plan view and cross-section for the barrier are provided on Sheets 3 and 4, respectively.

2.1.1 Depth and Alignment

It is estimated that the total depth of the barrier wall will be approximately 25 to 30 feet below ground surface. Required barrier wall depths are relatively well defined along the river and in the vicinity of the Center Avenue right-of-way but are less delineated in the northern portion of the site and upgradient towards Water Street. Although the previous subsurface investigative data demonstrates that the lower clay unit is laterally continuous across the site and is serving as an aquitard for vertical migration of MGP residuals, the elevation of the top of the clay unit varies. Based on this consideration, six additional borings will be advanced in the northern and eastern portions of the site to confirm the proposed key-in-depth to the clay layer. The Key-Depth Boring Work Plan is included as Appendix B. Verification of key-in depths will be integral to construction quality control documentation.

2.1.2 Upgradient Hydraulic Controls

Design requirements will be identified for an upgradient hydraulic control consisting of a shallow groundwater drainage system that will prevent hydraulic mounding over the cap and barrier wall. This drainage system will provide a means for diverting groundwater around the wall and towards the river, in the case of groundwater elevations increasing significantly above existing elevations. Diversion will minimize overflow of groundwater into the barrier wall, as well. Upgradient hydraulic controls are shown on Sheet 4, Detail 1.

2.2 Materials and Components

A variety of materials were evaluated for construction of the vertical barrier wall. Sheet pile, geomembrane and slurry walls were reviewed for basic design parameters, including:

- Hydraulic conductivity of less than 1 x 10^{-7} cm/second;
- Compatibility with contaminants;
- Amount of spoil generated;
- Constructability in conjunction with subsurface debris;
- Surface area required for material preparation and storage; and,
- Prior success at waste sites for long-term containment.

Based on these criteria, sheet pile was selected as the material of choice. The advantages of sheet pile include:

- Meets the design performance standard with interlock sealant;
- Exhibits a wide range contaminant compatibility;
- Does not generate spoil during installation;
- May be installed through some subsurface debris;
- Requires the least amount of surface area for installation; and,
- Used successfully at MGP sites.

The vertical barrier will consist of a steel sheet pile specifically designed for environmental applications that can be sealed with cementitious grout, polyurethane, or a hydrophilic caulk. Material type was further specified by selecting the sheet pile sealant and manufacturer from the configurations summarized in Appendix A. Final material was selected based upon:

- Material and installation costs;
- Sealant compatibility with contaminants present;
- Availability; and,

- Quality control/quality assurance characteristics of the sheet pile.

Based on an in-depth review of the sealant and sheet pile material summarized in Appendix A, Waterloo Sheet Pile System is recommended for the vertical barrier wall. Waterloo Sheet Pile System consists of steel sheet pile with an oversized, rolled interlock cavity. After installation of the sheet pile, the cavity is cleaned and sealed using a cement-based grout. Due to the large interlock cavity, Waterloo Sheet Pile provides a quality control measure not available in conventional sheet pile. After curing, hydraulic conductivity values of less than 1×10^{-7} cm/second have been consistently achieved. With regard to the final material selection criteria, the cost is comparable with conventional sheet pile, cement grout is compatible with MGP contaminants, availability and transportation from the Canadian Metal Rolling Mills can accommodate the project, and the quality control is superior to conventional sheet pile.

2.3 Construction

Following completion of Phase I activities, as presented in the Phase I Work Plan, barrier wall construction will proceed, as shown in the Proposed Schedule, Figure 4. Working surface preparation, pre-excavation of the sheet pile alignment, and overall site preparation activities will be conducted during Phase I. Barrier wall construction will consist of material delivery; mobilization of installation equipment; field alignment verification; installation; and quality control activities.

Transportation of equipment and material to the site will be coordinated with the completion of Phase I activities. Field verification of alignment will include re-surveying the layout of the barrier wall for approval by the engineer for the installation contractor. Installation of the sheet pile panels will be with the male interlock leading in the direction of installation. After installation of the sheet pile, the cavity is cleaned and sealed by a contractor certified by the manufacturer, Canadian Metal Rolling Mills. The interlocks are jet-cleaned with pressurized water prior to grouting. During jetting, a certified installer will perform quality control checks to determine if each interlock is properly seated at the proper key depth. Remedial measures can be taken for unsatisfactory interlocks prior to sealing the interlocks. After jet-cleaning, each

interlock is sealed, using a tremied grout from bottom to top. The grout is allowed to cure, completing the sheet pile construction.

3 LOW FLOW BIOSPARGING SYSTEM

A low flow air sparging system, commonly known as a biosparging system, will be installed following sheet pile installation as a supplement to the primary remedy of containment. Biosparging is a treatment technology for groundwater consisting of injecting oxygen below the water table through a system of wells to enhance aerobic microbial degradation of contaminants. Injection of air is typically the most cost-effective means of introducing oxygen to the subsurface. Injection will be conducted at the lowest flow rate that will achieve measurable increase in biological degradation of contaminants present at the site. The biosparge system is meant to be a low-cost supplement to containment. The design of the biosparge system will be based on the results of a pilot test. The Phase II final design plans and specifications will provide additional detail to the sections included herein, including materials, system components, construction, startup and operation procedures.

3.1 Basis for Design

A pilot test is proposed that will serve as the initial design basis for a low flow biosparging system within the containment zone at the site. Details of the proposed pilot test are presented in the *Pilot Test Work Plan*, dated March 30, 2000. The pilot test work plan was sent to WDNR under separate cover, but is also included for reference in Appendix C. The pilot test will include assessing the following key parameters:

- Radius of influence and flow rate;
- Dissolved oxygen (DO);
- Biological indicator parameters in groundwater such as methane, dissolved iron and sulfate;
- Pressure distributions; and,
- Total vapor phase volatile organic compounds (VOCs).

This will be a one-day test that will include installation of an air sparge well and several monitoring points for vapor phase and groundwater monitoring. Low flow air injection will be accomplished using an oil-less compressor. Also, part of the test will include a bail down or slug test, as a measure of hydraulic conductivity. Full-scale design of a biosparge system will follow evaluation of pilot test results. The results of the pilot test will be evaluated to achieve the engineering objectives, including:

- Determine actual air entry pressure required to initiate airflow;
- Evaluate optimal biosparging air flowrate by examining pressure/DO characteristics;
- Evaluate optimal vertical and/or horizontal well spacing and configuration; and,
- Assess vapor off-gas quality during sparging.

3.2 Materials and Components

Biosparge injection well and passive venting configuration will be established in the final design, based on the results of the pilot test. Above-ground treatment component sizing will also be based upon the results of the pilot test. Above-ground treatment components will be housed in an enclosure at a location to be agreed upon by WPS and the City of Sheboygan.

A process flow diagram showing above-ground treatment components is presented in Figure 3. The biosparge air supply will be provided by either a blower or compressor, depending upon required air pressure to achieve the optimal radius of influence. Because of the encapsulation of the treatment area, a venting system will be required to allow off-gassing of sparged air and microbial respiration byproducts. Off-gassing can likely be accomplished using a passive venting system, possibly with the assistance of a wind turbine. Provisions for an active venting contingency will be made during the final design and installation.

Requirements for installation and operation of an active venting system will be based on at least one of the following criteria:

- Off-gas exhibits nuisance level concentrations of organic contaminants.
- Off-gas exhibits concentrations of contaminant vapors above NR 400 action levels.
- Pressure builds up within the venting system at a rate greater than the passive venting system can adequately discharge.

If nuisance level contaminant vapors or concentrations of contaminants above NR 400 regulatory action levels are emitted, the off-gas will require treatment prior to discharge, using vapor-phase carbon. As an alternative to active treatment for nuisance-level odors, air sparge flow rates may be reduced or the system may be operated intermittently on a scheduled basis. Routine monitoring of pressure and discharge air quality for parameters of concern will be conducted to regularly monitor for these criteria during system operation.

3.3 Construction

Final plans and specifications for the biosparge system will be submitted to the WDNR prior to construction. Due to changes to the hydrogeologic conditions caused by the cutoff wall and cap, full-scale system installation will be phased, with approximately one-third of the wells to be installed weeks prior to the rest of the wells. The full-scale above-ground system will also be installed, as designed for the full-scale biosparge system. Phased installation will allow verification of design parameters, including indications of biodegredation prior to completion of well installation. Following verification of the design parameters, the remainder of the biosparge system will be installed.

3.4 Startup and Operation

After the first portion of the biosparge wells and above ground treatment system is installed, a shake down period will be scheduled to evaluate system operation. Predictions of in-situ parameters such as radius of influence will be confirmed, as the pilot test was conducted prior to the encapsulation of the groundwater to be treated. After a short initial startup and operation period

consisting of one or more weeks of operation, the remainder of the wells will be installed and operated.

The operation of the biosparge system will be cyclic and timed in a manner that minimizes the volatilization of contaminants of concern, such as benzene and naphthalene, while maintaining desired levels of oxygen in the groundwater. The timing of the operating cycle will be initially based on groundwater monitoring during the pilot test, and further modified during initial startup and operation. The cycle will be set to maintain desired concentration range of dissolved oxygen in the groundwater. In addition, operation may be intermittent as long as a desirable level of aerobic biological activity can be sustained.

Because the system is supplementary to containment, flexibility in operation will be utilized as much as possible. For example, areas of high historical groundwater contaminant concentration within the containment walls may be targeted prior to other areas of the site. Operation in this manner will not require a relatively large treatment system, resulting in lower capital and operating costs. Specific plans for system startup and criteria for operation will be submitted under separate cover. An operation, maintenance and monitoring plan will be submitted prior to system startup.

4 ENGINEERED GEOSYNTHETIC CAP

4.1 Basis for Design

Design objectives for the engineered cap consist of the following:

- Reduce the potential for direct contact exposure to vapor phase MGP residuals or MGP residuals in unsaturated soil; and,
- Minimize infiltration of surface water and contact of surface water with MGP residuals.

Key design considerations and criteria to meet these objectives included the following:

- 100 Year Flood Level: Although the site is not located within a designated flood plain, the minimum elevation for the cap was set to above the 100 year flood plain elevation that is at 584 feet above mean seal level (msl) or +4 in the City of Sheboygan datum;
- Surface Drainage Controls: Surface water infiltration to the top of the cap will require controls to route water to the river and minimize developing saturated conditions that could affect landscaping or slope stability;
- Containment Area Hydraulic Controls: Possible leakage of water into the cap and/or unlikely increases in the groundwater elevations could potentially result in MGP affected water escaping from the containment zone; and,
- Clearance for Construction of the Neighborhood Park and River Walk: Elevations and grades for the cap require minimum planting depths for trees, Shrubbery, and park foundations.

Two cap configurations were initially considered for the site that consisted of the following:

- Low Permeability Clay Cap: This configuration would consist of placing compacted clay with a permeability of less than $1x10^{-7}$ cm/second. Key advantages of this type of cap is the relative ease of placement, self-sealing attributes due to penetration by foreign objects or other deleterious materials, and

limited maintenance requirements. Key disadvantages include thick root zone layer, possible chemical degradation, frost heave, desiccation that could lead to cracking and possible intrusion due to root growth and animal burrowing. Other potential issues could include locating a suitable borrow source for the low permeability clay and relatively extensive QA/QC field testing that would be required.

- Engineered Geosynthetic Cap: This configuration would consist of a flexible membrane liner that could be manufactured of a variety materials such as high density polyethylene (HDPE), very flexible polyethylene (VFPE) or polypropylene. The membrane liner would be protected by a cushion non-woven geofabric placed on either side of the membrane. Key advantages of this configuration include its ability to meet low permeability requirements with a very low profile, demonstrated chemical compatibility and relative ease of installation. Key disadvantages include potentially higher installation and material costs.

An engineered geosynthetic cap was selected based on a comparison of the design criteria with site specific constraints for constructing the park and river walk. The key decision making criteria included:

- Maintaining the elevation of the cap above the 100 year flood elevation;
- Providing sufficient planting depth for future landscaping of the park above the cap; and,
- Minimizing the amount of MGP material requiring thermal treatment.

In addition, limiting the amount of material removed also reduces the risk for direct contact exposure. Other concerns regarding a clay cap included possible limited cover depths over the cap that could lead to frost damage or desiccation of a compacted clay liner.

4.2 Materials and Components

A plan view for the proposed engineered cap is provided in Sheet 3. Cross-sections and construction details are provided in Sheet 4. Materials and components from the bottom to the top of the cap are discussed below.

Foundation layer

Following completion of the Phase I excavation and grading activities the exposed subgrade will be graded and compacted to provide a relatively uniform sub-base. In the main portion of Campmarina, this sub-base will consist primarily of existing fill material that may contain some MGP residuals. Areas along the Center Avenue right-of-way and along the river bank will likely be backfilled with thermally treated material. To mitigate concerns for possible direct contact exposure to fugitive dust, odors or surface water run-off to the river the site will be backfilled and compacted with 6 inches of crushed stone. Crushed stone will provide a hard durable working surface for the vertical barrier installation and other contractor activities. Prior to cap installation, this surface will be wheel-rolled to a relatively smooth surface and inspected to remove any sharp or angular protrusions or rocks, and will serve as the foundation layer for the cap.

Hydraulic and Vapor Control and Collection Layer

This layer will consist of a laterally continuous bi-planer geonet bonded on each side with a non woven geofabric that will serve two essential functions. The first function will be for passive vapor collection during low flow biosparging. The geonet will be integrated with passive vapor collection piping to be constructed as part of the low flow biosparging system. Vapor collection piping design will be finalized following the pilot test. The second function will be to provide hydraulic control in the event that water accumulates directly beneath the cap due to unanticipated changes in groundwater levels or leakage through the cap. The geonet will be routed to a perimeter drainage collection system as indicated on Sheet 4, Details 1 and 2. This system will consist of a polyethylene perforated drainage pipe located around the perimeter of the sheet pile wall and below the top of the wall in a shallow, free-draining gravel backfilled trench. The drainage piping will be routed to a polyethylene sump to be located within the containment zone. The sump will be equipped with a vapor tight cover for access and a level indicator. Frequent water management within the containment zone is not anticipated as groundwater levels should remain relatively static following installation of the sheet pile wall and infiltration through the cover will be negligible.

The non-woven geotextile fabric layers on either side of the geonet will each serve two functions. The lower geotextile will serve as cushioning fabric for placement of the liner components against the foundation layer and will prevent fines from migrating into the geonet. The upper fabric will serve as a cushioning layer for the geomembrane and will provide a working surface for geomembrane installation and seaming.

Low Permeability Flexible Membrane Liner

Directly over the geonet composite, a flexible membrane liner consisting of a 40 mil high density polyethylene (HDPE) geomembrane will be placed to serve as the barrier layer. Use of a textured membrane may be considered in the Center Avenue right-of-way for enhancing slope stability. HDPE was selected over other materials such as polypropylene or polyvinyl chloride because of its superior chemical resistance to MGP residuals, competitive cost, durability and demonstrated performance at other sites. The geomembrane will be extended beyond the limit of the sheet pile wall and anchored. Anchoring will be accomplished using a cast in-place concrete curb that will be installed around the entire perimeter of the containment zone as indicated on the construction details provided in Sheet 4.

Drainage Layer

Above the geomembrane, a geosynthetic drainage layer consisting of a thick non-woven geotextile will be placed to route surface water infiltration off the cap and provide a protective cushion for the underlying geomembrane. Slopes across the site range from approximately two percent to greater than 14 percent and drainage is towards the river. The geotextile will be extended beyond the perimeter of the sheet pile wall and routed into the anchor trench for the geomembrane where perforated polyethylene drainage pipe will be placed and backfilled with free draining gravel. The drainage pipe will be sloped and routed to a storm water discharge pipe to the river. The drainage pipe will be extended around the entire perimeter of the containment zone and will also serve as the upgradient hydraulic control previously discussed.

Protective Layer

This layer will consist of a minimum of six inches of compacted engineered fill that will serve as a protective layer for the geosynthetic cap components. Directly above this engineered fill a

distinctive marker layer consisting of a woven geotextile fabric will be placed to visually document the location of the cap to future site workers or maintenance personnel.

4.3 Construction

Construction of the cap will be initiated following installation of the low flow biosparging system subgrade piping and will include the following activities:

- Prior to geosynthetic placement, reinforced concrete foundation footers for the future park lights, basketball hoop and other park features will be constructed. Foundation locations and construction details are indicated on Sheet 2.
- Through the duration of construction, engineering and erosion control measures will be maintained in accordance with the Phase I Work Plans.
- The top of the sheet pile wall will be set at the 100 year flood elevation and covered with a cushioning non-woven geofabric to protect the geomembrane.
- The foundation layer will be wheel-rolled and smoothed as required to meet geomembrane manufacturer requirements for installation and warranty. If required, an additional 2 to 4 inches of engineered fill will be placed over the compacted crushed stone.
- Following placement of the geomembrane, protrusions through the cap will be booted and sealed as indicated on Sheets 2 and 4. Along the existing concrete wall the geomembrane will be secured using stainless steel or aluminum battens, neoprene gaskets and stainless steel anchor bolts, as shown in Sheet 4, Detail 1.

A comprehensive CQA program will be developed for the installation to assure that the materials are properly placed and that all seaming meets manufacturer quality assurance/quality control (QA/QC) requirements. A CQA plan will be prepared that will outline testing and inspection requirements for the cap installation.

5 BACKFILLING AND SITE RESTORATION

5.1 Phase II Final Grading Plan

A final grading plan for completion of the Phase II remedial activities is provided in Sheet 5. Key objectives for final grading consist of the following:

- Restore the site to pre-existing grades in preparation for construction of the neighborhood park and river walk;
- Provide a minimum of one foot of cover over the engineered geosynthetic cap; and,
- Provide a working surface for future access and movement of equipment and materials for park and river walk construction.

Final grades indicated in Sheet 5 closely reflect pre-existing contours prior to implementation of the Phase I excavation and grading. In addition, final grades were also coordinated with and reviewed by the City of Sheboygan's landscape architect and engineers to meet minimum planting depths for future park trees and shrubbery and construction grades in the Center Avenue right-of-way for the river walk. Grades across the site will be further raised as part of future construction. Other key elements of the final grading plan include the following:

- Riverbank slopes along Campmarina and the Center Avenue right-of-way will continue to be maintained at a slope of 1.5 feet horizontal to 1 foot vertical (1.5:1) with the exception of one portion of the river bank between Campmarina and the right-of-way that will be 2 feet horizontal to 1 foot vertical (2:1).
- Phase II temporary shoring will be removed or cut down and left in place with the exception of one portion in the Center Avenue right-of-way that will be maintained until retaining walls to be constructed by the City along the right-of-way are in-place and backfilling is completed. Slope restoration requirements following river walk construction will be coordinated with the City and may include additional fill placement behind retaining wall structures. Restoration requirements will be evaluated with the City following completion of the river walk design plans and specifications and identified in the Phase II detailed plans and specifications.

- Slope cutbacks will be made upgradient of the Phase II work platform in the right-of-way to maintain slope stability during final grading. These cutbacks will be made within the footprint of the proposed condominium building to be constructed but will be maintained above proposed building foundation grades. Slope cutbacks will be reviewed with the building architect for approval prior to proceeding.

- Phase II contours will be matched and blended with pre-existing contours outside the limits of the work platform established for Phase II construction.

5.2 Material Management

Thermally treated material and material that did not require treatment as part of the Phase I excavation and grading will be stockpiled at both Campmarina and WPS's Wildwood facility for future beneficial reuse as backfill at Campmarina and the Center Avenue right-of-way. Phase I backfilling will include restoring the river bank and the right-of way in preparation for Phase II construction as indicated in the Phase I Work Plan. Phase II backfilling will include fill placement over the engineered geosynthetic cap. The objective for material management will be to reuse as much of the excavated treated material as possible in order to minimize the need for off-site disposal and/or alternate placement. Key concerns to be addressed as part of material management consist of the following:

- Structural stability of thermally treated material used as backfill along the riverbank and beneath the alignment of the planned river walk in the right of-way;

- Slope stability within the right-of-way. Reconstruction within the right-of-way will require relatively steep slopes directly downgradient of the proposed third condominium; and,

- Ability for untreated material to support growth of trees, shrubbery and plants for the park. Thermal treatment will effectively remove inorganic nutrients from the soil and reuse as fill above the cap will require amendment by mixing the soil with organic material and/or nutrients.

To address geotechnical concerns for structural and slope stability, several index and strength property tests will be conducted that will include the following:

- Atterberg Limits (ASTM D4318) for assessing the liquid limit, plastic limit and plasticity index of soil;
- Mechanical grain size analyses (ASTM D422); and,
- Standard Proctor Tests (ASTM D698) to determine optimum moisture content and maximum dry density for compaction.

Selective triaxial testing may also be conducted to assess total and effective strength parameters for stability evaluations within the right-of-way. These tests may include conducting consolidated undrained (CU) or undrained unconsolidated (UU) tests of remolded soils. Triaxial testing requirements will be confirmed on the basis of initial geotechnical testing identified above.

Existing geotechnical data obtained during the pre-feasibility investigative activities will be used to estimate minimum and acceptable factors of safety for slope stability in the right-of-way and along the riverbank for completing the detailed Phase II plans and specifications. Stability evaluations within the right-of-way will include assessing both possible circular (rotational) and wedge (translational) type slope failure scenarios. It is anticipated that the sheet pile barrier wall will effectively stabilize the subgrade within the right-of-way beneath the cap and river walk. The results of additional geotechnical testing will be used to confirm estimated acceptable factors of safety. Stability assessments will also be conducted to evaluate sufficient shear strength development between geosynthetic components of the cap that will include:

- Factor of safety at the upper woven geotextile marker layer interface;
- Factor of safety between the non-woven geotextile over the geomembrane and the geomembrane;
- Factor of safety between the geomembrane and the non woven geotextile directly beneath the geomembrane; and,
- Anchor trench strength.

To address amending thermally treated material for reuse above the cap, a mix design will be developed that will include the following;

- Establishing an appropriate mix ratio of selected organically rich topsoil to treated material. Mix designs used at other MGP sites have included mixing one part topsoil to six parts thermally treated material;
- Identifying requirements for nutrient addition such as nitrogen and phosphorus; and,
- Establishing moisture conditioning parameters.

The mix design will be submitted to the City of Sheboygan for review and approval prior to placement.

This mix design will also serve as the basis for finalizing a material balance evaluation with regard to how much of the treated material may be reused as backfill at the site. Pending acceptable geotechnical testing results and approval of the mix design by the City, a majority of the material will be beneficially reused at the site. As an alternate, a portion of the treated and untreated material may be placed at the Wildwood facility. Details regarding the mix design and placement and quantities of both treated and untreated material to be beneficially reused will be provided in the Phase II plans and specifications.

5.3 Backfilling and Site Restoration

Phase I backfilling will be conducted to provide a suitable subgrade for construction of the geosynthetic cap and meet City of Sheboygan future construction subgrade requirements. Details regarding placement of fill to restore Phase I excavated areas are provided in the Phase I Work Plan. Phase II backfilling will include bringing the site to final grades as indicated in Sheet 5. Placement and compaction for the Phase I excavation areas and during Phase II beneath the river walk, park and other structural areas will be coordinated and reviewed with the City of Sheboygan to meet minimum compaction requirements. Phase II placement of material in

landscaped areas will be conducted to minimize over compaction that could inhibit acceptable root growth. This may include over-placement of materials to grades slightly higher than design grades and allowing the material to naturally consolidate.

During and following backfilling, erosion control measures will be maintained in accordance with the interim site restoration requirements identified in the Phase I Work Plan. This will include maintaining silt fencing along the river, and placement of erosion control netting or hay bales. Completion of the Phase II activities will be coordinated with startup of the construction operations for the park and river walk with the City of Sheboygan.

5.4 Engineering and Institutional Controls

Following completion of the Phase II activities, an as-built survey will be prepared to document final limits and elevations of the engineered cap and barrier wall. In addition, the site will contain a number of remediation wells and conveyance piping that will extend through the cap

The cap, wells, piping and other appurtenances will require protection during the park and river walk construction, to occur subsequent to the Phase II remedial actions. In addition, affected sediment in the river should not be disturbed. As a result, specifications for construction will be prepared for future park and river walk contractors. Special Contractor requirements for conducting work over the cap and barrier will include the following conditions:

- *Awareness of the environmental conditions at the site.* Environmental investigation reports, work plans and design plans and specifications for the cap and vertical barrier construction will be available for Contractor review at the City of Sheboygan Engineer's office.

- *`Verification of the subgrade elevation for the top of the cap.* Prior to the installation of any trees, shrubbery, foundations, underground utilities or other underground appurtenances, the depth available for excavation and/or planting will be carefully reviewed. The top of the cap will be clearly marked by a distinctive marker layer of non-woven geofabric, in the case that it is breached. No construction will be conducted below the marker elevation unless approved in writing by the City and WPS.

- *Stop-work should the cap be breached.* In the event that that the integrity of the cap is compromised by digging, or heavy equipment operation or any components of the cap are otherwise damaged, the Contractor will immediately stop work at the location where the damage occurred and notify the City Engineer.

- *Liability for cap damage.* In the event the Contractor or its Subcontractor(s) damages the cap liner system, flexible membrane boots and seals around structures that extend through the cap, monitoring/remediation wells, conveyance piping, or related components, the Contractor will be responsible for repairing the damage at no expense to the City or WPS.

- *Disturbance of river sediment.* No fill material, riprap or debris will be placed directly in the river that would otherwise disturb affected river sediment. No heavy equipment operation will be conducted directly in the river. The Contractor will implement and maintain adequate engineering and erosion control measures (e.g., silt fencing or barriers) to prevent disturbing any sediment in the river.

- *Site access for WPS.* Access to the site shall be provided to WPS by the City and the Contractor during final construction and during maintenance of the above-grade remediation system. Activities may include but not be limited to placement of well covers, installation of aboveground remediation structures or equipment final routing of underground utilities above the existing cap, and routine operation, maintenance and monitoring of the remediation system.

In addition to these special provisions, construction/contractor issues for City of Sheboygan review and approval will be clarified in the Phase II plans and specifications that will be submitted for WDNR review. Additional issues will include:

- Reuse of amended thermally treated material as backfill over the cover;

- Installation of park foundations that will penetrate the cap; and,

- Deed restrictions for future maintenance activities of the cap.

6 SCHEDULE

6.1 Phase I and II Construction

Remedy implementation will be initiated during the fall of 2000 and the Phase I and II site activities will be integrated to the extent practical. It is anticipated that remedial construction activities will follow the general schedule outlined in Figure 4. This is an approximate schedule subject to field conditions, weather, contractor availability, etc. Excavation and grading during the fall will take advantage of cool weather for excavating, transporting and processing MGP affected soil and debris. WDNR will be kept informed of the progress or deviations from this work plan as appropriate via verbal or written correspondence.

6.2 Future Submittals

Following submittal of the Phase II Work Plan, design plans and specifications will be completed for construction. As part of this task, a refined engineering estimate and more detailed schedule for construction will be prepared. Detailed plans, cross sections and details will be prepared for each of the remedy components. Specifications will be prepared in accordance with WPS format and Contract requirements. Drafts of the plans and specifications will be submitted to WPS for review and approval. Following incorporation of WPS comments, the plans and specifications will be forwarded to the WDNR.

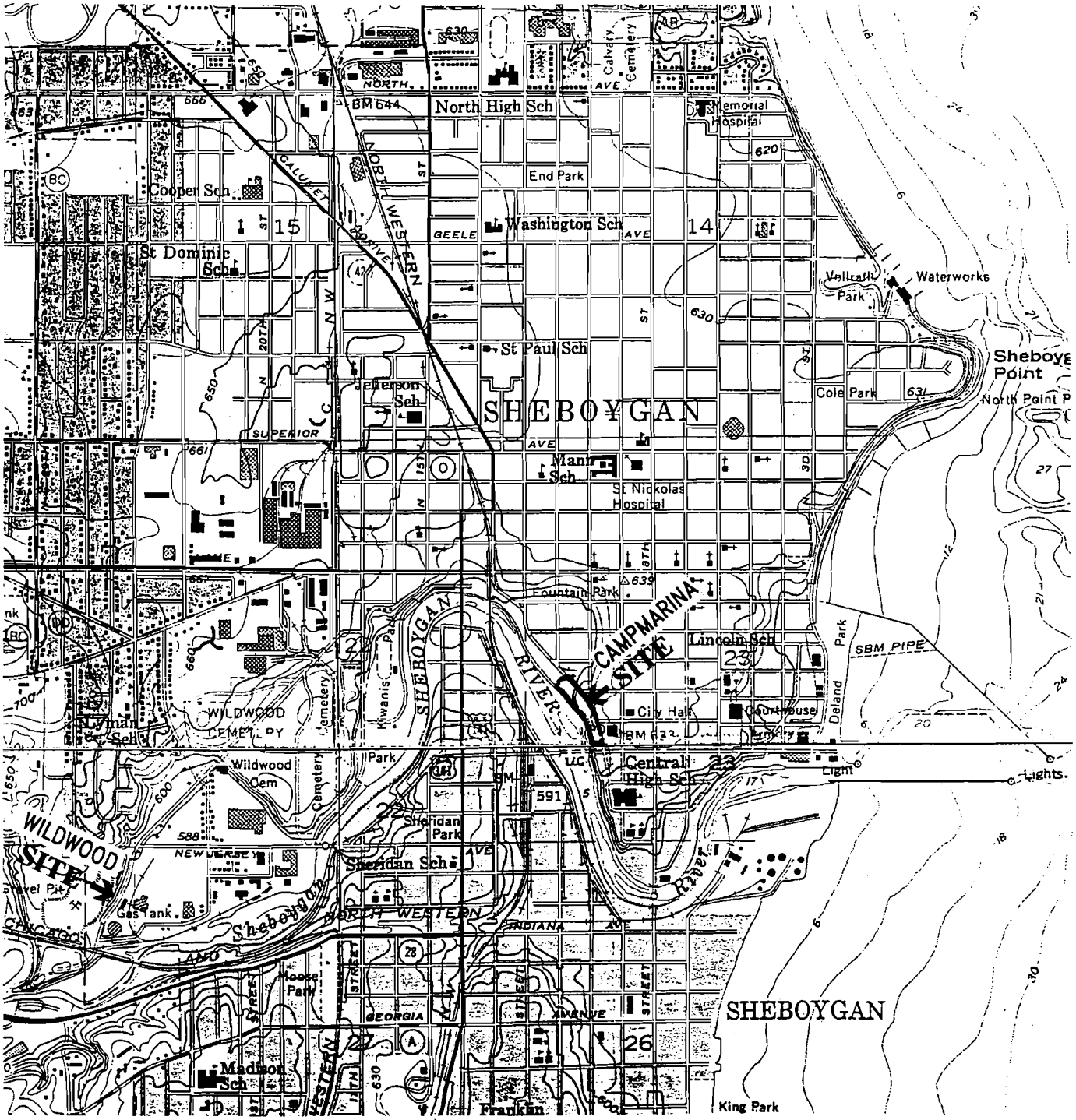
In addition to the Phase II design plans and specifications, the following documents will be prepared in accordance with the Contract task requirements:

- Subtask 13d, Monitoring Program Plan: This plan will outline future groundwater monitoring and reporting requirements following remedy construction;
- Subtask 14a, Operation and Maintenance (O&M) Plan: This plan will outline routine O&M requirements for the low flow biosparging system and engineered cap;

- Subtask 15a, Construction Quality Assurance (CQA) Project Plan: This plan will include field inspection, testing and documentation requirements to be conducted during construction of each of the remedy components; and,

- Subtask 16c, Final Remedy Report: This report will document remedy construction and completion.

FIGURES



SOURCE: USGS 7.5 MINUTE QUADRANGLE, SHEBOYGAN NORTH AND SOUTH. DATED 1954. PHOTOREVISED 1973.

Natural Resource Technology

N R T

SITE LOCATION MAP

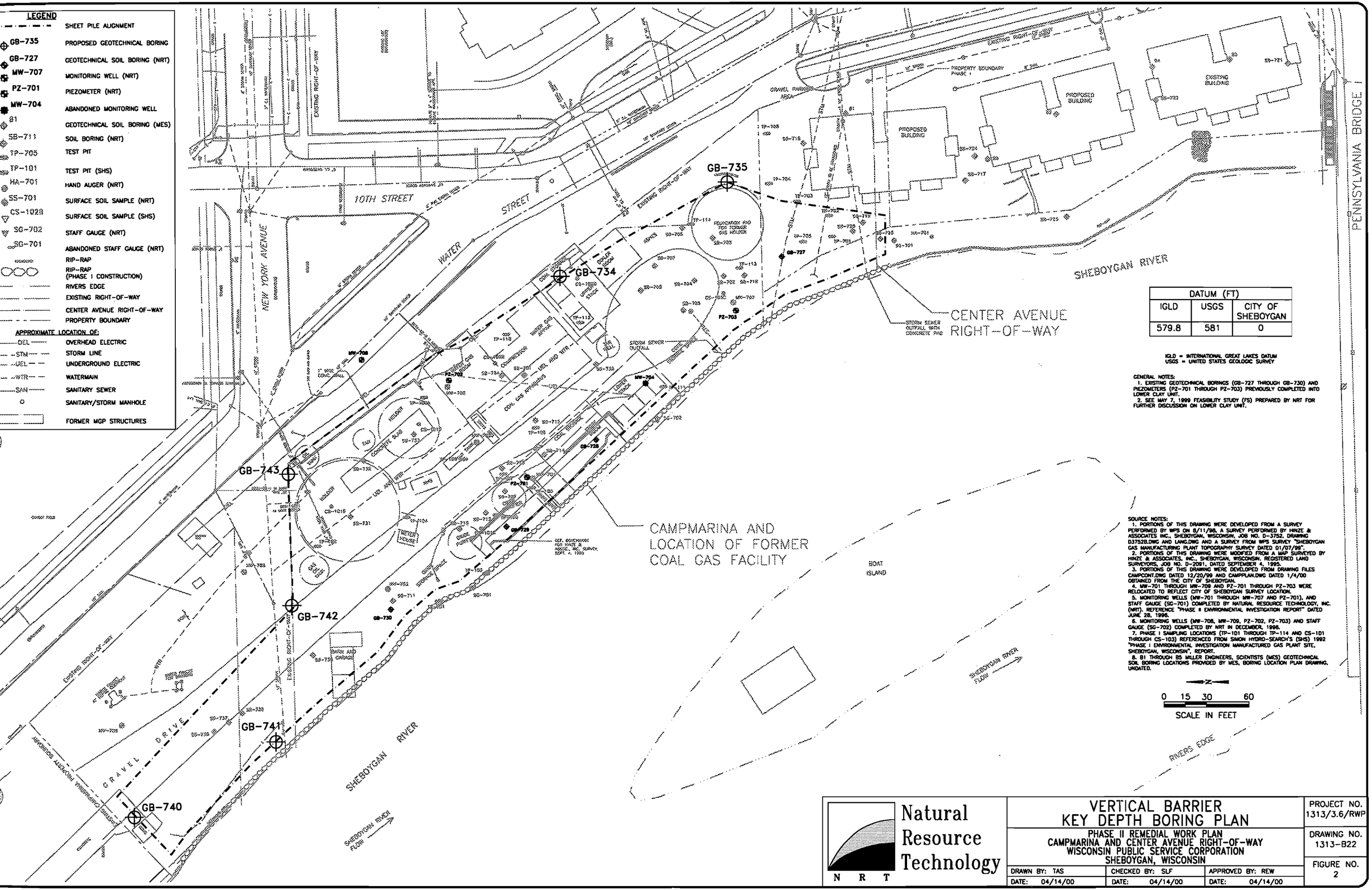
CAMPMARINA AND WILDWOOD, FORMER COAL GAS FACILITIES
WISCONSIN PUBLIC SERVICE CORPORATION
SHEBOYGAN, WISCONSIN

DRAWN BY: TAS APPROVED BY: REW DATE: 02/02/00

PROJECT NO. 1313

DRAWING NO. 1313-A03

FIGURE NO. 1



DATUM (FT)		
IGLD	USGS	CITY OF SHEBOYGAN
579.8	581	0

IGLD = INTERNATIONAL GREAT LAKES DATUM
USGS = UNITED STATES GEOLOGIC SURVEY

GENERAL NOTES:
1. EXISTING GEOTECHNICAL BORINGS (GB-727 THROUGH GB-730) AND PIEZOMETERS (PZ-701 THROUGH PZ-703) PREVIOUSLY COMPLETED INTO LOWER CLAY UNIT.
2. SEE MAY 7, 1999 FEASIBILITY STUDY (FS) PREPARED BY NRT FOR FURTHER DISCUSSION ON LOWER CLAY UNIT.

SOURCE NOTES:
1. PORTIONS OF THIS DRAWING WERE DEVELOPED FROM A SURVEY PERFORMED BY WPS ON 8/11/98, A SURVEY PERFORMED BY HINZE & ASSOCIATES INC., SHEBOYGAN, WISCONSIN, JOB NO. D-3752, DRAWING D3752B.DWG AND LANG.DWG AND A SURVEY FROM WPS SURVEY "SHEBOYGAN GAS MANUFACTURING PLANT TOPOGRAPHY SURVEY DATED 01/07/99".
2. PORTIONS OF THIS DRAWING WERE MODIFIED FROM A MAP SURVEYED BY HINZE & ASSOCIATES, INC., SHEBOYGAN, WISCONSIN, REGISTERED LAND SURVEYORS, JOB NO. D-2091, DATED SEPTEMBER 4, 1995.
3. PORTIONS OF THIS DRAWING WERE DEVELOPED FROM DRAWING FILES CAMPCONT.DWG DATED 12/20/99 AND CAMPPLAN.DWG DATED 1/4/00 OBTAINED FROM THE CITY OF SHEBOYGAN.
4. MW-701 THROUGH MW-709 AND PZ-701 THROUGH PZ-703 WERE RELOCATED TO REFLECT CITY OF SHEBOYGAN SURVEY LOCATION.
5. MONITORING WELLS (MW-701 THROUGH MW-707 AND PZ-701), AND STAFF GAUGE (SG-701) COMPLETED BY NATURAL RESOURCE TECHNOLOGY, INC. (NRT), REFERENCE "PHASE II ENVIRONMENTAL INVESTIGATION REPORT" DATED JUNE 28, 1996.
6. MONITORING WELLS (MW-708, MW-709, PZ-702, PZ-703) AND STAFF GAUGE (SG-702) COMPLETED BY NRT IN DECEMBER, 1998.
7. PHASE I SAMPLING LOCATIONS (TP-101 THROUGH TP-114 AND CS-101 THROUGH CS-103) REFERENCED FROM SIMON HYDRO-SEARCH'S (SHS) 1992 "PHASE I ENVIRONMENTAL INVESTIGATION MANUFACTURED GAS PLANT SITE, SHEBOYGAN, WISCONSIN", REPORT.
8. B1 THROUGH B5 MILLER ENGINEERS, SCIENTISTS (MES) GEOTECHNICAL SOIL BORING LOCATIONS PROVIDED BY MES, BORING LOCATION PLAN DRAWING, UNDATED.

Natural Resource Technology
N R T

VERTICAL BARRIER KEY DEPTH BORING PLAN

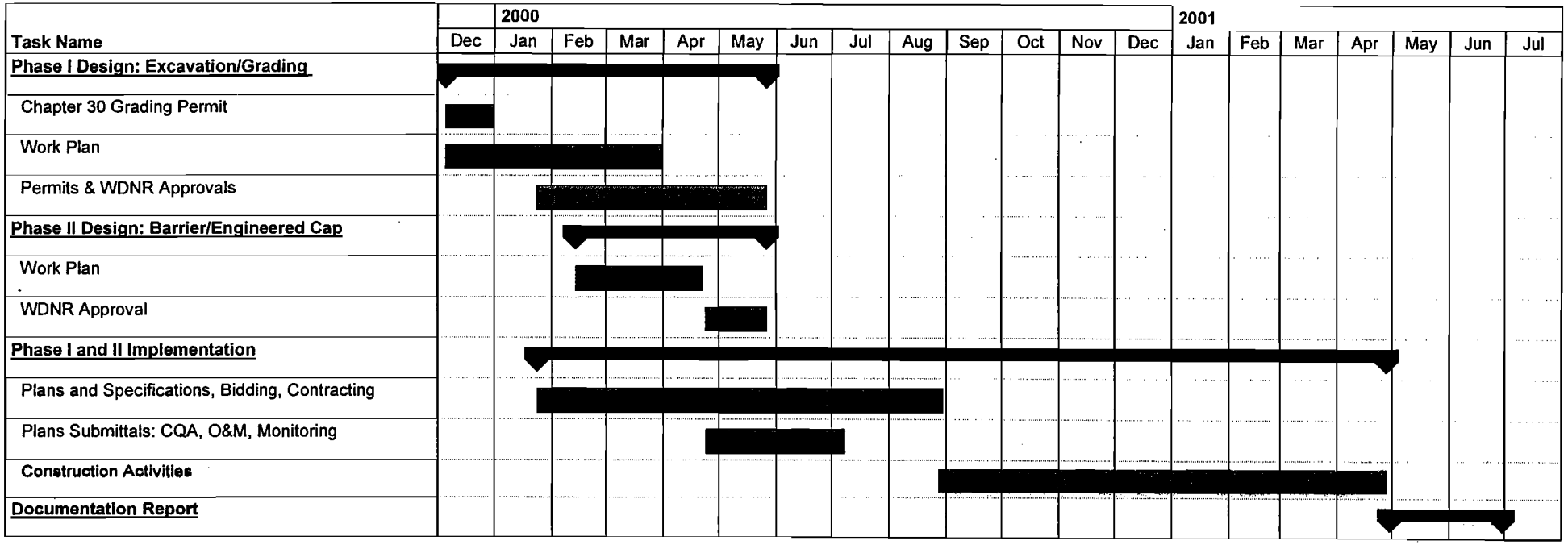
PHASE II REMEDIAL WORK PLAN
CAMPMARINA AND CENTER AVENUE RIGHT-OF-WAY
WISCONSIN PUBLIC SERVICE CORPORATION
SHEBOYGAN, WISCONSIN

DRAWN BY: TAS	CHECKED BY: SLF	APPROVED BY: REW
DATE: 04/14/00	DATE: 04/14/00	DATE: 04/14/00

PROJECT NO. 1313/3.6/RWP
DRAWING NO. 1313-B22
FIGURE NO. 2

AUTOCAD FILE: 1313-B20.DWG
SHEBOYGAN, WISCONSIN

FIGURE 4--PROPOSED PROJECT SCHEDULE
Phase I and Phase II Remedial Action, Campmarina, Former Coal Gas Facility
Wisconsin Public Service Corporation, Sheboygan, Wisconsin



Task

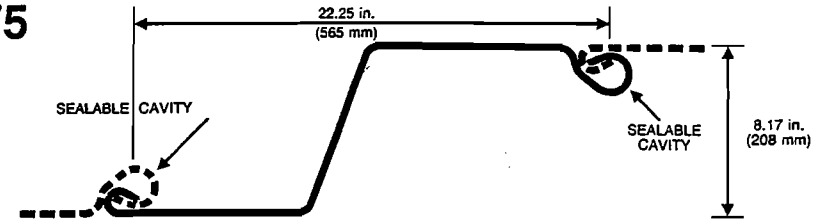
Note: Schedule subject to factors such as final WDNR approval, material procurement and delivery lead times, and contractor availability.

APPENDIX A

SHEET PILE MATERIALS AND COMPONENTS

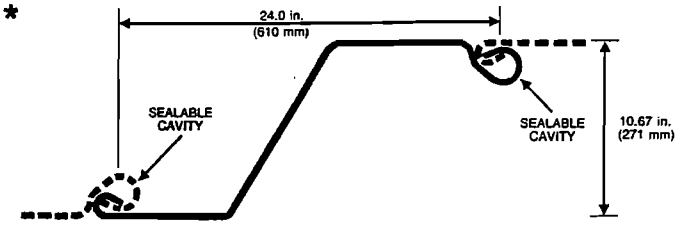
WATERLOO BARRIER™
IS AVAILABLE IN TWO DESIGNS. THE MEDIUM WALL WZ75 AND THE HEAVY WALL WEZ95

WZ75



SECTION	THICKNESS in (mm)	HEIGHT in (mm)	NOMINAL WIDTH in (mm)	SECTION AREA in² (cm²)	WEIGHT lbs/lin. ft. (kg/lin.m)	WEIGHT lbs/ft² (kg/m²)	MOMENT OF INERTIA in⁴/wall ft. (cm⁴/wall m)	RADIUS OF GYRATION in (mm)	SECTION MODULUS in³/wall ft. (cm³/wall m)
WZ75	.295 (7.50)	8.17 (208)	22.25 (565)	10.5 (67.5)	35.6 (53.0)	19.2 (93.7)	64.8 (8870)	3.39 (86.1)	15.9 (860)

WEZ95*



SECTION	THICKNESS in (mm)	HEIGHT in (mm)	NOMINAL WIDTH in (mm)	SECTION AREA in ² (cm²)	WEIGHT lbs/lin. ft. (kg/lin. m)	WEIGHT lbs/ft² (kg/m²)	MOMENT OF INERTIA in⁴/wall ft. (cm⁴/wall m)	RADIUS OF GYRATION in (mm)	SECTION MODULUS in³/wall ft. (cm³/wall m)
WEZ95	.375 (9.50)	10.67 (271)	24.0 (610)	14.4 (92.9)	49.0 (72.9)	24.5 (120)	132 18000)	4.28 (109)	24.7 (1330)

* In production planning stage at date of printing. Please inquire for production update.

SPECIFICATIONS:

RAW MATERIAL: ASTM A572 GR50
CSA G40.21 GR 350W

MANUFACTURING: ASTM A6
CSA G40.20

COATINGS:
1) GALVANIZED
ASTM A123, CSA G164
2) COAL TAR EPOXY
SSPC-16

ACCESSORIES: BENDS CAN BE SUPPLIED TO ANY ANGLE. 'T' SECTIONS AND OTHER WELDED FABRICATIONS ARE AVAILABLE.

WHAT IS WATERLOO BARRIER™?

Waterloo Barrier is a low permeability cutoff wall for groundwater containment and control. It is a new design of steel sheet piling featuring joints that can be sealed after the sheets have been driven into the ground. The product was developed by researchers at the University of Waterloo (UW) and has patent/patent pending status in several countries. Canadian Metal Rolling Mills assisted in the development of the product and are currently the sole manufacturer. Field tests confirm that Waterloo Barrier is an effective method for providing low bulk hydraulic conductivity containment of groundwater in subsurface soil environments.

DEVELOPMENT OF WATERLOO BARRIER™

Low permeability containment walls are increasingly being applied in the control and remediation of groundwater pollution. Conventional technologies such as slurry walls and geomembranes do not necessarily provide cost-effective and efficient subsurface containment in all settings. Groundwater researchers at UW considered this in their construction of containment cells for field experiments involving contaminated groundwater. The concept of driving steel sheet piling and sealing the joints between adjacent piles was thus introduced. After a series of successful experimental cells the potential utility of Waterloo Barrier in real site conditions was confirmed with approximately one year of prototype field testing. UW and Canadian Metal Rolling Mills then collaborated to develop sheet piling in which a sealable cavity was incorporated into the pile interlock in the manufacturing process. A roll-formed shape was produced, and made available for field trials in 1991. Extensive field scale tests were conducted by UW, and bulk hydraulic conductivity values of less than 10^{-8} cm/sec were achieved. Installations of a commercial nature are currently in service.

COMMERCIAL APPLICATIONS

Potential uses of the Waterloo Barrier include:

- deep, enclosing barriers around hazardous waste sites or municipal landfills.
- shallow, enclosing barriers to contain petroleum products or other light contaminants which float on the water table.
- shallow or deep enclosures to control future groundwater contamination at new industrial or waste disposal sites.
- temporary, enclosing barriers to facilitate various removal or in situ remediation procedures.
- barriers along shorelines to prevent seepage of contaminated groundwater into waterways.
- isolation of accidental spills.
- cofferdams in waterways to facilitate efficient dewatering procedures.
- funnelling or directing contaminant plumes to enhance the efficiency of pump-and-treat techniques.
- groundwater control in construction projects involving excavating and tunnelling.

FEATURES & BENEFITS

- rapid installation and sealing.
- minimal disturbance of site during construction.
- easily adapted to irregular layouts.
- limited site access less of a problem compared to alternative cutoff wall techniques.
- easily installed in areas with high water tables and surface water.
- easy to inspect and monitor for superior quality assurance and control during construction.
- predictable hydraulic performance.
- positive public perception.
- long service life for permanent installations.
- can be easily removed where applications are temporary.

INSTALLATION AND SEALING

Waterloo Barrier sheet piles are installed using the same equipment and techniques as conventional product. Vibro equipment is suitable for most soil conditions although better results may be achieved with impact equipment in certain cohesive soils. Vibratory drivers with an eccentric moment in the area of 3000 in-lbs are recommended for both WZ75 and WEZ95. Pile lengths of up to 70 feet are available and for greater depths the piles can be spliced. Corners and special fabrications are available for any geometrical layout. A foot plate at the toe of each larger interlock prevents most of the soil from entering the sealable cavity during driving. After driving the cavities are water jetted to remove small amounts of loose soil and are ready for the injection of sealant. A number of clay-based, cementitious, polymer and mechanical sealants are available to meet a variety of site conditions.

QUALITY ASSURANCE & CONTROL

Potential leak paths through the Barrier are limited to the sealed joints and therefore the joints are the focus of the quality control procedures. Joints are inspected before the sealing operation to confirm that the complete length of the cavity is open and can be sealed. Video inspection equipment can be lowered into each clean cavity to provide a permanent visual record. Each joint is sealed from bottom to top facilitating the emplacement of sealant into the entire length of the joint. Repair procedures can be initiated if joint separation or blockage is suspected. Quality assurance and control is further confirmed by the requirement that the pile driving and sealing be carried out by or under the supervision of trained and licenced personnel.

WATERLOO BARRIER® GROUNDWATER CONTAINMENT WALL

Summary of Applications

Site	Location	Date	Consultant/ Licensed Installer	Area (SF)	Depth (ft)	Description
Industrial Facility	Burlington, VT	Nov. 1993	ABB Environmental/ Slurry Systems	6,560	16	two shallow cut-off walls to divert a contaminant plume
Operating Plant Site	Seattle, WA	Apr. 1994	Roy F. Weston/ RCI Environmental, C3 Environmental	60,000	25 - 50	three enclosures to contain TCE source zones, partially installed within existing warehouse with limited overhead clearance.
Hill AFB	Utah	June 1994	Montgomery Watson/ C3 Environmental	1,560	30	closed cell isolating portion of aquifer for alcohol flushing experiments
Dover AFB	Delaware	Nov. 1994	University of Waterloo	8,800	50	two side-by-side closed cells to test P & T versus pulsed P & T under controlled conditions
Shell Canada Petrochemical Facility	Toronto, ON	Nov. 1994	CH2M Hill/ C3 Environmental	18,000	15 - 18	cut-off wall along property boundary to assist with dewatering during excavation of contaminated soils and to limit groundwater migration
US Army Corps of Engineers Depot	Pueblo, CO	Mar. 1995	Geraghty & Miller, RUST/ Slurry Systems	3,100	20	cut-off wall across shallow ravine to allow plume collection for treatment, anchored to bedrock
Industrial Site	Sherburne, NY	May 1995	Stearns & Wheler/ Slurry Systems	890	20	EPA SITE Program pilot scale Funnel-and-Gate™ system to demonstrate degradation of chlorinated solvents using elemental iron (ETI process)
Ottawa Street Landfill	Kitchener, ON	June 1995	CH2M Hill/ C3 Environmental	36,000	24-35	methane gas and groundwater barrier along property margin at abandoned landfill site

Hill AFB	Utah	Aug. 1995	US EPA, Montgomery Watson/C3 Environmental	13,420	35	8 closed cells installed for remediation experimentation by Robert S. Kerr Environmental Research Lab
Former Venus Mine	Yukon	Sept. 1995	Dept. of Indian & Northern Affairs/C3 Environmental	10,460	18-24	isolation of tailings impoundment from adjacent lake at abandoned mine site
Union Pacific Railyard	San Jose, CA	Oct. 1995	Levine-Fricke/ C3 Environmental	6,000	30 - 35	structural wall and groundwater barrier installed alongside railbed to facilitate excavation of contaminated soils
Lowry AFB	Denver, CO	Nov. 1995	Dames & Moore/ C3 Environmental	1,320	20	pilot scale Funnel-and-Gate™ system with ETI process
Dover AFB	Delaware	Feb. 1996	Applied Research/ C3 Environmental	12,000	50	double-walled test cell for remediation experimentation under controlled conditions
Industrial Facility	Lake Charles, LA	Feb. 1996	IT/C3 Environmental	2,700	32	closed cell for pilot scale testing of surfactant injection
Industrial Facility	Toms River, NJ	July 1996	Owner/ C3 Environmental	3,450	30	closed cell for remediation experimentation
Glass Manufacturing Plant	Hamilton, ON	Sept. 1996	Acres/C3 Environmental	8,500	15-34	site isolation and structural wall for excavation of contaminated soils
Denver Federal Center	Denver, CO	Oct. 1996	IT/C3 Environmental	28,000	24-31	full scale Funnel-and-Gate™ system with ETI process in multiple gates
Dow Chemical Site	Sarnia, ON	Oct. 1996	Dow	15,000	25	cut-off wall along property boundary
Dover AFB	Delaware	Nov. 1996	US EPA, Mantech Environmental/ C3 Environmental	12,800	50	closed cell test facility installed for Robert S. Kerr Environmental Research Lab
Alameda Naval Air Station	Alameda, CA	Dec. 1996	Rice Consortium/C3 Environmental	2,670	25	pilot scale Funnel-and-Gate™ to test sequential treatment of complex complex plume
Dow Chemical Site Phase 2	Sarnia, ON	Sept. 1997	Dow	35,227	25	cut-off wall along property boundary

Beta Steel Plant	Port of Indiana, IN	Oct. 1997	Slurry Systems	22,500	42	closed cell and structural wall constructed of new heavy WEZ 95 sheet pile, construction dewatering application
ICI Site	Shawinigan, PQ	Dec. 1997	Sanexen/C3 Environmental	17,000	27	cut-off wall to isolate contaminated soils and limit groundwater flow to adjacent waterway
Dover AFB	Delaware	Dec. 1997	Battelle/C3 Environmental	2,442	37	pilot scale Funnel-and-Gate™ system
Pratt Whitney Site	New Haven, NJ	Jul. 1998	University of Connecticut/University of Waterloo	780	32	closed cell for pilot scale remediation testing
Industrial Site	North Vancouver, BC	Aug. 1998	SRK Robinson/C3 Environmental	42,000	43	groundwater barrier and structural wall for excavation of contaminated soils, heavy WEZ 95 sheet pile
Atomic Energy of Canada Site	Chalk River, ON	Nov. 1998	AECL/CH2M Hill/C3 Environmental	4,900	27	in situ treatment system for Sr^{90} plume
Petroleum Refinery Site	Arkansas City, KS	Nov. 1998	Enecotech/Slurry Systems	5,120	32	containment of hydrocarbon-contaminated soils adjacent to creek
General Electric Site	Pittsfield, MA	Dec. 1998	Maxymillian/C3 Environmental	2,760	30	cut-off wall to prevent groundwater contamination from entering river
Canadian Crown Corporation Site	St. John, NB	Dec. 1998	Jacques Whitford/C3 Environmental	4,000	7	cut-off wall to limit migration of liquid creosote into adjacent creek

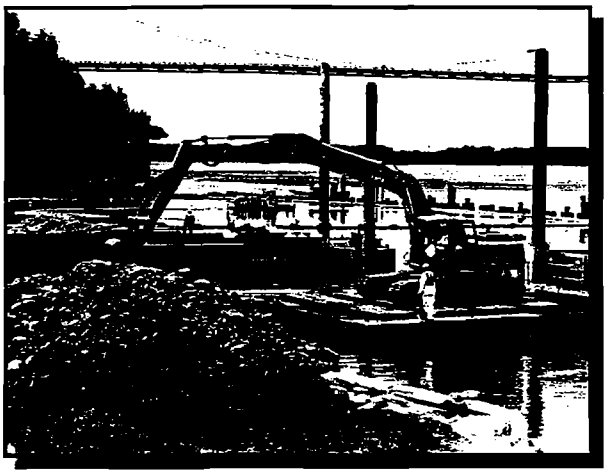
SKYLINE STEEL CORPORATION

Remediation of the St. Lawrence River Site with ARBED AZ 13 and AZ 18 Steel Sheet Piles

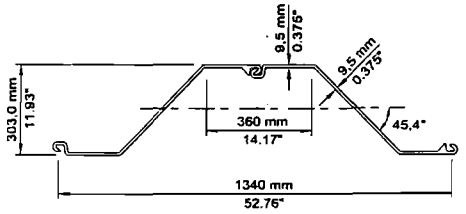
RELEVANT PROJECT FEATURES

St. Lawrence River Site Remediation
Massena, New York

- **Challenging PCB sediment dredging/ dewatering in the St. Lawrence River**
- **2,200 wall feet of steel sheet piling up to 250' from shore**



ARBED AZ 13



Mass: 21.92 lb/ft^2 - Section modulus: 24.2 in^3/ft
Tonnage: 1400 tons AZ 13 & AZ 18 (temporary)

Brief Project Description

From 1959 to 1974 a plant used PCB containing hydraulic fluid in the manufacture of aluminum cylinder heads. Over that period, sludge containing PCB's was deposited in several disposal areas on site.
In 1995, dredging of approximately 13,800 cy of PCB-contaminated river sediments started, about 20 percent of which were known to have high ppm of PCBs.
A previous contractor had been unsuccessful on the project. The new contractor performed his own complete treatability study in order to contract for the project under performance specifications.
Swift currents (5 fps) and eddies, wakes from ships passing in the nearby St. Lawrence Seaway, and cobbles and boulders in the dredge area, all presented special challenges for this project.

After completing site infrastructure including constructing a pier, the contractor enclosed the dredge area by a continuous 2,200 wall foot steel sheeting wall with ARBED AZ 13 and AZ 18 sheets. The AZ sections were found best suited for this project application. Being wider and lighter than other sections with comparable strength, the installation time was reduced and thus the total labor time.
The enclosure's purpose was to prevent sediments disturbed during operations from polluting the river.
Before dredging commenced, the sheet pile enclosed dredge area was cleared of cobbles and boulders by a barge-mounted longstick excavator with perforated bucket. Then the contaminated sediments were removed.
Dredging was carried out up to 250 feet from shore at depths from 5 to 22 feet.
The project was completed in 10 months.

Designer: Glynn Geotechnical Engineering
Contractor: Sevenson Environmental Services, Inc.

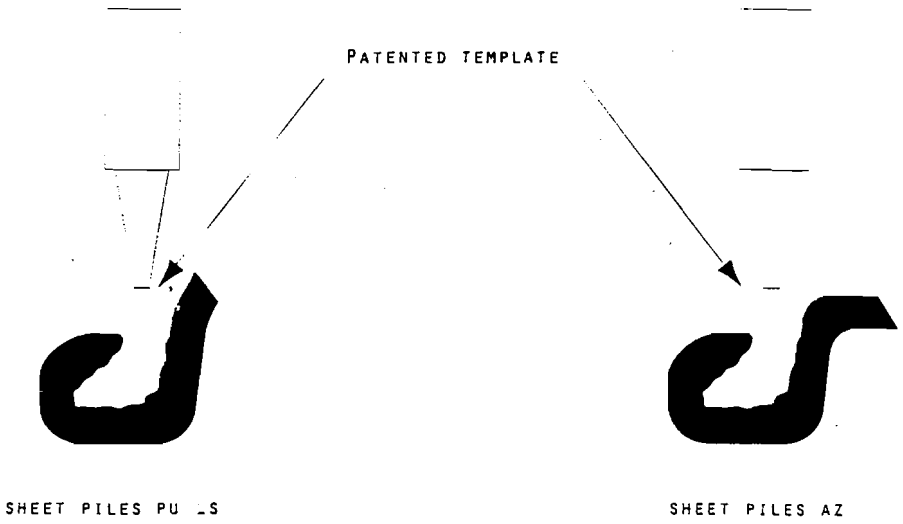
ARBED GROUP

SKYLINE STEEL CORPORATION

Ref. 04/1999

Water-swelling product: Feeding into sheet pile interlocks

1) Filling the free interlock with a water-swelling product



2) Expansion of water-swelling sealer in threaded interlocks

Figure 6

1.1.2 Water-swelling product

1.1.2.1 Features of the product

Composition:	normally urethane prepolymer
Density at 20°C:	1.22
Inflammation point:	500°C
Maximum expansion:	• continuous immersion in drinking water: 115% in sea water: 90% • alternate cycles drinking water: 115% sea water: 90% • no expansion in oil • expansion in alkaline salts: identical to drinking water
Colour:	normally light grey

These features are only given as an indication and can be modified by the supplier as required.

1.1.2.2 Packaging

The product is supplied in cartridges of 320 ml or in barrels of approximately 15 l for extrusion.

1.1.2.3 Conditions of application

The behaviour of the water-swelling product when it is installed is set out below:

- application on a surface covered with standing water: impossible
- application on damp metal (dew point): excellent
- application on metal at –10°C: delicate or critical
- application on metal at +5°C to +70°C: excellent
- polymerization in rain: delicate to critical
- polymerization in UV light: excellent

1.1.2.4 Durability of the product in different *environments*

ie durability in the installed steel sheet piling:
- water with pH 3.5 to pH 11.5: excellent
- sea water: excellent
- mineral oil: excellent
- petrol: excellent
- crude oil: excellent

1.1.2.5 Consumption

Application into an open interlock **(Figure 6)**: consumption approximately 0.15 l per metre of interlock.

1.1.2.6 Installation of seal at the factory (Figures 7, 8 and 9)

The application of the water-swelling product is made preferably at the factory and must be carried out to comply with the following requirements:

- the interlock must be dry; possible slight humidity is permitted;

- laying out the piling in a perfectly horizontal position is not essential;
- so that the product can adhere in the interlocks, recently rolled piles need to be cleaned with a jet of compressed air. In the event of the presence of corrosion in the interlocks, cleaning with a steel wire brush and/or high-pressure water jet is necessary;

- positioning the product by extrusion and spreading the product using a special template (ProfilArbed patent LU 88397) which distributes the product properly in the interlock:

Take care!! *Spreading using the special template* is **essential** to ensure the sealing of the interlock.

- filling the interlocks taking into account the direction of driving:

- if the piles are supplied in single units: fill one free interlock per single pile **(Figure 7)**;

- if the piles are supplied in units already fitted together (doubles):

  * either fill the intermediate interlock before they are fitted together, together with one free interlock **(Figure 8)**;

  * or weld the intermediate interlock and fill one free interlock **(Figure 8)**.

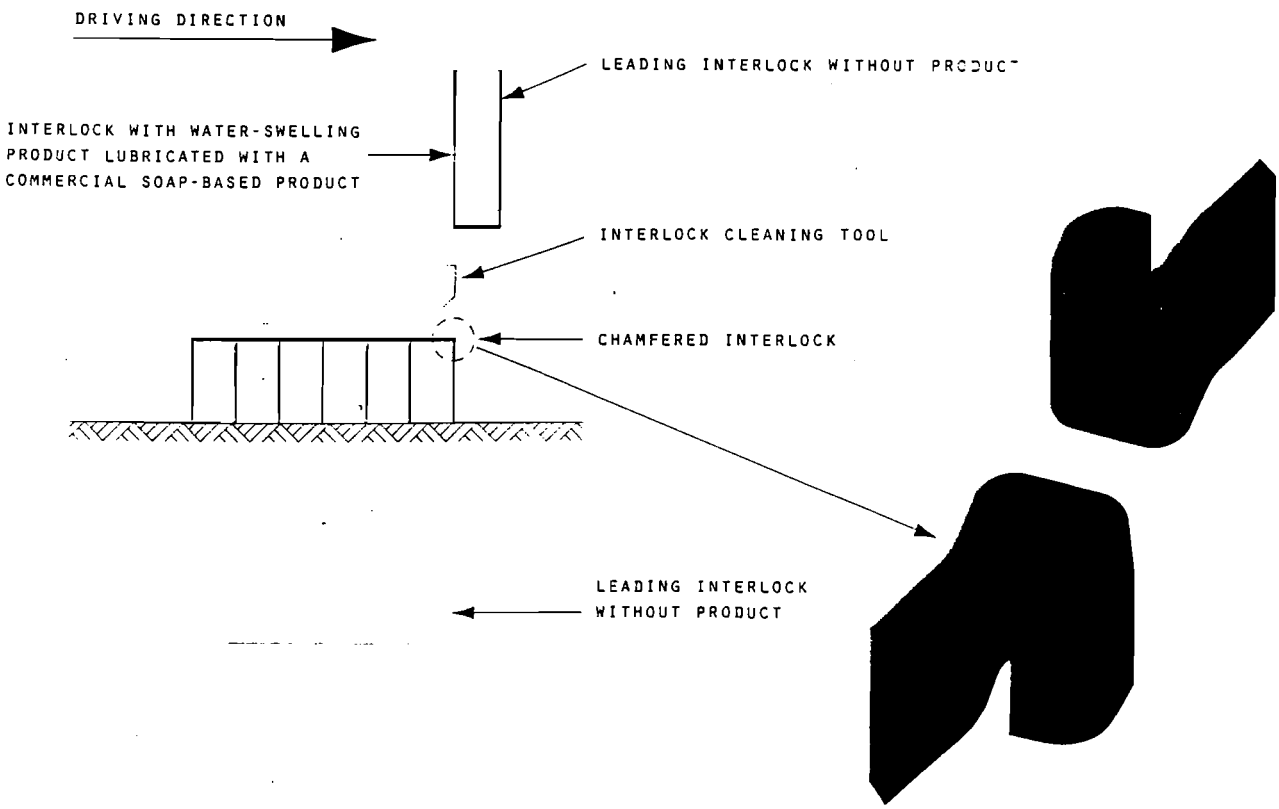
It should be noted that it is possible to crimp the piles once they have been sealed and threaded together.

1.1.2.7 Installing the seal in situ

Application of the water-swelling product in situ is not advised unless the work can be carried out under shelter. It must then be carried out to comply with the same requirements as for application at the factory (with assistance from ISPC's Technical Advice Service).

Installation of sheet piles sealed with a water-swelling product

1) Single sheet piles with water-swelling product



2) Threaded double sheet piles with water-swelling product

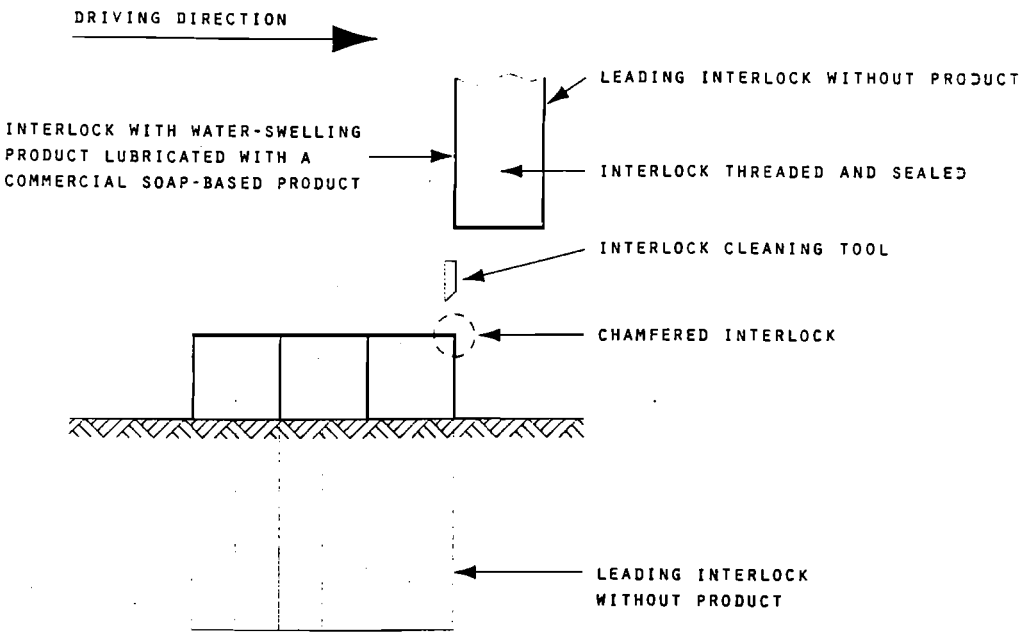
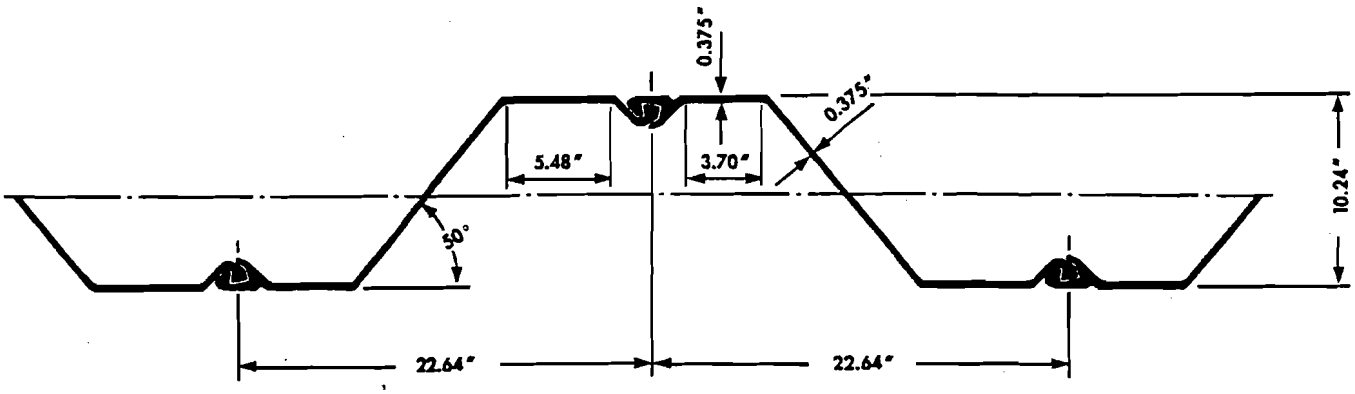


Figure 11

Hoesch 1200 Steel Sheet Piling



Dimensions and Properties								
Driving distance per pile	Depth	Thickness		Weight		Section Modulus		Moment of Inertia
		Web	Flange	per single pile	per sq. ft. of wall	per single pile	per ft. of wall	per ft. of wall
in.	in.	in.		lbs./ft.	lbs.	$in.^3$	$in.^3$	$in.^4$
22.64	10.24	0.375	0.375	41.33	21.91	39.96	21.20	108.54

Steel qualities			
Steel qualities	**Minimum yield point**	**Minimum tensile strength**	**Minimum elongation**
ASTM	psi	psi	%
ASTM A 328	39000	70000	17
ASTM A 572 gr. 50	50000	65000	18
ASTM A 690	50000	70000	17

DIN EN 10248	psi	psi	%
S 240 GP (St Sp 37)	34286	48571	26
S 270 GP (St Sp 45)	38500	58571	24
S 320 GP	45714	62857	23
S 355 GP (St Sp S)	50714	68571	22
S 390 GP	55714	70000	20
S 430 GP	61428	72857	19

HSP Hoesch Spundwand und Profil GmbH
Alte Radstrasse 27
D-44147 Dortmund
Postal address:
D-44120 Dortmund
Telephone (231) 844-1
Telefax (231) 844-6455

**A company in the
Steel division of the Krupp Group**

Krupp Hoesch Stahlexport GmbH
Theodor-Althoff-Strasse 1
D-45133 Essen
Telephone (201) 809-0
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Krupp Hoesch Steel Products, Inc.
180 Interstate North Parkway
Atlanta, Georgia 30339-2194
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01/96

KRUPP

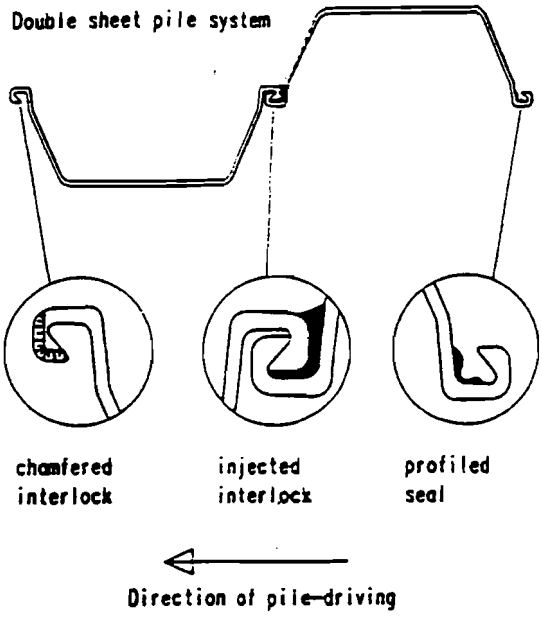


Fig.2: Interlock seal Hoesch system

The middle interlock can be welded or fitted with an injected seal adjusted to the interlock slot. The driving interlock is not sealed, as it is driven as a free interlock into which the sealed site interlock of the next element is threaded. The site interlock is usually fitted with the Hoesch interlock sealing system (DBP 27 22 978) [5]. This is a continuously profiled seal, fitted mechanically, which is designed so that restoring forces are activated when the pile is driven which seal the interlock slot. The basic material for the seal is a polyurethane which is practically permanently elastic. Past experience shows that the best method of installing sheet piles which are sealed with the Hoesch sealing system is pile-driving. When Larssen sheet piles are driven, care must be taken that the free interlock (driven interlock) is driven first of all, and the interlock with the seal (site interlock) is threaded in. The position of the seal is marked in colour so that it can be easily recognised on site (Fig. 3). It is therefore important to lay down the driving direction beforehand in a plan. Pile-driving must be carried out with great care and with corresponding expertise. With this barrier wall system permeability degrees of $Q < 8$ cm3/h*m^2 wall can be achieved (cf.Section 5.1.1)

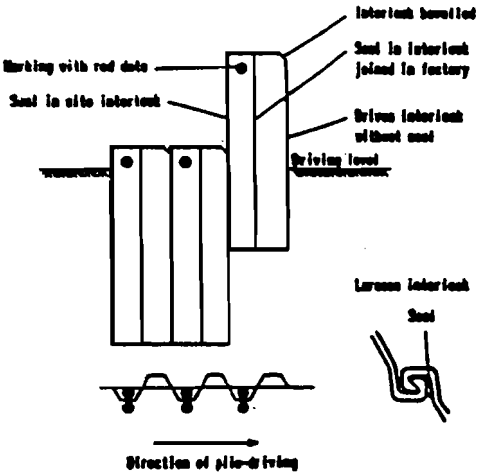


Fig.3: On-site interlocking system with the Hoesch interlock sealing system

APPENDIX B

VERTICAL BARRIER KEY DEPTH PLAN

APPENDIX B
VERTICAL BARRIER KEY DEPTH EVALUATION

The following work plan describes additional data collection activities for design of the vertical barrier wall for the Campmarina and Center Avenue right of way. Specifically, up to six soil borings will be advanced to verify the elevation of the continuous clay layer that is serving as an aquitard to vertical contaminant migration; and the alignment and key-in depth for the sheet pile barrier.

This design evaluation will be conducted in accordance with Task 14C, Additional Studies, of the March 5, 1991 Contract between WPS, the City of Sheboygan and the Wisconsin Department of Natural Resources. Proposed boring locations are shown on Figure 2. Historical boring locations that extended into the confining layer are also shown on Figure 2. Borings will be advanced using 4 ¼-inch hollow stem auger. Soil boring split-spoon sampling will be limited to the intervals immediately above and within the first 5 feet of confining layer. Quality assurance measures described in the February 2, 2000 Phase I Work Plan will also apply to this work.

Grain size analyses will be conducted on soil from at least one interval per boring. Soil will be classified by ASTM standards D2487 and D2488 at continuous intervals immediately above and within the confining clay layer. Grain size results and and boring log classifications will be used to estimate hydraulic conductivity. One sample from each boring will be collected in Shelby tubes for future documentation of key-in depth strata. Drilling spoil will be placed on and covered by sheet plastic on-site in accordance with NR 718, pending soil treatment during Phase I excavation and grading activities in the fall of 2000.

Results of this evaluation will be included in a Phase II Design Report, to be forwarded to the WDNR under separate cover. The specifications will include soil boring logs, abandonment forms, results of grain size analyses, depth to continuous clay strata and any additional data that may be useful in completing the containment barrier design.

APPENDIX C

PILOT TEST WORK PLAN

APPENDIX C

PILOT TEST WORK PLAN

WISCONSIN PUBLIC SERVICE CORPORATION
SHEBOYGAN, WI

PILOT TEST WORK PLAN

CAMPMARINA, FORMER COAL GAS FACILITY
WISCONSIN PUBLIC SERVICE CORPORATION
SHEBOYGAN, WISCONSIN

PROJECT NO. 1313

Natural
Resource
Technology

N R T

Natural
Resource
Technology, Inc.

N R T

PILOT TEST WORK PLAN
CAMPMARINA, FORMER COAL GAS FACILITY
WISCONSIN PUBLIC SERVICE CORPORATION
SHEBOYGAN, WISCONSIN

Project No: 1313

Prepared For:

Wisconsin Public Service Corporation
700 N. Adams Street
Green Bay, WI 54307

Prepared By:

Natural Resource Technology, Inc.
23713 W. Paul Road, Suite D
Pewaukee, WI 53072

March 30, 2000

Spiros L. Fafalios, P.E.
Project Engineer

"I, Spiros L. Fafalios, hereby certify that I am a registered professional engineer in the State of Wisconsin, registered in accordance with the requirements of ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, 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. NR 700 to 726, Wis. Adm. Code."

WISCONSIN
ROY E.
WITTENBERG
E-32332
FOX POINT
PROFESSIONAL ENGINEER

Roy E. Wittenberg, P.E. WI
Senior Engineer

"I, Roy E. Wittenberg, hereby certify that I am a registered professional engineer in the State of Wisconsin, registered in accordance with the requirements of ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, 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. NR 700 to 726, Wis. Adm. Code."

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

1 INTRODUCTION

1.1 Project Description

Presented in this document is a Pilot Test Work Plan for Wisconsin Public Service Corporation's (WPS's) former coal gas facility located at Campmarina in Sheboygan, Wisconsin (Figure 1). Campmarina and the Center Avenue right-of-way encompass approximately 2.6 acres and are bounded on the north by the New York Avenue right-of-way, on the east by North Water Street, on the west by the Sheboygan River and on the south by the Center Avenue right-of-way.

This Pilot Test Work Plan was prepared in substantive conformance with the May 7, 1999 Feasibility Study (FS) as approved by the Wisconsin Department of Natural Resources (WDNR) on October 27, 1999 and the March 5, 1991 Contract between WPS, the City of Sheboygan and the Wisconsin Department of Natural Resources (WDNR). Pilot study requirements are outlined under Task 5 of the Contract. Work described herein also meets the regulatory requirements of the NR 700 series and is in general accordance with WDNR *Guidance for Design, Installation and Operation of In Situ Air Sparging Systems* as well as guidance provided by the United States Environmental Protection Agency's (U.S. EPA's) document *Guide for Conducting Treatability Studies under CERCLA*, EPA/540/R-92/071a, dated October 1992.

The City of Sheboygan is redeveloping Campmarina and the Center Avenue right-of-way immediately to the south as a park. Remedial actions for Campmarina and the Center Avenue right-of-way will be implemented in two phases to better meet site-specific conditions and current scheduling requests from the City. The first phase of the OU RD/RA Work Plan is described in the Phase I Work Plan submitted to the WDNR on February 2, 2000. Phase I site activities will consist of the excavation, site grading, material management and off-site thermal treatment or disposal of MGP affected soil and debris. The Phase II Work Plan will be forwarded under separate cover, and will include installing a vertical sheet pile wall around affected portions of

Campmarina and the right-of-way, constructing a low permeability geosynthetic composite cap, backfilling the site to pre-existing grades and installing a low flow biosparging system.

1.2 Treatment Technology Description

Biosparging has been implemented at other MGP sites. At the Campmarina site, a low flow system will serve as an enhancement for natural biodegradation processes and would not be relied upon as a primary source control action. Based on results from previous studies, substantial reductions in hydrocarbons such as the concentrations of BTEX and low-molecular weight PAH such as napthalene can be achieved. Less success has been observed with heavier end hydrocarbons but these are also generally less mobile and would pose less of concern for on-going contribution to groundwater affects. Low flow air injection would be maintained to facilitate MGP residual biodegradation and minimize volatilization of BTEX compounds. The proposed pilot test will be conducted to establish a basis for full-scale biosparging system design.

2 BASIS FOR PILOT TEST DESIGN

2.1 Test Objectives

The general objective of the pilot test is to gather data for full-scale design of a biosparge system as a secondary component of the remedial action at the site. Specific objectives of the test include:

- Determine actual air entry pressure required to initiate airflow;
- Evaluate optimal biosparging air flowrate by examining pressure/DO characteristics;
- Evaluate optimal well spacing; and,
- Assess vapor off-gas quality during sparging.

2.2 Test Design and Setup Procedures

Pilot test setup will include installation of five pilot test wells. The proposed configuration of pilot test wells is shown in Figure 2. Construction details for pilot test wells are shown on Figures 3 and 4, and are presented below. One well (SW-701) will be used as the pilot test sparge well. Three soil gas probes (GP-701 to GP-703) will be installed to measure soil vapor during the test. Two temporary monitoring wells (TW-701 and TW-702) will be installed to measure groundwater and soil vapor parameters during the test. The two monitoring wells will be installed at distances of 10 and 20 feet from the pilot test well. Existing groundwater monitoring well MW-703 will be used as a monitoring point, located 30 feet from the proposed pilot test sparge well. Three gas probes will be installed at 5, 15, and 25 feet radially from the sparge well. Appendix B contains soil boring logs for nearby borings and MW-703. The well construction log for MW-703 is also included.

2.2.1 Sparge well

The sparge well will be constructed as recommended in the Wisconsin DNR *Guidance for Design, Installation and Operation of In Situ Air Sparging Systems* as shown on Figure 3. Construction will include 2-inch schedule 40 PVC, using a 4¼-inch hollow stem auger drill rig. The sparge well will be installed to approximately 20 feet below ground surface (bgs), or 1 foot into the sandy clay layer. A 0.01-inch, 2 ½ foot well screen will be used, with filter pack consisting of medium sand (#30) extending 6 inches above the top of the screen. A 15-foot riser will be used. Above the medium sand, 6 inches of fine sand (#40-50), and a well seal consisting of 3/8-inch bentonite chips will be installed to surface grade. Bentonite will be hydrated, and the well will be developed in accordance with NR141 to minimize the amount of fines injected into the filter pack. The top of casing may extend above the ground surface and will be threaded, to accommodate pilot test compressor connections. At least 6 inches of the outside of the top of casing should be clear of well construction materials (bentonite, sand, etc.). Grain size samples will be collected in the sparge interval to verify soil characteristics at sparge depth.

2.2.2 Soil Gas Probes

The three soil gas probes will be constructed with 2-inch schedule 40 PVC, using a 4¼-inch hollow stem auger drill rig as shown in Figure 4. The soil gas probes will be installed to approximately 8 feet bgs. A 0.01-inch slot, 5-foot well screen will be used with a 5-foot riser, and filter pack consisting of medium sand (#30) extending 6 inches above the top of the screen. Six inches of fine sand (#40-50), and granular bentonite chips will be installed above the medium sand to surface grade. Bentonite will be hydrated to prevent short-circuiting of air to the surface. At least 6 inches of the outside of the top of casing should be clear of well construction materials (grout, sand, etc.) to accommodate pilot test measurement equipment.

2.2.3 Monitoring Wells

Two temporary monitoring wells will be installed in accordance with NR141 to complement the existing monitoring well (MW-703) that will be used to collect data for the pilot test, as shown in Figure 4. The monitoring wells will be installed to approximately the same elevation as the sparge well, but above the top of the clay confining layer, or approximately 18 ft bgs. The wells will be screened to approximately 3 feet bgs (15 feet of screen). The filter pack will include medium sand (#30) to the top of the screened section, 6 inches of fine sand (#40-50), and finished with granular bentonite (hydrated) to surface grade. At least 6 inches of the outside of the top of casing should be clear of well construction materials (grout, sand, etc.). Monitoring wells will be developed in accordance with NR141.

2.3 Permits and Notifications

In accordance with NR 724.09, this work plan includes a listing of permits and notifications anticipated to be required to conduct the pilot test.

2.3.1 Digger's Hotline Clearance

Prior to any subsurface activities, public and private utilities will be located. Diggers Hotline, WPS, and the City of Sheboygan will be notified to locate underground utilities in and near the pilot test well locations.

2.3.2 Temporary Exemption for Injection of Remedial Materials

In accordance with NR140.28, a temporary exemption is required for a pilot scale study for injection of "remedial materials", defined in NR 140.05 to include naturally occurring gaseous material (air). An exemption will be requested of the WDNR prior to conducting the air sparge pilot test. Based on existing site conditions at the location of the pilot test, injection of air for the duration of the pilot test will not result in off-site migration of contaminants of concern. Free product was not encountered in adjacent borings (sheen only – see Appendix B), and the nearest

utility piping is a storm sewer approximately 50 feet to the north (Figure 2). This storm sewer will be removed as part of the planned Phase I work.

2.3.3 City Access Notification

The City of Sheboygan has provided formal access authorization to the Campmarina and the Center Avenue right-of-way, presented in Appendix A. Notification of electrical power use at the site will be provided prior to the pilot test.

2.4 Equipment and Materials

Monitoring equipment to be used for the pilot test include:

- Multiple parameter downhole Water Quality Meter to measure DO, ORP, temp, cond., and pH;
- Water level indicator;
- Photoionization Detector to measure ionizable air constituents;
- Four-gas meter, including H_2S, O2, CO and LEL (only O2 and LEL will be recorded);
- Carbon dioxide colorimetric tubes;
- Magnahelic pressure gages;
- Pressure, flow and temperature gages on the pilot test compressor unit;
- Thermal anemometer.

Groundwater sampling supplies, fittings for connection to sparge and monitoring wells, and health and safety supplies will also be utilized. In addition, an In-Situ Hermit data logger and pressure transducer will be used to conduct slug tests. Pilot test equipment will include a 1½ hp oil-less rotary vane compressor, as shown in Appendix C. The compressor is capable of 15 scfm at 15 psig, as shown on the performance curve (Model 2067).

3.0 PLAN OF OPERATION

3.1 Sampling and Analysis

One day of operation is assumed for the pilot test. Slug tests and groundwater samples for laboratory analysis will be collected prior to the date of the pilot test. The air sparge pilot test segment will be approximately 8 hours in duration. Test duration may be increased or decreased up to 4 hours if justified based on data required to complete the test. After completion of the test, post-pilot test monitoring activities will be concluded prior to capping the wells. Samples and measurements will be collected as shown in Table 1 on forms presented in Appendix D.

3.1.1 Pre-Pilot Test Measurements

Prior to the date of the pilot test, the following measurements and samples will be collected as shown in Table 1:

- Soil grain size for SW-701;
- Groundwater elevations for sparge and monitoring wells;
- Groundwater sample from a monitoring well; and,
- Slug tests for TW-701 and TW-702.

On the date of the pilot test, wells will be opened and allowed to equilibrate with atmospheric conditions. Groundwater elevation will be measured until stable, at least twice prior to conducting the pilot test. After water levels equilibrate, monitoring wells and gas probes will be fitted with removable seals for measuring pressure and collecting air samples.

3.1.2 Variable Flow Testing

The first 4 hours of the test will be dedicated to incrementally increasing the injection pressure at one hour intervals, allowing for air and water field readings to generally equilibrate at each step. As specified in Table 1, a vapor sample will be collected at the greatest pressure near the end of the first 4 hours of the air sparging pilot test segment for VOC and atmospheric gas analyses (methane, CO_2, O_2) from one of the monitoring wells.

Air samples will be collected using Summa® canisters for VOC and atmospheric gas analyses (methane, CO_2, O_2). These canisters provide a simple method of collecting a large sample volume for multiple analyses. One canister will be collected for each sample. In addition to providing a large sample volume, whole air samples are not subject to shortfalls of media sampling tubes, such as reduced adsorption due to moisture and relatively low breakthrough conditions for compounds such as benzene.

3.1.3 Biosparge Flow Testing

The final 4 hours of the test will consist of sparging at a rate likely to be used for the full-scale biosparge system to achieve the most efficient oxygenation of the aquifer and radius of influence. After 4 hours of biosparge-mode operation, a second vapor sample will be collected, using a Summa® canister for the same parameters stated above, from one of the monitoring wells. Monitoring parameters will be collected, as stated in Table 1. Soil gas probes and monitoring wells will be sealed with fittings and stopcocks to observe any pressure changes that may occur. Seals will be temporarily removed when water quality readings are collected from monitoring wells. Pressure readings will be observed using magnahelic pressure gages. The pilot test sparge well will be fitted with a quick-connect coupling to facilitate proper sealing with the pilot test compressor.

3.1.4 Post Pilot Test Measurements

Post-pilot test data will be collected until groundwater field measurements have equilibrated. Groundwater elevations and water quality parameters will be monitored for approximately one to

two hours after completion of the test. Parameters will be collected as shown in Table 1 following the pilot test. Groundwater will also be sampled from the same monitoring well sampled prior to the pilot test for BTEX, PAH and water quality parameters. Drummed purge water will be analyzed for benzene to evaluate disposal options.

3.2 Data Management

Field monitoring forms included in Appendix D will be used to record measured parameters, shown on Table 1. The frequency of data collection presented in Table 1 may be increased, or decreased based on the rate of parameter changes based on pilot test observations and variations to injection pressure.

Field measurements will be collected using equipment described in Section 2.4, in accordance with the manufacturer's instructions for use, maintenance, and calibration. All samples for laboratory analysis will be collected in laboratory supplied containers. All QA/QC procedures presented in the Phase I Work Plan Quality Assurance Project Plan will be followed. Lab QA/QC summary and chain of custody documentation shall be submitted with analytical results. Wisconsin laboratory certification in accordance with NR 149 does not apply to air analyses.

3.3 Data Analysis and Interpretation

Data analysis and interpretation will include evaluation of field and laboratory data. Following completion of pilot test activities, data will be analyzed to achieve engineering objectives. Optimal well spacing will be based on observed air injection pressures to obtain an acceptable flowrate of oxygen to the subsurface within a reasonable radius of influence. Vertical and horizontal well configurations will be assessed to optimize air distribution. In addition, alternate means of oxygen delivery to the saturated zone may be reviewed, such as increased sparged oxygen concentrations or the use of oxygen releasing compounds. Following establishment of design parameters, full-scale design of a biosparge system will be incorporated in the Phase II design report. Based on changes to the hydrogeologic conditions caused by the cutoff wall, full-scale system deployment will be

phased, with approximately 1/3 of the system installed and tested weeks prior to the rest of the system. Operational planning will be addressed in the Phase II Work Plan. Phased installation will allow verification of design parameters, including indications of biodegredation prior to completion of system installation.

In addition to the injection well spacing, passive venting configuration will also be established, based on the unsaturated zone pressure gradients achieved during the pilot test. Temperature, carbon dioxide, and oxygen concentration data will be analyzed to evaluate "short circuiting" through the soil surface and underground conduits, as well as biological degredation potential.

3.4 Health and Safety Plan

WPS, its contractors and NRT personnel will be qualified and knowledgeable with respect to health and safety requirements relating to the remedial action. NRT will develop a Health and Safety Plan for NRT and WPS personnel working at the site, as described in the Phase I Work Plan.

3.5 Residuals Management

Drilling and well development waste will be containerized on-site pending characterization and disposal, most likely in the following fashion:

- Soil cuttings to be stockpiled in accordance with NR 718 at the site. Drilling spoil will be placed on and covered by sheet plastic pending remediation activities in the fall.
- Groundwater from well development and sampling to be drummed pending disposal, after receipt of analytical data. If purge water sampling results indicate benzene above 0.5 mg/l, purge water will be disposed as hazardous. Past sampling results for MW-703 indicate purge water from nearby wells may also be hazardous.
- Personal protective equipment and well construction and sampling materials will be disposed as non-hazardous waste.

Pilot test wells will be abandoned in-place according to NR 141. The wells will be filled with bentonite chips and riser piping will be removed to at least 30 inches below surface grade. MW-703 will not be abandoned.

4 REPORTING

4.1 Submittals

The results of the Pilot Test will be included in the Phase II Work Plan, and substantively meet the requirements of Task 5 of the Contract. Results will include data analysis and interpretation described in Section 3.3. Included in the Phase II Work Plan will be field data, analytical results, diagrams, and other design data collected during the pilot test.

4.2 Schedule

We intend to proceed with the Pilot Test within 1-3 weeks from WDNR approval. Installation of wells, pre-pilot test data collection, and pilot testing are planned for completion in 1-2 weeks. Laboratory analytical results will be turned around in 2-3 weeks. Data evaluation and initial full-scale biosparge system design will be completed concurrent with the Phase II Work Plan. This is an approximate schedule subject to field conditions, weather, contractor availability, etc. WDNR will be kept informed of the progress or deviations from this work plan as appropriate via verbal or written correspondence.

4.3 Staffing

Key project principals and personnel are listed below:

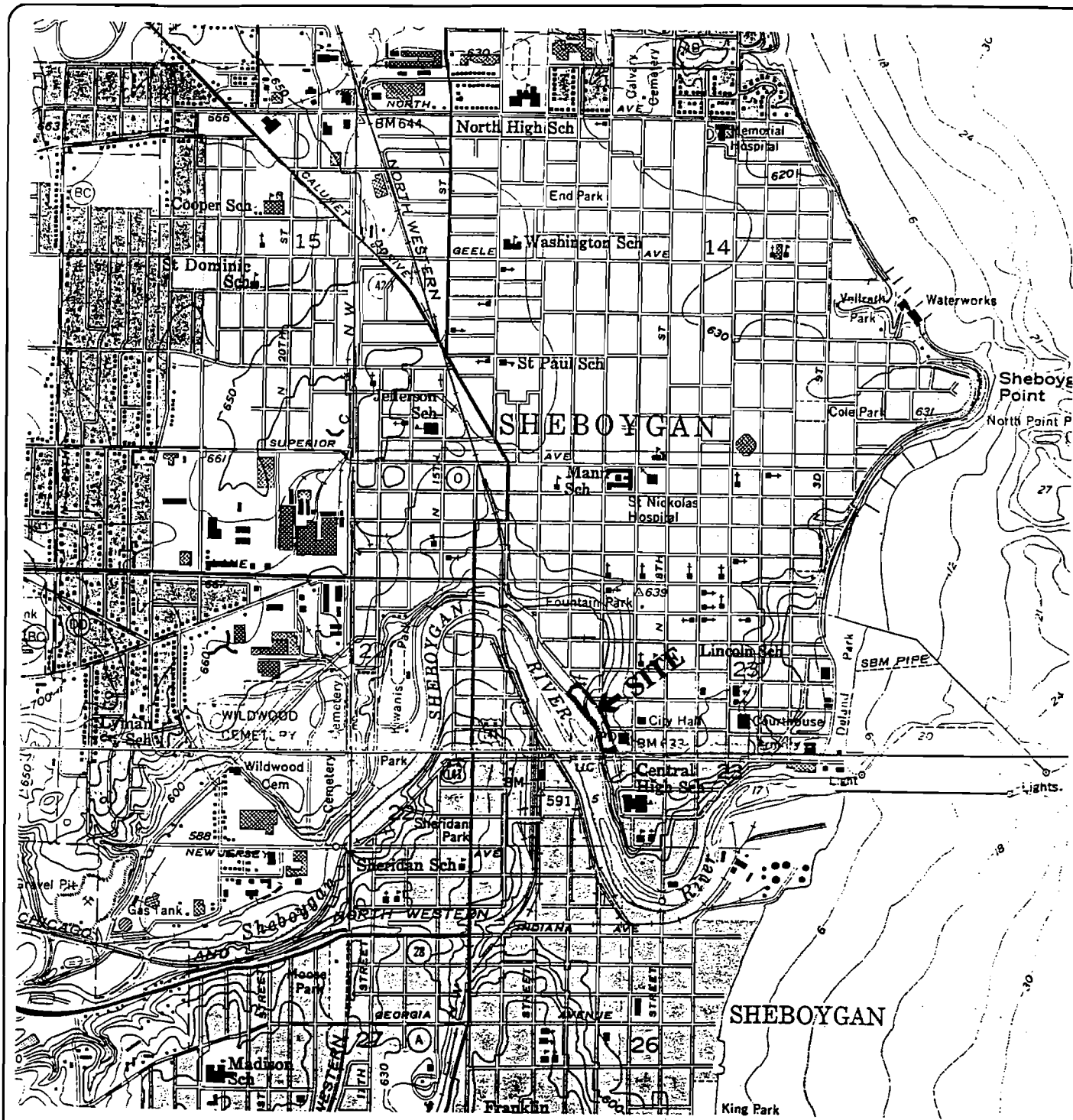
Site Owner:

City of Sheboygan
807 Center Avenue
Sheboygan, WI 53081
Contact: Mr. Bob Peterson
(920) 459-3380

Former MGP Operator:	Wisconsin Public Service Corporation 700 North Adams Street, P. O. Box 19002 Green Bay, WI 54307-9002 Contact: Ms. Connie Lawniczak (920) 433-1140
Site Location:	732 North Water Street Sheboygan , Wisconsin Sheboygan County NW ¼, SW ¼, Section 23, T15N, R23E Refer to Figure 1
Consultant:	Natural Resource Technology, Inc. (NRT) 23713 W. Paul Road, Unit D Pewaukee, WI 53072 Contact: Mr. Roy E. Wittenberg (262) 523-9000

Key WPS personnel that will be involved in the implementation include Ms. Connie Lawniczak, Project Director. Key NRT personnel involved in the implementation of remedial actions at the Campmarina site includes Mr. Roy Wittenberg, P.E. (Project Manager), Ms. Laurie Parsons, P.E. (Senior Review Engineer), Mr. Spiros Fafalios, P.E. (Project Engineer) and Mr. Dan Plovnick (Field Engineer).

FIGURES



SOURCE: USGS 7.5 MINUTE QUADRANGLE, SHEBOYGAN NORTH. DATED 1954. PHOTOREVISED 1973.

Natural Resource Technology

N R T

SITE LOCATION MAP

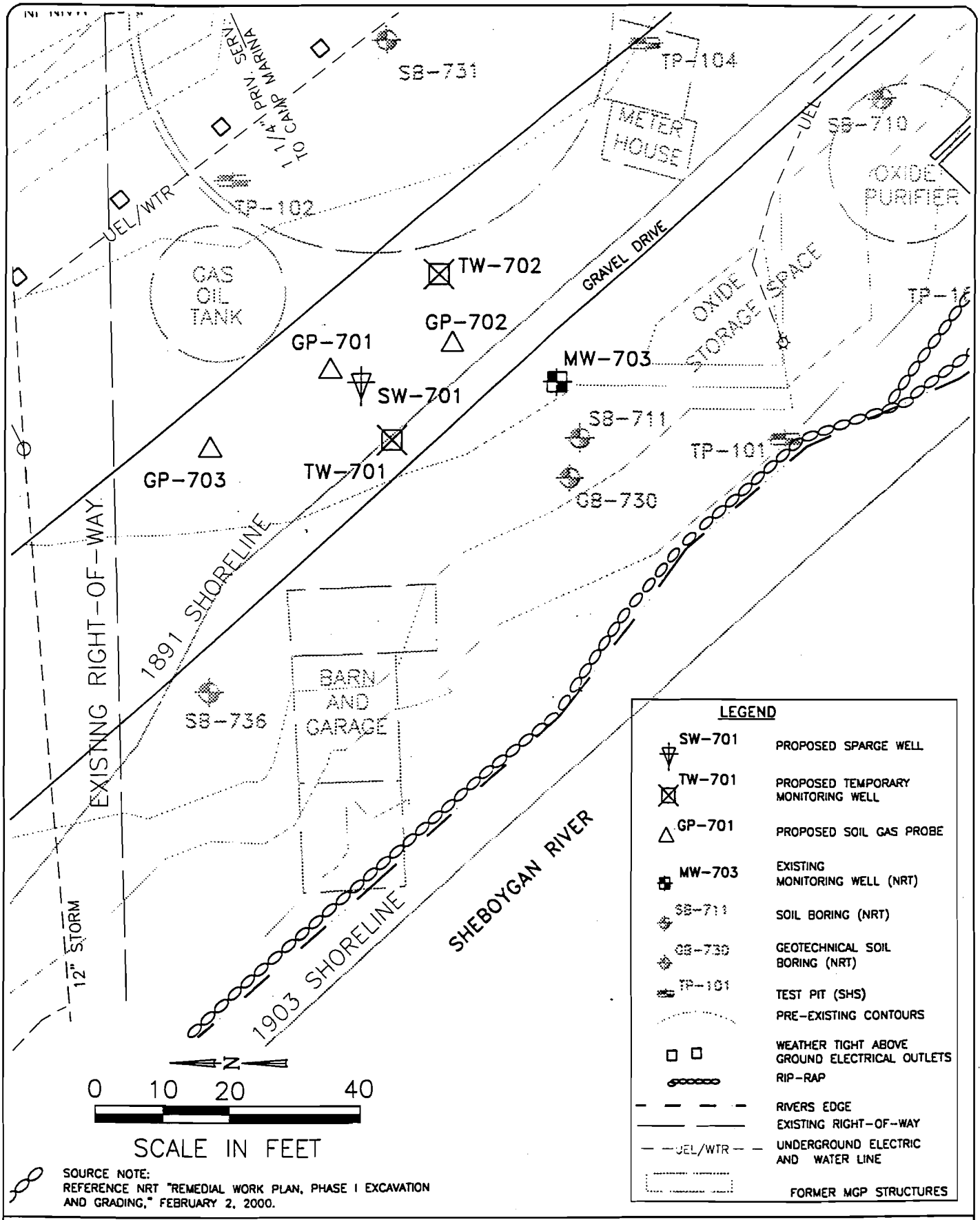
CAMPMARINA, FORMER COAL GAS FACILITY
WISCONSIN PUBLIC SERVICE CORPORATION (WPSC)
SHEBOYGAN, WISCONSIN

DRAWN BY: TAS APPROVED BY: KEW DATE: 5/6/99

PROJECT NO. 1313

DRAWING NO. 1313-A01

FIGURE NO. 1



SOURCE NOTE:
REFERENCE NRT "REMEDIAL WORK PLAN, PHASE I EXCAVATION AND GRADING," FEBRUARY 2, 2000.

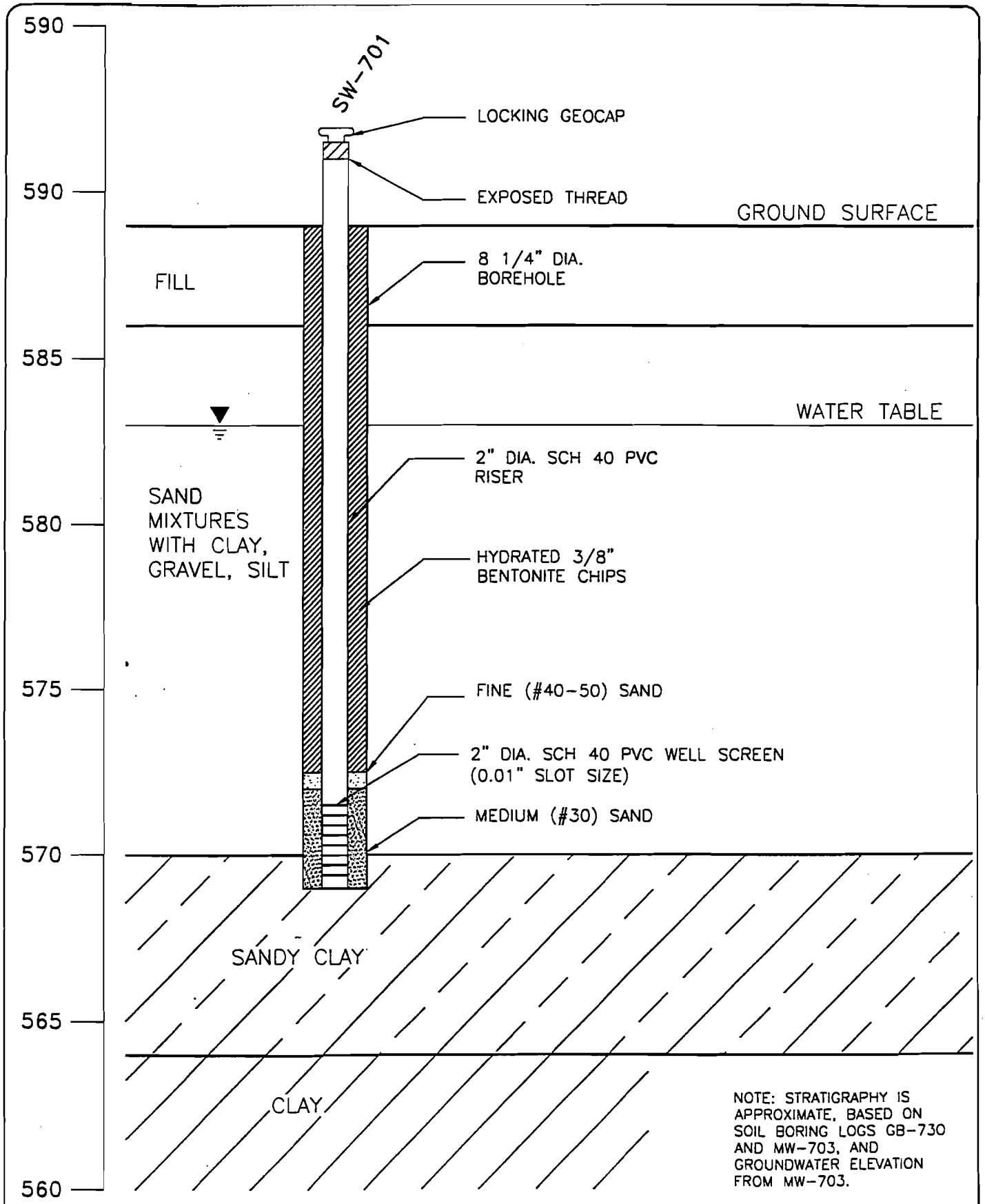
Natural Resource Technology
N R T

BIOSPARGE PILOT TEST WELLS

PILOT TEST WORK PLAN
CAMPMARINA AND CENTER AVENUE RIGHT-OF-WAY
WISCONSIN PUBLIC SERVICE CORPORATION
SHEBOYGAN, WISCONSIN

DRAWN BY: TAS 03/30/00 APP'D BY: REW DATE: 4/4/00

PROJECT NO. 1313/3.6
DRAWING NO. 1313-A03
FIGURE NO. 2



Natural Resource Technology

N R T

PROPOSED PILOT TEST SPARGE WELL DETAIL

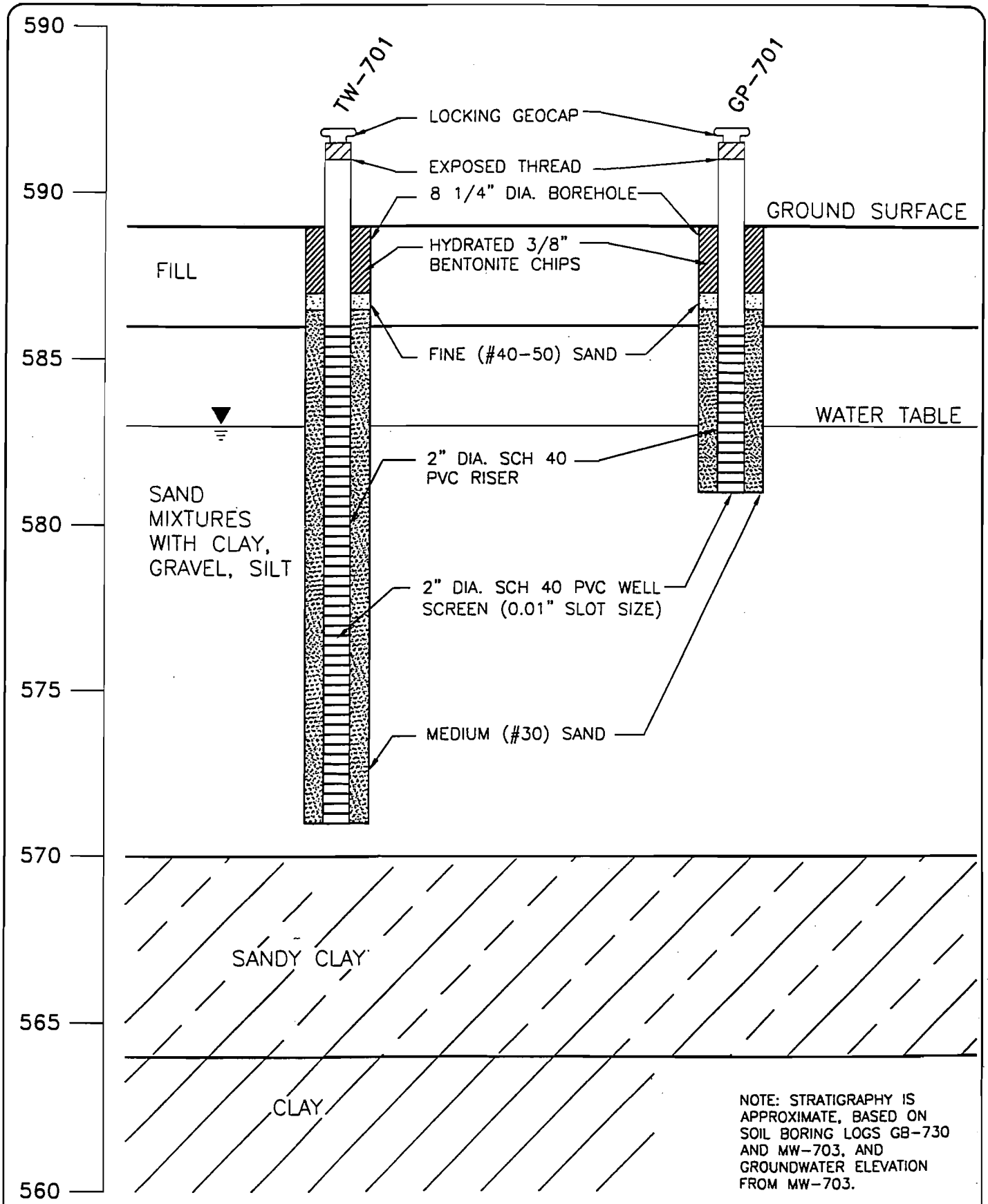
PROJECT NO. 1313/3.6

PILOT TEST WORK PLAN
CAMPMARINA AND CENTER AVENUE RIGHT-OF-WAY
WISCONSIN PUBLIC SERVICE CORPORATION
SHEBOYGAN, WISCONSIN

DRAWING NO. 1313-A04

FIGURE NO. 3

DRAWN BY: TAS 03/30/00 APP'D BY: REW DATE: 4/4/00



Natural Resource Technology

N R T

PROPOSED TEMPORARY MONITORING WELL AND GAS PROBE DETAIL

PILOT TEST WORK PLAN
CAMPMARINA AND CENTER AVENUE RIGHT-OF-WAY
WISCONSIN PUBLIC SERVICE CORPORATION
SHEBOYGAN, WISCONSIN

DRAWN BY: TAS 03/30/00 APP'D BY: REW DATE: 4/4/00

PROJECT NO. 1313/3.6

DRAWING NO. 1313-A05

FIGURE NO. 4

TABLE

Table 1 - Pilot Test Measurement Matrix
Pilot Test Work Plan
WPSC - Sheboygan Campmarina MGP

Parameter	Frequency***	Air Sparge Well	Monitoring Wells	Gas Probes
		SW-701	TW-701, TW-702, MW-703	GP-701, GP-702, GP-703
Pre-pilot Test Data				
Hydraulic Conductivity	1x	Slug Test	Slug Tests (TW-701, TW-702)	
GW Field Parameters	2x or until stable	Elevation, Water Quality Meter (DO, ORP, temp., cond., pH)	Elevation, Water Quality Meter (DO, ORP, temp., cond., pH)	
Lab Parameters	1x	Grain Size	BTEX (8260) PAH (8310) WQ Parameters*	
Pilot Test Data				
Sparge-Air Measurements	every 10 to 15 minutes	Pressure, Temperature, Flowrate	Pressure, GW Elevation	Pressure
Sparge-Air Quality	every 30 minutes		PID, 4-gas Meter**, CO_2	PID, 4-gas meter**, CO_2
Sparge-Water Quality	every 30 minutes		Water Quality Meter (DO, ORP, temp., cond., pH)	
Lab Parameters	2x			BTEX + naphthalene (EPA TO-14) methane, oxygen, CO_2 (ASTM 1946)
Post-pilot Test Data				
GW Field Parameters	2x or until stable	Elevation, Water Quality Meter (DO, ORP, temp., cond., pH)	GW Elevation, Water Quality Meter (DO, ORP, temp., cond., pH)	
Lab Parameters	1x		BTEX (8260) PAH (8310) WQ Parameters*	

Notes:
*WQ Parameters = methane, sulfate, nitrate + nitrite, dissolved iron, and alkalinity.
**4-gas Meter to measure O2 and LEL only.
***Frequency is meant as a guide only. Actual measurement frequency may vary, based on observed conditions.

by: DVP
ch'd: SLF

APPENDIX A

CITY OF SHEBOYGAN ACCESS AGREEMENT

City of Sheboygan
spirit on the lake.

February 21, 2000

Wisconsin Public Service Corp.
Attn: Connie K. Lawniczak
700 N. Adams Street
P.O. Box 19002
Green Bay, WI 54307-9002

Dear Ms. Lawniczak:

Please let this letter serve as your permission to enter onto the property on Water Street (known as Camp Marina).

It is my understanding that you will be conducting some remedial work in the site and on the Center Avenue right-of-way extended to the west of Water Street.

Proper signing is required to safeguard the public.

The City retains the right to enter onto the property at anytime.

Please call my office if you have any questions. Thank you for your time in this matter.

Sincerely yours,

Lloyd L. Turner, P.E.
Director of Public Works

c Bob Peterson, City Development
Tom Holtan, Engineering

DEPARTMENT OF
PUBLIC WORKS AND
CITY ENGINEERING

333 CENTER AVENUE
SHEBOYGAN, WI
53081

M 920/459-3366
ENG. 920/459-3394
FAX 920/459-0227

APPENDIX B

SELECTED SOIL BORING LOGS AND MW-703 WELL CONSTRUCTION FORM

State of Wisconsin
Department of Natural Resources

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Superfund ☐ Other:

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 5-92

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
C - Vacant City Property South of Campmarina		GB-730

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
Boart Longyear Randy Radtke	12/14/98	12/14/98	4 1/4" (ID) HSA / ROTAR

DNR Facility Well No.	WI Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet MSL	588.66 Feet MSL	8.25 / 6 inches

Boring Location State Plane	Feet N Feet E	Lat Long	Local Grid Location (If applicable)
			4863.2 feet ☒ N ☐ S 5231.3 feet ☒ E ☐ W

County	DNR County Code	Civil Town/City/ or Village
Sheboygan	60	Sheboygan

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
GB730 (1)	9	10,11 11,12	2	Grassy surface w/ associated top soil to 1' BGS (sand, fine and medium grained, some organics)	SP			0.0						
GB730 (3)	14	4,5 5,6	4	1'-3' FILL SILTY CLAY, reddish brown (5YR 5/4), few medium sand, stiff-dry, no odor. In=3 3'-6' FILL SAND, dark gray, fine grained, **some cinders**, little silt and clay, loose-dry, no odor.	FILL			8.1						
GB730 (5)	0	11,13 18,7	6	NO RECOVERY 4'-6' BGS.				NR						
GB730 (7)	10	3,2 3,1	8	6'-18' SAND W/ SILT, dark gray (5Y 4/1), little coarse sand and fine gravel, soft-moist to very moist, **minor tar, visual staining, strong odor.**	SM			16.3						
GB730 (9)	16	3,1 1,1	10	**Minor tar and strong odors continue to 10' BGS**				32.7						
GB730 (11)	0	pushed	12	Wet at 9'	SW			NR						Shelby Tube 10' - 12'
GB730 (13)	18	1,1 1,3	14	At 9.5', 4" lense of SAND, well graded, predominanty fine to medium, some coarse sand, **slight odor.**	SM			24.5						Shelby Tube 12' - 14'
GB730 (15)	20	1,1 1,1	16	SHELBY TUBE SAMPLE 10'-12' NO RECOVERY				40.9						
GB730 (17)	18	1,1 1,1	18	SHELBY TUBE SAMPLE 12'-14' NO RECOVERY, drove 2" split spoon	SW			40.9						
GB730 (19)	20	5,5 10,17	20	At 12.5', some lenses of SAND, well graded, predominantly fine to medium, some coarse sand, **slight odor.**	SM			24.5						
GB730 (21)	18	7,7 7,13	22	At 14.5', 6" lense of SAND as at 9.5'.				8.1						
GB730 (23)	24	pushed		At 15', little organics, few medium sand, trace coarse sand, **slight odor.**	CL			NS						Shelby Tube 22' - 24'
				At 16'-18', lenses of SAND as at 12.5', little clay.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Chris Ruff

Firm: Natural Resource Technology

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comm
GB730 (25)	24	7,12 18,22	26	19'-25' SILTY CLAY, dark grayish brown (10YR 4/2), few medium sand, trace coarse sand and fine gravel, stiff-moist to slightly moist,no odor.	CL			8.1						Augered to 24' bgs
GB730 (27)	24	5,10 10,10	28	SHELBY TUBE SAMPLE COLLECTED FROM 22'-24' BGS.	CL			8.1						
GB730 (29)	20	pushed	30	At 24.6', 2" lense clayey silt, light gray (10YR 7/2).	SP			NS						
GB730 (31)	24	10,11 13,10	32	25'-32' CLAY, dark grayish brown and dusky red (10YR 4/2 and 2.5YR 4/4), few silt, trace coarse sand, hard-slightly moist, no odor.	CL			8.1						
			34	At 28', some clayey silt seams, light gray.										
			36	At 28.6', 6" lense of GRAVELLY SAND, coarse grained sand, fine gravel, little clay, loose-wet.										
			38	At 27.2', grades to CLAY, dark grayish brown (10YR 4/2), few silt, trace coarse sand and fine gravel, very stiff-slightly moist, no odor.										
			40	End of Boring at 32' BGS										
			42											
			44											
			46											
			48											
			50											
			52											
			54											
			56											
			58											
			60											
			62											

State of Wisconsin
Department of Natural Resources

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Superfund ☐ Other:

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 5-92

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
WPSC-Sheboygan Water Street Feasibility Study		*SB-731*

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
Boart Longyear Environmental Drilling, Inc. *Randy Radke*	*12/10/98*	*12/10/98*	*HSA and Mud Rotary*

DNR Facility Well No.	WI Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet MSL	*590.70 Feet MSL*	*inches*

Boring Location State Plane	Feet N Feet E	Lat Long	Local Grid Location (If applicable)
			4889.6 feet ☒ *N* ☐ *S* *5298.2 feet* ☒ *E* ☐ *W*

County	DNR County Code	Civil Town/City/ or Village
Sheboygan	*60*	*Sheboygan*

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
SB731 (1)	10	4/4 6/8	0	0'-4.5' FILL, SILTY GRAVEL WITH SAND, light yellowish brown (10YR 6/4), poorly graded, fine to coarse subround sand - predominantly medium, fine to medium subangular gravel - predominantly medium, compact, slightly moist, no odor.	FILL			1.0						
SB731 (3)	14	5/3 6/8	2					3.4						
3731 (5)	21	3/4 4/4	4	mixed with organics, trace cinders, red brick fragments, CLAY WITH SILT, and SILTY SAND, compact, moist, no odor.	PEAT CL			21						
SB731 (7)	0	2/4 6/5	6	4.5'-5' PEAT	CL			ns						
SB731 (9)	18	5/5 6/9	8	grading to CLAY, greenish gray (5GY 5/1), trace organics, trace silt and very fine sand, high plasticity, soft, wet, no odor.				5.6						
SB731 (11)	15	4/6 7/4	10	grading to SANDY CLAY WITH ORGANICS	SM			4.3						
SB731 (13)	19	3/4 4/4	12	8'-14' SILTY SAND WITH CLAY, olive gray (5Y 5/2), poorly graded, very fine to medium sand, predominantly fine, fine laminations throughout with varying amounts of silt and clay, soft, wet, no odor.				3.1						
SB731 (15)	17	4/7 16/20	14	trace to no clay	CL			6.8						
SB731 (17)	22	8/10 15/17	16	14'-18' CLAY WITH SILT, dark reddish gray (5YR 4/2), trace to 5% fine subangular to subround gravel, medium plasticity, very hard, slightly moist, no odor.				4.7						
			18	few very fine to fine laminations of silt and fine to medium sand.										
			20	*End Of Boring @ 18'*										
			22											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
Helen M Hyde	**Natural Resource Technology**

State of Wisconsin
Department of Natural Resources

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Superfund ☐ Other:

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 5-92

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
WPSC-Sheboygan I /1060/ Site Investigation		MW-703

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
Boart Longyear Scott/Kurt	07/18/95	07/18/95	HSA 4 1/4" (ID)

DNR Facility Well No.	WI Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		MW-703	583.17 Feet MSL	589.18 Feet MSL	8.25 inches

Boring Location State Plane	Feet N Feet E	Lat Long	Local Grid Location (If applicable)
NW1/4, SW1/4, 23, T15N, R23E			4864.4 feet ☒ N ☐ S 5245.7 feet ☒ E ☐ W

County	DNR County Code	Civil Town/City/ or Village
Sheboygan	60	Sheboygan

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			2	GRAVEL, base for drive w/ bricks/ silt/ CINDERS. (FILL) BRICKS w/ silt, dry, compact, no odor (FILL)	GP FILL									
MW703 (3)	18	12	4					69.4						
MW703 (5)	8	8	6	4'-6' SANDY CLAY W/ GRAVEL, grysh brn (2.5Y 5/2), 5% CINDERS, sand, firm, mst, sl. odor (FILL)	CL (FILL)			185						
MW703 (7)	12	2	8	6'-8' CLAYEY SAND W/ GRAVEL, grysh brn (2.5Y 5/2) w/ blck mtting, TRC CINDERS, pred f-med, subrnd, soft, v. mst, sl. odor (FILL)	SC (FILL)			118						
MW703 (9)	14	2	10	8'-10' interbedded CLAY & SANDY CLAY, drk gry (2.5Y 4/1), few blk lamin, med plast, soft, wet, sl. odor (FILL)	CL (FILL)			125						
MW703 (11)	17	2	12	10'-14' CLAY, grading drk grnsh gry (10Y 4/1) abund brwn orgnc to grysh gry (10Y 5/1), abund gast. shells, v. mst, firm, sl. odor	CL									
MW703 (13)	15	2	14	no shells, some sand, soft, wet, grdng to below										
MW703 (15)	13	6	16	14'-18' SAND, blk (N 2.5), prly grd, med-crs, compact, SHEEN, wet, odor	SP									
MW703 (17)	21	13	18	18'-20' SANDY CLAY, drk grysh brn, med plast, soft, wet	CL									
MW703 (19)	14	7	20	firm, moist										
			22	EOB @ 20'										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Edward J. Ogle Firm: Natural Resource Technology

This form is authorized by Chapters 144.147 and 182, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 182.08, Wis. Stats.

State of Wisconsin
Department of Natural Resources

Route to: Solid Waste ☐ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 4-90

Facility/Project Name: WPSC - Shelboygan II	Local Grid Location of Well: 4864.4 ft. ☒ N. ☐ S. 5245.7 ft. ☒ E. ☐ W.	Well Name: MW-703
Facility License, Permit or Monitoring Number:	Grid Origin Location: Lat. ° ' " Long. ° ' " or St. Plane ft. N, ft. E.	Wis. Unique Well Number: DNR Well Number:
Type of Well: Water Table Observation Well ☒ 11; Piezometer ☐ 12	Section Location of Waste/Source: NW 1/4 of SW 1/4 of Sec. 23 T. 15 N. R. 23 ☒ E. ☐ W.	Date Well Installed: 07/18/95
Distance Well Is From Waste/Source Boundary: ft.	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☒ Sidegradient d ☒ Downgradient n ☐ Not Known	Well Installed By: (Person's Name and Firm) Scott Burke; Boart Longyear
Is Well A Point of Enforcement Std. Application? ☒ Yes ☐ No		

A. Protective pipe, top elevation 589.16 ft. MSL
B. Well casing, top elevation 588.80 ft. MSL
C. Land surface elevation 589.16 ft. MSL
D. Surface seal, bottom _____ ft. MSL or 1.0 ft.

12. USC classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☒ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis attached? ☒ Yes ☐ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☒ 41; _____ Other ☐

15. Drilling fluid used: Water ☐ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No

Describe _____

17. Source of water (attach analysis): NA

E. Bentonite seal, top _____ ft. MSL or _____ ft.
F. Fine sand, top _____ ft. MSL or _____ ft.
G. Filter pack, top _____ ft. MSL or 3.0 ft.
H. Screen joint, top _____ ft. MSL or 3.5 ft.
I. Well bottom _____ ft. MSL or 13.5 ft.
J. Filter pack, bottom _____ ft. MSL or 14.5 ft.
K. Borehole, bottom _____ ft. MSL or 20.0 ft.
L. Borehole, diameter 8.0 in.
M. O.D. well casing 2.37 in.
N. I.D. well casing 2.06 in.

1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
a. Inside diameter: 8.0 in.
b. Length: 1.0 ft.
c. Material: Steel ☒ 04; _____ Other ☐
d. Additional protection? ☐ Yes ☒ No
If yes, describe: _____
3. Surface seal: Bentonite ☐ 30; Concrete ☒ 01; _____ Other ☐
4. Material between well casing and protective pipe: Bentonite ☐ 30; Annular space seal ☐; #30 American Material Other ☒
5. Annular space seal: a. Granular Bentonite ☒ 33
b. _____ Lbs/gal mud weight . . Bentonite-sand slurry ☐ 35
c. _____ Lbs/gal mud weight . . . Bentonite slurry ☐ 31
d. _____ % Bentonite . . . Bentonite-cement grout ☐ 50
e. _____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01; Tremie pumped ☐ 02; Gravity ☒ 08
6. Bentonite seal: a. Bentonite granules ☒ 33
b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite pellets ☐ 32
c. _____ Other ☐
7. Fine sand material: Manufacturer, product name and mesh size
a. _____
b. Volume added _____ ft^3
8. Filter pack material: Manufacturer, product name and mesh size
a. #30 American Material
b. Volume added _____ ft^3
9. Well casing: Flush threaded PVC schedule 40 ☒ 23; Flush threaded PVC schedule 80 ☐ 24; _____ Other ☐
10. Screen material: PVC
a. Screen Type: Factory cut ☒ 11; Continuous slot ☐ 01; _____ Other ☐
b. Manufacturer Boart Longyear
c. Slot size: 0.010 in.
d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☐ 14; #30 American Material Other ☒

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: [signature] Firm: Boart Longyear, 101 Alderson Street Tel: (715) 359-7090 Fax: (715) 355-5715

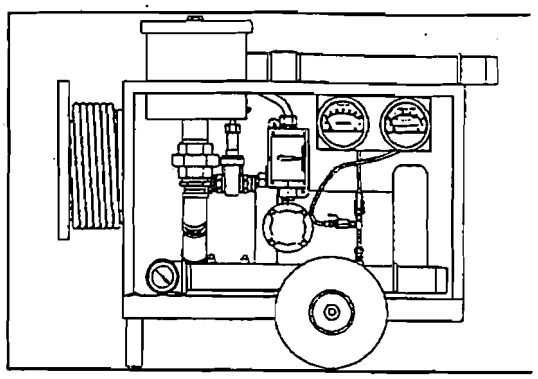
Please complete both sides of this form and return to the appropriate DNR office listed at the top of this form as required by chs. 144, 147 and 160, Wis. Stats., and ch. NR 141, Wis. Ad. Code. In accordance with ch. 144, Wis Stats., failure to file this form may result in a forfeiture of not less than $10, nor more than $5000 for each day of violation. In accordance with ch. 147, Wis. Stats., failure to file this form may result in a forfeiture of not more than $10,000 for each day of violation. NOTE: Shaded areas are for DNR use only. See instructions for more information including where the completed form should be sent.

APPENDIX C

SPECIFICATIONS FOR PILOT TEST EQUIPMENT

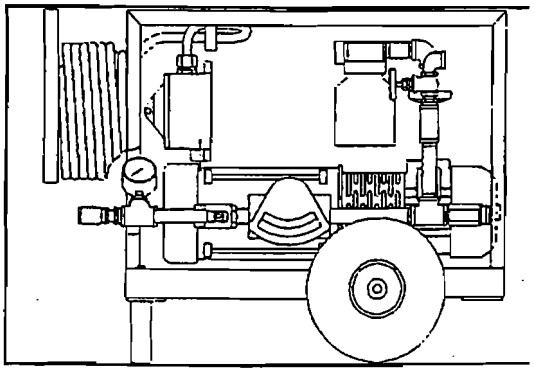
Pilot Test Systems
Vacuum Extraction
Air Sparging

Vacuum Extraction



- Regenerative Vacuum Extractor
  - Maximum Air Flow: 100 SCFM
  - Maximum Vacuum: 50" w.c.
- 1 HP 115 VAC 1Ø Explosion-proof Electric Motor
- Explosion-proof On/Off Switch With Thermal Protection
- 100' Heavy Duty Service Cord
- Inline Air Filter
- Vacuum Gauge
- Air Flow Meter
- Inlet Temperature Gauge
- Outlet Temperature Gauge
- Inlet Sample Port
- Outlet Sample Port
- Frame Mounted
- Inlet Connection 2" MIPT and/or 2" PVC Schedule 40 Slip Fitting
- Approximately 125 Pounds

Air Sparging



- Oil-less Rotary Vane Compressor
  - Maximum Airflow: 15 SCFM
  - Maximum Pressure: 15 psig
- 1 HP 115 VAC 1Ø Electric Motor
- Explosion-proof On/Off Switch With Thermal Protection
- 100' Heavy Duty Service Cord
- Inlet Air Filter
- Discharge Temperature Gauge
- Discharge Pressure Gauge
- Air Bleed Valve
- Pressure Relief Valve
- Direct Reading Flow Meter
- Regulating Valve
- Outlet Connection ¾" FNPT
- Approximately 90 Pounds

For Sale or Rental

Product Specifications

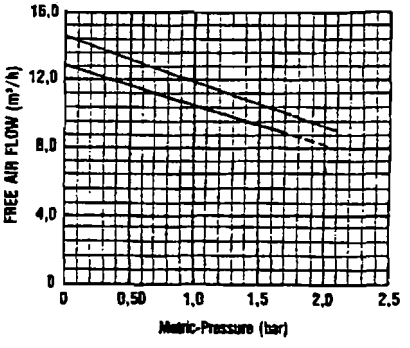
Model Number	Motor	RPM 60 cycle	RPM 50 cycle	HP	kW	Net Wt. lbs.	Net Wt. kg
1067-P2	Not included	1725	1425	1½	1,1	33	15,0
1067-P4 (metric)	Not included	1725	1425	1½	1,1	33	15,0
†1067-P6-G561X (like 1067-P2 plus motor)	110/220-240; 115/208-230; 50/60-1	1725	–	1	0,75	65	29,5
2067-P2	Not included	1725	1425	1½	1,1	46	20,9
2067-P4 (metric)	Not included	1725	1425	1½	1,1	46	20,9
†2067-P6-G561X (like 2067-P2 plus motor)	110/220-240; 115/208-230; 50/60-1	1725	–	1	0,75	88	39,9
2567-P2	Not included	1725	1425	2	1,5	48	21,8
2567-P4 (metric)	Not included	1725	1425	2	1,5	48	21,8
2567-P6-G475 (like 2567-P2 plus motor)	230/460-60-3	1725	–	2	1,5	83	37,7

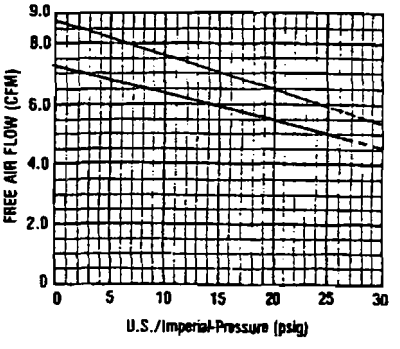
†Motor includes Thermotector.

Product Performance (Metric U.S. Imperial)

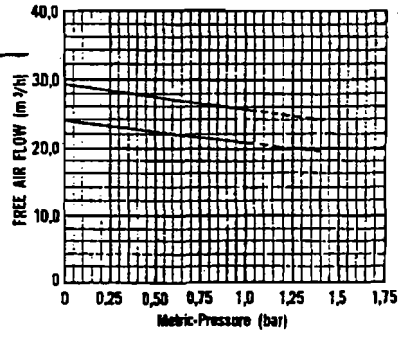
Black line on curve is for 60 cycle performance.
Blue line on curve is for 50 cycle performance.

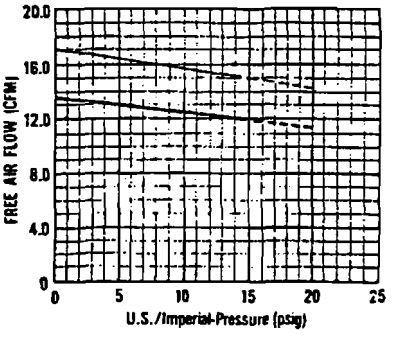
Model 1067





Model 2067





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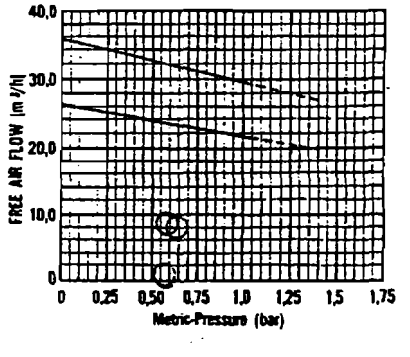

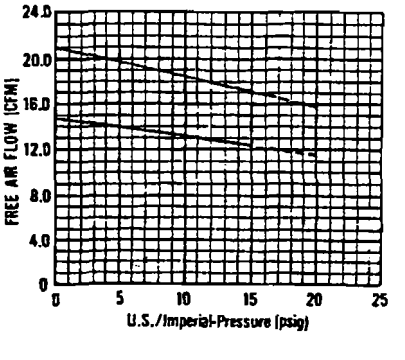

APPENDIX D

EXAMPLE PILOT TEST FIELD FORMS

	TIME								
SW-701	Pressure								
	Temp								
	Flowrate								
GP-701	DTW								
	Pressure								
GP-702	DTW								
	Pressure								
GP-703	DTW								
	Pressure								
TW-701	DTW								
	Pressure								
TW-702	DTW								
	Pressure								
MW-703	DTW								
	Pressure								

	TIME								
SW-701	Pressure								
	Temp								
	Flowrate								
GP-701	DTW								
	Pressure								
GP-702	DTW								
	Pressure								
GP-703	DTW								
	Pressure								
TW-701	DTW								
	Pressure								
TW-702	DTW								
	Pressure								
MW-703	DTW								
	Pressure								

Notes:

Sheboygan Campmarina Pilot Test 30 Minute Measurements PAGE _____

	TIME							
GP-701	oxygen							
	VOC							
	methane							
	PID							
	CO2							
GP-702	oxygen							
	VOC							
	methane							
	PID							
	CO2							
GP-703	oxygen							
	VOC							
	methane							
	PID							
	CO2							
TW-701	Tem							
	DO							
	SpC							
	pH							
	ORP							
	oxygen							
	VOC							
	methane							
	PID							
	CO2							
TW-702	Tem							
	DO							
	SpC							
	pH							
	ORP							
	oxygen							
	VOC							
	methane							
	PID							
	CO2							
MW-703	oxygen							
	VOC							
	methane							
	PID							
	CO2							
	Tem							
	DO							
	SpC							
	pH							
	ORP							

DESIGN DRAWINGS