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WORK SCOPE FOR SUPPLEMENTAL SITE INVESTIGATIONS AND DOCUMENTATION

APPLETON WIRE (FORMER)
908 NORTH LAWE STREET
APPLETON, WISCONSIN 54911
WDNR BRRTS #: 02-45-000015

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HYDROGEOLOGIST CERTIFICATION

"I, Wayne P. Fassbender, certify I am a Hydrogeologist as that term is defined in s NR 712.03 (1) Wisconsin Administrative Code; and that to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements of chs. NR 700 to 726, Wisconsin Administrative Code."

Wayne P. Fassbender, P.G. 1/31/17
Date

Document Reference: Work Scope for Supplemental Site Investigations and Documentation; Appleton Wire (former); 908 N. Lawe Street, Appleton, Wisconsin; February 6, 2017

1.0 INTRODUCTION

Environmental Forensic Investigations, Inc. (EnviroForensics) has been contracted by Albany International Corp. (Albany) to evaluate past investigative data collected by various consultants at the former Appleton Wire facility located at 908 N. Lawe Street, Appleton Wisconsin (Site) from 1987 to present, and to prepare a work scope to address data gaps. The data was collected in regards to subsurface impacts caused by releases from former chromium plating operations which took place at the Site. The contaminant of concern (COC) for this Site is the metal chromium. Currently there is an active groundwater collection and treatment system in place to provide hydrologic control of groundwater migration and to remove chromium from groundwater. The groundwater treatment system has been in operation since 1988, with several enhancements over time.

The objectives of this work scope are as follows:

- Determine any significant gaps in the current understanding of the distribution of chromium impacts in soil and groundwater and any associated migration pathways, and address further investigations to close these gaps;
- Address additional data needed to perform an evaluation of potential enhancements to the current remedial system or other potential remedial actions which could result in case closure within a reasonable period of time.

After achieving these objectives, a Site Investigation Report will be prepared satisfying the requirements of Chapter NR 716, Wisconsin Administrative Code (WAC), and a Remedial Action Options Report will be prepared in accordance with Chapter NR 722, WAC.

2.0 BACKGROUND

2.1 Location and Surroundings

The location of the Site is depicted on the U.S.G.S. 1:24,000 scale topographic quadrangle map as **Figure 1**. The Site is located at 908 North Lawe Street, Appleton, Wisconsin, and is situated in a mixed area of industrial and residential properties as seen on the aerial photograph, **Figure 2**.

Currently, the Site property is owned by Luvata Appleton, LLC and consists of one (1) single-story slab-on-grade manufacturing building of approximately 42,500 square feet and an attached warehouse of approximately 10,500 square feet. The warehouse has a partial basement in the southeast corner that has an approximate area of 1,300 square feet and is 11 feet below grade (**Figure 3**). As seen on **Figure 2**, the Site is nearly completely under roof or paved. Adjacent properties to the north, west, and south are industrial, while adjacent properties to the east are residential.

As can be seen on **Figure 1**, the topography in the immediate area of the Site is relatively flat, slightly sloping downward to the east. A surface water drainage channel leading to the Fox River exists approximately 1,200 feet from the Site to the east. The Fox River at its closest point to the Site is located approximately 2,800 feet to the southeast. Water in the Fox River flows to the northeast.

2.2 History of Ownership, Operations, and Discovery of Impacts

Based on available information, the Site and adjacent Appleton Papers, Inc. property was owned by Albany International Corp. and operated as Appleton Wire from 1963 to 1983. The northern portion of the parcel was sold to Valley Cast in 1984, which was then sold to Luvata Appleton, LLC (Luvata) in 2006. The southern portion of the Site was sold to Appleton Papers, Inc. (now Appvion) sometime between 1985 and 1990, which has resulted in the current ownership and property boundaries shown on **Figure 2**.

Appleton Wire performed chrome plating operations from 1963 to 1981 in the current warehouse area shown on **Figure 3**. Since then, the plating equipment and machinery has been removed, and plating is no longer performed at the Site. There were two (2) chrome plating lines, one over the basement area in the southeast section of the warehouse, and one in the northeast section of the warehouse. The plating lines were oriented east/west. Wire mesh used in the paper making industry was plated with hard chrome to increase durability. The form of chromium used for plating was hexavalent chromium. Chrome plating solution was pumped up to the plating lines from an above ground storage tank located in the south portion of the basement. Conversations with persons familiar with past Site operations have indicated that the solution was fed directly into the southern plating line, while the solution was fed to the northern line via piping contained within a concrete lined trench, the location of which is shown on **Figure 3**. The concrete-lined trench was sloped back to the basement area. It was also indicated that during decommissioning efforts, the piping within the trench was observed to be deteriorated and that leaks from the piping likely occurred. Staining in the concrete block wall in the basement where the old piping trench entered the basement provides evidence that plating solution entered the subsurface from this source. In addition, scouring of the floor surfaces in the warehouse area and in the basement are indicators that floor spills of the highly caustic (acidic) plating solution occurred.

Evidently, the basement area of the warehouse is prone to flooding and sump and pump are located in the northeast corner to control this. In 1982, the basement area flooded with 2-3 feet of water and periodically thereafter. In 1985, yellow coloration of the flood water was reported to Albany International. Subsequent soil sampling by STS Consultants, Inc. (STS) in 1986 revealed chromium contamination, which was then reported to the Wisconsin Department of Natural Resources (WDNR).

2.3 Summary of Past Sub-surface Investigations and Remedial Actions

The following is brief summary of Site investigations and remedial actions performed by various consultants to date. The locations of past data collection points and other items of interest can be seen on **Figure 3**. The locations of data points on **Figure 3** were scaled off several existing figures of past consultants and the scaling of these points may not be survey accurate.

Between 1985 and 1990, STS completed several rounds of investigations to determine the extent of soil and groundwater impacts. As a first phase of investigation in 1985, soil samples were collected from borings B-1, B-2, and B-3. In addition, three (3) test pits were dug on the north side of the warehouse building. The soil samples contained significant concentrations of chromium, and groundwater samples from all temporary wells contained chromium at levels exceeding the groundwater enforcement standard (ES) at the time of 50 micrograms per liter (ug/l). (The current ES for chromium is 100 ug/l and the preventative action limit is 10 ug/l). This discovery prompted sampling of groundwater in basement sumps of residences located across Meade Street to the east. Sump samples were collected from the residence at 806 and 820 N. Meade Street (see **Figure 3** for locations of properties). The property at 814 N. Meade Street does not have a basement and the owners of property 802 N. Meade Street were not available at the time. The groundwater sump samples collected at 806 and 820 did not contain detectable concentrations of either total chromium or hexavalent chromium (CrVI).

STS collected shallow soil samples from below the basement slab, the warehouse slab, and through the basement walls (C-1 through C-6) and collected water samples from installed water table wells MW-1, MW-2, MW-5, MW-10 (abandoned and replaced with MW-10R in 1998 or 1999), MW-11, MW-17, and piezometers MW-2A, MW-5A, and MW-17A located to better determine the distribution of chromium impacts inside and outside of the warehouse building.

Based on results of these investigations, unconsolidated soil was determined to consist of 1-3 feet of sandy fill, followed by silty clay. The silty clay was observed to be fractured with additional secondary porosity. However, later slug testing performed in five (5) of the water table wells and three (3) of the piezometers showed hydraulic conductivity values ranged between $9.7\text{x}10^{-6}$ and $1.4\text{x}10^{-7}$ centimeters per second (cm/s), which are very low. The lower values for hydraulic conductivity were observed in the piezometers indicating that the permeability of the clay soil decreases with depth. The pH of soil samples collected ranged from 7.6 to 8.6, which is slightly to moderately alkaline.

STS concluded that soil and groundwater impacts were concentrated below the basement, limited in extent to approximately 30 feet laterally away from the warehouse building, and limited in depth to approximately 15 feet deep (refer to **Table 1** for a summary of soil analytical results and **Table 2** for groundwater analytical results). The water table in the silty clay and fill was encountered from 3-8 feet and was determined to flow in an easterly direction. However, it was felt that nearby utilities and the building foundations were affecting the flow of groundwater. It was also determined that the vast majority of chromium detected in groundwater was of the form of CrVI. Background concentrations of chromium were determined to range from 6-8 milligrams per kilogram (mg/kg).

Soil samples were collected from borings B-18 through B-23 to determine if soil was hazardous prior to excavation and installation of a French drain to collect contaminated groundwater. It was determined that 180 milligrams per kilogram (mg/kg) of total chromium in soil represented the concentration that would exceed the EP toxicity characteristic of 5 mg/l. This limit was approved by the WDNR and utilized to determine waste handling criteria of soil excavated during installation of the French drain.

In 1988, STS began batch treatment of basement flood water by pumping from a sump located in the basement and treating by removing the chromium through precipitation, filtration, and discharge to the sanitary sewer system under permit from the City of Appleton. In 1992, STS directed the installation of a French drain along the north side of the warehouse building to enhance collection of groundwater for treatment to remove chromium (refer to the location of the French drain and collection trench outline on **Figure 3**). The groundwater collected in a large sump. The sump contained a submersible pump which relayed water to treatment storage tanks located in the basement of the warehouse and the water was treated to remove chromium through precipitation prior to discharge to the sanitary sewer system. In 1998, the precipitation and filtration process to remove chromium from the sump and French drain and basement sump water was replaced with a process of removal using ion-exchange resin.

Between 2002 and 2004, eleven temporary groundwater monitoring wells (GMW-01 through GMW-11) and a well cluster consisting of one (1) shallow and one (1) deep well (MW-18 and MW-18A, respectively) were installed as shown on **Figure 3** by McMahon Associates, Inc. to better define the extent of impacts and to determine the zone of groundwater capture resulting from operation of the remedial pump and treat system. Based on these additional wells, McMahon concluded that the extent of groundwater impacts had been determined, that contaminated groundwater was not migrating preferentially along the utilities in Meade Street, and the flow of contaminated groundwater was controlled and captured by the existing pump and treat system. It appears that only the sanitary sewer exiting the warehouse directly to the east was checked for impacts with no borings or wells north or south along the mains in Meade Street.

An additional well cluster (MW-19 and MW-19A) was installed by Badger Laboratories and Engineering, Inc. (Badger) in 2009. Soil borings GP-1 through GP-13 were completed in 2014 by Badger to better determine the distribution of soil impacts within the warehouse building. Based on the results, Badger installed additional well clusters MW-20 and MW-20A, and MW-21 and MW-21A to better define the distribution of impacts in groundwater. High concentrations of chromium in soil and groundwater were detected at the location of MW-20. It was discovered that a second plating line was located in this area.

2.4 Chromium in the Subsurface

Natural chromium can occur in subsurface soil of glacially deposited origin. Glaciers advanced from the north in Wisconsin scouring igneous and metamorphic bedrock of the Canadian Shield and northern Wisconsin. This type of bedrock contains many metals, including chromium. Upon melting, the glaciers deposited soil consisting of this material throughout most of Wisconsin. Chromium can exist in two valence states; trivalent chromium (Cr^{+3}) and hexavalent chromium (Cr^{+6}). The most common form of naturally occurring chromium is trivalent. Trivalent chromium can convert to hexavalent chromium in an oxidizing environment, but under low pH conditions not typical of the natural environment. Hexavalent chromium will also be persistent under oxidizing conditions.

Hexavalent chromium is acutely toxic, mutagenic and carcinogenic, as well as being very mobile and soluble in the environment. Hexavalent chromium can be reduced to trivalent chromium using various electron donors in solution such as ferrous iron, sodium or calcium metabisulfite, or calcium polysulfite to name a few. The trivalent chromium produced by the reduction of hexavalent chromium forms hydroxide precipitates which are largely immobile.

Reducing agents can be injected within the subsurface, can be infiltrated, or can be incorporated into reactive barrier walls. It is very important to know the soil and groundwater chemistry to determine the current geochemistry of the subsurface environment and establish a baseline. This information is needed to determine the type of reductant that will be effective, the application methods to utilize, the subsurface geochemical reactions that will occur, and to predict the changes in subsurface geochemistry that will prevail over time.

3.0 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) describes the characteristics of a site and the processes by which potential contaminants may move from source(s) to receptor(s). CSMs facilitate site understanding and help organize site activities. The CSM is constantly updated based on new Site data. The current version of the CSM is based on our review of existing Site data produced by former consultants.

3.1 Release Sources

Past Site operations from 1963 to 1981 have resulted in releases of chromium plating solution to the subsurface. The releases have been determined to be the result of floor spills around plating lines formerly located in the current warehouse structure and in a partial basement of that structure where plating solution was stored. In addition, leaking supply pipes within unlined concrete trenches likely contributed to the subsurface impacts. The contaminant of concern for this Site is hexavalent chromium, as this was the form of chromium used in the plating process and it has been determined that almost all total chromium concentrations detected in groundwater are in the hexavalent state (refer to groundwater results for wells MW-5, MW-19, and MW-20 in **Table 2**).

3.2 Geology/Hydrogeology

The geology encountered beneath the warehouse is predominantly silty clay of glacial origin and having low hydraulic conductivity. However, 1-3 feet of sandy fill was encountered below the slab of the warehouse and below the basement slab, and the clay was observed to be fractured in some locations causing higher secondary porosity locally and resulting in higher hydraulic conductivity. Dolomite bedrock is encountered at between 100 to 115 feet below ground surface in the Site area.

Background levels of total chromium can range up to 44 milligrams per kilogram (mg/kg) in Wisconsin according to the soil standards in WDNR PUB RR 890. Natural background concentrations of trivalent chromium at the Site can be factored from total chromium and hexavalent chromium concentrations measured in soil samples collected from STS borings B-1 through B-16 shown in **Table 1**. By subtracting the hexavalent chromium results from the total chromium results, it appears that background concentrations of trivalent chromium are between 5-8 mg/kg.

Groundwater was observed at approximately 5-6 feet below the floor of the warehouse, but water levels in groundwater monitoring wells fluctuate widely throughout the season in response to precipitation events. Due to the low hydraulic conductivity of the clay soil and localized secondary porosity, the wells do not recharge at the same rates which makes it difficult to directly correlate the groundwater elevations with a direction of groundwater flow. In addition, all existing water table monitoring wells, except wells MW-20 and MW-21 are constructed with screens that are submerged between 2 and 8 feet below the water table based on water table fluctuations. This may not allow an accurate measure of the potentiometric surface of the water table because there appears to be a downward hydraulic gradient between the water table wells and piezometers in each well cluster. The current pump and treat system operates continuously and affects the direction of groundwater flow, locally depressing the water table and directing groundwater towards the French drain and basement sump. The local terrain is relatively flat. However, the direction of natural groundwater flow in the shallow silty clay soil without the influence of the pump and treat system is expected to be in an easterly or southeasterly direction towards the Fox River and associated drainage channels. These surface drainage features can be seen on **Figure 1**.

Drinking water in the City of Appleton is supplied by several municipal wells. There are two (2) nearby municipal wells, but they are located greater than 2,000 feet southeast and southwest of the Site on the south side of the Fox River.

3.3 Observed Extent of Soil Impacts

Concentrations of chromium in past soil samples can be seen in **Table 1**. The lateral distribution of soil impacts can be seen on **Figure 4** and the vertical distribution can be seen on the geologic cross-sections (**Figures 6** and **7**). The analytical results of borings B-18 through B-23 are not shown on **Figure 4** at this time to reduce cluttering and also because these borings lie within the footprint of the existing groundwater recovery trench. As can be seen on these figures, chromium concentrations in soil within the warehouse source area appear concentrated near MW-20, GP-11, and beneath the basement floor at GP-12 and GP-13. The concentrations of chromium decrease with depth to between 15 and 20 mg/kg below a depth of approximately 20-25 feet bgs. The exception is directly below the basement area at GP-12 and GP-13, which were not sampled beyond 10 feet below the basement slab. Although chromium concentrations decrease with depth, they are above background levels, and deep piezometers MW-20A and MW-19A have periodic concentrations exceeding regulatory standards.

3.4 Observed Extent of Groundwater Impacts

Figure 5 shows the distribution of groundwater impacts. Only the last four (4) sampling events of existing Site wells have been included on this figure due to space limitations. In addition, the last four (4) events of some historical wells and grab water samples (now abandoned) have been included for perspective. The full set of groundwater analytical data can be seen in **Table 2**. In addition, groundwater concentrations with depth can be seen on **Figures 6** and **7**.

Concentrations of chromium below the ES in shallow groundwater appear defined to the south by well MW-1 and well MW-18; directly to the east by well MW-10R; to the north by former well GMW-11 and current well MW-17; to the southwest by MW-2; and directly to the west by well MW-21. The extent of impacts deeper within the water table is defined to the south by well MW-18A; to the southwest by well MWS-2A; to the west by well MW-21A; and to the northwest by well MW-17A. The extent of impacts directly to the north, northeast, and southeast are somewhat uncertain due to the lack of monitoring points.

As can be seen on **Figures 7** and **8**, and in **Table 2**, groundwater concentrations in deeper piezometers MW-5A, MW-19A, and MW-20A have periodically yielded groundwater having chromium impacts exceeding the groundwater enforcement standard (ES) of 100 micrograms per liter (ug/l) and/or the groundwater preventative action limit (PAL) of 10 ug/l. The data trends for these wells are not consistent, but concentrations appear to decrease over time. In addition, ES and/or PAL exceedances have been followed by multiple sampling events where no regulatory standards have been exceeded. This is most evident in the sampling history of MW-5A. The reason for these wide fluctuations in deeper concentrations is not currently known.

3.5 Effectiveness of Groundwater Pump and Treat System

The current groundwater collection and treatment system consists of a French drain along the north side of the warehouse and a sump located in the basement of the warehouse. These features can be seen on **Figures 3** through **5**, and **Figure 8**. Gravity drainage of groundwater is maintained by a submersible pump within a sump connected to the French drain. In addition, gravity drainage of groundwater below the basement floor is maintained by pumping from the basement sump. The pumps contain high level switches and automatically deliver groundwater on demand to two (2) 2,000-gallon tanks situated in the basement of the warehouse. An operator inspects water levels in the tanks several times a week, and determines when to batch treat the contaminated groundwater. The pH of the water is lowered in the treatment tanks and the water is manually pumped to ion-exchange filters located on the warehouse main floor. After filtration, the water is pumped back down to the treatment tanks, the pH of the water is raised, and then discharged to the City of Appleton sanitary sewer system under permit after testing has confirmed removal of chromium to acceptable discharge limits. This system has been in operation since 1988, or approximately 28 years.

Based on our review of past semi-annual system operation and groundwater sampling reports, the system has removed a considerable amount of chromium as seen in the summary of cumulative pounds of chromium removed, **Table 3**. During the period of system operation, groundwater concentrations in the French drain, basement sump, and several groundwater monitoring wells have decreased (see **Table 4** for historic analytical results of French drain sump and basement sump sampling, and **Table 2**). However, as can be seen in these tables and on **Figures 5**, **7**, and **8**, significant concentrations likely remain in saturated and unsaturated soil as observed by sustained concentrations in the sump samples and continued impacts in groundwater exceeding the ES, especially at the locations of MW-19 and MW-20. Groundwater flow maps constructed over time indicate that localized groundwater flow has been directed towards the groundwater collection system from the north and east (refer to past groundwater flow maps in **Attachment 1**). However, a groundwater high at MW-5 located just south of the warehouse indicates that periodically, the zone of capture does not extend to this well and may not capture the concentrations of chromium above the ES that exist near this well.

The concern with continued operation of the pump and treat system in its current configuration is the time it will take to achieve compliance with the groundwater standard, if ever. The silty clay soil of low permeability will continue to yield hexavalent chromium slowly. During the 1980's when the current system was installed, there were not many options for remediation of chromium other than excavation of unsaturated soil impacts and pumping and treatment of groundwater impacts. However, new methodologies have evolved since then that typically include fixation of hexavalent chromium by reduction and conversion to the less toxic trivalent form. Various methods can be utilized to introduce reducing agents to the subsurface which may shorten the time needed for continued groundwater extraction, or eliminate groundwater extraction altogether. Other potential remedial options that should be considered are limited excavation, and soil flushing.

4.0 WORK SCOPE FOR ADDITIONAL SITE INVESTIGATIONS

Previous investigations over the past 31 years are extensive and have helped define the degree and extent of subsurface impacts. However, there are data gaps that need to be filled in order to complete an assessment of the vertical and lateral distribution of hexavalent chromium impacts within the subsurface. Additional "sentinel" wells are needed around the perimeter of the impact areas to ensure that migration has not occurred off-site. Additional sampling is needed inside the warehouse areas to assess contaminant distribution near the former trench and to assess the size and shape of potential future treatment zones.

There is also additional data that needs to be collected to determine the existing geochemical conditions within the subsurface environment that will allow us to evaluate appropriate additional remedial actions aimed at reducing the time and cost to reach remedial endpoints.

Guidance is given in an EPA document, *In-Situ Treatment of Soil and Groundwater Contaminated with Chromium* (October 2000). In this document, the parameters recommended for characterization are summarized in Table 2-2, provided as **Attachment 2**. Additional parameters are also recommended for a complete understanding of the naturally occurring minerals and compounds that may become reactants.

The principles of adsorption and reduction are important in understanding the interaction of the contaminant and the impacted media, and so analysis of the cation exchange capacity (CEC) are recommended. The lower the CEC, the better suited the impacted material is for in-situ treatment. Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC) are proposed, which will allow the Particulate Organic Carbon (POC) to be calculated, and the fractional organic carbon (foc) should be measured in soil. The measurement and/or analysis of pH, Redox Potential (Eh) and total manganese, iron, aluminum, nitrate, nitrite, and sulfate are proposed as they are critical in understanding current subsurface conditions and the feasibility of in-situ methods. These additional tests will be referred to as the "suite of geochemical parameters", which are proposed in a limited amount of select soil sample locations. The analyses of these parameters vary between soil and groundwater and the differences will be explained in section 4.2 below.

These additional tests will be collected from a limited amount of select soil and groundwater sample locations within and outside the contaminant source area. The data will be evaluated to allow a thorough feasibility of treatment options to be assessed as part of the development of a Remedial Action Options Report (RAOR).

The following sections provide details of means, methods, and justification for this proposed additional work.

4.1 General Work Elements

EnviroForensics recommends the following main work elements based on data gaps that were recognized during our review of past site investigative data. The locations of proposed additional data collection points are shown on **Figure 9**. Details regarding construction, sampling and analysis procedures are presented in the following section 4.2:

1. A deeper piezometer should be installed at the location of well MW-10R having a five-foot long screen set at between 40-45 feet below grade. Soil samples collected in the basement of the warehouse contained considerable concentrations of chromium to at least 10 feet below the floor at GP-13. The basement is 11 feet below grade, so impacts are at least 20 feet below grade. MW-10R is a water table well with the screen interval set at approximately 10-20 feet below grade. A deeper piezometer is needed to determine if there has been vertical migration of groundwater impacts directly to the east of the source area. This proposed well is labeled MW-10A;

2. Additional permanent well clusters MW-22/MW-22A, MW-23/MW-23A, and MW-24/MW-24A consisting of a water table well set from 4-14 feet below grade and a piezometer set between 35-40 feet below grade and a single piezometer installed adjacent to MW-1 (MW-1A) should be screened between 40-45 feet below grade. These wells are designed to complete the lateral and vertical extents of impacts to the north, northeast, east, south, and southeast of the source area and will act as "sentinel wells" to monitor the clean boundaries. The groundwater elevation measurements taken in the water table wells will allow a more accurate determination of the direction of groundwater flow;

3. Groundwater grab samples should be collected both north and south of the warehouse between the water and sanitary sewer mains located within Meade Street at locations labeled UB-1 and UB-2. The samples will ensure that these utilities have not acted as preferential migration pathways for Site impacts. The utilities lie at depths of between 10-15 feet below grade and are beneath the water table. The utilities are likely bedded in gravel. Geo-imaging will be utilized to locate the sanitary sewer accurately so that the gravel backfill can be contacted. Due to the depth of these utilities, hand augers cannot be used. Instead direct push methods will be used to set one-inch diameter well points for collecting water samples. These well points will be removed immediately upon collecting a sample and the borehole will be abandoned and the surfacing repaired. If recharge is too slow, they will be completed as temporary wells with flush mount covers;

4. An additional deep piezometer should be installed at MW-5B to determine the vertical extent of impacts at this location. The well screen should be set at between 55 to 60 feet below grade; and

5. Additional temporary single wells and well nests labeled with a "TW" identifier should be located within the warehouse area. These data points will be completed to better assess the distribution of subsurface impacts and to collect geochemical parameters, both in soil and groundwater. The distribution of impacts within this source area is critical for assessing potential *in-situ* remedial methods. These temporary wells may also serve a purpose during any follow up remedial pilot testing that may be recommended. The screen intervals and construction details of these wells are provided in section 4.2 below.

4.2 Procedures

The detailed procedures for completing the main work scope elements are provided in this section.

4.2.1 Access

Access agreements will be secured from Luvata Appleton, LLC and Appvion for planned work on their premises. Access will also be required from the City of Appleton because utility borings UB-1 and UB-2, and monitoring wells MW-23/MW-23A, MW-10A, and MW-24/MW-24A will be installed within the Meade Street right-of-way.

4.2.2 Utility Clearance and Traffic Control

Prior to drilling, utility clearance will be obtained in accordance with safe work practices by notifying Diggers Hotline. In addition, EnviroForensics will subcontract a private locate service to perform subsurface geophysical imaging to locate private utilities and clear soil boring and monitoring well locations. Geophysical imaging will also be employed to help confirm the exact locations and depths of the water main and sanitary sewer main located within Meade Street. Methods for the subsurface imaging include ground penetrating radar (GPR) and other electro-magnetic metal detection systems.

Traffic control will be maintained during completion of borings and grab water sampling at the locations of UB-1 and UB-2. Traffic control will be performed in accordance with the 2009 Manual on Uniform Traffic Control Devices (MUTCD) and other local requirements.

4.2.3 Health & Safety Plan

EnviroForensics recognizes and stresses the importance of safe work practices for site workers and the public. Prior to the onset of field activities, EnviroForensics will modify the current Health and Safety Plan (HASP) for this project to include the work elements of this scoping document. The HASP will be used by members of the project team, all of whom have completed and are current with the requisite Hazardous Waste Operations Training (29 CFR 1910.120). The HASP will provide health and safety guidelines for the investigation activities and will address key safety issues and potential hazards associated with the project. The HASP will describe the scope of work, specify the appropriate personal protective equipment (PPE), discuss emergency procedures and contacts, list project team member responsibilities, and outline work zones and decontamination procedures to be used. All site personnel will be required to read and sign the HASP prior to beginning work, to acknowledge that they understand the contents of the HASP and will abide by it. All personnel that enter the work areas will be equipped with the minimum level of PPE specified by the HASP.

The anticipated occupational hazards of hexavalent chromium are ingestion and inhalation of dust. This could occur during drilling within the warehouse area. It is anticipated that dust will be low due to moisture within the unsaturated soil and saturated soil below 5-6 feet. In addition, concrete coring will be performed with water as a lubricant. It is anticipated that PPE will consist of modified level D with full Tyvek suits, booties, and nitrile gloves. Since the warehouse is actively operated by Appvion employees, the warehouse will be cordoned off during drilling procedures to restrict access to Appvion employees that are not protected with PPE. Site workers will be required to change discard PPE if they leave this “exclusion zone”, and will don new PPE when re-entering. Full or half-face respirators will be available, and their use will be evaluated during drilling operations.

4.2.4 Soil Boring Procedures and Sampling Protocol

Soil samples will be collected from temporary well locations to determine the distribution of impacts within the warehouse source area and to establish existing geochemical parameters. Soil samples will also be collected from some permanent well locations to establish geochemical parameters outside of the impact zone.

Soil Borings

Where soil samples are needed, they will collected using direct push technology. Upon completion, the boreholes will be enlarged using augers to facilitate well installations. Soil cores of five-feet in length will be collected in acetate sleeves continuously to the depth of termination during direct push sampling. Soil lithology will be continuously logged in accordance with the Unified Soil Classification System (USCS). New disposable nitrile gloves will be worn by the field geologist and new plastic sleeves will be inserted into the sample probe for each sample. The sample sleeves will be placed on plastic and the cutting tool and soil sampling tools will be decontaminated using an Alconox™ cleaning solution with a triple rinse in fresh water between samples for the duration of sampling. Decontamination of the sample probe will occur between each sample, and the push rods decontaminated between each borehole.

The borings for temporary wells TW-1A and TW-4A will be completed in areas having high concentrations of impacts. To minimize the potential for draw-down of contaminants to deeper zones, direct push sampling will be terminated at an initial depth of 25 feet. Hollow stem augers will then be used to enlarge the borehole. The augers will be left in place to act as a borehole seal, and the direct push probe will be advanced down the center of the augers to the depth of completion.

Investigation-derived media generated during direct push sampling will include soil cuttings and will be contained in labeled US Department of Transportation (DOT) 17H-rated drums, or equivalent, and staged onsite awaiting management.

Soil Analyses

Soil samples will be analyzed for total chromium using U.S. EPA SW 846, Method 6010B, and hexavalent chromium by EPA SW 846, Method 7196A. In addition, select soil samples will be analyzed for the "suite of geochemical parameters". The suite of geochemical parameters and their respective analytical methods for soil are as follows:

- Oxidation/reduction potential (ORP) by U.S. EPA SW 846, Method 2580B;
- Fraction organic carbon (Foc) by Walkley-Black Method, MSA Part 3 (1996);
- Cation exchange capacity (CEC) using MSA, Part 3 (1996);
- pH using EPA SW 846, Method 7045C; and
- Manganese, barium, iron, and aluminum using EPA SW 846, Method 6010.

Soil samples for laboratory analyses will be collected from the following locations and analyzed for the stated parameters:

- Four (4) samples for total chromium analysis will be collected from each of the borings for temporary wells TW-1A and TW-4A from the depth intervals of 40-45, 45-50, 50-55, and 55-60 feet. Two (2) samples for hexavalent chromium analysis will be collected from each of the borings at the depth intervals of 0-5 and 10-15 feet for speciation purposes. Two (2) samples for analysis of the geochemical parameters will be collected from each of the borings at the depth intervals of 5-10 and 20-25 feet;

- Soil samples for total chromium analysis will be collected from each five-foot interval in the borings for temporary wells TW-2A, TW-3A, and TW-5A through TW-8A to a depth of 40 feet. This will result in a total of seven (7) samples from each location or a total of 42 samples. In addition, three (3) samples from each boring will be collected from the depth intervals of 0-5, 10-15, and 20-25 feet for hexavalent chromium speciation for a total of 21 samples for hexavalent chromium analysis;

- Two (2) samples for the analysis of geochemical parameters will be collected from TW-3 at the depth intervals of 5-10 and 20-25 feet; and

- Two (2) samples for the analysis of geochemical parameters will be collected from each of the borings for permanent wells MW-1A and MW-22 at the depth intervals of 5-10 and 20-25 feet.

The soil samples will be sent to ESC Lab Sciences, Tennessee under appropriate chain of custody for analysis. This laboratory is certified in the State of Wisconsin. Upon completion of soil sampling, the boreholes will be enlarged with hollow-stem augers for installation of the permanent and temporary wells.

4.2.5 Well Construction Procedures and Sampling Protocol

Permanent Well Construction

Permanent wells MW-1A, MW-5B, and MW-10A, and well clusters MW-22/MW-22A, MW-23/MW-23A, and MW-24/MW-24A will be installed using hollow stem augers having an inside diameter of 4.25 inches. The rules in NR 141 will be followed for installation of all permanent water table wells and piezometers.

Wells MW-22, MW-23, and MW-24 are water-table monitoring wells and will be constructed with 2-inch diameter PVC riser and screen sections. The screens will be constructed with 0.010-

inch slots. Water table wells will have screen lengths of ten feet. The well screens of the water table wells will be installed to intersect the soil/groundwater interface. Based on previous observations of depth to groundwater, the wells are expected to be screened from roughly 4-14 feet below ground surface. This will result in a shortened filter pack seal and annular space seal. Therefore, sand pack materials will be placed from the bottom of the screen up to 6-inches above the well screen. In compliance with NR 141, the filter pack seal will consist of 6-inches of fine sand placed on top of the filter pack and hydrated bentonite granules will be used to seal the remaining annular space to just below ground surface.

Permanent piezometers MW-1A, MW-5B, MW-10A, MW-22A, MW-23A, and MW-24A will be constructed of similar materials as the water table wells, but the screens will be 5-feet in length. All piezometers, except MW-5A will be installed to a total depth of 40 feet below grade. MW-5A will be installed to a total depth of 60 feet below grade. It is expected that the column of standing water in these wells will be greater than 30 feet. According to NR 141, wells with standing water greater than 30 feet require that the annular space seal consist of high-solids grout. This is to prevent bridging or incomplete sealing of the borehole due to expansion of bentonite chips or pellets as they move through the water column. However, past Site data indicates that recharge is very slow to the existing wells, and complete recharge can take days. Therefore a variance will be requested from the WDNR to use bentonite chips for the annular space seal because they are much easier to work with than high-solids grout. If approved, the filter pack will extend 2-feet above the screen and the filter pack seal will consist of 2-feet of fine sand, followed by bentonite chips to just below ground surface.

Utility Grab Water Samples

Water samples will be collected at the locations of UB-1 and UB-2. Direct push soil borings will be utilized to extract the groundwater samples. It is anticipated that the disturbed soil and backfill of the sanitary sewer main will be contacted. This material is below the water table and should yield good quantities of water. A temporary 5-foot section of 1-inch diameter PVC well screen with attached riser will be lowered into each borehole to the invert of the sanitary sewer and the borehole will be filled to the top of the screen with filter pack sand. Two (2) water samples will be collected from each location using a disposable bailer. One sample will be unfiltered, and the other sample will be passed through a 0.45 micron filter using a filter press. Both samples from each boring location will be analyzed for total chromium by EPA SW 846, Method 6010/200.7.

Temporary Well Construction

Temporary wells TW-1A and TW-4A are deep piezometers screened from 55-60 feet below grade. They will be installed in areas of high soil impacts. To prevent the draw-down of soil impacts to lower depths, these wells will be installed unconventionally which will require a variance from the WDNR. It is proposed that these wells consist of 1-inch diameter PVC well casing and factory pre-packed well screens having a length of five feet. The well screens are constructed of a PVC inner core having a 1-inch inside diameter and 0.010-inch factory cut slots. A filter pack consisting of washed 20/40 mesh sand is packed around the screen and stabilized in place with stainless steel wire mesh sized to retain the filter pack sand. Upon installing the pre-packed screen, the direct push probe is raised and the remaining well installation elements can be put in place. Diagrams of this type of well are provided in **Attachment 3**.

Temporary well nests TW-2/TW-2A, TW-3/TW-3A, and TW-5/TW-5A through TW-8/TW-8A will consist each of two (2) one-inch diameter PVC wells in a single borehole having an outside diameter of approximately 8.5 inches. This configuration will also require a variance from the WDNR. These wells will be installed using a combination of hollow stem augers having an inside diameter of 4.25-inches and direct push methods. The piezometer screen length will be five-feet long and the water table screen length will be ten-feet long. The shallow well will be screened to intersect the water table at between 4 to 14 feet below grade, and the deeper screen will be installed from 35-40 below grade.

The deeper piezometer within each cluster will have factory pre-packed screens of the construction configurations previously discussed. They will be installed through the direct push probe that will be advanced through the hollow stem augers which will be set in place at a depth of 25 feet to limit draw-down of contaminants from upper zones. The piezometer will be completed with a filter pack seal of fine sand extending two feet above the screen and the annular space will be filled with hydrated bentonite chips. This will allow an annular space seal between the two wells of approximately 17 feet. Two feet of fine sand will be emplaced on top of the bentonite seal, and the water table well will be installed. The filter pack seal for the water table well will be shortened to 6-inches of fine sand and hydrated bentonite granules will be used as the annular space seal to just below grade.

Surface completions for each of the temporary water table wells and piezometers will consist of flush mount well vaults cemented into the existing floor slab. Expandable locking caps and keyed alike locks will be placed on each well.

Investigation-derived media generated during direct push sampling will include soil cuttings and will be contained in labeled US Department of Transportation (DOT) 17H-rated drums, or equivalent, and staged onsite awaiting management.

Well Development Procedures

All permanent and temporary groundwater monitoring wells will be developed at least 24 hours after well installation. Past monitoring data indicates that wells within the clay soil recharge slowly and more time may be needed for adequate recharge. Well development procedures will consist of removing 3 to 5 well volumes of water with a submersible bladder pump or bailers, as appropriate for recharge. Surging will be used during the development process to remove fine grained sediment from the sand pack and create good communication between the borehole and surrounding formation. Decontamination of the pump will be completed between each monitoring well. Disposable tubing will be used during the well development activities with new tubing employed at each new monitoring well. If recharge is very slow, then the wells may be developed using bailers. The bailers will be suspended within the wells for use in future sampling.

Groundwater Sample Analyses

All groundwater samples will be analyzed for total chromium using U.S. EPA SW 846, Method 200.7. Samples from the temporary wells will be sampled once for hexavalent chromium per EPA SW 846, Method 7196A to compare speciation. Any groundwater samples having a visible coloration (typically yellow or green) will not be analyzed for hexavalent chromium since the test for hexavalent chromium is colorimetric and sample colorations will render results inaccurate.

The suite of geochemical parameters and their respective analytical methods for groundwater are as follows:

- Total organic carbon (TOC) using EPA SW 846, Method 5310C;
- Dissolved organic carbon (DOC) using EPA SW 846, Method 9060;
- Chemical oxygen demand (COD) using EPA SW 846, Method 5220D;
- Nitrate, nitrite, and sulfate using EPA SW 846, Method 353.2; and
- Dissolved and total manganese, iron, and aluminum (filtered, and unfiltered) using EPA SW 846, Method 200.7.

In addition to the above laboratory analyses, a multi-meter probe will be utilized to test all groundwater samples in the field for temperature, pH, electrical conductivity, DO, ORP, and turbidity. This suite of in-field samples will be referred to as "field parameters".

Groundwater samples for laboratory analyses will be collected from the following locations and analyzed for the stated parameters:

- Samples collected from all existing and new permanent and temporary monitoring wells and piezometers will be analyzed for total chromium. These samples will be filtered. Filtration will be accomplished by low-flow methods using an in-line filter, if groundwater recharge is adequate. Field parameters will be collected using the multi-meter probe during low-flow sampling. If recharge is not adequate, groundwater samples will be collected with a bailer, field parameters will be measured, and samples for chromium analysis will be passed through a 0.45 micron filter using a filter press;
- Samples collected from all temporary wells located inside the warehouse will be analyzed for hexavalent chromium. These samples will also be filtered. Any samples exhibiting visible coloration will not be analyzed; and
- Samples collected from MW-1, MW-1A, MW-22, MW-22A, MW-21, MW-21A, TW-1, TW-1A, TW-3, TW-3A, TW-4, and TW-4A will be analyzed for the groundwater suite of geochemical parameters.

Groundwater Sampling Procedures

All wells will be allowed at least 24 hours to stabilize after development and prior to sampling. Based on past observations, the wells may not stabilize for days. Prior to sampling, water level measurements will be collected from the well network using an electronic water level indicator. The monitoring wells will be allowed to equilibrate to atmospheric pressure by removing well lids a minimum of 15 minutes before measuring the water levels. The depth-to-water measurements will be recorded to the nearest 0.01 foot.

Groundwater sampling will be completed in accordance with standard low flow (minimal drawdown) groundwater sampling procedures using a bladder pump and multi-parameter water quality meter. Temperature, pH, Oxidation-Reduction Potential (ORP), specific conductance, and dissolved oxygen will be measured to verify stabilization prior to groundwater sample collection. Equipment will be calibrated prior to use. Data collected during the sampling activities will be documented on Low Flow Groundwater Field Sampling Forms and presented in the final report. If the wells cannot sustain low flow, a bailer will be utilized to purge the well dry. After allowing the wells to recharge, water samples will be collected using dedicated bailers.

Sample preservatives will be utilized as indicated by the analytical laboratory and following EPA

SW 846 Methods. Following sample collection, containers will be placed into a cooler containing ice and transported to State of Wisconsin Certified Laboratories for analysis. Hold times vary for the analytes and they will be met as needed. Proper chain-of-custody documentation will be maintained at all times.

One (1) duplicate groundwater sample will be collected for every ten (10) or fewer investigative samples, one (1) equipment blank sample will be collected for every ten (10) or fewer investigative groundwater samples if low flow sampling is utilized, and one (1) trip blank sample will be analyzed per sample cooler for quality assurance and quality control (QA/QC) purposes. If dedicated bailers are used, equipment blanks will not be collected.

Development water, purge water, and decontamination fluids will be stored on-Site in sealed and labeled DOT 17H-rated drums, or equivalent, until arrangements are made for testing and appropriate disposal.

Frequency of Groundwater Sampling

A new groundwater monitoring plan for all temporary and permanent Site wells will be established following the results of this investigation.

4.2.6 Comprehensive Site Survey

Following the installation of new temporary and permanent monitoring wells, a survey will be performed to locate the wells including northing and easting as well as state plane coordinates. The survey will also include the ground surface and top of casing elevations.

There is no comprehensive Site survey that correlates the locations of existing data points in reference to building structures and nearby points of interest such as: roadways, sidewalks, adjacent buildings and property boundaries, old piping runs inside the warehouse, or utilities. A comprehensive site survey will be performed to correlate these features along with the new data points.

4.2.7 Site Investigation Report (SIR)

It is anticipated that the extent of chromium impacts in all Site media will have been determined to the extent practicable for remedial planning upon completion of this investigation. If that is the outcome, then a comprehensive SIR report will be prepared to document all past and present investigation activities following the reporting requirements of Chapter NR 716 of the Wisconsin Administrative Code.

4.2.8 Remedial Action Options Report (RAOR)

Data is being collected during this proposed investigation to allow characterization of the subsurface geochemistry, which will allow for various alternate remedial strategies to be evaluated. Following WDNR approval of the NR 716 SIR, EnviroForensics will prepare an evaluation of potential remedial actions aimed at more effectively reducing the the chromium concentrations in soil and groundwater. Various remedial strategies will be evaluated for technical feasibility, relative ease of implementation, duration, and relative cost over time.

5.0 SCHEDULE

Upon approval of this work scope, EnviroForensics anticipates that all field work elements can be completed within three (3) months. Another two (2) months will be needed to complete the comprehensive SIR, if the results of this investigation are deemed complete.

TABLES

TABLE 1
SOIL ANALYTICAL RESULTS
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

Boring Identification	Sample Depth (feet)	Sample Date	Total Chromium	Hexavalent Chromium	TCLP Chrome
Industrial RCL [1]			**NE**	**5.58**	
Non-Industrial RCL [1]			**NE**	**0.293**	
B-1	8-9.5	2/12/1987	**5.8**	**0.2**	NA
B-2	2-3.5	2/12/1987	**12.7**	**0.4**	NA
B-3	4-5.5	2/12/1987	**5.6**	**0.5**	NA
B-4	2-3.5	2/12/1987	**7.6**	**0.6**	NA
B-5 / MW-5A	2.5-4	2/12/1987	**10.5**	**0.4**	NA
	5-6.5	2/12/1987	**9.7**	**0.2**	NA
	7.5-9	2/12/1987	**9.6**	**2.6**	NA
	10-11.5	2/12/1987	**18.2**	**18.2**	NA
	12.5-14	2/12/1987	**29.1**	**21.7**	NA
	15-16.5	2/12/1987	**7.9**	**0.2**	NA
B-6	2.5-4	2/12/1987	**6.6**	**0.2**	NA
B-7		NS			
B-8		NS			
B-9	7.5-9	2/12/1987	**7.1**	**0.2**	NA
	10-11.5	2/12/1987	**6.9**	**1.9**	NA
B-10	5-6.5	2/12/1987	**6.2**	**0.2**	NA
B-11	5-6.5	2/12/1987	**9.4**	**1.3**	NA
	7.5-9	2/12/1987	**9.5**	**0.9**	NA
	10-11.5	2/12/1987	**10.5**	**8.1**	NA
B-13	5-6.5	2/12/1987	**68.8**	**68.8**	NA
	7.5-9	2/12/1987	**44.6**	**44.6**	NA
	10-11.5	2/12/1987	**188**	**188**	NA
B-15	5-6.5	2/12/1987	**6.8**	**0.2**	NA
	7.5-9	2/12/1987	**5.6**	**2**	NA
B-16	5-6.5	2/12/1987	**6.5**	**0.2**	NA
	7.5-9	2/12/1987	**7.1**	**0.2**	NA
TP-1		NS			
TP-2	15	3/26/1986	**36.6**	**30.8**	NA
TP-3	13	3/26/1986	<0.30	<0.08	NA
C-1	0-1	8/14/1986	**0.6**	**0.6**	NA
C-2	0	8/14/1986	**7317**	**7,300**	NA
C-3	0-2	8/14/1986	<0.2	**0.1**	NA
C-4	1-1.5	8/14/1986	**57**	**57**	NA
C-5	NA	8/14/1986	**20**	**20**	NA
C-6	0-10	8/14/1986	**14**	**14**	NA

TABLE 1
SOIL ANALYTICAL RESULTS
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

Boring Identification	Sample Depth (feet)	Sample Date	Total Chromium	Hexavalent Chromium	TCLP Chrome
Industrial RCL [1]			**NE**	**5.58**	
Non-Industrial RCL [1]			**NE**	**0.293**	
B-18	2	2/1/1990	**26.1**	NA	NA
	3	2/1/1990	**46.7**	NA	NA
	4	2/1/1990	**38.7**	NA	NA
	5	2/1/1990	**40**	NA	NA
	6	2/1/1990	**36.6**	NA	NA
	7	2/1/1990	**23.9**	NA	NA
	8	2/1/1990	**20.9**	NA	NA
	9	2/1/1990	**20.2**	NA	NA
B-19	2	2/1/1990	**164**	NA	<0.04
	3	2/1/1990	**105**	NA	**0.4**
	4	2/1/1990	**138**	NA	**1.7**
	5	2/1/1990	**103**	NA	**2.8**
	6	2/1/1990	**42.8**	NA	NA
	7	2/1/1990	**24.7**	NA	NA
	8	2/1/1990	**23.6**	NA	NA
	9	2/1/1990	**22.6**	NA	NA
B-20	2	2/1/1990	**96.2**	NA	NA
	3	2/1/1990	**111**	NA	**0.97**
	4	2/1/1990	**138**	NA	**4**
	5	2/1/1990	**340**	NA	**10.1**
	6	2/1/1990	**167**	NA	4.5
	7	2/1/1990	**20.5**	NA	NA
	8	2/1/1990	**22.2**	NA	NA
	9	2/1/1990	**22.2**	NA	NA
B-21	2	2/1/1990	**138**	NA	<0.04
	3	2/1/1990	**148**	NA	**0.24**
	4	2/1/1990	**170**	NA	**4.3**
	5	2/1/1990	**439**	NA	**10.9**
	6	2/1/1990	**596**	NA	**21.5**
	7	2/1/1990	**280**	NA	**1.8**
	8	2/1/1990	**20.4**	NA	NA
	9	2/1/1990	**19.6**	NA	NA
B-22	2	2/1/1990	**472**	NA	<0.04
	3	2/1/1990	**150**	NA	<0.04
	4	2/1/1990	**121**	NA	**1.2**
	5	2/1/1990	**184**	NA	**5**
	6	2/1/1990	**510**	NA	**15**
	7	2/1/1990	**21**	NA	NA
	8	2/1/1990	**20.9**	NA	NA
	9	2/1/1990	**21.8**	NA	NA

TABLE 1
SOIL ANALYTICAL RESULTS
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

Boring Identification	Sample Depth (feet)	Sample Date	Total Chromium	Hexavalent Chromium	TCLP Chrome
Industrial RCL [1]			**NE**	**5.58**	
Non-Industrial RCL [1]			**NE**	**0.293**	
B-23	2	2/1/1990	**20.4**	NA	NA
	3	2/1/1990	**108**	NA	**0.83**
	4	2/1/1990	**142**	NA	**3.4**
	5	2/1/1990	**203**	NA	**7**
	6	2/1/1990	**140**	NA	**4.1**
MW-20A	0-5	5/13/2014	**362**	**3.08**	**2.6**
	5-10	5/13/2014	**146**	**0.941**	**1.5**
	10-15	5/13/2014	**263**	NA	**4.5**
	15-20	5/13/2014	**24**	**0.469**	NA
	20-25	5/13/2014	**16**	**0.55**	NA
	25-30	5/13/2014	**17**	**0.277**	NA
	30-35	5/13/2014	**15**	<0.231	NA
	35-40	5/13/2014	**15**	<0.211	NA
MW-21A	0-5	5/14/2014	**21**	<0.229	NA
	5-10	5/14/2014	**13**	<0.224	NA
	10-15	5/14/2014	**18**	NA	NA
	15-20	5/14/2014	**15**	<0.226	NA
GP-1	0-5	5/13/2014	NS	NS	NS
	5-10	5/13/2014	**37**	<0.221	NA
	10-15	5/13/2014	**18**	NA	NA
	15-20	5/13/2014	**62**	<0.234	NA
GP-2	0-5	5/13/2014	**25**	<0.253	NA
	5-10	5/13/2014	**18**	<0.211	NA
	10-15	5/13/2014	NS	NS	NS
	15-20	5/13/2014	NS	NS	NS
GP-3	0-5	5/13/2014	**27**	<0.212	NA
	5-10	5/13/2014	**55**	<0.223	NA
	10-15	5/13/2014	NS	NS	NS
	15-20	5/13/2014	NS	NS	NS
GP-6	0-5	5/13/2014	**51**	<0.229	NA
	5-10	5/13/2014	**18**	**1.23**	NA
	10-15	5/13/2014	**23**	NA	NA
	15-20	5/13/2014	NS	NS	NS
GP-7	0-5	5/12/2014	**18**	<0.227	NA
	5-10	5/12/2014	**18**	**0.368**	NA
	10-15	5/12/2014	**22**	NA	NA
	15-20	5/12/2014	**28**	**0.287**	NA

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TABLE 1

SOIL ANALYTICAL RESULTS

Albany International - Luvata Site

908 N. Lawe St., Appleton, WI 54911

Boring Identification	Sample Depth (feet)	Sample Date	Total Chromium	Hexavalent Chromium	TCLP Chrome
Industrial RCL [1]			**NE**	**5.58**	
Non-Industrial RCL [1]			**NE**	**0.293**	
GP-8	0-5	5/12/2014	**39**	**0.45**	NA
	5-10	5/12/2014	**48**	**0.761**	NA
	10-15	5/12/2014	**46**	NA	NA
	15-20	5/12/2014	NS	NS	NS
GP-9	0-5	5/12/2014	**29**	<0.228	NA
	5-10	5/12/2014	**42**	**0.748**	NA
	10-15	5/12/2014	**23**	NA	NA
	15-20	5/12/2014	**15**	0.774	NA
GP-10	0-5	5/12/2014	**77**	**10.3**	NA
	5-10	5/12/2014	**48**	**1.11**	NA
	10-15	5/12/2014	**22**	NA	NA
	15-20	5/12/2014	NS	NS	NS
GP-11	0-5	5/12/2014	**1130**	**4.48**	**13**
	5-10	5/12/2014	**76**	**1.77**	NA
	10-15	5/12/2014	**45**	NA	NA
	15-20	5/12/2014	**15**	<0.236	NA
GP-12	0-5	5/12/2014	**355**	<0.221	**0.09**
	5-10	5/12/2014	**128**	<0.237	<0.03
	10-15	5/12/2014	NS	NS	NS
	15-20	5/12/2014	NS	NS	NS
GP-13	0-5	5/12/2014	**164**	**3.06**	<0.03
	5-10	5/12/2014	**43**	**0.306**	NA
	10-15	5/12/2014	NS	NS	NS
	15-20	5/12/2014	NS	NS	NS

Notes:

[1] Residual Contaminant Levels calculated according to the procedures described in WDNR Publication RR-890

All concentrations reported in milligrams per kilogram mg/kg

Bolded values are above Laboratory Detection Limits

Bolded and Orange Shaded value indicates an exceedance of the Industrial Residual Contaminant Level

Bolded and Green Shaded value indicates an exceedance of the Non-Industrial Residual Contaminant Level

Bolded and Blue Shaded value indicates an exceedance of the EP Toxicity limit of 5 mg/l.

TCLP = Toxicity Characteristic Leaching Procedure

NS = Not Sampled

RCL = Residual Contaminant Level

NA = Not Analyzed

NE = Not Established

TABLE 2
GROUNDWATER ANALYTICAL RESULTS
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
B-1	06/05/17	0.19	0.19
B-2	06/05/17	8.4	8.4
B-3	06/05/17	*27*	23
GP-7 (Temp)	05/12/14	**183**	29
GP-13 (Temp)	05/13/14	**2,991**	1,600
MW-1	02/09/87	*50*	NA
	07/29/87	<40	NA
	09/25/87	<100	NA
	12/11/87	<100	NA
	03/21/88	*1.6*	NA
	06/13/88	3.0	NA
	09/08/88	*9*	NA
	12/15/88	2.5	NA
	03/26/92	<40	NA
	06/16/92	4.9	NA
	09/04/92	*50*	NA
	12/17/92	NS	NS
	03/25/93	<80	NA
	06/22/93	NS	NS
	09/16/93	<80	NA
	12/03/93	NS	NS
	03/15/94	<70	NA
	06/16/94	NS	NS
	09/20/94	*13*	NA
	12/13/94	NS	NS
	03/31/95	*39*	NA
	06/15/95	NS	NS
	09/07/95	7.2	NA
	12/11/95	NS	NS
	03/15/96	*15*	NA
	06/27/96	NS	NS
	09/05/96	6.4	NA
	12/03/96	NS	NS
	04/26/97	*11*	NA
	04/30/98	*60*	NA

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TABLE 2
GROUNDWATER ANALYTICAL RESULTS
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
MW-1 (continued)	10/22/98	7	NA
	04/16/99	*12*	NA
	10/19/99	9.3	NA
	04/17/00	*22*	NA
	04/06/01	<11	NA
	04/18/02	<11	NA
	04/16/03	2.9	NA
	04/19/04	2.8	<2.0
	04/11/05	*82*	16
	07/18/05	<30	<2
	04/11/06	1.7	<2.0
	04/29/07	4	<2.0
	04/23/08	4.4	<2.0
	04/07/09	4.6	<0.1
	04/13/10	*26*	<3.0
	04/27/11	3	<3
	04/10/12	1.7	<3
	04/15/13	2.6	<2.6
	04/09/14	4.2	<3.0
	04/21/15	0.5	<0.5
	04/14/16	0.35	<2
MW-2	02/09/87	*70*	NA
	07/29/87	<40	NA
	09/25/87	**100**	NA
	12/11/87	**100**	NA
	03/21/88	*85*	NA
	06/13/88	**140**	NA
	09/08/88	*71*	NA
	12/15/88	**130**	NA
	03/26/92	<40	NA
	06/16/92	*17*	NA
	09/04/92	<40	NA
	12/17/92	NS	NS
	03/25/93	<80	NA
	06/22/93	NS	NS
	09/16/93	<80	NA
	12/03/93	NS	NS

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TABLE 2
GROUNDWATER ANALYTICAL RESULTS
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
MW-2 (continued)	03/15/94	<70	NA
	06/16/94	NS	NS
	09/20/94	*19*	NA
	12/13/94	NS	NS
	03/31/95	*19*	NA
	06/15/95	NS	NS
	09/07/95	*14*	NA
	12/11/95	NS	NS
	03/15/96	*11*	NA
	06/27/96	NS	NS
	09/05/96	*29*	NA
	12/03/96	NS	NS
	04/26/97	9.2	NA
	10/29/97	*10*	NA
	04/30/98	*11*	NA
	10/22/98	9.3	NA
	04/16/99	7.7	NA
	10/19/99	6.8	NA
	04/17/00	*22*	NA
	04/06/01	<11	NA
	04/18/02	<11	NA
	04/16/03	<1.1	NA
	04/19/04	1.0	<2.0
	04/11/05	1.3	<2.0
	04/11/06	0.4	<2.0
	04/29/07	1.5	<2.0
	04/23/08	2.4	<2.0
	04/07/09	8.3	<.1
	04/13/10	5	<3.0
	04/27/11	3	<3.0
	04/10/12	0.7	<3.0
	04/15/13	0.4	<.4
	04/09/14	0.6	<0.6
	04/21/15	0.94	<0.94
	04/14/16	4.9	<2

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TABLE 2
GROUNDWATER ANALYTICAL RESULTS
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
MW-2A	03/26/92	<40	NA
	06/16/92	1.5	NA
	09/04/92	<40	NA
	12/17/92	NS	NS
	03/25/93	<80	NA
	06/22/93	NS	NS
	09/16/93	<80	NA
	12/03/93	NS	NS
	03/15/94	<70	NA
	06/16/94	NS	NS
	09/20/94	*14*	NA
	12/13/94	NS	NS
	03/31/95	*17*	NA
	06/15/95	NS	NS
	09/07/95	3.9	NA
	12/11/95	NS	NS
	03/15/96	3.6	NA
	06/27/96	NS	NS
	09/05/96	1.2	NA
	12/03/96	NS	NS
	04/26/97	0.3	NA
	04/30/98	2.5	NA
	04/16/99	2.4	NA
	04/17/00	*23*	NA
	04/06/01	<11	NA
	04/18/02	<11	NA
	04/16/03	<1.1	NA
	04/19/04	0.6	<2.0
	04/11/05	0.4	<2.0
	04/11/06	<0.2	<2.0
	04/29/07	0.7	<2.0
	04/23/08	<0.4	<2.0
	04/07/09	1.5	<0.1
	04/13/10	5	<3.0
	04/27/11	2	<3.0
	04/10/12	0.5	<3.0
	04/15/13	<0.2	<0.2
	04/09/14	0.4	<0.4
	04/21/15	0.11	<0.11
	04/14/16	0.56	<2

TABLE 2
GROUNDWATER ANALYTICAL RESULTS
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
MW-5*	03/26/92	**33,000**	NA
	06/16/92	**27,000**	NA
	09/04/92	**33,000**	NA
	12/17/92	**28,000**	NA
	03/25/93	**29,000**	NA
	06/22/93	**24,000**	NA
	09/16/93	**25,000**	NA
	12/03/93	**26,000**	NA
	03/15/94	**26,000**	NA
	06/16/94	**2,013**	NA
	09/20/94	**29,000**	NA
	12/13/94	**19,000**	NA
	03/31/95	**19,960**	NA
	06/15/95	**21,190**	NA
	09/07/95	**25,400**	NA
	12/11/95	**18,000**	NA
	03/15/96	**15,830**	NA
	06/27/96	**18,000**	NA
	09/05/96	**14,000**	NA
	12/03/96	**24,000**	NA
	01/23/97	**22,000**	NA
	04/26/97	**17,000**	NA
	07/16/97	**20,000**	NA
	10/29/97	**1,600**	NA
	01/20/98	**18,000**	NA
	04/30/98	**15,000**	NA
	07/10/98	**18,000**	NA
	10/22/98	**21,000**	NA
	01/19/99	**14,000**	NA
	04/16/99	**15,000**	NA
	07/23/99	**14,000**	NA
	10/19/99	**18,175**	NA
	01/10/00	**12,000**	NA
	04/17/00	**8,500**	NA
	07/20/00	**11,000**	NA
	10/25/00	**8,500**	NA
	01/17/01	**14,000**	NA
	04/06/01	**7,900**	NA
	07/20/01	**10,000**	NA
	10/16/01	**12,000**	NA
	01/14/02	**11,000**	NA

TABLE 2
GROUNDWATER ANALYTICAL RESULTS
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
MW-5* (continued)	04/18/02	**5,500**	NA
	07/23/02	**788**	NA
	10/30/02	**1,500**	NA
	01/20/03	**19,000**	NA
	04/16/03	**7,000**	NA
	07/10/03	*33*	NA
	10/07/03	**3,300**	NA
	01/30/04	**1,200**	NA
	04/19/04	**7,900**	10,000
	07/26/04	**6,700**	6,300
	10/11/04	**6,500**	6,500
	01/12/05	**6,460**	6,300
	04/11/05	**5,085**	4,500
	07/18/05	**4,900**	4,900
	10/11/05	**5,100**	4,900
	01/10/06	**10,880**	10,000
	04/11/06	**4,455**	3,880
	07/27/06	**3,190**	3,400
	10/18/06	**5,100**	4,500
	01/09/07	**2,900**	2,800
	04/29/07	**2,895**	2,500
	07/24/07	**2,465**	2,465
	10/24/07	**3,205**	2,700
	01/16/08	**2,335**	2,300
	04/23/08	**2,067**	1,700
	07/15/08	**2,425**	1,700
	10/23/08	**2,400**	1,800
	01/22/09	**2,024**	1,900
	04/07/09	**2,116**	1,700
	07/07/09	**2,200**	2,000
	10/11/09	**2,500**	2,300
	01/19/10	**2,015**	1,900
	04/13/10	**1,600**	1,400
	07/29/10	**1,800**	1,300
	10/19/10	**1,700**	1,400
	01/13/11	**1,500**	1,400
	04/27/11	**1,200**	1,200
	07/19/11	**1,100**	1,000
	10/11/11	**1,100**	1,000
	01/10/12	**1,140**	950

TABLE 2
GROUNDWATER ANALYTICAL RESULTS
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Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
MW-5* (continued)	04/10/12	**1,200**	1,100
	08/08/12	**1,200**	49
	10/09/12	**1,139**	1,100
	01/08/13	**1,500**	1,310
	04/15/13	**1,166**	1,166
	07/10/13	**1,300**	1,300
	10/14/13	**1,338**	1,300
	01/15/14	**1,594**	1,730
	04/09/14	**1,430**	1,280
	07/08/14	**1,300**	1,180
	10/14/14	**960**	960
	01/13/15	**784**	670
	04/21/15	**576**	514
	07/15/15	**605**	591
	10/20/15	**604**	512
	01/21/16	**444**	408
	04/14/16	**462**	430
	07/14/16	**536**	466
	10/18/16	*37*	48
MW-5A*	02/09/87	*80*	NA
	07/29/87	**8,000**	NA
	09/25/87	**2,100**	NA
	12/11/87	**14,400**	NA
	03/21/88	**26,000**	NA
	06/13/88	**7,800**	NA
	09/08/88	**3,000**	NA
	12/15/88	**7,100**	NA
	03/26/92	**5,600**	NA
	06/16/92	**7,600**	NA
	09/04/92	**13,000**	NA
	12/17/92	**1,500**	NA
	03/25/93	**2,200**	NA
	06/22/93	**1,400**	NA
	09/16/93	**3,800**	NA
	12/03/93	**10,000**	NA
	03/15/94	**900**	NA
	06/16/94	**312**	NA
	09/20/94	**350**	NA
	12/13/94	**580**	NA
	03/31/95	**568**	NA

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TABLE 2
GROUNDWATER ANALYTICAL RESULTS
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
MW-5A* (continued)	06/15/95	**228**	NA
	09/07/95	**1,928**	NA
	12/11/95	*24*	NA
	03/15/96	**552**	NA
	06/27/96	**490**	NA
	09/05/96	**2,200**	NA
	12/03/96	**1,600**	NA
	01/23/97	**170**	NA
	04/26/97	*68*	NA
	07/16/97	*40*	NA
	10/29/97	**140**	NA
	01/20/98	**1,500**	NA
	04/30/98	**130**	NA
	07/10/98	**150**	NA
	10/22/98	**160**	NA
	01/19/99	**900**	NA
	04/16/99	*99*	NA
	07/23/99	*76*	NA
	10/19/99	**104**	NA
	01/10/00	**1,200**	NA
	04/17/00	**880**	NA
	07/20/00	**400**	NA
	10/25/00	**1,100**	NA
	01/17/01	**280**	NA
	04/06/01	*65*	NA
	07/20/01	*11*	NA
	10/16/01	*16*	NA
	01/14/02	*78*	NA
	04/18/02	**380**	NA
	07/23/02	**207**	NA
	10/30/02	*45*	NA
	01/20/03	**1,200**	NA
	04/16/03	**270**	NA
	07/10/03	**1,200**	NA
	10/07/03	*16*	NA
	01/30/04	*23*	NA
	04/19/04	**480**	82
	07/26/04	*40*	<4
	10/11/04	*12*	12
	01/12/05	*30*	<2
	04/11/05	*13*	10

TABLE 2
GROUNDWATER ANALYTICAL RESULTS
Albany International - Luvata Site
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Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
MW-5A* (continued)	07/18/05	<30	<2
	10/11/05	*26*	<2
	01/10/06	3.5	<2
	04//11/06	*36*	<2
	07/27/06	**755**	720
	10/18/06	5.2	5.2
	01/09/07	2.3	<2.0
	04/29/07	*12*	10
	07/24/07	2.4	<2.0
	10/24/07	2.7	<2.0
	01/16/08	*10*	<2.0
	04/23/08	**167**	20
	07/15/08	6.4	<1.0
	10/23/08	18	10
	01/22/09	**248**	210
	04/07/09	**630**	590
	07/07/09	7	<4.0
	10/11/09	*33*	<3.0
	01/19/10	*24*	<3.0
	04/13/10	7	7
	07/29/10	6	<3.0
	10/19/10	5	5
	01/13/11	5	5
	04/27/11	*27*	14
	07/19/11	<3	<3
	10/11/11	*11*	7
	01/10/12	*94*	60
	04/10/12	4.2	<3.0
	08/08/12	*49*	<3.0
	10/09/12	*39*	26
	01/08/13	7.9	<3.0
	04/15/13	3.7	<3.0
	07/10/13	**1,300**	<3.0
	10/14/13	*65*	67
	01/15/14	*23*	21
	04/09/14	*12*	7
	07/08/14	4	<3
	10/14/14	5	<3
	01/13/15	3.1	<3
	04/21/15	1.2	<1.2

TABLE 2
GROUNDWATER ANALYTICAL RESULTS
Albany International - Luvata Site
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Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
MW-5A* (continued)	07/15/15	4.6	<0.1
	10/20/15	*16*	<2.0
	01/21/16	7.8	<2.0
	04/14/16	1.2	9
	07/14/16	*12*	6
	10/18/16	0.79	<2
MW-10R	01/19/99	3.7	NA
	04/16/99	4.4	NA
	07/23/99	8.3	NA
	10/19/99	1	NA
	01/10/00	<11	NA
	04/17/00	*13*	NA
	07/20/00	*16*	NA
	10/25/00	<11	NA
	01/17/01	<11	NA
	04/06/01	<11	NA
	04/18/02	<11	NA
	04/30/03	1.1	NA
	04/19/04	1.2	<2.0
	04/11/05	1.2	<2.0
	07/18/05	<30	<2.0
	04/11/06	1	<2.0
	04/29/07	1.5	1.5
	04/23/08	3.5	3.5
	04/07/09	4.4	<0.1
	04/13/10	*11*	<3.0
	04/27/11	5	<3.0
	04/10/12	5.5	<3.0
	04/15/13	0.5	<0.5
	04/09/14	0.5	<0.5
	04/21/15	0.41	<0.41
	04/14/16	0.31	<2

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TABLE 2
GROUNDWATER ANALYTICAL RESULTS
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Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
MW-17	03/26/92	<40	NA
	06/16/92	1.3	NA
	09/04/92	<40	NA
	12/17/92	NS	NS
	03/25/93	<80	NA
	06/22/93	NS	NS
	09/16/93	<80	NA
	12/30/93	NS	NS
	03/15/94	<70	NA
	06/16/94	NS	NS
	09/20/94	*15*	NA
	12/13/94	NS	NS
	03/31/95	9.8	NA
	06/15/95	NS	NS
	09/07/95	8.1	NA
	12/11/95	NS	NS
	03/15/96	3.6	NA
	06/27/96	NS	NS
	09/05/96	2.4	NA
	12/03/96	NS	NS
	04/26/97	0.5	NA
	04/30/98	1.7	NA
	04/16/99	2.9	NA
	04/17/00	<11	NA
	04/06/01	<11	NA
	04/18/02	<11	NA
	04/16/03	<1.1	NA
	04/19/04	1.7	<2.0
	04/11/05	0.3	<2.0
	04/11/06	1.5	<2.0
	04/29/07	0.8	<2.0
	04/23/08	<0.4	<2.0
	04/07/09	1.7	<0.1
	04/13/10	12	<3.0
	04/27/11	2	<3.0
	04/10/12	0.4	<3.0
	04/15/13	<0.2	<0.2
	04/09/14	0.8	<0.8
	04/21/15	0.39	<0.39
	04/14/16	0.68	<2

TABLE 2
GROUNDWATER ANALYTICAL RESULTS
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Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
MW-17A	03/26/92	<40	NA
	06/16/92	*26*	NA
	09/04/92	<40	NA
	12/17/92	NS	NS
	03/25/93	<80	NA
	06/22/93	NS	NS
	09/16/93	<80	NA
	12/03/93	NS	NS
	03/15/94	<70	NA
	06/16/94	NS	NS
	09/20/94	*22*	NA
	12/13/94	NS	NS
	03/31/95	*14*	NA
	06/15/95	NS	NS
	09/07/95	6.4	NA
	12/11/95	NS	NS
	03/15/96	3.4	NA
	06/27/96	NS	NS
	09/05/96	0.7	NA
	12/03/96	NS	NS
	04/26/97	<.2	NA
	04/30/98	1.5	NA
	04/16/99	0.9	NA
	04/17/00	<11	NA
	04/06/01	<11	NA
	04/18/02	<11	NA
	04/16/03	<1.1	NA
	04/19/04	0.2	<2.0
	04/11/05	0.3	<2.0
	04/11/06	<0.2	<2.0
	04/29/07	0.2	<2.0
	04/23/08	<0.4	<2.0
	04/07/09	0.3	<0.1
	04/13/10	0.9	<3.0
	04/27/11	3	<3.0
	04/10/12	0.5	<3.0
	04/15/13	0.2	0.2
	04/09/14	0.2	<0.2
	04/21/15	0.17	<0.17
	04/14/16	<0.2	<2

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GROUNDWATER ANALYTICAL RESULTS
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Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
MW-18	08/13/02	<12	NA
	04/16/03	<1.1	NA
	04/19/04	<0.2	<2.0
	04/11/05	<0.2	<2.0
	04/11/06	<0.2	<2.0
	04/29/07	0.3	<2.0
	04/23/08	1.1	<4.0
	04/07/09	3.8	<0.1
	04/13/10	6.9	<3.0
	04/27/11	0.4	<3.0
	04/10/12	0.2	<3.0
	04/15/13	<0.2	<0.2
	04/09/14	0.4	<0.4
	04/21/15	<0.1	<0.1
	04/14/16	1.6	<2
MW-18A	08/13/02	<12	NA
	04/16/03	<1.1	NA
	04/19/04	<0.2	<2.0
	04/11/05	0.4	<2.0
	04/11/06	1.5	<2.0
	04/29/07	0.3	<2.0
	04/23/08	1.1	<4.0
	04/07/09	3.8	<2.0
	04/13/10	6.9	<3.0
	04/27/11	0.4	<3.0
	04/10/12	0.2	<3.0
	04/15/13	<0.2	<0.2
	04/09/14	3.3	<3.0
	04/21/15	*15*	<3.0
	04/14/16	<0.2	2

TABLE 2
GROUNDWATER ANALYTICAL RESULTS
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Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
MW-19	07/13/09	**13,000**	15,000
	07/28/09	**22,000**	20,000
	10/11/09	**5,300**	4,000
	01/19/10	**3,030**	2,600
	04/13/10	**5,270**	5,270
	07/29/10	**6,400**	3,900
	10/19/10	**7,100**	4,800
	01/13/11	**7,100**	7,100
	04/27/11	**15,000**	15,000
	07/19/11	**9,400**	8,700
	10/11/11	**21,000**	17,000
	01/10/12	**41,100**	40,000
	04/10/12	**21,672**	23,000
	08/08/12	**26,000**	26,000
	10/09/12	**14,187**	13,000
	01/08/13	**12,575**	11,000
	04/15/13	**16,300**	16,300
	07/10/13	**19,000**	19,000
	10/14/13	**15,440**	16,000
	04/09/14	**20,005**	20,005
	07/08/14	**18,000**	17,000
	10/14/14	**21,600**	21,300
	01/13/15	**18,050**	15,000
	04/21/15	**18,587**	18,000
	07/15/15	**17,200**	16,000
	10/20/15	**18,000**	18,000
	01/21/16	**15,295**	17,000
	04/14/16	**18,420**	18,100
	07/14/16	**16,227**	17,600
	10/18/16	**18,618**	17,100

ENVIRO forensics

TABLE 2
GROUNDWATER ANALYTICAL RESULTS
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
MW-19A	07/13/09	*30*	50
	07/28/09	*40*	40
	10/11/09	3	<3.0
	01/19/10	4.3	<3.0
	04/13/10	8.2	<3.0
	07/29/10	3	<3.0
	10/19/10	1	<3.0
	01/13/11	1	1
	04/27/11	3	3
	07/19/11	**143**	<3
	10/11/11	4	4
	01/10/12	4	<3.0
	04/10/12	1.8	<3.0
	08/08/12	**6,100**	5400
	10/09/12	*22*	40
	01/08/13	8.1	<3.0
	04/15/13	**500**	<3.0
	04/09/14	1.8	<1.8
	07/08/14	3.8	<3
	10/14/14	4	<3
	01/13/15	**321**	<3
	04/21/15	1.5	<1.5
	07/15/15	*97*	<2.0
	10/20/15	1.7	<2.0
	01/21/16	**121**	<2.0
	04/14/16	**233**	<2.0
	07/14/16	1	2
	10/18/16	3.5	<2
MW-20	06/02/14	**338,000**	338,000
	07/08/14	**283,000**	89,000
	10/14/14	**330,000**	297,000
	01/13/15	**199,000**	155,000
	04/21/15	**248,900**	248,900
	07/15/15	**248,150**	247,000
	10/20/15	**385,000**	385,000
	01/21/16	**212,000**	234,000
	04/14/16	**412,750**	279,000
	07/14/16	**287,875**	326,000
	10/18/16	**269,075**	283,000

ENVIRO forensics

TABLE 2
GROUNDWATER ANALYTICAL RESULTS
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
MW-20A	06/02/14	**1,200**	1,060
	07/08/14	**230**	15
	10/14/14	**117**	<3
	01/13/15	*11*	<3
	04/21/15	1.1	<1.1
	07/15/15	**192**	<2.0
	10/20/15	*23*	<2.0
	01/21/16	5.4	<2.0
	04/14/16	*66*	8
	07/14/16	5.3	4
	10/18/16	**140**	<19
MW-21	06/02/14	2.6	<30
	07/08/14	**210**	<3
	10/14/14	<0.1	<3
	01/13/15	0.63	<3
	04/21/15	5.9	<3.0
	07/15/15	2.6	<2.0
	10/20/15	1.7	<2.0
	01/21/16	0.89	<2.0
	04/14/16	2.2	<2.0
	07/14/16	0.62	4
	10/18/16	0.29	<19

TABLE 2
GROUNDWATER ANALYTICAL RESULTS
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

Monitoring Well Identification	Sample Date	Total Chromium	Hexavalent Chromium
Public Health Enforcement Standard		**100**	NE
Public Health Preventive Action Limit		*10*	NE
MW-21A	06/02/14	1.8	<30
	07/08/14	1.1	<3
	10/14/14	<0.1	<3
	01/13/15	<0.1	<3
	04/21/15	0.054	<0.54
	07/15/15	0.1	<2.0
	10/20/15	0.51	<2.0
	01/21/16	0.21	<2
	04/14/16	0.6	<2.0
	07/14/16	<0.2	8
	10/18/16	<0.2	<19

Notes:

* As of 8/13/02 the designations for MW-05 and MW-05A were switched to assign the "A" suffix to the piezometer formerly designated as MW-05

All concentrations reported in units of micrograms per liter (µg/l)

Only detected compounds are listed

Bolded and Orange Shaded values indicates an exceedance of the Public Health Enforcement Standard

Italicized and Blue Shaded values indicates an exceedance the Public Health Preventive Action Limit

NE = Not Established

NA = Not Analyzed

NS = Not Sampled

TABLE 3

CUMULATIVE POUNDS OF CHROMIUM REMOVED

Albany International - Luvata Site

908 N. Lawe St., Appleton, WI 54911

Year	Amount			
	Sump	**Manhole**	**Annual Total**	**Cummulative Total**
*1988-1998	NA	NA	NA	550.00
**1998	10.68	13.26	23.94	573.94
1999	21.81	8.40	30.21	604.15
2000	NA	NA	22.00	626.15
2001	18.75	8.69	27.64	653.79
2002	13.10	9.98	23.08	676.8/7
2003	12.94	4.95	17.89	694.76
2004	12.83	5.29	18.12	712.88
2005	8.07	4.57	12.64	725.52
2006	7.36	4.27	11.63	736.88
2007	11.72	2.87	14.59	751.47
2008	16.40	3.40	19.80	771.27
2009	13.79	2.66	16.45	796.03
2010	17.09	3.36	20.45	816.48
2011	16.26	2.60	18.86	835.34
2012	11.66	2.39	14.05	849.39
2013	8.24	1.78	10.02	859.37
2014	8.10	1.30	9.40	868.77
2015	8.59	1.30	9.89	878.66
2016	8.37	1.49	9.86	888.52

Notes:

*Chemical Precipitation process was utilized from June 29, 1988 to April 20, 1998.

During that period 550# of chromium was removed in the form of chromium sulfate.

** Partial Year - Ion exchange System on-line April 20, 1998

NA - Data not available

TABLE 4
ANALYTICAL RESULTS OF FRENCH DRAIN AND BASEMENT SUMP SAMPLING
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

	Total Chromium		**Hexavalent Chromium**	
Public Health Enforcement Standard	**100**		NE	
Public Health Preventive Action Limit	*10*		NE	
Date	French Drain Sump	Basement Sump	Manhole	Sump
1989*	NS	**9,700**	NS	NA
1990*	NS	**129,000**	NS	NA
1991*	NS	**94,000**	NS	NA
1992*	**125,000**	**101,000**	NA	NA
1993*	**71,000**	**72,000**	NA	NA
1994*	**58,000**	**76,000**	NA	NA
1995*	**36,000**	**88,000**	NA	NA
1996*	**44,000**	**35,000**	NA	NA
1997*	**32,000**	**41,000**	NA	NA
1998*	**37,000**	**61,000**	NA	NA
12/9/1999	**21,000**	**76,000**	NA	NA
3/8/2000	**13,000**	**33,000**	NA	NA
1/17/2001	**20,000**	**6,000**	NA	NA
2/15/2001	**11,000**	**35,000**	NA	NA
3/15/2001	**19,000**	**38,000**	NA	NA
4/6/2001	**8,300**	**21,000**	NA	NA
5/18/2001	**15,000**	**48,000**	NA	NA
6/18/2001	**15,000**	**51,000**	NA	NA
7/20/2001	**31,000**	**74,000**	NA	NA
8/14/2001	**17,000**	**70,000**	NA	NA
9/18/2001	**16,000**	**55,000**	NA	NA
10/16/2001	**13,000**	**38,000**	NA	NA
11/12/2001	**17,000**	**53,000**	NA	NA
12/25/2001	**15,000**	**39,000**	NA	NA
1/11/2002	**15,000**	**54,000**	NA	NA
2/12/2002	**16,000**	**43,000**	NA	NA
3/13/2002	**11,000**	**27,000**	NA	NA
4/18/2002	**11,000**	**17,000**	NA	NA
5/20/2002	**17,000**	**49,000**	NA	NA
6/20/2002	**14,000**	**35,000**	NA	NA
7/15/2002	**16,000**	**61,000**	NA	NA
8/15/2002	**19,000**	**63,000**	NA	NA
9/18/2002	**13,000**	**61,000**	NA	NA
10/30/2002	**18,000**	**12,000**	NA	NA
11/20/2002	**13,000**	**38,000**	NA	NA

TABLE 4
ANALYTICAL RESULTS OF FRENCH DRAIN AND BASEMENT SUMP SAMPLING
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

	Total Chromium		Hexavalent Chromium	
Public Health Enforcement Standard	**100**		NE	
Public Health Preventive Action Limit	*10*		NE	
12/12/2002	**13,000**	**44,000**	NA	NA
1/20/2003	**16,000**	**47,000**	NA	NA
2/19/2003	**22,000**	**37,000**	NA	NA
3/17/2003	**9,000***	**30,000**	NA	NA
4/16/2003	**8,800**	**5,300**	NA	NA
5/28/2003	**11,000**	**32,000**	NA	NA
6/10/2003	**10,000**	**66,000**	NA	NA
7/10/2003	**9,600**	**27,000**	NA	NA
8/20/2003	**13,000**	**55,000**	NA	NA
9/12/2003	**16,000**	**64,000**	NA	NA
10/7/2003	**9,800**	**32,000**	NA	NA
11/18/2003	**8,100**	**29,000**	NA	NA
12/8/2003	**8,700**	**31,000**	NA	NA
1/30/2004	**9,700**	**44,000**	NA	NA
2/12/2004	**11,260**	**42,175**	NA	NA
3/25/2004	**9,200**	**55,000**	NA	NA
4/19/2004	**13,000**	**41,000**	14,000	41,000
5/10/2004	**10,000**	**17,000**	NA	NA
6/14/2004	**5,400**	**16,000**	5,000	15,000
7/19/2004	**8,700**	**52,000**	8,700	52,000
8/17/2004	**11,000**	**79,000**	10,000	66,000
9/14/2004	**12,000**	**76,000**	12,000	43,000
10/11/2004	**9,900**	**80,000**	8,900	73,000
11/16/2004	**11,000**	**55,000**	10,500	53,000
12/8/2004	**15,000**	**7,700**	NA	NA
1/12/2005	**8,900**	**33,000**	7,200	13,100
2/16/2005	**6,200**	**25,000**	5,600	22,000
3/7/2005	**9,900**	**9,800**	8,500	7,600
4/11/2005	**5,700**	**33,000**	5,800	31,000
5/18/2005	**12,000**	**33,000**	9,200	33,000
6/13/2005	**11,000**	**42,000**	8,000	42,000
7/18/2005	**10,000**	**82,000**	10,000	40,000
8/19/2005	**10,000**	**76,000**	9,500	80,000
9/15/2005	**8,900**	**64,000**	7,600	60,000
10/11/2005	**8,100**	**46,000**	7,400	46,000
11/16/2005	**8,200**	**14,000**	6,500	13,000
12/15/2005	**7,900**	**43,000**	7,000	40,000

ENVIROforensics

TABLE 4

ANALYTICAL RESULTS OF FRENCH DRAIN AND BASEMENT SUMP SAMPLING

Albany International - Luvata Site

908 N. Lawe St., Appleton, WI 54911

	Total Chromium		Hexavalent Chromium	
Public Health Enforcement Standard	**100**		NE	
Public Health Preventive Action Limit	*10*		NE	
1/10/2006	**5,600**	**17,000**	5,100	15,000
02/01/06	**7,000**	**15,000**	5,800	14,000
03/13/06	**3,800**	**9,000**	3,400	7,200
04/11/06	**8,000**	**25,000**	8,000	23,900
05/17/06	**6,800**	**23,000**	6,800	23,000
06/21/06	**6,900**	**66,000**	6,800	67,000
07/27/06	**7,400**	**67,000**	7,200	67,000
08/11/06	**11,000**	**80,000**	9,800	59,000
09/12/06	**6,800**	**19,000**	6,000	17,000
10/18/06	**8,200**	**9,100**	6,500	6,900
11/14/06	**7,800**	**47,000**	4,200	22,900
12/13/06	**7,800**	**32,000**	7,000	26,000
01/09/07	**6,900**	**32,000**	6,900	32,000
02/14/07	**7,100**	**48,000**	6,900	48,000
03/06/07	**5,100**	**29,000**	4,500	29,000
04/29/07	**7,500**	**31,000**	7,400	16,200
05/14/07	**8,400**	**45,000**	6,600	17,800
06/17/07	**7,600**	**18,000**	3,900	9,800
07/24/07	**8,000**	**103,000**	7,300	103,000
08/09/07	**11,000**	**95,000**	8,200	95,000
09/20/07	**7,100**	**58,000**	6,200	50,000
10/24/07	**5,800**	**22,000**	5,600	18,700
11/27/007	**6,400**	**65,000**	4,000	26,500
12/12/07	**5,500**	**60,000**	4,700	60,000
01/16/08	**4,700**	**25,000**	3,700	27,000
02/07/08	**6,000**	**45,000**	4,300	9,600
03/05/08	**6,100**	**15,000**	5,600	9,600
04/23/08	**5,900**	**48,000**	5,100	48,000
05/21/08	**5,900**	**49,000**	1,500	25,000
06/16/08	**4,900**	**34,000**	3,900	23,000
07/15/08	**6,600**	**68,000**	3,900	52,000
08/21/08	**7,500**	**94,000**	6,200	69,000
09/09/08	**5,565**	**94,800**	4,600	64,000
10/23/08	**5,900**	**89,000**	4,700	88,000
11/20/08	**6,400**	**48,000**	3,600	21,000
12/16/08	**4,900**	**21,000**	3,700	8,900
01/22/09	**5,200**	**40,000**	3,200	18,000

TABLE 4
ANALYTICAL RESULTS OF FRENCH DRAIN AND BASEMENT SUMP SAMPLING
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

	Total Chromium		Hexavalent Chromium	
Public Health Enforcement Standard	**100**		NE	
Public Health Preventive Action Limit	*10*		NE	
02/10/09	**5,200**	**5,800**	3,600	4,000
03/16/09	**3,100**	**8,900**	1,700	3,800
04/07/09	**3,900**	**33,000**	2,800	15,000
05/12/09	**3,400**	**41,000**	1,600	19,000
06/17/09	**3,200**	**47,000**	2,300	39,000
07/07/09	**6,000**	**91,000**	4,000	49,000
08/11/09	**4,900**	**95,000**	3,500	94,000
09/08/09	**7,200**	**99,000**	2,900	61,000
10/08/09	**7,800**	**38,000**	3,100	15,000
11/10/09	**4,900**	**49,000**	4,400	42,000
12/15/09	**5,000**	**47,000**	3,600	17,000
01/19/10	**5,300**	**43,000**	5,300	44,000
02/09/10	**4,400**	**36,000**	4,100	31,000
03/15/10	**2,000**	**19,000**	1,800	16,000
04/13/10	**3,900**	**31,000**	2,800	20,000
05/11/10	**5,000**	**23,000**	4,200	20,000
06/08/10	**5,500**	**52,000**	5,100	42,000
07/14/10	**5,800**	**66,000**	3,800	27,000
08/24/10	**7,700**	**66,000**	2,700	26,000
09/15/10	**5,700**	**85,000**	2,900	39,000
10/19/10	**5,800**	**81,000**	2,300	62,000
11/04/10	**5,000**	**53,000**	3,500	53,000
12/14/10	**4,800**	**49,000**	3,000	65,000
01/13/11	**320**	**39,000**	3,200	36,000
02/08/11	**5,700**	**46,000**	4,000	43,000
03/15/11	**3,500**	**9,500**	3,300	7,100
04/27/11	**2,400**	**20,000**	2,400	20,000
05/16/11	**5,500**	**25,000**	5,300	25,000
06/07/11	**5,500**	**56,000**	5,200	62,000
07/19/11	**4,200**	**105,000**	3,600	51,000
08/23/11	**4,900**	**98,000**	4,100	89,000
09/13/11	**5,300**	**100,000**	3,900	61,000
10/11/11	**31,000**	**88,000**	26,000	72,000
11/08/11	**4,300**	**54,000**	2,800	39,000
12/13/11	**3,600**	**57,000**	3,400	52,000
01/10/12	**5,400**	**60,000**	3,800	49,000
02/14/12	**420**	**41,000**	360	39,000

ENVIRO forensics

TABLE 4

ANALYTICAL RESULTS OF FRENCH DRAIN AND BASEMENT SUMP SAMPLING

Albany International - Luvata Site

908 N. Lawe St., Appleton, WI 54911

	Total Chromium		**Hexavalent Chromium**	
Public Health Enforcement Standard	**100**		NE	
Public Health Preventive Action Limit	*10*		NE	
03/13/12	**2,000**	**20,000**	1,500	18,000
04/10/12	**4,800**	**44,000**	4,200	32,000
05/22/12	**5,300**	**84,000**	5,100	37,000
06/18/12	**5,000**	**111,000**	4,400	88,000
07/18/12	**4,800**	**122,000**	4,200	90,000
08/08/12	**6,100**	**63,000**	5,500	18,000
09/11/12	**4,100**	**101,000**	4,100	92,000
10/09/12	**620**	**89,000**	505	92,000
11/20/12	**3,500**	**43,000**	3,400	44,000
12/18/12	**3,600**	**30,000**	3,200	30,000
01/08/13	<30	**41,000**	<3	33,000
02/11/13	**3,300**	**13,000**	3,000	14,000
03/12/13	**2,600**	**12,000**	2,200	7,500
04/15/13	**3,900**	**25,000**	3,490	25,000
05/07/13	**3,900**	**38,000**	3,900	35,000
06/20/13	**3,900**	**48,000**	3,900	50,000
07/10/13	**4,300**	**9,000**	4,300	41,506
08/20/13	**5,100**	**84,000**	5,000	80,000
09/19/13	**6,000**	**76,000**	6,000	76,000
10/14/13	**3,800**	**75,000**	3,800	85,000
11/12/13	**3,900**	**27,000**	3,700	29,000
12/17/13	**3,700**	**46,000**	3,500	48,000
01/15/14	**170**	**27,000**	126	27,600
02/18/14	**12,000**	**39,000**	2,900	38,000
03/11/14	**2,300**	**7,300**	2,400	6,100
04/09/14	**1,900**	**19,000**	1,570	17,000
05/12/14	**2,200**	**4,400**	2,200	4,400
06/02/14	**1,500**	**7,000**	1,500	6,800
07/08/14	**3,800**	**27,000**	3,200	27,000
08/05/14	**4,200**	**64,000**	3,300	41,000
09/09/14	**4,700**	**67,000**	4,000	61,000
10/16/14	**3,300**	**8,000**	3,300	6,800
11/4/14	**2,600**	**37,000**	2,600	37,000
12/16/14	**3,000**	**15,000**	2,700	12,000
1/13/15	**2,400**	**36,000**	2,100	31,000
2/10/15	**3,200**	**39,000**	2,500	33,000
3/10/15	**2,700**	**25,000**	2,400	18,000

TABLE 4
ANALYTICAL RESULTS OF FRENCH DRAIN AND BASEMENT SUMP SAMPLING
Albany International - Luvata Site
908 N. Lawe St., Appleton, WI 54911

	Total Chromium		Hexavalent Chromium	
Public Health Enforcement Standard	**100**		NE	
Public Health Preventive Action Limit	*10*		NE	
4/21/15	**1,800**	**16,000**	1,600	4,400
5/18/15	**2,700**	**1,900**	1,800	8,600
6/9/15	**1,900**	**56,000**	1,700	9,100
7/15/15	**3,441**	**10,627**	3,300	10,000
8/11/15	**3,700**	**45,000**	3,200	32,000
9/8/15	**5,900**	**42,000**	3,400	24,000
10/20/15	**3,700**	**50,000**	3,200	42,000
11/10/15	**3,700**	**24,000**	3,000	19,000
12/8/15	**3,300**	**25,000**	2,700	7,900
1/21/16	**2,800**	**22,000**	2,640	22,400
2/8/16	**3,200**	**6,700**	3,150	6,130
3/14/16	**2,600**	**17,000**	2,490	16,500
4/14/16	**3,200**	**19,000**	3,150	18,200
5/17/16	**3,100**	**26,000**	2,880	0
6/9/16	**2,700**	**35,000**	2,210	24,400
7/14/16	**2,900**	**52,000**	2,960	26,500
8/9/16	**3,300**	**77,000**	3,300	77,000
9/7/16	**4,400**	**22,000**	3,080	21,200
10/18/16	**3,500**	**24,000**	3,400	33,500
11/16/16	**3,200**	**32,000**	3,470	29,000
12/6/16	**3,400**	**16,000**	3,030	12,800

Notes:

All concentrations reported in units of micrograms per liter (µg/l)

Only detected compounds are listed

NA= Not Analyzed

NS= Not Sampled

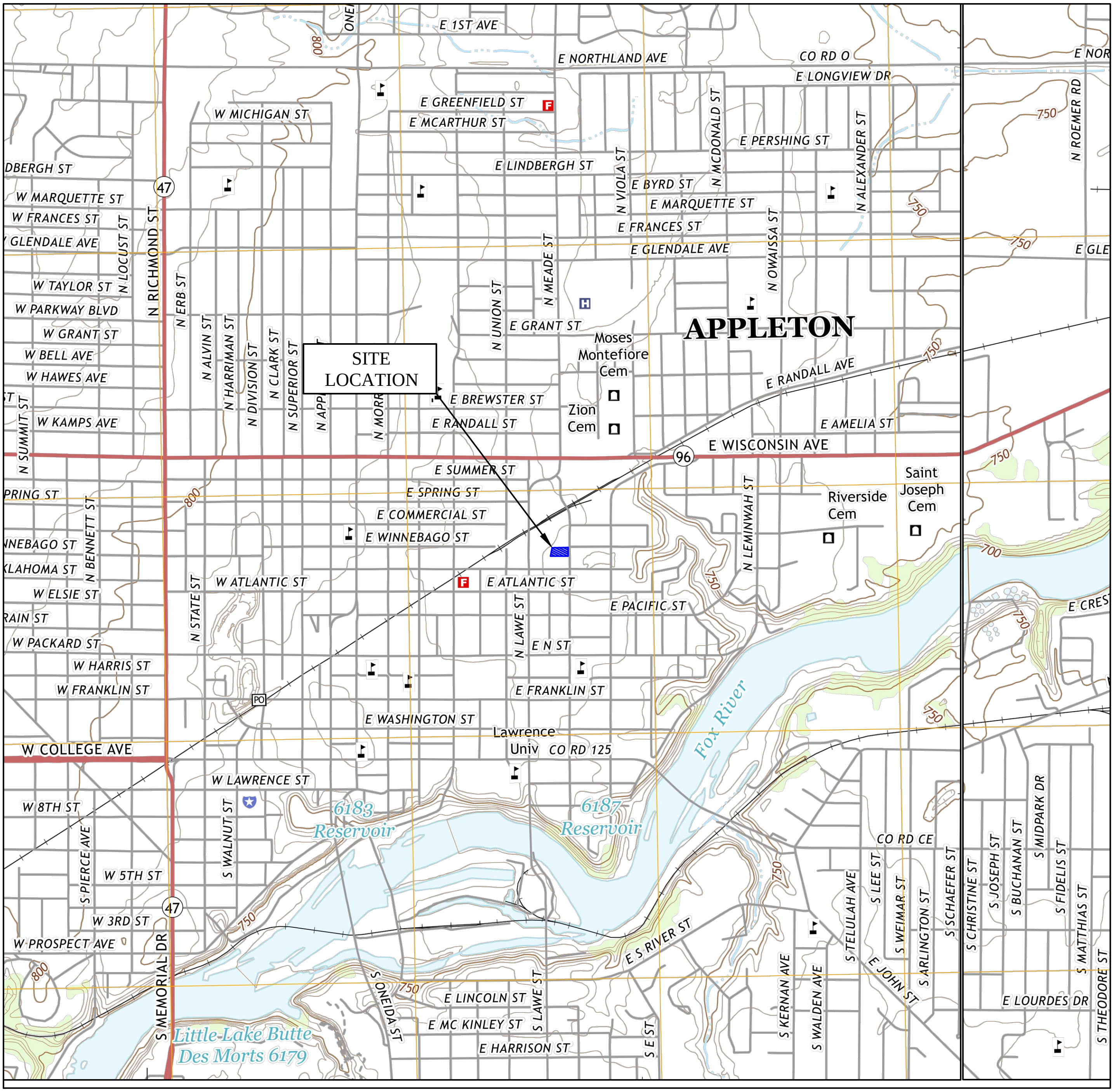
Bolded **and Orange Shaded** values indicates an exceedance of the Public Health Enforcement Standard

Italicized and Blue Shaded values indicates an exceedance the Public Health Preventive Action Limit

* Anaytical correlated with subject dates represent an annual average

ENVIROforensics

FIGURES



Scale 1:24,000

1 1/2 0 1 Mile

1000 0 1000 2000 3000 4000 5000 6000 7000 Feet

N

Source: US Geological Survey, Appleton, Wisconsin, 7.5 Minute Series, 2016
Source: US Geological Survey, kaukauna, Wisconsin, 7.5 Minute Series, 2016

No.	Date	Revision	Approved

ENVIRO forensics
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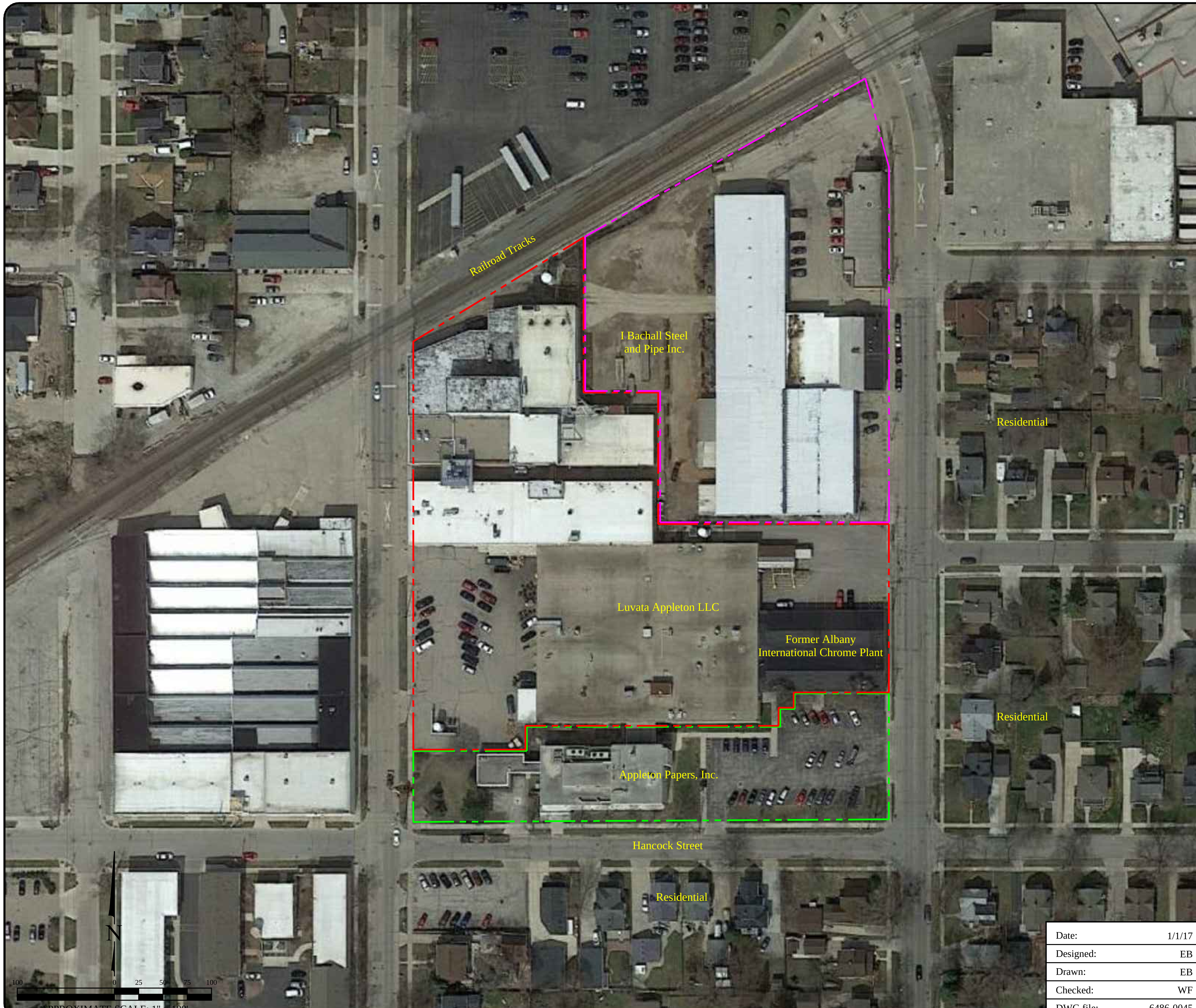
825 North Capitol Avenue • Indianapolis, IN 46204
EnviroForensics.com

Date:	1/11/17
Designed:	EB
Drawn:	EB
Checked:	WF
DWG file:	6486-0044

SITE TOPOGRAPHIC MAP

Albany International - Luvata Site
908 North Lawe Street
Appleton, Wisconsin

Figure
1
Project
6486



Legend

— · — Property boundary

SITE AERIAL

Albany International - Luvata Site
908 North Lawe Street
Appleton, Wisconsin

Date:	1/1/17
Designed:	EB
Drawn:	EB
Checked:	WF
DWG file:	6486-0045

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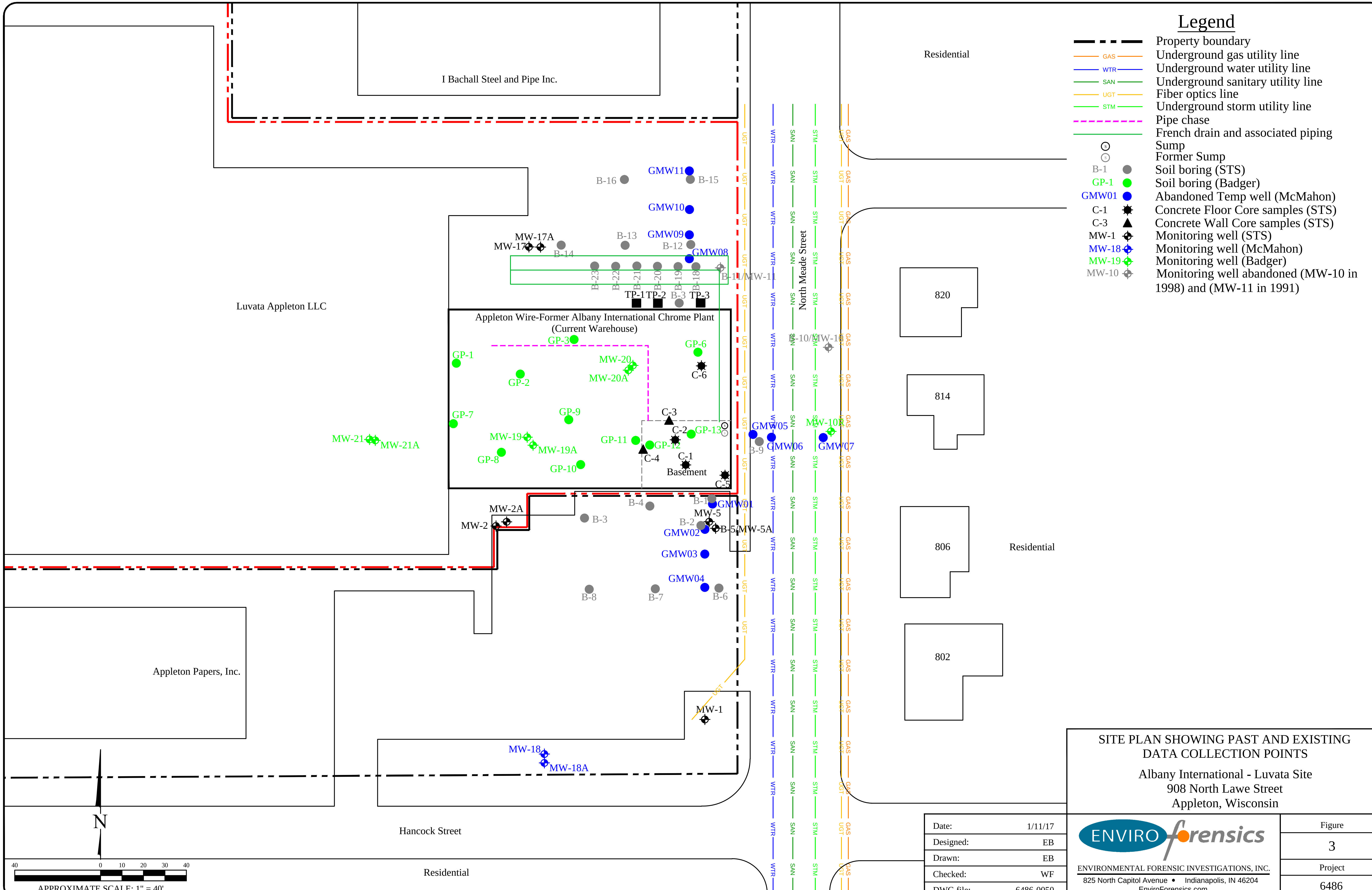
Figure	2
Project	6486



SITE PLAN SHOWING PAST AND EXISTING DATA COLLECTION POINTS

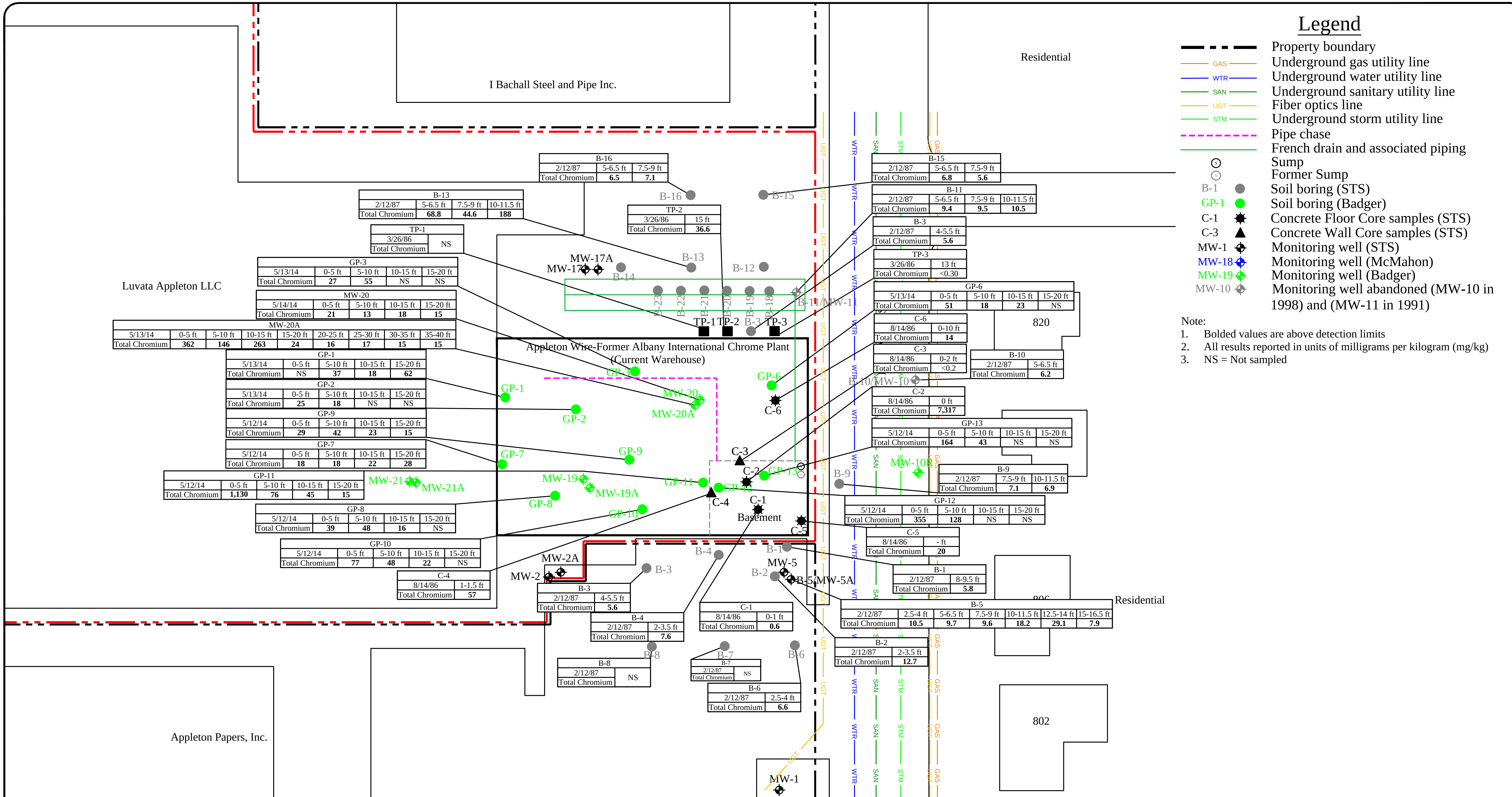
Albany International - Luvata Site
908 North Lawe Street
Appleton, Wisconsin

Date:	1/11/17
Designed:	EB
Drawn:	EB
Checked:	WF
DWG file:	6486-0050

ENVIRO forensics
ENVIRONMENTAL FORENSIC INVESTIGATIONS, INC.
825 North Capitol Avenue • Indianapolis, IN 46204
EnviroForensics.com

Figure 3

Project 6486



SOIL ANALYTICAL RESULTS

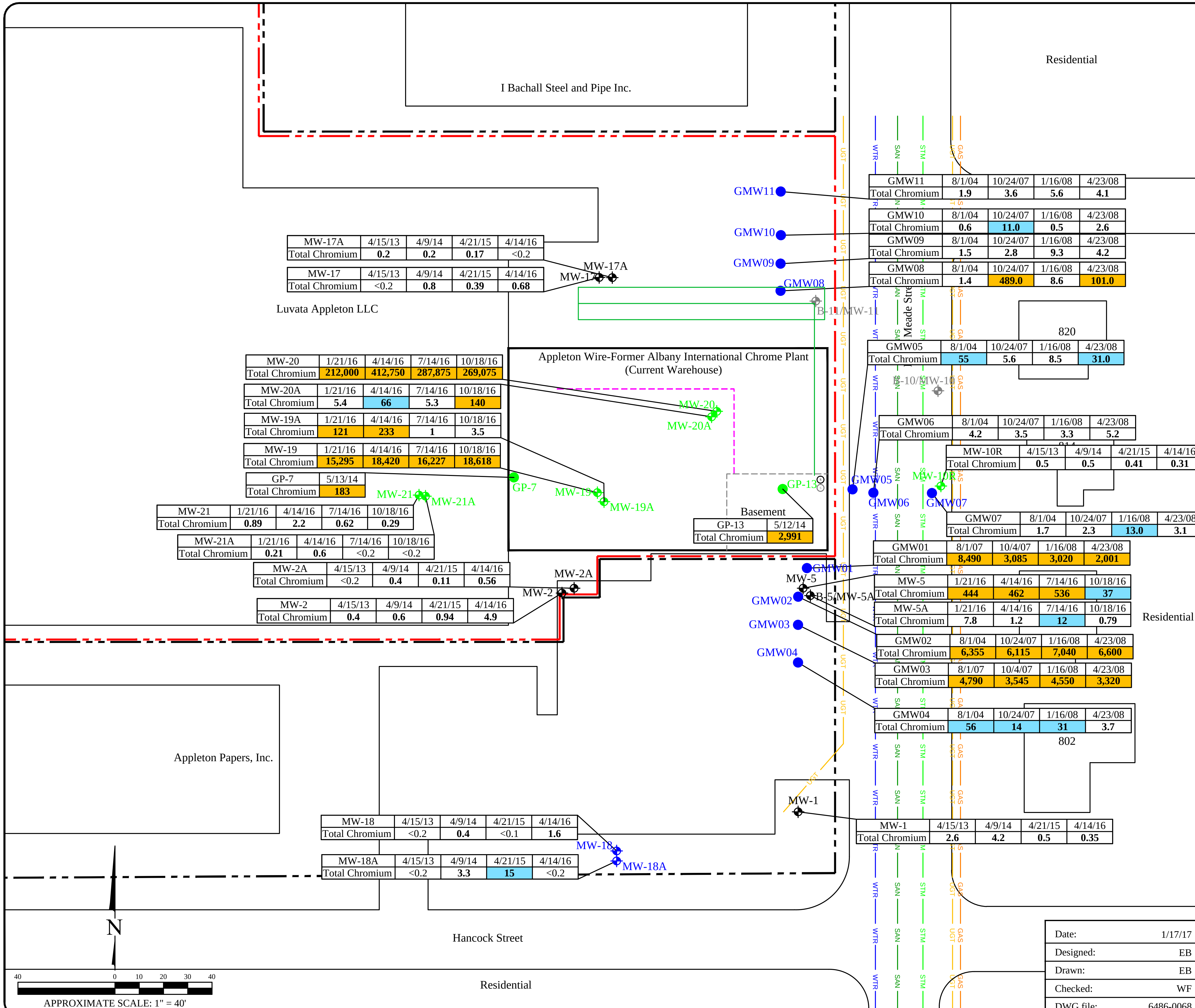
Albany International - Luvata Site
908 North Lawe Street
Appleton, Wisconsin

Date:	1/16/17
Designed:	EB
Drawn:	EB
Checked:	WF
DWG file:	6486-0051

ENVIRO forensics
ENVIRONMENTAL FORENSIC INVESTIGATIONS, INC.
825 North Capitol Avenue • Indianapolis, IN 46204
EnviroForensics.com

Figure 4

Project 6486



MW-17A	4/15/13	4/9/14	4/21/15	4/14/16
Total Chromium	**0.2**	**0.2**	**0.17**	<0.2

MW-17	4/15/13	4/9/14	4/21/15	4/14/16
Total Chromium	<0.2	**0.8**	**0.39**	**0.68**

MW-20	1/21/16	4/14/16	7/14/16	10/18/16
Total Chromium	**212,000**	**412,750**	**287,875**	**269,075**

MW-20A	1/21/16	4/14/16	7/14/16	10/18/16
Total Chromium	**5.4**	**66**	**5.3**	**140**

MW-19A	1/21/16	4/14/16	7/14/16	10/18/16
Total Chromium	**121**	**233**	**1**	**3.5**

MW-19	1/21/16	4/14/16	7/14/16	10/18/16
Total Chromium	**15,295**	**18,420**	**16,227**	**18,618**

GP-7	5/13/14
Total Chromium	**183**

MW-21	1/21/16	4/14/16	7/14/16	10/18/16
Total Chromium	**0.89**	**2.2**	**0.62**	**0.29**

MW-21A	1/21/16	4/14/16	7/14/16	10/18/16
Total Chromium	**0.21**	**0.6**	<0.2	<0.2

MW-2A	4/15/13	4/9/14	4/21/15	4/14/16
Total Chromium	<0.2	**0.4**	**0.11**	**0.56**

MW-2	4/15/13	4/9/14	4/21/15	4/14/16
Total Chromium	**0.4**	**0.6**	**0.94**	**4.9**

MW-18	4/15/13	4/9/14	4/21/15	4/14/16
Total Chromium	<0.2	**0.4**	<0.1	**1.6**

MW-18A	4/15/13	4/9/14	4/21/15	4/14/16
Total Chromium	<0.2	**3.3**	**15**	<0.2

GP-13	5/12/14
Total Chromium	**2,991**

GMW11	8/1/04	10/24/07	1/16/08	4/23/08
Total Chromium	**1.9**	**3.6**	**5.6**	**4.1**

GMW10	8/1/04	10/24/07	1/16/08	4/23/08
Total Chromium	**0.6**	**11.0**	**0.5**	**2.6**

GMW09	8/1/04	10/24/07	1/16/08	4/23/08
Total Chromium	**1.5**	**2.8**	**9.3**	**4.2**

GMW08	8/1/04	10/24/07	1/16/08	4/23/08
Total Chromium	**1.4**	**489.0**	**8.6**	**101.0**

GMW05	8/1/04	10/24/07	1/16/08	4/23/08
Total Chromium	**55**	**5.6**	**8.5**	**31.0**

GMW06	8/1/04	10/24/07	1/16/08	4/23/08
Total Chromium	**4.2**	**3.5**	**3.3**	**5.2**

MW-10R	4/15/13	4/9/14	4/21/15	4/14/16
Total Chromium	**0.5**	**0.5**	**0.41**	**0.31**

GMW07	8/1/04	10/24/07	1/16/08	4/23/08
Total Chromium	**1.7**	**2.3**	**13.0**	**3.1**

GMW01	8/1/07	10/4/07	1/16/08	4/23/08
Total Chromium	**8,490**	**3,085**	**3,020**	**2,001**

MW-5	1/21/16	4/14/16	7/14/16	10/18/16
Total Chromium	**444**	**462**	**536**	**37**

MW-5A	1/21/16	4/14/16	7/14/16	10/18/16
Total Chromium	**7.8**	**1.2**	**12**	**0.79**

GMW02	8/1/04	10/24/07	1/16/08	4/23/08
Total Chromium	**6,355**	**6,115**	**7,040**	**6,600**

GMW03	8/1/07	10/4/07	1/16/08	4/23/08
Total Chromium	**4,790**	**3,545**	**4,550**	**3,320**

GMW04	8/1/04	10/24/07	1/16/08	4/23/08
Total Chromium	**56**	**14**	**31**	**3.7**

MW-1	4/15/13	4/9/14	4/21/15	4/14/16
Total Chromium	**2.6**	**4.2**	**0.5**	**0.35**

Legend

- Property boundary
- Underground gas utility line
- Underground water utility line
- Underground sanitary utility line
- Fiber optics line
- Underground storm utility line
- Pipe chase
- French drain and associated piping
- Sump
- Former Sump
- GP-7 Soil boring Temp well (Badger)
- GMW01 Abandoned Temp well (McMahon)
- MW-1 Monitoring well (STS)
- MW-18 Monitoring well (McMahon)
- MW-19 Monitoring well (Badger)
- MW-10 Monitoring well abandoned (MW-10 in 1998) and (MW-11 in 1991)

Analyte	Public Health Preventive Action Limit	Public Health Enforcement Standard
Total Chromium	10	100

Note:

1. Bolded and orange shaded values exceed the Public Health Enforcement Standard
2. Bolded and blue shaded values exceed the Public Health Preventive Action Limit
3. Bolded values are above detection limits
4. J = Analyte concentration less that laboratory detection limits
5. All results reported in units of micrograms per liter (µg/L)

GROUNDWATER ANALYTICAL RESULTS

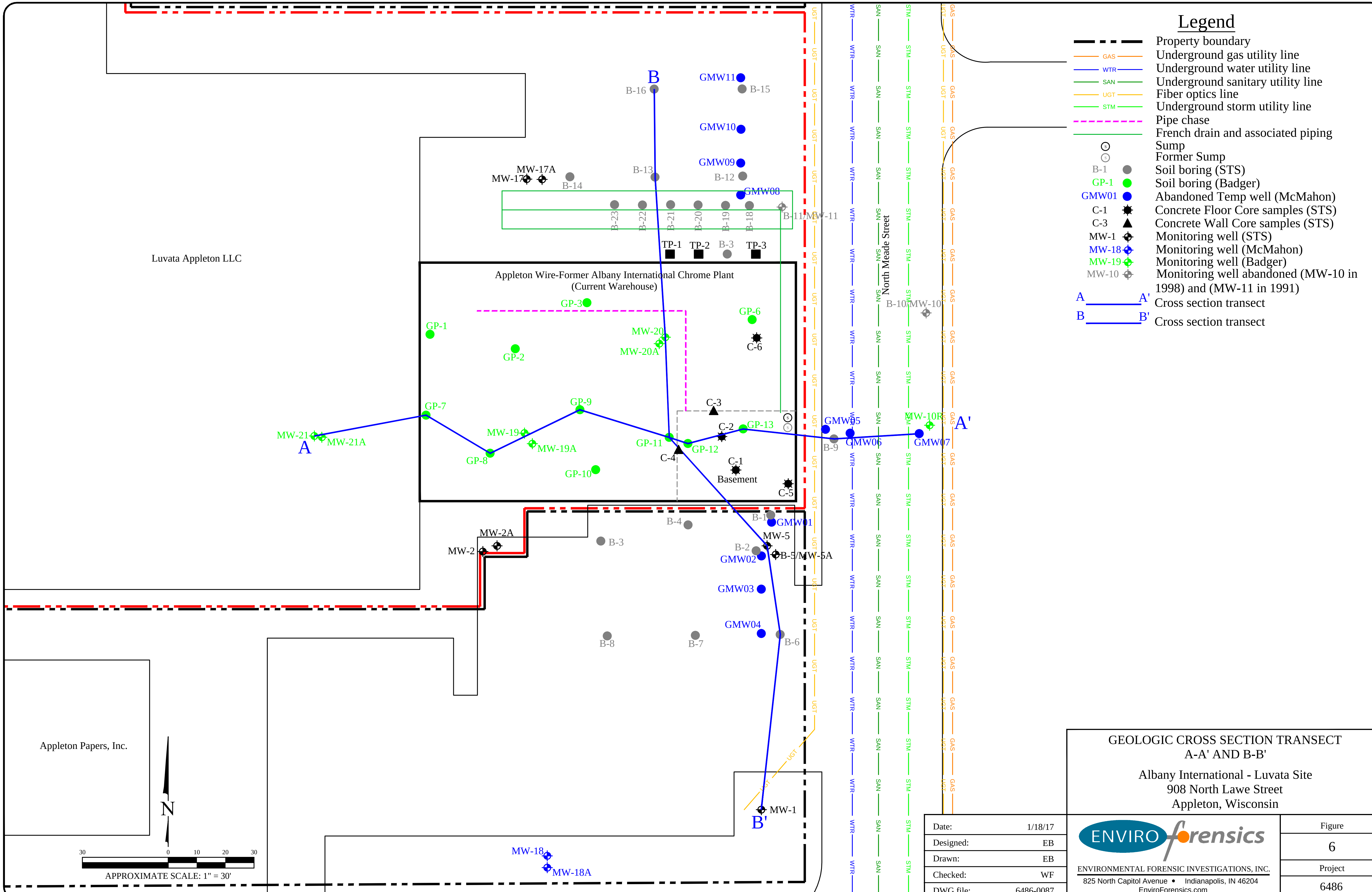
Albany International - Luvata Site
908 North Lawe Street
Appleton, Wisconsin

Date:	1/17/17
Designed:	EB
Drawn:	EB
Checked:	WF
DWG file:	6486-0068

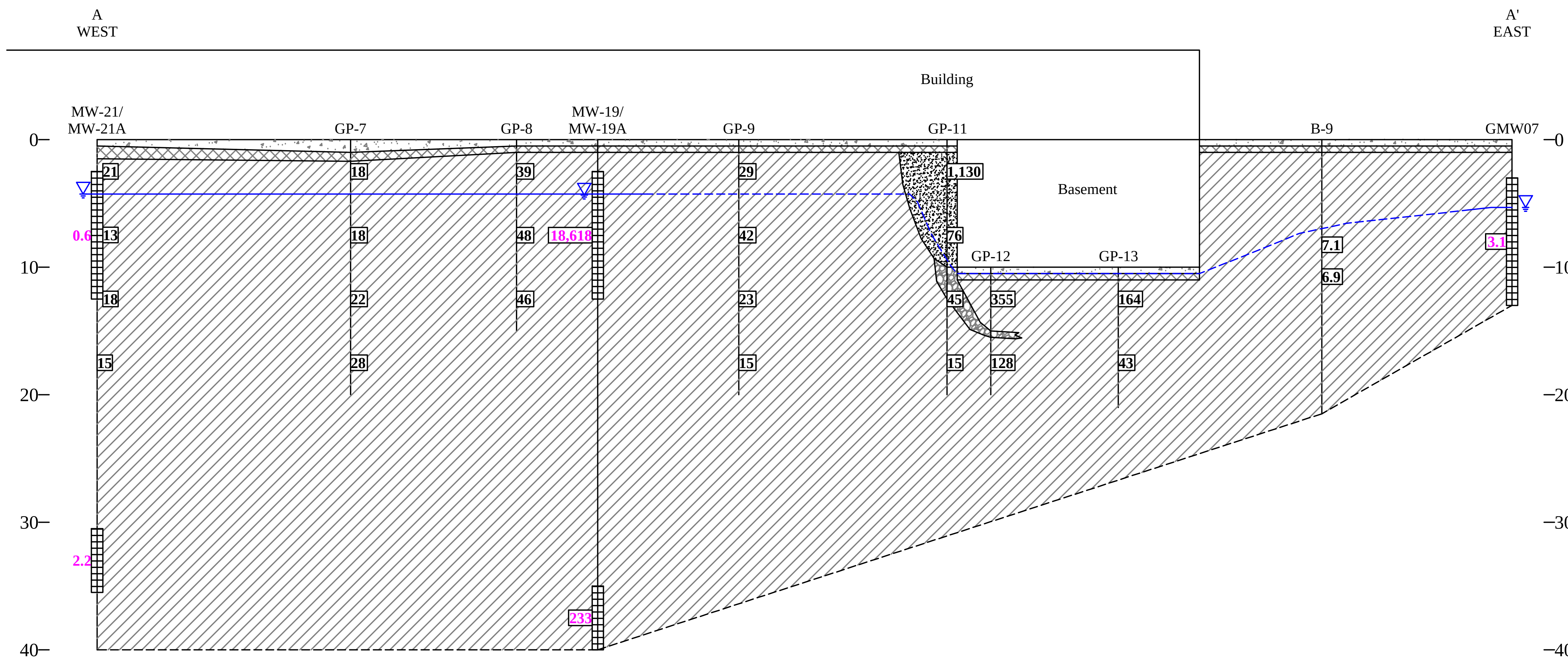
ENVIRO forensics
ENVIRONMENTAL FORENSIC INVESTIGATIONS, INC.
825 North Capitol Avenue • Indianapolis, IN 46204
EnviroForensics.com

Figure 5

Project 6486



Legend
Property boundary
Underground gas utility line
Underground water utility line
Underground sanitary utility line
Fiber optics line
Underground storm utility line
Pipe chase
French drain and associated piping
Sump
Former Sump
B-1 Soil boring (STS)
GP-1 Soil boring (Badger)
GMW01 Abandoned Temp well (McMahon)
C-1 Concrete Floor Core samples (STS)
C-3 Concrete Wall Core samples (STS)
MW-1 Monitoring well (STS)
MW-18 Monitoring well (McMahon)
MW-19 Monitoring well (Badger)
MW-10 Monitoring well abandoned (MW-10 in 1998) and (MW-11 in 1991)
A A' Cross section transect
B B' Cross section transect
Luvata Appleton LLC
Appleton Wire-Former Albany International Chrome Plant (Current Warehouse)
Appleton Papers, Inc.
North Meade Street
A
A'
B
B'
Basement
N
APPROXIMATE SCALE: 1" = 30'
GEOLOGIC CROSS SECTION TRANSECT A-A' AND B-B'
Albany International - Luvata Site
908 North Lawe Street
Appleton, Wisconsin
Date: 1/18/17
Designed: EB
Drawn: EB
Checked: WF
DWG file: 6486-0087
ENVIRO forensics
ENVIRONMENTAL FORENSIC INVESTIGATIONS, INC.
825 North Capitol Avenue • Indianapolis, IN 46204
EnviroForensics.com
Figure 6
Project 6486



Legend

	Concrete
	Top Soil
	Fill
	Sand
	Clay
	Gravel/Sand

700 Total Chromium concentration in soil sample (mg/kg)

700 Total Chromium concentration in monitoring well sample (µg/L)

Monitoring well screen

Dashed boundaries are inferred

Observed groundwater elevation in shallow monitoring wells December 6, 2016

Horizontal Scale: 1" = 20'
Vertical Scale: 1" = 10'
VERTICAL EXAGGERATION: 2X

10
0
0 20
SCALE

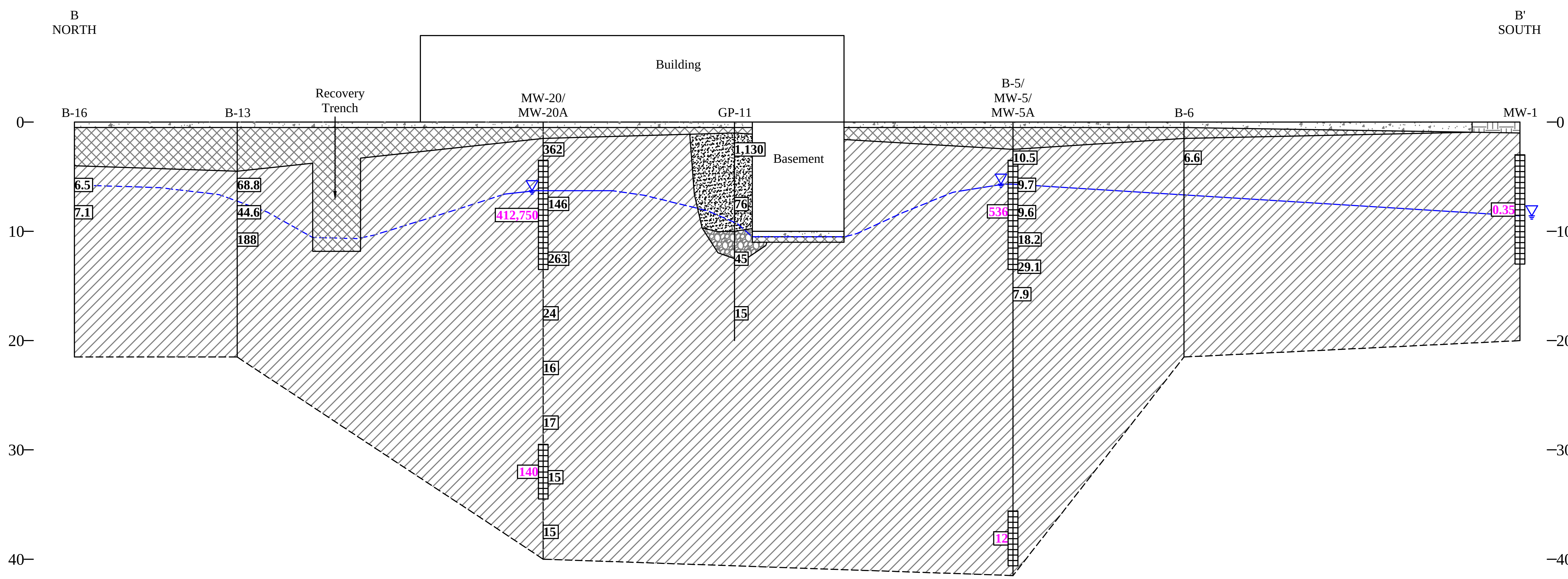
GEOLOGIC CROSS SECTION
A-A'

Albany International - Luvata Site
908 North Lawe Street
Appleton, Wisconsin

Date:	1/18/17
Designed:	EB
Drawn:	EB
Checked:	WF
DWG file:	6486-0087

ENVIRO forensics
ENVIRONMENTAL FORENSIC INVESTIGATIONS, INC.
825 North Capitol Avenue • Indianapolis, IN 46204
EnviroForensics.com

Figure	7
Project	6486



Legend

Concrete	
Top Soil	
Fill	
Sand	
Clay	
Gravel/Sand	

700 Total Chromium concentration in soil sample (mg/kg)
700 Total Chromium concentration in monitoring well sample (µg/L)

Monitoring well screen

Dashed boundaries are inferred

Observed groundwater elevation in shallow monitoring wells December 6, 2016

Horizontal Scale: 1" = 20'
Vertical Scale: 1" = 10'
VERTICAL EXAGGERATION: 2X

10
0
0 *20*
SCALE

GEOLOGIC CROSS SECTION
B-B'

Albany International - Luvata Site
908 North Lawe Street
Appleton, Wisconsin

Date:	1/18/17
Designed:	EB
Drawn:	EB
Checked:	WF
DWG file:	6486-0087

ENVIRO forensics
ENVIRONMENTAL FORENSIC INVESTIGATIONS, INC.
825 North Capitol Avenue • Indianapolis, IN 46204
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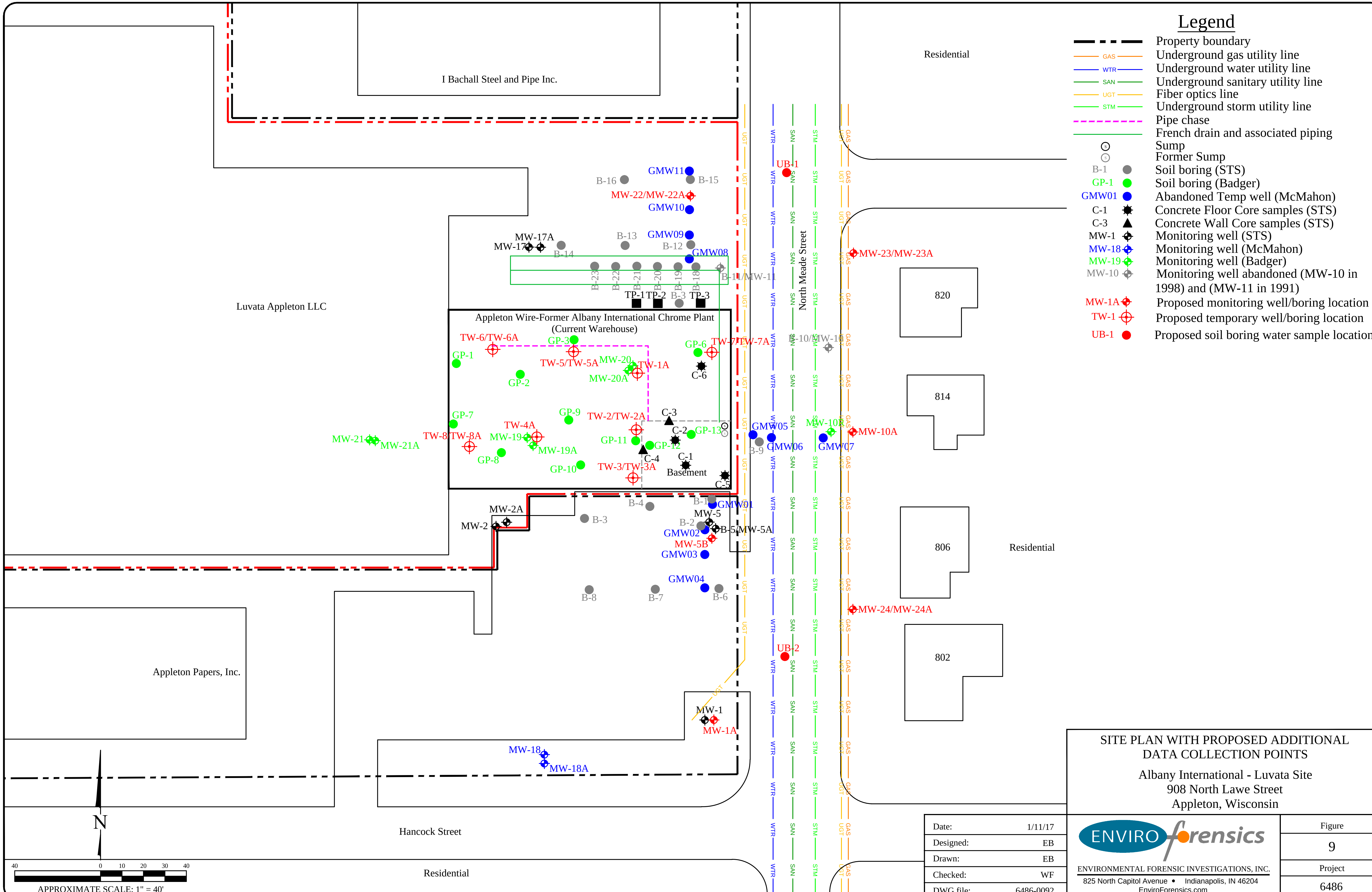
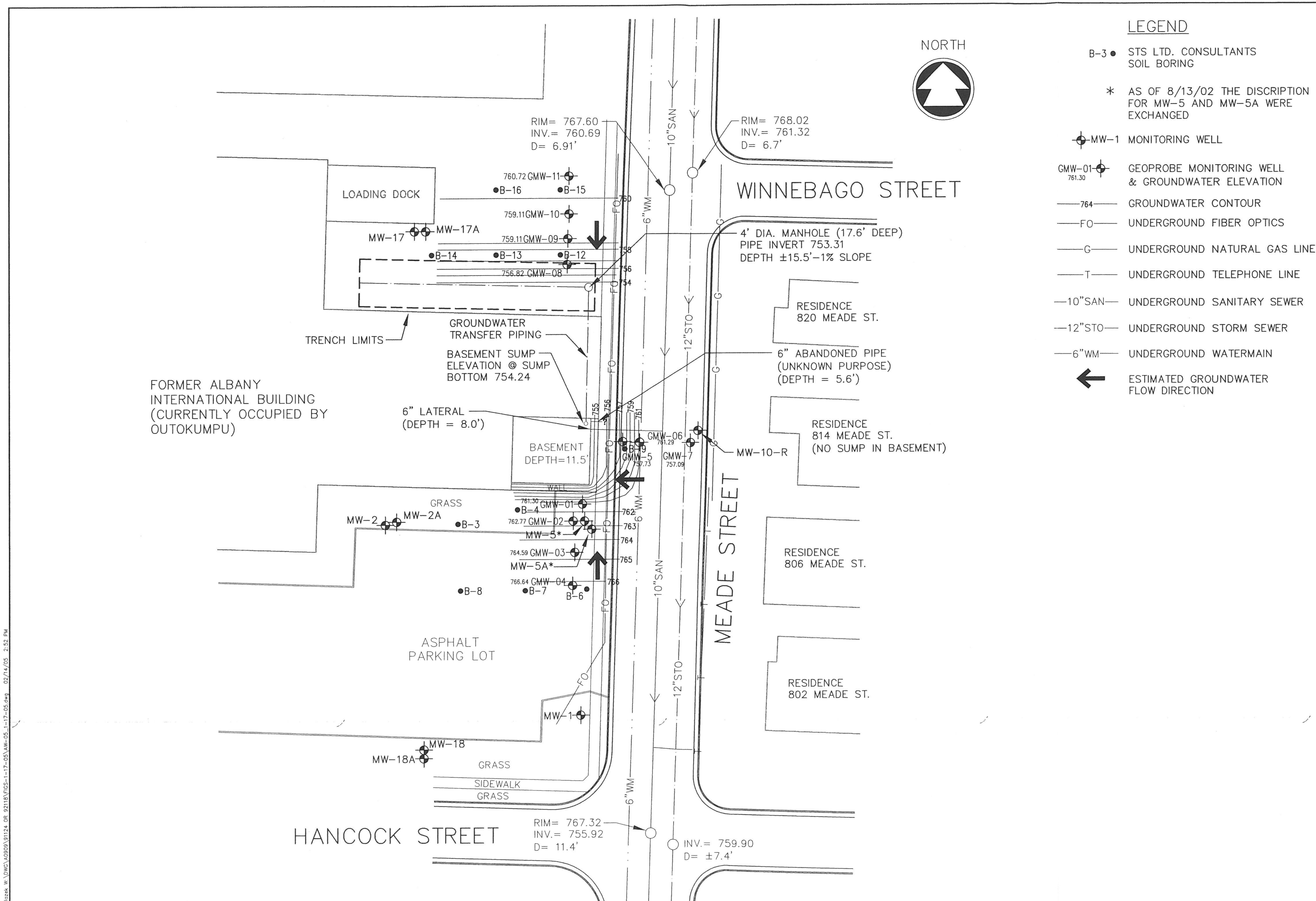
Figure	Project
8	6486



Legend
Property boundary
Underground gas utility line
Underground water utility line
Underground sanitary utility line
Fiber optics line
Underground storm utility line
Pipe chase
French drain and associated piping
Sump
Former Sump
B-1 Soil boring (STS)
GP-1 Soil boring (Badger)
GMW01 Abandoned Temp well (McMahon)
C-1 Concrete Floor Core samples (STS)
C-3 Concrete Wall Core samples (STS)
MW-1 Monitoring well (STS)
MW-18 Monitoring well (McMahon)
MW-19 Monitoring well (Badger)
MW-10 Monitoring well abandoned (MW-10 in 1998) and (MW-11 in 1991)
MW-1A Proposed monitoring well/boring location
TW-1 Proposed temporary well/boring location
UB-1 Proposed soil boring water sample location
I Bachall Steel and Pipe Inc.
Residential
Luvata Appleton LLC
Appleton Wire-Former Albany International Chrome Plant
(Current Warehouse)
North Meade Street
Appleton Papers, Inc.
Hancock Street
Residential
820
814
806
802
Residential
N
APPROXIMATE SCALE: 1" = 40'
40 0 10 20 30 40
GMW11
B-16
B-15
MW-22/MW-22A
GMW10
MW-17A
MW-17
B-13
GMW09
B-12
B-14
GMW08
B-23
B-22
B-21
B-20
B-19
B-18
B-11/MW-11
TP-1
TP-2
B-3
TP-3
UB-1
MW-23/MW-23A
TW-6/TW-6A
GP-3
GP-6
TW-7/TW-7A
B-10/MW-10
GP-1
TW-5/TW-5A
MW-20
TW-1A
C-6
GP-2
MW-20A
GP-7
GP-9
TW-2/TW-2A
C-3
MW-10B
MW-10A
GMW05
GMW06
GMW07
B-9
TW-4A
C-2
GP-13
MW-21
TW-8/TW-8A
MW-19
GP-11
GP-12
MW-21A
MW-19A
C-4
C-1
GP-8
TW-3/TW-3A
Basement
GP-10
C-5
B-4
B-1
GMW01
MW-2A
B-3
MW-5
MW-2
B-2
B-5/MW-5A
GMW02
MW-5B
GMW03
GMW04
B-8
B-7
B-6
MW-24/MW-24A
UB-2
MW-1
MW-1A
MW-18
MW-18A
SITE PLAN WITH PROPOSED ADDITIONAL DATA COLLECTION POINTS
Albany International - Luvata Site
908 North Lawe Street
Appleton, Wisconsin
Date: 1/11/17
Designed: EB
Drawn: EB
Checked: WF
DWG file: 6486-0092
ENVIRO forensics
ENVIRONMENTAL FORENSIC INVESTIGATIONS, INC.
825 North Capitol Avenue • Indianapolis, IN 46204
EnviroForensics.com
Figure
9
Project
6486

ATTACHMENT 1

Past Groundwater Flow Maps



GROUNDWATER CONTOURS - JUNE 30, 2004
ALBANY INTERNATIONAL SITE
APPLETON, WISCONSIN

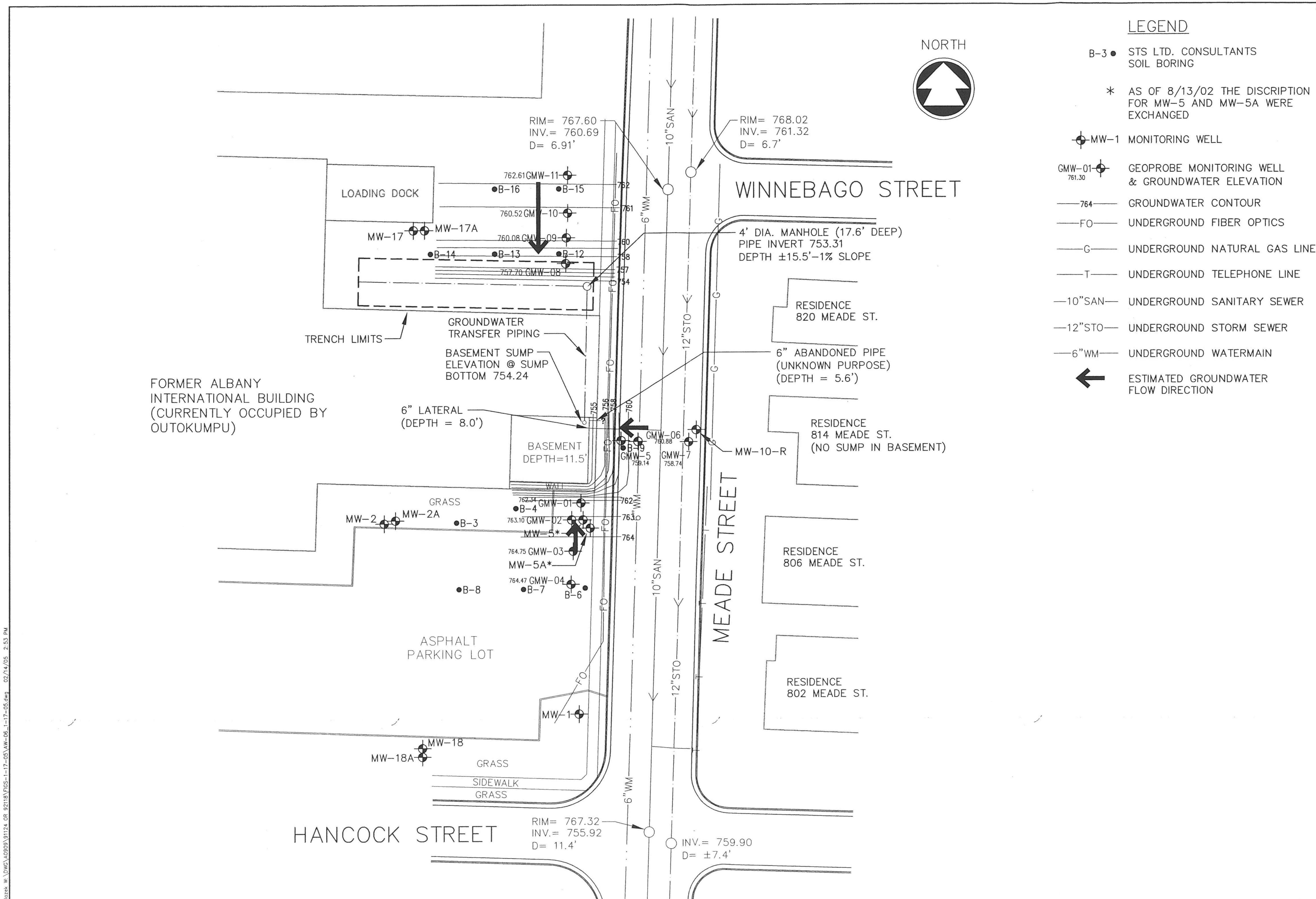
McMAHON ASSOCIATES, INC. ENGINEERS ARCHITECTS SCIENTISTS SURVEYORS
1445 McMahon Drive Neenah, WI 54956
Mailing Address: P.O. Box 1025 Neenah, WI 54957-1025
TEL: 920-751-4200 FAX: 920-751-4284

REVISION | DATE | NO.

SURVEYED | DRAWN BLB | CHECKED SAB

SCALE 1" = 40'
DATE 1/17/05
PROJECT NO. A0909-920118.06
SHEET NO. 5
FILE NO. CAD

bblizek W:\DWG\A0909\91124 OR 92118\FIGS-1-17-05\AW-05_1-17-05.dwg 02/14/05 2:52 PM



GROUNDWATER CONTOURS - JULY 26, 2004
ALBANY INTERNATIONAL SITE
APPLETON, WISCONSIN

McMAHON ENGINEERS ARCHITECTS SCIENTISTS SURVEYORS
McMAHON ASSOCIATES, INC.
1445 McMahon Drive Neenah, WI 54956
Mailing Address: P.O. Box 1025 Neenah, WI 54957-1025
TEL: 920-751-4200 FAX: 920-751-4284

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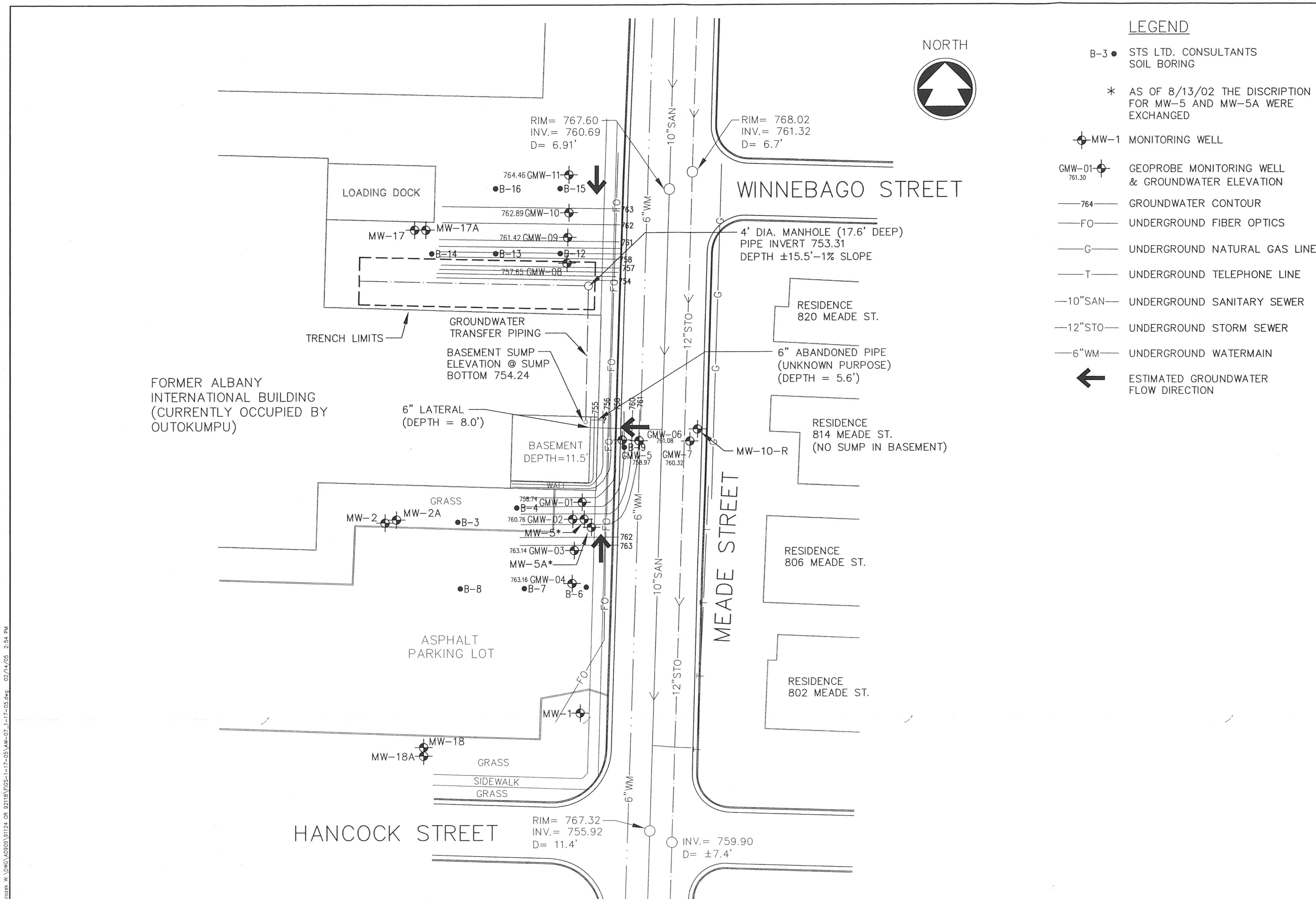
SURVEYED
DRAWN BLB
CHECKED SAB

SCALE 1" = 40'
DATE 1/17/05
PROJECT NO. A0909-92018.06
SHEET NO. 6
FILE NO. CAD

bblozek W:\DWG\A0909\91124 OR 92118\FIGS-1-17-05\AW-06_1-17-05.dwg 02/14/05 2:53 PM



GROUNDWATER CONTOURS – OCTOBER 19, 2004
ALBANY INTERNATIONAL SITE
APPLETON, WISCONSIN

McMAHON ASSOCIATES, INC. ENGINEERS ARCHITECTS SCIENTISTS SURVEYORS
1445 McMahon Drive Neenah, WI 54956
Mailing Address: P.O. Box 1025 Neenah, WI 54957-1025
TEL: 920-751-4200 FAX: 920-751-4284

REVISION | DATE | NO.
SURVEYED | DRAWN BLB | CHECKED SAB
SCALE 1" = 40' | DATE 1/17/05 | PROJECT NO. A0909-920118.06
SHEET NO. 7
FILE NO. CAD

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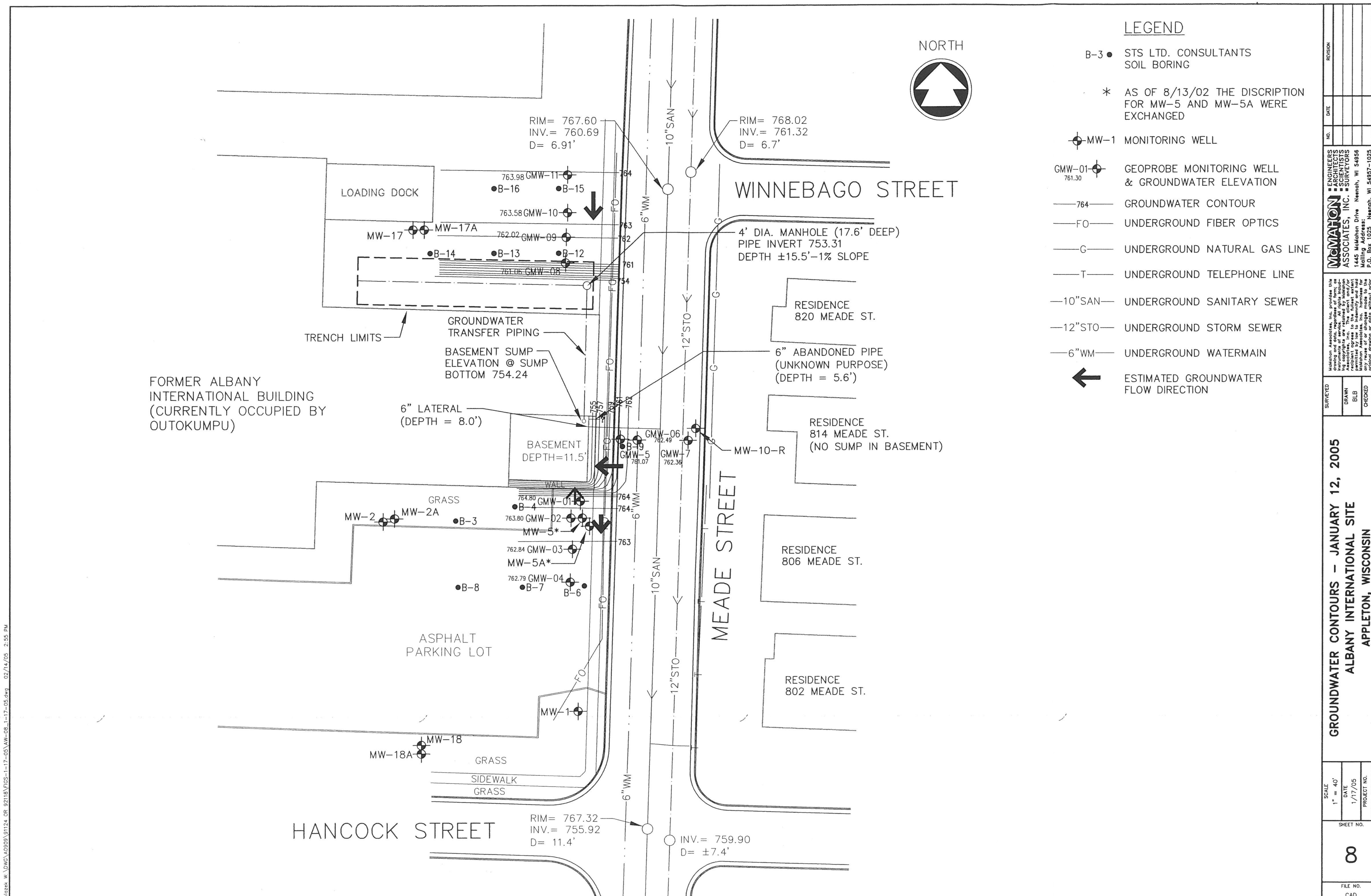
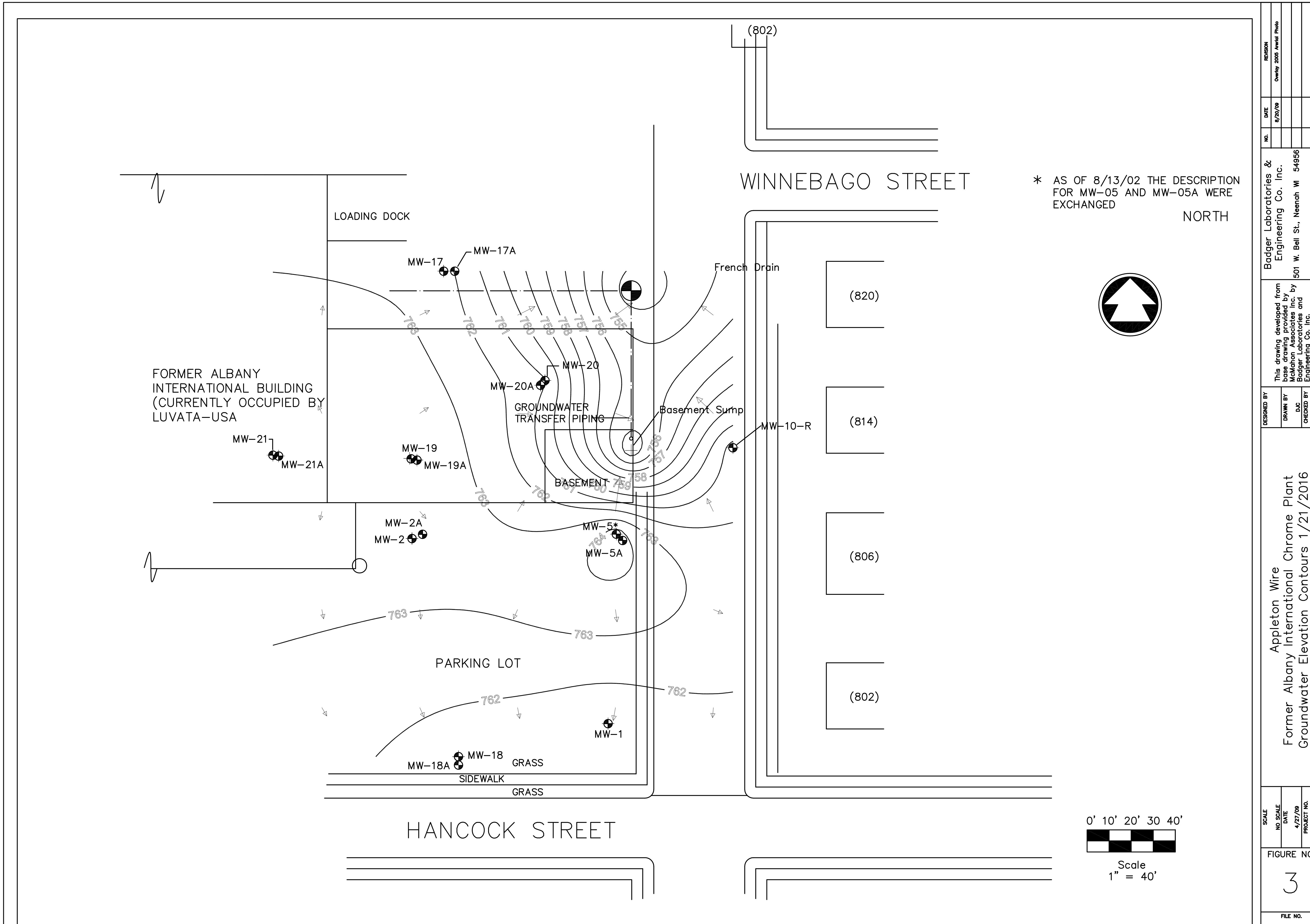
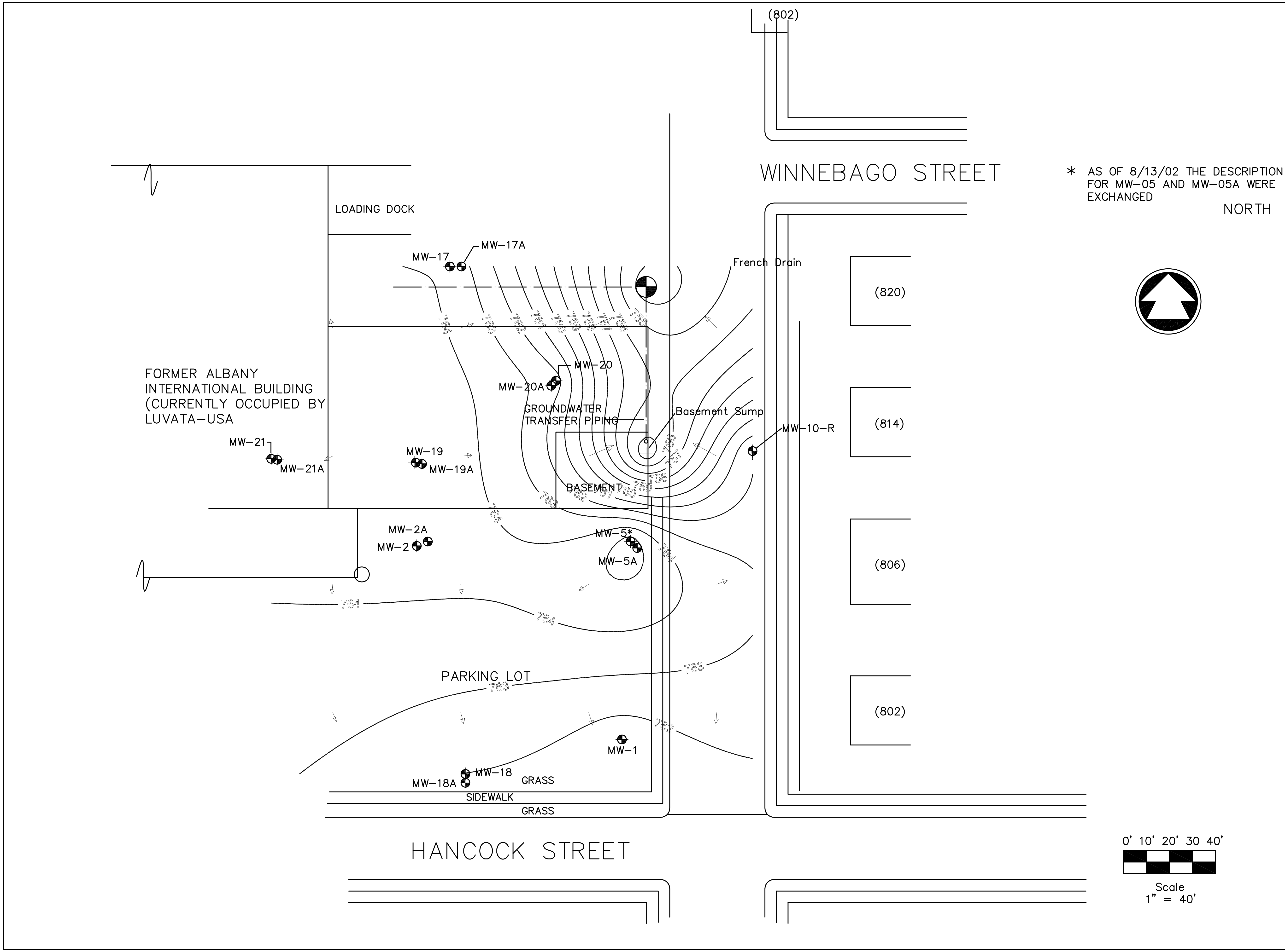


NORTH
WINNEBAGO STREET
MEADE STREET
HANCOCK STREET
LOADING DOCK
FORMER ALBANY INTERNATIONAL BUILDING (CURRENTLY OCCUPIED BY OUTOKUMPU)
RIM= 767.60 INV.= 760.69 D= 6.91'
RIM= 768.02 INV.= 761.32 D= 6.7'
RIM= 767.32 INV.= 755.92 D= 11.4'
INV.= 759.90 D= ±7.4'
4' DIA. MANHOLE (17.6' DEEP) PIPE INVERT 753.31 DEPTH ±15.5'-1% SLOPE
TRENCH LIMITS
GROUNDWATER TRANSFER PIPING
BASEMENT SUMP ELEVATION @ SUMP BOTTOM 754.24
6" ABANDONED PIPE (UNKNOWN PURPOSE) (DEPTH = 5.6')
6" LATERAL (DEPTH = 8.0')
BASEMENT DEPTH=11.5'
WALL
GRASS
SIDEWALK
ASPHALT PARKING LOT
RESIDENCE 820 MEADE ST.
RESIDENCE 814 MEADE ST. (NO SUMP IN BASEMENT)
RESIDENCE 806 MEADE ST.
RESIDENCE 802 MEADE ST.
763.98 GMW-11
763.58 GMW-10
762.02 GMW-09
761.06 GMW-08
GMW-06 762.49
GMW-5 761.07
GMW-7 762.36
764.80 GMW-01
763.80 GMW-02
762.84 GMW-03
762.79 GMW-04
MW-17 MW-17A
MW-2 MW-2A
MW-5* MW-5A*
MW-10-R
MW-1
MW-18 MW-18A
B-3 B-4 B-6 B-7 B-8 B-12 B-13 B-14 B-15 B-16 B-19
764 763 762 761 754 755 757 759 761 762
10"SAN 12"STO 6"WM FO G
LEGEND
B-3 ● STS LTD. CONSULTANTS SOIL BORING
* AS OF 8/13/02 THE DISCRIPTION FOR MW-5 AND MW-5A WERE EXCHANGED
MW-1 MONITORING WELL
GMW-01 761.30 GEOPROBE MONITORING WELL & GROUNDWATER ELEVATION
764 GROUNDWATER CONTOUR
FO UNDERGROUND FIBER OPTICS
G UNDERGROUND NATURAL GAS LINE
T UNDERGROUND TELEPHONE LINE
10"SAN UNDERGROUND SANITARY SEWER
12"STO UNDERGROUND STORM SEWER
6"WM UNDERGROUND WATERMAIN
ESTIMATED GROUNDWATER FLOW DIRECTION
McMAHON ASSOCIATES, INC. ENGINEERS ARCHITECTS SCIENTISTS SURVEYORS
1445 McMahon Drive Neenah, WI 54956
Mailing Address: P.O. Box 1025 Neenah, WI 54957-1025
TEL: 920-751-4200 FAX: 920-751-4284
DRAWN BLB
CHECKED SAB
GROUNDWATER CONTOURS – JANUARY 12, 2005
ALBANY INTERNATIONAL SITE
APPLETON, WISCONSIN
SCALE 1" = 40'
DATE 1/17/05
PROJECT NO. A0909-920118.06
SHEET NO. 8
FILE NO. CAD



WINNEBAGO STREET
HANCOCK STREET
* AS OF 8/13/02 THE DESCRIPTION FOR MW-05 AND MW-05A WERE EXCHANGED
NORTH
(802)
(820)
(814)
(806)
(802)
LOADING DOCK
FORMER ALBANY INTERNATIONAL BUILDING (CURRENTLY OCCUPIED BY LUVATA-USA
French Drain
Basement Sump
GROUNDWATER TRANSFER PIPING
BASEMENT
PARKING LOT
GRASS
SIDEWALK
GRASS
MW-17
MW-17A
MW-20
MW-20A
MW-21
MW-21A
MW-19
MW-19A
MW-10-R
MW-2A
MW-2
MW-5*
MW-5A
MW-1
MW-18
MW-18A
763
762
761
760
759
758
757
756
755
0' 10' 20' 30 40'
Scale
1" = 40'
Badger Laboratories & Engineering Co. Inc.
501 W. Bell St., Neenah WI 54956
This drawing developed from base drawing provided by McMahon Associates Inc. by Badger Laboratories and Engineering Co. Inc.
Appleton Wire
Former Albany International Chrome Plant
Groundwater Elevation Contours 1/21/2016
FIGURE NO.
3



NO.	DATE	REVISION
	8/20/09	Overlay 2005 Arerial Photo

Badger Laboratories & Engineering Co. Inc.
501 W. Bell St., Neenah WI 54956
TEL: (920) 729-1100 FAX: (920) 729-4945

This drawing developed from base drawing provided by McMahon Associates Inc. by Badger Laboratories and Engineering Co. Inc.

DESIGNED BY
DRAWN BY DJC
CHECKED BY KDC

Appleton Wire
Former Albany International Chrome Plant
Groundwater Elevation Contours 4/14/16

SCALE NO SCALE
DATE 4/27/09
PROJECT NO. Albany Int. CrO2

FIGURE NO.
4

FILE NO.

ATTACHMENT 2

EPA Suggested Geochemical Characterization Parameters

Table 2-2. Recommended Analytical Methods

Sample Type	Analyte	
Site Characterization	TOC (water)	EPA 415.1 or 415.2
	TOC (soil)	SW-846 modified 9060
	DOC (water)	0.45 µm filter, then EPA 415.1 or 415.2
	Particulate Organic Carbon	TOC minus DOC
	Soil pH	SW-846 9045C (use distilled water)
	Groundwater pH	EPA 150.1
	CEC	EPA 9081
	Total Cr(VI) reducing capacity by soil	Walkley-Black method
	Total manganese (soil)	Digest: SW-846 3050B, 3051, or 3052 Analysis: SW-846 7460, 6010B, or 6020
Groundwater **Pre- and Post-Treatment**	Total Chromium	0.45 µm filter, Digest: SW-846 3020A Analysis: SW-846 7191 -or- Digest: SW-846 3005A Analysis: SW-846 6010B or 6020
	Cr(VI)	0.45 µm filter Analysis: SW-846 7196A
	Cr(III)	Total Cr – Cr(VI)
Soil **Pre- and Post-Treatment**	Total Chromium	Digest: SW-846 3050B, 3051, or 3052 Analysis: SW-846 7090, 6010B, or 6020
	Cr(VI)	Digest: SW-846 3060A Analysis: SW-846 7196A
	Trivalent Chromium	Total Cr – Cr(VI)
	Available Cr(III) (to be mobilized)	Prep: K_2H - citrate extract (Bartlett, 1991) Analysis: SW-846 7196A
Soil **Post-Treatment (Leachate)**	Cr(III)	Leachate: Title 22 Waste Extraction Test (WET) Digest: SW-846, 3010A Analysis: SW-846 7090, 6010B, or 6020 -or- Digest:SW-846 3020A Analysis: SW-846 7191

ATTACHMENT 3

Pre-packed Well Schematics

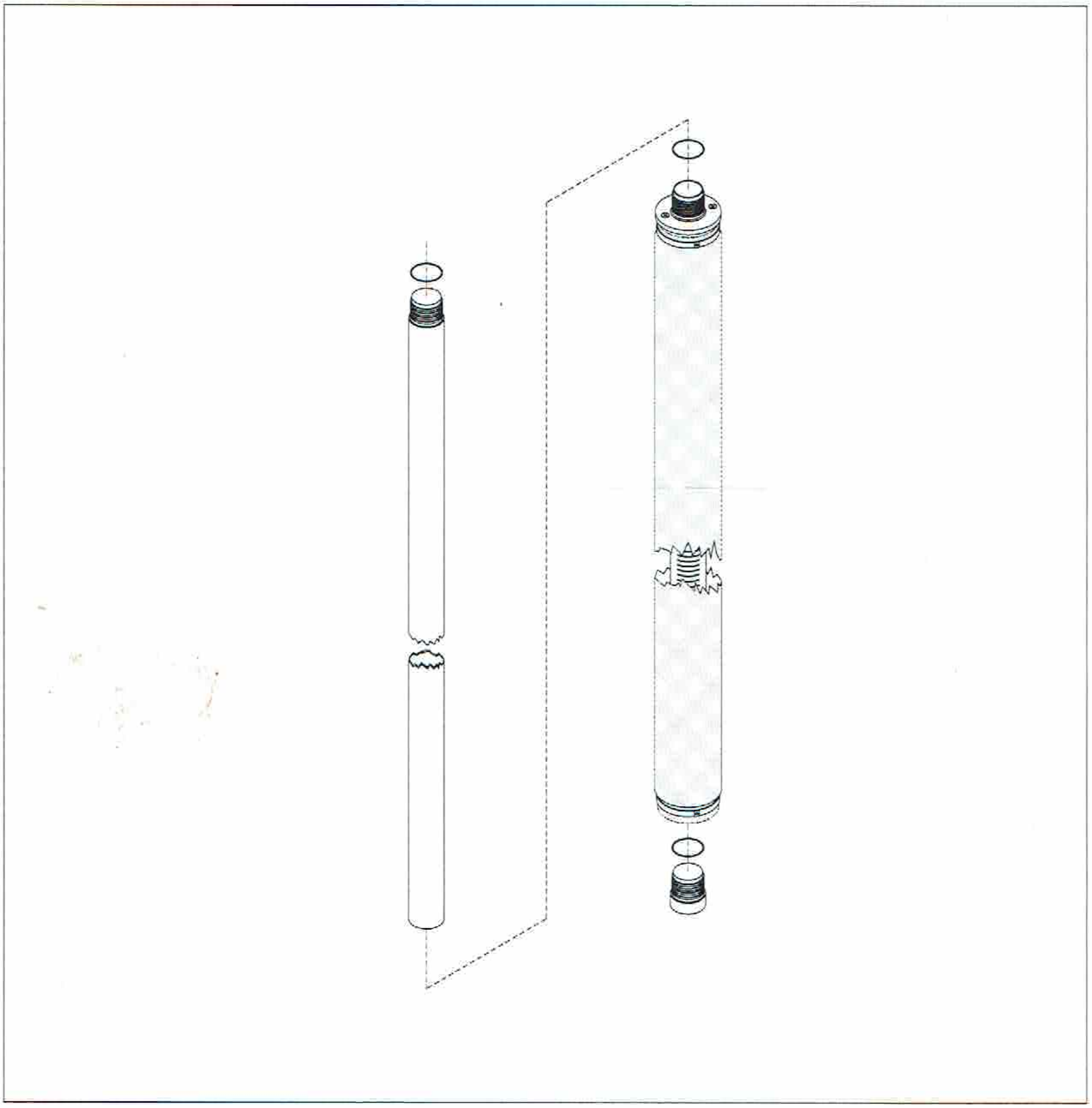
Geoprobe® 1.0-in. x 2.5-in. OD and 1.5-in. x 2.5-in. OD Prepacked Screen Monitoring Wells

Standard Operating Procedure

Technical Bulletin No. 992500

PREPARED: August, 1999

REVISED: January, 2011



GEOPROBE® 1.0-in. x 2.5-in. O.D. PREPACKED SCREEN AND PVC RISER

1.0 OBJECTIVE

The objective of this procedure is to install a permanent, small-diameter groundwater monitoring well that can be used to collect water quality samples, conduct hydrologic and pressure measurements, or perform any other sampling event that does not require large amounts of water over a short period of time (e.g. flow rate > 1 liter/minute). These methods meet or exceed the specifications discussed for direct push installation of permanent monitoring wells with prepacked screens in the U.S. Environmental Protection Agency's guidance document, *Expedited Site Assessment Tools For Underground Storage Tank Sites*, (EPA, 1997) and ASTM Standards *D 6724* (ASTM, 2002) and *D 6725* (ASTM, 2002).

2.0 BACKGROUND

2.1 Definitions

Geoprobe® Direct Push Machine: A vehicle-mounted, hydraulically-powered machine that uses static force and percussion to advance small-diameter sampling tools into the subsurface for collecting soil core, soil gas, or groundwater samples. The Geoprobe® brand name refers to both machines and tools manufactured by Geoprobe Systems®, Salina, Kansas. Geoprobe® tools are used to perform soil core and soil gas sampling, groundwater sampling, soil conductivity and contaminant logging, grouting, materials injection, and to install small-diameter permanent monitoring wells or temporary piezometers.
**Geoprobe® and Geoprobe Systems® are registered trademarks of Kejr, Inc., Salina, Kansas.*

1.0-inch x 2.5-inch OD Prepacked Well Screen (1.0-inch prepack): An assembly consisting of a slotted PVC pipe surrounded by environmental grade sand contained within a stainless steel wire mesh cylinder. The inner component of the prepacked screen is a flush-threaded, 1.0-inch Schedule 40 PVC pipe with 0.01-inch (0.25 mm) slots. Stainless steel wire mesh with a pore size of 0.011 inches (0.28 mm) makes up the outer component of the prepack. The space between the inner slotted pipe and outer wire mesh is filled with 20/40 mesh silica sand. Geoprobe® 1.0-inch x 2.5-inch prepacks are available in 5-foot sections and have an outside diameter of 2.5 inches (64 mm) and a nominal inside diameter of 1.0 inches (25 mm).

The 1.0-inch prepack is also available in a "field pack" configuration in which the user adds sand to the screen prior to installation. This reduces shipping weight by approximately 12.3 pounds (5.6 kg) per screen.

1.5-inch x 2.5-inch OD Prepacked Well Screen (1.5-inch prepack): An assembly consisting of a slotted PVC pipe surrounded by environmental grade sand contained within a stainless steel wire mesh cylinder. The inner component of the prepacked screen is a flush-threaded, 1.5-inch Schedule 40 PVC pipe with 0.01-inch (0.25 mm) slots. Stainless steel wire mesh with a pore size of 0.011 inches (0.28 mm) makes up the outer component of the prepack. The space between the inner slotted pipe and outer wire mesh is filled with 20/40 mesh silica sand. Geoprobe® 1.5-inch x 2.5-inch prepacks are available in 5-foot sections and have an outside diameter of 2.5 inches (64 mm) and a nominal inside diameter of 1.5 inches (38 mm).

2.2 Discussion

Conventional monitoring wells are typically constructed through hollow stem augers by lowering slotted PVC pipe (screen) to depth on the leading end of a string of threaded PVC riser pipe. A filter pack is then installed by pouring clean sand of known particle size through the tool string annulus until the slotted section of the PVC pipe is sufficiently covered.

Installing the entire filter pack through the tool string annulus becomes a delicate and time-consuming process when performed with small-diameter direct push tooling. Sand must be poured very slowly in order to avoid bridging between the riser pipe and probe rod. When bridging does occur, considerable time can be lost in attempting to dislodge the sand or possibly pulling the tool string and starting over.

Prepacked screens greatly decrease the volume of loose sand required for well installation as each screen assembly includes the necessary sand filter pack. Sand must still be delivered through the casing annulus to provide a minimum 2-foot grout barrier, but this volume is significantly less than for the entire screened interval.

The procedures outlined in this document describe construction of a permanent groundwater monitoring well using Geoprobe® 3.5-inch (89 mm) or 3.25-inch (83 mm) outside diameter (OD) probe rods and 2.5-inch OD prepacked screens. Geoprobe® 2.5-inch OD prepacks are available with either nominal 1.0-inch or 1.5-inch schedule 40 PVC components with a running length of 5 feet.

Installation of a prepack monitoring well begins by advancing 3.5-inch (89 mm) or 3.25-inch (83 mm) probe rods to depth with a Geoprobe® direct push machine. Prepacked screen(s) are then assembled and installed through the 2.625-inch (67 mm) inside diameter (ID) of the probe rods using corresponding 1.0-inch or 1.5-inch schedule 40 PVC riser (Fig. 2.1). Once the prepacks are lowered to depth, the rod string is slowly retracted until the leading end of the rods is approximately 3 feet above the top prepack.

Regulations generally require a minimum 2-foot grout barrier above the top prepack (Fig. 2.2) to avoid contaminating the well screens with bentonite or cement during installation. In some instances, natural formation collapse will provide the required barrier. If the formation is stable and does not collapse around the riser as the rod string is retracted, environmental grade 20/40 mesh sand may be installed through the probe rods to provide the minimum 2-foot grout barrier.

Granular bentonite or bentonite slurry is then installed in the annulus to form a well seal (Fig. 2.2). A high-pressure grout pump (Geoprobe® Model GP300 or GP350) may be used to tremie high-solids bentonite slurry or neat cement grout to fill the well annulus as the probe rods are retracted (Fig. 2.3). The grout mixture must be installed with a tremie tube from the bottom up to accomplish a tight seal without voids to meet regulatory requirements.

In certain formation conditions, the prepacked screens may bind inside the probe rods as the rods are retracted. This is most common in sandy formations sometimes called flowing or heaving sands. This binding can generally be overcome by lowering extension rods down the inside of the well riser and gently, but firmly, tapping the extension rods against the base of the well as the rods are slowly retracted. If the binding persists, clean tap water or distilled water may be poured down the annulus of the rods to increase the hydraulic head inside the well. This, combined with the use of the extension rods, will free up the prepacked screen and allow for proper emplacement.

Once the well is set, conventional flush-mount or aboveground well protection can be installed to prevent tampering or damage to the well head (Fig. 2.2). These wells can be sampled by several available methods (mechanical bladder pump, mini-bailer, Geoprobe® tubing check valve, etc.) to obtain high integrity water quality samples. These wells also provide accurate water level measurements and can be used as observation wells during aquifer pump tests.

When installed properly, these small-diameter wells generally meet regulatory requirements for a permanent monitoring well. While a detailed installation procedure is given in this document, it is by no means totally inclusive. **Always check local regulatory requirements and modify the well installation procedure accordingly.** These methods meet or exceed the specifications discussed for direct push installation of permanent monitoring wells with prepacked screens in the U.S. Environmental Protection Agency's guidance document, *Expedited Site Assessment Tools For Underground Storage Tank Sites*, (EPA, 1997) and ASTM Standards *D 6724* (ASTM, 2002) and *D 6725* (ASTM, 2002).

** The Mechanical Bladder Pump is manufactured under U.S. Patent No. 6,877,965 issued April 12, 2005.*

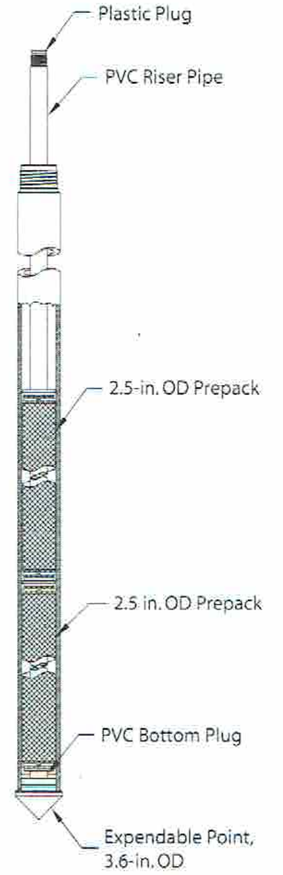


FIGURE 2.1
Insertion of Prepack Screens

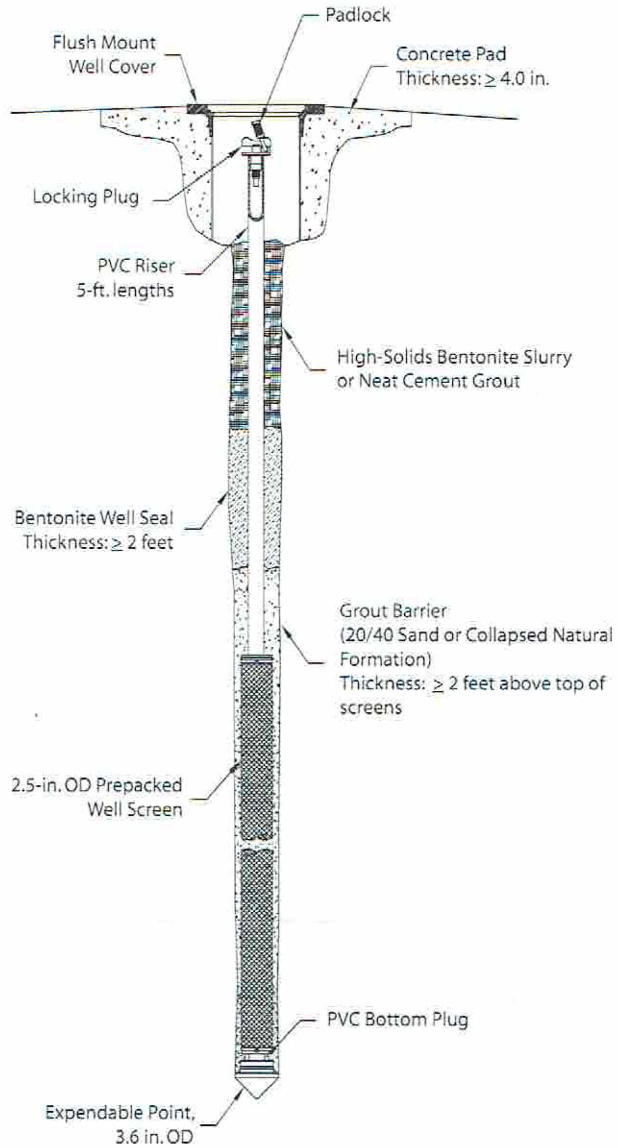


FIGURE 2.2
Installed Geoprobe® 2.5-in. OD Prepacked Screen Monitoring Well

3.0 TOOLS AND EQUIPMENT

The following equipment is required to install a permanent monitoring well with Geoprobe® 2.5-inch OD prepacked screens. Refer to Figures 3.1 and 3.2 for illustrations of well components.

1.0-in. X 2.5-in. Prepack Well Components	Part Number
1.0-in. x 2.5-in. Prepacked Screen, 5-ft. length	17467
1.0-in. x 2.5-in. Fieldpacked Screen (w/o sand), 5-ft. length	11679
1.0-in. x 2.5-in. Fieldpacked Screen (w/o sand), 3-ft. length	GW2436
PVC Riser, 1.0-in. sch. 40, 5-ft. length	12876
O-rings for 1.0-in. PVC Riser, Pkg. of 25	13196
PE Top Plug, 1.0-in. sch. 40 riser	13227
Locking Well Plug, for 1.0-in. sch. 40 riser	WP1710
PVC Bottom Plug, 1.0-in. sch. 40 flush thread	12881
Expendable Drive Point, 3.5 or 3.25-in. rods / 3.6-in. OD	AT3215

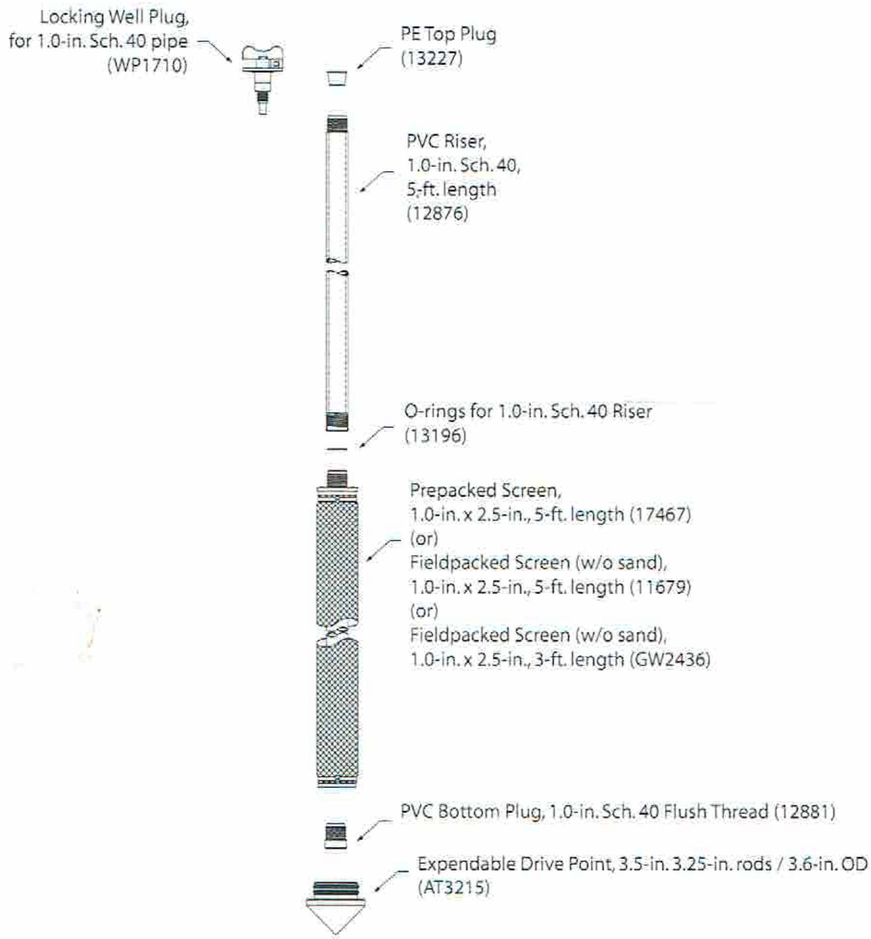


FIGURE 3.1:
1.0-in. x 2.5-in. Prepacked and Fieldpacked Screen Monitoring Well Parts

1.5-in. X 2.5-in. Prepack Well Components	Part Number
1.5-in. x 2.5-in. Prepacked Screen, 5-ft. length	17401
PVC Riser, 1.5-in. sch. 40, 5-ft. length	17405
O-rings for 1.5-in. PVC Riser, Pkg. of 25	18782
PE Top Plug, 1.5-in. sch. 40 riser	21465
Locking Well Plug, for 1.5-in. sch. 40 riser	WP1715
PVC Bottom Plug, 1.5-in. sch. 40 flush thread	17407
Expendable Drive Point, 3.5 or 3.25-in. rods / 3.6-in. OD	AT3215

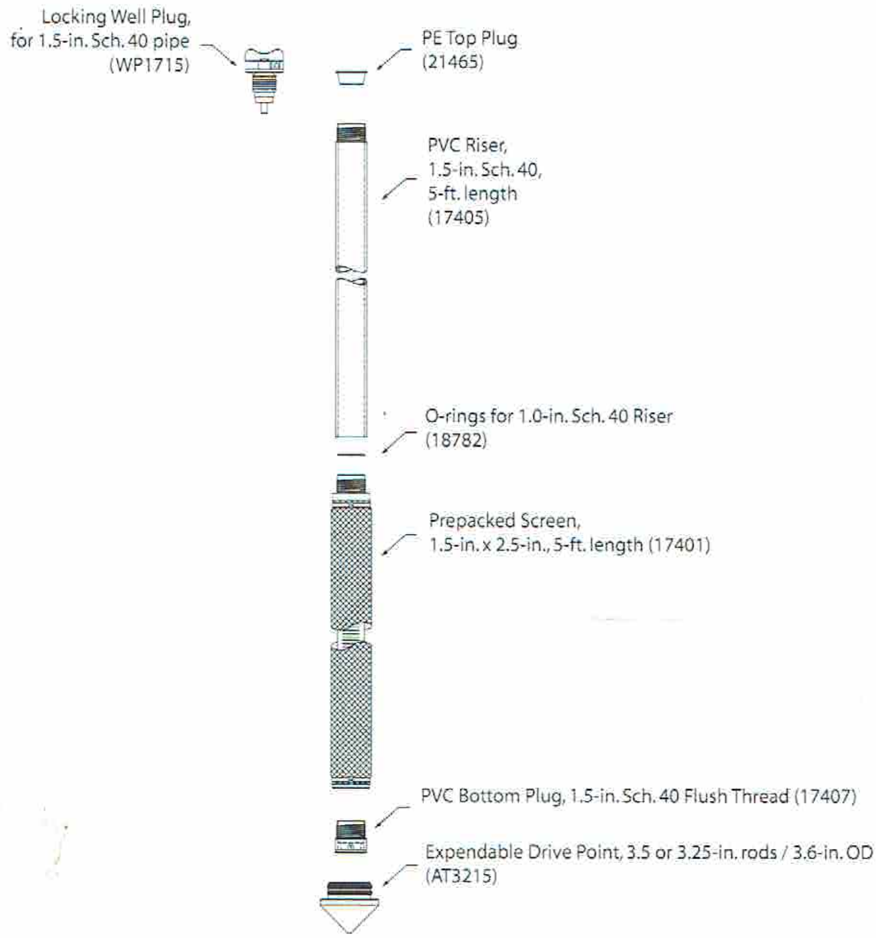


FIGURE 3.2:
1.5-in. x 2.5-in. Prepacked Screen Monitoring Well Parts

Monitoring Well Accessories	Part Number
Well Cover, flush-mount, 4-in. x 12-in., cast iron / ABS skirt	WP1741
Well Cover, flush-mount, 7-in. x 10-in., cast iron / galvanized skirt	WP1771
Sand, environmental grade (20/40 mesh), 50-lb. bag	AT95
Bentonite, granular (8 mesh), 50-lb. bag	AT91
Bentonite, powdered (200 mesh), 50-lb. bag	AT92

Geoprobe® Tools and Equipment	Part Number
Probe Rod, 3.5-in x 48-in. or 60-in.	38951 or 36641
Probe Rod, 3.5-in x 1 meter (optional)	38952
Probe Rod, 3.25-in. x 48-in. or 60-in.	10594 or 9040
Probe Rod, 3.25 in. x 1 meter (optional)	13925
O-Rings for 3.25-in. Probe Rods (Pkg. of 25)	9960
Expendabel Point Holder, 3.5-in. x 48-in. or 60-in.	38953 or 37763
Expendable Point Holder, 3.25-in. x 48-in. or 60-in.	10596 or 9796
Expendable Point Holder, 3.5-in x 1 meter (optional	38955
Expendable Point Holder, 3.25 in. x 1 meter (optional)	13926
Expendable Point Assembly, Steel, 3.6-inch OD	AT3215
Drive Cap, Threadless, 3.5-inch Probe Rods (GH40 Hammer)	38982
Drive Cap, Threadless, 3.5-inch Probe Rods (GH60 Hammer)	36642
Drive Cap, Threadless, 3.25-inch Probe Rods (GH40 Hammer)	10605
Drive Cap, Threadless, 3.25-inch Probe Rods (GH60 Hammer)	9742
Rod Grip Pull Handle, 3.5-in. Probe Rods (GH40 Hammer)	38983
Rod Grip Pull Handle, 3.5-in. Probe Rods (GH60 Hammer)	44688
Rod Grip Pull Handle, 3.25-in. Probe Rods (GH40 Hammer)	12235
Rod Grip Pull Handle, 3.25-in. Probe Rods (GH60 Hammer)	9757
Extension Rod, 48-in. or 60-in.	AT671 or 10073
Extension Rod, 1-meter (optional)	AT675
Extension Rod Coupler	AT68
Extension Rod Handle	AT69
Extension Rod Quick Links Pin	AT695
Extension Rod Quick Link Box	AT696
Screen Push Adapter	GW1535
Grout Machine	GP300 or GP350
Grout System Accessories, 1.5-in. Rods	GS1015
Water Level Meter, 0.438-in. OD Probe, 100-ft. Cable*	GW2000
Stainless Steel Mini-Bailer (optional)	GW41
Check Valve Assembly, 0.375-in. OD Tubing*	GW4210
Well Development Tool 1.5-in.	34558
Well Development Tool 1.0-in.	35364
Polyethylene Tubing, 0.375-in. OD, 500-ft. (for purging, sampling, etc.)	TB25L
Mechanical Bladder Pump	MB470
Low-Density Polyethylene Tubing, 0.625-in. OD, 100-ft. (for tremie tube grouting)	16857
Grout Tubing Adapter, for 0.625-in. OD Tubing	16893

**Refer to Appendix A for additional tool options.*

***Refer to Standard Operating Procedure (SOP) for the Mechanical Bladder Pump (Technical Bulletin No. MK3013) for additional tooling needs.*

4.0 SAND INSTALLATION IN 1.0 IN. X 2.5-IN. FIELDPACK WELL SCREEN

Due to the significant weight of the sand in a 1.0-in. x 2.5-in. Prepack Well Screen (17467), a 1.0-in. x 2.5-in. OD Fieldpack Screen (11679) is available without sand to reduce shipping costs. It is necessary to add sand to the fieldpack screen prior to installation. A specific packing procedure must be followed in order to prevent the sand from settling in the screen after well installation. This section describes the procedure for properly installing sand in a 1.0-in. x 2.5-in. Fieldpack Well Screen.

4.1 Required Equipment

1 Quart (1 L) Container (1)
Phillips-Head Screwdriver (1)
20-40 Mesh Sand (1gallon / 3.75 L)
Fieldpack Screen Asm., P/N 11679 (1):
- PE Top Plug, (1)
- Stainless Steel Screw, (2)
- Gray PVC Cap, (1)
- Sand Cylinder, (1)

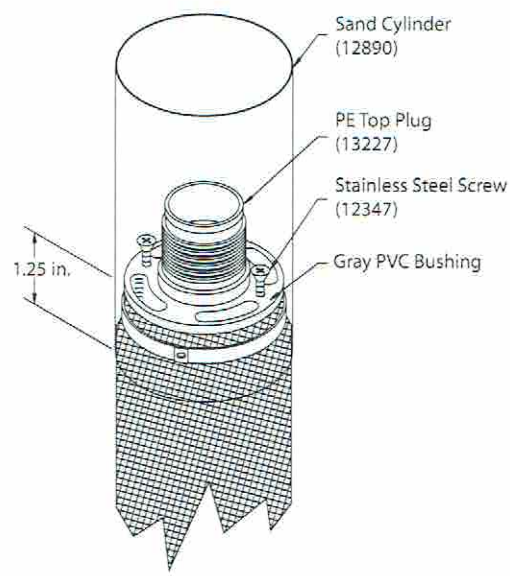


FIGURE 4.1.
Selected components of a 1.0-in. x 2.5-in. OD Fieldpack Well Screen

4.2 Procedure

1. Ensure that the PE top plug is pushed into the top of the PVC riser and both screws are threaded into the gray bushing (Fig. 4.1).
2. Slide the clear sand cylinder over the screen such that the leading end of the cylinder is approximately 1.25 inches below the top of the gray PVC bushing (Fig. 4.1).

IMPORTANT: Do not push the sand cylinder farther onto the screen than indicated as this will make it difficult to remove once the screen is packed with sand.

CAUTION: Use care when handling the screen with bare hands. Small wires protruding from the screen can easily puncture the skin.

3. Pour 3 quarts (3 L) of sand into the sand cylinder. This will fill the screen approximately 3/4 to 7/8 full.

4. The screen must now be tapped on the ground to settle (pack) the sand.
   a) Gently grasp the screen and raise it approximately 2 inches (5 cm) off the ground.

IMPORTANT: Be careful when gripping the screen to squeeze it just hard enough to lift it from the ground. The screen may be damaged if too much pressure is applied before the screen is packed with sand.

   b) Release the screen and allow it to fall back to the ground.

IMPORTANT: Do not drop the screen more than 2 inches (5 cm) as this can damage the screen.

   c) Repeat Steps 4.2.4-A and B for a total of 15 "drops".

5. Completely fill the screen with sand. Add enough sand to also fill the sand cylinder approximately three/quarters full.

   NOTE: Screen will hold approximately 4 quarts (3.75 L) of sand when all has settled after packing.

6. Lift and drop the screen an additional 60-80 times to finish packing the sand. Remember not to drop the screen from a height of more than 2 inches (5 cm). After this step, the screen should feel very firm.

7. Remove the sand cylinder by rocking it from side-to-side while pulling upward. Let the excess sand drain from the bottom of the cylinder. Brush any remaining sand from the top of the gray bushing.

8. Remove the stainless steel screws (Fig. 4.1) from the gray bushing using the phillips-head screwdriver.

9. Place the gray PVC cap on top of the screen with the countersunk holes "up" as shown in Figure 4.2.

IMPORTANT: **Ensure that no sand is trapped between the cap and bushing as this may allow sand to leak from the screen during handling.**

10. Attach the PVC cap to the PVC bushing by installing the two stainless steel screws (Figs. 4.2).

Installation of sand in the fieldpack screen is now complete. Remember to remove the top plug from the screen before attaching the first section of riser pipe. Do not throw away the plug as it may be used to keep grout and other materials from entering the top of the riser during well installation.

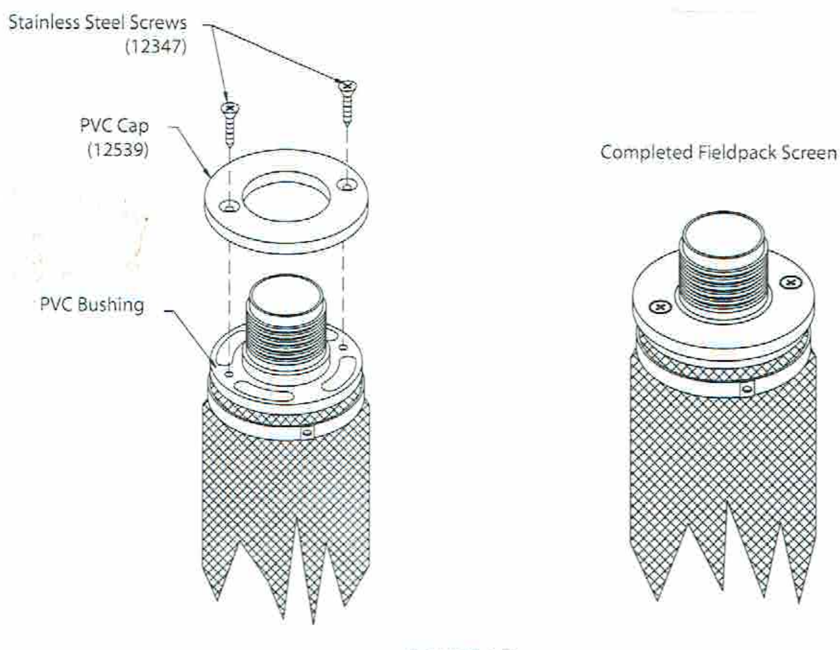
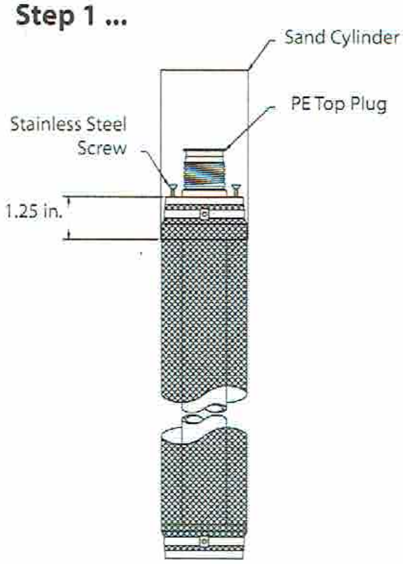


FIGURE 4.2.
The PVC cap is attached to the top of the screen with two stainless steel screws.

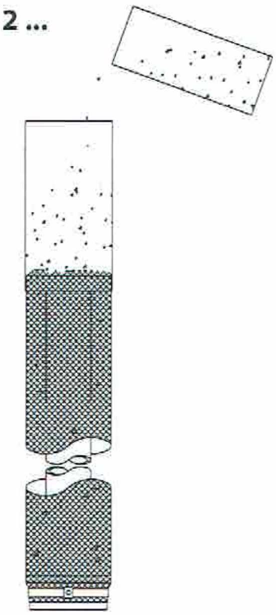
Sand Installation Quick Reference Guide

Step 1 ...



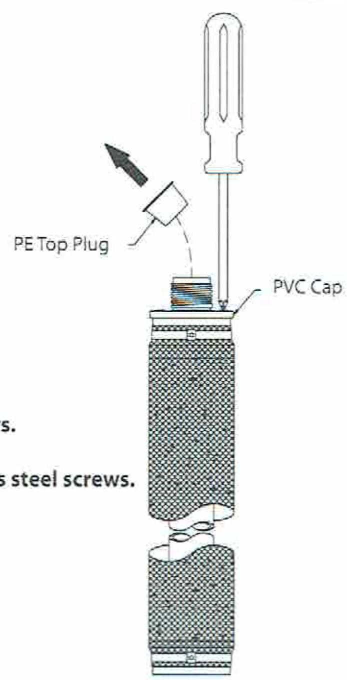
1. Position sand Cylinder.

Step 2 ...



1. Fill screen with sand.
2. Tap screen on ground to pack sand.
3. Add more sand to completely fill screen.
   Screen will hold about 4 quarts (3.75 L) of sand.

Step 3 ...



1. Remove sand cylinder.
2. Remove stainless steel screws.
3. Position PVC cap.
4. Replace and tighten stainless steel screws.
5. Remove top plug.

5.0 WELL INSTALLATION

Monitoring well installation can be divided into the six main tasks listed below. This section provides specific instructions for the completion of all six tasks.

- Driving the probe rods to depth
- Deploying the screen(s) and riser pipe
- Installing a sand/grout barrier
- Installing a bentonite seal above the screen
- Grouting the well annulus
- Installing surface protection

NOTE: The many prepacked screen options have resulted in an extensive list of Geoprobe® part numbers. To simplify the instructions presented in this document, part numbers for well components are not specified in the text or illustrations. Refer to Section 3.0 for part numbers and complete descriptions for all well components and accessories.

Installing sand in the 1.0-in. x 2.5-in Fieldpacked Well Screen

The 1.0-inch x 2.5-inch fieldpacks can be packed with sand before arriving at the job site or at the job site. To help make the well installation process more efficient, Geoprobe Systems® recommends packing all well screens with sand before mobilizing to the job site. Each box of 1.0-inch x 2.5-inch Fieldpacked Screens includes a complete set of sand filling instructions. The process of filling the screens with sand is also described in Section 4.0 of this document.

5.1 Driving Probe Rods to Depth

1. Place the Geoprobe® direct push machine at the proposed monitoring well location and unfold the probe assembly into the operating position as instructed in the machine Owner's Manual. Because access to the top of the probe rod string is required, it is important to allow room for derrick retraction when positioning the unit for operation.

2. Insert a 3.6-inch OD Expendable Point Assembly into the unthreaded end of a 3.5-inch or 3.25-inch Expendable Point Holder. See Figure 5.1.

3. Place a 3.5-inch or 3.25-inch Drive Cap over the threaded end of the expendable point holder.

4. Place the expendable point holder under the hydraulic hammer in the driving position (refer to direct push machine Owner's Manual). Advance the point holder into the ground, using percussion if necessary. To install an accurately placed monitoring well, it is important to drive the rod string as straight as possible. If the point holder is not straight, retract the assembly from the ground and start over with Step 1.

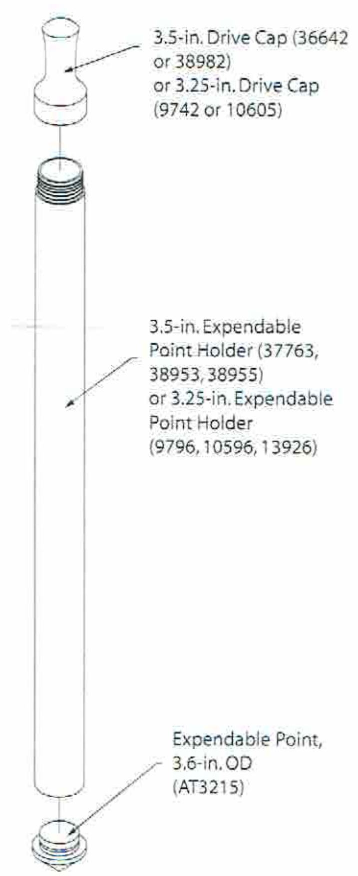


FIGURE 5.1
Drive Cap, Expendable Point Holder and Expendable Point Assembly

5. Remove the drive cap from the expendable point holder. Install an O-ring on the point holder in the groove located at the base of the male threads (Fig. 5.2) Make sure the O-ring groove and O-ring mating surface are clean. Any foreign material located in these areas will prevent the O-ring from sealing properly.

IMPORTANT: O-rings must always be used to seal the Probe Rod joints.

6. Lubricate the O-ring and O-ring mating surface (Fig. 5.3) with a small amount of clean water. Apply the water with either a moist cloth or a spray bottle.

7. Thread a 3.5-inch or 3.25-inch Probe Rod onto the expendable point.

8. Place the drive cap on the probe rod and advance the rod string the full stroke of the machine.

9. Remove the drive cap. Again, install an O-ring in the O-ring groove of the probe rod. Lubricate the O-ring and the O-ring mating surface (Fig. 5.3). Add the next probe rod, replace the drive cap, and advance the rod string.

10. Repeat Step 9 until the leading end of the rod string is 1.5 inches (3.8 cm) below the bottom of the desired screen interval. The additional depth adjusts for the extra height created by the expendable point and the PVC Bottom Plug. The top probe rod must also extend at least 15 inches (38 cm) above the ground surface to allow room for the rod grip puller used later in this procedure. (An additional rod may be added if necessary.) Move the machine foot back to provide access to the top of the rod string.

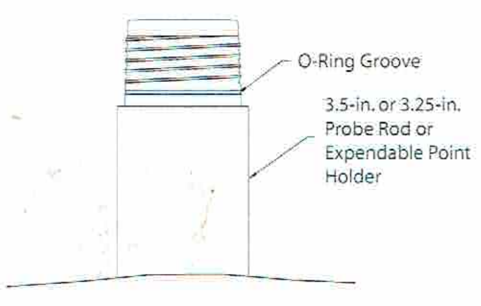


FIGURE 5.2
Probe Rod O-Ring Groove

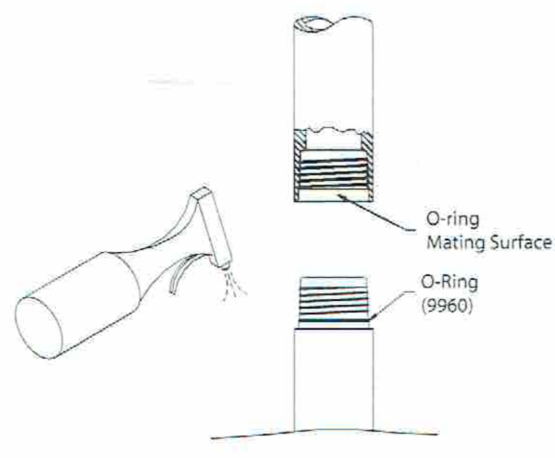


FIGURE 5.3
Lubricating O-Ring and Mating Surface

5.2 Deploying the Screen(s) and Riser Pipe

1. With the probe rods driven to the proper depth, the next step is to deploy the prepacked or field-packed screen(s) and riser pipe. If using fieldpacks, inspect the screens to ensure that:

   a) the plastic plug is removed.
   b) the stainless steel screws are snug.(See Fig. 5.4)

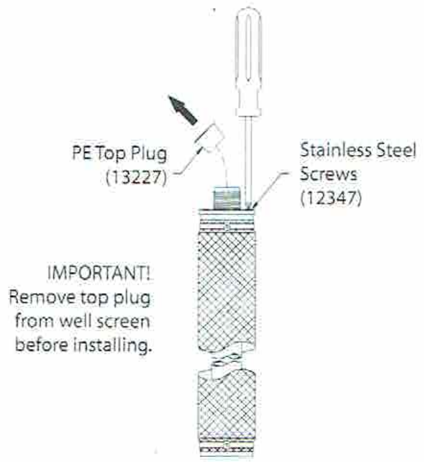


FIGURE 5.4
Inspecting a Fieldpacked Screen

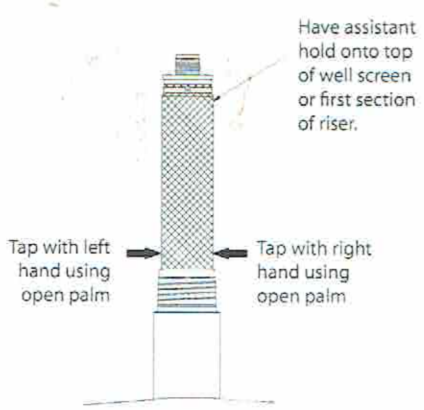


FIGURE 5.6
Tap On Sides of Prepack
If Difficult to Install

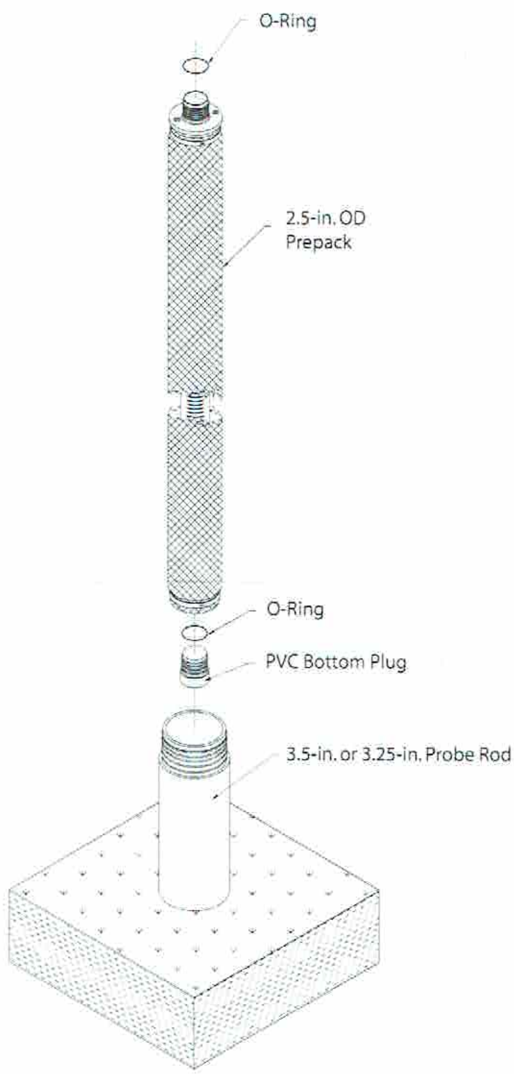


FIGURE 5.5
Prepacked Screen Assembly
Inserted Into Rod String

IMPORTANT: The following installation instructions specify "prepack(s)" and "prepacked screen(s)", but are also applicable to 1.0-in. x 2.5-in. fieldpacked screens.

2. Thread a PVC Bottom Plug into a 2.5-in. OD prepack. An O-ring may be used on the plug if desired.

3. Leading with the bottom plug, insert the prepacked screen assembly into the probe rod string as shown in Figure 5.5. If the prepack does not slide easily into the rods, do not force it. With the lower end of the prepack in the probe rod, hit the screen simultaneously with both hands using a clapping motion (Fig. 5.6). With this technique, the screen will drop by gravity into the probe rods. Have an assistant hold onto the top portion of the screen to prevent the screen from unexpectedly falling downhole.

CAUTION: Be careful when "kneading" the screen. Sudden screen slippage can pinch hands between the screen and the probe rod. To prevent screen slippage, have an assistant hold onto the prepack during the "kneading" operation.

4. Add additional five-foot prepacks to obtain the desired screened interval. O-rings can be installed between the prepack sections if desired.

5. With the assistance of a second person, attach five-foot sections of 1.0-inch Schedule 40 PVC Riser to the top of the screen assembly. O-rings are required at each riser joint to prevent groundwater, located above the desired monitoring interval, from seeping into the well. Continue to add riser sections until the assembly reaches the bottom of the probe rods (Fig. 5.7). At least one foot (0.3 m) of riser should extend past the top probe rod. Place the plastic plug into the top riser. Duct tape may be used to help keep the plug in the riser.

6. It is now time to pull up the probe rods from around the well screen and riser. Reposition the probe unit so that the Rod Grip Puller can be attached to the rod string.

(continued on Page 16)

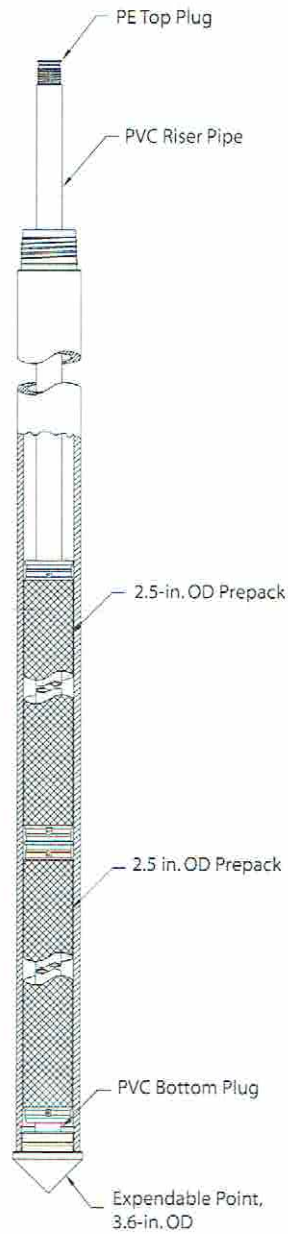


FIGURE 5.7
Prepack Assembly Inside Probe Rods

7. Retract the rod string the total length of all the screens plus an additional 3 feet (1 m). While pulling the rods, observe whether the top PVC riser stays in place or moves up with the rods.

   a) If the riser stays in place, stable formation conditions are present. Continue retracting the rods to the depth specified above. Go to Section 4.4.

   b) If the riser moves up with the probe rods, have a second person hold it in place while pulling up the rods. An additional section of PVC riser may be helpful. Once the probe rods have cleared the lower section of screen, the screen and riser assembly should stop rising with the rods. Continue retracting to the depth specified above. Go to Section 5.4.

   c) If the risers continue to move up with the probe rods and cannot be held in place by hand, sand heave has most likely caused the screen to bind to the inside of the rods. Extension rods are now required. (Refer to Figure 5.8 for an illustration of extension rod accessories.)

   d) Place a Screen Push Adapter on the end of an Extension Rod. Insert the adapter and extension rod into the PVC riser and hold either by hand or with an Extension Rod Jig. Attach additional extension rods with Extension Rod Couplers or Extension Rod Quick Links until the push adapter contacts the bottom of the screens (Fig. 5.9). Place an Extension Rod Handle on the top extension rod after leaving 3 to 4 feet (1 to 1.2m) of extra height above the last probe rod.

   e) Slowly retract the probe rods while another person pushes and taps on the screen bottom with the extension rods (Fig. 5.9). To ensure proper placement of the screen interval and to prevent well damage, be careful not to get ahead while pulling the probe rods. The risers should stay in place once the probe rods are withdrawn past the screens. Retrieve the extension rods. Place the plug back into the top riser and secure it with duct tape if necessary.

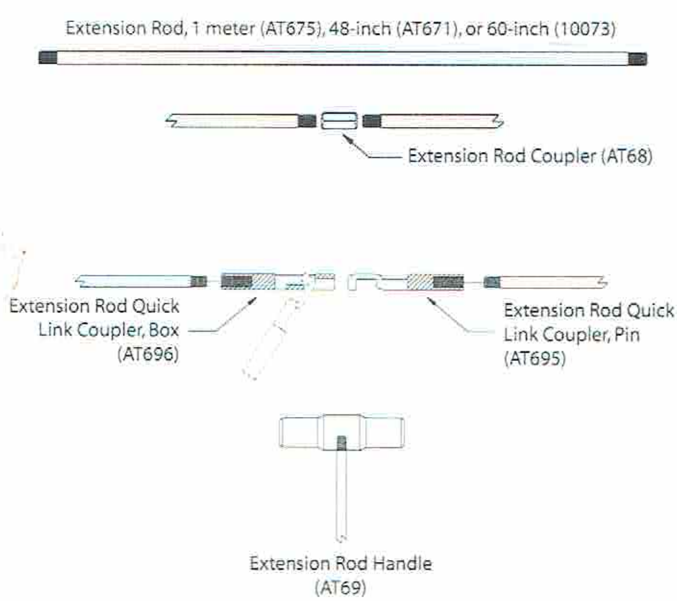


FIGURE 5.8
Geoprobe® Extension Rods and Accessories

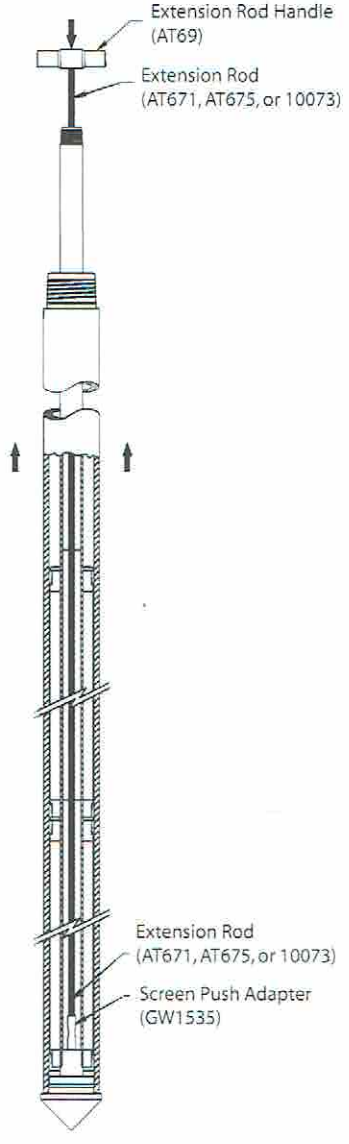


FIGURE 5.9
Using Extension Rods to Tap Out Wedged Screens

5.3 Installing the Grout Barrier

The natural formation will sometimes collapse around the well screens and PVC riser as the probe rod string is pulled back. This provides an effective barrier between the screens and grout material used to seal the well annulus. If the formation does not collapse, a sand barrier must be installed from the surface. This portion of the well installation procedure is important because an inadequate barrier will allow grout to reach the well screens. Grout contamination can produce non-representative samples and retard groundwater flow into the well.

1. Using a Water Level Indicator or flat tape measure, determine the depth from the top of the PVC riser to the bottom of the riser and probe rod annulus. Two scenarios are possible:

   a) **Measured depth is 2 to 3 feet (0.6 to 0.9 m) less than riser length:** This indicates that unstable conditions have resulted in formation collapse. A natural grout barrier was formed as material collapsed around the PVC riser when the probe rods were retracted. This commonly occurs in sandy formations. No further action is required. Proceed with Section 5.5 and perform Step 2 (unstable formation).

   b) **Measured depth is equal to or greater than riser length:** This indicates that stable conditions are present. The probe hole has remained open and void space exists between the riser (and possibly the screen) and formation material. Clean sand must be placed downhole to provide a suitable grout barrier. Continue with Step 2.

2. Begin slowly pouring 20/40 grade sand down the annulus between the PVC riser and probe rod string. Reduce spillage by using a funnel or flexible container as shown in Figure 5.10. Add approximately 1.4 gal. (5.3 L) for each 5-foot (1.5 m) screen section, plus 0.9 gal. (3.4 L) for a minimum 2-foot (0.6 m) layer of sand above the screen section.

3. Measure the annulus depth after each 1,5 liters of sand. The sand may not fall all the way past the screen due to the tight annulus and possible water intrusion. This is acceptable, however, since the prepacked screens do not require the addition of sand. The important thing is that a sand barrier is provided <u>above</u> the screens.

4. Sand may also bridge within the annulus between the risers and probe rods and consequently fail to reach total depth (Fig. 5.10). This most likely occurs when the sand contacts the water table during deep well installations. Wet probe rods also contribute to sand bridging. If the annulus is open, skip to Section 5.5, Step 1. If bridging is evident, continue with Step 5.

5. In case of a sand bridge <u>above</u> the screens (wet rods, high water table, etc.), insert clean extension rods into the well annulus to break up the sand (Fig. 5.10). Simultaneously retracting the probe rods usually helps. Check annulus depth again. If sand is no longer bridged, proceed to Section 5.5. If bridging is still evident, continue with Step 6.

6. If the sand bridge cannot be broken up with extension rods, inject a small amount of clean water into the annulus using a Geoprobe GP300 or GP350 Grout Machine and 3/8-in. (9.5mm) OD polyethylene tubing. Simply insert the poly tubing down the well annulus until the sand bridge is contacted. Attach the tubing to the grout machine and pump up to one gallon of clean water while moving the tubing up and down. The jetting action of the water will loosen and remove the sand bridge. Check the annulus depth again. The distance should be 2 to 3 feet (0.6 to 0.9 m) less than the riser length. Proceed with Section 5.5.

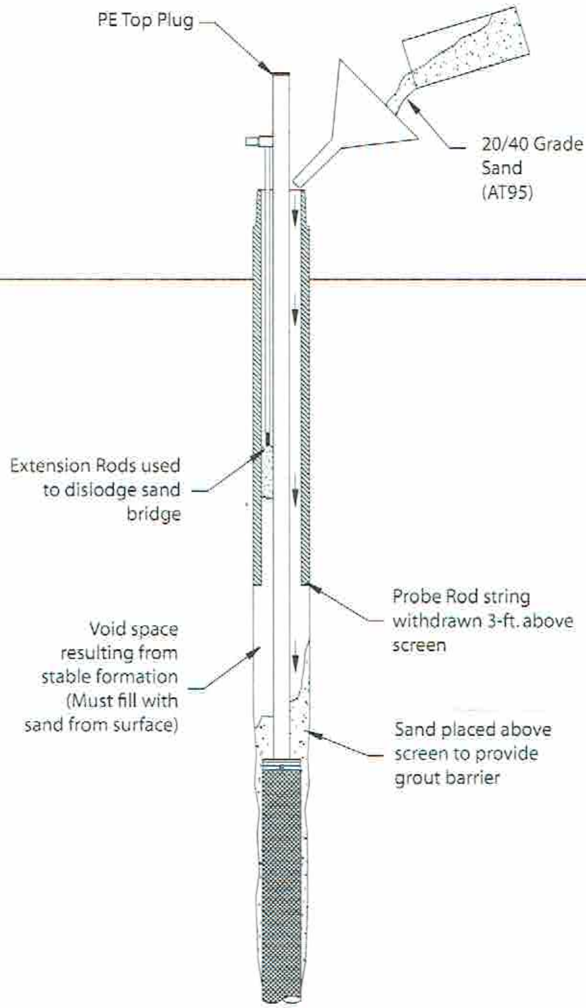


FIGURE 5.10
Installing Grout Barrier from Ground Surface with 20/40 Grade Sand

5.4 Bentonite Seal Above Screen

Bentonite is an expanding clay which exhibits very low permeability. When properly placed, bentonite prevents contaminants from moving into the well screens from above the desired monitoring interval. The seal is formed either by pouring granular bentonite into the annulus from the ground surface, or by injecting a high-solids bentonite slurry directly above the grout barrier. The use of granular bentonite is limited to cases in which the top of the screen ends above the water table (no water is present in the probe rods). Whichever method is used, at least 2 feet (0.6 m) of bentonite must be placed above the sand pack.

1. **Stable Formation.** Granular bentonite is recommended if the following conditions are met:
   - Top of screen interval is above the water table
   - Formation remained open when probe rods were retracted
   - Bridging was not encountered while installing sand for the grout barrier in Section 5.4

   a) Withdraw the probe rod string another 3 to 4 feet (0.9 to 1 m) and ensure that the PVC riser does not lift with the rods. It is important that the bottom of the rod string is above the proposed seal interval. If positioned too low, dry bentonite will backup into the expendable point holder. Bridging then results if moisture is present inside the probe rods.

   b) Pour bentonite between the probe rods and PVC riser as was done with the sand in Section 5.4. To properly hydrate the granular bentonite, it is necessary to periodically add water through a tremie tube while installing the bentonite. To accomplish this, repeat adding six inches of granular bentonite followed by 1.0 gallon (3.8 L) of water through a tremie tube until a minimum 2-foot (0.6 m) bentonite layer is created. Use the following procedure:

      i. Pour 0.8 liters of granular bentonite into the annulus. This volume of bentonite will fill approximately 6 inches (15 cm) of annular space.

      ii. Check for bridging inside the annulus. Measure the riser depth to the bottom of the annulus. The depth should equal the riser length minus the 2-foot sand pack and the added bentonite. If the measured depth is significantly less than expected, the bentonite has more than likely bridged somewhere inside the rod string. A procedure similar to that identified for bridged sand (Section 5.4, Steps 5 and 6) may be used to dislodge the granular bentonite.

      iii. Hydrate the bentonite by adding 1 gallon (3.8 L) of water to the annulus through a tremie tube. Do not pour water directly into the annulus. A tremie tube will help prevent bridging by keeping the rod string dry.

      iv. Repeat this procedure an additional three times or until the 2-foot (0.6 m) thick bentonite layer is completed.

2. **Unstable formation.** A grout machine is required to install the bentonite seal if the formation collapsed when the rods were retracted or the sand bridged when installing the grout barrier. The grout machine can pump a high-solids bentonite slurry under sufficient pressure to displace collapsing soil. Void spaces often develop when poured (gravity installed) granular bentonite is used under these conditions, resulting in an inadequate annular seal. Wet rods will often lead to bridging problems as well. Use the procedure on the following page to install a bentonite seal with a grout pump.

a) Mix 1.5 gallons (5.7 L) of high-solids bentonite (20 to 25 percent by dry weight) and place in the hopper of the grout machine.

b) Insert flexible tubing to the bottom of the annulus between the probe rods and well riser. Leaving at least 25 feet (8 m) extending from the top of the rod string, connect the tubing to the grout machine. This extra length will give needed slack for rod extraction (completed later in the procedure).

NOTE: The side-port tremie method is recommended to prevent intrusion of grout into the sand barrier. To accomplish side-port discharge of grout, cut a notch approximately one-inch (25 mm) up from the leading end of the tubing and then seal the leading end with a threaded plug of suitable size.

c) Reposition the probe unit and attach the 3.5-inc or 3.25-inch Rod Grip Puller.

d) Activate the pump and fill the tremie tube with bentonite. Begin slowly pulling the rod string approximately 3 feet (1.0 m) while operating the pump (Fig. 5.11). This will place bentonite in the void left by the retracted rods before it is filled by the collapsing formation. Continue to watch that the PVC riser does not come up with the rod string.

NOTE: When removing the retracted probe rod, slide the rod over the tremie tube and place it on the ground next to the grout machine. This eliminates cutting and reattaching the tubing for each rod removed from the string. Take care not to "kink" the tremie tube during this process as it will create a weak spot which may cause the tubing to burst when pressure is applied.

e) Measure the annulus depth to ensure that at least 2 feet (0.6 m) of bentonite was delivered. Pump additional bentonite slurry if needed.

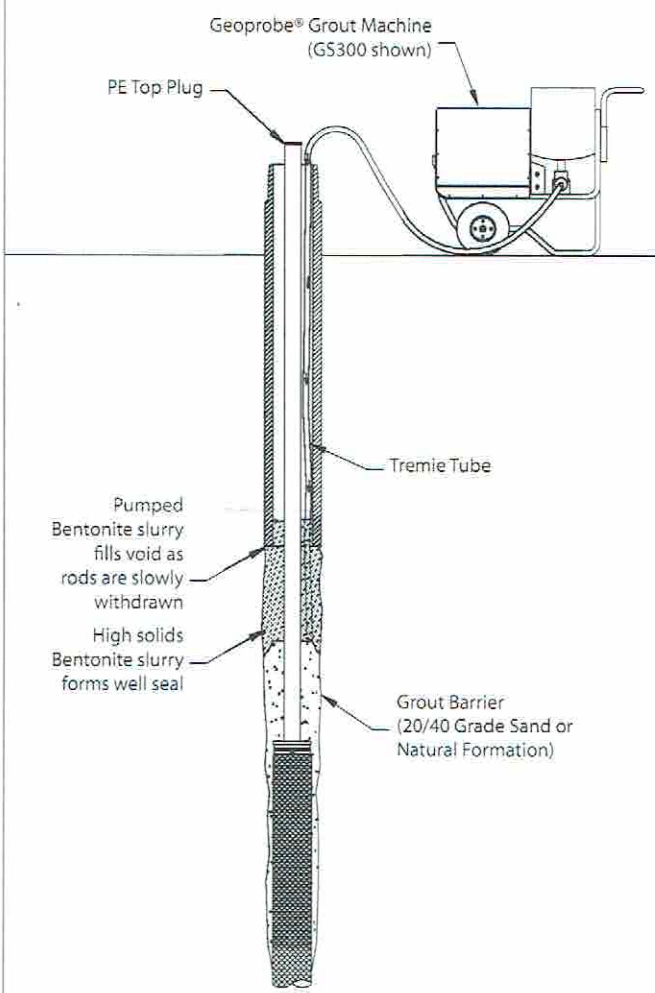


FIGURE 5.11
Installing Bentonite Seal with Geoprobe® GS300 Grout Machine

5.5 Grouting the well annulus

The placement of grout material within the remaining well annulus provides additional protection from vertical contaminant migration. Most grout mixes are composed of neat cement, high-solids bentonite slurry, or a combination of cement and bentonite. Such mixes must be delivered with a high-pressure grout pump. When stable formations exist, the well may be sealed by pouring dry granular bentonite directly into the annulus from the ground surface. Consult the appropriate regulatory agency to determine approved grouting methods. This section presents the procedure for grouting the well annulus with the Geoprobe Model GP300 or GP350 Grout Machine. Refer to Figure 5.12 as needed.

1. Mix an appropriate amount of grout material and place it in the hopper of the grout machine.

NOTE: It is recommended that an additional 20 to 25 percent of the calculated annulus volume be added to the total grout volume. This additional amount allows for grout that either remains in the grout hose or moves into the formation during pumping. Including the additional 20 percent, it will take approximately 0.54 gallons (2.0 L) of grout for each foot of riser below ground surface.

2. Insert tremie tube into the well annulus until the end of the flexible tubing reaches the top of the bentonite seal. Ensure that at least 25 feet (8 m) of tubing extends from the top of the rod string. This extra length allows rod retraction with the tubing attached to the pump.

3. Attach the tubing to the grout machine and begin pumping. If the bentonite seal was below the water table (deep well installation), water will be displaced and flow from the probe rods as the annulus is filled with grout. Continue operating the pump until undiluted grout flows from the top probe rod.

4. Reposition the probe unit and prepare to pull rods.

5. Begin pulling the probe rods while continuing to pump grout. Match the pulling speed to grout flow so that the rods remain filled to the ground surface. This maintains hydraulic head within the probe rods and ensures that the void left by the withdrawn rods is completely filled with grout.

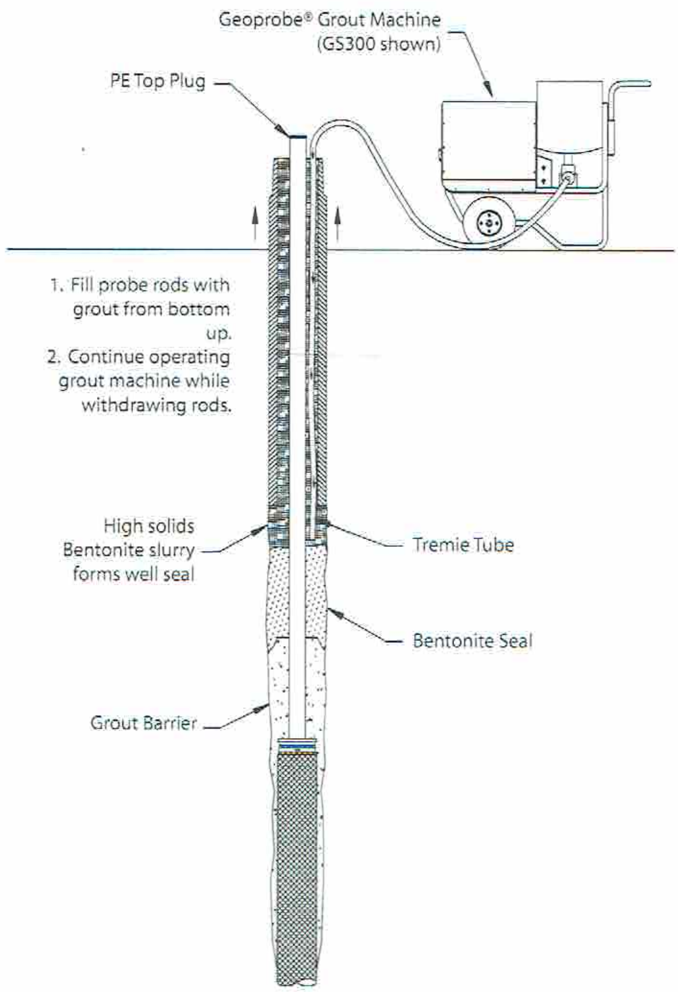


FIGURE 5.12
Grouting Well Annulus with Geoprobe® GS300 Grout Machine

NOTE: Slide the probe rods over the tremie tube and place neatly on the ground next to the grout machine. Be careful to not pinch or bind the flexible tubing as this forms weak spots which may burst when pressure is applied.

NOTE: Try to avoid filling the upper 12 inches (305 mm) of well annulus with grout when pulling the expendable point holder. This will make for a cleaner well cap installation.

6. When all probe rods have been retrieved and the well is adequately grouted, unstring the tremie tube and begin cleanup. It is important to promptly clean the probe rods, grout machine, and accessories. This is especially true of cement mixes as they quickly set up and are difficult to remove once dried.

5.6 Surface Cover/Well Protection

A surface cover protects the PVC well riser from damage and tampering. Although aboveground and flush-mount well covers may be used, most Geoprobe® monitoring wells have been installed with flush-mount covers (Fig. 5.13 - Page 24). Consult the project planners and/or appropriate regulators to determine the approved well cover configuration for your specific application.

1. In order to fit under a flush-mount cover, the top of the well riser must be below the ground surface. Place the well cover over the riser and push it into the ground to mark the cover diameter. Remove the cover and dig out approximately 6 inches (152 mm) of soil from within the cover mark.

2. Remove the PE top plug from the PVC riser. The top of the riser should be approximately 4 inches (102 mm) above the bottom of the hole. If a joint is near this level, unthread the top riser. If a joint is not positioned near the specified level, cut off the riser with PVC cutters.

IMPORTANT: Do not cut off the riser with a hacksaw as cuttings will fall down into the screens.

3. Insert a locking well plug into the top of the PVC riser. Tighten the center wing-bolt on the plug until it fits snugly within the riser. Secure the well plug by installing a padlock over one side of the wingbolt and through the hole provided on top of the plug.

4. Position the well cover so that it is centered over the PVC pipe. Push the cover into the ground using the machine foot if needed. Provide at least 0.5 inches (13 mm) of space between the top of the locking cap and bottom of the well cover lid. Do not push the cover so deep as to place the top of the lid below the surrounding ground surface.

5. Support the well cover by installing a concrete pad according to project requirements. Pads are commonly square-shaped with a thickness of 4 inches (102 mm) and sides measuring 24 inches (610 mm) or greater. Finish the pad so that the edges slope away from the center to prevent ponding of surface water on the well cover.

6. Fill the inside of the well cover with sand up to approximately 2 to 3 inches (51 to 76 mm) from the top of the PVC riser.

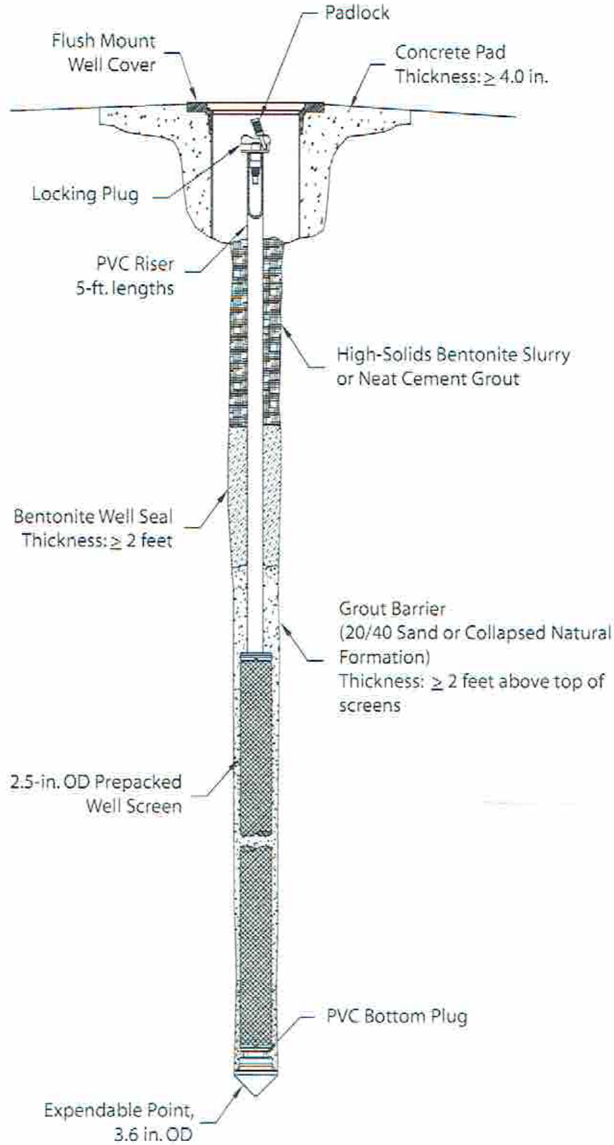


FIGURE 5.13
Properly Installed Geoprobe® 2.5-in. OD Prepacked Screen Monitoring Well

6.0 WELL DEVELOPMENT

"The development serves to remove the finer grained material from the well screen and filter pack that may otherwise interfere with water quality analyses, restore groundwater properties disturbed during the installation (probing) process, and to improve the hydraulic characteristics of the filter pack and hydraulic communication between the well and the hydrologic unit adjacent to the well screen," (ASTM D 5092).

The two most common methods of well development are purging (bailing or pumping) and mechanical surging.

6.1 **Purging** involves removing at least three well volumes of water with either a Tubing Bottom Check Valve (Fig. 6.1), Stainless Steel Mini-Bailer Assembly, Well Development Tool or Mechanical Bladd Pump. Include the entire 3.6-inch (91 mm) diameter of disturbed soil at the screen interval when calculating the well volume.

6.2 **Mechanical Surging** uses a surge block which is attached to extension rods and lowered inside the riser to the screen interval. The extension rods and surge block are moved up and down, forcing water into and out of the screen. Water and loosened sediments are then removed using one of three methods listed in 6.1.

IMPORTANT: **Mechanical surging may damage the well screen and/or reduce groundwater flow across the filter pack if performed incorrectly or under improper conditions. Refer to ASTM D 5521, "Standard Guide for Development of Groundwater Monitoring Wells in Granular Aquifers" for a detailed discussion of mechanical surging.**

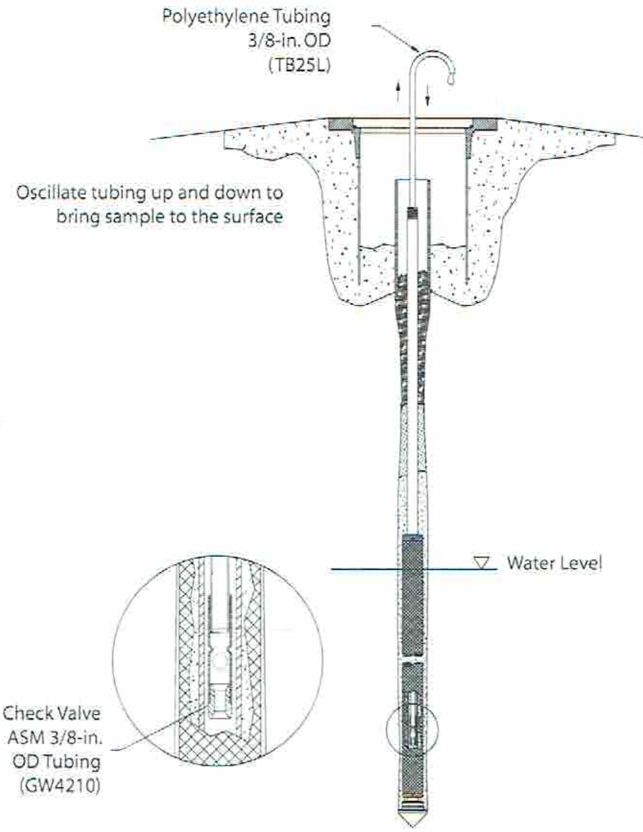


FIGURE 6.1
Sampling with Polyethylene Tubing and a Tubing Bottom Check Valve

Development should continue until consecutive samples yield representative water. "Representative water is assumed to have been obtained when pH, temperature, and specific conductivity readings stabilize and the water is visually clear of suspended solids," (ASTM D 5092).

7.0 SAMPLE COLLECTION

As the federal EPA and more state agencies are recommending or requiring use of the "low-flow" sampling protocol (EPA 1996), the ability to sample small-diameter, direct push (DP) installed monitoring wells with bladder pumps has significantly increased. The latest option for collecting groundwater is to utilize a Geoprobe® MB470 Mechanical Bladder Pump. It may be used to meet requirements of the low-flow sampling protocol (EPA 1996). The low-flow sampling method is preferred when sampling for volatile contaminants or metal analytes. The Mechanical Bladder Pump can be used with any of the available flow-through-cells and water quality monitoring probes. Smaller volume flow-through-cells are recommended when available. Use of the Mechanical Bladder Pump and flow-through-cell allows you to meet the stringent requirements for monitoring pH, specific conductance, DO, and ORP, and obtaining low-turbidity samples for metals analysis.

Groundwater samples may be collected with a check valve assembly (with 3/8-inch OD poly tubing as shown in Fig. 6.1) or a stainless steel mini-bailer assembly when appropriate. While the check valve is the quicker and more economical sampling device, some operators still prefer the traditional mini-bailer.

Before going into the field to sample monitoring wells (or groundwater samplers), be sure to know the level of sample quality that will be required. For high-integrity samples that must meet strict data quality objectives, sampling with a mechanical bladder pump may be required. Conversely, if screening level data is required (is it there and about how much?) a check valve assembly may be sufficient and could save time and money. For further information on this topic, request the Geoprobe® bulletin titled *Groundwater Quality and Turbidity vs. Low Flow.*

8.0 REFERENCES

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APPENDIX A
ALTERNATIVE PARTS

Groundwater Purging and Sampling Accessories	Part Number
Polyethylene Tubing, 0.25-inch OD, 500 ft.	TB17L
Polyethylene Tubing, 0.5-inch OD, 500 ft.	TB37L
Polyethylene Tubing, 0.625-inch OD, 50 ft.	TB50L
Check Valve Assembly, 0.25-inch OD Tubing	GW4240
Check Valve Assembly, 0.5-inch OD Tubing	GW4220
Check Valve Assembly, 0.625-inch OD Tubing	GW4230
Well Development Tool 1.5-inch	34558
Well Development Tool 1.0-inch	35364
Water Level Meter, 0.375-inch OD Probe, 100-ft. cable	GW2001
Water Level Meter, 0.438-inch OD Probe, 200 ft. cable	GW2002
Water Level Meter, 0.375-inch OD Probe, 200-ft. cable	GW2003
Water Level Meter, 0.438-inch OD Probe, 30-m cable	GW2005
Water Level Meter, 0.438-inch OD Probe, 60-m cable	GW2007
Water Level Meter, 0.375-inch OD Probe, 60-m cable	GW2008

Additional Tools, Equipment, and Supplies

Locking Pliers
Pipe Wrench
Volumetric Measuring Cup
PVC Cutting Pliers
Weighted Measuring Tape (optional)
Small Funnel or Flexible Container (for pouring sand)
Duct or Electrical Tape Roll
Bucket or Tub (for dry grout material, water, and mixing)
Portland Cement, Type I
Concrete Mix (premixed cement and aggregate)
Clean Water (of suitable quality for exposure to well components)

Equipment and tool specifications, including weights, dimensions, materials, and operating specifications included in this brochure are subject to change without notice. Where specifications are critical to your application, please consult Geoprobe Systems®.

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