Terracon

FOCUSED FEASIBILITY STUDY

PAYNESVILLE MUNICIPAL WATER SUPPLY / MIDTOWN SERVICE STATION
500 LAKE AVENUE SOUTH
PAYNESVILLE, MINNESOTA
MPCA SITE ID#: LEAK00000131 and LEAK00002181

TERRACON PROJECT NO. 41987018
March 15, 2006

Prepared for:

MINNESOTA POLLUTION CONTROL AGENCY
525 S. Lake Avenue, Suite 400
Duluth, Minnesota 55802

Prepared by:

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March 15, 2006

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Petroleum Remediation Unit 1
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RE: Focused Feasibility Study
Paynesville Municipal Water Supply/Former Midtown Service Station
500 Lake Street Avenue South
Paynesville, Minnesota
Terracon Project No. 41987018
MPCA Site ID #: LEAK00002181
MPCA Site ID #: LEAK00000131

Dear Ms. Kania:

This report summarizes the characterization and remediation efforts completed at the former Midtown Service Station in Paynesville, Minnesota. The report includes an evaluation of the pilot testing and treatment systems installed at the site. Additionally, the report provides recommendations for additional source area assessment and a list of potential remedial alternatives.

If you have questions or comments regarding this report, please do not hesitate to contact our office at 651-770-1500.

Sincerely,
TERRACON

Carol J. Van Neste

Carol J. Van Neste, P.E.
Senior Environmental Engineer

Paul J. Wiese, P.G.
Project Manager / Hydrogeologist

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September 11, 2006

Mr. Ron Mergen
City of Paynesville
221 Washburne Avenue
Paynesville, Minnesota 56362

RE: Focused Feasibility Study
Paynesville Public Water Supply / Former Midtown Service Station
500 Lake Avenue South
Paynesville, Minnesota 56362
Terracon Project No. 41987018
MPCA Site ID #: LEAK00000131 and LEAK00002181

Dear Ron:

On the behalf of the Minnesota Pollution Control Agency (MPCA), Terracon is submitting a copy of our *Focused Feasibility Study* report dated March 15, 2006 for the above referenced project for your file. Your assistance on this project has been greatly appreciated.

If you have questions or require additional information please do not hesitate to contact our office at 651-770-1500.

Sincerely,
TERRACON

Paul J. Wiese, P.G.
Project Manager/Hydrogeologist

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cc: Laurie Kania, MPCA, RD/PCLRS–PR Unit 1, 525 S. Lake Ave., Ste. 400, Duluth, MN 55802

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FOCUSED FEASIBILITY STUDY
Paynesville Municipal Water Supply/Former Midtown Service Station
500 Lake Avenue South
Paynesville, Minnesota
Terracon Project No. 41987018
MPCA Site ID #: LEAK00002181 and MPCA Site ID #: LEAK00000131

INTRODUCTION

Terracon completed a review of the Minnesota Pollution Control Agency (MPCA) file for the former Midtown Service Station (LEAK00002181) as an initial step necessary to develop a limited focused feasibility study (FFS). The limited FFS includes a summary of the historic activities on site and assessment of the effectiveness of corrective actions that have previously targeted the source area at the site. The FFS also includes recommendations for further definition of the source area to be remediated; proposes a plan for developing cleanup objectives for the site; and provides a summary of potential corrective actions. Corrective action alternatives evaluated in this FFS include: free product recovery, excavation, bioslurping (multi-phase extraction), soil excavation and *in situ* soil flushing. The FFS does not include a recommendation for implementing a specific corrective action to address the current extent and magnitude of the petroleum impacts in and near the source area.

SITE LOCATION AND DESCRIPTION

The site is located at 500 Lake Avenue South at the former Midtown Service Station in Paynesville, Minnesota. A site location is presented in Figure 1

BACKGROUND INFORMATION

The Midtown Service Station was in operation from 1971 to 1988. Prior to 1971, the site was utilized as a service station. Aerial site photographs indicate the presence of a building on the property since at least 1938[1]. In 1987, the service station owners filed for bankruptcy protection and abandoned the property. The State Bank of Eden Valley took ownership of the property in 1987 and closed the service station in 1988. A number of environmental activities have been completed since the bank took ownership of the property. The property was eventually sold to the current owner who uses it as a residence.

Tank Removal/Soil Excavation

The State Bank of Eden Valley contracted Twin Cities Testing (TCT) to document Underground Storage Tank (UST) removal at the site. Tank removal activities were completed in December 1990. Tanks removed from the site include the following:

- UST #1 - 500 gallon diesel tank (fair condition)
- UST #2 -1,000 gallon unleaded gasoline tank (poor condition)
- UST #3 - 4,000 gallon leaded gas tank (good condition)

- UST #4 - 4,000 gallon diesel tank (good condition)
- UST #5 - 4,000 gallon leaded or unleaded gasoline tank (good condition)

The initial tank excavations were terminated at nine feet below ground surface (bgs) [2]. Visible contamination was observed on the walls and floors of some of the tank excavations. Soil screening results and soil analytical results confirmed a release of petroleum hydrocarbons to site soils in excavations for Tanks #2 through #5. Excavated soils were returned to the excavations. Tank excavation areas are depicted in Figure 2.

Additional excavation activities were completed in November 1990. The tank excavations were extended to 12-19 feet bgs. The additional excavation areas are presented in Figure 3. Soil contamination was still observed at the base of the excavations. Approximately 1,500 cubic yards of impacted soil were excavated from the site. The impacted soil was transported off site and land applied in the spring of 1991 a site in Eden Lake Township.

Remedial Investigation

TCT completed an initial remedial investigation in 1991. This investigation included the following:

- Advancing 15 standard penetration (STP) soils borings and three flight auger (FA) soil borings to depths of up to 40 feet bgs. Submitting soil samples from the STP soil borings for laboratory analysis of petroleum hydrocarbon related compounds.
- Installing and developing four polyvinyl chloride (PVC) groundwater monitoring wells. Collecting groundwater samples from the new wells and submitting the samples for laboratory analysis of petroleum hydrocarbon related compounds.
- Collecting representative groundwater samples from two City of Paynesville water wells and submitting the samples for laboratory analysis of petroleum hydrocarbon related compounds.
- Performed *in situ* hydraulic conductivity testing in three of the four monitoring wells

Monitoring wells MW-1, MW-10, MW-14 and MW-15 were installed in conjunction with this initial investigation. Monitor well installation information is presented in Table 1. A copy of the TCT Site Map (Figure 4) showing monitor well locations is attached in Appendix A.

Monitor wells installed during this effort include the following:

- MW-1 Screened 17 feet to 27 feet bgs (static water level 8.2 feet bgs)
- MW-10 Screened 17.5 feet to 27.5 feet bgs (static water level 15.1 feet bgs)
- MW-14 Screened 18.5 feet to 28.5 feet bgs (static water level 18.0 feet bgs)
- MW-15 Screened 17 feet to 27 feet bgs (static water level 17.6 feet bgs)

None of these wells appear to have been installed to intersect the groundwater surface.

Lithology

Site borings were advanced to depths ranging from 23 to 40 feet bgs. *The soil samples recovered from the borings revealed a stratigraphy of 2 to 4 feet of fill and topsoil underlain by coarse alluvium and glacial till to the terminal depths of the borings. An upper and lower layer of coarse alluvium is separated by a layer of glacial till throughout all the borings. The coarse alluvium consists of sands with silt and a little gravel. The glacial till consists of clayey sands and sandy lean clays with gravels.*[1] Cross sections of the shallow subsurface geology along the lines A-A' and B-B' are depicted on Figures 5 and 6, respectively. The cross section lines are depicted on Figure 4. Saturated soils were encountered at depths ranging from 18.5 to 24 feet bgs.

Hydraulic Conductivity

Hydraulic conductivity was measured in monitoring wells MW-10, MW-14 and MW-15. The corrected report listed the average hydraulic conductivity of 6.4×10^{-4} feet per second (ft/s). The reported groundwater flow direction is north to northeast at 0.2 to 0.3 feet per day (ft/day).

Free Product Removal

Two feet of free product was observed in monitoring well MW-1 on July 17, 1991. TCT utilized a free product recover sump and peristaltic pump to remove free product. Between August 13, 1991 and January 13, 1992 approximately 7 to 12 gallons of product was recovered. The thickness of free product observed varied from zero to >2 feet. The report concluded that no free product was observed when the water level in monitoring well MW-1 was measured and found to be above the screen.

City Water Wells

Low concentrations of petroleum hydrocarbon contamination were detected groundwater samples collected from the City of Paynesville well CW-3 and CW-4 in 1990 and 1991.

Remedial Investigation Conclusions

A review of the soil boring analytical and screening data indicated the aerial extent of soil contamination is as exhibited on Figure 7. The gasoline contamination extends approximately 17 feet into the water table to at least 37 feet below grade on the site. The contamination at the site appears to have spread laterally through the upper sand and clay soil layers for a limited distance away from the site (Figure 7). The contamination then migrated to the north and northeast in the lower sand layers (Figures 5 and 6)[1].

Review of the groundwater data indicates that the sands and clays beneath the site are moderately permeable and groundwater flow is most likely to the north and northeast under the

an in-line pitot tube. No vacuum was observed at any of the observation points. Rollies reported that the disappointing SVE pilot test results could have resulted from either unsuitable site soil conditions or near field saturation levels filling soil void space.[4] Therefore, Rollies concluded that SVE would be an infeasible treatment option for the existing site conditions.

Groundwater Pumping Test

The groundwater pump test indicated two distinct characteristics of the deposits on the site. *Wells screened in the upper portion of the unit do not appear to be influenced by pumping the lower coarse alluvium. The coarser alluvium lower in the unit has a higher transmissivity than initial suspected and is reflected in the draw down and subsequent recovery…The dense till unit may act as a reservoir, diffusing contaminants into the alluvial aquifer.*[4]

Free Product Recovery

The existing free product recovery system includes active collection (pump) in monitoring well MW-20 and passive hydrophobic collectors in monitoring wells MW-1 and MW-19.

Correct Action Supplement Conclusions

The proposed soil vapor extraction system and groundwater recovery/treatment system have not been installed at this site, at this time according to recommendations and conversations between the original project managers, Mr. Paul Brandt and Mr. John Kaehler, the site hydrologist from the MPCA. These phases should be held off until the effectiveness of free product has been determined. If the free product recovery is effective in reducing the contaminant concentrations in the groundwater plume, then these phases may not be implemented.[4]

Remedial Investigation Report Form

Rollies implemented the free product recovery system in August 1994 and operated the system until January 1995. Rollies collected a total of 110 gallons of free product during this period of operation.

Pinnacle Engineering (Pinnacle) began collecting free product from the existing monitoring wells in July 1996. Pinnacle collected free product from monitoring wells MW-1, MW-18 and MW-19 using a hand bailer.

Pinnacle concluded that the limited amount of free product collected is a result of slow product recharge in the wells. Additionally, the presence of fine-grained glacial till and improper well screen placement may slow recharge in the wells.[5] Pinnacle also completed another free product bail down test in April and May of 1997. This newest bail down test confirmed earlier results showing slow free product recharge rates. Pinnacle also concluded that the slow rate of free product recovery could be due to fluctuating water levels and incorrect screen placements in the wells.

Pinnacle further concluded that groundwater contamination associated with the former Midtown Service Station does not represent a significant threat to drinking water in the City of Paynesville. This conclusion is based on the sporadic, but low concentrations of petroleum hydrocarbon compounds detected in samples collected from City Wells CW-3 and CW-4, the apparent evidence suggesting natural attenuation of the dissolved phase plume and the lack of contamination in samples collected from monitoring well MW-14.[5]

Pinnacle proposed installation of a passive free product collection system utilizing a series of large diameter wells (5, 4-inch diameter wells). These wells would be constructed with a 20-foot screen placed from 10 to 30 feet below grade in order to intersect the widely fluctuating water table on site. The wells would serve a dual purpose of providing a mechanism to define the extent of free product on the site and assisting in the collection of free product.

Pinnacle proposed installation of a passive free product collection system. The system will utilize the Ferret in-well separators to remove free product from four collection wells. The Ferret separators operate by drawing water and product into a pump chamber, using gravity to separate the two fluids, and pumping the product to a separate collection tank. Compressed air is used to power the pumping action. Additional monitoring well locations also have been proposed.

RI/CAD Report Addendum

Low concentrations of benzene were detected in groundwater samples collected from Paynesville City Wells CW-3 and CW-4 since 1990. Samples collected from City Well CW-4 in 1997 showed benzene concentrations high enough to warrant shutting down the well. Since City Well CW-4 was shut down, benzene concentrations in City Well CW-3 rose substantially and MPCA requested additional characterization activities.

Five additional monitoring wells were installed in February 1998 (Figure 9). The newly installed wells included the following:

- MW-21 Screened 10 feet to 30 feet bgs (static water level 16 feet bgs)
- MW-22 Screened 10 feet to 30 feet bgs (static water level 16 feet bgs)
- MW-23 Screened 10 feet to 30 feet bgs (static water level 16 feet bgs)
- MW-24 Screened 10 feet to 30 feet bgs (static water level 16 feet bgs)
- MW-25 Screened 10 feet to 30 feet bgs (static water level 16 feet bgs)

Additionally, two deep wells were installed in March 1998. The deep monitoring wells included the following:

- MW-10D Screened 10 feet to 30 feet bgs (static water level 16 feet bgs)

- MW-14D Screened 10 feet to 30 feet bgs (static water level 16 feet bgs)

Free Product Recovery Test

At the time of development, free product was not present in the new monitoring wells on the site; however, free product was present at varying thicknesses in monitoring wells MW-1, MW-18, MW-19 and MW-20. Approximately one-inch of free product was observed in monitoring well MW-25 on March 20, 1998 and the product thickness had increased to one foot by April 10, 1998. No more than a film of free product was present in the remaining new wells at that time. A free product recovery test was initiated on the site on April 23, 1998. At that time, the free product levels were bailed down to approximately ½ inch, with the exception of monitoring well MW-25. Free product levels were observed to recharge during bail down in monitoring well MW-25, and it was not possible to bail this well down below 1 ½ inches. Product levels were observed for recharge on April 27, April 30, May 5, May 20 and June 22, 1998. Free product levels were bailed down again on May 20, 1998. Figure 10 presents the recover test results.

RI/CAD Report Addendum Conclusions

The aerial extent of free product has been defined to the north, west northeast, and southwest; however, the extent remains poorly defined to the east and southeast, based on the presence of free product in MW-19 and MW-25. Free product continues to occur in discontinuous thickness on the site, based on the relative lack of free product in MW-24 and the presence of one foot of free product in MW-25. Free product recharge rates appear to increase in the wells on site during the latest free product recovery test period. The relatively rapid recharge of product in MW-25 is encouraging, and it is possible that this well will be amenable to automated free product removal.

The presence of highly contaminated groundwater associated with the sand and gravel layer at a depth of 35 to 37 feet (GP-1) suggests that the dissolved phase contamination is being preferentially carried through relatively thin, discontinuous permeable layers that appear to occur at depths of approximately 35 to 65 feet below the surface. The lack of contaminants in deep monitoring wells (screened from 80 to 90 feet) near MW-10 and MW-14 further suggests that the dissolved phase plume is not equally distributed throughout the aquifer. It is probable that the withdrawal of groundwater from City Well #3 has contributed significantly to the increased rate of movement of the contaminant plume to the northeast.[6]

Proposed Corrective Action

The City of Paynesville will utilize City Well CW-4 for gradient control limiting further contaminant impacts to the other city wells. Water collected from City Well CW-4 will be discharged to the city storm sewer system. Additional gradient controls may be necessary.

1999 Annual Report

Pinnacle installed the proposed free product recover system in March 1999. Ferret™ pumps were installed in monitoring wells MW-1, MW-18, MW-19 and MW-25. Free product continued to be present in MW-1, MW-18, MW-19, MW-20, MW-22, MW-24, and MW-25 (on site wells). Impacted groundwater was present in MW-14, MW-15, MW-17, DW-6, and RW-1. Recovery pumps were collecting too much water and the recovery system was shut down in August 1999. A representative of QED Environmental Systems, manufacturer of the Ferret pumps, visited the site in October 1999. After dismantling, cleaning and restarting the system, the pumps were still not functioning properly. The free product recovery system was shut down on October 20, 1999.

Recommendations (1999 Annual Report)

The free product recovery method currently in operation appears to be ineffective in removing significant amounts of product. Because the volume of contamination at the site is considerable and because the contamination continues to impact area receptors, additional corrective action is required. However, due to the considerable financial resources necessary to continue corrective action and based on his status as a voluntary party, William Senescall is unable to continue his involvement with the on-going clean-up at the site. Therefore, due to the necessity for a more complex remedial solution and due to the lack of resources to continue the current system, Pinnacle recommends that the MPCA assume responsibility for additional corrective actions at the site.[7]

2002 Annual Report

Cirrus Environmental Group, Inc. (Cirrus) replaced Pinnacle as the environmental consultant on the site. According to Cirrus, the last known report submitted for the site was the October 1999 Annual Report (Pinnacle). Quarterly groundwater monitoring efforts were initiated in October 2000. The 2002 Annual Report includes the results from December 2000 through March 2002 (five sampling events). Monitoring wells MW-1, MW-18, MW-19, MW-20, MW-22, MW-23, MW-24, MW-25, and recovery well RW-1 were not sampled due to the presence of free product in the wells.[8]

Corrective Action Design System Monitoring Worksheet (2005)

On March 20, 2002 a portable Keck Spoiler system was installed at the site to automate the collection using technology similar to the Keck Product Recovery Canisters (PRC). The Keck Spoiler system is a controllerless recovery system designed to remove free phase hydrocarbon from wells/sumps larger than two inches in diameter. The system uses an internally regulated pneumatic bladder pump combined with a floating skimmer attachment. This system is designed to operate in wells tracking water level fluctuations in excess of 24 inches.

However, the Keck Spoiler system was not effective and produced results similar to that of the previously installed Ferret system. Therefore, the system was turned off. The Corrective Action Design System Monitoring Worksheet did not identify the wells included in the Keck Spoiler System. Manual recovery in wells containing free product continued with the Keck PCS system continued in the wells that contained free product. Cirrus indicated that slow product recovery rates and fluctuating water levels resulted in the poor performance of the free product recovery system.[9]

Approximately 24.2 gallons of free product has been removed from the site from January 31, 2001 through February 26, 2004. Approximately 18.2 gallons was removed by Cirrus. Free product was collected from monitoring wells MW-1, MW-18, MW-20, MW-22, MW-24, and MW-25.[9]

2005 Annual Report

Quarterly groundwater monitoring efforts have continued. For the sample period presented in the 2005 Annual Report, monitoring wells MW-19, MW-20, MW-21, MW-23, MW-26, and recovery well RW-1 were sampled. At one point each of these wells contained free product. Monitoring wells MW-1, MW-18, MW-22, MW-24, MW-25 and recovery well RW-1 were not sampled due to the presence of free product in the wells.

<u>Recommendations (2005 Annual Report)</u>
It has been shown that, although using PRC collectors is effective at collecting free product, a significant amount of free product could remain, as evidenced by the continued presence of free product. The Keck Spoiler system has also been ineffective due to the slow recharge of product at the wells.

Therefore, a more aggressive approach to corrective action is recommended.[10]

CORRECT ACTION EFFECTIVENESS

Several types of corrective actions and pilot tests have been conducted at the Former Midtown Service Station. Free product recovery and SVE pilot testing were included in earlier assessments.

Free Product Recovery

Free product removal efforts have been unsuccessful throughout the history of the site cleanup efforts. Three separate free product recovery systems have been attempted. The free product recovery systems include the following:

- Active collection (pump) in monitoring well MW-20 and passive hydrophobic collectors in monitoring wells MW-1 and MW-19

- Ferret™ pumps were installed in monitoring wells MW-1, MW-18, MW-19 and MW-25.

- A portable Keck Spoiler system was installed at the site to automate the collection using technology similar to the Keck Product Recovery Canisters (PRC). Specific monitoring well information was not provided.

Additionally, manual free product recovery efforts have been initiated at various times throughout the project.

The most noteworthy component of the failed free product recovery efforts is the use of improperly constructed monitoring wells. Most of the first wells installed included screens set just at or just below the groundwater surface. For instance, the wells listed above include the following:

- MW-1 Screened 17 feet to 27 feet bgs (static water level 8.2 feet bgs)
- MW-18 Screened 20 feet to 30 feet bgs (static water level 20.5 feet bgs)
- MW-19 Screened 20 feet to 30 feet bgs (static water level 20.3 feet bgs)
- MW-20 Screened 13 feet to 23 feet bgs (static water level 15.97 feet bgs)
- MW-25 Screened 10 feet to 30 feet bgs (static water level 16 feet bgs)

Groundwater elevations at the site reportedly vary almost 10 feet throughout the year. Thus, may of the wells utilized for the free product recovery systems would yield low to no free product, even if present, because it could not flow to the well.

This improperly constructed well issue has been documented throughout the MPCA site review but the wells were never reinstalled. In fact, consultants continued to use the same wells for free product recovery pumping and assessment. Monitoring wells MW-21 through MW-25, installed in 1998, appear to have the most appropriate screen placement.

The two attempts to use active free product recovery system failed to collect significant volumes of free product. This may be the result of free product weathering. Significantly weathered free product can result in density and viscosity variations that may impede in-well separation and skimmer-type recovery systems.

Soil Vapor Extraction

SVE pilot testing was initiated early in the project to aide in the design of the proposed soil treatment option. The SVE pilot test was conducted in June 1993. Vacuums were placed on monitoring wells MW-1, MW-18 and MW-19. Maximum vacuums were generated at each point but little airflow was observed. Additionally, vacuum readings were not observed at any of the designated monitoring points. The consultant concluded the site conditions were not

appropriate for SVE. However, the SVE test suffered from the same well design flaw encountered with free product recover efforts. None of the selected SVE vacuum wells had screen above the groundwater surface. Therefore, the vacuum was being applied to solid well casing. In addition, the monitoring wells were likely not constructed to be used for SVE. Even if the water table had been lower than the top of the screen, the pilot test may have failed because of the small slot size.

Pump and Treat (Gradient Control)

Recovery well RW-1 is screened through the fine grained alluvium and till and into the upper portion of the drinking water aquifer. The groundwater pumping test performed on recovery well RW-1 likely had little impact on the monitoring wells at the site because the drinking water aquifer is semi-confined in some areas of Paynesville and has a high transmissivity. Pumping on the drinking water aquifer within the source area would likely capture petroleum contamination near the top of the aquifer, but it also may increase the downward migration of contamination from the finer grained materials into the aquifer.

Plume containment activities using City Well CW-4 have been a successful means of containing the dissolved phase petroleum plume. However, the plume containment activities do not address the source area and may increase the downward migration of petroleum contamination into the drinking water aquifer. MPCA Staff and Terracon installed a gradient control well (DW-5) and pump out system near the intersection Lake Avenue and State Highway 23 as an initial attempt to intercept the petroleum contamination in the area where it appears to be migrating into the drinking water aquifer. Well DW-5 was screened in a sand and gravel unit within the fine grained alluvium, but did not produce enough water to significantly influence the plume.

CORRECTIVE ACTION OBJECTIVES

The site corrective action objectives (CAOs) must consider the overall protection of human health and the environment. Currently, gradient control is preventing migration of contaminant to existing drinking water wells. However, long term CAOs should be developed with the assumption that the plume containment (CW-4) will eventually be eliminated. The plume containment activities can only be stopped if contaminant concentrations in the drinking water aquifer are below the Health Risk Limits (HRLs) established by the Minnesota Department of Health or the EPA Maximum Contaminant Levels (MCLs) by the time they reach an active drinking water well. The compliance point locations and concentration can be determined at a later date, but should include the installation of a new monitoring (sentinel) well(s) between the site and existing municipal wells. Contaminant transport modeling could be used to estimate CAO concentrations for specific compliance points.

The continued release of dissolved phase petroleum compounds from the source area (free product) into the shallow groundwater is resulting in excessive concentrations of petroleum related compounds to migrate into the drinking water aquifer. With this ongoing source present at the site, meeting the site CAO is not feasible. Therefore, source removal will be required. Once the source has been removed, natural attenuation, biodegradation, and groundwater pumping actions will act to help reduce the concentrations of petroleum compounds in the dissolved phase plume. Groundwater modeling may be required to determine the schedule for eliminating the pumping activities required for gradient control.

Some vapor intrusion assessment (VIA) activities have been completed near the site. The VIA activities indicates several nearby residences are at risk of exposure from the soil gas cloud associated with the site. The VIA activities have not yet included an assessment determining the potential vapor impacts to structures. Therefore, this issue has not been included as a corrective action objective, but it should be considered during the evaluation process as remediation of the groundwater issue will not necessary address potential vapor intrusion impacts.

DEFINITION OF SOURCE AREA CONTAMINATION

Source removal efforts at the Former Midtown Service Station have historically produced disappointing results. The improperly constructed wells were utilized for both free product migration assessment and the effectiveness of several free product recovery systems. However, a thorough understanding of the distribution of the free product in the subsurface was never obtained. Most of the data collected during the early site investigations is nearly fifteen years old and no longer represents current site conditions. The free product plume may have migrated downgradient or become trapped in a confining geologic strata.

Therefore, further free product delineation needs to precede any free product removal efforts. This activity should include a true three dimensional assessment of existing free product. Since many existing monitoring wells are unusable for this purpose, new assessment techniques are necessary. The additional assessment activities must also consider the occurrence of pressurized gas pockets that have been encountered near the water table in several soil probes north of the site (P-32 and VP-3).

Direct sensing equipment can provide real time data to help locate and quantify the existing plume. Because geologic formations may greatly affect plume migration, conductivity measurements also would be helpful. Direct sensing for both contaminants and conductivity are suggested. Additional confirmation soil and groundwater sampling via conventional push-probe methods also would be required. Both of these assessment tools utilize push probe methodology. A grid pattern will be established across the suspected free product plume. Locations for both probes should be placed in close proximity to help correlate free product

pockets to specific conductivity zones. Data collected from these assessment activities would be used to install a monitoring well network round the site, possibly replace several existing monitoring well and potentially install test wells to evaluate one or more remedial technologies.

Source Area Delineation/ Laser-Induced Fluorescence

A Laser-Induced Fluorescence (LIF) petroleum sensor is attached to a probe that is pushed into the ground with a truck-mounted hydraulic system to make real-time contaminant measurements. The chemical sensor consists of a laser that fires short pulses of light into an optical fiber running through the probe. As the laser pulses pass into the soil through the probe window, petroleum contaminants respond by giving off a characteristic "glow." This emitted light is carried back to the surface over a second fiber, and it is measured with a detector. The optical screening method provides a nearly continuous profile of contaminant distribution as the probe is pushed into the ground. Parallel integration of multiple sensors on a single probe will more thoroughly delineate the vertical and horizontal extent of site contamination. The LIF probe would be used as a semi-quantitative method of evaluating the presence of free product. Discrete soil and groundwater confirmation samples would be collected near select LIF probes. Monitoring wells, existing or new, may be required to verify the most highly impacted areas.

Soil Conductivity Testing

Similar to the LIF system, direct soil conductivity testing utilizes a truck-mounted hydraulic system to push a sensor (electrical conductivity logging tool) into unconsolidated material. During the push, up hole instrumentation applies an excitation current to the probe and collects data. A conductivity log is obtained and then compared with existing lithological data to determine log response to various strata. Soil probe would be advanced near select conductivity probes to confirm conductivity readings.

SOURCE AREA REMEDIATION

Once the extent and magnitude of the free product is fully delineated, technology selection for source area remediation (primarily free product removal) can be initiated. The delineation activity will be required prior technology selection to ensure site specific conditions are used in the assessment. Some of the possible technologies that could be used to remove free product are included for informational purposes.

Free Product Recovery

Free product recovery pumps have been unsuccessfully utilized at the site three separate times. However, those past systems attempted to withdrawal free product from inappropriately constructed monitoring wells. This may be a viable option with properly installed wells and / or combined with another technology. The delineation and conductivity assessment will help determine if site conditions would suggest this option is viable.

Excavation

Excavation activities can be implemented to removal overburden soil to the groundwater surface. Impacted soil and free product would be removed from the excavation and treated/transported offsite for disposal. Implementation of an excavation alternative will depend on the depth and aerial extent of free product determined during the delineation phase. Large areas or deep pools of free product may pose significant implementability obstacles. It is anticipated that the source area requiring remediation extends under Mill Street and Lake Avenue.

Bioslurping or Multi-Phase Extraction

Bioslurping or multi-phase extraction (MPE) is the adaptation and application of vacuum-enhanced dewatering technologies to remediate hydrocarbon-contaminated sites. Bioslurping utilizes elements of both, bioventing and free product recovery, to address two separate contaminant media. Bioslurping combines elements of both technologies to simultaneously recover free product and bioremediate vadose zone soils. This technology often utilizes horizontal well construction. Bioslurping can improve free product recovery efficiency without extracting large quantities of groundwater. In bioslurping, vacuum-enhanced pumping allows LNAPL to be lifted off the water table and released from the capillary fringe. This minimizes changes in the water table elevation which minimizes the creation of a smear zone. Bioventing of vadose zone soils is achieved by drawing air into the soil due to withdrawing soil gas via the recovery well. The system is designed to minimize environmental discharge of groundwater and soil gas. MPE uses a similar design, but typically much high vacuum to essentially dewater fine grained materials to allow the removal of the hydrocarbons in the vapor phase. The extraction wells are typically vertical wells screening the impacted areas in the vadose zone and the smear zone near the water table.

In Situ Soil Flushing

In situ flushing is the injection or infiltration of an aqueous solution into a free product zone, followed by down-gradient extraction of groundwater/free product and elutriate (flushing solution mixed with the contaminants) and aboveground separation, treatment and discharge or disposal. Flushing solutions range from plain water to surfactants, cosolvents, or other facilitators. *In situ* flushing enhances conventional pump and treat, bioslurping and MPE technologies through increasing the efficiency of a flushing pore volume, or accelerating natural flushing action. Successful application of the technology is highly site-specific, though it is not limited by the depth of the contaminant or their location within the hydrogeologic setting. The site specificity of application of this technology necessitates extensive pre-design data collection and treatability studies. Only relatively small pools of free product can be addressed with this technology because of the potential to spread the contaminants unless contaminant movement is tightly controlled.

- Laser induced fluorescence (LIF) and conductive probes should be advanced on-site and along the Mill Street, Lake Avenue and Kronis Avenue road right-of-ways to attempt to delineate the horizontal and vertical extent of free product impacts (Figure 11). The source area delineation would be divided into two phases of field activities. Figure 11 shows the boundaries of both phases of activities. The first phase will be designed to focus on off-site free product migration. Several intersecting lines will be used to focus on the outer boundaries of the free product migration. Probe locations along these lines will define the eastern, western, northern and southern boundaries of free product using both LIF and conductivity probes. The second phase of activity will look at on-site free product delineation. Soil probes should be advanced near select LIF and conductivity probes to confirm the soil stratigraphy and to collect confirmation soil and groundwater samples for laboratory analysis. Terracon estimates that a total of 24 LIF probes locations will be utilized for the off-site assessment. An additional 18 LIF probes will be utilized for the on-site assessment. An estimated 50 percent of these locations would include an additional conductivity probe evaluation. Also, approximately 20 percent of the probe locations will require confirmatory sampling.

- Based upon the results of the source area assessment additional monitoring wells should be installed to provide fixed sampling points for collecting fluid levels and groundwater quality data. It is anticipated that monitoring well clusters may be installed at several locations with a variety of screened intervals. Water table monitoring wells should be constructed using 15 to 20 foot screens to compensate for fluctuations in the water table. Test well(s) could also be installed at this time should pilot testing be required.

- The current Work Order includes funds for performing additional VIA activities at locations where MPCA has already obtained access. These activities may include installation of additional soil gas probes and / or sub-slab sampling points and collection of soil gas samples for laboratory analyses. At this time, an access agreement has been obtained for property located at 347 Lake Avenue North (east of the former Midtown Service station) (Figure 11).

- Based upon the result of the source area assessment activities, a potential corrective action alternative will be determined. Pilot testing may be required before full scale implementation. Additionally, a Corrective Action Design report should be prepared consistent with the requirements of MPCA Guidance Document 4-11. The results of the assessment activities and pilot testing, if applicable, would be summarized in the report.

GENERAL COMMENTS

The analysis and opinions expressed in this report are based upon data obtained from the assessment and laboratory chemical analyses at the indicated locations or from other information discussed in this report. This report does not reflect variations in subsurface stratigraphy, hydrogeology, and contaminant distribution that may occur across the site. Actual subsurface conditions may vary and may not become evident without further assessment.

This report is prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted environmental engineering practices. No warranties, express or implied are intended or made. In the event any changes in the nature or location of suspected sources of contamination as outlined in this report are observed, the conclusions and recommendations contained in this report shall not be valid unless these changes are reviewed and the opinions of this report are modified or verified in writing by Terracon.

CJV/PJW:cjv N:\98\98_7018\LTR-RPT-FAX\018FFS 3-06.DOC

REFERENCES

1. *Petroleum Tank Release Report Remedial Investigation Work, Twin City Testing, 1992.*

2. *Removal and Excavation Observation, Twin City Testing, 1990.*

3. *Petroleum Tank Release Report Proposed Corrective Action Design, Twin City Testing, 1992.*

4. *Corrective Action Design Supplement, Midtown Service Paynesville, MN, Rollies sales & Service, Inc., 1994.*

5. *Remedial Investigation Report Form, Pinnacle Engineering, Inc., April 1996.*

6. *RI/CAD Addendum, Pinnacle Engineering, July 1998.*

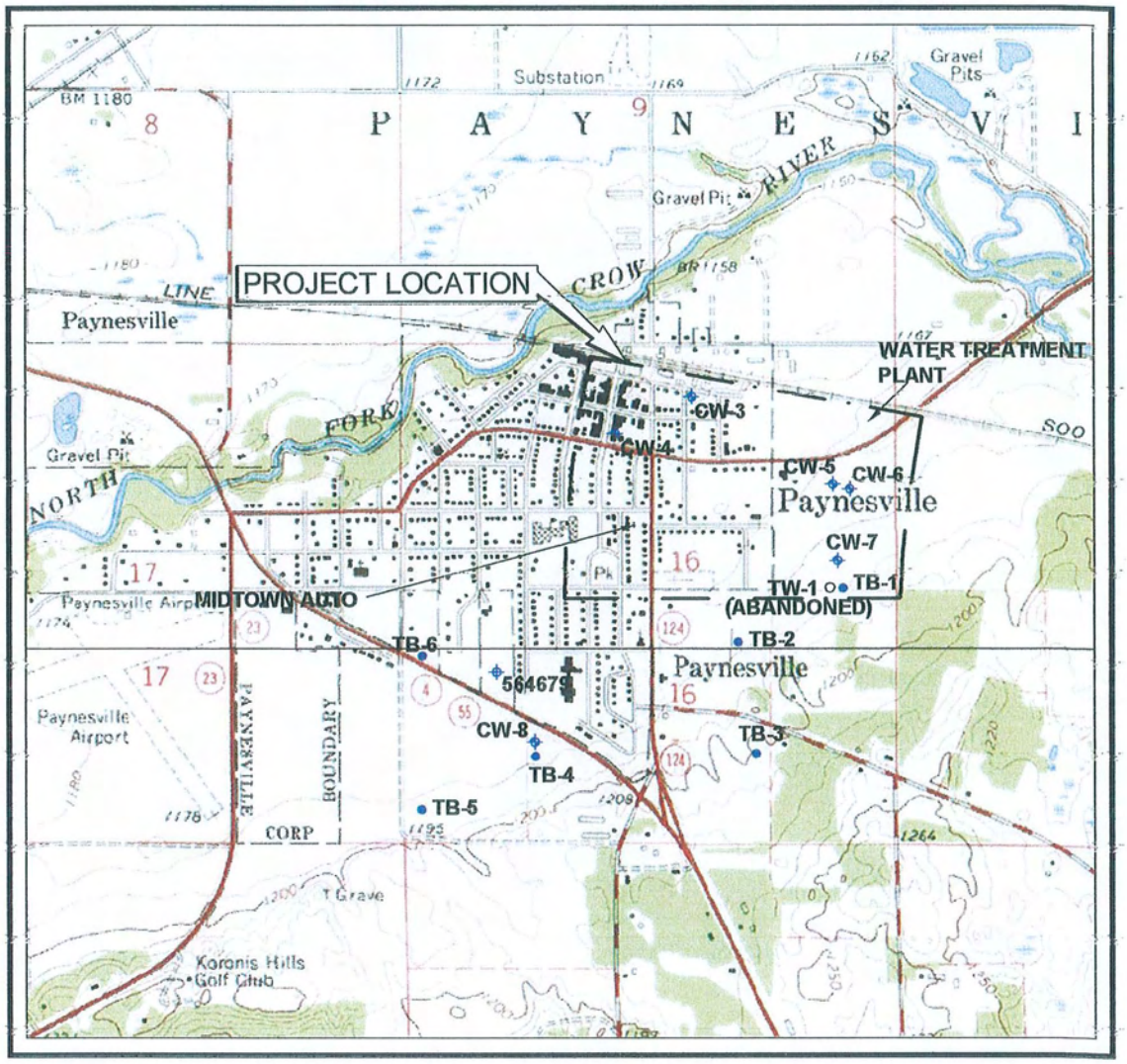
7. *Annual Monitoring Report, Pinnacle Engineering, October 1999.*

8. *Annual Monitoring Report, Cirrus Environmental, October 2002.*

9. *Corrective Action Design System Monitoring Worksheet, Cirrus Environmental, March 2005.*

10. *Annual Monitoring Report, Cirrus Environmental, March 2005.*

UNITED STATES - DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY



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METERS: 1000 0 1000 2000

MILES: 1 .5 0 1

FEET: 1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000

PAYNESVILLE QUADRANGLE

MINNESOTA - STERNS COUNTY

7.5 MINUTE SERIES (TOPOGRAPHIC)

LEGEND

- TEST BORING
- TEST WELL
- CITY WELL
- POTABLE WELL

N

SITE LOCATION MAP

PAYNESVILLE MUNICIPAL WATER SUPPLY

MINNESOTA STATE HIGHWAY 23

PAYNESVILLE, MN

MPCA

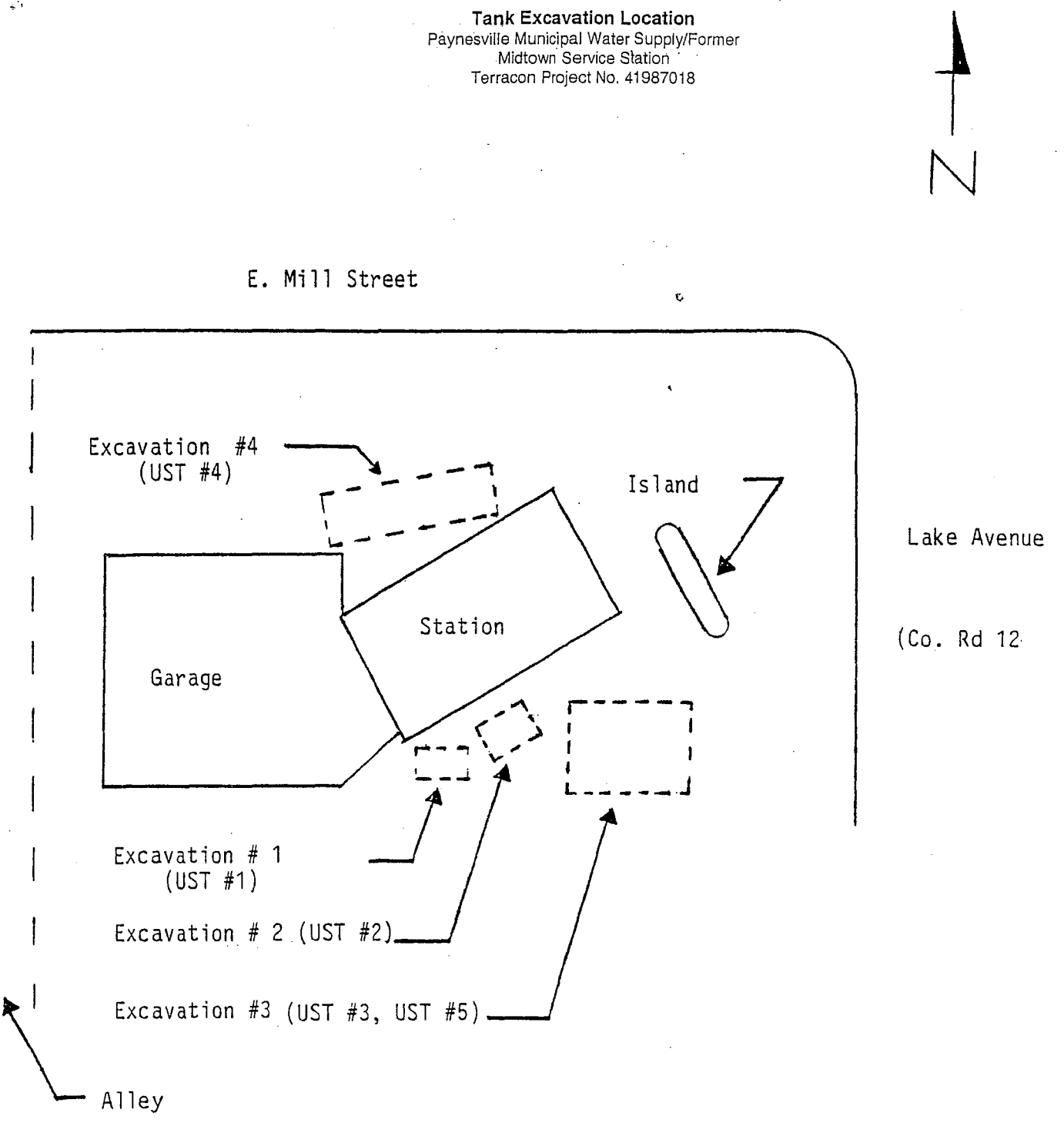
Project Mngr:	PJW	Terracon	Project No.	41987018
Designed By:	STH		Scale:	AS SHOWN
Checked By:	PJW	3535 Hoffman Road East White Bear Lake, MN 55110	Date:	5/14/04
Approved By:	PJW		Drawn By:	CDR (41)
File Name:	41987018sl.dwg	TOPO	Figure No.	1

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

corporation

FIGURE 2

Tank Excavation Location
Paynesville Municipal Water Supply/Former
Midtown Service Station
Terracon Project No. 41987018



Site is surrounded entirely by residential areas.

UST #1	500 gal diesel
UST #2	1,000 gal unleaded
UST #3	4,000 gal leaded
UST #4	4,000 gal diesel
UST #5	4,000 gal leaded or unleaded

Figure 2	JOB NO. 4700 90-75	SCALE: 1" = 25'	DRAWN BY GN	CHECKED BY kk

FIGURE 3
SITE DETAIL MAP
MIDTOWN SERVICE STATION
PAYNESVILLE, MINNESOTA
#4700 90-75

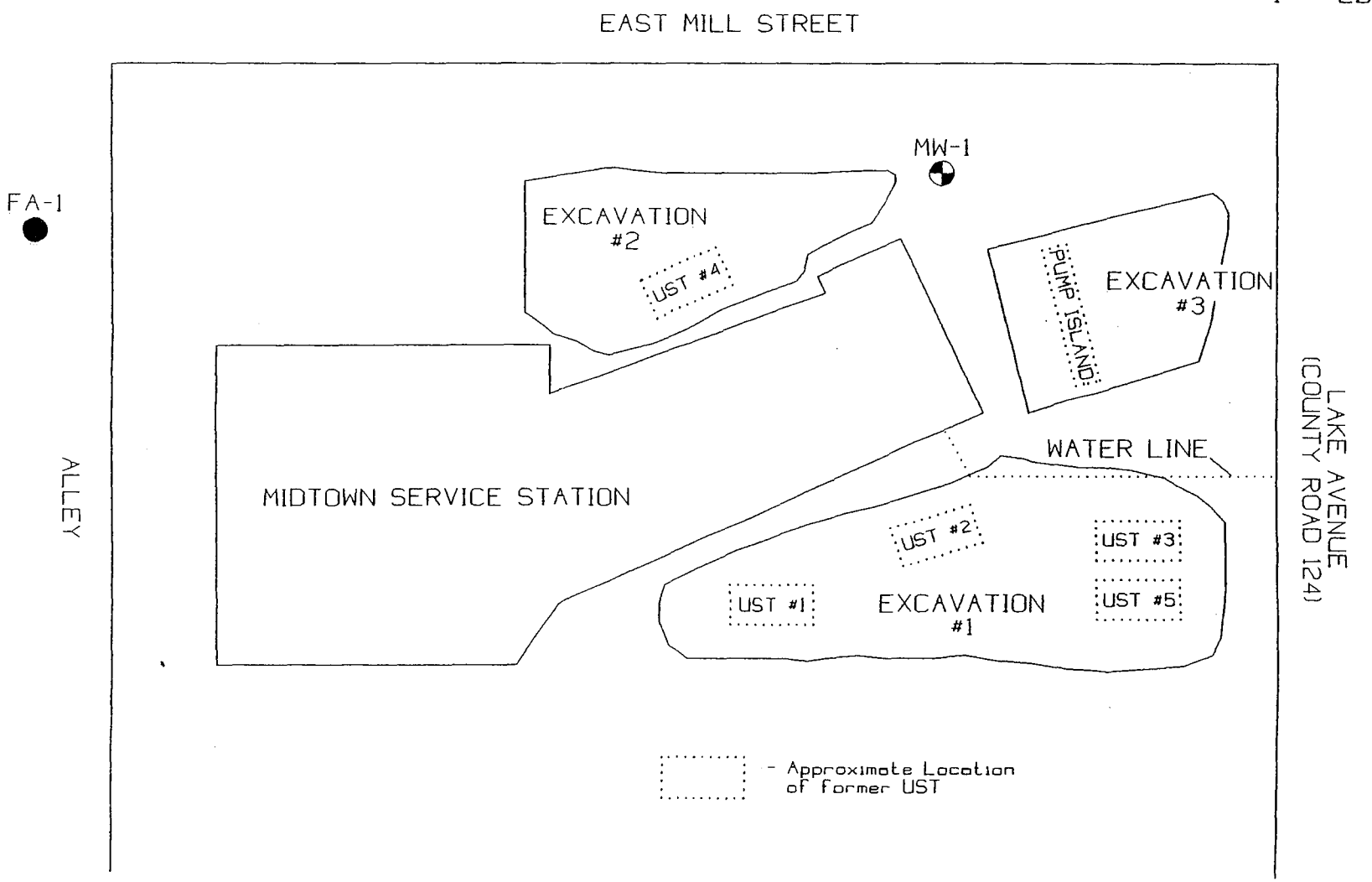


FIGURE 3

Additional Excavation Locations

Paynesville Municipal Water Supply/Former Midtown Service Station

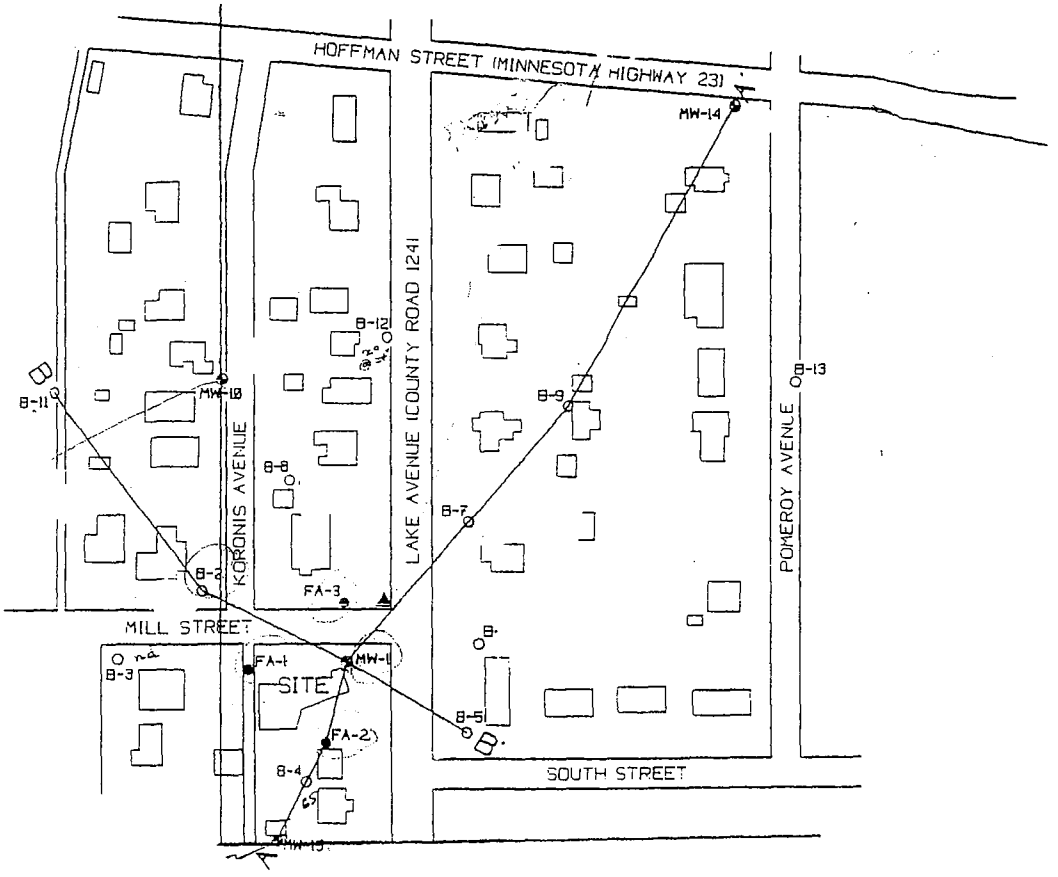
Terracon Project No. 41987018

twin city testing corporation

FIGURE 4

Site Well Locations (TCT)
Paynesville Municipal Water Supply/Former
Midtown Service Station
Terracon Project No. 41987018

FIGURE 2
SITE MAP
MIDTOWN SERVICE STATION
PAYNESVILLE, MINNESOTA
#4700 90-75



EXPLANATION

- Monitoring Well
- Standard Penetration Boring
- Flight Auger Boring
- Benchmark
- A—A' Cross Section Line

N

0 200

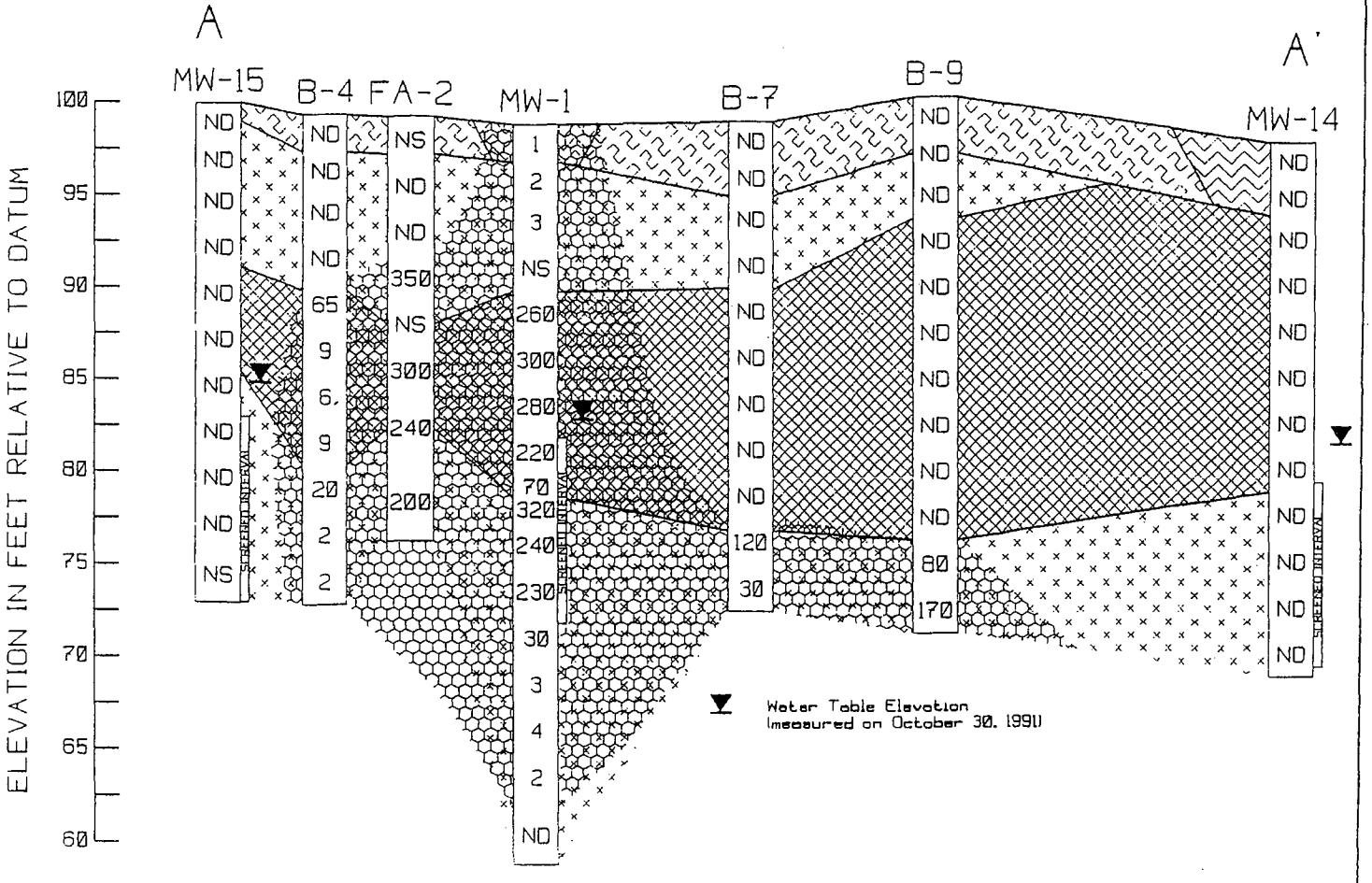
SCALE
1" = 200'

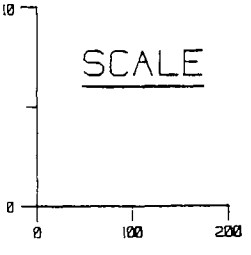
twin city testing

FIGURE 5

Geologic Cross Sections (A-A')
Paynesville Municipal Water Supply/Former
Midtown Service Station
Terracon Project No. 41987018

FIGURE 7
GEOLOGIC CROSS SECTION
A - A'
MIDTOWN SERVICE STATION
PAYNESVILLE, MINNESOTA
#4700 90-75





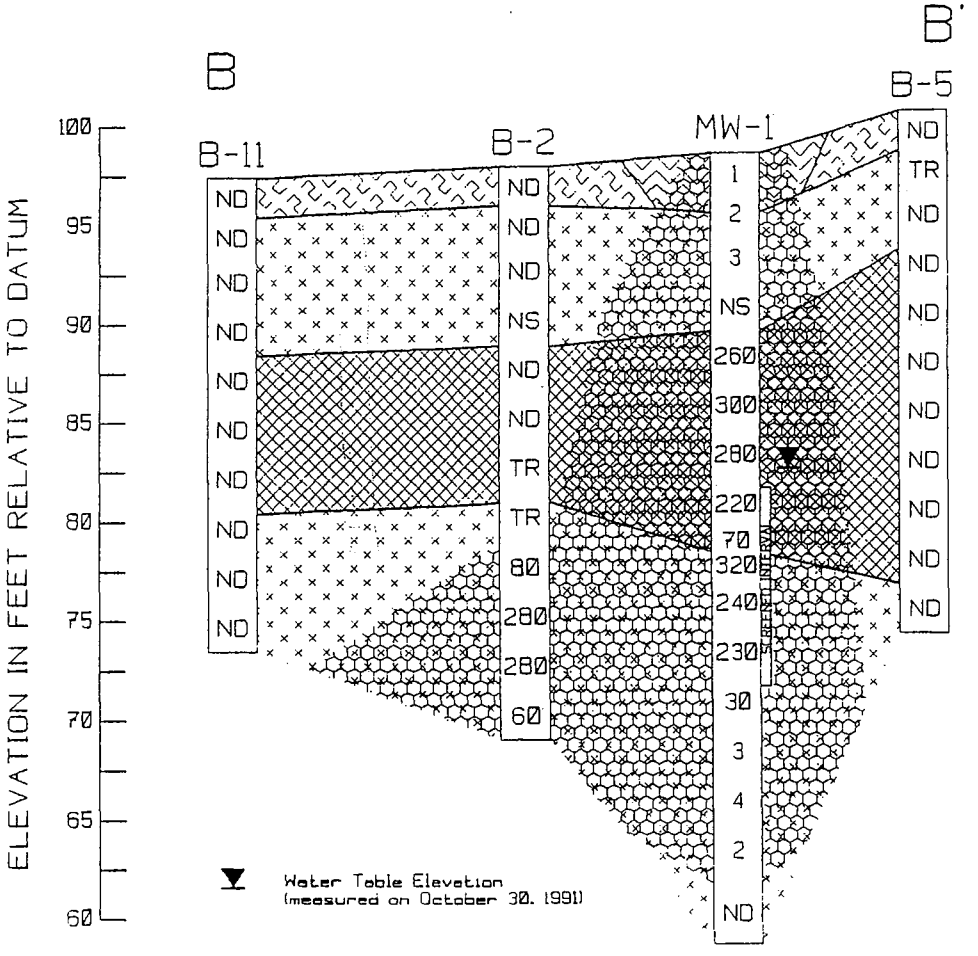
EXPLANATION

- Topsoil
- Glacial Till
- Fill
- Coarse Alluvium
- Soil Contamination > 1 ppm
- ND hNu Value
- ND = Not Detected
- NS = Not Sampled

FIGURE 6

Geologic Cross Sections (B-B')
Paynesville Municipal Water Supply/Former
Midtown Service Station
Terracon Project No. 41987018

FIGURE 8
GEOLOGIC CROSS SECTION
B - B'
MIDTOWN SERVICE STATION
PAYNESVILLE, MINNESOTA
#4700 90-75



EXPLANATION

- Topsoil
- Glacial Till
- Fill
- Coarse Alluvium
- Soil Contamination > 1 ppm
- ND — hNu Value
- ND = Not Detected
- NS = Not Sampled
- TR = Trace

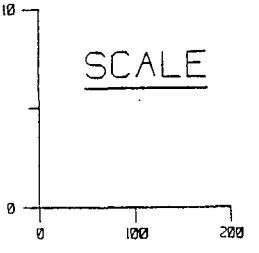
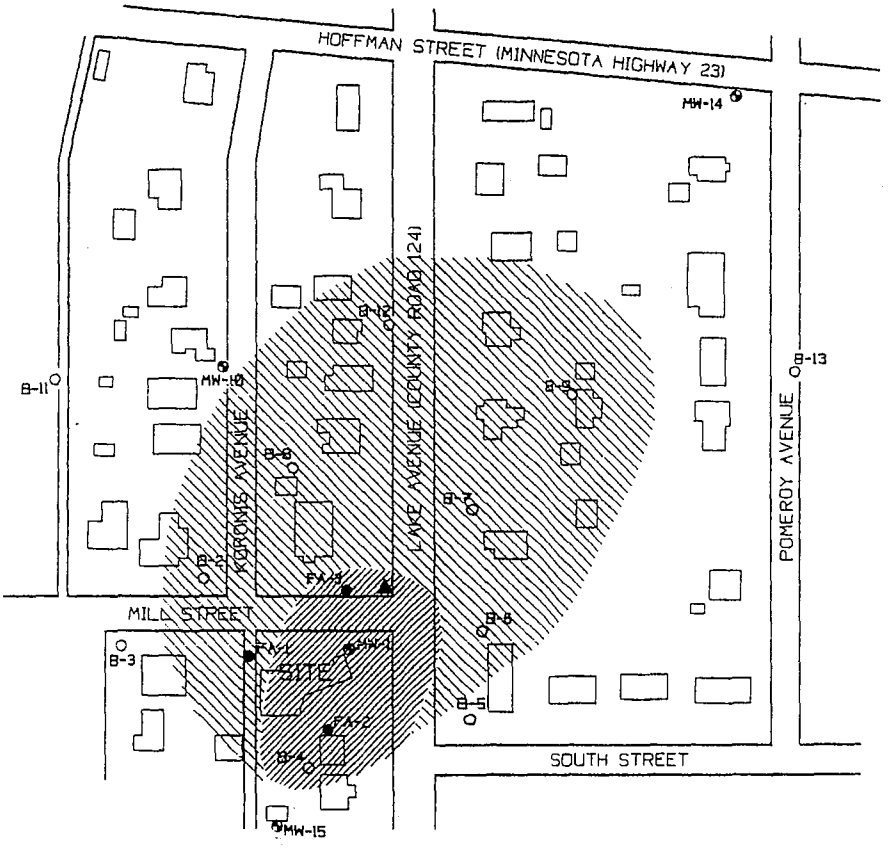


FIGURE 7

Aerial Extent of Contamination
Paynesville Municipal Water Supply/Former
Midtown Service Station
Terracon Project No. 41987018

FIGURE 15
AREAL EXTENT OF SOIL CC
MIDTOWN SERVICE STATION
PAYNESVILLE, MINNESOTA
#4700 90-75



EXPLANATION

- Monitoring Well
- Standard Penetration Boring
- Flight Auger Boring
- Benchmark
- Approximate Extent of Contamination in Lower Sand Unit
- Approximate Extent of Contamination in Till and Sand Units

N

0 200
SCALE
1" = 200'

twin city testing

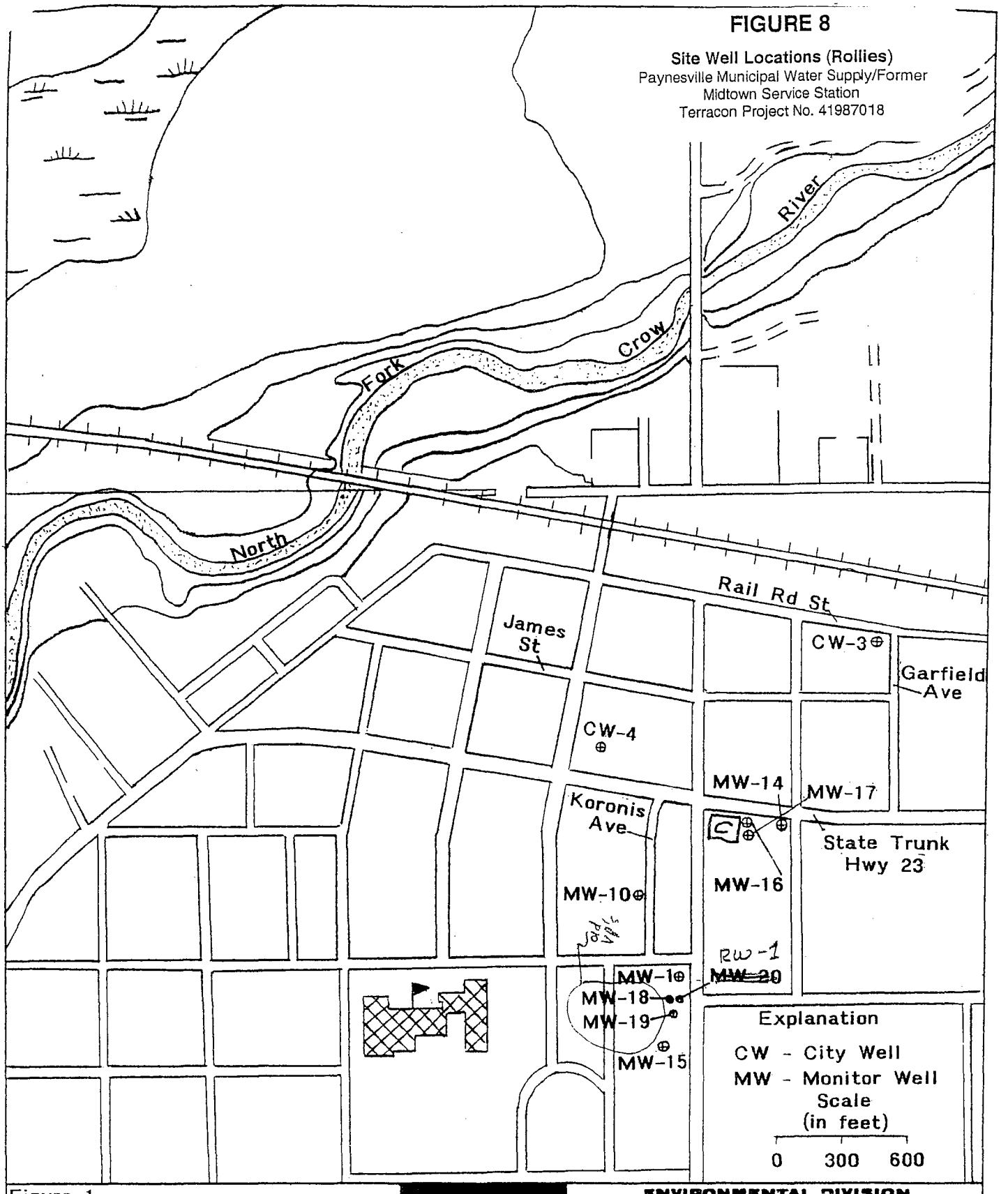


Figure 1

Site Detail Map

Midtown Service
Paynesville, Mn
MPCA Leak # 2181

ENVIRONMENTAL DIVISION

Rollies Sales & Service Inc.

Hwy. 27 West
Osakis, MN 56360

BAH	PJB	1186

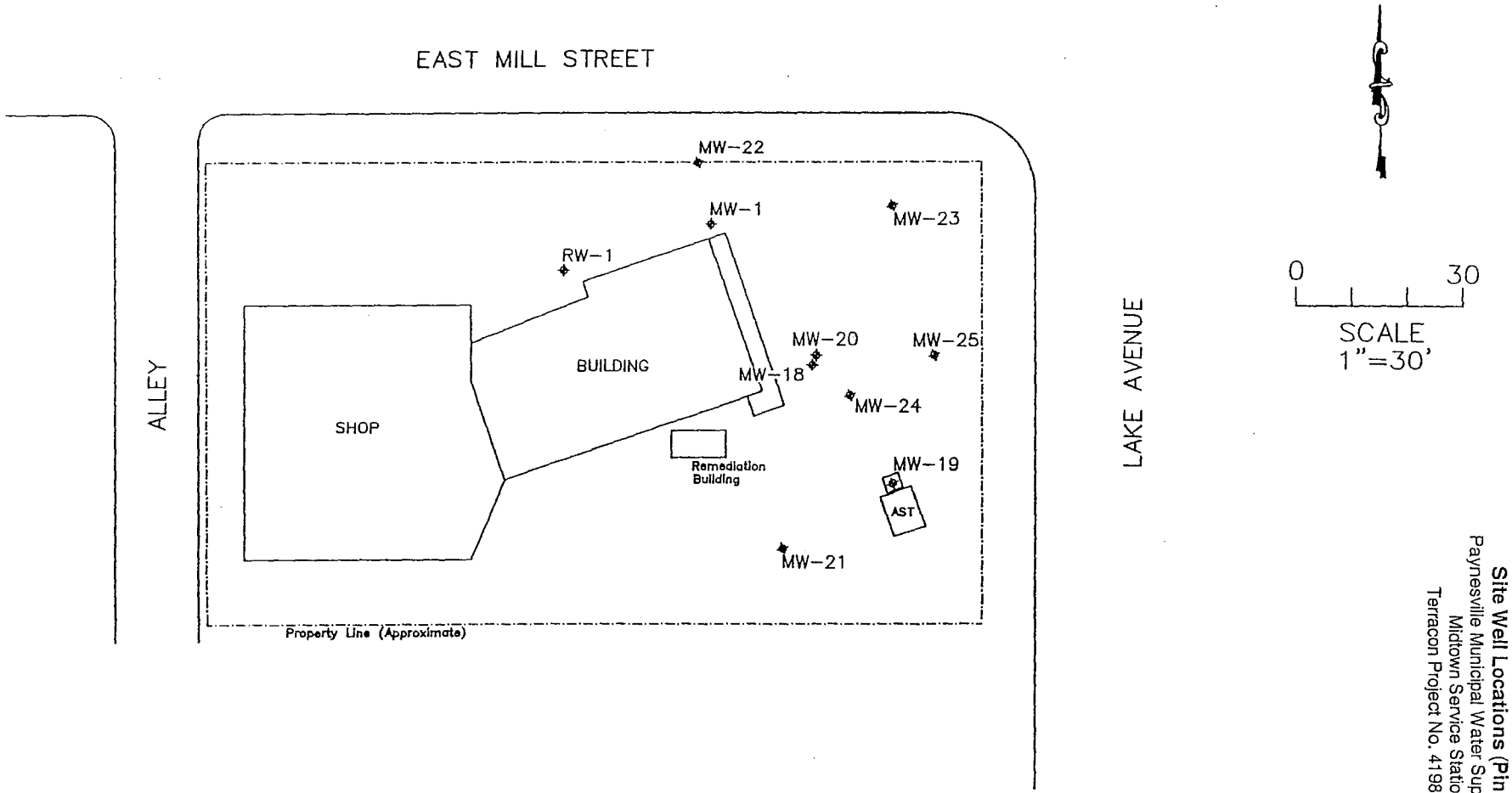


FIGURE 9

Site Well Locations (Pinnacle)

Paynesville Municipal Water Supply/Former Midtown Service Station

Terracon Project No. 41987018

Pinnacle Engineering

11000-93rd AVENUE NORTH
MAPLE GROVE, MN 55369
(612) 315-4501

FIGURE 3
SITE DETAIL MAP
MIDTOWN SERVICE STATION
PAYNESVILLE, MINNESOTA

PREPARED BY: JP/MH

DATE: 5/19/98

FILE NAME: RIADDF3.DWG

FIGURE 10

Free Product Recovery Data
Paynesville Municipal Water Supply/Former
Midtown Service Station
Terracon Project No. 41987018

TABLE 2

FREE PRODUCT RECOVERY TEST DATA

DATE	TIME	FREE PRODUCT DEPTH	GROUNDWATER DEPTH	FREE PRODUCT THICKNESS
		MW-1		
4/23/98	5:00PM	16.67	17.4	0.712
4/23/98	5:30PM			0.05
4/27/98	7:30AM	16.96	17.25	0.272
4/30/98	12:00PM	16.75	17	0.232
5/5/98	7:30AM	16.84	17.11	0.252
		MW-18		
4/23/98	5:00PM	16.54	18.88	2.322
4/23/98	5:30PM			0.05
4/27/98	7:30AM	17.21	17.9	0.672
4/30/98	12:00PM	16.92	17.71	0.772
5/5/98	7:30AM	16.99	18.04	1.032
		MW-19		
4/23/98	5:00PM	16.84	17.52	0.662
4/27/98	7:30AM	17.14	17.59	0.432
4/30/98	12:00PM	16.96	17.31	0.332
5/5/98	7:30AM	17.01	17.47	0.442
		MW-20		
4/23/98	5:00PM	16.41	16.85	0.422
4/23/98	5:30PM			0.05
4/27/98	7:30AM	16.96	17.25	0.272
4/30/98	12:00PM	16.75	17	0.232
5/5/98	7:30AM	16.84	17.11	0.252
		MW-21		
4/23/98	5:00PM	16.99	17.2	0.192
4/23/98	5:30PM			NA
4/27/98	7:30AM	NR	NR	NA
4/30/98	12:00PM	16.87	17.09	0.202
5/5/98	7:30AM	16.99	17.21	0.202
		MW-24		
4/23/98	5:00PM	17.14	17.24	0.082
4/23/98	5:30PM			NA
4/27/98	7:30AM	17.37	17.49	0.102
4/30/98	12:00PM	17.14	17.26	0.102
5/5/98	7:30AM	17.25	17.38	0.112
		MW-25		
4/23/98	5:00PM	16.98	17.96	0.962
4/23/98	5:30PM			0.125
4/27/98	7:30AM	17.28	18.1	0.802
4/30/98	12:00PM	NR	NR	NA
5/5/98	7:30AM	17.16	17.94	0.762

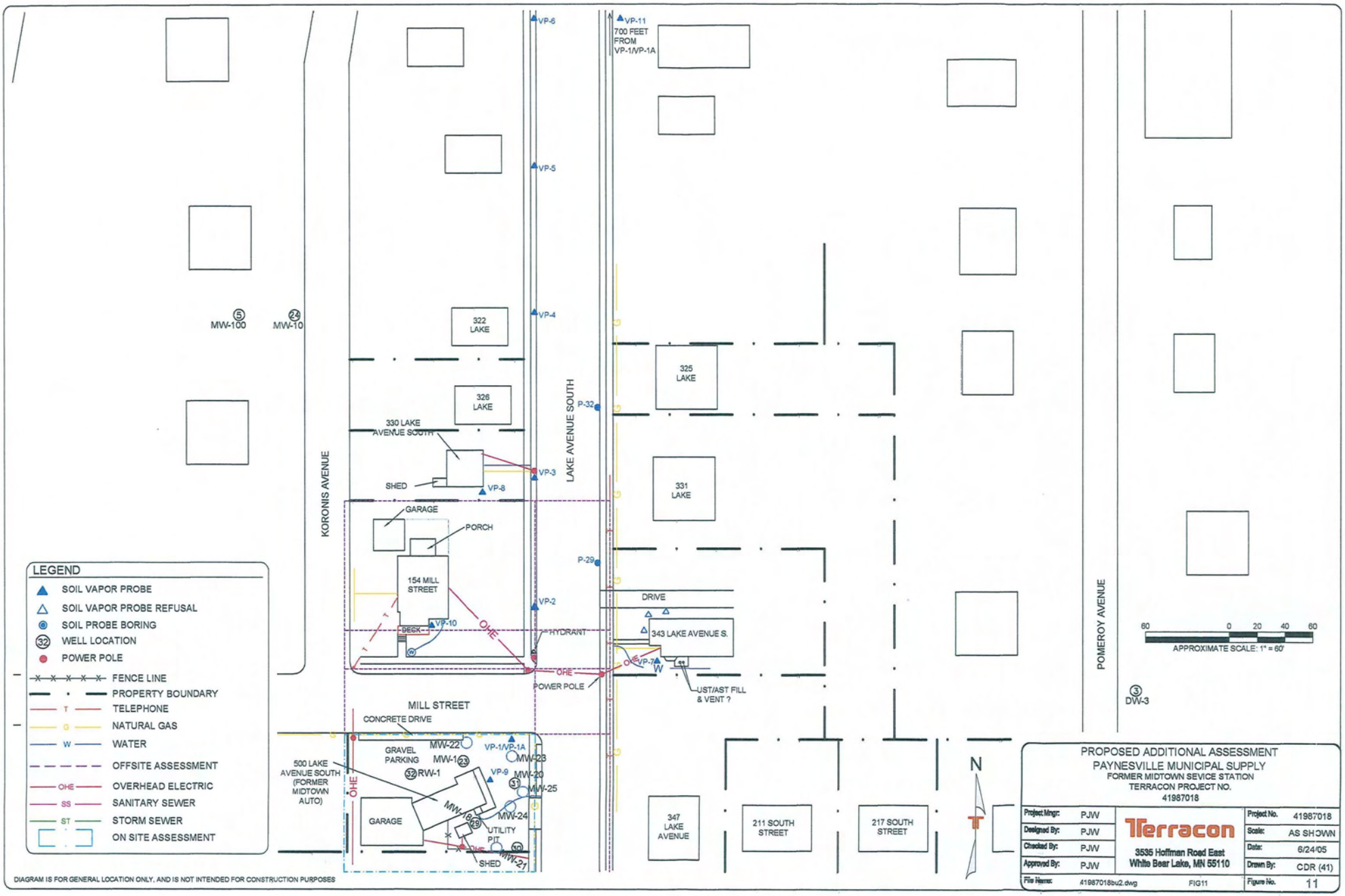

VP-6
VP-11
700 FEET FROM VP-1/VP-1A
VP-5
VP-4
MW-100
MW-10
322 LAKE
326 LAKE
325 LAKE
331 LAKE
330 LAKE AVENUE SOUTH
SHED
VP-8
VP-3
P-32
LAKE AVENUE SOUTH
KORONIS AVENUE
GARAGE
PORCH
154 MILL STREET
P-29
VP-2
DRIVE
343 LAKE AVENUE S.
DECK
VP-10
OHE
HYDRANT
VP-7
W
POWER POLE
UST/AST FILL & VENT ?
POMEROY AVENUE
DW-3
APPROXIMATE SCALE: 1" = 60'
MILL STREET
CONCRETE DRIVE
GRAVEL PARKING
MW-22
MW-16
VP-1/VP-1A
MW-23
RW-1
VP-9
MW-20
MW-25
500 LAKE AVENUE SOUTH (FORMER MIDTOWN AUTO)
MW-18
MW-24
GARAGE
UTILITY PIT
SHED
MW-21
347 LAKE AVENUE
211 SOUTH STREET
217 SOUTH STREET
N
LEGEND
SOIL VAPOR PROBE
SOIL VAPOR PROBE REFUSAL
SOIL PROBE BORING
WELL LOCATION
POWER POLE
FENCE LINE
PROPERTY BOUNDARY
TELEPHONE
NATURAL GAS
WATER
OFFSITE ASSESSMENT
OVERHEAD ELECTRIC
SANITARY SEWER
STORM SEWER
ON SITE ASSESSMENT
DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES
PROPOSED ADDITIONAL ASSESSMENT
PAYNESVILLE MUNICIPAL SUPPLY
FORMER MIDTOWN SEVICE STATION
TERRACON PROJECT NO.
41987018
Project Mngr: PJW
Designed By: PJW
Checked By: PJW
Approved By: PJW
File Name: 41987018bu2.dwg
FIG11
Terracon
3535 Hoffman Road East
White Bear Lake, MN 55110
Project No. 41987018
Scale: AS SHOWN
Date: 6/24/05
Drawn By: CDR (41)
Figure No. 11

Table 1
Monitoring Well Information
Paynesvill Municipal Water Supply/Former Mid Town Service Station
Terracon Project No. 41987018

Paynesville Wells						
Well	**Date**	**Top of Casing**	**Bottom of Casing**	**Water Level at Installation**	**Intended Use**	**Company**
MW-1	Oct-91	17	27	8.2	free product recovery	TCT
MW-10	Oct-91	17.5	27.5	15.1	shallow monitoring well	TCT
MW-10D	Mar-98	80	90	23.0	deep well next to MW-10	Stearns
MW-14	Oct-91	18.5	28.5	18.0	shallow monitoring well	TCT
MW-14D	Mar-98	78	88	23.0	deep well next to MW-14	Stearns
MW-15	Oct-91	17	27	17.6	shallow monitoring well	TCT
MW-16	May-93	17	27	21.0	shallow monitoring well	Stearns
MW-17	May-93	60	65	21.0	deep well next to MW-16	Stearns
MW-18	Apr-93	20	30	20.5	Initially P-1/SVE test well	Stearns
MW-19	Apr-93	20	30	20.3	Initially P-2/SVE test well	Stearns
MW-20	Jun-94	13	23	16.0	free product recovery	Stearns
RW-1	Apr-93	10	40	21.0	free product recovery	Stearns
MW-21	Apr-98	16	26	18.0	shallow monitoring well	Stearns
MW-22	Feb-98	10	30	16.0	shallow monitoring well	Stearns
MW-23	Feb-98	10	30	16.0	shallow monitoring well	Stearns
MW-24	Feb-98	10	30	16.0	shallow monitoring well	Stearns
MW-25	Feb-98	10	30	16.0	shallow monitoring well	Stearns