463IHS153

DocumentID	NONCD0001101
Site Name	STRONGHAVEN WAREHOUSE
DocumentType	Remedial Action Plan (RAP)
RptSegment	1
DocDate	7/1/2008
DocRcvd	8/4/2008
Box	SF153
AccessLevel	PUBLIC
Division	WASTE MANAGEMENT
Section	SUPERFUND
Program	IHS (IHS)
DocCat	FACILITY

REMEDIAL ACTION PLAN
STRONGHAVEN WAREHOUSE SITE NONCD 000 1101
433 EAST JOHN STREET
MATTHEWS, NORTH CAROLINA 28105
ADMINISTRATIVE AGREEMENT
DOCKET NUMBER 03-SF-222

Prepared for

Stronghaven, Inc.
7750 The Bluffs, Suite 2
Austell, Georgia 30168

and

North Carolina Department of Environment and Natural Resources
Division of Waste Management, Superfund Section
Inactive Hazardous Site Branch

Prepared by

Strata Environmental
110 Perimeter Park, Suite E
Knoxville, Tennessee 37922
(865) 539-2077

July 2008

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North Carolina Departement of Environment and Natural Resources
Division of Waste Management
Superfund Section
Inactive Hazardous Sites Branch

PROPOSED REMEDIAL ACTION PLAN COMPLETION CERTIFICATION 15A NCAC 13C.0306(b)(5)(C)

Media (check all that apply): All Media___ Soil ___ Ground water X Surface water___ Sediment___

Site Name Stronghaven Warehouse   Street Address 433 East John Street

County Mecklenburg   Matthews, NC 28105

Site ID No. NONCD 0001101

The proposed remedial action plan, which is the subject of this certification has, to the best of my knowledge, been completed in compliance with the Inactive Hazardous Sites Response Act G.S. 130A-310, et seq. and the remedial action program Rules 15A NCAC 13C .0300, and

Strata Environmental Services, Inc.
[REC Name]

is in compliance with Rules .0305(b)(2) and .0305(b)(3), of this section. I am aware that there are significant penalties for willfully submitting false, inaccurate or incomplete information.

[signature]
RSM Signature

10/17/2008
Date

Timothy L. Riddle
RSM Name

Strata Environmental Services, Inc.
REC Name

110 Perimeter Park, Suite E
Mailing Address

00114
REC No.

Knoxville, TN 37922
City, State, ZIP

Tennessee (Enter State)
Knox **COUNTY**

I, Kelli M. Travis, a Notary Public of said County and State, do hereby certify that Timothy L. Riddle did personally appear and sign before me this day, produced proper identification in the form of TN. Drivers License, was duly sworn or affirmed, and declared that, he or she is the duly authorized environmental consultant of the remediating party of the property referenced above and that, to the best of his or her knowledge and belief, after thorough investigation, the information contained in the above certification is true and accurate, and he or she then signed this Certification in my presence.

WITNESS my hand and official seal this 17 day of October, 2008.

Kelli M. Travis
Notary Public (signature)
My commission expires: 5-9-12.

KELLI M. TRAVIS
OFFICIAL SEAL
STATE OF TENNESSEE NOTARY PUBLIC
KNOX COUNTY

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APPENDICES

1.0 INTRODUCTION

Strata Environmental (Strata) prepared this Remedial Action Plan (RAP), on behalf of Stronghaven Inc. (Stronghaven), to address impacted groundwater in the vicinity of the Stronghaven Warehouse Site (the site) located in Matthews, North Carolina. A RAP to address soil contamination is not required because site soils already meet established Inactive Hazardous Site Branch Soil Remediation Goals (SRGs). This RAP was prepared following the requirements outlined in the August 2007 Implementation Guidance of the North Carolina Department of Environment and Natural Resources (NCDENR) Division of Waste Management, Superfund Section, Inactive Hazardous Sites Branch, Registered Environmental Consultant (REC) Program. The objective of this RAP is to identify, evaluate, and compare various alternatives in order to select the appropriate method to remediate impacted groundwater in the vicinity of the site.

On December 30, 2003, Stronghaven entered into an Administrative Agreement for Registered Environmental Consultant-Directed Assessment and Remedial Action with the NCDENR Division of Waste Management Superfund Section (Docket Number 03-SF-222). The Agreement provides for implementation by Stronghaven of a voluntary remedial action program for the site pursuant to N.C.G.S. 130A-310.9(c) and 15A NCAC 13C.0300. The Administrative Agreement designates Strata as the REC tasked with overseeing the voluntary remedial action for the site. Strata conducted a Remedial Investigation (RI) to characterize soil and groundwater in the vicinity of the site and to delineate the horizontal and vertical extent of contamination at the site. The RI findings set the basis for the RAP.

1.1 Site Description

1.1.1 Location

The Stronghaven Warehouse Site is situated on a 2.45 acre lot located at 433 East John Street, Matthews, Mecklenburg County, North Carolina. The East John Street property was formerly a manufacturing facility and currently serves as an active warehouse. The geographic map coordinates for the facility are 35° 6' 48" north latitude and 80° 43' 5" west longitude. The warehouse facility is located within a primarily residential area. The warehouse property is bordered to the northeast by Charles Street and then a CSX railroad line and residential property; to the southeast by a church; to the southwest by East John Street and single family residences; and to the northwest by an undeveloped tract and then residential property. The facility is owned by Stronghaven, Inc.

1.1.2 Site History

The facility was constructed on undeveloped land in the mid-1960s and was initially owned and operated by Associated Engineering. Associated Engineering reportedly manufactured components for electrical transformers and leased a portion of the facility to Radiator Specialty Company for warehousing. Associated Engineering operated on the property until the early 1990s.

Since its purchase in 1995 by Stronghaven, the facility has been used exclusively for warehousing cardboard products and kraft paper. The building is locked when personnel are not on-site and a security fence surrounds the grounds on the north and west of the building.

1.1.3 Topography

The site is relatively flat with the northern portion of the warehouse property at a slightly higher elevation than the southern portion. There is a gentle slope of the surrounding properties to the southeast. Elevations range from approximately 710 to 720 feet mean sea level (msl). The site and regional topography are depicted on a portion of the Matthews Quadrangle 1971/1988 United States Geological

Survey topographic map included as Figure 1 (Appendix A). Approximately half of the site is developed with structures and paved areas.

1.1.4 Geology

According to the 1977 U.S.D.A. Mecklenburg County Soil Survey, the soil underlying the site belongs to the Cecil Group. The Cecil Group comprises of gently sloping to strongly sloping, well-drained sandy clay loam soils that have predominantly clayey subsoil and is formed in residuum from acid igneous and metamorphic rock formation. The permeability of the sub-soil and shallow Cecil Group soils typically ranges from 0.6 - 2.0 inches per hour with a low to moderate shrink/swell potential. The liquid limits (LL) for this soil group range from 21 to 35 percent in the shallow soil and 41 to 80 percent in the sub-soil greater than six inches in depth. The typical plasticity indices (PI) for soils in this group range from 3 to 15 in the shallow soil and 9 to 37 in the sub-soil.

The site is situated near the eastern edge of the Charlotte Metamorphic Belt of the Central Piedmont Physiographic Province of North Carolina and is characterized by superimposed higher grade metamorphism. The bedrock underlying the site is characterized as either a metagranitoid or metagabbro. The site is located near the western edge of the Gold Hill Fault Zone. Based on observations made during the site investigation, bedrock in the vicinity of the site tends to weather to a thick mantle of saprolite, typically seventy-five feet or greater in thickness.

Strata observed soil in samples from soil borings to consist of primarily red and orange saprolite in the upper zone (0-30 feet) and occasionally greenish red saprolite 30-40 feet below ground surface (bgs). The saprolite was generally mottled clay from ground surface to a depth of approximately 35-40 feet bgs then retaining more parent structure further down until bedrock was encountered. The saprolite typically terminated in a zone of partially weathered bedrock or directly on bedrock. The bedrock consisted of fractured felsic and mafic rock at varying depths.

1.1.5 Hydrogeology

1.1.5.1 Regional Hydrogeology

The Piedmont is characterized by rolling foothills caused by the erosion of underlying crystalline rock. Groundwater occurrence in the upper unconsolidated saprolite (shallow aquifer) is a function of the pore space in the saprolite, which controls the flow of groundwater and transport of contaminants. Groundwater flow in the underlying bedrock (deeper aquifer) is generally a function of fractures in the bedrock.

As depth increases, the saprolite contains increasing amounts of parent material from the underlying metamorphic rocks, reducing hydraulic conductivity and, therefore, groundwater flow in the lower portion of the shallow aquifer. The deep aquifer generally consists of a transition zone from saprolite to bedrock and the underlying bedrock. The transition zone between the saprolite and bedrock is characterized by fractured weathered rock is characterized by higher horizontal groundwater flow compared to the flow in the limited pore space in the saprolite above. Increased flow velocities are also observed in the upper portion of the bedrock, which has a greater occurrence of fracture. The amount of fractures decreases with increasing depth of the bedrock, limiting the potential for groundwater storage and movement at depth.

1.1.5.2 Site Hydrogeology

The shallow (saprolite) and deep (bedrock) aquifers are the primary zones of concern for groundwater at the site. During the RI, monitoring wells were constructed in the shallow and deep aquifers. Figure 2 (Appendix A) shows the locations of the shallow aquifer monitoring wells, and Figure 3 (Appendix A) shows the locations of the deep aquifer monitoring wells. The system of groundwater monitoring wells includes: eleven monitoring wells on the Stronghaven warehouse property (designated with SH proceeding the well number); seven monitoring wells installed on the Matthews Church of God property (designated with CG preceding the well number); three monitoring wells constructed in the state right-of-way on East John Street (designated with RW preceding the well number); one monitoring well installed on the Francis Allen property (designated with FA preceding the well number); three monitoring wells installed at different addresses in the city of Matthews right-of-way along Sadie Drive (designated with BP, BC, and BB preceding the well numbers); one monitoring well installed on the Matthews First Baptist Church property (designated with FB preceding the well number); and one monitoring well at the former Matthews Public Works/Sewage Treatment Facility (designated with PW preceding the well number).

Based on drilling observations, the shallow aquifer varies in thickness from approximately 60 feet near BB-MW-1R to approximately 120 feet near SH-MW-11R. The groundwater in the shallow aquifer flows in a south, southwest direction with an average gradient of 0.001 ft/ft. According to potentiometric contours, the groundwater appears to flow toward Four Mile Creek, which is situated approximately 4,200 feet southwest of the Stronghaven facility. The direction of groundwater movement in the deep aquifer is toward the southwest with an average approximate gradient of 0.02 ft/ft.

The hydraulic conductivity of the shallow and deep aquifers were evaluated using the Bouwer and Rich slug test method. The slug tests were performed using a ten-foot solid PVC slug to displace water within the well. The change in water levels was recorded until the well returned to equilibrium. Slug test data was obtained using a pressure transducer and data logger method. Based on a falling-head slug test conducted at SH-MW-6 on November 16, 2004, the hydraulic conductivity of the shallow aquifer is calculated to be 0.045 feet/day. Based on a rising-head slug test performed at CG-MW-3Rock, hydraulic conductivity of the bedrock is estimated at 0.13 feet/day.

1.2 Summary of Site Investigation Activities

Multiple investigations have occurred on-site from the early 1990s until the completion of the RI in 2004. The following sections are a summary of the historical investigations.

1.2.1 Previous Investigations

Five documents assessing conditions at the warehouse property were reviewed to evaluate historical activities on the property and in the development of the work plan for the RI.

- Report of Site Reconnaissance and Soil Sampling and Analysis, Associated Engineering Facility, 433 East John Street, Matthews, North Carolina, prepared by Law Engineering, Inc. (Law), Law Job No. 229-07927-01, prepared for Associated Engineering, Inc., Matthews, North Carolina, October 16, 1992 (Remedial Investigation).

- Phase I Environmental Site Assessment, Associated Engineering Facility, 433 East John Street, Matthews, North Carolina, prepared by Cooper Environmental, Inc. (Cooper), 2300 Sardis Road, Charlotte, North Carolina, prepared for John S. Johnson, Esq., 250 North Trade Street, Suite 203, Matthews, North Carolina 28105, June 20, 1995 (Remedial Investigation).

- Additional Phase II Assessment, Associated Engineering Facility, 433 East John Street, Matthews, North Carolina, prepared by Cooper Environmental, Inc., 2300 Sardis Road, Charlotte, North Carolina, prepared for John S. Johnson, Esq., 250

North Trade Street, Suite 203, Matthews, North Carolina 28105, November 2, 1995 (Remedial Investigation).

- Phase I Environmental Site Assessment, Stronghaven, Inc., 760 and 763 West John Street, and 433 East John Street, Matthews, North Carolina, prepared by Strata Environmental, 110 Perimeter Park, Suite E, Knoxville, Tennessee 37922, prepared for Kirkland & Ellis, 655 Fifteenth Street NW, Washington, DC 20005, August 1996 (Remedial Investigation).

- Phase II Assessment, Stronghaven Warehouse, 433 East John Street, Matthews, North Carolina, prepared by Strata Environmental, 110 Perimeter Park, Suite E, Knoxville, Tennessee 37748 prepared for Henry Key, Stronghaven, 55 Enterprise Boulevard, Atlanta, Georgia 30336, May 4, 1999 (Remedial Investigation).

The 1992 Law report of Site Reconnaissance and Soil Sampling was prepared for a previous site owner, Associated Engineering, in connection with a property transaction. The site reconnaissance portion of the report identified drums of solvents stored in the chemical/hazardous waste storage area located on a covered concrete pad on the west side of the facility. Solvents in drums that were reportedly observed by Law included toluene, methylene chloride, 1,1,1-trichloroethane, and mineral spirits. Law described the soil sampling assessments as the collection of two shallow soil samples on the west side of the facility near the chemical storage area. Toluene was detected in one of the soil samples at a concentration of 210 ug/kg. According to the report, no other volatile organic compounds (VOCs) were detected.

Cooper prepared a Phase II Assessment Report in 1995 on behalf of Stronghaven, which included twelve soil borings to depths ranging from seven to thirty feet below ground surface. Soil samples were collected at five foot intervals from each soil boring. Samples from seven of the soil borings were submitted for laboratory analysis for oil and grease, purgeable organics, or both. Groundwater samples were collected from temporary wells in two areas: (1) the vicinity of two former machine pits in the building and (2) chemical/hazardous waste storage area. Cooper reported numerous VOCs detected in the groundwater samples. VOCs 1,1-dichloroethene (1,1-DCE), tetrachloroethene (PCE), and chloroform were detected at concentrations exceeding the North Carolina 2L standards. VOCs PCE (as high as 930 ug/kg) and dichloromethane were detected in the soil samples from two of the soil borings. Cooper indicated that the highest concentrations of contaminants were detected in the vicinity of the former machine pits at a location that was previously outside the back door of the building. At the time of the 1995 investigation, this area had been covered by the plant building as a result of an expansion of the facility.

Strata conducted a Phase II Environmental Assessment of the warehouse property in 1999 at the request of Stronghaven. The assessment included twelve soil borings across the facility using direct push drilling technology. A total of fourteen soil samples and six groundwater samples were collected for laboratory analysis of VOCs, semi-volatile organic compounds (SVOCs), RCRA metals, and PCBs. Laboratory analysis of the soil samples detected low concentrations of one VOC (PCE), one SVOC (bis2-ethylhexylphthalate), and PCB 1254 in one soil sample that was located near the former back door to the original facility. The concentrations of the constituents in this sample were below applicable standards. Several metals including chromium, copper, lead, nickel, zinc, selenium, and arsenic were detected at concentrations below regulatory standards. Five of the six groundwater samples had levels of target constituents exceeding the North Carolina 2L standards including chloroform at concentrations ranging from 10.4 ug/l to 2.58 ug/l, 1,1-DCE from 24 ug/l to 34.2 ug/l, and PCE from 3.2 ug/l to 17.5 ug/l. Metals were detected at concentrations exceeding the state's standards in four of the groundwater samples. These metals included chromium, lead and nickel.

1.2.2 Remedial Investigation

Based on previous investigations, Strata identified three potential on-site sources for constituents of concern (COCs) in soil and groundwater at the site. These potential sources or areas of concern (AOCs) are (1) the former on-site chemical/hazardous waste storage area operated by the previous owner, (2) releases at former back door/machine pits area of the original facility during operations by the previous owner, and (3) a sanitary sewer line that cross the subject property. Strata observed the former chemical/hazardous waste storage area on the northwest side of the facility (see Figure 2, Appendix A) as an approximately 450 s.f. one-foot thick concrete pad covered and fenced. The former back door of the original facility is located approximately twenty feet northeast of the former machine pits. A later addition to the facility is currently situated where the backdoor formerly exited the building, and concrete flooring now covers the former ground surface. The sanitary sewer line that enters the northwest edge (upgradient) of the warehouse property was investigated to determine if COCs may have been discharged into and leaked from the sewer line. Although the sanitary sewer line is situated on the Stronghaven warehouse property, the warehouse is not connected to this section of the sanitary sewer.

Based on previous investigations, the RI identified COCs as VOCs, PCBs, and priority pollutant metals. Only one SVOC (bis-2-ethylhexyl phthalate, a common laboratory artifact) was detected in one of twelve samples during previous investigations. Therefore, SVOCs were not considered COCs in the RI.

Strata installed groundwater monitoring wells for the RI in six separate phases. Each well installation phase further delineated impacted groundwater. The locations of shallow groundwater monitoring wells are shown on Figure 2 in Appendix A, and the deep groundwater monitoring wells are shown on Figure 3 in Appendix A. A North Carolina Licensed Surveyor (NCLS) determined the locations and elevations of the groundwater monitoring wells.

Three monitoring wells were present at the warehouse site prior to the signing of the Administrative Agreement. These wells include Monitoring Wells SH-MW-1, SH-MW-2, and SH-MW-3. These monitoring wells were installed by MACTEC in 2000 as part of a proposed property transaction. Construction logs (labeled MW-1, MW-2, and MW-3) for these wells were provided in the RI report.

The first phase of the groundwater RI was conducted in August 2004 with the installation of five shallow monitoring wells at the Stronghaven warehouse facility. The monitoring wells installed during this phase of the RI included SH-MW-4, SH-MW-5, SH-MW-6, SH-MW-7, and SH-MW-8. Strata sampled monitoring wells SH-MW-1 through SH-MW-8 in August 2004 and November 2004.

Phase II of the RI was conducted in October 2005 with the installation of two monitoring wells (CG-MW-1 and CG-MW-2) on the neighboring Matthews Church of God property. The Church of God property is situated immediately southeast of the Stronghaven warehouse property.

The third phase of the RI was conducted in January 2006. Strata installed four additional off-site shallow groundwater monitoring wells (CG-MW-3D, CG-MW-4, CG-MW-5, and CG-MW-6) on the neighboring Matthews Church of God property, three shallow off-site monitoring wells (RW-MW-1, RW-MW-2, and RW-MW-3) in the state right-of-way southwest of East John Street, and an additional on-site shallow groundwater monitoring well (SH-MW-9) at the Stronghaven warehouse facility. Strata drilled a shallow well, CG-MW-3D, to the top of bedrock constructed with the well screen situated at the bottom of the shallow aquifer to characterize COC impacts at the base of the shallow aquifer and to identify the depth to competent bedrock at the site. Strata installed SH-MW-9 to characterize the groundwater in the immediate vicinity of the sewer line on the northwest side of the Stronghaven warehouse.

Strata constructed one shallow off-site groundwater monitoring well (FA-MW-1), one deep aquifer (bedrock) well (CG-MW-3 Rock), and an additional on-site shallow well (SH-MW-10) in May 2006 as part of the fourth phase. SH-MW-10 was installed to provide more definition of the limits of the contaminant plume at the site.

In August 2006, during the fifth phase of the RI, Strata installed two off-site bedrock groundwater monitoring wells (BP-MW-1R and BB-MW-1R) and one off-site shallow groundwater monitoring well (BC-MW-1S), all located in the City of Matthews right-of-way of Sadie Drive. Sadie Drive is located one block southwest of and parallel to East John Street. In addition, an upgradient bedrock groundwater monitoring well (SH-MW-11R) was installed on the northeast side of the Stronghaven warehouse property.

In November 2006, during the sixth and final phase of the RI, Strata constructed two off-site bedrock monitoring wells (FB-MW-1R and PW-MW-1R). FB-MW-1R is located on property owned by First Baptist Church Matthews on Sadie Drive, and PW-MW-1R is situated at the former Matthews Public Works/Sewage Treatment facility located at 311 South Trade Street.

1.3 Nature and Extent of Contamination

Laboratory analyses of soil, groundwater, and sewer samples collected during the RI was conducted by Pace Analytical, 9800 Kincey Avenue, Huntersville, North Carolina. Strata followed the sampling QA/QC procedures in general accordance with the U. S. Environmental Protection Agency Region IV Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Strata's QA/QC included the collection of one duplicate sample, per media, per container type, per field day, and the collection of blank samples. Laboratory analytical data for the samples collected during the RI are provided in the RI Report.

1.3.1 Soil

Based on the analytical results from the RI, COCs are not currently present in the soils at the site at concentrations exceeding the established SRGs or PGWSRGs. Information developed during the RI indicates concentrations of PCE in the soils underlying the former back door area of the Stronghaven facility have decreased significantly since originally discovered in the mid 1990s. Therefore, no soil remedial activities are planned in the source area.

1.3.2 Groundwater

1.3.2.1 Shallow Aquifer

The results from the RI indicate that groundwater has been impacted beneath the Stronghaven warehouse property and off the property. Impacted groundwater extends in the shallow aquifer approximately 300 feet in a south, southwest direction. The only COCs detected above the 2L standard in groundwater are PCE and 1,1-DCE. Potential sources for the groundwater impact include (1) historical activities by the previous owner on the subject property, and (2) potential leaks from the city sanitary sewer system crossing the Stronghaven warehouse and the Matthews Church of God properties.

Tetrachloroethene (PCE)
As documented in the RI report, concentrations of PCE exceeded the NACA 15A 2L standard of 0.7 ug/l (see Tables 1 and 2 Appendix A) in ten of the twenty-one shallow groundwater monitoring wells (Figure 4 Appendix A) at the site. Detected concentrations of PCE in the shallow groundwater monitoring wells ranged from 3.1 ug/l at SH-MW-2 to 190 ug/l at FA-MW-1.

1,1-Dicholoroethene (1,1-DCE)
As documented in the RI report, concentrations of 1,1-DCE exceeded the NACA 15A 2L standard of 7 ug/l (see Tables 1 and 2 Appendix A) in the groundwater from one well (SH-MW-5). Detected concentrations of 1,1-DCE ranged from 1.1 ug/l at FA-MW-1 to 28 ug/l at SH-MW-5 (Figure 5 in Appendix A). 1,1-DCE is a common product of the natural degradation of PCE.

1.3.2.2 Bedrock Aquifer

Because the bedrock fractures have a higher hydraulic conductivity, the area of impact in the deep aquifer extends approximately 850 feet off the warehouse property toward the southwest. The only COC detected above the 2L standard in deep groundwater is PCE. Potential sources for the deep groundwater impact include (1) historical activities on the subject property, and (2) potential leaks from the city sanitary sewer system crossing the Stronghaven warehouse and the Matthews Church of God properties.

Tetrachloroethene (PCE)
As documented in the RI report, concentrations of PCE exceeded the NACA 15A 2L standard of 0.7 ug/l (see Table 3 in Appendix A) in two of the six deep groundwater monitoring wells (Figure 6 Appendix A) at the site. Detected concentrations of PCE in the two deep groundwater monitoring wells ranged from 13 ug/l at CG-MW-3R to 64 ug/l at BB-MW-1R.

2.0 REMEDIAL ACTION OBJECTIVES AND EVALUATION OF REMEDIES

This section describes the remedial action objectives (RAOs), regulatory requirements, and available and plausible methods of remedial technologies. Technologies commonly used on similar sites for remedial action were considered for the remedial action. Screened technologies were combined into alternatives and evaluated using criteria set forth in Section 5.0 of the August 2007 Inactive Hazardous Sites Program Guidelines for Assessment and Cleanup.

2.1 Remedial Action Objectives

The RAOs specify site remediation goals and identify COCs, media of concern, and exposure pathways to be addressed by remedial actions. The RAOs are used to screen, evaluate, and compare remedial alternatives and technologies. The media of concern is the groundwater which contains elevated levels of chlorinated solvents (PCE and 1,1-DCE). As with any remediation project the primary RAO for the site is to protect human health and the environment. Specific candidate RAOs considered for the site are based on the impacted media and are as follows:

- Minimize further degradation of groundwater;
- Reduce further migration from the Stronghaven warehouse property;
- Prevent groundwater impacts to potential receptors;
- Achieve clean-up requirements (groundwater remediation goals) for impacted groundwater beneath the Stronghaven warehouse site;
- Achieve the requirements of the Inactive Hazardous Sites Voluntary Cleanup Program as outlined in the Guidelines.

The groundwater remediation goals (GRGs) for remediation of the impacted groundwater in the vicinity of the Stronghaven warehouse are equal to the lower of the following levels: the permanent and interim groundwater standards established under NCAN 15A 2L; the Federal Environmental Protection Agency (EPA) Drinking Water maximum contaminant level (MCL); and the EPA Drinking Water non-zero maximum contaminant level goal (MCLG). Where a standard or established level does not exist for the above, the most current Preliminary Remedial Goal (PRG) for Tap Water established by EPA Region IX (multiplied by a factor of 0.1 for non carcinogens) was used as a goal. The only COCs related to past activities at the site as identified in groundwater at concentrations above the GRGs are PCE and 1,1-DCE. The GRGs for PCE and 1,1-DCE are 0.7 ug/l and 7 ug/l, respectively.

2.2 Compliance with Regulatory Requirements

This section describes federal, state, and local laws and regulations (if applicable) which are relevant to remedial activities at the site. These laws and regulations are to be followed during all remediation activities to meet clean up requirements. Regulatory remediation requirements for groundwater are driven by North Carolina Groundwater Standards GRGs and Federal Drinking Water Standard MCLs. The remediation goals are shown in Tables 1, 2 and 3 (Appendix A) along with the maximum observed concentrations of constituents in groundwater at the site.

2.3 Technology Screening

Remediation of groundwater in the vicinity of the site will be required to achieve the RAOs. Several remedial methods or technologies exist to decrease the amount of chlorinated solvents in groundwater, but due to the size of the contaminant plume, drilling limitations in the surrounding neighborhood and potential interference with the operation of the warehouse facility, viable remedial options for the Stronghaven Warehouse site are limited. Screening was based on the ability of a given technology and/or process to achieve RAOs. Additionally, the technology's ability to meet applicable regulatory requirements, remedial effectiveness, implementation, community and facility disruption, and cost associated with the remediation were considered in the screening process.

Groundwater remediation technologies under consideration in the following sections were categorized in terms of the following general response actions:

- Monitored Natural Attenuation
- Extraction Technologies
- In-Situ Treatment Technologies

For technology screening purposes, one or more technology options were retained from each category for evaluation of the remedial effectiveness.

2.3.1 Monitored Natural Attenuation

Natural attenuation is a passive remedial option that relies on the natural processes of dispersion, dilution and bio-degradation to reduce COCs in groundwater. This option is employed at many sites because it is cost effective, innovative, and predictable. The current COCs at the site are favorable for natural attenuation due to the low concentrations of COCs that have been detected and limited access to the groundwater in the densely developed surrounding properties. Therefore, this option was retained as a potential groundwater remediation technology.

2.3.2 In-Situ Treatment Technologies

In-situ treatment process options for groundwater were considered in the screening process. Reactive walls/zones and air sparging curtains were two treatment technologies considered as potentially applicable options and were retained. Some of the in-situ processes, such as anaerobic bioremediation (reductive dechlorination) using hydrogen release compounds (HRCs) have proven effective at similar sites. In-situ chemical oxidation is becoming a popular remediation tool for dealing with groundwater impacted with chlorinated solvents. Therefore, this option was retained as a potential groundwater remediation technology.

2.3.3 Extraction Technologies

Groundwater extraction using conventional recovery wells and vacuum enhanced recovery was retained as alternative remedial options. These technologies are commonly used for the containment and remediation of contaminated groundwater. However, the practicality of effectively capturing a significant volume of impacted groundwater without considerable interruption to the surrounding residences and properties is questionable. Based on the COCs in groundwater, physical/chemical treatment process options such as precipitation/flocculation, filtration, and air stripping were considered as methods of treatment for the extracted groundwater. Air stripping is the most preferable of the extraction technologies for treatment of VOCs and was retained for further evaluation. An activated carbon system may also be necessary as a polishing step.

2.4 Development and Evaluation of Remedial Alternatives

The previous section of this RAP identified general response actions and the related remedial technologies and process options for the site. Remedial technologies and process options were screened to narrow the list and develop alternatives for remedial action at the site. These alternatives, which are presented in this section, will be evaluated using a set of criteria listed in the REC Program Guidelines. These criteria are listed below:

- Overall protection of human health and the environment, including attainment of remediation goals;
- Compliance with applicable federal, state and local regulations;
- Long-term effectiveness and performance;
- Reduction in toxicity, mobility, and volume;
- Short-term effectiveness: effectiveness at minimizing the impact of the site remediation activities on the environment and the local community;
- Implementability: technical and logistical feasibility;
- Cost; and
- Community acceptance.

2.4.1 Evaluation of Remediation Alternatives

The groundwater remediation alternatives (GWA) selected for shallow (unconsolidated aquifer) groundwater and deep (bedrock) groundwater for the dissolved COCs at the Stronghaven Warehouse are as follows:

- GWA-1: Monitored Natural Attenuation
- GWA-2: Enhanced Natural Attenuation Using In-situ Chemical Treatment (reductive dechlorination)
- GWA-3: Conventional Recovery of Groundwater, Treatment and Disposal

The following sections provide a brief description of each of the alternatives.

2.4.1.1 GWA-1 Monitored Natural Attenuation

The natural attenuation alternative is a passive remediation strategy. In natural attenuation, active remediation of contaminated groundwater is not undertaken. Groundwater samples from representative monitoring wells are collected and analyzed on a routine basis to evaluate the effectiveness of the natural degradation of the contaminants and to monitor the downgradient migration of the contaminant plume. The degradation and remediation of the COCs in the groundwater are driven by natural processes of biodegradation, dispersion, and dilution.

Based on the limited groundwater sample analysis from wells installed during the RI (Tables 1, 2, and 3 Appendix A), natural attenuation is currently occurring with respect to the contaminant plumes in both the deep and shallow aquifer. For example, laboratory analysis of groundwater samples collected from SH-MW-7 situated in the center of the contaminant plume on the Stronghaven property has shown a significant decrease in the concentration of PCE since the well was first sampled in July 2004. The initial groundwater sample collected from SH-MW-7 had a PCE concentration of 81 ug/l, while the most resent sample collected from the well (April 2007) had a PCE concentration of 4.2 ug/l. Likewise, the analysis of groundwater samples from CG-MW-3D located on the Church of God Property has demonstrated significant natural attenuation of PCE. The initial groundwater samples collected form this well had a PCE concentration of 110 ug/l in January 2006, while the most recent sample (April 2007) had a concentration PCE of 48 ug/l.

Modeling of natural attenuation of the contaminant plume based on the limited available analytical data has been performed by Strata using EPA issue paper *Calculations and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies* as guidance. Modeling the data from various wells using concentration vs. time rate constants to estimate the length of time required to achieve the RAOs, indicates that RAOs can be achieved over a period of time ranging from approximately 4 to 22 years. However, due to the limited data set available for modeling, the variability of natural attention models, and based on experience with similar sites, it is estimated that remediation of the plume through natural attenuation may require 30 years.

2.4.1.2 GWA-2 Enhanced Natural Attenuation Using Chemical Treatment

This remedial alternative uses enhanced biodegradation technology, which has been successfully used to clean up petroleum contaminated sites for several years, and, more recently, chlorinated solvent contamination. Biodegradation of chlorinated compounds (i.e. reductive dechlorination), such as the COCs at the site, occurs in an oxygen-deficient or anaerobic environment. Reductive dechlorination is now recognized as one of the primary attenuation mechanisms by which chlorinated solvents in groundwater plumes can be contained, degraded, and remediated.

Under this method, the reductive dechlorination of the site would be accelerated by injecting a HRC into the subsurface via numerous injection wells in the both the shallow and deep aquifer. The HRC compound will slowly release lactate. Lactate is metabolized by naturally occurring microorganisms, resulting in the creation of anaerobic aquifer conditions and the production of hydrogen. Naturally occurring microorganisms would then use the hydrogen to progressively remove chlorine atoms from chlorinated hydrocarbon contaminants (i.e., COCs) to produce ethene, an innocuous compound.

The injection system discussed in this alternative would likely require approximately 25 shallow and deep injection wells located on the southwest side of the Stronghaven property. Off-site injection wells would not be constructed due to the dense residential development in the area and limited access to rights-of-way. Off-site areas of the contaminant plume beyond the influence of the treatment area would be remediated through natural attenuation.

2.4.1.3 GWA-3 Conventional Recovery of Groundwater, Treatment and Disposal

The scope of this alternative includes groundwater extraction in the shallow (saprolite) and deep (bedrock) aquifer using conventional "pump and treat" technology or vacuum extraction with above grade treatment of groundwater. The extracted groundwater from the pumping systems would be treated with an on-site air stripper to remove VOCs prior to disposal. It is assumed that the treated water would be discharged to the publicly owned treatment works (POTW). It is also assumed that the concentrations of dissolved organics in the recovered groundwater would be relatively low; therefore, emissions from the air stripper or vacuum extraction would not require vapor-phase treatment.

The recovery system discussed in this alternative would likely consist of one to four shallow extraction wells located on the southwest side of the Stronghaven property. There would also be one bedrock extraction well located in the same vicinity. Off-site wells would not be constructed due to the dense residential development in the area and limited access to rights-of-way for installing a network of pumping and wiring. Off-site areas of the contaminant plume beyond the influence of the treatment system would be remediated through natural attenuation.

2.5 Comparative Analysis of Alternatives

This section compares the relative performance of the GWAs to the eight REC Program evaluation criteria mentioned in Section 2.4. Three GWAs have been identified for the site. The alternatives, which are described briefly in Section 2.4.1, include GWA-1: Monitored Natural Attenuation; GWA-2: Enhanced Natural Attenuation using Chemical Treatment; GWA-3: and Conventional Recovery of Groundwater, Treatment and Disposal.

2.5.1 Overall Protection of Human Health and the Environment

Groundwater samples obtained during the RI indicate that contamination is present above applicable groundwater standards in both the shallow and deep aquifers. Analytical results from the shallow aquifer depict a contamination plume that extends approximately 300 feet in a south, southwest direction off the warehouse property. Analytical results from the deep aquifer depict a contaminant plume that extends approximately 850 feet toward the southwest. The contaminants in both the shallow and deep aquifer are expected to naturally attenuate over an extended period of time. GWA-1 is protective of the environment and human health due to the fact that there are no groundwater receptors identified within, or close proximity to, the contamination plume and exposure to the plume is not possible since it is located 30 – 120 feet below ground surface. Therefore, protection of human health is expected to be achieved.

Groundwater remediation alternatives GWA-2 and GWA-3 involve active remediation that would decrease the concentrations of the COCs in the groundwater under the Stronghaven property, decrease the speed of further plume migration off of the Stronghaven property, and to a limited degree reduce the time required for natural attenuation. Exposure to impacted groundwater by the general public is not expected. Furthermore, any access to impacted groundwater from wells and/or treatment systems would be restricted by locking the wells and restricting the access to any extraction or treatment system. Both scenarios are considered to protect human health and the environment.

2.5.2 Compliance with Applicable Regulations

The monitored natural attenuation approach would allow COCs to degrade naturally over time. It is not expected that the GWA-1 approach would attain RAOs for the site or applicable state or federal regulations in a short-term period. However, based on modeling of the limited groundwater data, the RAOs can be attained and the groundwater should ultimately attain compliance status with applicable standards.

The remaining alternatives, GWA-2 and GWA-3, are remediation strategies that are expected to lower the contaminant concentrations and meet groundwater remediation goals in the area of the truck loading bay on the Stronghaven property. GWA-2 would require an injection well permit as required by NCAC Title 15A, Chapter 2C. GWA-3 would require permits for the installation of recovery wells. Based on the low concentrations that would be recovered and treated through air stripping, an air permit is likely not required. A permit for discharging the treated water into the sanitary sewer may also be required.

2.5.3 Long-Term Effectiveness and Performance

Based on modeling of the limited groundwater data, GWA-1 could require thirty years of time to naturally attenuate. However, without a continual source area feeding the contamination, the groundwater is expected to naturally attenuate.

GWA-2 would likely to reduce the amount of COCs in the groundwater in the immediate vicinity of the Stronghaven property in a shorter period of time. GWA-2 is expected to treat the immediate area of injection within 1-2 years thereby reducing the total volume of contaminants in the shallow and deep aquifer. As a result, the volume of water requiring attenuation would be reduced. If necessary, additional injection of HRC can be performed.

Traditional pump and treat technologies that would be utilized as a part GWA-3 typically only capture a small amount of the plume in the immediate vicinity of the recovery wells and would require many years of pumping. Furthermore, due to limited off-property access, placement of the extraction wells will be limited to Stronghaven property situated at the trailing edge of the plume. As a result, GWA-3 would be expected to be effective in reducing the total volume of contaminants in the groundwater plumes in the long term. However, GWA-3 is not likely to be as effective at reducing the volume of contaminants as GWA-2 in the short term. Strata's experience and review of published technical reports indicates traditional pump and treat systems (GWA-3) can require extended periods of time to reduce contaminants in the groundwater to regulatory level. Remediation of the area outside of the influence of the treatment system would be dependant upon natural attenuation.

2.5.4 Reduction of Toxicity, Mobility and Volume

The natural degradation associated with GWA-1 would be expected to decrease the toxicity, mobility and/or volume over time in the groundwater as groundwater monitoring of site wells has demonstrated. Alternatives GWA-2 and GWA-3 would treat portions of the contaminated groundwater plume, but neither would be able to totally capture, or treat, the entirety of the plume due to limited off-site access. GWA-2 would rapidly treat the groundwater in the injection area but would not have as significant an impact effect on the groundwater that has already migrated off-property. GWA-3 would likely treat the same amount of area as GWA-2 but would require a longer time to decrease the amount of COCs compared to enhanced bioremediation proposed in GWA-2. Off-site areas of the contaminant plume beyond the influence of the treatment systems would be remediated through natural attenuation.

2.5.5 Short-Term Effectiveness

GWA-1 would likely demonstrate little effectiveness in short term remediation. GWA-2 is expected to demonstrate a high level of short-term effectiveness in the immediate vicinity of the Stronghaven property. Bioremediation techniques drastically reduce the level of contamination usually within one to two years. However, there would be little short-term effect in the portions of the contaminant plume not located under the Stronghaven site. GWA-3 would likely have little short-term effectiveness do to limitations associated with the physical extraction of the impacted water and effectiveness would be restricted by the drawdown radius of the recovery wells.

2.5.6 Implementability

Because monitoring wells are already in place, GWA-1 would require only a limited amount of activity; therefore, the implementation would be relatively straightforward. Due to the nature and depth of the saprolite, using less intrusive direct push methods for injection is not feasible. Therefore, GWA-2 would require an air rotary drill rig to install the injection wells in both the saprolite and bedrock. The well construction (approximately 25 wells) could take one to two months to complete. After the wells are constructed, injection of the HRC material would take place. The estimated time for the injection is two to three weeks. After two or three years, a possible second injection may be necessary based on monitoring results. Eventually, the injection wells would require abandonment following completion of the enhanced phase of remediation.

Implementation of GWA-3 would require the construction of a pump and treat system near the truck loading bay including multiple wells and a treatment system. Permits would have to be obtained and approximately four extraction wells installed. The extraction wells would be screened both in the shallow and deep aquifers.

An additional factor impacting the implementability of GWA-2 and GWA-3 is the disruption to the operation of the facility. The implementation of either of these alternatives would require the installation and/or operation of injection or recovery wells that would block the only loading bay for the facility. This would result in a significant disruption to the operation of the facility. Stronghaven estimates that the cost of the interruption to the business, and the cost to modify the structure by installing a loading bay at the rear of the building would be approximately $240,000.

2.5.7 Costs

Based on a comparison of the cost of the three remedial alternatives, over an assumed thirty year remediation GWA-1 has the lowest estimated remedial cost $1,202,430 (present net value cost $945,397) due to the fact that the monitoring wells are already in place and that there are limited start-up costs associated with this approach. GWA-2 has the highest estimated cost ranging from $2,229,430 for two injection events to $2,025,930 for one injection even (present net value cost range $1,960,242 to $1,767,347). GWA-3 has an estimated cost of $1,718,430 (present net value cost $1,418,988). See Appendix B for the specific cost associated with each GWA.

2.5.8 Community Acceptance

It is unknown at the current time how the community will accept the remediation alternatives. GWA-1 can likely be implemented with little to no disturbance to the community. The start-up activities associated with GWA-2, including the construction of injection wells, will likely create a disturbance for the community and would severely limit the operation of the Stronghaven warehouse. However, once the injection wells are in place there should be little or no nuisance to the surrounding properties. Likewise, the start-up disturbances associated with the GWA-3 well installations and/or continued noise from the blowers from a pump and treat system could potentially be a nuisance to properties in the vicinity of the site.

2.6 Selection of Remedial Alternatives

The following section briefly describes the preferred groundwater remediation alternative.

2.6.1 Selection of the Groundwater Remediation Alternative

Groundwater remediation alternatives GWA-1, GWA-2, and GWA-3 described in Section 2.4 presented various methods for remediating groundwater contamination, each of which are capable of satisfying the RAOs that have been established for the site. These alternatives were evaluated with respect to the selection criteria presented in Section 2.5.

GWA-1 would not include active groundwater remediation. Based on the low concentrations of the COCs, the natural attenuation approach would be a cost effective remedial alternative and in the absence of any identified receptors in the plume would be protective of human health and the environment.

Furthermore the approach would cause little or no disturbance to the community. Monitoring of groundwater wells installed during the RI of the site demonstrate that natural attenuation is currently occurring in the contaminant plume.

The in-situ reductive dechlorination process in alternative GWA-2 is an innovative method and has the potential for rapid reductions in contaminant concentrations in both the deep and shallow aquifers. Reductive dechlorination has been used successfully at many sites to treat groundwater contaminated with chlorinated solvents. This method would reduce the total volume of COCs in the groundwater and would be protective of human health and the environment. However, the start-up activities consisting of well construction and HRC injection could create a short-term disturbance for the community. Furthermore, pump test performed on the shallow aquifer by Strata indicated that this formation may not accept the volume of injected HRC needed to effectively remediate the shallow groundwater. Remediation of off-site areas of the contaminant plume beyond the influence of the treatment system would rely on natural attenuation.

GWA-3 (conventional recovery of groundwater, treatment and disposal option) would require the construction of a groundwater pump and treat system for remediation of the shallow and deep aquifers. This method would reduce the total volume of COCs in the groundwater and would be protective of human health and the environment. However, based on the limitations of a pump and treat design at this site, this method is likely the least cost effective of the three options. Furthermore, the long term operation of a pump and treat system could be an ongoing nuisance to the community. Remediation of off-site areas of the contaminant plume beyond the influence of the treatment system would rely on natural attenuation.

Based on its ease of implementation, long term effectiveness, the limited disturbance to the neighborhood, limited interruption to the operation of the facility, and cost; the recommended alternative for groundwater remediation at the site is GWA-1.

3.0 PROPOSED REMEDIAL ALTERNATIVE

3.1 Description of the Proposed Remedial Action

This section presents a conceptual design to remediate the groundwater in the vicinity of the site. The information presented is not intended to be the final design for the remedy.

3.1.2 Conceptual Design of the Proposed Remedial Action

Groundwater monitoring of the natural attenuation will be conducted quarterly for the first five years after the approval of the plan. Groundwater monitoring events will be conducted semi-annually thereafter until RAOs have been achieved. Nine existing shallow aquifer monitoring wells (Figure 7 in Appendix A) and four existing bedrock monitoring wells (Figure 8 in Appendix A) will be used in the groundwater monitoring. A full scan of VOCs by EPA Method 8260 will be analyzed on each sample to measure the COCs. The groundwater monitoring protocol outlined in the May 2004 Remedial Investigation Workplan and subsequent addendums will be followed and modified as necessary to comply with the current version of the US Environmental Protection agency Region IV Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, and North Carolina Department of Environment and Natural Resources, Registered Environmental Consultant Program Implementation Guidance. To remain consistent with previous work, quality control samples will consist of one duplicate sample, per medium, per day.

3.1.2.1 Treatment Area

Natural attenuation is expected to occur throughout the entire contaminant plume.

3.1.2.2 Waste Containment, Treatment and Disposal

Assuming permission can be obtained from the City of Charlotte, purge water from monitoring events will be discharge directly into the city sanitary sewer system. If permission for direct disposal is not granted, purged water from all wells will be contained at the Stronghaven facility in secured containers until the laboratory analysis of the groundwater samples from the wells has been completed. Once the laboratory analysis of the samples is available, Strata will contract with a wastewater disposal contractor to dispose of the purged water in an approved method.

4.0 FUTURE REPORTING

Throughout implementation of the groundwater remediation process, progress reports will be submitted to the NCDENR as required in the REC Program Guidelines. The reports will contain a brief description of remedial activities conducted to date in a brief memo form. Several major reports will be submitted in addition to the quarterly progress reports. The major reports include the following.

4.1 Preconstruction Reports

Prior to implementation of the groundwater remediation, Preconstruction Reports will be submitted to NCDENR describing the following items:

1. Final Design Report, which will include a detailed description of the final design, a summary of changes from the conceptual design in the RAP, and final construction plans and specifications.

2. Copies of any required permits or approvals.

3. An updated project schedule.

4.2 Construction Completion Report/Remedial Action Completion Reports

Within 90 days of construction completion, a Construction Completion Report (CCR) will be submitted to NCDENR. These reports will include the "as built" plans and specifications, a summary of any variances from the final RAP, and a summary of any problems that were encountered in during construction.

4.3 Groundwater Monitoring Reports

Within 90 days of the completion of each groundwater monitoring event, a groundwater monitoring report will be prepared that summarizes for the previous period, groundwater treatment performance and groundwater monitoring results.

5.0 REFERENCES

Remedial Investigation Report, Stronghaven Warehouse, East John Street, Matthews, North Carolina, Strata Environmental, December 2006.

Implementation Guidance of the North Carolina Department of Environment and Natural Resources (NCDENR) Division of Waste Management, Superfund Section, Inactive Hazardous Sites Branch, Registered Environmental Consultant (REC) Program, August 2007.

The Geology of the Carolinas, Horton, Wright, J. and Victor A. Zullo, Carolina Geological Society Fiftieth Anniversary Volume, The University of Tennessee Press, 2001.

A Master Conceptual Model for Hydrogeological Site Characterization in the Piedmont and Mountain Region of North Carolina, LeGrand, Harry E., North Carolina Department of Environment and Natural Resources, 2004.

Soil Survey of Mecklenburg County, North Carolina. United States Department of Agriculture Soil Conservation Service, McCarchen, Clifford M., 1980.

North Carolina Department of Environmental and Natural Resources (NC DENR) Division of Waste Management Superfund Section (Docket Number 03-SF-222).

Regenesis 3DMe Technical Bulletin 1.0, 2006.

Calculation and Use of First-Order Rater Constants for Monitored Natural Attenuation Studies, EPA Issue Paper, EPA/540/S-02/500, November 2002.

6. CERTIFICATION

REMEDIATING PARTY CERTIFICATION STATEMENT

I certify that under penalty of law that I have personally examined and am familiar with the information contained in this submittal, including any and all documents accompanying this certification, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, the material and information contained herein is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for willfully submitting false, inaccurate or incomplete information.

Douglas Johnston
(Printed Name of Remediating Party Official)

(Signature of Remediating Party Official) 7/28/08
Date

State of Georgia

Carroll County

I, Tracey Berna, a Notary Public of said County and State, do hereby certify that Douglas Johnston did personally appear and sign before me this the 28 day of July, 2008

Notary Public (signature) (OFFICIAL SEAL)

My Commission expires:

TRACEY BERNA
MY COMMISSION
NOTARY
PUBLIC
EXPIRES JULY 6, 2009
CARROLL COUNTY, GEORGIA

REGISTERED SITE MANAGER CERTIFICATION STATEMENT

I certify that under penalty of law that I am personally familiar with the information contained in this submittal, including any and all supporting documents accompanying this certification, and that the material and information contained herein is, to the best of my knowledge and belief, true, accurate and complete and complies with the Inactive Hazardous Sites Response Act G.S. 130A-310, et seq, and the voluntary remedial action program Rules 15A NCAC 13C .0300. I am aware that there are significant penalties for willfully submitting false, inaccurate or incomplete information.

Timothy L. Riddle
(Printed Name of Registered Site Manager)

[signature]
(Signature of Registered Site Manager)

8/1/08
Date

State of Tennessee

Knox County

I, Kelli M. Travis, a Notary Public of said County and State, do hereby certify that Timothy L. Riddle did personally appear and sign before me this the 1st day of August, 2008.

[signature]
Notary Public (signature)

My Commission expires: 5/9/2012

KELLI M. TRAVIS STATE OF TENNESSEE NOTARY PUBLIC KNOX COUNTY (OFFICIAL SEAL)

APPENDIX A
FIGURES AND TABLES

TABLE 1
Analytical Summary Of Laboratory Results
On-Site Groundwater Monitoring Wells
Stronghaven Warehouse,
Matthew, NC

Volatiles (ug/L)	Remediation Goal	SH-MW-1 8/04	SH-MW-1 DUP 8/04	SH-MW-1 11/04	SH-MW-2 8/04	SH-MW-2 11/04	SH-MW-3 8/04	SH-MW-3 11/04	SH-MW-4 8/04	SH-MW-4 DUP 8/04	SH-MW-4 11/04	SH-MW-5 8/04	SH-MW-5 11/04	SH-MW-5 DUP 11/04	SH-MW-6 8/04	SH-MW-6 11/04	SH-MW-7 8/04	SH-MW-7/Dissolved 8/04	SH-MW-7 11/04	SH-MW-7 DUP 11/04	SH-MW-8 8/04	SH-MW-8 11/04	SH-MW-9 01/06	SH-MW-10 05/06	SH-MW-10 DUP 05/06	SH-MW-11R 08/06	SH-MW-11R DUP 08/06
1,1-Dichloroethene	7	ND	ND	ND	ND	4.1	ND	ND	ND	ND	ND	**28**	ND	**27**	ND	ND	ND	NA	ND	ND	ND	ND	2.6	1.2	1.2	ND	ND
Tetrachloroethene	0.7	**5.8**	**6.2**	**7.9**	ND	**3.1**	ND	ND	ND	ND	ND	**4.5**	**5.3**	**7**	ND	ND	**81**	NA	**71**	**94**	ND	ND	ND	ND	ND	ND	ND

Table list only constituents detected above quantitation limit

ug/L - micrograms per liter

ND- None Detected

NA - Sample was not analyzed for constituent

Remediation goal is based on NCAC 15A 2L Groundwater Classification and Standards unless otherwise noted.

*Remediation goal is based on the US EPA MCL or Non-Zero MCLG.

Bolded entries exceed Remediation Goal

TABLE 2
Analytical Summary Of Laboratory Results
Off-Site Shallow Groundwater Monitoring Wells
Stronghaven Warehouse
Matthews, NC

Volatiles (ug/l)	Groundwater Remediation Goal	CG-MW-1 10/05	CG-MW-2 10/05	CG-MW-2 DUP 10/05	CG-MW-1 01/06	CG-MW-1 DUP 01/06	CG-MW-2 01/06	CG-MW-3D 01/06	CG-MW-3D DUP 01/06	CG-MW-4 01/06	CG-MW-5 01/06	CG-MW-6 01/06	RW-MW-1 01/06	RW-MW-1 06/06	RW-MW-2 01/06	RW-MW-3 01/06	RW-MW-3 06/06	FA-MW-1 05/06	FA-MW-1 06/06	BC-MW-1S 08/06
1,1-Dichloroethene	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.4	1.1	ND
Tetrachloroethene	0.7	**140**	**13**	**14**	**140**	**110**	**1.7**	**110**	**120**	ND	ND	ND	**12**	**10**	**110**	ND	ND	**190**	**160**	ND

ug/l - micrograms per liter
ND- None Detected
Remediation goal is based on NCAC 15A 2L Groundwater Classification and Standards unless otherwise noted.
*Remediation goal is based on the US EPA MCL or Non-Zero MCLG.
** EPA Region IX PRG multiplied by a Factor of 0.1.
Bolded entries exceed Groundwater Remediation Goal

TABLE 3

Analytical Summary Of Laboratory Results

Deep (Bedrock) Groundwater Monitoring Wells

Stronghaven Warehouse

Matthews, NC

	Groundwater Remediation Goal	SH-MW-11R 08/06	SH-MW-11R DUP 08/06	CG-MW-3R 05/06	CG-MW-3R 06/06	CG-MW-3R DUP 06/06	BP-MW-1R 08/06	BB-MW-1R 08/06	BB-MW-1R 09/06	BB-MW-1R DUP 09/06	FB-MW-1R 11/06	FB-MW-1R DUP 11/06	PW-MW-1R 11/06	PW-MW-1R DUP 11/06
Volatiles (ug/l)														
1,1-Dichloroethene	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	0.7	ND	ND	**13**	**19**	**19**	ND	**32**	**53**	**64**	ND	ND	ND	ND

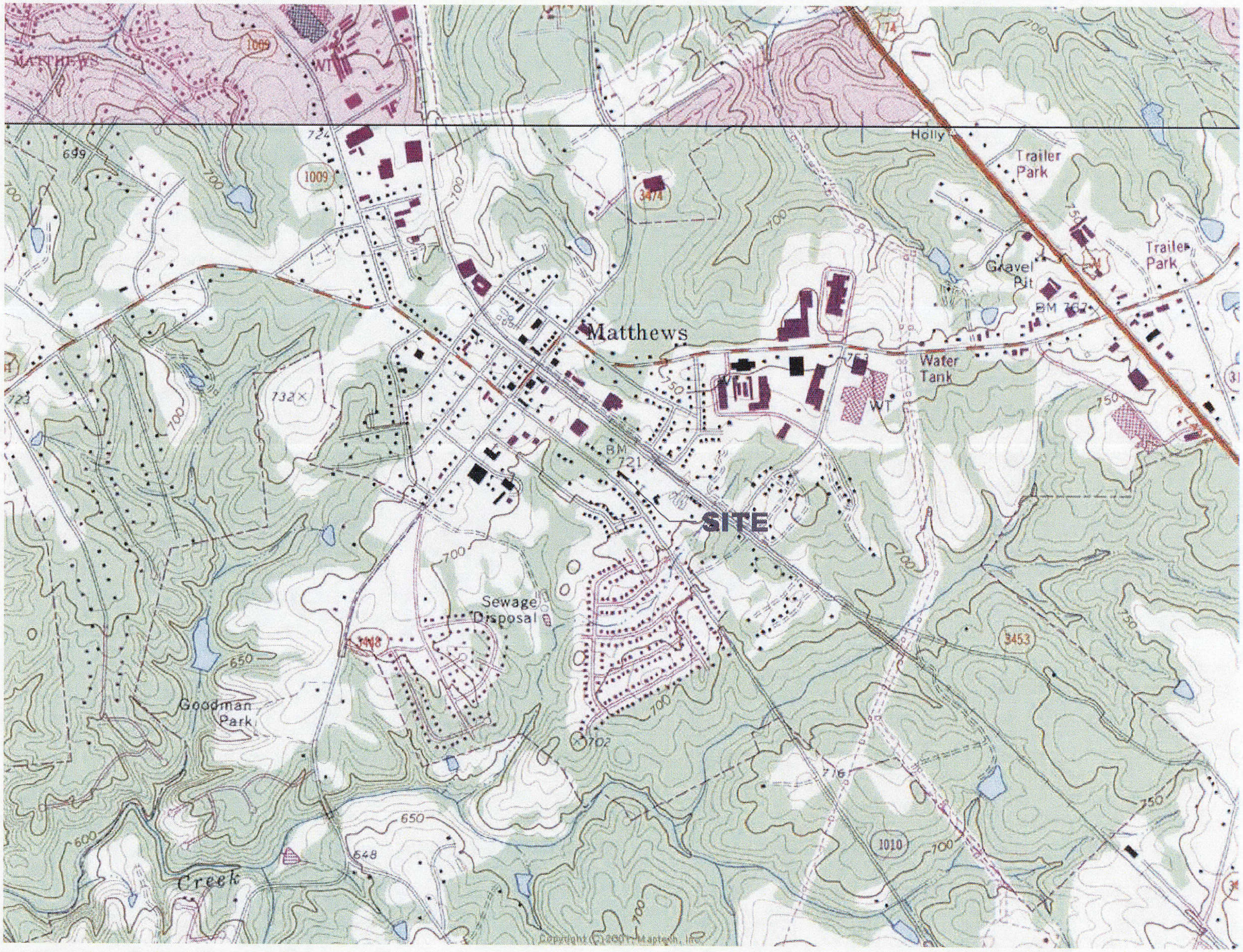
ug/L - micrograms per liter

ND- None Detected

Remediation goal is based on NCAC 15A 2L Groundwater Classification and Standards unless otherwise noted.

*Remediation goal is based on the US EPA MCL or Non-Zero MCLG.

Bolded entries exceed Remediation Goal



Strata ENVIRONMENTAL

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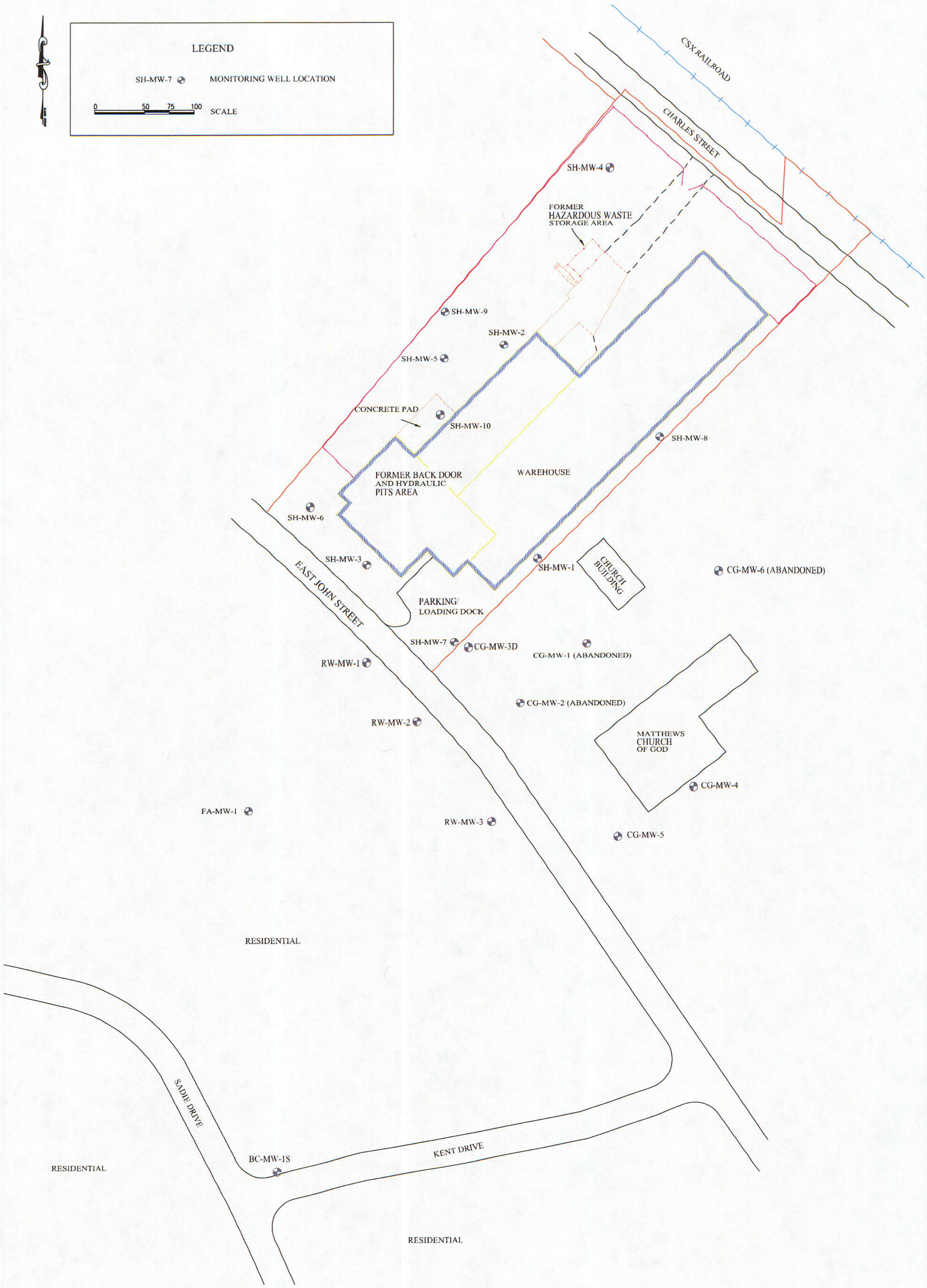
FAX (865) 539-3970

Stronghaven Warehouse
Matthews Quadrangle; 1971, 1988

Matthews, NC

FILE	DATE	FIGURE
0325401	July 2008	1



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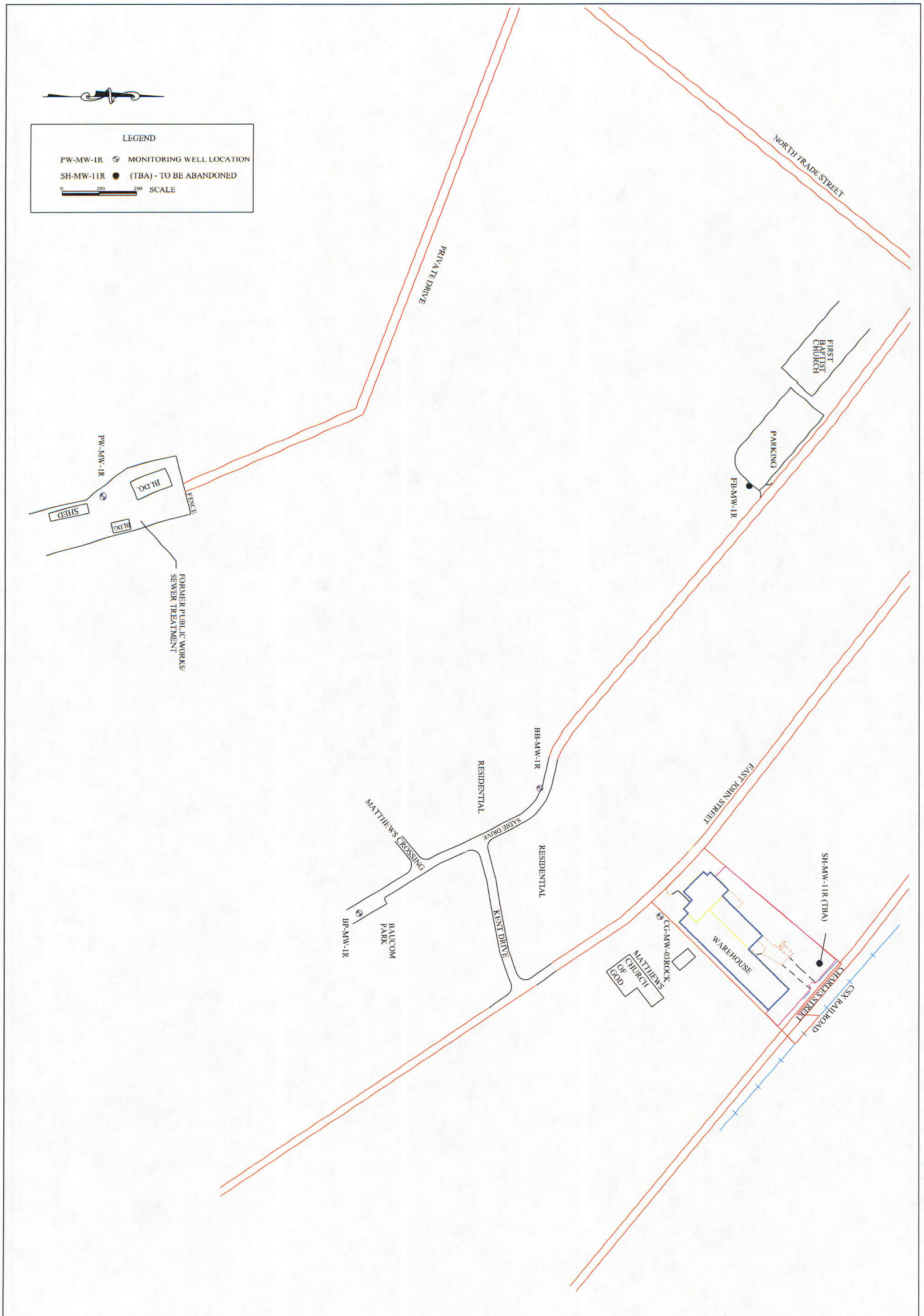
Stronghaven Warehouse
Location of the Shallow Groundwater Monitoring Wells

FIGURE 2

FILE	DATE	
0325401	July 2008	Matthews, NC



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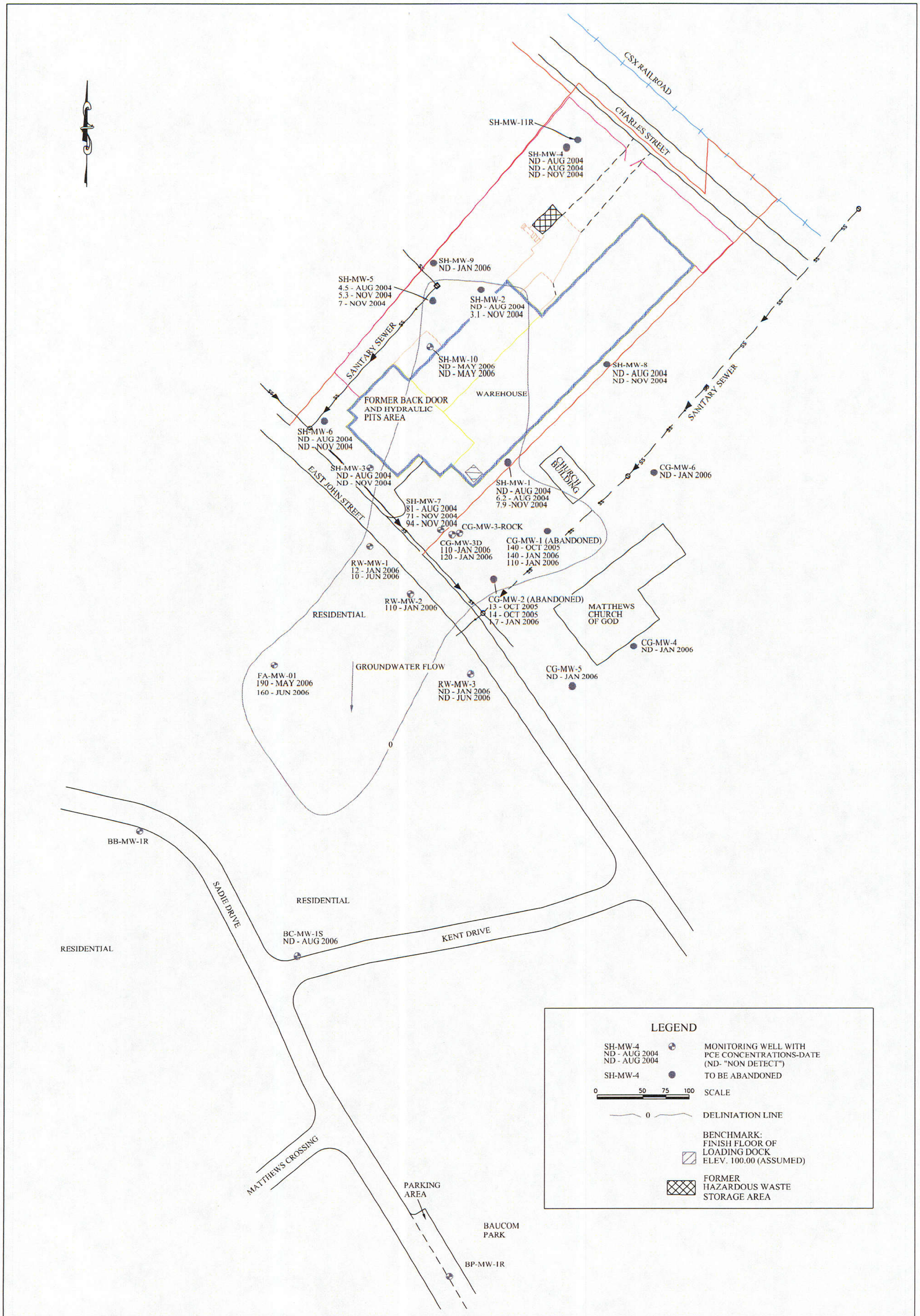
FILE 0325401 | DATE July 2008

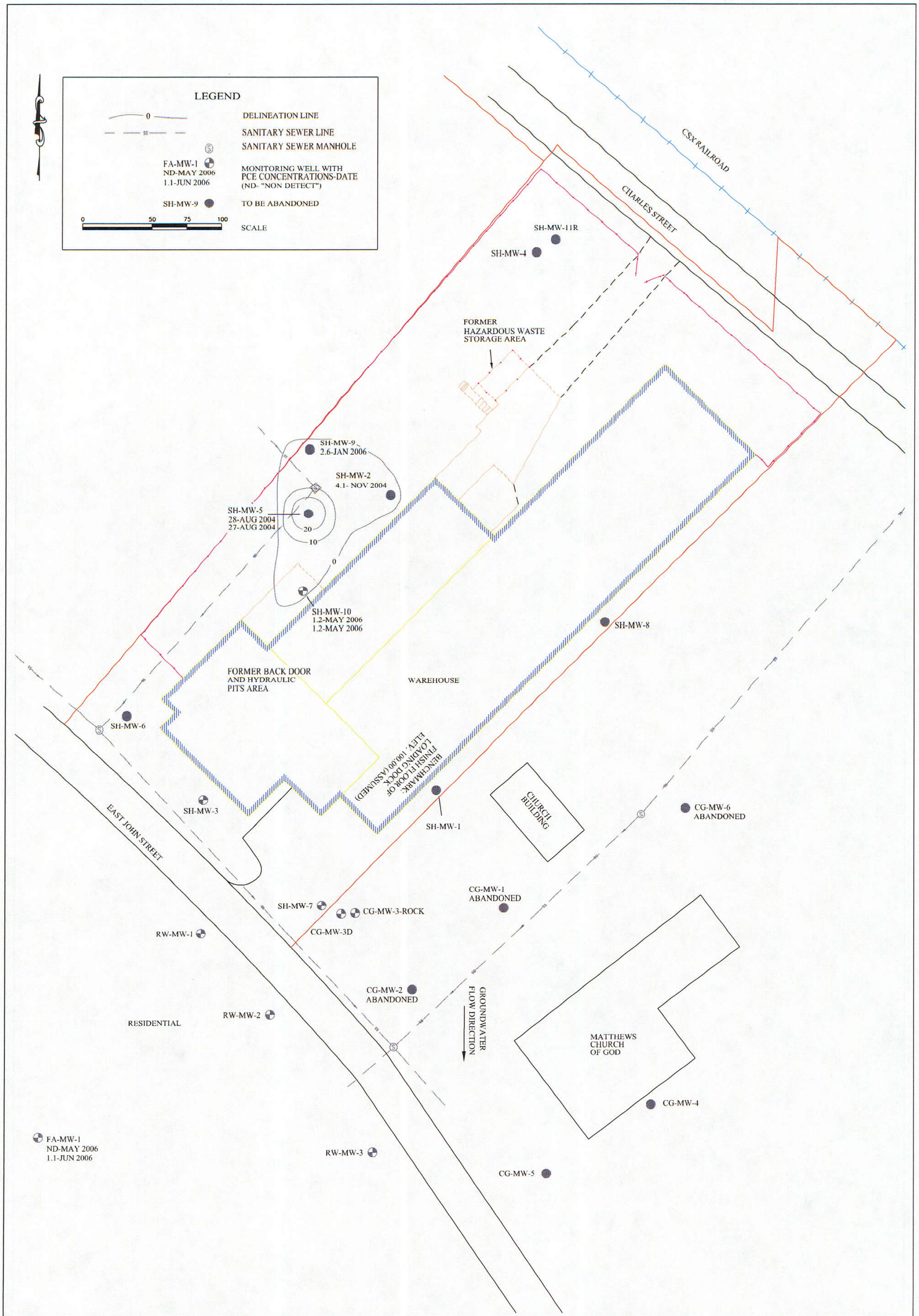
Stronghaven Warehouse
Location of Deep (Bedrock) Groundwater Monitoring Wells

Matthews, NC

FIGURE 3



Strata ENVIRONMENTAL	110 PERIMETER PARK SUITE E KNOXVILLE, TN 37922 PHONE (865) 539-2077 FAX (865) 539-3970	Stronghaven Warehouse PCE Concentrations and Deliniated Extent in Shallow Zone	FIGURE 4
	FILE 0325401 / DATE July 2008	Matthews, NC	



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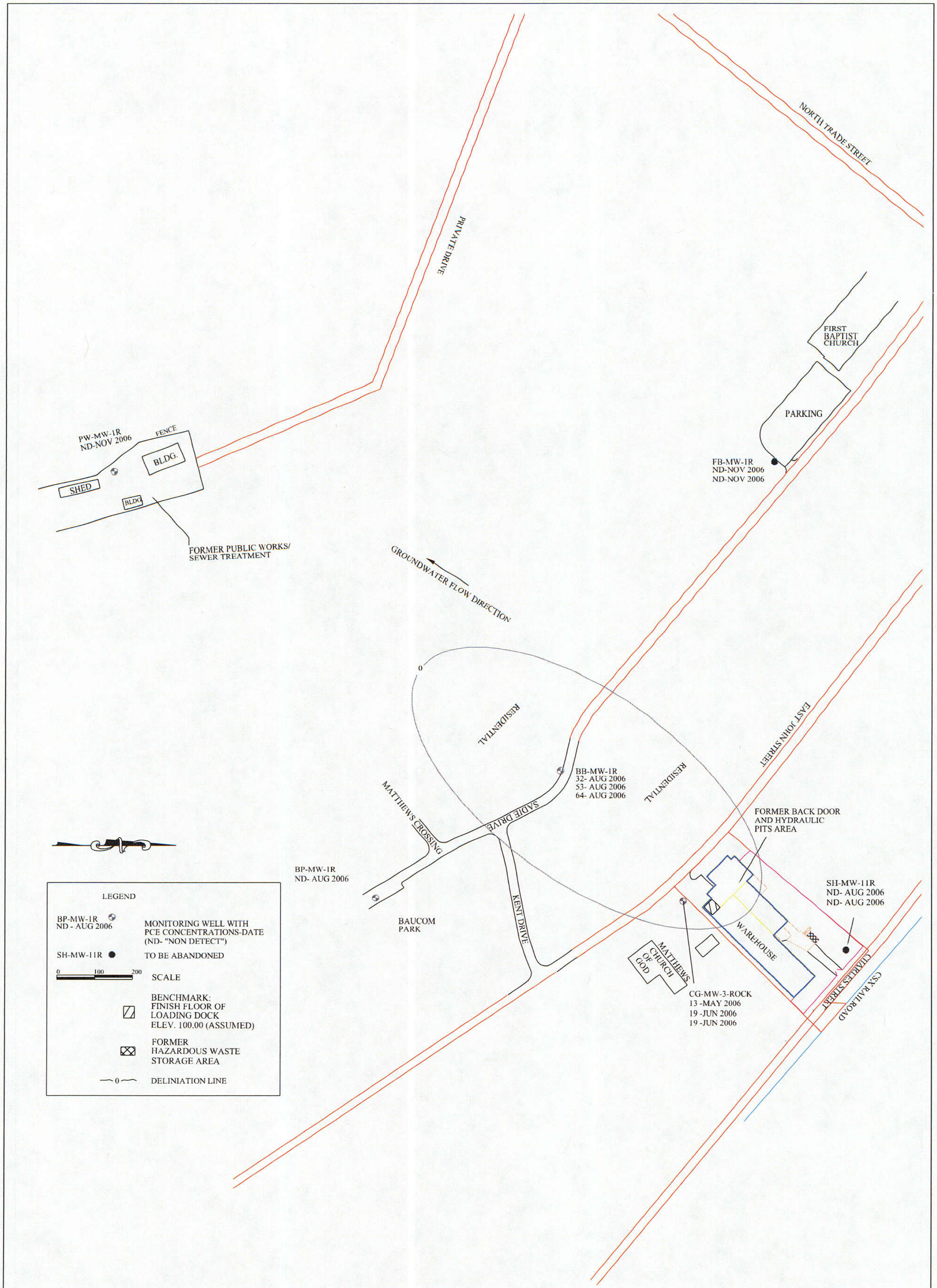
Stronghaven Warehouse
Delineated Extent of 1,1-Dichloroethene in Shallow Aquifer

Matthews, NC

FILE	DATE	FIGURE
0325401	July 2008	5



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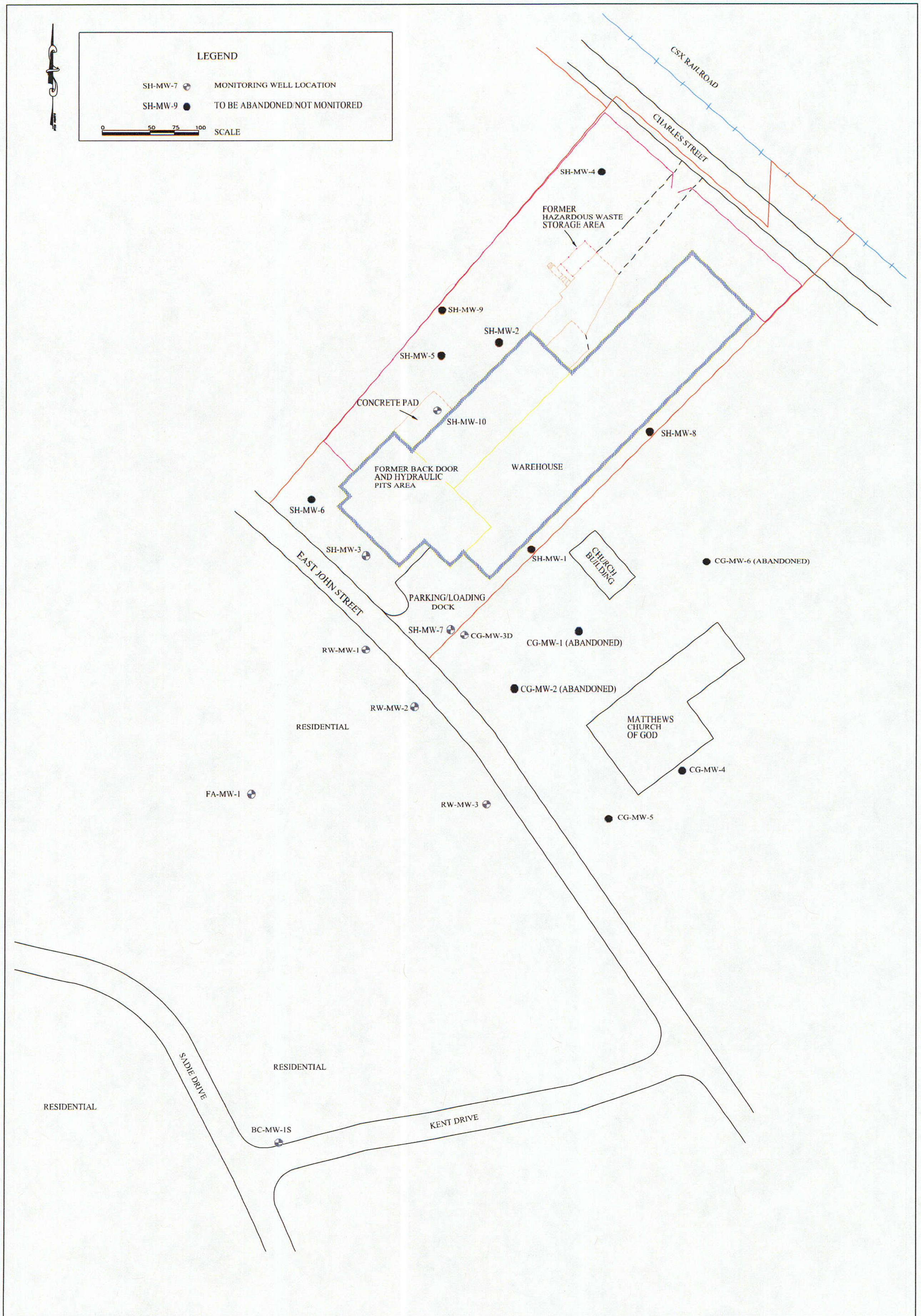
Stronghaven Warehouse
Delineated Extent of PCE in the Deep Aquifer

FIGURE 6

FILE	DATE	
0325401	July 2008	Matthews, NC



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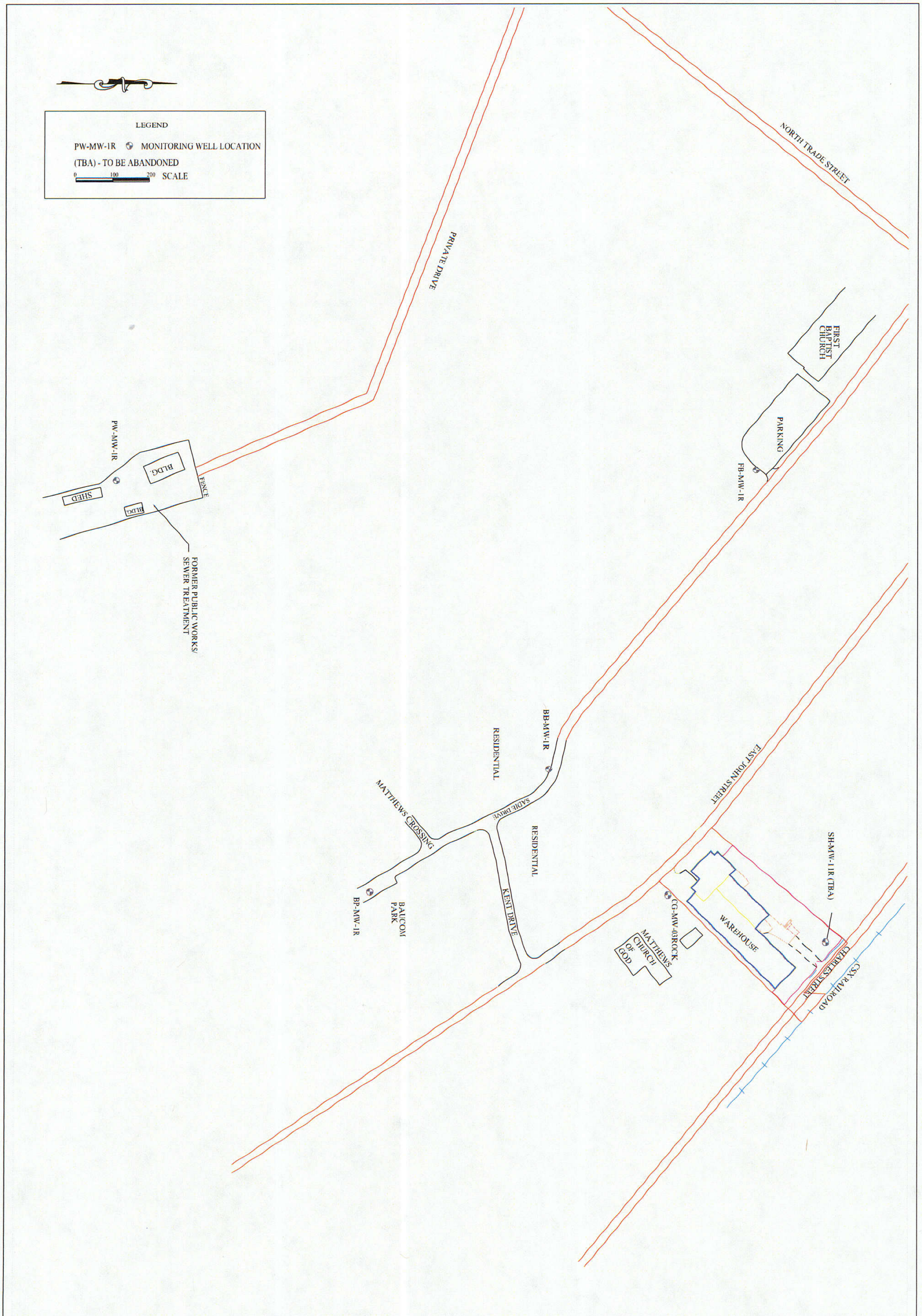
Stronghaven Warehouse
Remedial Action Shallow Groundwater Monitoring Wells

FIGURE 7

FILE	DATE
0325401	July 2008

Matthews, NC



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Stronghaven Warehouse
Remedial Action Deep Groundwater Monitoring Wells

FIGURE 8

FILE	DATE	
0325401	July 2008	Matthews, NC

APPENDIX B
PRESENT NET VALUE COST CALAUCLATIONS

Remedial Cost Monitored Natural Attenuation (13 Wells Monitored)
Stronghaven Warehouse
Matthews, NC

Rate
1.80%

Year		Well Replacement	Well Abandonment	Groundwater Sampling and Reporting*	Yearly Total	PV Factor	Net Present
	1		7480		7480	1.0000	7480
	2			55000	55000	0.9823	54028
	3			55000	55000	0.9649	53072
	4			55000	55000	0.9479	52134
	5			55000	55000	0.9311	51212
	6			55000	55000	0.9147	50306
	7			29000	29000	0.8985	26056
	8			29000	29000	0.8826	25595
	9			29000	29000	0.8670	25143
	10			29000	29000	0.8517	24698
	11			29000	29000	0.8366	24262
	12			29000	29000	0.8218	23833
	13			29000	29000	0.8073	23411
	14			29000	29000	0.7930	22997
	15			29000	29000	0.7790	22591
	16	169950	12500	29000	211450	0.7652	161805
	17			29000	29000	0.7517	21799
	18			29000	29000	0.7384	21413
	19			29000	29000	0.7253	21035
	20			29000	29000	0.7125	20663
	21			29000	29000	0.6999	20297
	22			29000	29000	0.6875	19939
	23			29000	29000	0.6754	19586
	24			29000	29000	0.6634	19240
	25			29000	29000	0.6517	18900
	26			29000	29000	0.6402	18565
	27			29000	29000	0.6289	18237
	28			29000	29000	0.6177	17915
	29			29000	29000	0.6068	17598
	30			29000	29000	0.5961	17287
	31		12500	29000	41500	0.5856	24300
Subtotal		169950	32480	1000000	**Present Value**		**945397**

Total Cost **1202430**

Includes a 10% Contingency
* Quarterly sampling for the first five years and semi annual thereafter

Remedial Cost Pump and Treat (13 Wells Monitored)
Stronghaven Warehouse
Matthews, NC

Rate
1.80%

Year		Well Construction	Well Abandonment	Facility Modification	Pump/Treat System and Operating Costs	Groundwater Sampling and Reporting*	Yearly Total	PV Factor	Net Present Value
	1	52500	7480	240000	42000		341980	1.0000	341980
	2				3000	55000	58000	0.9823	56974
	3				3000	55000	58000	0.9649	55967
	4				3000	55000	58000	0.9479	54977
	5				3000	55000	58000	0.9311	54005
	6				3000	55000	58000	0.9147	53050
	7				3000	29000	32000	0.8985	28752
	8				3000	29000	32000	0.8826	28243
	9				3000	29000	32000	0.8670	27744
	10				3000	29000	32000	0.8517	27253
	11				3000	29000	32000	0.8366	26771
	12				3000	29000	32000	0.8218	26298
	13				3000	29000	32000	0.8073	25833
	14				3000	29000	32000	0.7930	25376
	15				3000	29000	32000	0.7790	24928
	16	222450	12500		42000	29000	305950	0.7652	234117
	17				3000	29000	32000	0.7517	24054
	18				3000	29000	32000	0.7384	23629
	19				3000	29000	32000	0.7253	23211
	20				3000	29000	32000	0.7125	22800
	21				3000	29000	32000	0.6999	22397
	22				3000	29000	32000	0.6875	22001
	23				3000	29000	32000	0.6754	21612
	24				3000	29000	32000	0.6634	21230
	25				3000	29000	32000	0.6517	20855
	26				3000	29000	32000	0.6402	20486
	27				3000	29000	32000	0.6289	20124
	28				3000	29000	32000	0.6177	19768
	29				3000	29000	32000	0.6068	19418
	30				3000	29000	32000	0.5961	19075
	31		12500		3000	29000	44500	0.5856	26057
Subtotal		274950	32480	240000	171000	1000000	**Present Value**		**1418988**

Total Cost **1718430**

Includes a 10% Contingency
* Quarterly sampling for the first five years and semi annual thereafter

Remedial Cost Enhanced Natural Attenuation Using Chemical Treatment Two Injection Events
Stronghaven Warehouse
Matthews, NC

Rate
1.80%

Year	Well Construction	Well Abandonment	Facility Modification	HRC Injection	Groundwater Sampling and Reporting*	Yearly Total	PV Factor	Net Present Value
1	357500	7480	240000	203500		808480	1.0000	808480
2					55000	55000	0.9823	54028
3					55000	55000	0.9649	53072
4				203500	55000	258500	0.9479	245029
5		22500			55000	77500	0.9311	72162
6					55000	55000	0.9147	50306
7					29000	29000	0.8985	26056
8					29000	29000	0.8826	25595
9					29000	29000	0.8670	25143
10					29000	29000	0.8517	24698
11					29000	29000	0.8366	24262
12					29000	29000	0.8218	23833
13					29000	29000	0.8073	23411
14					29000	29000	0.7930	22997
15					29000	29000	0.7790	22591
16	169950	12500			29000	211450	0.7652	161805
17					29000	29000	0.7517	21799
18					29000	29000	0.7384	21413
19					29000	29000	0.7253	21035
20					29000	29000	0.7125	20663
21					29000	29000	0.6999	20297
22					29000	29000	0.6875	19939
23					29000	29000	0.6754	19586
24					29000	29000	0.6634	19240
25					29000	29000	0.6517	18900
26					29000	29000	0.6402	18565
27					29000	29000	0.6289	18237
28					29000	29000	0.6177	17915
29					29000	29000	0.6068	17598
30					29000	29000	0.5961	17287
31		12500			29000	41500	0.5856	24300
Subtotal	527450	54980	240000	407000	1000000	**Present Value**		**1960242**

Total Cost **2229430**

Includes a 10% Contingency
* Quarterly sampling for the first five years and semi annual thereafter

Remedial Cost Enhanced Natural Attenuation Using Chemical Treatment One Injection Event
Stronghaven Warehouse
Matthews, NC

							Rate	
							1.80%	
Year	**Well Construction**	**Well Abandonment**	**Facility Modification**	**HRC Injection**	**Groundwater Sampling and Reporting***	**Yearly Total**	**PV Factor**	**Net Present Value**
1	357500	7480	240000	203500		808480	1.0000	808480
2					55000	55000	0.9823	54028
3					55000	55000	0.9649	53072
4					55000	55000	0.9479	52134
5		22500			55000	77500	0.9311	72162
6					55000	55000	0.9147	50306
7					29000	29000	0.8985	26056
8					29000	29000	0.8826	25595
9					29000	29000	0.8670	25143
10					29000	29000	0.8517	24698
11					29000	29000	0.8366	24262
12					29000	29000	0.8218	23833
13					29000	29000	0.8073	23411
14					29000	29000	0.7930	22997
15					29000	29000	0.7790	22591
16	169950	12500			29000	211450	0.7652	161805
17					29000	29000	0.7517	21799
18					29000	29000	0.7384	21413
19					29000	29000	0.7253	21035
20					29000	29000	0.7125	20663
21					29000	29000	0.6999	20297
22					29000	29000	0.6875	19939
23					29000	29000	0.6754	19586
24					29000	29000	0.6634	19240
25					29000	29000	0.6517	18900
26					29000	29000	0.6402	18565
27					29000	29000	0.6289	18237
28					29000	29000	0.6177	17915
29					29000	29000	0.6068	17598
30					29000	29000	0.5961	17287
31		12500			29000	41500	0.5856	24300
Subtotal	527450	54980	240000	203500	1000000	**Present Value**		**1767347**

Total Cost **2025930**

Includes a 10% Contingency
* Quarterly sampling for the first five years and semi annual thereafter

APPENDIX C
PRELININARY NATURAL ATTENUTAION MODELING

$$t = \frac{-\mathrm{Ln}\left[\frac{C_{goal}}{C_{start}}\right]}{k_{point}}$$

t= Time to remediate
k_{point} = Slope of Ln of Concentration
C_{goal} = Remediation goal of 0.7 ug/l
C_{start} = Initial Concentration

Time Elapsed (yr)	PCE Concentration ug/l	LN (PCE)	Slope (Kpoint)	-Ln *[Cgoal/Cstart]	Estimated Time to Remediate (yr)
MW-7					
0	81	4.394449	-1.09606	-4.75112	**4.3**
2.7	4.2	1.435085			
CG-3D					
0	120	4.787492	-0.74495	-5.14417	**6.90**
1.23	48	3.871201			
RW-MW-1					
0	12	2.484907	-0.34442	-2.84158	**8.25**
0.41	10	2.302585			
1.3	7.6	2.028148			
FA-MW-1					
0	190	5.247024	-0.25694	-5.6037	**21.80**
0.92	150	5.010635			
SH-MW-2					
0	3.1	1.131402	-0.36514	-1.48808	**4.07**
2.38	1.3	0.262364			
RW-MW-2					
0	110	4.70048	-0.60914	-5.05716	**8.30**
1.23	52	3.951244			
CG-MW-3R					
0	19	2.944439	-0.28828	-3.30111	**11.45**
0.82	15	2.70805			
BB-MW-1R					
0	60	4.094345	-0.38808	-4.45102	**11.46**
0.575	48	3.871201			