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FOCUSED FEASIBILITY STUDY
FF/NN LANDFILL, RIPON, WI

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Prepared for:

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1.0 EXECUTIVE SUMMARY

In 1994, a Feasibility Study (FS) was prepared for the FF/NN Landfill in Ripon, Wisconsin, which was based on the results of a Remedial Investigation (RI) that had been performed at the site. That FS examined landfill capping, leachate and gas extraction alternatives. It also looked at several groundwater pumping and treatment alternatives for shallow groundwater. The Record of Decision (ROD) issued by the WDNR in 1994 required the construction of a composite landfill cap and passive gas collection system; this work was completed in 1996. The ROD did not require the active remediation of groundwater because groundwater contamination that had migrated from the landfill was not severe enough to warrant active groundwater remedial measures.

During routine groundwater monitoring in the fall of 2001, vinyl chloride was detected in two private drinking wells located in the sandstone aquifer and down gradient of the FF/NN Landfill. As a result of the vinyl chloride detections, the Wisconsin Department of Natural Resources (WDNR) requested that the PRP group evaluate alternatives to remediate groundwater at the site.

This Focused Feasibility Study (FFS) has been prepared to evaluate actions for remediating groundwater at the site using CERCLA guidelines. These guidelines emphasize the use of treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of waste. Appropriate technologies were initially screened and alternatives were identified and screened using the nine criteria specified in the CERCLA guidelines. These alternatives are:

- Alternative A, No Action
- Alternative B, Institutional Controls with Connection to Municipal Water
- Alternative C1, Source Control via Landfill Gas Extraction Using Passive Vent System
- Alternative C2, Source Control via Landfill Gas Extraction with Vertical Extraction Wells
- Alternative C3, Source Control via Groundwater Extraction and Treatment
- Alternative C4, Source Control via Shallow Biobarrier System
- Alternative D1, Deep Aquifer Remediation via Circulation Wells
- Alternative D2, Deep Aquifer Remediation via Groundwater Extraction and Treatment
- Alternative D3,- Deep Aquifer Remediation via Monitored Natural Attenuation with Source Control (Alternative C)

2.0 INTRODUCTION

2.1 Purpose

In 1994, a Feasibility Study (FS) was prepared for the FF/NN Landfill in Ripon, Wisconsin, which was based on the results of a Remedial Investigation (RI) that had been performed at the site. That FS examined landfill capping, leachate and gas extraction alternatives. It also looked at several groundwater pumping and treatment alternatives for shallow groundwater. The Record of Decision (ROD) issued by the WDNR in 1994 required the construction of a composite landfill cap and passive gas collection system; this work was completed in 1996. The ROD did not require the active remediation of groundwater because groundwater contamination that had migrated from the landfill was not severe enough to warrant active groundwater remedial measures.

During routine groundwater monitoring in the fall of 2001, vinyl chloride was detected in one private drinking water supply well located in the sandstone aquifer and down gradient of the FF/NN Landfill. Additional monitoring at a new home adjacent to this well indicated that its water supply well was also impacted. As a result of the vinyl chloride detections, the Wisconsin Department of Natural Resources (WDNR) requested that the PRP group evaluate alternatives to address the groundwater plume that was found since the ROD was issued.

An FS is the mechanism for developing, screening, and evaluating in detail alternatives for remedial actions. The primary objective of this Focused FS for the FF/NN Landfill is to develop and evaluate remedial action alternatives that are capable of mitigating unacceptable environmental risks from impacted groundwater. The approach and structure of the Focused FS are in accordance with the U.S. Environmental Protection Agency's (EPA) *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (1988) and *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* (1991).

2.2 Background

2.2.1 Landfill History

The FF/NN Landfill occupies approximately 7.3 acres in the northwest corner of Fond du Lac County in the Town of Ripon, Wisconsin (SE ¼ of the SE ¼ of Section 7, T16N, R17E). Landfilling activities occurred at the site from 1967 to 1983. The land was leased from the property owner, Mr. Lyle Sauer, and subsequently, Mrs. Arlene Sauer. In 1967, Speed Queen leased the property for disposal of wastes from its facility in Ripon. In 1968, the City of Ripon (City) leased the property. In 1978, the City and Town of Ripon (Town) were signatory to the lease. A license to operate the landfill (#467) was issued by the WDNR to the City in 1969. In 1970, the City and Town contracted to share the costs of operating the landfill. The landfill was operated by the City and Town from 1970 to 1983. Throughout its 16-year history, the landfill accepted municipal, commercial, and industrial solid waste. After landfill operations ceased, the site was capped with a clay cap in 1985. The site was used for growing hay from 1985 to 1993. The City of Ripon is the current owner of the site.

2.2.2 NPL Inclusion

In 1982, the WDNR began evaluating the landfill for possible inclusion on the federal National Priorities List (NPL). In 1993, the FF/NN Landfill was proposed for listing on the NPL by the USEPA and was officially listed on May 31, 1994.

2.2.3 Remedial Investigation

A Remedial Investigation (RI) was conducted at the site by the PRP group and the final RI Report was completed in August, 1994. The RI found that five VOCs exceeded NR 140 Preventive Action Limits (PALs) and two, vinyl chloride and cis-1,2-dichloroethene, were present at concentrations which exceeded NR 140 Enforcement Standards (ESs). The lateral extent of shallow groundwater contamination was approximately 500 feet and was limited to wells immediately adjacent to or downgradient of the landfill. Contaminants present in the deeper groundwater were not shown to extend more than 1000 feet to the south of the landfill. No VOCs were present in any private water supply wells except the former Bosveld well, which was located about 200 feet south of the landfill.

2.2.4 Feasibility Study

In December, 1994, a Feasibility Study (FS) was completed for the site based on the results of the RI. The FS examined alternatives for landfill capping, leachate and gas extraction, and shallow groundwater extraction and treatment.

2.2.5 Record of Decision

A ROD was issued for this site on February 26, 1996. Specifically, the ROD describes the selected remedy as follows:

> "The Department of Natural Resources has evaluated remedial alternatives for two operable units at the site: a source control operable unit and a groundwater operable unit. The selected source control remedy is Alternative O, Composite Landfill Cap and Passive Gas Venting in conjunction with a groundwater monitoring plan. Details of the selected source control operable unit remedy can be found in the Feasibility Study. The specific components of the source control operable unit remedy include:
>
> - constructing a composite landfill cover (i.e. a landfill cap made with both a plastic membrane and soil materials) over the entire landfill;
> - installing a passive landfill gas venting system as part of the composite cap to effectively vent landfill gas from the waste;
> - monitoring of the groundwater quality to determine the effectiveness of the landfill cap towards improving groundwater quality;
> - monitoring the landfill gas probes around the landfill to make sure that landfill gas is not migrating away from the site in an uncontrolled manner;
> - maintenance of the landfill cap to repair erosion that may develop;
> - a deed restriction prohibiting disturbing the landfill cap except for maintenance purposes; and
> - fencing of the landfill perimeter to restrict access.
>
> "For the groundwater operable unit, the Department has selected Alternative A, the No Action Alternative. The groundwater contamination that has migrated from this landfill is not severe enough to warrant active groundwater remedial measures to restore groundwater quality. The implementation of the source control operable unit

remedy will result in decreased migration of contaminants from the landfill to the groundwater."

2.2.6 Remedial Action

In 1996, in compliance with the ROD for this site, a composite membrane/clay cap was constructed on top of the existing clay cap. In addition, a passive gas collection system was installed within the landfill.

2.2.7 Post Remediation Monitoring

From 1996 to 2001, semi-annual groundwater monitoring with annual monitoring of private water supply wells was conducted. In October 2001, routine sampling detected vinyl chloride in a residential water supply well (Altnau, N8798 S. Koro Rd.). Follow-up sampling detected vinyl chloride in the water supply well of a recently built home (Ehster, W14271 Charles St.). Ten subsequent quarterly groundwater sampling events have confirmed that no detectable VOCs are present in any other private water supply wells located immediately down gradient of the landfill.

2.2.8 Private Water Supply Response Actions

The PRP group cooperated fully with the WDNR in responding to the 2001 vinyl chloride detections. Initially, bottled water was provided to the two residences. Subsequently, air strippers with granular activated carbon treatment systems were installed at the two residences with impacted groundwater as an interim measure until the homes were hooked up to the municipal water supply.

In November 2002, a municipal water supply pipeline was extended from the City of Ripon along South Koro Road up to and along Charles Street by Alliant Energy. The two homes with impacted wells (Altnau and Ehster) were connected to this municipal water supply, as well as a third home with a non-impacted water supply (Miller, N8756 S. Koro Rd.). Municipal water was also offered to the other residents on Charles Street. In 2004, the Hadel (W14292 Charles St) and Wiese (N8778 S. Koro Rd) homes were voluntarily connected to municipal water supply and their private wells were converted to piezometers.

2.2.9 Supplemental Groundwater Investigation and Monitoring

A supplemental groundwater investigation was conducted to better define the horizontal and vertical extent of vinyl chloride impacts. Three deep piezometers were installed in 2002 at two locations downgradient of the landfill. In December 2003, a fourth deep piezometer was installed directly downgradient of the landfill adjacent to the existing 103 well nest.

2.2.10 Landfill Gas Evaluation

In 2003, the WDNR requested that gas probes be installed outside the limits of waste to observe any off-site migration of landfill gas, and in 2004, 11 gas probes were installed. Methane measurements at the probes and monitoring wells have shown concentrations that exceed 25% of its lower explosive limit (LEL) at several locations outside the limits of the landfill. In addition, recent analysis of landfill gas samples has indicated that vinyl chloride is present in several landfill gas samples, which may serve as the source of vinyl chloride detected in groundwater at the site.

2.2.11 Active Landfill Gas Extraction Interim Action

The presence of methane at concentrations greater than its LEL in gas probes located outside of the limits of fill exceeds an ARAR for the site, section NR504.04(4)(e) of the Wisconsin Administrative Code (WAC). In response to the elevated methane levels, pilot testing of active gas extraction was performed in June of 2005. The pilot test demonstrated that conversion of the passive gas control system into an active gas extraction system was feasible. Based upon the results of the pilot test the FF/NN Landfill PRP Group will be performing an Interim Action of installing an active gas removal system which utilizes the existing passive gas collection system in the landfill. The design for this remedial system was submitted to the WDNR for review and approval in August, 2005.

2.3 Applicable or Relevant and Appropriate Requirements

A comprehensive listing of Potential Applicable or Relevant and Appropriate Requirements (ARARs) for the FF/NN Landfill site was identified in the 1994 FS. That listing has been updated, and is provided as Table 2-1.

The major changes that have occurred since the 1994 FS have not been changes to the ARARs, but in the interpretation of them by the US EPA and the WDNR. Both have issued numerous studies and reports which are available on their respective websites and are not reproduced in this report. These reports indicate that remediation technologies that are acceptable under the exiting ARARs include Monitored Natural Attenuation and Engineered Barriers. Reports such as *Understanding Chlorinated Hydrocarbon Behavior in Groundwater: Investigation, Assessment and Limitations of Monitored Natural Attenuation* (WDNR, 2002) also present a much greater understanding of the natural processes that affect contaminants in the environment than existed in 1994.

The ARAR which necessitated further remedial actions at the site since the ROD is NR140 of the Wisconsin Administrative Code. Specifically, NR140 contains health-based ground water quality criteria, one of which, that for vinyl chloride, exceeded its Enforcement Standard (ES) in two private wells and in groundwater monitoring wells downgradient of the landfill.

2.4 Report Organization

The remainder of the Focused FS consists of four sections. Section 3 summarizes existing conditions, including the geology, hydrogeology and contaminant characterization. Section 4 includes general response actions and technologies to meet the Remedial Action Objectives (RAOs). A screening evaluation of these remedial technologies based on their applicability to the FF/NN Landfill is conducted in Section 4 to identify the technologies retained for further evaluation. In Section 5, the appropriate remedial technologies are combined to form remedial alternatives, and these alternatives are evaluated using the nine criteria in the NCP. Section 6 provides a comparison of the alternatives based on the NCP criteria.

3.0 EXISTING CONDITIONS

The *Remedial Investigation Report* issued August 26, 1994 by Hydro-Search, Inc. (n.k.a GeoTrans, Inc.) contained a summary of the physical characteristics of the FF/NN Landfill site and surrounding area. This summary included topography, meteorology, surface hydrology, geology, hydrogeology, ecology and demography. The Hydrogeologic Characterization and Contaminant Characterization sections in the 1994 *Feasibility Study* summarized geological and hydrogeological information as well as contaminant characterization pertinent to evaluating remedial action options for the landfill. This Focused FS (FFS) provides an update of that information, as well as landfill gas monitoring and pilot study results.

3.1 Geologic Characterization

With vinyl chloride impacts detected approximately 1,400 feet downgradient of the landfill, it was important to better define the downgradient geology. The 1994 remedial investigation clearly defined the local geology beneath the landfill but did not extend more than approximately 900 feet downgradient of the landfill boundaries. In order to gain a better understanding of the downgradient geology, the following resources were utilized:

- Private well logs at homes along South Koro Road and Charles Street
- Private well logs at homes south of Silver Creek
- Borehole logs from the three piezometers installed as part of the 2002 investigation
- Geologists with the Wisconsin Geological and Natural History Survey (WGNHS)

With these resources, the cross-sections presented in the 1994 *Remedial Investigation* were updated. Specifically, geologic cross-section A-A' (Plate 1) was extended to the south by approximately 2200 feet. A new cross section, C-C' (Plate 3), was created that runs along an east-west line south of the landfill and along Charles Street. These two cross-sections, along with cross section B-B' (Plate 2) that runs at an east-west line through the landfill, are included with this FFS.

The primary findings from the geological update are as follows:

- The geology of the site consists of unconsolidated glacial deposits ranging in thickness from 150 to 220 feet. The 1994 remedial investigation indicated the unconsolidated deposits were comprised mainly of gravel, sand and silt. The 2002 review of downgradient borehole logs indicates the presence of a clay deposit beginning near the P-103D well nest and increasing to a thickness of 100 to 130 feet to the south.

- The bedrock is comprised of Cambrian-age sandstone that is approximately 150 feet thick at the site. The bedrock surface beneath the site occurs at an elevation of approximately 690 feet msl. Approximately 1000 feet south of the site the bedrock surface begins to slope to the south-southwest as part of a regional northeast-southwest trending bedrock valley. Beneath the sandstone is Precambrian-age granite and quartzite at a depth of 330 feet as noted in P-107D. No other wells or boreholes in the area extend to the top of the granite including wells MW-3A, P-113A, and Alliant public water supply well #9.

3.2 Hydrogeologic Characterization

As noted previously, four deep wells (P-103D, P-111D, P-113A and P-113B) have been installed since 2001. In addition, two former WP&L wells (MW-3A and MW-3B) have been included in the monitoring program. Finally, three private drinking water wells (Ehster, Hadel and Wiese) have been converted into piezometers (P-114, P-116 and P-115, respectively).

With these new wells, there are 27 wells from which groundwater quality and water levels are being monitored. To assist monitoring efforts, these wells were organized into four stratigraphic units based on well screen elevation and were labeled Layers 1 through 4. Table 3-1 provides the groupings for all wells.

3.2.1 Groundwater Flow Direction

Figures 3-1, 3-2, 3-3 and 3-4 show the groundwater flow direction determined from groundwater elevations measured in April 2005. In Layers 1 and 2, the flow is generally to the southwest. In Layer 3, there is a southwesterly flow that turns westerly based on the potentiometric surfaces measured in P-113B and P-116. Green Lake lies to the southwest and, according to Bill Batten at the Wisconsin Geologic and Natural History Survey (phone conversation, fall 2003) the lake may influence groundwater flow even at these depths. In Layer 4, flow is to the southeast.

In 2002, a significant drop in groundwater elevation was observed in both water table wells (Layer 1) and shallow piezometers (about 25 feet below the water table surface; Layer 2). It was determined that Northeast Asphalt, located east of the landfill on Highway FF, was pumping up to 5 millions gallons of groundwater daily as part of their dewatering operations for gravel extraction. This pumping caused all nine water table wells to go dry and caused up to 20 feet of water level drop in the Layer 2 wells. Northeast Asphalt was notified by the WDNR of their impact on the local groundwater system at a Superfund site and they stopped their dewatering operations. By 2004, Layers 1 and 2 appeared to have reached new groundwater equilibrium and water had returned to all nine water table wells.

3.2.2 Vertical Hydraulic Gradient

There are 13 pairs of wells at ten locations that can provide vertical gradient information across the site. Of these 13 pairs, eight include a water table well.

The vertical gradients for each well pair are noted below based on the April 2005 and historical (pre-2001) measurements. The comparison shows consistent results between the two sets of data. Near the landfill, there is generally an upward gradient in the shallow unconsolidated materials and a downward gradient in the deeper unconsolidated deposits and bedrock formations. Gradients in bedrock wells farther south of the landfill (MW-3A, MW-3B, P-113A, P-113B) are generally downward. The well nest to the west (MW-108, P-108), near the wetland, shows an upward gradient.

Vertical Gradients

Well Pairs	April 2005	Historical (pre-2001)
Layer 1 to Layer 2		
MW-101, P-101	Downward to flat	Downward
MW-102, P-102	Upward	Upward
MW-103, P-103	Upward	Upward
MW-104, P-104	Upward	Upward
MW-106, P-106	Downward	Downward
MW-107, P-107	Upward to flat	Upward to downward
MW-108, P-108	Upward	Upward
MW-111, P-111	Downward	Downward
Layer 2 to Layer 3		
P-103, P-103D	Downward	P-103D installed in 2003
P-111, P-111D	Upward	P-111D installed in 2002
Layer 2 to Layer 4		
P-107, P-107D	Downward	Downward
Layer 3 to Layer 4		
P-113A, P-113B	Flat to downward	Wells installed in 2002
MW-3A, MW-3B	Downward	Not measured prior to 2002

3.2.3 Hydraulic Conductivity and Groundwater Velocity Calculations

Slug test data from the 1994 investigation indicated an average hydraulic conductivity of 2.5 x 10^{-2} ft/min (1.3 x 10^{-2} cm/sec) for sand and gravel deposits, and 2.9 x 10^{-3} ft/min (1.5 x 10^{-3} cm/sec) for sand and silt deposits.

In 2003 and 2004, slug testing was conducted in nine Layer 3 and 4 wells (four newly installed wells, three converted private wells and two existing wells). Hydraulic conductivity values for Layers 3 and 4 ranged from 2.6 x 10^{-2} ft/min to 9.4 x 10^{-4} ft/min (1.3 x 10^{-2} cm/sec to 4.8 x 10^{-4} cm/sec) with a geometric mean of 3.7 x 10^{-3} ft/min (1.9 x 10^{-3} cm/sec).

The linear groundwater flow velocity was calculated for each layer using the range and geometric mean value for hydraulic conductivity and horizontal gradient. An average porosity of 20% and 10% was assumed for the unconsolidated deposits and sandstone bedrock, respectively. The resulting velocities are summarized below; calculations and input variables can be found in Appendix A.

	Groundwater Velocity (feet/year)		
	Low	High	Arithmetic Mean
Layer 1 Wells	0.02	708	99
Layer 2 Wells	0.24	1639	113
Layer 3 Wells	2.47	211	37
Layer 4 Wells	41.6	276	117
Arithmetic Mean			91
Arithmetic Mean without Layer 4			83

Note that the private water supply wells are located in Layer 3. The distance from the southern edge of the landfill to the impacted wells on Charles Street is approximately 1,500 feet. Dividing this distance by the arithmetic mean groundwater velocity of layers 1 through 3 (83 feet per year) results in an estimated travel time of 18 years. This would place the contaminant release in about 1983, which is prior to the capping of the landfill. The travel time estimated from the groundwater velocities confirms that the release which impacted the private wells in 2001 occurred prior to capping the landfill in 1985.

3.3 Groundwater Contamination

Volatile organic compounds (VOCs) comprise the groundwater contaminants at the landfill. Directly underneath the waste, chlorinated VOCs (CVOCs) as well as lighter petroleum hydrocarbons (BTEX) have been detected in groundwater in Layer 1 wells. CVOCs have been observed outside of and downgradient of the waste in wells in all four layers. BTEX compounds have occasionally been present in Layer 1 wells directly adjacent to the landfill but have not been found in wells beyond that point.

Historically, tetrachloroethene (PCE) and trichloroethene (TCE) have only been detected within 400 feet of the waste in Layers 1 & 2 wells. Cis-1,2-dichloroethene (1,2-DCE), a byproduct of reductive dechlorination of PCE and TCE, has been detected up to 1500 feet downgradient. Reductive dechlorination of 1,2-DCE produces vinyl chloride, which has been detected in wells in all four layers. Vinyl chloride is the only compound that is detected above a groundwater standard more than 400 feet downgradient of the landfill. Historical groundwater monitoring results are included in Table 3-2.

The vertical and horizontal extent of the vinyl chloride plume has been delineated with the existing monitoring well network. Figures 3-5, 3-6, 3-7 and 3-8 portray the extent of vinyl chloride impacts in each of the four layers in July 2005. As noted on these figures, the concentration of vinyl chloride ranges from non-detectable levels at the perimeter of the plume to 10 ug/l (parts per billion) in P-111D, which is about 900 feet south of the landfill.

Vinyl chloride has been detected 1500 feet downgradient of the landfill (well P-114). There are two monitoring locations downgradient of this well (P-116 and P-113 nest) and neither location has ever had a detection of vinyl chloride in groundwater samples. Sidegradient of the landfill to the east, well nest 102 has historically had no VOC detections while well P-106 has had low-level PAL exceedances of TCE. From 2002 to 2004, vinyl chloride was present in P-102 due to the effects of Northeast Asphalt's pumping, but has since returned to a non-detect status. Sidegradient to the west, well nest 108 has historically had no VOC detections. In October 2004, TCE, 1,2-DCE and vinyl chloride were detected at low concentrations in MW-108, which were confirmed in April 2005. These relatively new detections confirm that the extent of the plume in that direction is near the 108 well nest.

Overall, there are downward or stable trends in CVOC concentrations in groundwater. When monitoring began in 1993, MW-103 (adjacent to the landfill) had the highest CVOC concentrations up to 1500 ug/L. Currently, total VOC concentrations are approximately 12 ug/L in this well. MW-112 has had the next highest total VOC concentrations with an historic high of approximately 280 ug/L (in December 2002). In April 2005, total VOC concentrations in this well were slightly less than 100 ug/l. They decreased further to 7 ug/l in July 2005.

The quantity of contaminated groundwater is estimated to be about 27 million gallons (600 feet wide by 1500 feet long by 40 feet thick, with matrix porosity of 0.10). The total mass of vinyl chloride in the deep aquifer is estimated to be only about 2.2 pounds, assuming an average concentration of 10 ug/l).

3.4 Landfill Leachate

In the 1994 Feasibility Study, it was noted that leachate generation at the site was minimal and that attempts in 1994 to perform a pump test on the leachate wells were not successful. This lack of leachate generation continues at the site. Wells LC-1 and LC-3 routinely have no leachate in them. In July 2005, well LC-2 bailed dry after 1.5 gallons were removed. In addition, vinyl chloride has not been detected in leachate since 1996. Given this, management of leachate as a source control alternative is not warranted.

3.5 Landfill Gas

Section NR 506.07(4), WAC requires that methane concentrations greater than the lower explosive limit (LEL), or 5%, should not occur outside the limits of the wastes. MW-101, MW-102 and MW-103 are the three gas monitoring points located outside of the limits of the wastes that have historically been used to sample for landfill gas at this site. MW-112, also outside the waste limits, was added to the monitoring program in 2002. For these four locations, the only one where the concentration of methane has ever exceeded the LEL is at MW-103. See Table 3-2 for historical gas measurements at all monitoring points.

In 2004, 11 gas probes were installed within 150 feet of the perimeter of the waste on all four sides of the landfill. A summary of the methane measurements from these probes is included on Table 3-2. The LEL for methane has been exceeded in four of these 11 probes (GP-1, GP-2, GP-3 and GP-7). GP-1 is located east of the landfill, GP-2 is located west of the landfill and GP-3 and GP-7 are located south of the landfill. The table below shows the methane levels in these four probes.

		04/28/04	06/16/04	10/12/04	01/28/05	04/26/05
Probe ID	Distance from Landfill, feet	Percent Methane				
GP-1	65	43.6	28.7	29.7	17	41.9
GP-2	50	Not installed	24.7	23.6	22.5	30.6
GP-3	60	13.6	13	18.6	9.1	0.7
GP-7	135	Not installed	Not installed	5.9	1.7	2.6

In May 2005, a pilot study was conducted to determine the effectiveness of using the existing gas vent piping as the collection system for an active landfill gas extraction system. The purpose of this system would be to address the off-site migration of landfill gas and the transport of vinyl chloride. The pilot study did demonstrate that off-site concentrations of methane can be affected by an active landfill gas extraction system. A full scale interim system was recommended to address the source.

3.6 Continuing Source of Groundwater Contamination

Assuming the FF/NN Landfill is the continuing source of vinyl chloride in groundwater, then one or more of these pathways must be operating:

1. Direct contact of wastes with groundwater (i.e., the depth of wastes extends below the water table).
2. Leachate migration from the landfill to groundwater,
3. Transfer of VOCs contained in landfill gas to groundwater,

The base of the landfill is located approximately 20 feet above the water table. As a result, there is not now, nor has there been in the past, direct contact between the contents of the landfill and groundwater at the site. Therefore, the first pathway does not appear to be the cause of continued contamination from this site.

During the years1967 to 1983, when the landfill was accepting new waste, there was no cap over the existing wastes, leachate generation was at its greatest and the potential for leachate entering groundwater was also at its highest. Since the composite cap was constructed on the landfill in 1996, the levels of leachate in the leachate wells have fallen by 3 to 8 feet. This is consistent with the fact that the composite cap allows a negligible quantity of precipitation to enter the top of the landfill to produce leachate. In fact, two of the three leachate head wells, and specifically those in the thickest portion of the landfill, have generally been dry and recent sampling at LC-2 indicated that it bailed dry after removing 1.5 gallons. The construction logs for these wells indicate that they actually extend beneath the bottom of the wastes in the landfill, which indicates that there is no leachate in the landfill at these locations. Furthermore, the one leachate head well that does contain liquid, LC-2, has been sampled and analyzed indicating the presence of xylenes and ethylbenzene but no chlorinated solvents. If leachate from the vicinity of LC-2 is contaminating groundwater, then xylenes and ethylbenzene would likely be observed in groundwater monitoring wells at the site. In over ten years of monitoring, these compounds have never been detected in groundwater monitoring wells downgradient of the site. Therefore, while leachate generation may have been a source of groundwater contaminants in the past it does not appear to be an ongoing current mechanism.

Because vinyl chloride is currently present in landfill gas being generated by the landfill, the transfer of VOCs from the landfill gas to groundwater appears to be the most likely ongoing mechanism of groundwater contamination. The transfer of VOCs from landfill gas to groundwater may occur through direct contact of the gas with groundwater or through VOCs in gas condensate leaching to groundwater. Because methane is lighter than air and rises, because soils beneath and adjacent to the site are permeable sands and gravels and because there is a twenty-foot distance between the bottom of the landfill and the top of the water table, the mechanism for transport of vinyl chloride to the groundwater is unclear.

4.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

4.1 Overview

The purpose of this section is to identify site-specific Remedial Action Objectives (RAOs), General Response Actions (GRAs), and specific technologies which may be appropriate for the identified RAOs and GRAs for the site. After development of the RAOs and GRAs, the identified remedial technologies are screened to eliminate those which are inappropriate for inclusion in specific integrated alternatives. CERCLA guidelines emphasize the use of treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of waste. The technologies identified which satisfy the criteria and appear acceptable as components of final remedial actions will be retained for further evaluation and potential inclusion in remedial alternatives developed for the site.

4.2 Remedial Action Objectives

Based upon the existing conditions, RAOs were developed for three operable units at the site. The three operable units include source control, groundwater and residential water supply.

4.2.1 Source Control RAOs

The existing composite landfill cap addresses and satisfies many of the RAOs associated with source control including preventing direct contact with the waste, minimizing infiltration and resulting contaminant leaching to groundwater, and controlling surface water run-off and erosion. While collecting and treating leachate is a presumptive remedy for landfills, historic and current conditions at the site indicate the lack of leachate makes this RAO inapplicable. The RAO of controlling landfill gas has not been achieved with the existing passive gas control system. Therefore gas control is a RAO for the site.

4.2.2 Groundwater RAOs

Groundwater RAOs are driven by NR 140 groundwater quality requirements and standards. The NR 140 standards are, by definition, protective of human health and the environment. Therefore the RAO for groundwater is to restore contaminated groundwater to below NR 140 Preventive Action Limits within a reasonable period of time

4.2.3 Residential Water Supply RAOs

The RAO for residential water supplies is to ensure safe, reliable, potable drinking water for downgradient residents.

4.3 General Response Actions

GRAs have been developed for each operable unit in order to satisfy the RAOs.

4.3.1 Source Control GRAs

In order to meet the RAOs for the source control operable unit the following is the proposed GRA:

- Landfill Gas Control

4.3.2 Groundwater GRAs

In order to meet the RAOs for the groundwater operable unit the following are the proposed GRAs:

- Groundwater Extraction, Treatment and Discharge
- In-Situ Treatment of Groundwater

4.3.3 Residential Water Supply GRAs

In order to meet the RAOs for the residential water supply operable unit the following is the proposed GRA:

- Institutional Controls

4.4 Identification and Screening of Process Types and Options

Process types and options for each of these general response actions are described briefly below. Table 4-1 lists the general response actions and provides an initial screening of the technologies that should be considered further for this site.

4.4.1 No Action

This general response action allows the Site to remain in its present condition, without any additional actions which are not currently required. Evaluation of the No Action alternative is required for consideration by the National Contingency Plan (NCP) and provides a baseline to use for comparison against other alternatives. Because the existing ROD for the FF/NN landfill requires that the existing landfill cap is maintained and that groundwater is sampled regularly, the No Action Alternative will include these actions which are already being performed.

4.4.2 Institutional Controls

Institutional controls would not be effective in reducing contaminant concentrations, but they would be effective in reducing potential human exposure. The types of processes that are considered under institutional controls include access restrictions through legal and administrative constraints, providing an alternative water supply, and monitoring.

Process options for access restrictions include municipal ordinances and a well casing advisory. In the past year, these access restriction options have been implemented by the WDNR and the Town of Ripon and include the following:

- The WDNR has placed a "Special Well Casing Pipe Depth Area" advisory on the Geographic Information System (GIS) database for the area within 1.5 miles of the landfill. This notifies any well driller of possible contamination at that location, and a driller is required to notify a homeowner of this advisory. A copy of this advisory is provided in Appendix B.

- The Town of Ripon has passed an Ordinance requiring that any new development south (downgradient) of the landfill, in an area designated the Water Supply Protection Area, connect to the public water supply, and prohibiting the construction of new private wells. The Ordinance became effective May 9, 2005. The Water Supply Protection Area is a rectangular area bounded on the north by the former right-of-way of the Chicago and Northwestern Railroad; on the east by the section line running north-south between Sections 18 and 17, Town 16 North, Range 14 East; on the south by the line running east-west between the north and south halves of Section 18; and on the west by the line running north-south between the SE ¼ and SW ¼ of the NW ¼ of Section 18. A copy of this Ordinance is provided in Appendix B.

Process options for alternative water supply include municipal water, residential point-of-entry (POE) treatment systems, bottled water and relocating wells. In November 2002, a watermain from Ripon's water system was extended along South Koro Road up to and along Charles Street. The two homes with impacted wells (Altnau and Ehster) and three homes with non-impacted wells (Miller, Hadel and Wiese) were connected to this municipal water supply. Municipal water had also been offered at a reduced connection fee to the other residents on Charles Street. With the extension of municipal water to residences in the area of influence, POE treatment systems and well relocation are unnecessary for the long term and are therefore not carried forward as options. However, bottled water may be viable as an interim measure for a residence, prior to hook-up to the municipal system if their well became impacted.

The current groundwater monitoring program includes 3 private wells that are sampled on a quarterly basis for VOCs. An institutional control could include continued monitoring of residential water supply wells that are immediately downgradient of the groundwater contaminant plume, therefore this option is carried forward.

4.4.3 Groundwater Extraction, Treatment and Discharge

This general response action is used to reduce contaminant mass and the migration of impacted groundwater by hydraulic control. This general response action combines groundwater extraction with ex-situ treatment and discharge of the treated groundwater, but does not address the source of vinyl chloride within the landfill.

Groundwater Extraction

Groundwater extraction process options include extraction wells and horizontal trenches or drains. Groundwater extraction uses one or more pumps to draw contaminated groundwater to the surface for subsequent treatment. The extraction of groundwater forms a cone of depression in the water table or potentiometric surface providing hydraulic control of the contaminant plume. Because of the depth of contamination (150 to 300 feet deep), horizontal trenches and drains are impractical to construct and not cost effective, and were therefore not carried forward.

Groundwater Treatment

The types of processes for treatment of groundwater containing VOCs include physical/chemical and biological treatment. Physical/chemical treatment options include air stripping and carbon adsorption. Air stripping involves blowing a stream of ambient air through impacted groundwater which volatilizes the organic compounds, transferring the VOCs from the dissolved phase to the vapor phase. Carbon adsorption involves pumping extracted groundwater through a series of canisters containing granular activated carbon which adsorbs the dissolved organic contaminants. The primary contaminant of concern at the Site is vinyl chloride which is more effectively treated with air stripping than absorption, therefore carbon adsorption will not be carried forward.

Biological treatment includes both aerobic and anaerobic processes. In *ex-situ* biological treatment, processes, impacted groundwater is put into contact with microorganisms in biological reactors in which the microorganisms are either suspended or are attached to the reactor. In suspended systems, such as activated sludge, the groundwater is circulated in an aeration basin. In attached systems, such as trickling filters, microorganisms are established on an inert support matrix. This is a well-developed technology that has been used for many decades in the treatment of municipal wastewater. However, only in the last decade have bioreactors been used to clean up sites impacted with VOCs, typically those that can be destroyed by aerobic processes. This technology would be relatively difficult to implement at this Site because the low concentration of VOCs would not support an adequate microbial population density. In addition, the large quantity of impacted groundwater at this Site would require large bioreactors that would not be cost effective to construct or operate. Therefore, ex-situ biological treatment will not be carried forward.

Treated Groundwater Discharge

The process options for discharge of treated groundwater include direct discharge to surface waters, indirect discharge to surface water through the Ripon POTW, or discharge to groundwater through an infiltration gallery. The Ripon POTW may not be able to handle the increased volume; therefore this option is not carried forward. Discharge to an infiltration gallery allows treated water to percolate through the soil and recharge the underlying aquifer. Due to potential problems with clogging, cold weather maintenance, permitting and unsuitable surficial soils, this option will not be carried forward. Options for direct surface water discharge include the wetlands (300 feet southwest of the landfill) or Silver Creek (1500 feet southwest of the landfill). These options are carried forward for further consideration, but are feasible only if access to off-site properties can be obtained to install and maintain discharge lines.

4.4.4 In-Situ Groundwater Treatment

The types of processes for in-situ treatment of groundwater containing VOCs include physical/chemical, biological and natural attenuation.

Physical/Chemical Treatment

Physical/chemical in-situ treatment options include circulation wells, permeable reactive barriers and chemical oxidation. Circulation wells include a series of relatively large diameter (8” to 24”) wells with two screened intervals; the lower at the depth of the impacts and the upper located either at the surface of the water table or at the top of the impacted interval. An air injection riser is located within the well to supply compressed air to the lower screened interval. As air is injected into the lower screened interval, aerated water is lifted up the well and out of the upper screen. The loss of water from the upper screen forces additional groundwater to flow into the lower screen. This simultaneous extraction from the upper screen and injection through the lower screen establishes a circulation cell within the treatment zone, which can be quite large. Dissolved VOCs that enter the lower screen are transferred to the injected air stream through conventional stripping processes. The VOC-laden air is then either captured at the wellhead for subsequent treatment prior to atmospheric discharge or discharged without treatment. This is a proven technology to remediate vinyl chloride in groundwater and can be less costly than conventional extraction and treatment approaches and will be carried forward for additional evaluation..

A permeable reactive barrier (PRB) is a wall built below the surface to allow impacted groundwater to flow through it. Reactive materials are built into the wall to trap VOCs or to convert VOCs to harmless chemicals. Treated groundwater then flows through to the other side of the wall. Reactive treatment walls work best at sites with loose, sandy soil and a steady flow of groundwater. This is a proven technology and has the benefits of no above ground equipment to maintain. Reactive treatment walls need to span the width and depth of the plume unless a funnel and gate is installed: an impermeable wall funnels water to the PRB through a narrow opening). This technology would be very difficult to implement at the Site due to the depth of the plume, therefore it is not carried forward.

Chemical oxidation involves the injection into the subsurface of chemicals which have a high oxidizing potential to degrade the organic contamination to carbon dioxide and water. The technology has been used to treat chlorinated solvent constituents. The technology is typically applied for the treatment of a source area, and has only been applied to large-scale sites on a limited basis. Chemical oxidants include hydrogen peroxide, Fenton's reagent and permanganate. These oxidants are injected in a tight grid pattern throughout the area requiring treatment. Because of the very dilute concentrations of vinyl chloride, and the depth and size of the contaminant plume, chemical oxidation is not appropriate for this Site and is therefore not carried forward.

Biological Treatment

In-situ biological treatment options include enhanced bioremediation or bioaugmentation. Bioremediation is a process in which indigenous or inoculated microorganisms (i.e., fungi, bacteria, and other microbes) transform organic materials in groundwater. Enhanced bioremediation is a process that attempts to accelerate the natural biodegradation process by providing nutrients and electron donors (such as lactate, molasses or vegetable oil) whose absence or limited availability may otherwise be limiting the rate of conversion of organics to non-toxic end products. Bioaugmentation goes a step further and adds microorganisms that will degrade site contaminants to augment the indigenous bacteria. Enhanced/augmented bioremediation would be difficult to implement for the contaminants in the sandstone aquifer because of the depth and width of the plume but it may be applicable near the source in the shallow groundwater, therefore this alternative will be carried forward.

Natural Attenuation

Under the monitored natural attenuation (MNA) treatment option, natural subsurface processes such as dilution, volatilization, biodegradation, absorption, adsorption, and other chemical reactions with subsurface materials, degrade contaminants or limit their movement in the subsurface. Natural attenuation is not the same as "no action," although some perceive it as such. MNA requires an adequate, long-term monitoring program that confirms the natural attenuation processes are protecting public health, welfare and the environment until cleanup standards are met. Based on the results of sampling since 1993, it is apparent that the chlorinated solvent parent compound TCE is degrading anaerobically by reductive dechlorination to 1,2- DCE and vinyl chloride. Showing that MNA will adequately address the remaining vinyl chloride requires that conditions for anaerobic breakdown of vinyl chloride are present, and that the vinyl chloride plume is either stable or receding. The fact that vinyl chloride migrated to the location of the private homes on Charles Street in 2001 indicates that natural attenuation has not been sufficient by itself to prevent the migration of vinyl chloride from the Site. However, because natural attenuation is taking place, it may be appropriate to consider MNA as a viable remedy in conjunction with another technology. Therefore MNA will be carried forward for further consideration.

4.4.5 Landfill Gas Control

Landfill Gas Extraction

This general response action is used to control the movement of landfill gas and prevent its migration beyond the boundaries of the waste in excess of standards. This general response action, which includes active or passive gas extraction and, if necessary, ex-situ treatment of recovered gas, may also eliminate or reduce a contaminant transport mechanism. Landfill gas control was evaluated under the 1994 FS and passive gas control without treatment was selected as part of the remedy. However, as noted in Section 3.5, landfill gas at levels greater than 25% of the LEL are present more than 135 feet outside the limits of fill, indicating that the passive gas collection system is not sufficient to control the migration of landfill gas. A June 29, 2005 gas extraction pilot study report demonstrated that the existing gas venting system installed in the landfill may be adequate to control landfill gas if it is converted to an active system by installing a blower. In addition to controlling landfill gas (methane), a gas control system would also serve as a VOC source control remedy. Recent analyses of landfill gas samples show vinyl chloride is present in several landfill gas samples. This information supports the hypothesis that landfill gas may be the mechanism by which vinyl chloride is transported to groundwater at the Site. Therefore, active landfill gas extraction will be carried forward.

Landfill Gas Treatment

Section NR 419.07 WAC requires air emission controls for a landfill gas extraction system if VOC emissions exceed 216 pounds per day or if a source emits more than 300 pounds per year of vinyl chloride (see ch. NR 445, Table 3, Hazardous Air Contaminants without Acceptable Ambient Concentrations Requiring Application of LAER or BACT). During the pilot study, off gases from the extraction system were analyzed for VOCs, including vinyl chloride. Total VOCs (total hydrocarbons as gas) were approximately 11.5 ppmv, and vinyl chloride was found to be between 1.0 and 3.0 ppmv. Based on the results of the pilot test, if one assumes an extraction rate of about 100 cubic feet per minute and an average VOC emission rate of 11.5 ppmv, the estimated average emission rate for VOCs is 0.015 lb/hr, 0.36 lb/day, or 131 lb/year. For vinyl chloride at a concentration of 2.0 ppmv, the estimated average emission rate would be 0.002 lb/hr, 0.048 lb/day or 17.5 lb/year. Based on these calculations, air emission controls for VOCs or vinyl chloride are not expected to be required for long-term operation of an active gas extraction system. Therefore, landfill gas treatment is not carried forward.

5.0 DEVELOPMENT AND ANALYSIS OF REMEDIAL ALTERNATIVES

5.1 Introduction

This section presents a more detailed description and analysis of the remedial options selected for further evaluation as part of the initial screening presented in Section 4.0 of this FFS. The analysis assesses each remedial alternative against a set of evaluation criteria outlined in the National Contingency Plan (NCP). This approach provides information to the WDNR and U.S. EPA sufficient to compare the alternatives and select an appropriate remedy for the Site. Criteria for evaluating remedial alternatives and the description and screening of the alternatives are discussed below.

5.2 Evaluation Criteria

In accordance with Section 121 of CERCLA, nine criteria are used as the basis for analysis and evaluation of each of the remedial alternatives during the FFS. The first two criteria are threshold criteria:

- Compliance with ARARs
- Overall protection of human health and environment

A potential remedy must meet these criteria in order to undergo further consideration.

The next five criteria are primary balancing criteria and include the following:

- Short-term effects
- Long-term effectiveness and performance
- Reduction of toxicity, mobility, and volume of materials
- Implementability
- Cost

These are the primary criteria used to analyze and compare the alternatives.

The remaining two criteria are modifying considerations and include the following:

- State acceptance
- Community acceptance

The following describe the nine evaluation criteria used in the analysis of alternatives.

5.2.1 Compliance with ARARs

This criterion is used to determine how each alternative complies with applicable regulations. Potential ARARs for the FF/NN Landfill are listed on Table 2-2.

5.2.2 Overall Protection of Human Health and Environment

This evaluation criterion provides a final check to assess whether each alternative provides adequate protection of human health and the environment. The overall assessment of protection draws on the assessments conducted under other criteria, especially the primary criteria of long-term effectiveness and permanence and short-term effects, and compliance with ARARs.

Evaluation of the overall effectiveness of an alternative will focus on whether a specific alternative achieves adequate protection and will describe how site risks posed through each pathway addressed by the FFS are eliminated, reduced, or controlled through treatment, engineering or institutional controls.

5.2.3 Short-Term Effects

This evaluation criterion involves assessment of the effects of the alternative during construction and implementation. Items of concern are the protection of the community and the workers during implementation of remedial measures, potential adverse environmental impacts, and the time required to achieve remedial action objectives.

5.2.4 Long-Term Effectiveness and Permanence

This evaluation criterion involves consideration of the risks that remain after the Site has been cleaned to acceptable levels as indicated in the remedial action objectives. Items of concern are the presence of any receptors near the Site, magnitude of the remaining risk from untreated waste or treatment residuals, adequacy of controls that are used to manage treatment residuals or untreated waste, and reliability of these controls.

5.2.5 Reduction of Toxicity, Mobility, and Volume of Materials

Consideration of this evaluation criterion is a result of statutory preference for selecting remedial actions that permanently and significantly reduce the toxicity, mobility, and volume of the materials and associated media.

The following factors are considered in this evaluation:

- The treatment process and materials they will treat.
- The amount of materials that will be treated.
- The degree of reduction in toxicity, mobility, or volume expected.
- The degree to which treatment will be irreversible.
- The type and quantity of materials that remain after remediation.

5.2.6 Implementability

This criterion considers the technical and administrative feasibility of implementing an alternative. Technical aspects evaluated for each alternative include construction and operation activities, reliability of the technologies involved, ease of undertaking additional remedial action, and monitoring after completion of activities. Administrative concerns include the need to obtain approvals from appropriate agencies to implement remedial actions (e.g., obtaining permits for construction and operation of a treatment unit). Other factors that must be considered when evaluating implementability of an alternative include availability of materials and equipment needed.

5.2.7 Cost

A remedial cleanup program must be implemented and operated in a cost-effective manner. In considering the cost-effectiveness of the various alternatives, the following categories are evaluated:

- *Capital Costs.* These costs include direct (construction) and indirect (non-construction and overhead) costs. Direct costs include expenditures for equipment, labor, and materials necessary to install remedial actions. Indirect costs are those that may be incurred for engineering, permitting, financial, or other services and that are necessary for completion of the activity but are not directly the result of the installation of remedial systems.

- *Operations and Maintenance (O&M) Costs.* These are post-construction costs incurred to ensure effective implementation of the alternative. Such costs may include, but are not limited to charges for maintenance materials, labor for operating and maintenance, energy, disposal of residues, administration, insurance, and licensing. The O&M costs include monitoring associated with measuring the effectiveness of remedial activities. Cost items may include sampling labor, laboratory analyses, and report preparation.

The capital and O&M costs for each alternative are prepared to provide an accuracy of -50 to +30%. The present-worth value method (2005 dollars basis) is utilized to evaluate the total cost of implementing a remedial alternative. The present-worth was calculated based on a project life of 10 to 30 years (depending on the alternative) and a 5 percent discount rate.

5.2.8 State Review

Implementation of the preferred alternative will be evaluated after WDNR reviews the FFS.

5.2.9 Community Comments

Community comments regarding the preferred alternative will be evaluated after the public comment period.

5.3 Description and Evaluation of Remedial Alternatives

Based on the retained process options, eight remedial alternatives have been selected as appropriate for the Site:

- Alternative A – No Action
- Alternative B – Institutional Controls with Connection to Municipal Water
- Alternative C1 and C2 – Source Control via Active Landfill Gas Extraction
- Alternative C3 – Source Control via Shallow Groundwater Extraction/Treatment

- Alternative C4 – Source Control via Shallow Bioaugmentation System
- Alternative D1 – Deep Aquifer Remediation via Circulation Wells
- Alternative D2 – Deep Aquifer Remediation via Groundwater Extraction/Treatment
- Alternative D3 – Deep Aquifer Remediation via Monitored Natural Attenuation in Conjunction with Source Control (Alternative C)

There is a current monitoring program for the FF/NN Landfill and such a program is required under the existing ROD. The required monitoring includes inspection of the landfill cap and sampling and analysis of groundwater monitoring wells, private water supply wells and leachate wells. Monitoring of gas probes is not part of the ROD but has been voluntarily undertaken by the PRPs. Continued monitoring is included as a component of all of the alternatives including the No Action alternative. Each of these alternatives will be described in greater detail below.

5.3.1 Alternative A - No Action

5.3.1.1 Description

Under the No Action alternative, the current monitoring program would continue but no additional remedial measures would be implemented. However, it is expected that the nature and scope of monitoring requirements may be reduced with prior WDNR approval. The No Action alternative is also included because it is the baseline for evaluating other remedial alternatives.

5.3.1.2 Detailed Evaluation

Compliance with ARARs: Implementation of the No Action alternative will not directly address impacted groundwater, and concentrations of vinyl chloride would likely remain above NR 140 standards in the sandstone aquifer for an extended period of time (15 to 30 years). Continued monitoring will show whether the vinyl chloride plume is stable, expanding or contracting.

Overall Protection of Human Health and the Environment: The No Action alternative may not reduce exposure or health risks. While natural attenuation is occurring at the Site, the rate of attenuation was too low to prevent migration of vinyl chloride to the Alnau and Ehster private water supply wells. Therefore, the potential risk of impact to residential wells downgradient from the Site may exist for an extended period of time.

Short-Term Effects: There are no potential short term effects from this alternative.

Long-Term Effectiveness and Permanence: This criterion is intended to evaluate the effectiveness of a remedial action relative to the risks that would remain after remedial action objectives have been achieved. Since the No Action alternative does not include active remedial measures, it is likely that the risks presented at the Site will remain for an extended period of time.

Reduction of Toxicity, Mobility, or Volume: The No Action alternative includes no active remedial or treatment elements for groundwater impacts detected at the Site. Vinyl chloride will be destroyed or diluted only by passive, natural processes. Toxicity and mobility of the dissolved materials will change over time, as vinyl chloride continues to degrade and its concentration is diluted. However, degradation sufficient to meet groundwater standards is not expected to occur for an extended period of time.

Implementability: The No Action alternative, which includes continued groundwater monitoring, can be readily implemented.

Cost: The present worth of the project (2005 dollars basis) was calculated based on a project life of 30 years and a 5 percent discount rate. The costs associated with this alternative include continued implementation of the current monitoring program, for which there are no capital costs but annual O&M costs estimated to be $35,000 per year, for a total present worth of $538,000.

5.3.2 Alternative B – Institutional Controls with Connection to Municipal Water

5.3.2.1 Description

The Institutional Controls alternative includes continuation of the monitoring program and institutional actions that reduce the potential for exposure to untreated groundwater. Existing institutional controls include the WDNR "Special Well Casing Pipe Depth Area" and the Town of Ripon "Water Supply Protection Area" Ordinance which control or prevent the installation of private water supply wells in areas potentially impacted by the VOC plume from the Site.

The institutional control of municipal water supply for the potentially affected area has also been partially implemented. In November 2002, the FF/NN Landfill PRP Group paid for the extension of Alliant public water service from the intersection of Highway 23 and South Koro Road to the western end of Charles Street. The PRP Group has since connected five residences (Altnau, Ehster, Hadel, Miller and Wiese) to the public water supply. The cost of these activities, borne entirely by the PRP group (except in the case of Miller), was approximately $250,000. At that time, the water utility was owned by Alliant Energy Company; the water utility was purchased by the City of Ripon in July 2005.

The major elements of this alternative include:

- Groundwater monitoring program;
- Connection of all remaining homes on Charles Street (Banek, Gaastra) and the Rhode residence, to the existing water main;
- Extending the water main 800 feet along the east-west portion of South Koro Road (old Highway 23);
- Connection of all remaining (nine) homes on South Koro Road to the new water main; and
- Abandonment of existing private drinking water wells.

The layout of the municipal water supply extension and connections of homes is portrayed on Figure 5-1. This figure also shows the Water Supply Protection Area in the Town of Ripon Ordinance.

Future water usage costs will be borne by each individual homeowner and the existing institutional controls require all new homes in the Water Supply Protection Area to connect to the public water supply with the costs and charges for extending City water to be resolved between the City of Ripon and the property owner under an assessment process approved by the Wisconsin Public Service Commission. Under the process, the cost of connection varies with the age of the system. Therefore, costs for connecting new homes to public water supply are not included in this cost estimate.

5.3.2.2 Detailed Evaluation

Compliance with ARARs: The institutional controls with extension of public water alternative provides for the monitoring of groundwater in existing monitoring wells. Continued monitoring will show whether the vinyl chloride plume is stable, expanding or contracting. Under this alternative, concentrations may remain above the NR140 standards for vinyl chloride for an extended period of time (15 to 30 years).

Overall Protection of Human Health and the Environment: The extension of the public water supply to all residents on Charles Street and South Koro Road provides overall protection of human health and the environment by preventing the use of impacted groundwater. Groundwater monitoring would continue in order to demonstrate that vinyl chloride is not continuing to migrate in groundwater.

Short-Term Effects: This alternative can be completed quickly, as evidenced by the extension of the water main that was completed in November 2002. Because vinyl chloride impacts are located at least 150 feet below the depth of any public water system, construction would not expose workers during construction activities.

Long-Term Effectiveness and Permanence: This criterion addresses the results of remedial action in terms of the risk remaining at the Site after response objectives have been met. Providing public water is considered a permanent remedy as noted in the March 8, 1990 Federal Register (Appendix C).

This alternative will achieve remedial objectives at the Site for source control and groundwater only after an extended period of time and exclusively through natural processes.

Reduction of Toxicity, Mobility, and Volume through Treatment: Extension of the public water supply provides no active treatment process for groundwater. As a result, vinyl chloride will continue to be remediated by passive, natural processes. Toxicity and mobility of the vinyl chloride are not changed by the extension of the water main. Further, the overall volume of affected groundwater may increase if the plume expands beyond its current extent.

Implementability: This alternative involves standard construction and plumbing activities, and is readily implementable.

Cost: Table 5-1 presents a detailed cost analysis for Alternative B. The present worth of the project (2005 dollars basis) was calculated based on a project life of 30 years and a 5 percent discount rate. In summary, capital costs were estimated to be $123,000 and annual O&M costs were estimated to be $34,000 per year, for a total present worth of $646,000. Note that the annual O&M cost for this alternative is slightly less than other alternatives because private water supply wells no longer need to be sampled.

5.3.3 Alternatives C1 and C2– Source Control via Active Landfill Gas Extraction

5.3.3.1 Description

Active gas collection was originally evaluated in the 1994 FS for the site. It is considered again in this FFS as a potential means to reduce the quantity of methane and VOCs escaping from the landfill and contaminating groundwater. If the source of the vinyl chloride in the groundwater is from the landfill gas, then the landfill gas extraction system should be effective in preventing the continued transport of vinyl chloride to the groundwater.

Recent monitoring has determined that vinyl chloride is present in landfill gas. The May 2005 pilot study for the landfill gas extraction system did demonstrate that a vacuum placed on the existing passive vent system did reduce concentrations of landfill gas (methane and VOCs) outside of the fill area. Based on the off-site methane levels as well as the vinyl chloride in the gas, full-scale implementation of an interim landfill gas extraction system is planned for the Site. The interim system is expected to be installed in 2005, with evaluation of a permanent system to be prepared and submitted to the WDNR by the end of 2006.

Alternative C1 would include a blower connected to the existing passive gas venting system. The header piping in a permanent system would be buried for freeze protection but would not extend below the existing geomembrane liner. In either the interim or permanent system a tank will be installed to collect moisture that condenses during system operation. The groundwater and gas monitoring program would also be continued as part of either alternative. A layout for Alternative C1 is provided on Figure 5-2.

Alternative C2 would include new vertical gas extraction wells into the landfill. It would also include the same mechanical equipment as Alternative C1. A layout for Alternative C2 is shown on Figure 5-3.

Operation of the interim action gas extraction system will indicate whether use of the passive vent system (equivalent to Alternative C1) is sufficient to improve groundwater quality, and whether it is necessary to continue active gas extraction or install vertical extraction wells (Alternative C2).

Alternatives C1 and C2 include continued groundwater monitoring, as well as the existing institutional controls that have already been implemented.

5.3.3.2 Detailed Evaluation

Compliance with ARARs: Alternatives C1 and C2 would meet the landfill gas control requirements of ch. NR506. This alternative would reduce or eliminate the transport of vinyl chloride into the groundwater in the future. With the source of vinyl chloride cut off, the remaining groundwater that has already been impacted with vinyl chloride would naturally attenuate. Continued monitoring will show whether the vinyl chloride plume is stable, expanding or contracting. Under this alternative, contaminant concentrations in the sandstone aquifer will remain above the NR140 standards for vinyl chloride for some period of time (15 to 30 years).

Overall Protection of Human Health and the Environment: The WDNR prepared a 1991 study entitled, "The Role of Active Gas Extraction Systems in Capturing VOCs from Municipal Landfill Waste and Leachate: A Preliminary Assessment." This study evaluated the VOCs found in leachate at two landfills and in groundwater at two landfills not constructed with a clay or membrane liner. Each of these sites was a recently closed landfill cell where VOC contamination of groundwater was present. The study of the two landfills with VOCs in groundwater found that the concentrations of VOCs decreased with the implementation of an active gas extraction system. However, the initial concentrations of VOCs in the groundwater at these two sites were much higher than the concentrations that are now observed at the Ripon site, and VOCs remained in groundwater above WDNR standards after installing these systems. This WDNR study indicates that installation of an active gas extraction system may reduce vinyl chloride concentrations in groundwater. If the source of the vinyl chloride and other VOCs in the groundwater is from the landfill gas, then the landfill gas extraction system should be effective in preventing the continued transport of vinyl chloride to the groundwater.

An active gas extraction system is expected to be protective of human health and the environment over the long term as it will reduce or eliminate the source of vinyl chloride impacts in the groundwater. Because it apparently took 18 to 30 years for the vinyl chloride plume in the sandstone aquifer to reach its current extent, NR140 PALs are not expected to be met for at least 15 years.

Short Term Effects: For Alternative C1, there would be no significant exposure of construction workers or the public to contaminants. The construction of vertical gas extraction wells for Alternative C2 would have a potential to expose workers to contaminants and the public to odors. This potential exposure would be for a limited period of time (a few days), and workers exposure would be limited by the use of personal protective equipment. The installation of extraction wells and the treatment system should not release a significant amount of vinyl chloride to the environment. Disposal of all generated wastes will follow proper handling practices and therefore should not have adverse impacts to the environment.

Alternative C2 will require that four new gas extraction wells will penetrate the existing composite cap on the landfill. This will require excavating to the membrane liner and cutting a hole in it to drill the well. Precipitation during well construction could enter the landfill, resulting in possible leachate generation if stormwater management controls are not implemented during construction.

Long Term Effectiveness and Permanence: The long term effectiveness of an active gas extraction system is that it prevents the migration of methane beyond the boundaries of the landfill and reduces the potential for groundwater to be impacted with VOCs, especially vinyl chloride. Active gas extraction will be required until the landfill is no longer generating a significant amount of methane.

Reduction of Toxicity, Mobility or Volume through Treatment: The LFG extraction system would remove LFG from the landfill and reduce the introduction of VOCs, particularly vinyl chloride in groundwater. The LFG system will not, however, reduce the toxicity, mobility or volume of contaminants already in groundwater. Treatment of the extracted gases is not required because the emissions will be below the NR445 threshold for vinyl chloride. As indicated in section 4.4.5, a landfill gas extraction system will remove about 17.5 pounds of vinyl chloride annually from the subsurface.

Implementability: The FF/NN Landfill PRP Group is currently planning to implement an interim active gas extraction system. This alternative is readily implementable.

Cost: There are two cost options for proceeding with this alternative. The first, Alternative C1, utilizes the existing passive gas vent system as the gas collection and routing system; it is shown on Table 5-2. The second, C2 includes installing new gas extraction wells as part of the extraction system; it is shown on Table 5-3.

The capital cost for Alternative C1 includes construction of a subsurface piping system and blower, and is $135,000. The annual O&M cost of this alternative, including gas monitoring, is $56,500. Because the landfill has already been closed for nearly 20 years, and gas generation rates decrease over time, it is assumed that these activities, except monitoring, would be conducted a 10 year period. The annual cost also assumes 30 years of groundwater monitoring. The present worth associated with Alternative C1 is estimated to be $839,000.

The capital cost for Alternative C2 includes construction of the four active LFG extraction wells, a subsurface piping system and blower, and is estimated to be $186,000. The annual cost of this alternative includes gas monitoring, system O&M for 10 years, and groundwater monitoring for 30 years. Annual O&M costs are estimated to be $61,600. The present worth associated with Alternative C2 is estimated to be $928,000.

Most of the capital costs related to alternatives C1 and C2 will be spent in implementing the interim active gas collection system. As a result, the additional cost of implementing either of these alternatives is less than the cost estimates given above.

5.3.4 Alternative C3 – Source Control via Shallow Groundwater Extraction and Treatment

5.3.4.1 Description

Shallow groundwater extraction was originally evaluated in the 1994 FS for the Site and that evaluation is included in Appendix D. The purpose of a shallow groundwater extraction system would be to remove VOCs from the groundwater near the source area, thereby preventing the continued transport of contaminants into the deeper groundwater aquifer.

An extraction system would consist of two wells located along the south boundary of the landfill and completed to a depth of 30 feet below the water table. Each well would operate at a pumping rate of 10 gallons per minute. Extracted groundwater would be treated with an air stripping treatment system.

The 1994 FS included four options for the discharge of treated water:

- To the wetland located west of Koro Road;
- To Silver Creek, about 1,500 feet south of the Site;
- To an infiltration gallery; and
- To the Ripon Publicly Owned Treatment Works (POTW).

The options of discharging water to an infiltration gallery or to the Ripon POTW were determined to be not viable in Section 4 of this FFS.

A WPDES permit would be required to discharge to the wetland or to Silver Creek, and would require extensive monitoring for flow and chemical constituents. An additional flow of 30,000 gallon per day would be a significant increase to the flow of Silver Creek, and could affect the ecology of the creek, and increase erosion of its banks. The oxidation and resulting precipitation of the high concentrations of iron and manganese in groundwater may also have a deleterious effect on surface waters. A hydrologic evaluation would be required for discharge to either the wetland or the creek.

For the purposes of evaluating alternative C3, discharge to the nearby wetland has been selected as the means of water disposal because it is the nearest location for discharge. Alternative C3 includes continued groundwater monitoring, as well as the existing institutional controls that have already been implemented.

5.3.4.2 Detailed Evaluation

The detailed evaluation for this alternative is included in Appendix D. Revisions and/or updates to that evaluation are provided below.

Compliance with ARARs: This alternative would reduce the potential for vinyl chloride to impact groundwater in the future, but would not remediate groundwater that has already been impacted with vinyl chloride, or address the source of vinyl chloride in landfill gas. Continued monitoring will show whether the vinyl chloride plume is stable, expanding or contracting. Under this alternative, concentrations of vinyl chloride will remain above the NR140 standards in the sandstone aquifer for an extended period of time (15 to 30 years).

Overall Protection of Human Health and the Environment: A shallow groundwater extraction and treatment system is protective of human health and the environment over the long term to the extent it reduces or eliminates the source of vinyl chloride impacts in the groundwater. The system will provide hydraulic control. Because it apparently took 18 to 30 years for the vinyl chloride plume to reach its current extent, vinyl chloride concentrations in the sandstone aquifer are expected to remain above NR140 standards for an extended period of time (15 to 30 years).

Short Term Effects: There is a limited potential for exposure of construction workers to VOCs during construction. This potential can be adequately addressed through the use of personal protective equipment. The installation of wells and the treatment system will not release a significant amount of vinyl chloride to the environment. Disposal of all wastes will follow proper handling practices and therefore should not have adverse impacts to the environment.

Long Term Effectiveness and Permanence: The long term effectiveness of a shallow groundwater pumping and treatment system is that it removes groundwater impacts, thereby preventing the continued migration of contaminants in the groundwater, but does not address the source of vinyl chloride in the landfill gas.

Reduction of Toxicity, Mobility or Volume through Treatment: As indicated in the 1994 FS (see page 26 of Section 6 in Appendix D), many pore volumes of groundwater must be removed in order to extract the contaminants from the aquifer matrix. As a result, pumping could be needed for many years to remove the vinyl chloride from the shallow aquifer. About 0.9 pounds per year of vinyl chloride would be removed from shallow groundwater by pumping 30,000 gallons per day containing 10 ppb vinyl chloride.

Implementability: This alternative involves the installation of two groundwater extraction wells, and one of four methods of treatment and discharge. As indicated above, there are potential constraints on implementing either of the means of discharging the treated groundwater. At the minimum, further environmental studies would be needed for discharge to the wetland or Silver Creek. These studies may indicate that discharge to the wetland or creek is not feasible.

Cost: Table 5-4 presents a detailed cost analysis for Alternative C3. The present worth of the project was calculated based on a project life of 30 years and a 5 percent discount rate. In summary, capital costs were estimated to be $231,000 and annual O & M costs were estimated to be $103,800, for a total present worth of $1,827,000.

5.3.5 Alternative C4 – Source Control via Shallow Biobarrier System

5.3.5.1 Description

This alternative includes establishing a zone of enhanced biodegradation that will take to completion the naturally occurring process of dechlorination that is already active at the Site by converting vinyl chloride (and TCE and 1,2-DCE) to ethene. The biobarrier would be established in the shallow groundwater near the source area, to remove higher level VOC concentrations and thereby prevent the continued transport of contaminants into the deeper groundwater aquifer.

This alternative includes direct push drilling techniques to inject an electron donor and, if needed, halorespiring bacteria to create a biobarrier along the southwest boundary of the Site. An initial pilot test area approximately 100 feet long and upgradient of MW-112 would be implemented first. If the process is effective the barrier could be extended north and east along the landfill boundary. The barrier would be approximately 400-500 feet long and extend 30 feet below the water table (i.e., about 70 feet deep). Geoprobe injections would be applied at an interval of 15 feet.

The electron donor used would be an emulsified vegetable oil supplied by EOS Remediation, Inc. (EOS). EOS is primarily emulsified soybean oil with approximately 4 percent sodium lactate by volume and has the consistency of milk. Since the product has soybean oil and lactate it acts as both a slow and a quick release electron donor, respectively. The product is initially water soluble so that it can migrate downgradient with the groundwater where it is adsorbed by the soil and builds up the biobarrier wall's thickness. The soybean oil is more reduced than lactate and its breakdown in the subsurface provides many more electron equivalents per pound (154) than lactate (45).

Following the addition of the electron donor, wells within the biobarrier would be monitored for general geochemical parameters and VOCs. It is possible that the donor addition alone may be sufficient to push the degradation of vinyl chloride to completion. If not, a halorespiring bacterial culture, such as KB-1, would be injected to augment the indigenous bacteria.

Depending on the longevity of the electron donor and the transport of VOCs into the biobarrier, maintenance injections of electron donor may be required after 3-5 years. Given the current concentration and decreasing trend in VOCs at MW-112 only one maintenance injection is presumed to be necessary; actual site conditions would indicate whether more than one injection in required.

Alternative C4 includes continued groundwater monitoring, as well as the existing institutional controls that have already been implemented.

5.3.5.2 Detailed Evaluation

Compliance with ARARs: This alternative would prevent the migration of vinyl chloride impacted groundwater from the Site in the future, but would not remediate groundwater that has already been impacted with vinyl chloride. Continued monitoring will show whether the vinyl chloride plume is stable, expanding or contracting. Even under this alternative, concentrations will remain above the NR140 standards for vinyl chloride for an extended period of time (15 to 30 years).

Overall Protection of Human Health and the Environment: A shallow biobarrier is protective of human health and the environment over the long term as it will prevent the future migration of vinyl chloride impacts in the groundwater. Because it apparently took 18 to 30 years for the vinyl chloride plume to reach its current extent, vinyl chloride concentrations in the sandstone aquifer are expected to remain above NR140 standards for an extended period of time (15 to 30 years).

Short Term Effects: There is a limited potential for exposure of construction workers to VOCs during construction. This potential can be adequately addressed through the use of personal protective equipment.

Long Term Effectiveness and Permanence: The long term effectiveness of a shallow biobarrier is that it removes groundwater impacts near their source, thereby preventing the continued migration of VOC contaminants from the landfill. As indicated above, it is possible that emulsified oil may need to be re-injected one or more times if the original materials are consumed and VOCs continue to be released from the landfill.

Reduction of Toxicity, Mobility or Volume through Treatment: A biobarrier would permanently treat the contaminants that come in contact with it, breaking them down into non-hazardous compounds. For contaminants that have already migrated from the landfill, natural attenuation processes would continue.

Implementability: Injection would be done using a GeoProbe-type direct push method. This methodology may not be able to consistently inject materials to a depth of 70 feet in sand and gravel. Therefore, hollow-stem augers could be used instead of a GeoProbe, increasing the cost of implementation.

Cost: Table 5-5 presents a detailed cost analysis for Alternative C4. The present worth of the project was calculated based on a project life of 30 years and a 5 percent discount rate. In summary, capital costs were estimated to be $132,000 and annual O & M costs were estimated to be $50,000 per year, for a total present worth of $785,000.

5.3.6 Alternative D1 – Deep Aquifer Remediation via Circulation Wells

5.3.6.1 Description

The objective of this alternative is to implement migration control through in-situ treatment using groundwater circulation wells (GCWs). This alternative focuses on stripping vinyl chloride from the groundwater in-situ.

In-well air stripping is generally accomplished through the installation and operation of GCWs. A GCW includes a relatively large diameter (typically 16") well with two screened intervals; one located at the depth of the impacted interval and one located either at the surface of the water table or at the top of the impacted interval. An air injection riser is located within the well to supply compressed air to the lower screened interval. As air is injected into the lower screened interval, aerated water is lifted up the well and out of the upper screen. The loss of water from the upper screen forces additional groundwater to flow into the lower screen. This simultaneous extraction from the upper screen and injection through the lower screen establishes a circulation cell within the treatment zone, which can have a radius of as much as 100 feet. Dissolved VOCs that enter the lower screen are transferred to the injected air stream through conventional stripping processes. The VOC-laden air can be captured, if necessary, at the wellhead for subsequent treatment prior to atmospheric discharge

To complete the evaluation of this alternative, certain engineering design basis elements were estimated based on the current level of understanding of Site hydrogeologic properties. Further field investigation and data evaluation would be necessary to finalize design basis elements.

According to publications of US EPA's Superfund Innovative Technology Program, GCWs have shown an effective radius of influence of 30 to 100 feet. For purposes of this evaluation, a radius of influence of 50 feet was assumed. Therefore, six groundwater circulation wells, located along the bike path north of Charles Street would be necessary to capture and treat impacted groundwater. For estimation purposes, each well will be constructed of eight-inch diameter PVC casing with two ten-foot screened sections at depths of 160 and 200 feet. A bentonite seal will separate the screened intervals. An eductor made of four-inch diameter PVC casing will be placed inside the eight-inch diameter casing using an inflatable packer. One-inch diameter PVC drop tube will be installed inside the eductor to supply air for lifting groundwater for recirculation and in-situ air stripping. A diagram of a typical groundwater circulation well is shown in Figure 5-3.

Air at a flow rate of 50 scfm will be supplied by a compressor to the base of the wells. The reduced density of the air-water mixture will cause water to rise inside the inner casing. In-situ stripping occurs as volatile compounds transfer from the dissolved phase to the vapor phase. The water discharges to the outer casing and then to the upper portions of the aquifer to be drawn back into the lower screened interval, creating a recirculation cell. The recirculation allows for multiple passes of the impacted groundwater through the in-well air stripper in order to provide sufficient mass removal. Vapors are drawn off of the outer casing. Because of the low concentrations of vinyl chloride present in the groundwater, less than one pound per year of vinyl chloride vapors will be emitted from all six wells. Therefore, no treatment will be necessary for vapors. Alternative D1 includes continued groundwater monitoring, as well as the existing institutional controls that have already been implemented.

5.3.6.2 Detailed Evaluation

Compliance with ARARs: This alternative provides for the in-situ treatment of the impacted groundwater. Once the impacted groundwater passes through the groundwater circulation well network, the groundwater is expected to comply with the ARARs. This alternative will require an extended period of time (15 to 30 years) for groundwater in the sandstone aquifer that is already impacted to achieve NR140 PALS. Because this alternative does not address the continuing source of VOCs at the landfill, the operation of the circulation wells would likely be required beyond 30 years.

Overall Protection of Human Health and the Environment: The GCW alternative provides overall protection of human health and the environment by preventing the migration of vinyl chloride past the circulation well network.

In-well air stripping has been demonstrated to be an effective method for eliminating volatile compounds from groundwater. However, GCWs have only been demonstrated at sites with significantly higher concentrations of VOCs than are present at the FF/NN Landfill, and have been effective at reducing those higher VOC concentrations. Their effectiveness at low parts-per-billion concentrations has not been demonstrated. Experience has shown that aquifer matrix anisotropy (the ratio of the horizontal to the vertical hydraulic conductivity) between 3 to 10 results in the most effective applications of GCWs. (The anisotropy of the sandstone aquifer at this site has not been determined). High dissolved iron and manganese concentrations can cause frequent and costly maintenance of these systems. Sampling results from private wells south of the bike path have indicated high iron and manganese concentrations.

Short-Term Effects: There is a limited potential for exposure of construction workers to VOCs during construction. This potential can be adequately addressed through the use of personal protective equipment. The installation of wells and the treatment system should not release a significant amount of vinyl chloride to the environment. Disposal of all wastes will follow proper handling practices and therefore should not have adverse impacts to the environment.

Long-Term Effectiveness and Permanence: The use of the GCWs to promote in-well stripping in Alternative D1 provides a permanent method for treating the materials of concern in the groundwater but does not address the vinyl chloride source in the landfill gas. Monitoring of wells will continue during the implementation of this alternative. It is possible that the treatment scenario will be modified during the course of this program. The plume of groundwater already impacted with vinyl chloride is expected to eventually be remediated to meet the NR140 standards, but this alternative does not prevent additional groundwater from being contaminated at the landfill. The effectiveness of this treatment method is also compromised by the presence of zones of lower permeability within the bedrock or soil matrix.

Reduction of Toxicity, Mobility, and Volume through Treatment: This alternative provides an in-situ treatment system designed to remove materials of concern from groundwater at the Site. The zone of capture of the GCWs will contain the plume and reduce the mobility of vinyl chloride in the groundwater medium. The total mass of vinyl chloride in the deep aquifer is estimated to be only about 2.3 pounds (see section 3.3). This alternative would be expected to remove some fraction of this on an annual basis. Treating the groundwater should reduce the concentrations of materials in the extracted water (and therefore, its toxicity) to levels that are protective of human health and the environment.

Implementability: This alternative involves installation of groundwater circulation wells, and an air delivery system. While this is a relatively new technology, all of this equipment is available and this alternative is implementable.

Cost: Table 5-6 presents a detailed cost analysis for Alternative D1. The present worth was calculated based on a project life of 30 years of GCW operation and 30 years of groundwater monitoring at a 5 percent discount rate. Capital costs were estimated to be $771,000 and annual O & M costs were estimated to be $85,000 per year, for a total present worth of $2,077,000. While the cost estimate is based on a project life of 30 years, this alternative may be required to operate more than 30 years because the continuing source of contaminants in groundwater is not addressed.

5.3.7 Alternative D2 – Deep Aquifer Remediation via Groundwater Extraction and Treatment

5.3.7.1 Description

Groundwater extraction wells would be installed in the contaminant plume, upgradient of the homes on Charles Street and near the downgradient extent of the deep aquifer plume. The purpose of these wells would be to remove contaminants from the deep aquifer and to prevent continued migration of the plume front.

Two groundwater extraction wells would be installed in the vicinity of Charles Street and screened in Layer 3, which is the layer in which the vinyl chloride is primarily traveling and in which private drinking water wells are screened. In the proposed pumping location near Charles Street, Layer 3 is a confined aquifer that is overlain by a wedge of clay that thickens to the south. In order to withdraw water from the portion of the aquifer used for drinking water supply, the extraction wells would be screened from approximately 160 feet to 200 feet bgs. The extraction rate would be 20 gpm for each well. Because of the greater overall flow rate of 40 gpm, it is unlikely that the water could be discharged to the nearby wetland. The pumped groundwater would be treated by air stripping and discharged to the other water discharge option discussed for Alternative C3. For purposes of evaluating this alternative, it is assumed that the water can be discharged to Silver Creek.

A two-dimensional groundwater modeling program, WinFlow™, was used to determine the pumping rate, radius of influence and depth and spacing of well(s) required to capture the plume at this location. This program assumes that groundwater flow is horizontal and occurs in an infinite aquifer, and hydraulic conductivity is isotropic and homogeneous. Further discussion of the model and its assumptions is found in Appendix E. The input variables of hydraulic conductivity and horizontal gradient for Layer 3 wells were used for this model. Appendix E contains the input variables and an output map showing the extraction wells and radius of influence. The results of the modeling indicate that the extraction wells are capable of creating a capture zone sufficient to remove contaminant mass from the deep aquifer and prevent contaminant migration.

Alternative D2 includes continued groundwater monitoring, as well as the existing institutional controls that have already been implemented.

5.3.7.2 Detailed Evaluation

Compliance with ARARs: Pumping and treating groundwater will eventually meet the remedial action objective of complying with the groundwater standards of NR 140. This alternative will require an extended period of time (15 to 30 years) for groundwater in the sandstone aquifer that is already impacted to achieve NR140 PALS. Because this alternative does not address the continuing source of VOCs at the landfill, the operation of the extraction wells would likely be required beyond 30 years.

Overall Protection of Human Health and the Environment: Extraction technologies are effective in removing impacted groundwater from the subsurface. However, they are limited in their ability to remove very low concentrations of contaminants, such as the low part-per-billion levels of vinyl chloride present at the Site. As a result, the primary benefit of pumping would be to act as a hydraulic control, rather than as a means of removing low concentrations of vinyl chloride. Pumping groundwater would provide an effective means of preventing the downgradient migration of vinyl chloride-impacted groundwater, but would not address the vinyl chloride source in the landfill gas.

This alternative is projected to achieve groundwater remedial objectives. However, the quantity of contaminated groundwater is estimated to be about 13.5 million gallons (600 feet wide by 1500 feet long by 40 feet thick, with matrix porosity of 0.10). Therefore, two pumps each operating at 20 gpm would require nearly eight months to remove one pore volume of impacted groundwater. Multiple pore volumes are typically necessary to remove contaminants from the aquifer (relevant literature provide estimates of 10 to 20 pore volumes). The total mass of vinyl chloride in the deep aquifer is estimated to be only about 2.3 pounds (section 3.3). This alternative would remove some fraction of this (probably about 10%) on an annual basis. Therefore, this alternative would provide hydraulic control of groundwater contamination within a short time frame, but achieving NR 140 groundwater standards will require an extended period (15 to 30 years).

Short-Term Effects: There is a limited potential for exposure of construction workers to VOCs during construction. This potential can be adequately addressed through the use of personal protective equipment. The installation of wells and the treatment system would not release a significant amount of vinyl chloride to the environment. Disposal of all wastes will follow proper handling practices and therefore would not have adverse impacts to the environment. Monitoring during start-up and operation of the treatment system will ensure that the remedial activities are effective in meeting all discharge criteria.

Long-Term Effectiveness and Permanence: This criterion addresses the results of remedial action in terms of the risk remaining at the Site after response objectives have been met. While this alternative addresses groundwater in the sandstone aquifer that has already been impacted with vinyl chloride, it does not include control of vinyl chloride in the landfill gas. As a result, pumping of deep groundwater may be needed for an extended period of time.

Reduction of Toxicity, Mobility, and Volume through Treatment: This alternative provides a system designed to extract and treat materials of concern in groundwater at the Site. It does reduce the toxicity, mobility and volume of contaminated groundwater. However, the total mass of vinyl chloride removed from the aquifer will be about 0.8 pounds per year, assuming that 20,000,000 gallons per year would be pumped with an average vinyl chloride concentration of 5 ppb.

Implementability: This alternative involves the installation of a groundwater extraction well, and one of four methods of treatment and discharge. Discharge of treated groundwater was previously discussed for Alternative C3; Alternative D2 will generate about twice as much water as Alternative C3, or about 58,000 gallons per day. As a result, this quantity of flow will be even more difficult to dispose than for Alternative C3. The flow rate may be too great for discharge to the wetland, Silver Creek or the Ripon POTW. At the minimum, further environmental studies would be needed for discharge to the wetland or Silver Creek. These studies may indicate that discharge to the wetland or creek is not feasible. In addition, discharge to an infiltration gallery would be subject to clogging, particularly because of the high iron and manganese content of the water in the deep aquifer.

Cost: Table 5-7 presents costs for Alternative D2, assuming discharge to Silver Creek. The present worth was calculated based on a project life of 30 years of pumping and groundwater monitoring, and a 5 percent discount rate. In summary, capital costs were estimated to be $285,000 and annual O & M costs were estimated to be $103,800 per year, for a total present worth of $1,881,000. While the cost estimate is based on a project life of 30 years, this alternative may be required to operate more than 30 years because the continuing source of contaminants in groundwater is not addressed.

5.3.8 Alternative D3 – Deep Aquifer Remediation via Monitored Natural Attenuation with Source Control (Alternative C)

5.3.8.1 Description

Based on the results of sampling since 1993, it is apparent that the chlorinated solvent parent compound TCE is degrading anaerobically by reductive dechlorination to 1,2-DCE and vinyl chloride. Even though natural degradation has been occurring, it has not been sufficient to prevent the migration of some vinyl chloride. However, if the source of vinyl chloride to groundwater is eliminated or significantly reduced by a source control alternative (C1, C2, C3 or C4), the deep aquifer plume will remain stable or shrink as a result of natural attenuation of the residual vinyl chloride. This alternative would consist of groundwater monitoring to determine if natural attenuation is occurring and resulting in a stable or shrinking plume.

5.3.8.2 Detailed Evaluation

Compliance with ARARs: This alternative would prevent the migration of vinyl chloride impacted groundwater from the landfill in the future, but would not remediate groundwater that has already been impacted with vinyl chloride. Continued monitoring will show whether the vinyl chloride plume is stable, expanding or contracting. Under this alternative, concentrations will remain above the NR140 standards for vinyl chloride for an extended period of time (15 to 30 years).

Overall Protection of Human Health and the Environment: Monitored Natural Attenuation coupled with a source control alternative is protective of human health and the environment over the long term as it will reduce or eliminate the source of vinyl chloride impacts in the groundwater. Because it apparently took 18 to 30 years for the vinyl chloride plume to reach its current extent, any improvement in groundwater quality at its leading edge may not occur for 15 to 30 years.

Short Term Effects: Short term effects would be limited, and would be the result of the source control option that is implemented.

Long Term Effectiveness and Permanence: The long term effectiveness of a source control action is that it prevents or reduces the potential for groundwater impacts near their source, thereby preventing the continued migration of contaminants from the landfill. This alternative will achieve remedial objectives at the Site for groundwater only after an extended period of time and exclusively through natural processes.

Reduction of Toxicity, Mobility or Volume through Treatment: The source control action (Alternative C1, C2, C3, or C4) would reduce the possibility that the landfill is a source of vinyl chloride in groundwater. Vinyl chloride will continue to be remediated by passive, natural processes in the groundwater that has already been impacted.

Implementability: The implementability of this alternative is only limited by the implementability of the source control alternatives, C1 through C4. Each of these can be readily implemented, except for C3; this alternative may be difficult to implement because of the need to discharge significant volumes of water that is pumped.

Cost: Table 5-8 presents a detailed cost analysis for Alternative D3. The present worth of the project was calculated based on 10 years of operating the active gas system and 30 years of groundwater monitoring and a 5 percent discount rate. For cost estimating purposes, Alternative C2, Active Gas Extraction with New Vertical Extraction Wells was used as the source control alternative; this source control alternative was included merely because it was the more costly of the two gas control alternatives. In summary, capital costs were estimated to be $151,000 and annual O & M costs were estimated to be $58,100 per year, for a total present worth of $868,000.

6.0 ALTERNATIVE REMEDIAL STRATEGY – COMPARATIVE ANALYSIS OF ALTERNATIVES

Table 6-1 provides a comparative analysis of the nine remedial alternatives evaluated against seven CERCLA criteria. As noted previously, the final two criteria (dealing with state and public comments) will be evaluated after this FFS has been reviewed by these parties. A brief comparison of these alternatives indicates:

- All of the alternatives will require an extended period of time (greater than 15 years) to achieve NR140 PALs.

- Alternative B (Institutional Controls with Connection to Municipal Water Supply) addresses human health issues but relies on natural processes to attenuate impacted groundwater to reach groundwater objectives.

- Alternatives C1 and C2 (active gas extraction) would effectively address off-site landfill gas migration. This alternative's ability to reduce vinyl chloride in groundwater under the landfill will be verified through operation of an interim action active landfill gas extraction system. These alternatives will also remove the greatest mass of vinyl chloride per year from the subsurface.

- Alternatives C1, C2 and D3 would be expected to remove about 17.5 pounds of vinyl chloride from the subsurface on an annual basis. Alternatives C3, D1 and D2 would each remove less than 1.0 pound of vinyl chloride. The remaining alternatives would not directly remove vinyl chloride from the subsurface, but would rely on natural attenuation to remove this compound from groundwater.

- Alternatives C3 (Shallow Groundwater Extraction), D1 (Groundwater Circulation Wells) and D2 (Deep Groundwater Extraction/Treatment) are all similar in cost, and the most costly alternatives. The present worth of each of these is between $1.8 and $1.9 million.

- Alternatives C3 (Shallow Groundwater Extraction) and C4 (Shallow Biobarrier) would be redundant and unnecessary if an active gas collection system is implemented at the Site.

- Alternatives D1 (Groundwater Circulation Wells) and D2 (Deep Groundwater Extraction /Treatment) would eventually treat groundwater that has already been impacted with vinyl chloride. These alternatives do not address the continuing source of vinyl chloride from the landfill, however, and their operation would be needed for a very long period of time unless a source control alternative is also implemented.

- Alternative D3 (Monitored Natural Attenuation with Source Control) reduces or eliminates the source of vinyl chloride to the groundwater while monitoring the continued attenuation of vinyl chloride in groundwater that has been impacted.

7.0 REFERENCES

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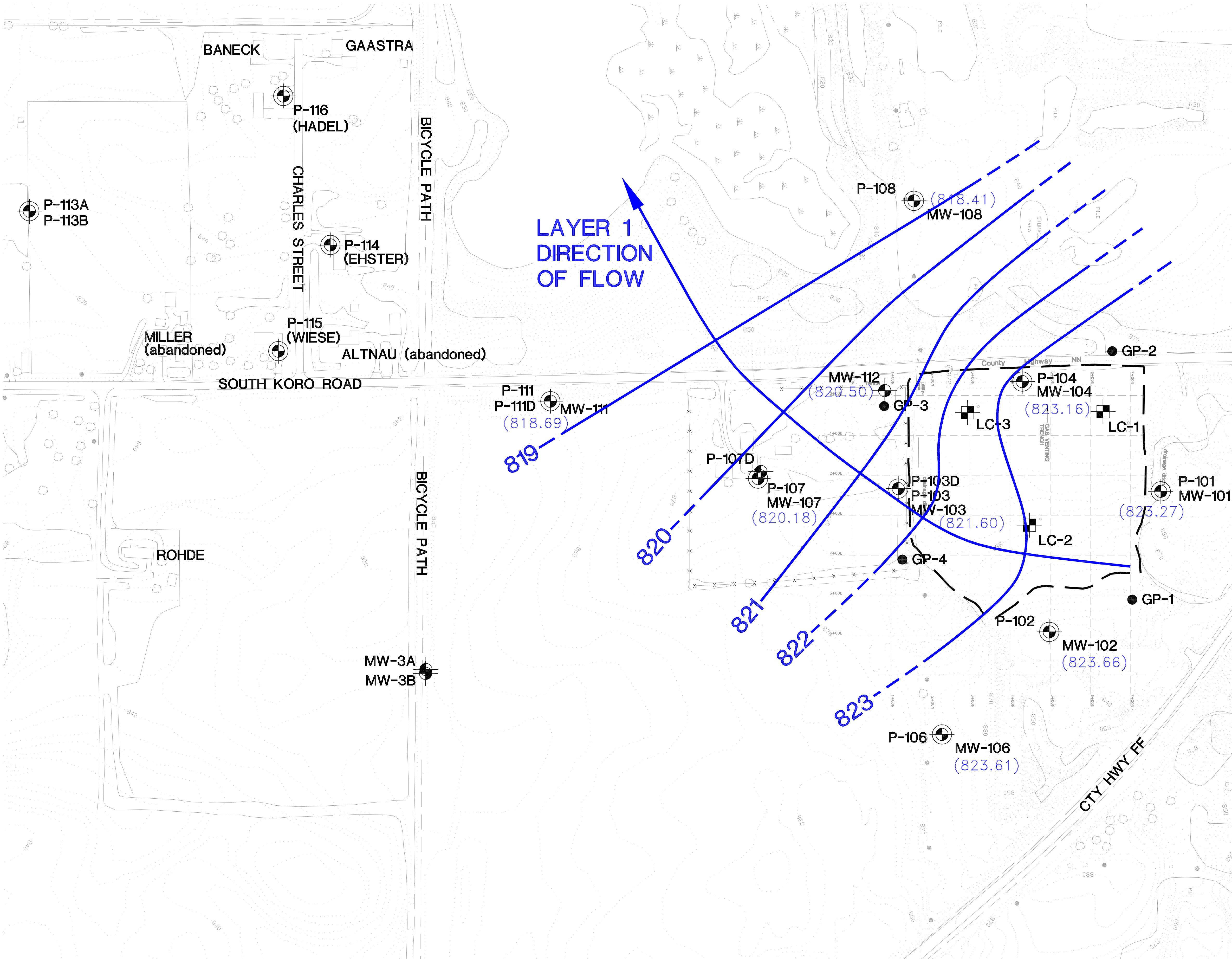
FIGURES



EXPLANATION

P-104 / MW-104	MONITOR WELL, PIEZOMETER LOCATION, DESIGNATION
LC-2	LEACHATE HEAD WELL LOCATION, DESIGNATION
— — —	OUTLINE OF CLOSED LANDFILL
● GP-1	GAS PROBE LOCATION AND DESIGNATION
(823.27)	GROUNDWATER ELEVATION

N

SCALE

0 500

Feet

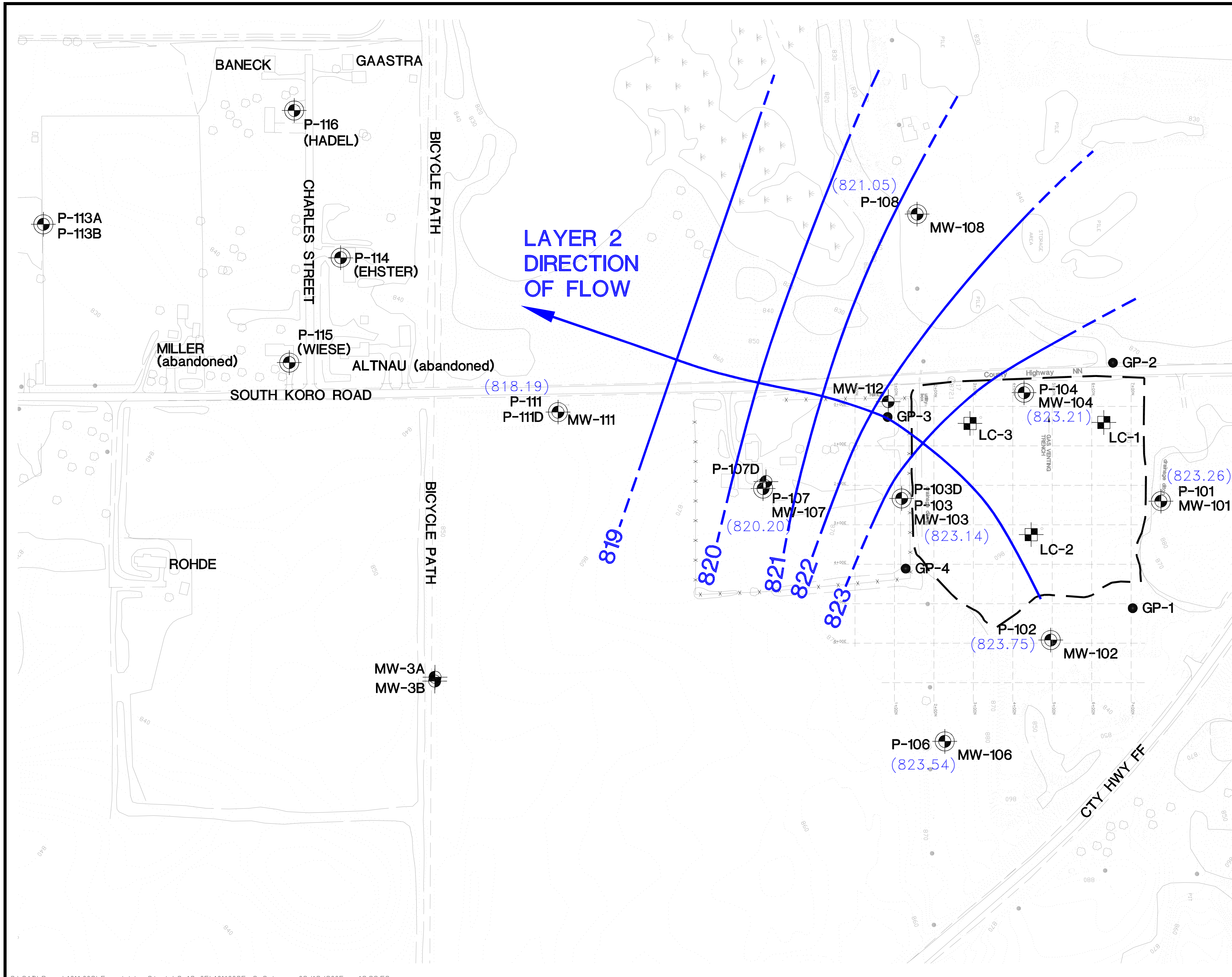
FF/NN LANDFILL
RIPON, WISCONSIN

GROUNDWATER ELEVATIONS
LAYER 1 WELLS
APRIL 2005

DATE:	6/1/05
DESIGNED:	GLD
CHECKED:	GLD
APPROVED:	GLD
DRAWN:	HJW
PROJ.:	1011.002

GeoTrans, Inc.
A TETRA TECH COMPANY

Figure 3-1



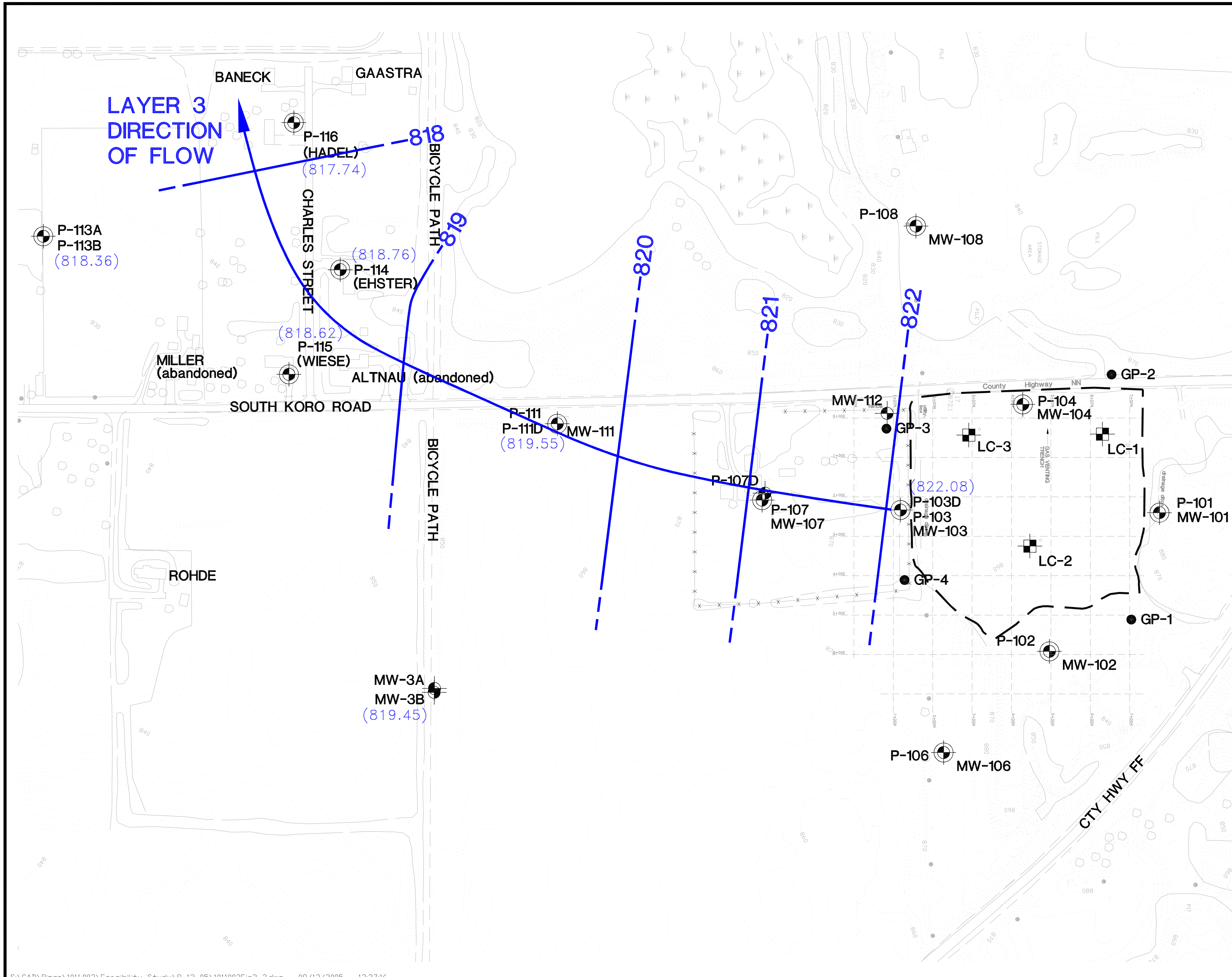
FF/NN LANDFILL
RIPON, WISCONSIN

GROUNDWATER ELEVATIONS
LAYER 2 WELLS
APRIL 2005

DATE:	6/1/05
DESIGNED:	GLD
CHECKED:	GLD
APPROVED:	GLD
DRAWN:	HJW
PROJ.:	1011.002

GeoTrans, Inc. A TETRA TECH COMPANY

Figure 3-2



EXPLANATION

- P-104 / MW-104 — MONITOR WELL, PIEZOMETER LOCATION, DESIGNATION
- LC-2 — LEACHATE HEAD WELL LOCATION, DESIGNATION
- — — — OUTLINE OF CLOSED LANDFILL
- ● GP-1 — GAS PROBE LOCATION AND DESIGNATION
- (822.08) — GROUNDWATER ELEVATION

N

SCALE

0 500

Feet

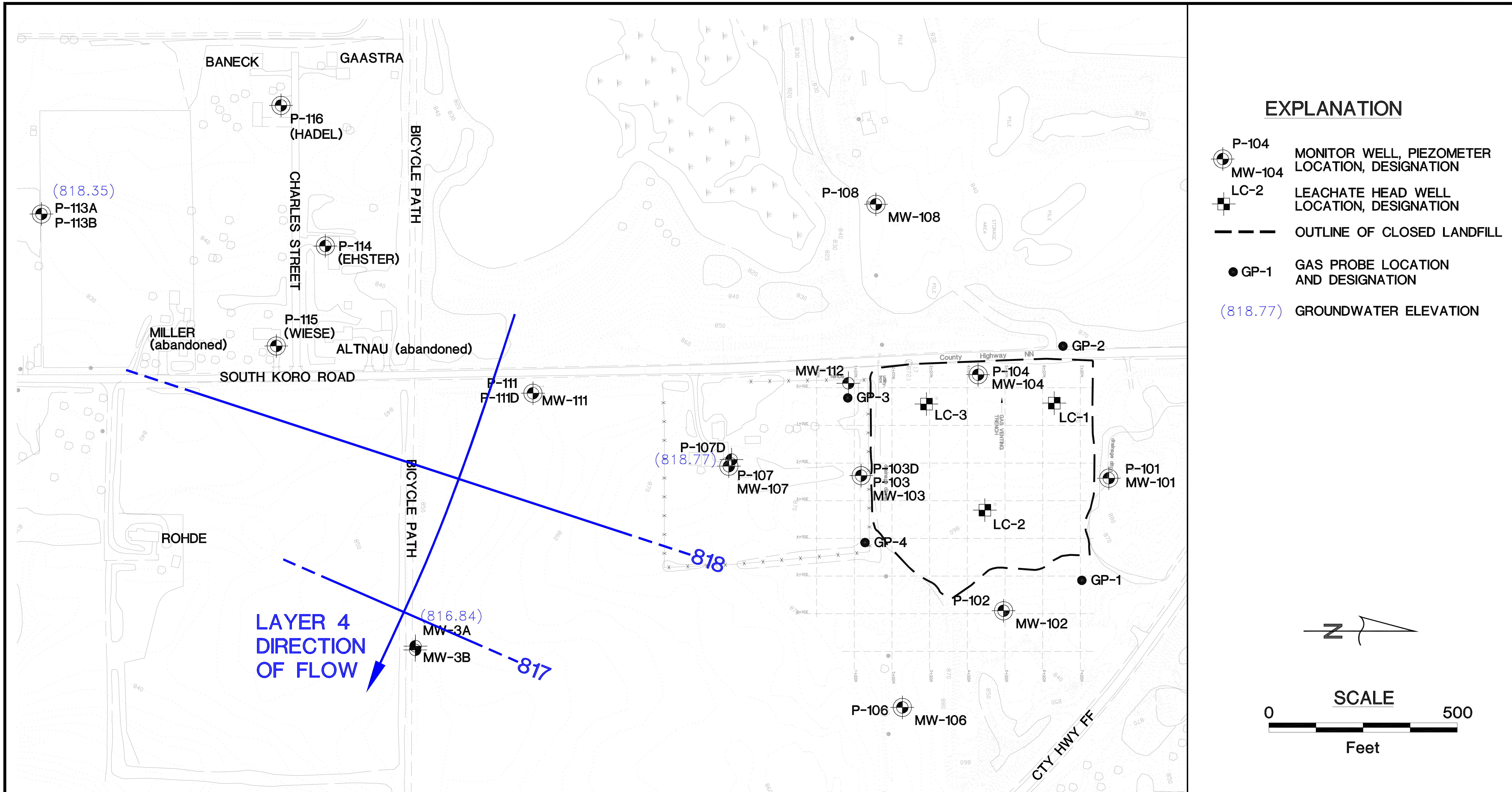
FF/NN LANDFILL
RIPON, WISCONSIN

GROUNDWATER ELEVATIONS
LAYER 3 WELLS
APRIL 2005

DATE:	6/1/05
DESIGNED:	GLD
CHECKED:	GLD
APPROVED:	GLD
DRAWN:	HJW
PROJ.:	1011.002

GeoTrans, Inc. A TETRA TECH COMPANY

Figure 3-3



FF/NN LANDFILL
RIPON, WISCONSIN

GROUNDWATER ELEVATIONS
LAYER 4 WELLS
APRIL 2005

DATE:	6/1/05
DESIGNED:	GLD
CHECKED:	GLD
APPROVED:	GLD
DRAWN:	HJW
PROJ.:	1011.002

GeoTrans, Inc.
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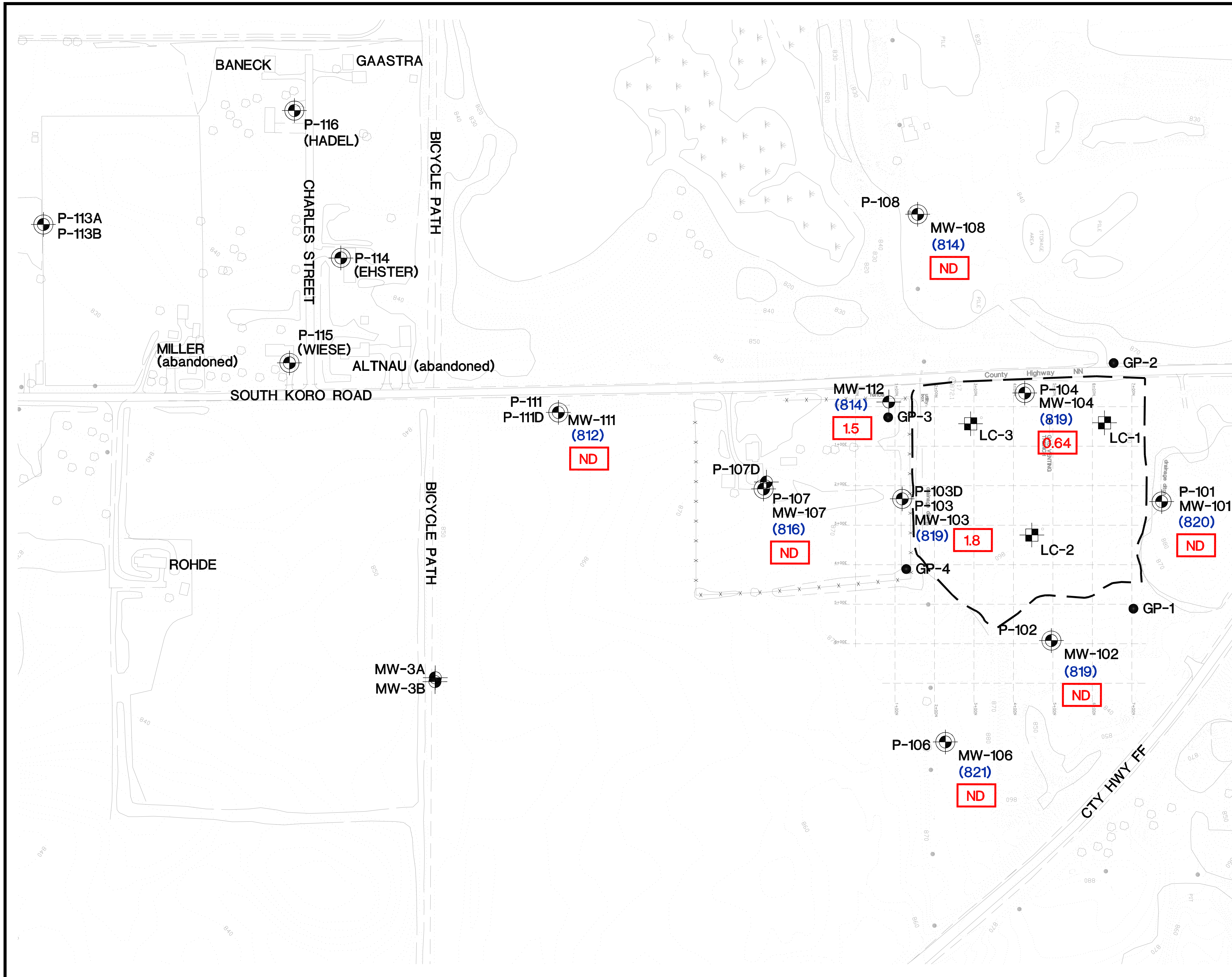
Figure 3-4



EXPLANATION

P-104 / MW-104	MONITOR WELL, PIEZOMETER LOCATION, DESIGNATION
LC-2	LEACHATE HEAD WELL LOCATION, DESIGNATION
— — —	OUTLINE OF CLOSED LANDFILL
● GP-1	GAS PROBE LOCATION AND DESIGNATION
(820)	ELEVATION OF BOTTOM OF WELL
0.64	VINYL CHLORIDE CONCENTRATIONS (ppb)
ND	NOT DETECTED

NOTES:

1. MW-111 LAST SAMPLED OCTOBER 2004.
2. MW-103, MW-104, AND MW-107 LAST SAMPLED APRIL 2005.

N

SCALE

0 500

Feet

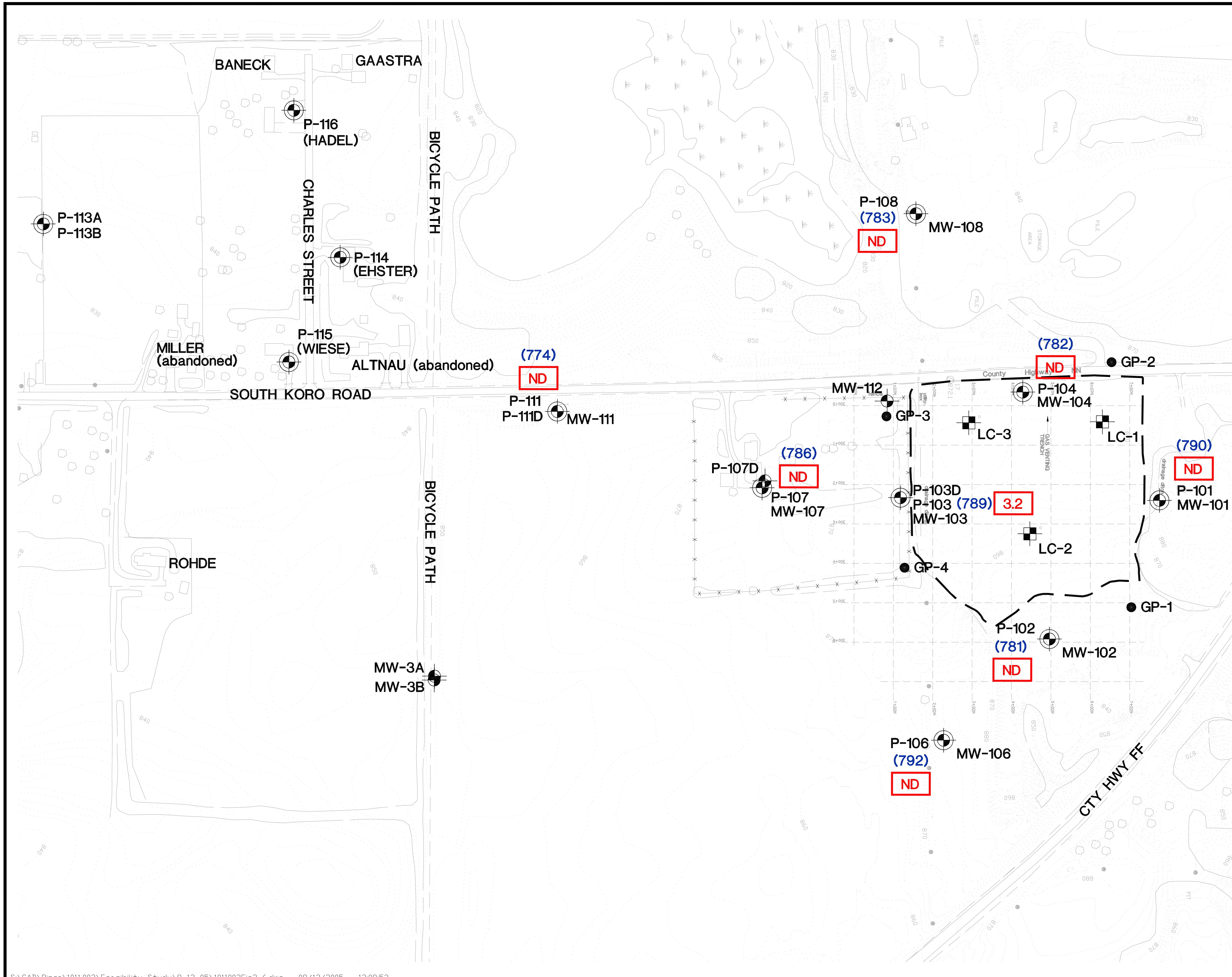
FF/NN LANDFILL
RIPON, WISCONSIN

VINYL CHLORIDE CONCENTRATIONS
LAYER 1 WELLS
JULY 2005

DATE: 9/13/05
DESIGNED: GLD
CHECKED: GLD
APPROVED: GLD
DRAWN: HJW
PROJ.: 1011.002

GeoTrans, Inc. A TETRA TECH COMPANY

Figure 3-5



EXPLANATION

P-104 / MW-104 — MONITOR WELL, PIEZOMETER LOCATION, DESIGNATION

LC-2 — LEACHATE HEAD WELL LOCATION, DESIGNATION

— — — OUTLINE OF CLOSED LANDFILL

● GP-1 — GAS PROBE LOCATION AND DESIGNATION

(789) — ELEVATION OF BOTTOM OF WELL

2.4 — VINYL CHLORIDE CONCENTRATIONS (ppb)

ND — NOT DETECTED

NOTES:

1. P-108 LAST SAMPLED JANUARY 2005.
2. P-101, P-106, AND P-107 LAST SAMPLED APRIL 2005.

N

SCALE

0 — 500

Feet

S:\CAD\Ripon\1011.002\Feasibility Study\9-13-05\1011002Fig3-6.dwg 09/13/2005 13:09:52

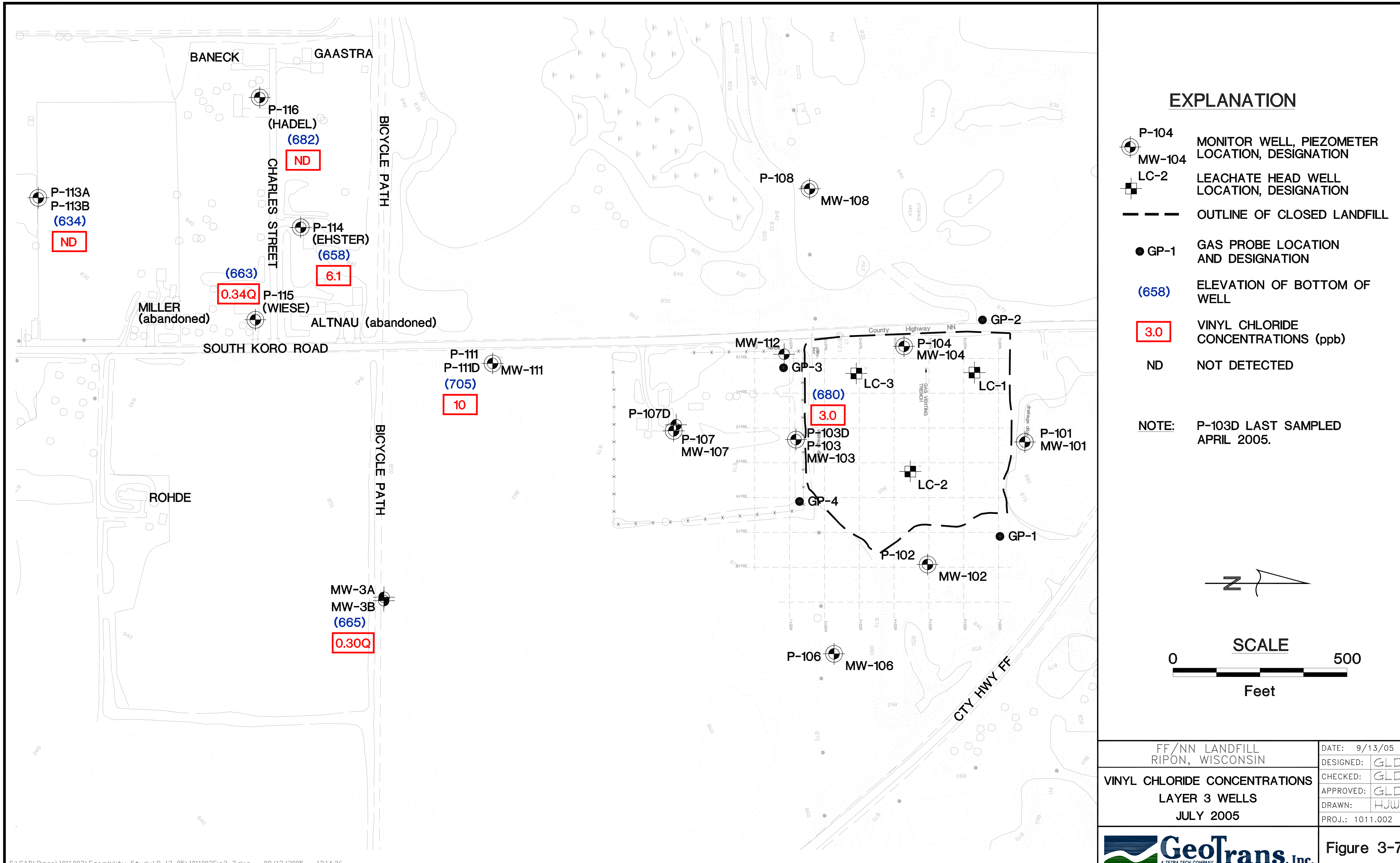
FF/NN LANDFILL
RIPON, WISCONSIN

VINYL CHLORIDE CONCENTRATIONS
LAYER 2 WELLS
JULY 2005

DATE:	9/13/05
DESIGNED:	GLD
CHECKED:	GLD
APPROVED:	GLD
DRAWN:	HJW
PROJ.:	1011.002

GeoTrans, Inc. A TETRA TECH COMPANY

Figure 3-6



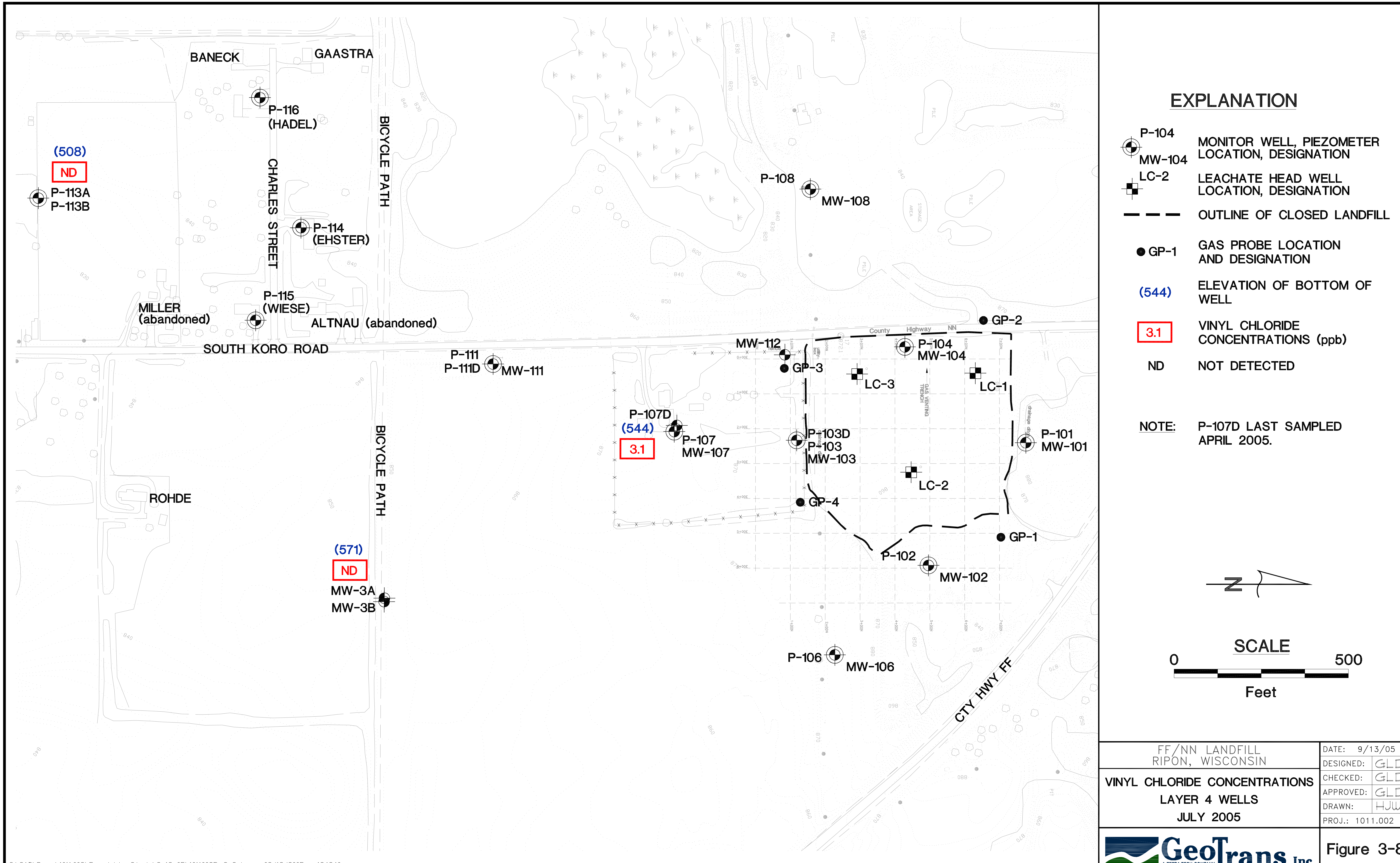
FF/NN LANDFILL
RIPON, WISCONSIN

VINYL CHLORIDE CONCENTRATIONS
LAYER 3 WELLS
JULY 2005

DATE: 9/13/05
DESIGNED: GLD
CHECKED: GLD
APPROVED: GLD
DRAWN: HJW
PROJ.: 1011.002

GeoTrans, Inc. A TETRA TECH COMPANY

Figure 3-7



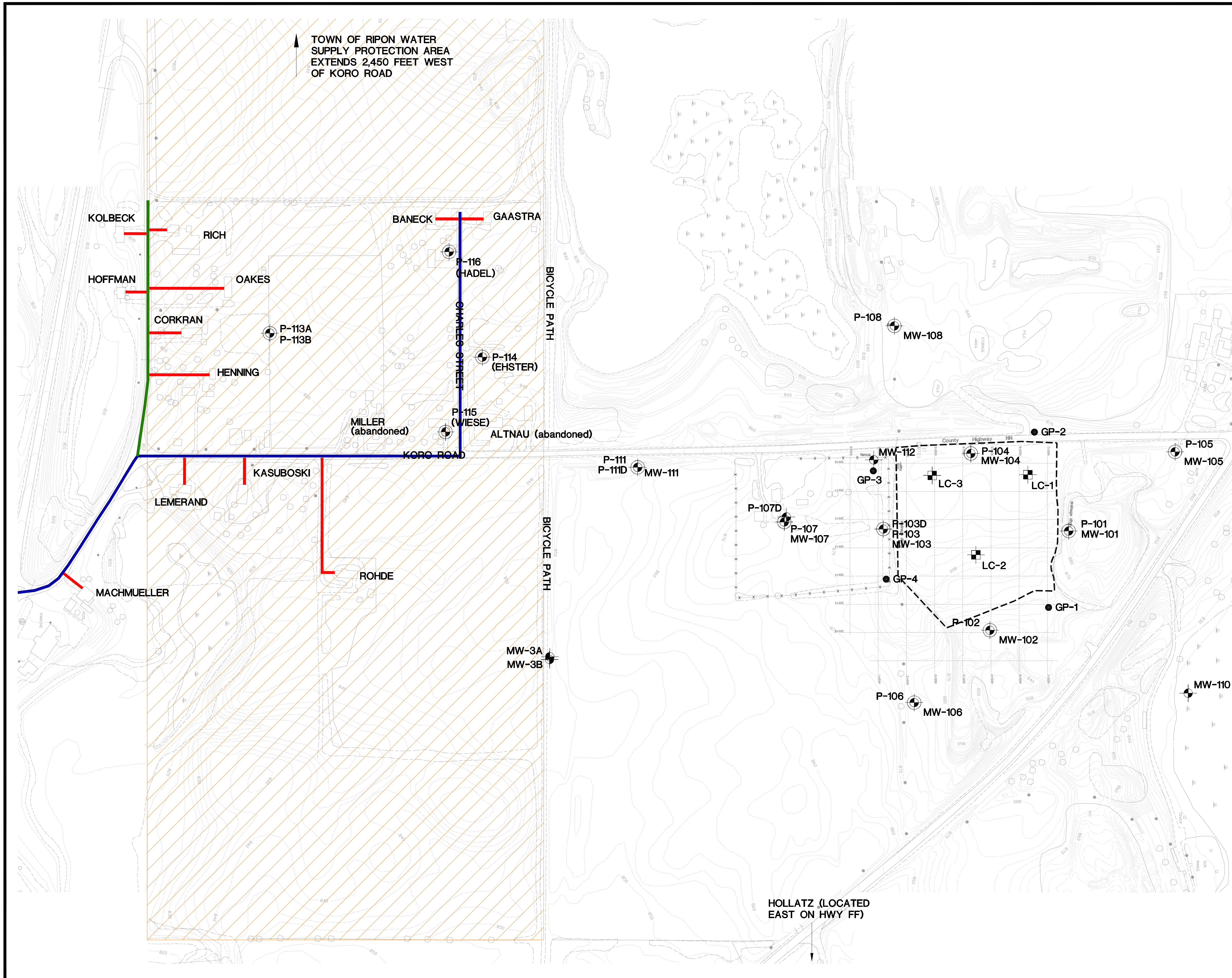
FF/NN LANDFILL
RIPON, WISCONSIN

VINYL CHLORIDE CONCENTRATIONS
LAYER 4 WELLS
JULY 2005

DATE:	9/13/05
DESIGNED:	GLD
CHECKED:	GLD
APPROVED:	GLD
DRAWN:	HJW
PROJ.:	1011.002

GeoTrans, Inc. A TETRA TECH COMPANY

Figure 3-8



EXPLANATION

P-104 / MW-104	MONITOR WELL, PIEZOMETER LOCATION, DESIGNATION
LC-2	LEACHATE HEAD WELL LOCATION, DESIGNATION
— — —	OUTLINE OF CLOSED LANDFILL
● GP-1	GAS PROBE LOCATION AND DESIGNATION
(blue line)	EXISTING WATER MAIN
(green line)	WATER MAIN EXTENSION
(red line)	SERVICE LATERALS TO HOMES
(hatched area)	TOWN OF RIPON WATER SUPPLY PROTECTION AREA

N

SCALE

0 700

Feet

RIPON FF/NN LANDFILL
RIPON, WISCONSIN

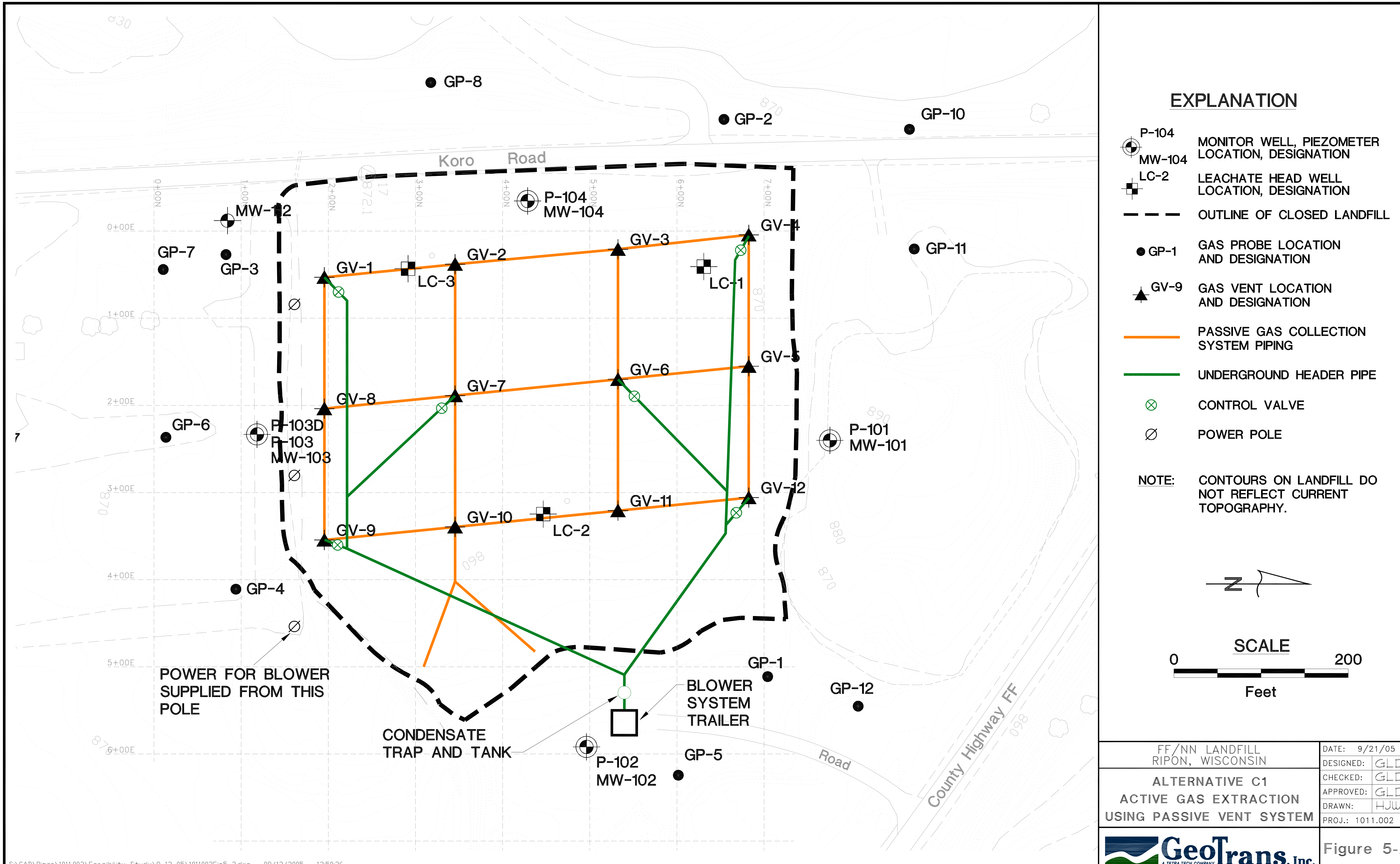
ALTERNATIVE B
EXTENSION OF
MUNICIPAL WATER

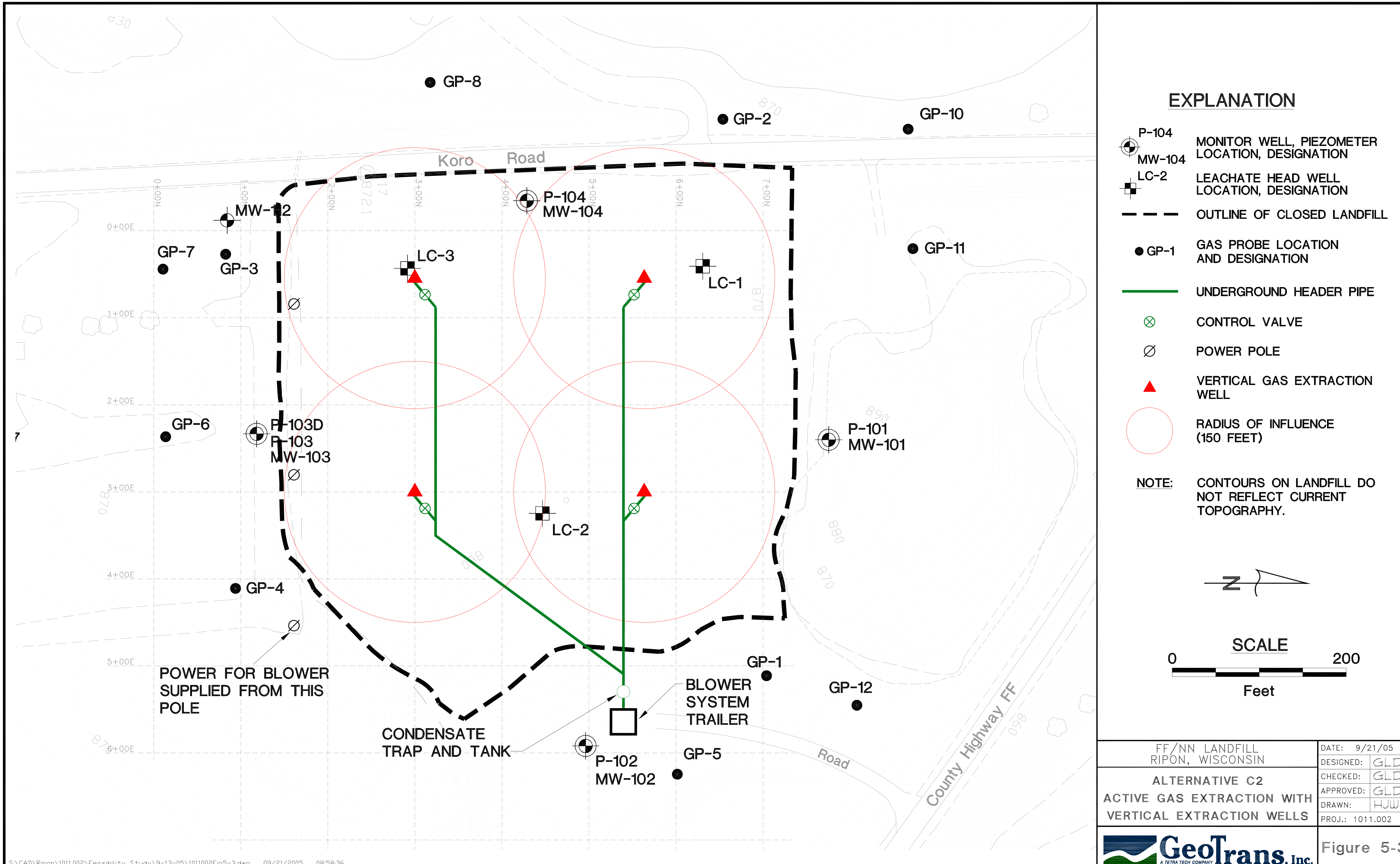
DATE:	8/31/05
DESIGNED:	GLD
CHECKED:	GLD
APPROVED:	GLD
DRAWN:	HJW
PROJ.:	1011.002

GeoTrans, Inc. A TETRA TECH COMPANY

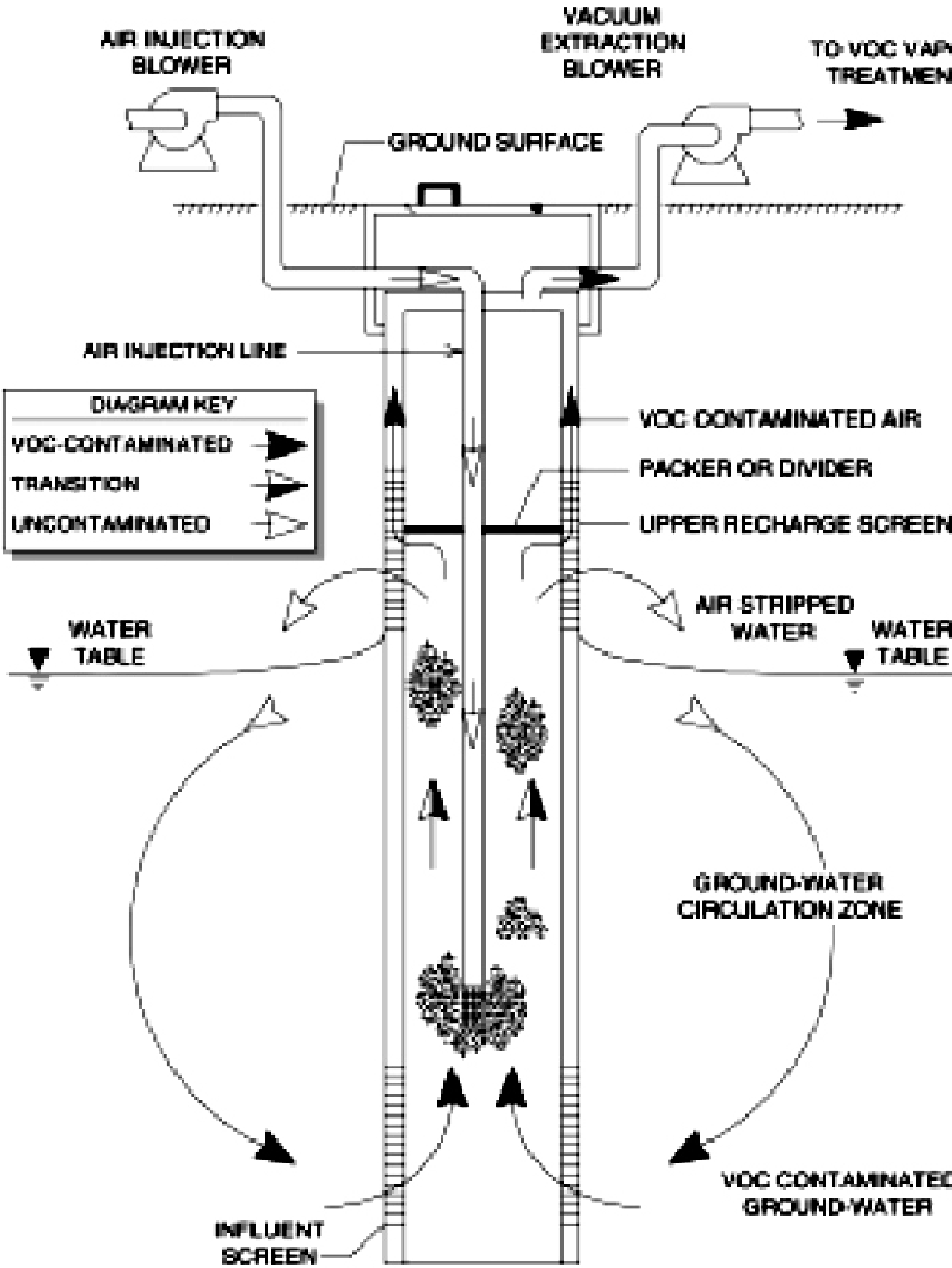
Figure 5-1

S:\CAD\Ripon\1011.002\Feasibility Study\AltB.dwg 08/31/2005 13:42:48


GP-8
GP-2
GP-10
Koro Road
P-104
MW-104
MW-112
GP-7
GP-3
GV-1
LC-3
GV-2
GV-3
GV-4
LC-1
GP-11
GV-5
GV-6
GV-7
GV-8
GP-6
P-103D
P-103
MW-103
P-101
MW-101
GV-12
GV-11
GV-10
LC-2
GV-9
GP-4
POWER FOR BLOWER SUPPLIED FROM THIS POLE
CONDENSATE TRAP AND TANK
BLOWER SYSTEM TRAILER
GP-1
GP-12
P-102
MW-102
GP-5
Road
County Highway FF
EXPLANATION
P-104 MW-104 MONITOR WELL, PIEZOMETER LOCATION, DESIGNATION
LC-2 LEACHATE HEAD WELL LOCATION, DESIGNATION
OUTLINE OF CLOSED LANDFILL
GP-1 GAS PROBE LOCATION AND DESIGNATION
GV-9 GAS VENT LOCATION AND DESIGNATION
PASSIVE GAS COLLECTION SYSTEM PIPING
UNDERGROUND HEADER PIPE
CONTROL VALVE
POWER POLE
NOTE: CONTOURS ON LANDFILL DO NOT REFLECT CURRENT TOPOGRAPHY.
N
SCALE
0
200
Feet
FF/NN LANDFILL
RIPON, WISCONSIN
ALTERNATIVE C1
ACTIVE GAS EXTRACTION USING PASSIVE VENT SYSTEM
DATE: 9/21/05
DESIGNED: GLD
CHECKED: GLD
APPROVED: GLD
DRAWN: HJW
PROJ.: 1011.002
GeoTrans, Inc.
A TETRA TECH COMPANY
Figure 5-2
S:\CAD\Ripon\1011.002\Feasibility Study\9-13-05\1011002Fig5-2.dwg 09/13/2005 13:50:36



GP-8
GP-2
GP-10
Koro Road
MW-102
P-104
MW-104
GP-7
GP-3
LC-3
LC-1
GP-11
GP-6
P-103D
P-103
MW-103
P-101
MW-101
LC-2
GP-4
POWER FOR BLOWER
SUPPLIED FROM THIS
POLE
CONDENSATE
TRAP AND TANK
BLOWER
SYSTEM
TRAILER
GP-1
GP-12
P-102
MW-102
GP-5
Road
County Highway FF
EXPLANATION
P-104
MW-104
MONITOR WELL, PIEZOMETER LOCATION, DESIGNATION
LC-2
LEACHATE HEAD WELL LOCATION, DESIGNATION
OUTLINE OF CLOSED LANDFILL
GP-1
GAS PROBE LOCATION AND DESIGNATION
UNDERGROUND HEADER PIPE
CONTROL VALVE
POWER POLE
VERTICAL GAS EXTRACTION WELL
RADIUS OF INFLUENCE (150 FEET)
NOTE: CONTOURS ON LANDFILL DO NOT REFLECT CURRENT TOPOGRAPHY.
N
SCALE
0
200
Feet
FF/NN LANDFILL
RIPON, WISCONSIN
ALTERNATIVE C2
ACTIVE GAS EXTRACTION WITH
VERTICAL EXTRACTION WELLS
DATE: 9/21/05
DESIGNED: GLD
CHECKED: GLD
APPROVED: GLD
DRAWN: HJW
PROJ.: 1011.002
GeoTrans, Inc.
A TETRA TECH COMPANY
Figure 5-3
S:\CAD\Ripon\1011.002\Feasibility Study\9-13-05\1011002Fig5-3.dwg 09/21/2005 08:58:36



FF/NN LANDFILL RIPON, WISCONSIN	DATE: 7/22/05
GROUNDWATER CIRCULATION WELLS	DESIGNED: GLD CHECKED: GLD APPROVED: GLD DRAWN: HJW PROJ.: 1011.002
GeoTrans, Inc. A TETRA TECH COMPANY	Figure 5-4

S:\CAD\Ripon\1011.002\Feasibility Study\7-21-05\1011002Fig5-4.dwg 09/21/2005 09:20:38

TABLES

Table 2-1 Potential ARARs for Remedial Actions
FF/NN Landfill, Ripon, Wisconsin
Focused Feasibility Study, 2005

		Remedial Alternatives								
		A	B	C1	C2	C3	C4	D1	D2	D3
Regulation, Policy or Law	Description	No Action	Institutional Controls with Connection to Municipal Water Supply	Active Gas Extraction using Existing Passive Collection Sustem	Active Gas Extraction with New Vertical Extraction Wells	Shallow Groundwater Extraction/ Treatment System	Shallow Biobarrier System	Ground water Circulation Wells	Deep Groundwater Extraction/ Treatment System	Monitored Natural Attenuation with Source Control (Alternative C)
FEDERAL REGULATIONS										
Clean Air Act (CAA) and National Ambient Air Quality Standards (NAAQS)	Regulates site air emissions	✔	✔	✔	✔	✔	✔	✔	✔	✔
40 CFR 52	Regional air quality plan for remedial activities. Federal Prevention of Significant Deterioration Program			✔	✔	✔		✔	✔	✔
40 CFR 50	Air quality standards for remedial activities			✔	✔	✔		✔	✔	✔
40 CFR 257	Criteria for classification of solid waste disposal facilities and practices	✔	✔	✔	✔	✔	✔	✔	✔	✔
40 CFR 261	Identification of hazardous waste	✔	✔	✔	✔	✔	✔	✔	✔	✔
40 CFR 262	Regulations for hazardous waste generators	✔	✔	✔	✔	✔	✔	✔	✔	✔
40 CFR 263	Regulations for transport of hazardous waste	✔	✔	✔	✔	✔	✔	✔	✔	✔
Department of Transportation Hazardous Materials Transportation Act	Off-site transport of hazardous waste		✔	✔	✔	✔	✔		✔	✔
Occupational Safety and Health Administration (OSHA)	Regulates worker safety	✔	✔	✔	✔	✔	✔	✔	✔	✔
Fish and Wildlife Coordination Act	Regulates flow modification of Silver Creek					✔			✔	
Endangered Species Act	Protects endangered species and habitats. No endangered species are known to exist at the site.	✔	✔	✔	✔	✔	✔	✔	✔	✔
OSWER Directive 9355.0-28	Control of air emissions from Superfund air strippers at Superfund groundwater sites (emissions threshold for air strippers is set at 3 lbs/hr or 15 lbs/day or a potential rate of 10 tons/yr of total VOCs)					✔		✔	✔	✔
40 CFR Part 264, AA	Requires total organic emissions from air strippers be reduced below 1.4 kg/hr and 2.8 megagrams/yrs or by 95% by weight					✔		✔	✔	✔
Executive Order 11988 and 11990; 40 CFR 6, Subpart A	Requirements for remedial actions impacting floodplains or wetlands					✔			✔	✔
RCRA, Subtitle C	Regulates hazardous waste. Water treatment residuals may be hazardous waste			✔	✔	✔		✔	✔	✔
Clean Water Act (CWA)	Regulates surface water quality					✔			✔	✔
40 CFR 264.18(b) (RCRA)	Requirements for design, construction, operation and maintenance of remedial actions at RCRA hazardous waste sites located in floodplain					✔			✔	✔
National Pollutant Discharge Elimination System (NPDES)	Regulates discharge into Silver Creek					✔			✔	✔
Pretreatment Requirements 40 CFR, Part 403.5	Pretreatment standards for discharge to POTW					✔			✔	✔

Table 2-1 Potential ARARs for Remedial Actions
FF/NN Landfill, Ripon, Wisconsin
Focused Feasibility Study, 2005

		A	B	C1	C2	C3	C4	D1	D2	D3
Regulation, Policy or Law	**Description**	**No Action**	**Institutional Controls with Connection to Municipal Water Supply**	**Active Gas Extraction using Existing Passive Collection Sustem**	**Active Gas Extraction with New Vertical Extraction Wells**	**Shallow Groundwater Extraction/ Treatment System**	**Shallow Biobarrier System**	**Ground water Circulation Wells**	**Deep Groundwater Extraction/ Treatment System**	**Monitored Natural Attenuation with Source Control (Alternative C)**
Fresh Water Quality Criteria (FWQC)	Surface water quality standards					✔			✔	✔
Executive Order for Wetlands and Floodplains	Regulates actions in wetlands or floodplains					✔			✔	✔
Response in a Floodplain or Wetlands; 40 CFR Part 6, Append. A	Construction in flood hazard areas					✔			✔	✔
STATE OF WISCONSIN REGULATIONS										
NR 102 - Water Quality Standards for Wisconsin Surface Waters	Specifies water quality standards for use classifications. Dissolved oxygen must not be lowered below 5 mg/L and pH must be maintained within 6 to 9 units. See NR 102 for additional standards					✔			✔	✔
NR 103 - Water Quality Standards for Wetlands	Regulates water discharges to wetlands					✔			✔	✔
NR 104 - Intrastate Water Uses and Designated Standards	Designates use classifications for surface waters.					✔			✔	✔
NR 105 - Surface Water Quality Criteria for Toxic and Organoleptic Substances	Specifies water quality criteria for toxic and organoleptic substances for protection of human health and welfare and aquatic life.					✔			✔	✔
NR 106 - Procedures for Calculating Water Quality-based Effluent Limitations for Toxic and Organoleptic Substances Discharged to Surface Waters	Specifies procedures for how effluent limitations are to be calculated for toxic and organoleptic substances.					✔			✔	✔
NR 108 - Requirement for Plans and Specifications - Submittal for Reviewable Projects and Operations of Community Water Systems, Sewerage Systems, and Industrial Waste Facilities	Sets guidelines for plans and specifications for actions which propose a discharge to ground water or community sewerage systems					✔			✔	✔
NR 112 - Well Construction and Pump Installation	Specifies construction standards for well and pump installations and abandonment of wells		✔			✔		✔	✔	✔
NR 116 - Wisconsin's Flood Plain Management Program	Requires and establishes standards for municipal flood plain zoning ordinances. Relevant and appropriate to construction of remediation facilities					✔			✔	✔
NR140 - Groundwater Quality	Specifies groundwater quality preventive action limits and enforcement standards. Notification requirements and potential response actions when standards are exceeded are listed.	✔	✔	✔	✔	✔	✔	✔	✔	✔
NR 149 Lab Certification	Sets analytical standards for lab certification	✔	✔	✔	✔	✔	✔	✔	✔	✔

Table 2-1 Potential ARARs for Remedial Actions
FF/NN Landfill, Ripon, Wisconsin
Focused Feasibility Study, 2005

		A	B	C1	C2	C3	C4	D1	D2	D3
Regulation, Policy or Law	**Description**	**No Action**	**Institutional Controls with Connection to Municipal Water Supply**	**Active Gas Extraction using Existing Passive Collection Sustem**	**Active Gas Extraction with New Vertical Extraction Wells**	**Shallow Groundwater Extraction/ Treatment System**	**Shallow Biobarrier System**	**Ground water Circulation Wells**	**Deep Groundwater Extraction/ Treatment System**	**Monitored Natural Attenuation with Source Control (Alternative C)**
NR 200 - Application for Discharge Permit	Discharge permit is required for discharges to surface waters and to land areas where water may percolate to ground water.					✔			✔	✔
NR 207 - Water Quality Antidegradation	Sets procedures for proposed new or increased discharge to ORWs or ERWs					✔			✔	✔
NR 211 - General Pretreatment Requirements	Prohibits discharges to POTWs which pass through or interfere with the operation or performance of the POTW and thereby cause a POTW to violate its WPDES permit.					✔			✔	✔
NR 214 - Land Application and Disposal of Liquid Industrial Wastes and Byproducts	Requires land disposal systems to meet design and construction criteria and requires plans and specification to be approved by WDNR. Effluent limitations and ground-water monitoring requirements are also specified.					✔			✔	✔
NR 218 - Sampling	Establishes sampling methods					✔			✔	✔
NR 219 - Analytical Test Methods and Procedures	Sets procedures applicable to effluent limitations for discharges from point sources					✔			✔	✔
NR 220 - Categories and Classes of Point Sources and Effluent Limitations	Requires WDNR to establish effluent limits for uncategorized point sources and to base those limits on best practicable control technology currently available or best available control technology economically achievable.					✔			✔	✔
Ch 147.Stats - Pollution Discharge Elimination	Requires point source discharges to obtain a permit from WDNR					✔			✔	✔
NR 445 - Control of Hazardous Pollutants	Specifies emission limits and control requirements for air contaminant sources emitting hazardous pollutants			✔	✔	✔		✔	✔	✔
NR 445.04 - Emission Limits for New or Modified Sources	Specifies air concentrations not to be exceeded off the source's property in terms of 24-hour and 1-hour averages. Requires lowest achievable control technology for air contaminants without acceptable ambient concentrations.			✔	✔	✔		✔	✔	✔
NR 507 - Monitoring for Landfills	Specifies monitoring requirements for ground water, leachate and gas.	✔	✔	✔	✔	✔	✔	✔	✔	✔
NR 508 - Responses when a groundwater standard is exceeded	Specifies procedures for responding to groundwater exceeding a standard.	✔	✔	✔	✔	✔	✔	✔	✔	✔
NR 600-620 - Hazardous Waste Management	Establishes requirements for the identification of hazardous waste and standards for the storage, transport, and disposal of hazardous waste. Generally parallels RCRA part 264 requirements (see Federal ARARs table).	✔	✔	✔	✔	✔	✔	✔	✔	✔

Table 2-1 Potential ARARs for Remedial Actions
FF/NN Landfill, Ripon, Wisconsin
Focused Feasibility Study, 2005

		A	B	C1	C2	C3	C4	D1	D2	D3
Regulation, Policy or Law	**Description**	**No Action**	**Institutional Controls with Connection to Municipal Water Supply**	**Active Gas Extraction using Existing Passive Collection Sustem**	**Active Gas Extraction with New Vertical Extraction Wells**	**Shallow Groundwater Extraction/ Treatment System**	**Shallow Biobarrier System**	**Ground water Circulation Wells**	**Deep Groundwater Extraction/ Treatment System**	**Monitored Natural Attenuation with Source Control (Alternative C)**
NR 700-754 - Investigation and Remediation of Environmental Contamination	Specifies standards and procedures pertaining to the identification, investigation and remediation of sites.	✔	✔	✔	✔	✔	✔	✔	✔	✔
NR 809 Safe Drinking Water	Establishes minimum standards for safe drinking water	✔	✔							✔
NR 811 Requirements for the Operation and Design of Community Water Systems	Establishes design and operation standards for community water systems		✔							✔
NR 812 Well Construction and Pump Installation	Establishes standards for extracting groundwater		✔			✔		✔	✔	✔

Table 3-1 Stratigraphic Groupings of Monitoring Wells
FF/NN Landfill, Ripon, WI

Layer	Well ID	Well Screen Elevation (ft msl)	Lithology at Well Screen
Layer 1 Wells	MW-106	821.0	sand
	MW-101	820.4	sand
	MW-104	819.3	sand & gravel
	MW-102	818.9	sand & gravel
	MW-103	818.7	sand
	MW-107	816.5	sand
	MW-108	814.9	sand
	MW-112	814.1	sand
	MW-111	812.3	sand
Layer 2 Wells	P-106	791.7	sand
	P-101	790.0	sand
	P-103	789.9	silt
	P-107	785.6	sand
	P-108	783.5	sand
	P-104	782.0	sand
	P-102	781.3	sand
	P-111	774.2	sand
Layer 3 Wells	P-111D	704.0	sand and gravel
	P-103D	682.08	sandstone
	MW-3B	665.0	sandstone
	P-113B	634.2	sandstone
	P-114	654.4	sandstone
	P-115	662.7	sandstone
	P-116	681.3	sandstone
Layer 4 wells	MW-3A	570.0	sandstone
	P-107D	544.0	granite
	P-113A	507.8	sandstone

Table 3-2 VOC Sampling Results for Groundwater
FF/NN Landfill, Ripon, WI

		Parameters																														
Sampling Point	Collection Date	Acetone[1]	Benzene	Bromomethane	2-Butanone (MEK)	sec-Butylbenzene	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	1,4-dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-dichloroethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloropropane	Ethylbenzene	Isopropylbenzene	Methylene chloride	MTBE	Tetrachloroethene	Tetrahydrofuran	Toluene	1,2,4-Trichlorobenzene	Trichloroethene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Total Xylenes
WDNR NR140	PAL	200	0.5	1	90	NE	NE	80	0.6	0.3	15	200	85	0.5	0.7	7	20	0.5	140	NE	0.5	12	0.5	10	200	14	0.5	NE	96		0.02	1000
	ES	1000	5	10	460	NE	NE	400	6	3	75	1000	850	5	7	70	100	5	700	NE	5	60	5	50	1000	70	5	NE	480		0.2	10000
MW-3A	04/04/02	NR			NA																											
	05/22/02	NR			NA																											
	08/20/02	NR																														
	12/05/02	NR																														
	04/22/03																															
	10/22/03																															
	05/11/04																															
	10/14/04																															
	01/27/05																															
	04/26/05																															
	08/02/05																															
MW-3B	04/04/02	NR			NA																				0.38						**0.31**	
	05/22/02	NR			NA																			NA								
	08/20/02	NR																						NA								
	12/05/02	NR																														
	4/22/03																															
	10/22/03																															
	05/11/04																														**0.2 Q**	
	07/22/04																															
	10/14/04																															
	1/27/05																															
	4/26/05																															
	8/2/05																														**0.30 Q**	

Table 3-2 VOC Sampling Results for Groundwater
FF/NN Landfill, Ripon, WI

		Parameters																												
Sampling Point	Collection Date	Acetone[1]	Benzene	Bromomethane	2-Butanone (MEK)	sec-Butylbenzene	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	1,4-dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-dichloroethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloropropane	Ethylbenzene	Isopropylbenzene	Methylene chloride	MTBE	Tetrachloroethene	Tetrahydrofuran	Toluene	1,2,4-Trichlorobenzene	Trichloroethene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Total Xylenes
WDNR NR140	PAL	200	0.5	1	90	NE	NE	80	0.6	0.3	15	200	85	0.5	0.7	7	20	0.5	140	NE	0.5	12	0.5	10	200	14	0.5	NE	96		0.02	1000
	ES	1000	5	10	460	NE	NE	400	6	3	75	1000	850	5	7	70	100	5	700	NE	5	60	5	50	1000	70	5	NE	480		0.2	10000
MW-101	10/1/93	NR																					0.7 J									
	04/1/94	NR																					0.6J									
	05/01/96	NR																					0.6J									
	10/01/96	NR								0.89 J													0.72 J									
	05/01/97	NR																														
	10/01/97	NR																					0.7									
	04/98*	NR																														
	10/01/98	NR																														
	04/01/99	NR																														
	10/01/99	NR																					0.7									
	05/01/00	NR																					0.32									
	10/01/00	NR																					0.38									
	05/01/02	NR																					0.28									
	10/11/01	NR																														
	02/05/02	NR			NA							0.19											0.32	NA			0.16					
	05/21/02 *		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	8/19/02 *		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	12/5/02 *		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4/21/03 *		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	10/23/2003																															
	4/28/2004																															
	10/13/2004	11																														
	4/27/05																															
P-101	10/01/93	NR																														
	04/01/94	NR																							0.5J							
	020/5/02	NR			NA																			NA								
	05/22/02	NR			NA																			NA								
	10/13/2004																															
	4/27/05																															

Table 3-2 VOC Sampling Results for Groundwater
FF/NN Landfill, Ripon, WI

		Parameters																														
Sampling Point	Collection Date	Acetone[1]	Benzene	Bromomethane	2-Butanone (MEK)	sec-Butylbenzene	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	1,4-dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-dichloroethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloropropane	Ethylbenzene	Isopropylbenzene	Methylene chloride	MTBE	Tetrachloroethene	Tetrahydrofuran	Toluene	1,2,4-Trichlorobenzene	Trichloroethene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Total Xylenes
WDNR NR140	PAL	200	0.5	1	90	NE	NE	80	0.6	0.3	15	200	85	0.5	0.7	7	20	0.5	140	NE	0.5	12	0.5	10	200	14	0.5	NE	96		0.02	1000
	ES	1000	5	10	460	NE	NE	400	6	3	75	1000	850	5	7	70	100	5	700	NE	5	60	5	50	1000	70	5	NE	480		0.2	10000
MW-102	10/26/93	NR																														
	04/11/94	NR																							3							
	05/08/96	NR																							0.4J							
	10/30/96	NR								0.99 J													0.30 J									
	05/12/97	NR																														
	10/26/97	NR																														
	04/13/98	NR														0.46																
	10/11/01	NR																														
	05/21/02 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	08/19/02 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	12/05/02 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	07/23/04																															
	10/14/2004																															
	4/27/05																															
P-102	10/26/93	NR																														
	04/11/94	NR																														
	10/11/01	NR																														
	05/21/02	NR			NA																			NA							**0.33Q**	
	08/20/02	NR																						NA							**0.62**	
	12/04/02	NR																													**0.68**	
	04/21/03																				0.48 Q&										**0.83**	
	10/22/03																														**0.96**	
	04/27/04																														**2.1**	
	10/14/2004									0.5 Q																					**0.32**	
	1/27/2005																															
	4/27/05																															
	8/3/2005																															
	8/3/2005 dup																															

Table 3-2 VOC Sampling Results for Groundwater
FF/NN Landfill, Ripon, WI

		Parameters																														
Sampling Point	Collection Date	Acetone[1]	Benzene	Bromomethane	2-Butanone (MEK)	sec-Butylbenzene	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	1,4-dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-dichloroethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloropropane	Ethylbenzene	Isopropylbenzene	Methylene chloride	MTBE	Tetrachloroethene	Tetrahydrofuran	Toluene	1,2,4-Trichlorobenzene	Trichloroethene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Total Xylenes
WDNR NR140	PAL	200	0.5	1	90	NE	NE	80	0.6	0.3	15	200	85	0.5	0.7	7	20	0.5	140	NE	0.5	12	0.5	10	200	14	0.5	NE	96		0.02	1000
	ES	1000	5	10	460	NE	NE	400	6	3	75	1000	850	5	7	70	100	5	700	NE	5	60	5	50	1000	70	5	NE	480		0.2	10000
	10/27/93	NR														**410**															**75**	
	04/11/94	NR														**1100**															**440**	
	04/01/94 Dup	NR														**970**															**410**	
	05/01/96	NR					7J									**740**	9J										**10J**				**170**	
	05/01/96 Dup	NR					8J			**9 J**						**840**	10J										**11J**				**180**	
	10/01/96	NR	3.3				8.1 J	1.9		1.1	0.76 J		0.99 J		0.30 J	**520 E**	5	1.9									4.7				**98 E**	
	05/01/97	NR	4.3				8.5	2.7			0.98		1.2	0.52	0.75	**790**	4.7	1.6				0.27					**5.6**				**230**	
	10/01/97	NR	4.2				7.9	2.4			1.4		0.89	0.38		**550J**	5.2	1.5				0.38		3.1			**6.6**				**220J**	
	04/98*	NR																														
	10/01/98	NR	2				5.7									**260**	3.3										**5.8**				**45**	
	04/01/99	NR	1.4				4.7									**150**	2.4										3.9				**47**	
	10/01/99	NR					5.2									**170**	2.6										2.4				**48**	
MW-103[2]	05/01/00	NR	1.8				6.5									**170**	3.4										4.1				**60**	
	10/01/00	NR	1.6				6.9	3.1			0.84		0.33			**130**	4.5	0.75									**6.6**				**78**	
	05/01/01	NR	1.2				5.7	1.5			0.92					**94**	3.4	0.54			2.6L			1.1			4.5				**46**	
	10/11/2001	NR	1.1		80		2.6	0.62			0.54					25	2.7				6.4L				0.8						**15**	
	2/4/2002	NR	1.8		NA		6.4	1.1			0.81		0.36			**71**	5.5	0.53			0.28		0.13	NA	0.72		3.1				**40**	
	5/21/2002*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	8/19/02 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	12/05/02 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	04/21/03 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	10/21/2003		0.8				1.3									58	1.9										1.7				**21**	
	04/28/04		0.61 Q		26		0.53 Q									16											1.9				**6.7**	
	10/13/2004	56	1.4				1.7			0.52						12	2.5								0.89		0.78				**7.9**	
	4/26/05		1.2				2.8									1.9	3.0								0.71						**1.8**	
	10/27/93	NR																														
	04/12/94	NR																														
	05/9/96	NR														0.1J									0.1J						0.1J	
	10/31/96	NR								0.84 J																						
	05/13/97	NR																														
	10/27/97	NR																														
P-103	04/13/98	NR																														
	2/4/2002	NR			NA																			NA								
	05/21/02	NR			NA											[0.54]								NA								
	10/13/2004									0.52 Q																					**1.7**	
	1/26/2005																															
	1/26/2005 dup																															
	4/26/05																														**2.4**	
	8/3/2005																														**3.2**	
	02/4/04				NA																0.55Q			NA							**1.1**	
	05/11/04																														**1.5**	

Table 3-2 VOC Sampling Results for Groundwater
FF/NN Landfill, Ripon, WI

Sampling Point	Collection Date	Parameters: Acetone[1]	Benzene	Bromomethane	2-Butanone (MEK)	sec-Butylbenzene	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	1,4-dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-dichloroethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloropropane	Ethylbenzene	Isopropylbenzene	Methylene chloride	MTBE	Tetrachloroethene	Tetrahydrofuran	Toluene	1,2,4-Trichlorobenzene	Trichloroethene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Total Xylenes
WDNR NR140	PAL	200	0.5	1	90	NE	NE	80	0.6	0.3	15	200	85	0.5	0.7	7	20	0.5	140	NE	0.5	12	0.5	10	200	14	0.5	NE	96		0.02	1000
	ES	1000	5	10	460	NE	NE	400	6	3	75	1000	850	5	7	70	100	5	700	NE	5	60	5	50	1000	70	5	NE	480		0.2	10000
P-103D	05/11/04 dup																														**1.5**	
	07/23/04																														**1.3**	
	07/23/04 dup																														**1.5**	
	10/13/2004									0.43 Q						0.86 Q																
	04/26/05															0.84 Q															**3.0**	
MW-104	10/27/1993	NR	2				2				2					1 JB									31							
	4/19/1994	NR	1				1				1					10											0.8J				**6.0**	
	05/9/96	NR	**6**				5	1		0.3 J			0.2 J			6	0.3 J		0.1J						0.2 J		0.5J				**10**	
	10/30/96	NR	0.64 J				1.1	0.34 J		0.46 J						3.6	0.22 J		0.80 J								0.31 J				**4.3**	0.77 J
	05/12/97	NR	4.8				4.5	1.5			0.91					1.1						0.32									**4.5**	
	10/27/97	NR	0.63				1.3				0.85					7.3															**18**	
	04/13/98	NR	1.2													**74**	0.67								0.46		3.5				**17**	
	10/13/98	NR	1.7								0.76					3.3															**15**	4.1
	04/07/99	NR	3.2				1.4									6.6											0.71				**6.1**	
	10/27/99	NR	3.5				5.4				0.92					4.5															**2.8**	
	05/2/00	NR	3				5.7				1.5					0.7									0.13						**1.1**	
	10/30/00	NR	2				6.2				1.6					2.6									0.12		0.33				**29**	
	05/1/01	NR	2.5				5.6				2	0.47				7				0.26	0.51L			0.81	0.13		0.66				**8.6**	
	10/11/01	NR	3.1				9.5				2.3				0.85	2					0.39L				0.1				0.14		**2.2**	
	02/5/02	NR	2.7		NA	0.16	8				2	0.19				5.1				0.23				NA	0.17		0.73				**13**	
	05/21/02*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	08/19/02 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	12/05/02 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4/21/2003 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	04/22/03		1.8		6.9Q		3.1									4.6															**6.5**	
	10/23/2003	3.2	4				7.8				1.8					3.3															**8.6**	
	04/28/04		2.4				6				2.2 Q					6.4															**8.7**	
	10/13/2004		2.5				6.5				2.2 Q					10															**20**	
	4/27/05		1.7				5.4				2.1 Q																				**0.64**	

Table 3-2 VOC Sampling Results for Groundwater
FF/NN Landfill, Ripon, WI

		Parameters																														
Sampling Point	Collection Date	Acetone[1]	Benzene	Bromomethane	2-Butanone (MEK)	sec-Butylbenzene	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	1,4-dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-dichloroethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloropropane	Ethylbenzene	Isopropylbenzene	Methylene chloride	MTBE	Tetrachloroethene	Tetrahydrofuran	Toluene	1,2,4-Trichlorobenzene	Trichloroethene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Total Xylenes
WDNR NR140	PAL	200	0.5	1	90	NE	NE	80	0.6	0.3	15	200	85	0.5	0.7	7	20	0.5	140	NE	0.5	12	0.5	10	200	14	0.5	NE	96		0.02	1000
	ES	1000	5	10	460	NE	NE	400	6	3	75	1000	850	5	7	70	100	5	700	NE	5	60	5	50	1000	70	5	NE	480		0.2	10000
P-104	10/27/94	NR																														
	04/19/94	NR																														
	05/09/96	NR																														
	10/30/96	NR								0.20 J																						
	05/12/97	NR																														
	10/27/97	NR																														
	04/13/98	NR																														
	10/11/01	NR																			0.52L											
	02/5/02	NR	0.18		NA					0.85														NA								
	5/21/2002	NR			NA																			NA								
	08/20/02	NR																						NA								
	10/13/2004									0.45 Q																						
	10/13/04 Dup																															
	8/3/2005																															
	8/3/05 Dup																															
MW-106	10/1/93	NR																														
	04/01/94	NR																							11							
	02/04/02	NR			NA																			NA	0.25							
	05/21/02 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	08/19/02 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	120/5/02 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	04/21/03 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	07/23/04																															
	4/27/05																															
	4/27/05 Dup																															

Table 3-2 VOC Sampling Results for Groundwater
FF/NN Landfill, Ripon, WI

		Parameters																														
Sampling Point	Collection Date	Acetone[1]	Benzene	Bromomethane	2-Butanone (MEK)	sec-Butylbenzene	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	1,4-dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-dichloroethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloropropane	Ethylbenzene	Isopropylbenzene	Methylene chloride	MTBE	Tetrachloroethene	Tetrahydrofuran	Toluene	1,2,4-Trichlorobenzene	Trichloroethene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Total Xylenes
WDNR NR140	PAL	200	0.5	1	90	NE	NE	80	0.6	0.3	15	200	85	0.5	0.7	7	20	0.5	140	NE	0.5	12	0.5	10	200	14	0.5	NE	96		0.02	1000
	ES	1000	5	10	460	NE	NE	400	6	3	75	1000	850	5	7	70	100	5	700	NE	5	60	5	50	1000	70	5	NE	480		0.2	10000
P-106	10/01/93	NR																									0.6J					
	04/01/94	NR																									0.8J					
	05/01/96	NR														0.2 J											0.8J					
	10/01/96	NR								0.62J																	0.22 J					
	05/01/97	NR																									0.65					
	10/01/97	NR																									0.67					
	04/01/98	NR																									0.61					
	10/01/98	NR																									0.71					
	04/01/99	NR																									0.58					
	10/1/99	NR																									0.61					
	05/01/00	NR																									0.56					
	10/01/00	NR																									0.6					
	05/01/01	NR																									0.56					
	10/11/01	NR																									0.39					
	2/5/2002	NR			NA																			NA			0.6					
	02/05/02 Dup	NR			NA																			NA			0.6					
	05/22/02	NR			NA																			NA			0.49					
	05/22/02Dup	NR			NA																			NA			0.47 Q					
	08/20/02	NR																						NA			0.43 Q					
	12/4/02	NR																									0.53					
	04/22/03																										0.55 Q					
	10/21/03																										0.56					
	10/21/03 Dup																															
	4/27/2004																															
	10/13/2004									0.9																	0.84 Q					
	4/27/05																															

Table 3-2 VOC Sampling Results for Groundwater
FF/NN Landfill, Ripon, WI

		Parameters																												
Sampling Point	Collection Date	Acetone[1]	Benzene	Bromomethane	2-Butanone (MEK)	sec-Butylbenzene	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	1,4-dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-dichloroethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloropropane	Ethylbenzene	Isopropylbenzene	Methylene chloride	MTBE	Tetrachloroethene	Tetrahydrofuran	Toluene	1,2,4-Trichlorobenzene	Trichloroethene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Total Xylenes
WDNR NR140	PAL	200	0.5	1	90	NE	NE	80	0.6	0.3	15	200	85	0.5	0.7	7	20	0.5	140	NE	0.5	12	0.5	10	200	14	0.5	NE	96		0.02	1000
	ES	1000	5	10	460	NE	NE	400	6	3	75	1000	850	5	7	70	100	5	700	NE	5	60	5	50	1000	70	5	NE	480		0.2	10000
MW-107	10/27/1993	NR																									2					
	4/12/1994	NR																									2					
	5/9/1996	NR																									2					
	10/21/1996	NR								0.80 J																	2.2					
	5/13/1997	NR										0.9															2.6					
	10/27/1997	NR										0.7															2					
	4/14/1998	NR																									2.1					
	10/13/98*	NR																									NA					
	4/6/1999	NR																									1.8					
	10/27/1999	NR																									1.1					
	5/2/2000	NR																									1.6					
	10/31/2000	NR																									1.2					
	5/31/2001	NR										0.47									0.57L						1.8					
	10/11/2001	NR																									0.87					
	2/4/2002	NR			NA							0.35												NA			1.4					
	05/21/2002*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	8/19/2002 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	12/5/2002 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4/21/2003																				0.52 Q&						1.2					
	10/21/2003																										2.2					
	4/27/2004																										1.9					
	10/13/2004									0.63 Q																	0.65 Q					
	4/27/05																										1.1					

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Table 3-2 VOC Sampling Results for Groundwater
FF/NN Landfill, Ripon, WI

Sampling Point	Collection Date	Acetone[1]	Benzene	Bromomethane	2-Butanone (MEK)	sec-Butylbenzene	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	1,4-dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-dichloroethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloropropane	Ethylbenzene	Isopropylbenzene	Methylene chloride	MTBE	Tetrachloroethene	Tetrahydrofuran	Toluene	1,2,4-Trichlorobenzene	Trichloroethene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Total Xylenes
WDNR NR140	PAL	200	0.5	1	90	NE	NE	80	0.6	0.3	15	200	85	0.5	0.7	7	20	0.5	140	NE	0.5	12	0.5	10	200	14	0.5	NE	96		0.02	1000
	ES	1000	5	10	460	NE	NE	400	6	3	75	1000	850	5	7	70	100	5	700	NE	5	60	5	50	1000	70	5	NE	480		0.2	10000
P-107	10/27/1993	NR														4															**6**	
	4/12/1994	NR														2									0.7J						**3**	
	4/12/94 Dup	NR														2									0.7J						**3**	
	5/9/1996	NR	0.1 J					0.2 J								2									0.1 J		0.1 J				**2**	
	10/23/1996	NR						0.19		0.79 J						1.9															**2.3**	
	10/23/96 Dup	NR						0.21		0.49 J						2.1															**2.7**	
	5/14/1997	NR														1.3															**2**	
	5/14/97 Dup	NR														1.1															**1.7**	
	10/27/1997	NR														2.2															**2.6**	
	10/27/97 DUP	NR														1.8															**2.3**	
	4/14/1998	NR														2.3															**2.2**	
	4/14/98 Dup	NR														2.3															**2.4**	
	10/14/1998	NR														2.1										0.2					**1.5**	
	10/14/98 DUP	NR														2.4															**1.7**	
	4/6/1999	NR														1.5															**0.58**	
	10/27/1999	NR														1.8																
	10/27/99 Dup	NR														1.8																
	5/2/2000	NR														1.5															**1.2**	
	5/02/00 Dup	NR														1.6															**1.2**	
	10/31/2000	NR														1.4																
	10/31/00 Dup	NR														1.4																
	5/9/2001	NR														0.96					0.52L			0.72			1.8				**0.85**	
	5/9/2001 Dup	NR														0.97					0.49L			0.79							**0.86**	
	10/11/2001	NR														1.6															**1.7**	
	10/11/01 Dup	NR														1.5															**1.7**	
	2/4/2002	NR			NA											1.6								NA							**1.2**	
	5/21/2002	NR			NA											1.8								NA							**1.5**	
	5/21/02 Dup	NR			NA											1.7								NA							**1.4**	
	8/20/2002	NR														0.84								NA							**0.54Q**	
	12/4/2002	NR														1.3															**1**	
	4/21/2003															1.5 Q															**1**	
	04/21/2003 Dup															1.3 Q																
	10/21/2003															1.3															**0.93**	
	4/27/2004															0.96 Q															**0.61**	
	10/13/2004															0.89 Q															**0.64**	
	10/13/04 Dup															1.1 Q																
	4/27/05																															

Table 3-2 VOC Sampling Results for Groundwater
FF/NN Landfill, Ripon, WI

Sampling Point	Collection Date	Acetone[1]	Benzene	Bromomethane	2-Butanone (MEK)	sec-Butylbenzene	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	1,4-dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-dichloroethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloropropane	Ethylbenzene	Isopropylbenzene	Methylene chloride	MTBE	Tetrachloroethene	Tetrahydrofuran	Toluene	1,2,4-Trichlorobenzene	Trichloroethene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Total Xylenes
WDNR NR140	PAL	200	0.5	1	90	NE	NE	80	0.6	0.3	15	200	85	0.5	0.7	7	20	0.5	140	NE	0.5	12	0.5	10	200	14	0.5	NE	96		0.02	1000
	ES	1000	5	10	460	NE	NE	400	6	3	75	1000	850	5	7	70	100	5	700	NE	5	60	5	50	1000	70	5	NE	480		0.2	10000
	10/27/1993	NR														2B															**6**	
	4/13/1994	NR																														
	5/9/1996	NR	0.1J							0.3J						0.2J									0.3J						**0.6J**	
	10/23/1996	NR								0.44 J																					**3.9**	
	5/14/1997	NR														0.49															**2.4**	
	10/27/1997	NR														1.7															**5.1**	
	4/14/1998	NR														1															**4.1**	
	10/14/1998	NR																													**2.2**	
	4/6/1999	NR														0.34															**0.87**	
	10/27/1999	NR																													**1.7**	
	5/2/2000	NR																													**1.3**	
	10/31/2000	NR														0.64																
P-107D	01/05/2001	NR		0.33												1.5					0.44L			0.72B							**5.6**	
	10/11/2001	NR														2.2															**10**	
	2/4/2002	NR			NA											1.2								NA			0.17				**3.9**	
	02/04/02 Dup	NR														1.2															**3.9**	
	5/21/2002	NR			NA											1.1								NA							**3.3**	
	8/20/2002	NR														1.1								NA							**3.1**	
	12/4/2002	NR														0.75															**0.81**	
	4/21/2003															1.3 Q															**3.3**	
	10/21/2003															0.97															**3.5**	
	4/27/2004															1.5 Q															**4.2**	
	10/13/2004							1.2 Q		0.93						2.0 Q															**5.9**	
	4/27/05															1.3 Q															**3.1**	
	4/27/05 Dup							1.9 Q								2.5															**6.2**	

Table 3-2 VOC Sampling Results for Groundwater
FF/NN Landfill, Ripon, WI

Parameters

Sampling Point	Collection Date	Acetone[1]	Benzene	Bromomethane	2-Butanone (MEK)	sec-Butylbenzene	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	1,4-dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-dichloroethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloropropane	Ethylbenzene	Isopropylbenzene	Methylene chloride	MTBE	Tetrachloroethene	Tetrahydrofuran	Toluene	1,2,4-Trichlorobenzene	Trichloroethene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Total Xylenes
WDNR NR140	PAL	200	0.5	1	90	NE	NE	80	0.6	0.3	15	200	85	0.5	0.7	7	20	0.5	140	NE	0.5	12	0.5	10	200	14	0.5	NE	96		0.02	1000
	ES	1000	5	10	460	NE	NE	400	6	3	75	1000	850	5	7	70	100	5	700	NE	5	60	5	50	1000	70	5	NE	480		0.2	10000
MW-108	10/18/1993	NR																							11							
	4/13/1994	NR																							2							
	5/8/1996	NR														0.2 J									0.2 J							
	10/23/1996	NR								0.85 J																						
	5/12/1997	NR																														
	10/27/1997	NR																														
	4/14/1998	NR																														
	10/11/2001	NR																			0.34L											
	05/21/2002*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	8/19/2002 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	12/5/2002	NR																														
	10/14/2004															1.2 Q											1.3 Q				**0.67**	
	4/27/05															1.0											0.7				**0.3**	
	8/3/2005																										0.70 Q					
P-108	10/25/1993	NR																														
	10/25/93 Dup	NR																														
	4/13/1994	NR																														
	4/13/94 Dup	NR																														
	10/11/2001	NR																			0.32L											
	2/5/2002	NR			NA																			NA								
	5/21/2002	NR			NA																			NA								
	10/14/2004									0.45 Q																						
	1/28/2005																															
MW-111	4/19/1994	NR																														
	10/11/2001	NR																			0.30L											
	05/21/2002*	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	8/19/2002	NR																						NA								
	12/5/2002	NR																														
	10/13/2004																															

Table 3-2 VOC Sampling Results for Groundwater
FF/NN Landfill, Ripon, WI

Sampling Point	Collection Date	Acetone[1]	Benzene	Bromomethane	2-Butanone (MEK)	sec-Butylbenzene	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	1,4-dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-dichloroethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloropropane	Ethylbenzene	Isopropylbenzene	Methylene chloride	MTBE	Tetrachloroethene	Tetrahydrofuran	Toluene	1,2,4-Trichlorobenzene	Trichloroethene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Total Xylenes
WDNR NR140	PAL	200	0.5	1	90	NE	NE	80	0.6	0.3	15	200	85	0.5	0.7	7	20	0.5	140	NE	0.5	12	0.5	10	200	14	0.5	NE	96		0.02	1000
	ES	1000	5	10	460	NE	NE	400	6	3	75	1000	850	5	7	70	100	5	700	NE	5	60	5	50	1000	70	5	NE	480		0.2	10000
P-111	4/19/1994	NR																							2							
	10/11/2001	NR																														
	2/5/2002	NR			NA																			NA								
	5/22/2002	NR			NA																			NA								
	8/19/2002	NR																						NA								
	08/19/02 Dup	NR																						NA								
	12/5/2002	NR																														
	12/05/02 Dup	NR																														
	4/22/2003																															
	10/22/2003																															
	4/28/2004																															
	8/3/2005																															
P-111D	4/4/2002	NR														0.6									0.3						**13**	
	5/22/2002	NR			NA											0.59 Q								NA							**15**	
	8/19/2002	NR														0.37 Q								NA							**12**	
	12/5/2002	NR														0.42 Q															**11**	
	4/23/2003																														**12**	
	10/23/2003																														**9.1**	
	5/11/2004							1.4																							**15**	
	07/23/04																														**14**	
	10/13/2004							1.9 Q																	1.6 Q						**11**	
	1/27/2005																														**8.8**	
	4/26/05							3.7								0.87 Q															**13**	
	4/26/05 Dup							3.5																							**13**	
	8/3/2005									2.9 Q						0.96 Q															**10**	

Table 3-2 VOC Sampling Results for Groundwater
FF/NN Landfill, Ripon, WI

Sampling Point	Collection Date	Parameters																													
		Acetone[1]	Benzene	Bromomethane	2-Butanone (MEK)	sec-Butylbenzene	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	1,4-dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-dichloroethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloropropane	Ethylbenzene	Isopropylbenzene	Methylene chloride	MTBE	Tetrachloroethene	Tetrahydrofuran	Toluene	1,2,4-Trichlorobenzene	Trichloroethene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Total Xylenes
WDNR NR140	PAL	200	0.5	1	90	NE	NE	80	0.6	0.3	15	200	85	0.5	0.7	7	20	0.5	140	NE	0.5	12	0.5	10	200	14	0.5	NE	96		0.02	1000
	ES	1000	5	10	460	NE	NE	400	6	3	75	1000	850	5	7	70	100	5	700	NE	5	60	5	50	1000	70	5	NE	480		0.2	10000
MW-112	11/27/1996	NR	0.6J					2 J								59	1 J										3J				**15**	
	11/27/96 Dup	NR	0.7J					2 J								58	1 J										4J				**16**	
	5/12/1997	NR	0.59				0.27									5.4															**2.2**	
	10/26/1997	NR	0.5				0.29									1.3																
	4/13/1998	NR	0.69					1.4								57	1.3										1.9				**12**	
	10/13/1998	NR	0.76													**80**											1.2				**25**	
	4/6/1999	NR	0.72					1.4								40	0.56										1.7				**7.9**	
	10/27/1999	NR														7.6											1					
	5/2/2000	NR	0.46													3.4											0.39					
	10/30/2000	NR					0.37									5.6											0.37					
	5/9/2001	NR	0.42				0.42									3.5															**0.98**	
	10/11/2001	NR	0.36				0.39	0.53								27											0.83				**3.7**	
	2/4/2002	NR	0.23		NA		0.48									0.49								NA								
	05/21/2002*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	8/19/2002 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	12/4/2002															**150**											2.7 Q				**56**	
	4/22/2003		1.2 Q					7.4 &								**220**	4.5 Q										**5.9**				**45**	
	10/22/2003	2.5	0.88					5.9								60	1.4										1.6				**51**	
	4/28/2004		0.53 Q				0.45 Q	4								18											1.1 Q				**9.9**	
	4/28/04 dup	6.5	0.61 Q				0.48 Q	4.7								22											1.1 Q				**9.3**	
	07/23/2004	110	1.1					23								**140**	2.6	0.58					1				**7.4**				**31**	
	10/13/2004		1.0 Q				0.42	14								**110**	2.4 Q										2.9				**25**	
	10/13/04 Dup		0.87 Q					15		0.56 Q						**94**	2.1 Q						0.60 Q				2.9				**29**	
	1/26/2005		0.76 Q					20								**85**	2.3 Q														**27**	
	4/26/05		0.6 Q					13								**64**	1.2 Q										1.8				**17**	
	8/3/2005						0.48 Q									4.6															**1.5**	
P-113A	9/12/2002	NR							0.37Q																1.0Q							
	12/3/2002	NR																														
	4/23/2003																								2.2							
	10/22/2003																															
	5/11/2004																															
	8/2/2005																															

Table 3-2 VOC Sampling Results for Groundwater
FF/NN Landfill, Ripon, WI

		Parameters																														
Sampling Point	Collection Date	Acetone[1]	Benzene	Bromomethane	2-Butanone (MEK)	sec-Butylbenzene	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	1,4-dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-dichloroethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloropropane	Ethylbenzene	Isopropylbenzene	Methylene chloride	MTBE	Tetrachloroethene	Tetrahydrofuran	Toluene	1,2,4-Trichlorobenzene	Trichloroethene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Total Xylenes
WDNR NR140	PAL	200	0.5	1	90	NE	NE	80	0.6	0.3	15	200	85	0.5	0.7	7	20	0.5	140	NE	0.5	12	0.5	10	200	14	0.5	NE	96		0.02	1000
	ES	1000	5	10	460	NE	NE	400	6	3	75	1000	850	5	7	70	100	5	700	NE	5	60	5	50	1000	70	5	NE	480		0.2	10000
P-113B	09/11/2002[3]	NR							1										0.41Q						6.6							2.6
	12/3/2002	NR																														
	4/23/2003																															
	7/30/2003																															
	10/22/2003																															
	2/4/2004																															
	5/11/2004																															
	07/22/04																															
	10/14/2004									0.49 Q																						
	1/27/2005																															
	4/27/05																															
	8/2/2005																															
P-114 (former Ehster well)	11/19/2001	NR														0.93															**7**	
	2/5/2002	NR														0.85															**5.5**	
	5/22/2002	NR														1.2															**6.2**	
	8/21/2002	NR														0.93															**5.4**	
	12/3/2002	NR														1.3									0.40Q						**6.3**	
	4/23/2003																														**3.3**	
	10/23/2003															1.2															**8.6**	
	10/23/03 Dup															1.4															**9.2**	
	5/11/2004															1.5 Q															**10**	
	07/22/04															1.4 Q															**7.9**	
	10/13/2004									0.39 Q						1.7 Q															**10**	
	1/27/2005																														**3.5**	
	4/26/05																														**3.0**	
	8/2/2005															1.1 Q															**6.1**	

Table 3-2 VOC Sampling Results for Groundwater
FF/NN Landfill, Ripon, WI

		Parameters																														
Sampling Point	Collection Date	Acetone[1]	Benzene	Bromomethane	2-Butanone (MEK)	sec-Butylbenzene	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	1,4-dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-dichloroethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloropropane	Ethylbenzene	Isopropylbenzene	Methylene chloride	MTBE	Tetrachloroethene	Tetrahydrofuran	Toluene	1,2,4-Trichlorobenzene	Trichloroethene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Total Xylenes
WDNR NR140	PAL	200	0.5	1	90	NE	NE	80	0.6	0.3	15	200	85	0.5	0.7	7	20	0.5	140	NE	0.5	12	0.5	10	200	14	0.5	NE	96		0.02	1000
	ES	1000	5	10	460	NE	NE	400	6	3	75	1000	850	5	7	70	100	5	700	NE	5	60	5	50	1000	70	5	NE	480		0.2	10000
P-115 (former Wiese well)	10/9/2001	NR																														
	10/09/01 Dup	NR																														
	11/19/2001	NR																														
	2/5/2002	NR																														
	5/22/2002	NR																														
	8/19/2002	NR								0.20Q																						
	12/3/2002	NR																														
	4/22/2003																															
	7/30/2003																															
	10/22/2003																															
	2/4/2004																															
	4/27/2004																															
	10/14/2004																														**0.33 Q**	
	1/27/2005																															
	4/26/05																															
	8/2/2005																														**0.34 Q**	

Table 3-2 VOC Sampling Results for Groundwater
FF/NN Landfill, Ripon, WI

		Parameters																														
Sampling Point	Collection Date	Acetone[1]	Benzene	Bromomethane	2-Butanone (MEK)	sec-Butylbenzene	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	1,4-dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-dichloroethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloropropane	Ethylbenzene	Isopropylbenzene	Methylene chloride	MTBE	Tetrachloroethene	Tetrahydrofuran	Toluene	1,2,4-Trichlorobenzene	Trichloroethene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Total Xylenes
WDNR NR140	PAL	200	0.5	1	90	NE	NE	80	0.6	0.3	15	200	85	0.5	0.7	7	20	0.5	140	NE	0.5	12	0.5	10	200	14	0.5	NE	96		0.02	1000
	ES	1000	5	10	460	NE	NE	400	6	3	75	1000	850	5	7	70	100	5	700	NE	5	60	5	50	1000	70	5	NE	480		0.2	10000
P-116 (former Hadel well)	10/9/2001	NR																														
	11/19/2001[4]	NR																														
	2/5/2002	NR																														
	5/22/2002	NR																														
	8/19/2002	NR																														
	08/19/02 Dup	NR																														
	12/3/2002	NR																														
	12/03/02 Dup	NR																														
	4/22/2003																															
	7/30/2003																															
	10/22/2003																															
	2/4/2004																															
	5/11/2004																															
	07/22/04																															
	10/14/2004																															
	1/27/2005																															
	4/26/05																															
	8/2/2005																															

Results in µg/L

B = analyte found in method blank as well as sample
E = exceeds calibration range
J = estimated value
L = Lab Artifact
Q = Detected between LOD and LOC
& = Laboratory control spike recovery not within control limits
NE = None Established
NA= Not Analyzed; no sample collected for analysis
NR = Value not reported by lab or not recorded during initial evaluation by GeoTrans

PAL = Preventive Action Limit
ES = Enforcement Standard
Underline indicates exceeds NR 140 PAL
Bolding indicates exceeds NR 140 ES
Blank = Not detected
Historical data for abandoned wells MW-105, P-105, P-109 and MW-110 can be found in reports prior to October 204

* Not sampled due to insufficient water for sample collectic

[1] The reporting of acetone on an 8260B VOC scan varies with labs. Enchem, which began analyzing samples in April 2003, does report acetone. Acetone has appeared in several wells beginning in Octobe

[2] MW-103 had low concentrations of isopropyl ether detected in October 1997 and February 2002. Acetone at 27 ppb was detected in April :

[3] this sample had detections of bromodichloromethane at 0.59 ppb and dibromochloromethane at 0.35 p|

[4] this sample in P-116 had 0.18 ppb of 1,1,1-trichloroethan

Table 3-3 Historical Methane
Gas Monitoring Measurements

	% Methane (CH4)											
Well/Vent #	05/15/97	10/28/97	04/28/98	10/13/98	10/28/99	05/03/00	10/30/00	05/09/01	10/23/01	05/21/02 [#]	12/03/02	04/21/03 [#]
LC-1	0.5	14.6	17	10.6	23	1.8	2.1	3	9.7	0	8	NT
LC-2	1	35.2	13.3	14.3	32	17.9	21	29	42.2	0	29.2	NT
LC-3	0	28.5	22.9	25.2	30	2.4	40.1	59.5	59	0	40.8	NT
MW-101	0.8	0.9	0.4	0	0	0	0	0	0	0	1.9	NT
MW-102	0	0	2.2	0	0	0.1	0	0	0	0	0.1	0
MW-103	0	4.6	10.6	11.6	4.3	0	11.4	0	0	0	1.5	0.1
MW-104	0	51.4	23.1	49.5	1.7	0	29.7	16.7	0	0	4.2	NT
MW-112	NT	NT	NT	NT	NT	NT	NT	NT	NT	0	1.2	0
GV-1	0	51.1	24	10.4	0	0	0	6.8	28.6	0.1	5.5	NT
GV-2	0.5	46.5	0.1	29.3	0.1	0.7	27.1	10.2	22.6	0	13	NT
GV-3	0	41.3	0	32.6	0.3	0.6	32	22.2	0	0	7.1	NT
GV-4	0	20.4	0	21.8	0.8	0	0	0.1	0	0	9.4	NT
GV-5	0.5	0	10.1	17.5	8.8	0	0	0	0	0	3.8	NT
GV-6	0	46	0	19.4	0.2	2.4	5.5	4.3	0	0	0	NT
GV-7	0	53.7	0	1.8	0.1	2.8	5.3	28.2	23.8	0	4.7	NT
GV-8	0	57	17	0	0.1	6.1	21.2	38.5	20.5	0	0.1	NT
GV-9	0	51.8	43.3	0	0	23.7	19.4	38.9	0	0	22.8	NT
GV-10	0	0	0	0	0	9.6	0	7.1	0	0	0.1	NT
GV-11	2.8	7.7	2.6	0	0	8.9	0	0	0	0	0	NT
GV-12	0	0	19.7	0	1.5	0	0	0	0	0	0.2	NT
GP-1										installed April 2004		
GP-2										installed May 2004		
GP-3										installed April 2004		
GP-4										installed May 2004		
GP-5												
GP-6												
GP-7												
GP-8												
GP-10												
GP-11										installed May 2004		
GP-12										installed May 2005		
Background	NR	NR	NR	NR	NR	NR	NR	NR	NR	0	0	0

Notes:
Measurements taken using a Landtec GA-90 methane - O2-CO2 analyzer unless otherwise noted
NT = Not Tested
NR = Not Recorded
[#] Meter experiencing mechanical difficulties
GP = Gas probe outside of perimeter of waste
GV = Gas vent inside waste boundaries
MW = monitoring well
Results for original vents #1 through #5 and all data prior to 1996 are found on historical data tables published prior to October 2004

Table 3-3 Historical Methane
Gas Monitoring Measurements

	% Methane (CH4)							
Well/Vent #	07/30/03	10/21/03	04/28/04	06/16/04	10/12/04	01/28/05	04/26/05	08/01/05
LC-1	2.4	0	0.6		1.6	6.9	57.3	60.5
LC-2	6.6	2.3	3.4		0	5.5	3.4	66
LC-3	17.2	0	31.2		0	3.8	5	57
MW-101	0	0	0		2.9	2.2	0	0
MW-102	2.8	0	0		0	0	0	0
MW-103	3.9	0	3.3		6.2	1.8	0	3
MW-104	11.1	0	11.5		22.4	10.1	0	15.1
MW-112	0.8	0	2.6		4.6	1.1	0	1.1
GV-1	0	0	0		0	0	0	29.3
GV-2	1	0	0		0	0	0	39.1
GV-3	0	6.1	0	not monitored	2.5	7.6	0	46
GV-4	0	0	0		17.5	1.9	0	0
GV-5	0	0	0		16.1	0	0	0
GV-6	0	2.1	0		22.1	6.3	8.7	31.5
GV-7	1.6	0	0		0	9.0	0.4	43
GV-8	0.6	0	0		0	0	2.9	46.5
GV-9	19.9	0	0		0	15.5	0	39.5
GV-10	0	0	21.3		0	0	12.2	31.5
GV-11	1	0	0		0	0	0	20.9
GV-12	0	2.1	6		0	0	0	8.7
GP-1			43.6	28.7	29.7	17	41.9	24.5
GP-2				24.7	23.6	22.5	30.6	15.5
GP-3			13.6	13	18.6	9.1	0.7	7.3
GP-4				0	0	0	0	0
GP-5		installed fall 2004			0	0	0	0
GP-6		installed fall 2004			0	0	0.6	0
GP-7		installed fall 2004			5.9	1.7	2.6	0
GP-8		installed fall 2004			4.2	0	0	0
GP-10		installed fall 2004			0	NT	0	0
GP-11		installed fall 2004			0	0	0	0
GP-12		installed fall 2004			0	0	0	0
Background	0	0	0	NR	0	0	0	0

Notes:
Measurements taken using a Landtec GA-90 methane - O2-CO2 analyzer unless otherwise noted
NT = Not Tested
NR = Not Recorded
[#] Meter experiencing mechanical difficulties
GP = Gas probe outside of perimeter of waste
GV = Gas vent inside waste boundaries
MW = monitoring well
Results for original vents #1 through #5 and all data prior to 1996
are found on historical data tables published prior to October 2004

Table 4-1 Screening of General Response Actions and Technologies

General Response Action	Potential Remedial Technology	Process Options	Description	Initial Screening
No Action	None	Not Applicable	No additional action. Groundwater would be subject to on-going, uncontrolled hydrologic processes.	Required for consideration by NCP
Institutional Controls	Access Restriction	Municipal Ordinance	For undeveloped properties, prohibit private well installation and require use of municipal water supply.	Potentially applicable. Already established by Town of Ripon
		Well Casing Advisory	Restrictions placed on new well construction.	Potentially applicable. Already established by WDNR
	Alternative Water Supply	Municpal Water Supply	Extension of existing municipal well system to serve residents in the area of influence.	Potentially applicable. Already implemented for some residences and available for others potentially at risk.
		Residential Point-of-Entry Treatment System	Install POE treatment at residences with impacted water. It is considered a temporary measure.	Not appropriate because municipal water available.
		Bottled water	Provide bottled water for residents with impacted private well. It is considered a temporary measure.	Potentially applicable. Interim response until municipal water supply hook-up is completed.
		Relocate wells	Install new wells to serve residents within potentially contaminated area.	Not appropriate because municipal water available.
	Monitoring	Groundwater monitoring	Ongoing monitoring of wells	Potentially applicable
Groundwater Extraction	Extraction	Extraction Wells	Series of wells to extract contaminated water	Potentially applicable.
	Subsurface Drains	Trench or Horizontal Drains	Trenches or horizontal boreholes with perforated pipes, and backfill with porous media to collect groundwater.	Not feasible because of depth of aquifer
Groundwater Treatment (Ex-situ)	Physical/Chemical Treatment	Air Stripping	Mixing large volumes of air with water in it in a packed column or trays to promote transfer of VOCs to air	Potentially applicable.
		Carbon Adsorption	Adsorption of VOCs onto activated carbon by passing water through carbon column	Not effective in removal of vinyl chloride.
	Biological Treatment	Aerobic	Degradation of VOCs using microorganisms in an aerobic environment	Not feasible due to insufficient contaminant mass to support an adequate microbial population density.
		Anerobic	Degradation of VOCs using microorganisms in an anaerobic environment	Not feasible due to insufficient contaminant mass to support an adequate microbial population density.

Table 4-1 Screening of General Response Actions and Technologies

General Response Action	Potential Remedial Technology	Process Options	Description	Initial Screening
Groundwater Discharge	Discharge	POTW	Discharge to Ripon POTW via sanitary sewer approximately 1 mile away.	Not feasible due to inability of POTW to handle volume of water
		Surface Waters	Discharge to Silver Creek or wetland.	Potentially applicable.
		Infiltration Gallery	Discharge to infiltration gallery upgradient of extraction wells.	Not feasible due to potential problems with clogging, cold weather maintenance, and unsuitable soils.
Groundwater Treatment (In-situ)	Physical/ Chemical treatment	Circulation Wells	Series of double-screened wells that are used for air injection to produce vertical circulation in the aquifer and provide in-situ air stripping of VOCs.	Potentially applicable.
		Permeable Reactive Barrier	Barriers constructed of reactive materials, such as iron filings, that serve to reductively dechlorinate VOCs as they pass through the permeable wall. Reactive materials can be implaced via trenches or injection wells.	Not feasible because of depth and thickness of aquifer
		Chemical Oxidation	System of injection wells to inject oxidizer such as hydrogen peroxide or potassium permanganate to oxidize VOCs	Not feasible because of depth and thickness of aquifer and areal extent of VOC plume
	Biological treatment	Bioaugmentation	System of injection wells to introduce and/or recirculate halorespiring bacteria and electron donor, such as lactate or emulsified oil, to produce anaerobic environment that results in reductive dechlorination of VOCs.	Potentially applicable.
	Natural Attenuation	Monitored Natural Attenuation	Monitoring groundwater parameters to determine if natural subsurface processes, such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials, are naturally reducing VOC concentrations such that the plume is stable or shrinking.	Potentially applicable.
Landfill Gas Control	Landfill Gas Extraction	Active Landfill Gas Extraction	Vacuum blower applied to vents and/or wells in the landfill to actively remove landfill gas.	Potentially applicable. Interim system to be installed.
		Passive Landfill Gas Extraction	Gases are passively vented from extraction vents and/or wells	Not appropriate because gases are not controlled.
	Landfill Gas Treatment	Flaring	Gases are combusted using thermal flare	Not appropriate because gases can be vented without treatment

Table 5-1 Cost Estimate for Alternative B- Institutional Controls with Connection to Municipal Water

Capital Costs				
Item	Unit Cost	Unit	Quantity	Total
Extend Water Main on South Koro Rd.	$ 50	linear ft	800	$40,000
Private Well Abandonments	$ 1,000	well	12	$12,000
Connection Fees	$ 600	home	12	$7,200
Plumbing, etc. to connect	$ 4,000	home	12	$48,000
Subtotal				$107,200
Contingency (15%)				$16,080
Total				$123,280

Annual Costs				
Groundwater Monitoring [1]	$34,000.00	year	1 year	$34,000
Total Annual Costs				$34,000
Present Worth of Groundwater Monitoring for 30 years*				$523,000

Present Worth of Alternative B	$646,000

Present Worth of Alternative B, excluding groundwater monitoring costs	$123,000

Notes

[1] Semiannual sampling of 15 groundwater monitoring wells and reporting

* Present worth calculated for 30 years at 5% (pwf = 15.372)

Table 5-2 Cost Estimate for Alternative C1- Source Control via Active Landfill Gas Extraction Using Existing Gas Vent System

Capital Costs				
Item	Unit Cost	Unit	Quantity	Total
Install Header System	$ 21	linear ft	1,500	$ 31,500
Purchase and Install Blower System	$ 36,000	each	1	$ 36,000
Building	$ 7,000	each	1	$ 7,000
Provide 3-Phase Power	$ 25,000	each	1	$ 25,000
Subtotal				$99,500
Design (10% of Costs)				$9,950
Construction Oversight and Reporting (8% of costs)				$7,960
Contingency (15%)				$17,612
Total				$135,022

Annual Costs	
System Maintenance and Repair (10% of Capital Costs)	$13,502
System Operation (electricity, condensate disposal)	$8,000
Groundwater Monitoring [1]	$35,000
Total Annual Costs	$56,502
Present Worth of Annual Costs (10 yrs for extraction system, 30 yrs for monitoring) *	$ 704,060

Present Worth of Alternative C1	$ 839,081

Present Worth of Alternative C1, excluding groundwater monitoring costs	$301,081

Notes

[1] Semiannual sampling of 15 monitoring wells and 3 private wells, annual sampling of 3 additional private wells and reporting.

* Present worth calculated for 10 years at 5% (pwf = 7.722) and 30 years at 5% (pwf = 15.372)

Table 5-3 Cost Estimate for Alternative C2- Source Control via Active Landfill Gas Extraction With Installation of New Gas Extraction Wells

Capital Costs				
Item	Unit Cost	Unit	Quantity	Total
Install Active Gas Extraction Wells	$ 10,000	each	4	$ 40,000
Install Header System	$ 21	linear ft	1,500	$ 31,500
Purchase and Install Blower System	$ 36,000	each	1	$ 36,000
Building	$ 7,000	each	1	$ 7,000
Provide 3-Phase Power	$ 25,000	each	1	$ 25,000
Subtotal				$ 139,500
Design (10% of Costs)				$ 13,950
Construction Oversight and Reporting (8% of costs)				$ 11,160
Contingency (15%)				$ 20,925
Total				$ 185,535

Annual Costs	
System Maintenance and Repair (10% of Capital Costs)	$ 18,554
System Operation (electricity, condensate disposal)	$ 8,000
Groundwater Monitoring [1]	$ 35,000
Total Annual Costs	$ 61,554
Present Worth of Annual Costs (10 yrs for extraction system, 30 yrs for monitoring) *	$ 743,066

Present Worth of Alternative C2	$ 928,601

Present Worth of Alternative C2, excluding groundwater monitoring costs	$390,601

Notes

[1] Semiannual sampling of 15 monitoring wells and 3 private wells, annual sampling of 3 additional private wells and reporting.

* Present worth calculated for 10 years at 5% (pwf = 7.722) and 30 years at 5% (pwf = 15.372)

Table 5-4 Cost Estimate for Alternative C3- Source Control via Groundwater Extraction and Treatment

Capital Costs				
Item	Unit Cost	Unit	Quantity	Total
Groundwater Extraction/Treatment System**	$109,920	each	1	$109,920
Subsurface Pipeline to Wetland	$40	linear ft	500	$20,000
Property Access	$20,000	each	1	$20,000
NPDES Permit/ Hydrologic Evaluation	$20,000	each	1	$20,000
Subtotal				$169,920
Design (10%)				$16,992
Construction Oversight (8%)				$13,594
Contingency (15%)				$30,076
Total				$230,581

Annual Costs			
Groundwater Extraction and Treatment System Operation**	$52,000	1	$52,000
Monthly Water Discharge Sampling and Analysis	$1,400	12	$16,800
Groundwater Monitoring [1]	$35,000	1	$35,000
Total Annual Costs			$103,800
Present Worth of Annual Costs, (30 years of operation & monitoring *)			$1,596,000

Present Worth of Alternative C3	$1,826,581

Present Worth of Alternative C3, excluding groundwater monitoring costs	$1,289,000

Notes

**Costs for this alternative were originally developed for 1994 Feasibility Study and have been adjusted using the Engineering News Record Construction index (1994: 5,400, 2005: 7,420).

[1] Semiannual sampling of 15 monitoring wells and 3 private wells, annual sampling of 3 additional private wells and reporting.

* Present worth calculated for 30 years at 5% (pwf = 15.372)

Table 5-5 Cost Estimate for Alternative C4- Source Control via Shallow Biobarrier System

Capital Costs				
Item	Unit Cost	Unit	Quantity	Total
Pilot Study (7 injection points, 15 barrels EOS)	$30,000	each	1	$30,000
Full Scale Injection of EOS with GeoProbe	$500	each	23	$11,500
Emulsified Oil Substance for full scale injection	$600	barrel	40	$24,000
Addition of bacterial innoculant**	$5	cy	2700	$13,500
Maintenance injection of EOS, if needed***	$600	barrel	30	$18,000
Subtotal				$97,000
Permitting and Design (10%)				$9,700
Construction Oversight (8%)				$7,760
Contingency (15%)				$17,169
Total				$131,629

Annual Costs			
Sampling and reporting regarding biobarrier	$15,000	1	$15,000
Groundwater Monitoring [1]	$35,000	1	$35,000
Total Annual Costs			$50,000
Present Worth of Annual Costs (10 years for biobarrier & 30 for monitoring *)			$653,850

Present Worth of Alternative C4	$785,479

Present Worth of Alternative C4, excluding groundwater monitoring costs	$247,479

Notes

Costs for this alternative were originally developed for 1994 Feasibility Study and have been adjusted using the Engineering News Record Construction index (1994: 5,400, 2005: 7,420).

[1] Semiannual sampling of 15 monitoring wells and 3 private wells, annual sampling of 3 additional

* Present worth calculated for 10 years at 5% (pwf = 7.722) and 30 years at 5% (pwf = 15.372)

**Assumes innoculant added to treatment zone of 30 feet by 400 feet long by 6 feet wi Added if needed.

*** Using small diameter wells installled as a part of initial injection.

Table 5-6 Cost Estimate for Alternative D1- Deep Aquifer Remediation via Groundwater Circulation Wells

Capital Costs				
Item	Unit Cost	Unit	Quantity	Total
Permitting, Design, and Regulatory Requirements	$50,000	each	1	$50,000
Well Installation, Equipment	$100,000	well	6	$600,000
Startup	$20,000	each	1	$20,000
Subtotal				$670,000
Contingency (15%)				$100,500
Total				$770,500

Annual Costs	
Operations and Maintenance	$50,000
Groundwater Monitoring [1]	$35,000
Total Annual Costs	$85,000
Present Worth of Annual Costs (30 yrs for circulation system and monitoring) *	$ 1,306,620

Present Worth of Alternative D1	$ 2,077,120

Present Worth of Alternative D1, excluding groundwater monitoring costs	$1,539,120

Notes

[1] Semiannual sampling of 15 monitoring wells and 3 private wells, annual sampling of 3 additional private wells and reporting.

* Present worth calculated for 30 years at 5% (pwf = 15.372)

Table 5-7 Cost Estimate for Alternative D2- Deep Aquifer Remediation via Groundwater Extraction and Treatment

Capital Costs				
Item	Unit Cost	Unit	Quantity	Total
Groundwater Extraction/Treatment Syst	$109,920	each	1	$109,920
Subsurface Pipeline to Silver Creek	$40	linear ft	1,500	$60,000
Property Access	$20,000	each	1	$20,000
NPDES Permit/ Hydrologic Evaluation	$20,000	each	1	$20,000
Subtotal				$209,920
Permitting and Design (10%)				$20,992
Construction Oversight (8%)				$16,794
Contingency (15%)				$37,156
Total				$284,861

Annual Costs			
Groundwater Extraction and Treatment System Operation**	$52,000	1	$52,000
Monthly Water Discharge Sampling	$1,400	12	$16,800
Groundwater Monitoring [1]	$35,000	1	$35,000
Total Annual Costs			$103,800
Present Worth of Annual Costs, (30 years of operation & monitoring *)			$1,595,614

Present Worth of Alternative D2	$ 1,880,475
Present Worth of Alternative D2, excluding groundwater monitoring costs	$ 1,342,475

Notes

[1] Semiannual sampling of 15 monitoring wells and 3 private wells, annual sampling of 3 additional private

* Present worth calculated for 30 years at 5% (pwf = 15.372)

** Cost updated from 1994 FS.

Table 5-8 Cost Estimate for Alternative D3- Deep Aquifer Remediation via Monitored Natural Attenuation with Source Control

Source Control is Active Gas Extraction With Installation of New Gas Extraction Wells

Capital Costs					
Item	Unit Cost	Unit	Quantity	Total	
Install Active Gas Extraction Wells	$ 10,000	each	4	$	40,000
Install Header System	$ 21	linear ft	1,500	$	31,500
Purchase and Install Blower System	$ 36,000	each	1	$	36,000
Building	$ 7,000	each	1	$	7,000
Provide 3-Phase Power	$ 25,000	each	1	$	25,000
Subtotal				$	139,500
Design (10% of Costs)				$	13,950
Construction Oversight and Reporting (8% of costs)				$	11,160
Contingency (15%)				$	20,925
Total				$	185,535

Annual Costs		
System Maintenance and Repair (10% of Capital Costs)	$	18,554
System Operation (electricity, condensate disposal)	$	8,000
Groundwater Monitoring [1]	$	35,000
Total Annual Costs	$	61,554
Present Worth of Annual Costs (10 yrs for extraction system, 30 yrs for monitorir	$	743,070

Present Worth of Alternative D3	$	928,605

Present Worth of Alternative D3, excluding groundwater monitoring costs	$	390,605

Notes

[1] Semiannual sampling of 15 monitoring wells and 3 private wells, annual sampling of 3 additional

* Present worth calculated for 10 years at 5% (pwf = 7.722) and 30 years at 5% (pwf = 15.372)

Table 6-1: Summary Evaluation of Remedial Alternatives
FF/NN Landfill, Ripon, WI

	Remedial Alternatives								
	A	**B**	**C1**	**C2**	**C3**	**C4**	**D1**	**D2**	**D3**
			Source Control				**Deep Aquifer Remediation**		
Criteria	**No Action**	**Institutional Controls with Connection to Municipal Water Supply**	**Active Gas Extraction using Existing Passive Collection System**	**Active Gas Extraction with New Vertical Extraction Wells**	**Shallow Groundwater Extraction/Treatment System**	**Shallow Biobarrier System**	**Ground water Circulation Wells**	**Deep Groundwater Extraction/Treatment System**	**Monitored Natural Attenuation with Source Control (Alternative C)**
Compliance with ARARs	Requires a relatively long period of time (greater than 15 years) to achieve NR 140 PALs.	Require a relatively long period of time (greater than 15 years) to achieve NR 140 PALs.	Complies with ARARs relative to landfill gas. This alternative would require a relatively long period of time (greater than 15 years) to achieve NR 140 PALs.	Complies with ARARs relative to landfill gas. This alternative would require a relatively long period of time (greater than 15 years) to achieve NR 140 PALs.	Can meet all groundwater sampling analysis, extraction, recovery and discharge ARARs. This alternative would require a relatively long period of time to (greater than 15 years) achieve NR 140 PALs.	Can meet all groundwater sampling and analysis ARARs. This alternative would require a relatively long period of time (greater than 15 years) to achieve NR 140 PALs.	Can meet all groundwater sampling and analysis ARARs. This alternative would require a relatively long period of time (probably more than 15 years) to achieve NR 140 PALs.	Can meet all groundwater sampling analysis, extraction recovery and discharge ARARs. This alternative would require a relatively long period of time (probably more than 15 years) to achieve NR 140 PALs.	Can meet all groundwater sampling and analysis ARARs. This alternative would require a relatively long period of time (greater than 15 years) to achieve NR 140 PALs.
Overall protection of human health and the environment	Does not directly address impacted groundwater. Concentrations of vinyl chloride will likely remain above NR 140 standards until natural attenuation processes degrade contaminant.	Provides drinking water quality protection to residents on Charles Street and South Koro Road.	Prevents or lessens future impacts to groundwater. Does not address groundwater that is already impacted. Concentrations of vinyl chloride will likely remain above NR 140 standards until natural attenuation processes degrade contaminant.	Prevents or lessens future impacts to groundwater. Does not address groundwater that is already impacted. Concentrations of vinyl chloride will likely remain above NR 140 standards until natural attenuation processes degrade contaminant.	Prevents or lessens future impacts to groundwater. Does not address groundwater that is already impacted. Concentrations of vinyl chloride will likely remain above NR 140 standards until natural attenuation processes degrade contaminant.	Prevents or lessens future impacts to groundwater. Does not address groundwater that is already impacted. Concentrations of vinyl chloride will likely remain above NR 140 standards until natural attenuation processes degrade contaminant.	Prevents downgradient migration of impacted groundwater to private wells. Effectiveness of circulation wells has not been demonstrated at very low concentrations.	Prevents downgradient migration of impacted groundwater to private wells. Effectiveness of removal is limited at low concentrations.	Prevents or lessens future impacts to groundwater. Does not address groundwater that is already impacted. Concentrations of vinyl chloride will likely remain above NR 140 standards until natural attenuation processes degrade contaminant.
Short-term effects	There would be no short-term additional risks associated with this alternative as it involves no new construction.	There would be no short-term additional risks to construction workers or the public as contaminants are at a much greater depth than water main construction.	There would be no short-term additional risks to construction workers or the public as all construction will occur above the wastes.	There would be limited exposure of construction workers during extraction well construction; use personal protective equipment. Odors will also be generated during extraction well construction.	There would be very limited exposure of construction workers to impacted groundwater during extraction well construction; use personal protective equipment.	There would be very limited exposure of construction workers to impacted groundwater during extraction well construction; use personal protective equipment.	There would be very limited exposure of construction workers to impacted groundwater during extraction well construction; use personal protective equipment.	There would be very limited exposure of construction workers to impacted groundwater during extraction well construction; use personal protective equipment.	Limited exposure to construction workers would occur during implementation of the source control alternative.
Long-term effectiveness and permanence	Improves the existing groundwater quality through natural attenuation processes only. Ongoing impacts to groundwater continue at the landfill.	Provides a permanent method for protecting public health. Improves the existing groundwater quality through natural attenuation processes only. Ongoing impacts to groundwater continue at the landfill.	Provides a long-term effectiveness and permanence by minimizing future groundwater impacts. It would be protective of groundwater in the long term. Improves the existing groundwater quality through natural attenuation processes.	Provides long-term effectiveness and permanence by minimizing future groundwater impacts. It would be protective of groundwater in the long term. Improves the existing groundwater quality through natural attenuation processes.	Provides long-term effectiveness and permanence by removing groundwater impacts near their source. It would be protective of groundwater in the long term. Improves the existing groundwater quality through natural attenuation processes.	Effectiveness will require a pilot test. Provides long-term effectiveness and permanence by preventing the migration o future impacts from the source. It would be protective of groundwater in the long term. Improves existing groundwater quality through natural attenuation proccesses.	Provides long-term effectiveness and permanence by preventing the migration of future impacts from the source. It would be protective of groundwater in the long term. Improves existing groundwater quality through natural attenuation proccesses downgradient of circulation wells.	Provides long-term effectiveness by removing existing groundwater impacts. Does not prevent continuing contamination from occurring at the source.	Provides long-term effectiveness and permanence by minimizing future groundwater impacts. It would be protective of groundwater in the long term. Improves the existing groundwater quality through natural attenuation processes.
Reduction of toxicity, mobility or volume through treatment	Treatment of ground-water occurs only via natural attenuation processes.	Treatment of ground-water occurs only via natural attenuation processes.	Vinyl chloride in landfill gas would be removed from the landfill and minimize future impacts to groundwater. Includes natural attenuation processes for groundwater that has been impacted. Removes about 17 pounds of vinyl chloride from subsurface annually.	Vinyl chloride in landfill gas would be removed from the landfill and minimize future impacts to groundwater. Includes natural attenuation processes for groundwater that has been impacted. Removes about 17 pounds of vinyl chloride from subsurface annually.	Provides groundwater extraction and treatment to prevent additional migration of groundwater impacts from the landfill. Includes natural attenuation processes for groundwater that has already been impacted. Removes about 0.9 pounds of vinyl chloride from subsurface annually.	Prevents additional migration of groundwater impacts from the landfill. Includes natural attenuation processes for groundwater that has already been impacted.	Provides groundwater treatment to restore groundwater quality to WDNR cleanup standards, though technology has not been demonstrated at very low concentrations. Includes natural attenuation processes for groundwater downgradient of the circulation wells. Removes about 0.5 pounds of vinyl chloride from subsurface annually.	Provides groundwater extraction and treatment to restore groundwater quality to WDNR cleanup standards. Removes about 0.3 pounds of vinyl chloride from subsurface annually.	Prevents additional migratio of groundwater impacts from the landfill. Includes natural attenuation processes for groundwater that has already been impacted.

Table 6-1: Summary Evaluation of Remedial Alternatives
FF/NN Landfill, Ripon, WI

	Remedial Alternatives								
	A	**B**	**C1**	**C2**	**C3**	**C4**	**D1**	**D2**	**D3**
			Source Control				**Deep Aquifer Remediation**		
Criteria	**No Action**	**Institutional Controls with Connection to Municipal Water Supply**	**Active Gas Extraction using Existing Passive Collection System**	**Active Gas Extraction with New Vertical Extraction Wells**	**Shallow Groundwater Extraction/Treatment System**	**Shallow Biobarrier System**	**Ground water Circulation Wells**	**Deep Groundwater Extraction/Treatment System**	**Monitored Natural Attenuation with Source Control (Alternative C)**
Implementability	This alternative involves no construction and would be easily implemented.	Connection of private homes to existing public water can be implemented quickly. The extension of the water main along Old Highway 23 may require the involvement of the Public Services Commission which could temporarily delay those homes from being connected. This alternative involves standard construction and plumbing and is readily implementable.	Construction, operation and maintenance of an active gas extraction system is readibly implementable.	Construction, operation and maintenance of an active gas extraction system is readibly implementable.	May be difficult to implement due to the the significance of flow relative to that in Silver Creek, or of discharge to the nearby wetland.	Use of GoProbe to consistently push to a depth of 70 feet in sand and gravel may be diffcult; use of augers would increase costs substantilly. Effectiveness will require a pilot test.	Installation of groundwater circulation wells is a relatively new technology. However, this is readily implementable.	May be difficult to implement due to the the significance of flow relative to that in Silver Creek, or of discharge to the nearby wetland.	Monitored Natural Attenuation is similar to the existing monitoring program. Implementability of alternative is related to that used for source control.
Approximate cost	Capital cost: $0 Annual cost: $35,000 Present worth: $538,000 Present worth w/o grndwater mon: $0	Capital cost: $123,000 Annual cost: $34,000 Present worth: $646,000 Present worth w/o grndwater mon: $123,000	Capital cost: $135,000 Annual cost: $56,500 Present worth: $839,000 Present worth w/o grndwater mon: $301,000	Capital cost: $186,000 Annual cost: $61,600 Present worth: $929,000 Present worth w/o grndwater mon: $391,000	Capital cost: $231,000 Annual cost: $103,800 Present worth: $1,827,000 Present worth w/o grndwater mon: $1,289,000	Capital cost: $132,000 Annual cost: $50,000 Present worth: $785,000 Present worth w/o grndwater mon: $247,000	Capital cost: $771,000 Annual cost: $85,000 Present worth: $2,077,000 Present worth w/o grndwater mon: $1,539,000	Capital cost: $285,000 Annual cost: $104,000 Present worth: $1,881,000 Present worth w/o grndwater mon: $1,342,000	Capital cost: $186,000 Annual cost: $61,600 Present worth: $929,000 Present worth w/o grndwater mon: $391,000

PLATES

FF/NN LANDFILL
RIPON, WISCONSIN

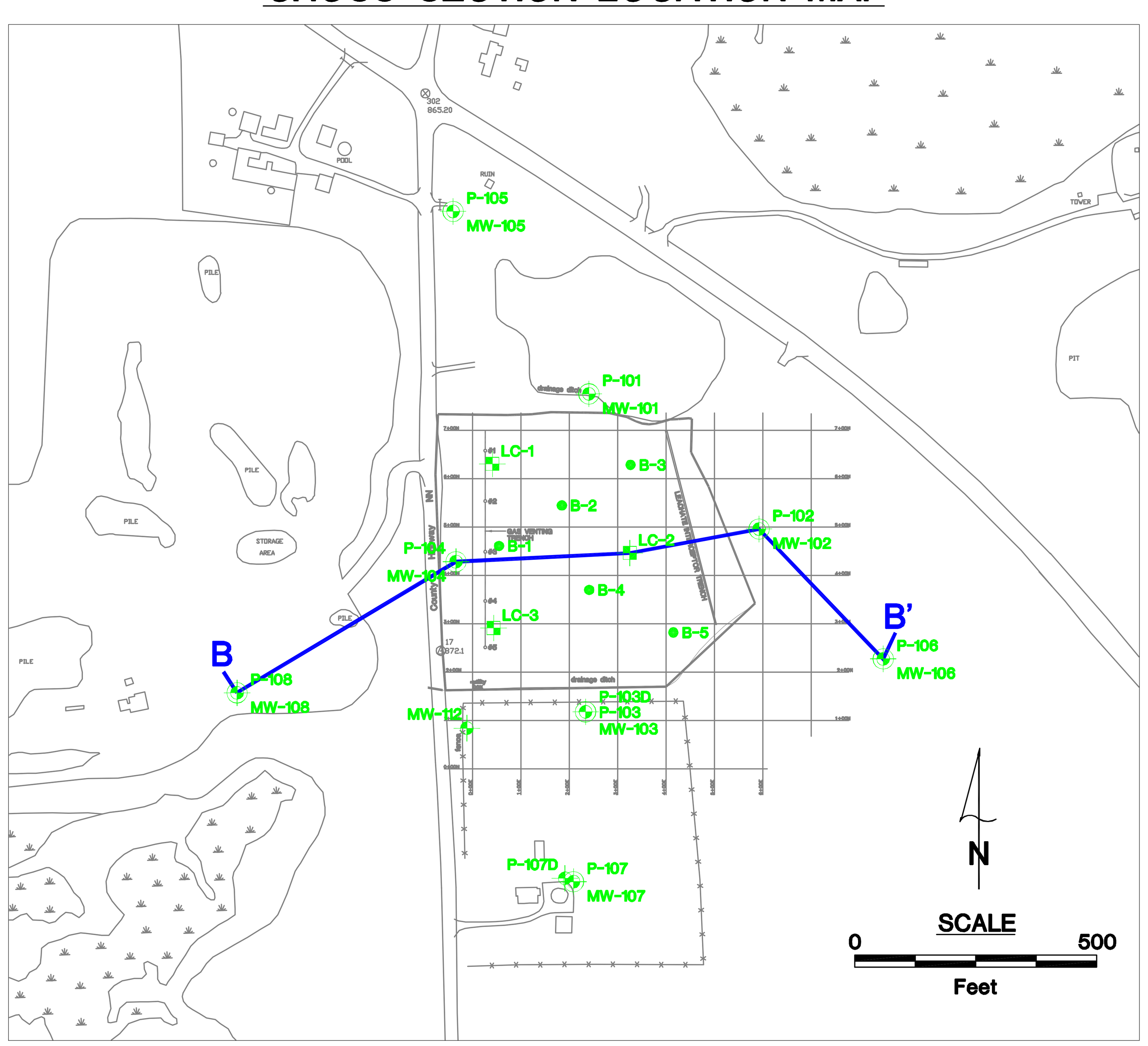
GEOLOGIC CROSS SECTION A-A'

GeoTrans, Inc. A TETRA TECH COMPANY

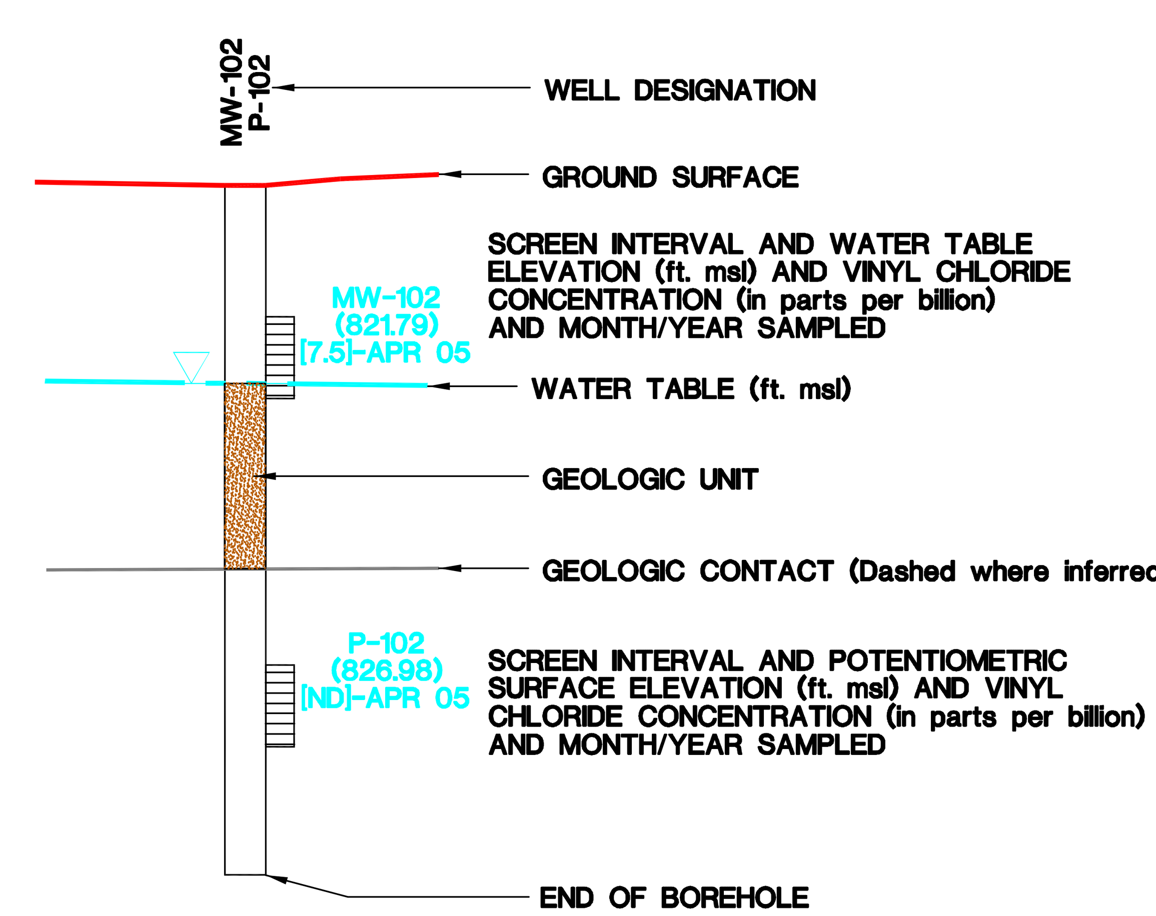
DATE:	7/19/05
DESIGNED:	HWY
CHECKED:	HWY
APPROVED:	GLD
DRAWN:	HJW
PROJ.:	1011.002

Plate 1

CROSS SECTION LOCATION MAP



BOREHOLE LEGEND



Notes : ND = NOT DETECTED: No vinyl chloride was detected in ground water samples collected at this location.

NA = NOT ANALYZED

All water table elevations, leachate head levels, and potentiometric surface elevations are from April 2005.

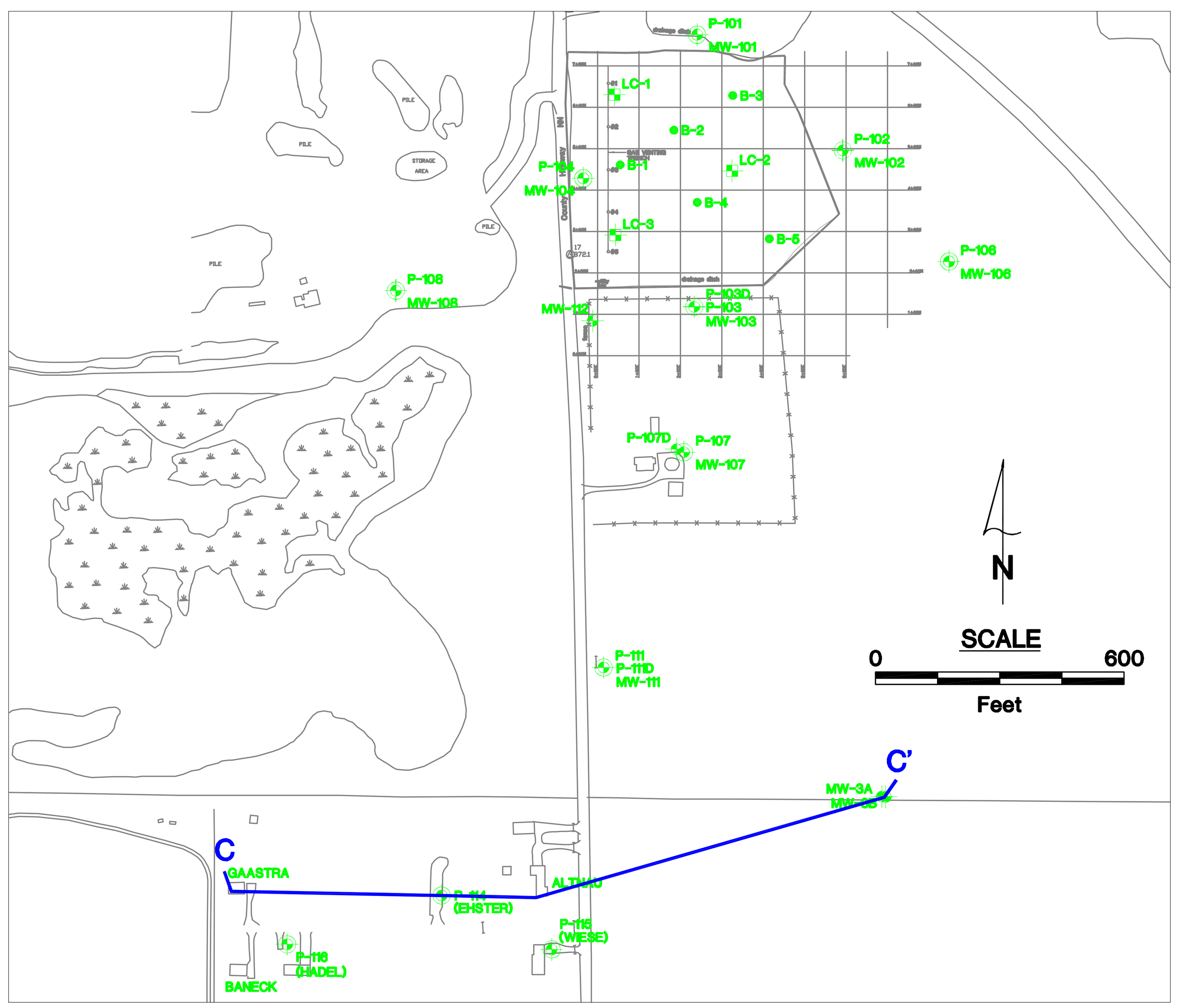
SCALE
0 225
Feet

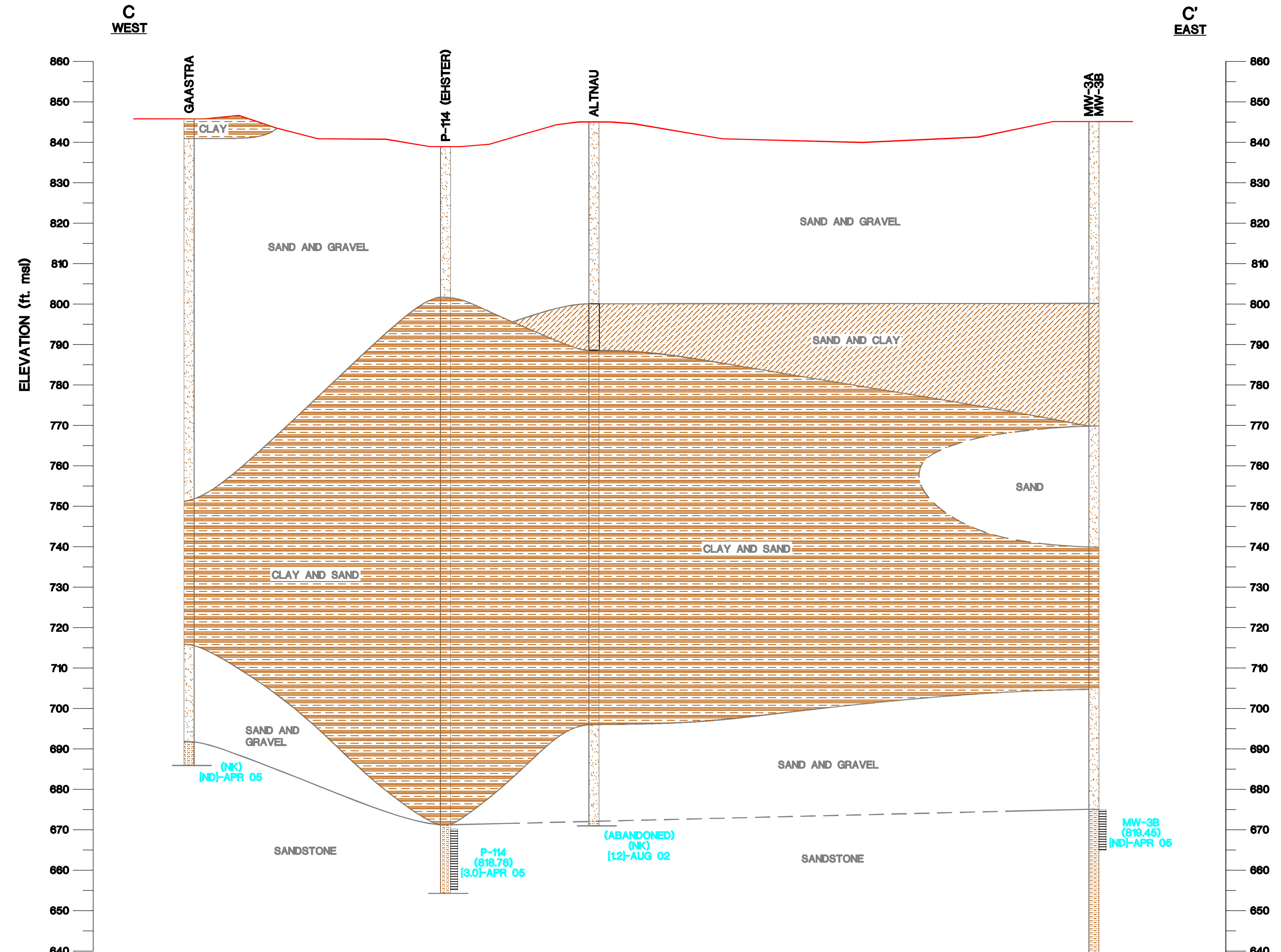
Vertical Exaggeration = 7.5x

FF/NN LANDFILL RIPON, WISCONSIN	DATE: 7/19/05
	DESIGNED: HWY
GEOLOGIC CROSS SECTION B-B'	CHECKED: HWY
	APPROVED: GLD
	DRAWN: HJW
	PROJ.: 1011.002
GeoTrans, Inc. A TETRA TECH COMPANY	Plate 2

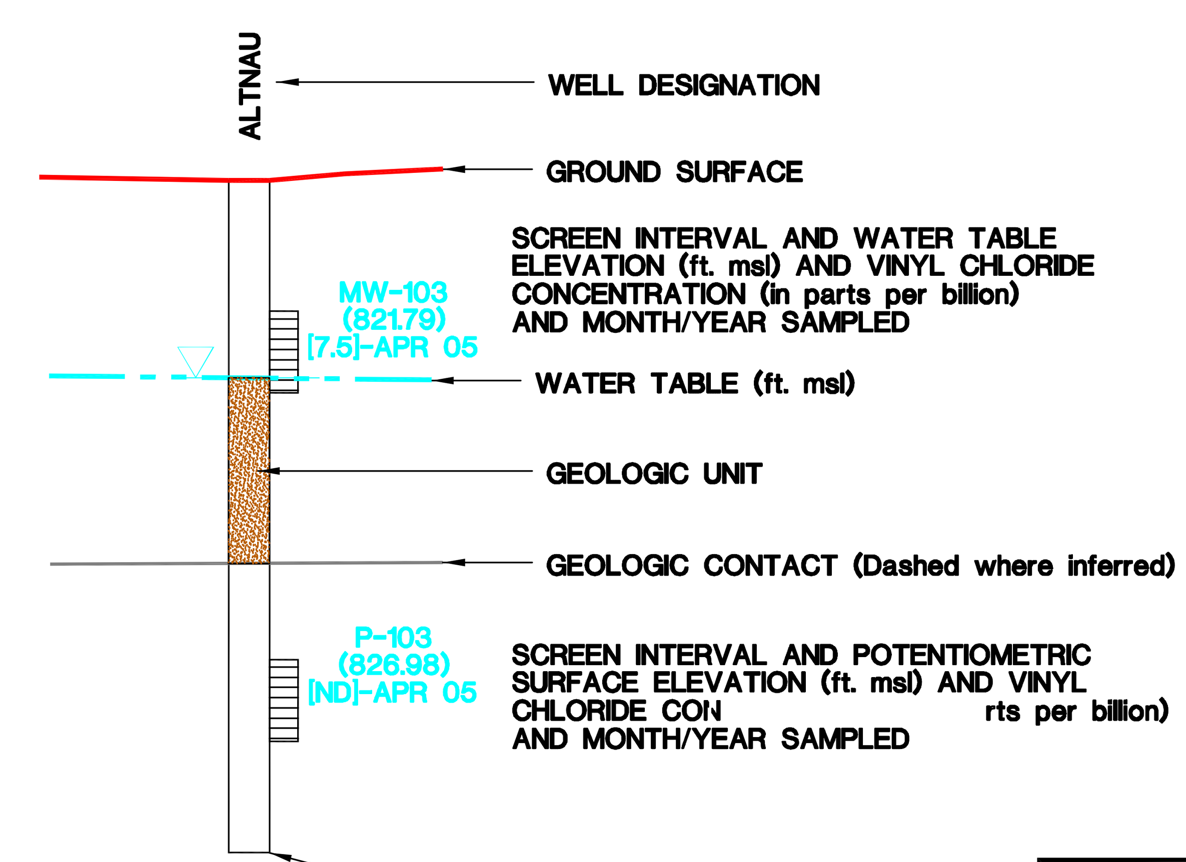
S:\CAD\Ripon\1011.002\Feasibility Study\7-11-05\1011002Plate2.dwg 07/19/2005 15:52:42

CROSS SECTION LOCATION MAP





BOREHOLE LEGEND



SCALE

0 450

Feet

Vertical Exaggeration = 7.5x

Notes : ND = NOT DETECTED: No vinyl chloride was detected in ground water samples collected at this location.

NK = Groundwater elevations not known for private wells.

NA = NOT ANALYZED

All water table and potentiometric surface elevations are from April 2005.

FF/NN LANDFILL RIPON, WISCONSIN	DATE: 7/20/05
GEOLOGIC CROSS SECTION C-C'	DESIGNED: HWY
	CHECKED: HWY
	APPROVED: GLD
	DRAWN: HJW
	PROJ.: 1011.002
GeoTrans, Inc. A TETRA TECH COMPANY	Plate 3

APPENDIX A

GROUNDWATER VELOCITY CALCULATIONS

Calculations for Horizontal Hydraulic Gradient (I)
FF/NN Landfill
April 2005 Data

	Elevation difference	Linear Distance	I (ft/ft)	Range
Layer 1 Wells				
MW101/MW104	0.11	440	0.0003	
MW102/MW103	2.06	525	0.0039	
MW102/MW112	3.16	725	0.0044	0.0003 to 0.009
MW104/MW108	4.75	525	0.0090	
MW106/MW107	3.43	785	0.0044	
MW106/MW111	4.92	1290	0.0038	
average			0.004	
Layer 2 Wells				
P101/P104	0.05	440	0.0001	
P102/P103	0.61	520	0.0012	
P103/P107	2.94	250	0.0118	0.0001 to 0.012
P104/P108	2.16	525	0.0041	
P107/P111	2.01	560	0.0036	
average			0.004	
Layer 3 Wells				
P103D/P111D	2.53	900	0.0028	
P111D/P115	0.93	690	0.0013	0.001 to 0.003
P111D/P116	1.81	1015	0.0018	
P111D/P114	0.79	270	0.0029	
average			0.002	
Layer 4 Wells				
P107D/MW3A			0.0021	

Calculations for Average Hydraulic Conductivity
FF/NN Landfill, Ripon, WI

Well ID	Hydraulic Conductivity (cm/sec)	Natural log	Average of logs	Average (cm/sec)
Layer 1 wells				
MW-101	1.37E-02	-4.28919		
MW-102	1.27E-02	-4.36615		
MW-103	6.60E-04	-7.32266		
MW-104	2.95E-03	-5.82717		
MW-105	3.05E-03	-5.79327	-5.34511547	4.77E-03
MW-106	1.52E-02	-4.18383		
MW-107	2.29E-03	-6.08095		
MW-108	2.34E-03	-6.05897		
MW-111	1.52E-02	-4.18383		
MW-110	1.02E-05	-11.4971	*not used*	
Layer 2 Wells				
P-101	5.08E-03	-5.28244		
P-102	1.88E-02	-3.97411		
P-103	1.57E-03	-6.45363		
P-104	8.13E-03	-4.81244		
P-105	7.11E-03	-4.94597		
P-106	2.64E-02	-3.63379	-5.20931368	5.47E-03
P-107	4.57E-04	-7.69039		
P-108	7.62E-04	-7.17956		
P-109	1.83E-02	-4.00151		
P-111	1.63E-02	-4.11929		
Layer 3 wells				
MW-3B	7.55E-04	-7.18901		
P-103D	8.53E-04	-7.0664		
P-111D	1.10E-03	-6.81245	-6.31974695	1.80E-03
P-114	7.44E-03	-4.90156		
P-115	4.77E-04	-7.64844		
P-116	1.36E-02	-4.30063		
P-113B	*1.30E-06*	*-13.5531*	*not used*	
Layer 4 wells				
MW-3A	3.83E-03	-5.56408		
P-113A	1.31E-02	-4.33438	-4.52382224	1.08E-02
P-107D	2.54E-02	-3.67301		

Layer 1 wells: (1994 data)

MW-110 is the only well completed in clay and is not representative of Layer 1 wells

Layer 2 wells: (1994 data)

Layer 3 wells: (2003/2004 data)

P-113B (1.3E-06) is believed to be an outlier and wasn't used for calculations

Layer 4 wells: (1994 and 2003/2004 data)

Groundwater Velocity Measurements
FF/NN Landfill, Ripon, WI

	Layer 1 Wells		Layer 2 Wells		Layer 3 Wells		Layer 4 Wells	
	K (cm/sec)	*ft/day*	*K (cm/sec)*	*ft/day*	*K (cm/sec)*	*ft/day*	*K (cm/sec)*	*ft/day*
K - low	1.02E-05	2.89E-02	4.57E-04	1.30E+00	4.77E-04	1.35E+00	3.83E-03	1.09E+01
K- high	1.52E-02	4.31E+01	2.64E-02	7.48E+01	1.36E-02	3.86E+01	2.54E-02	7.20E+01
n	20%		20%		10%		10%	
I - low	0.0003		0.000		0.001		0.002	
I - high	0.009		0.012		0.003			
v - low	0.000043	ft/day	0.00065	ft/day	0.0068	ft/day	0.1140	ft/day
	0.0158	ft/year	0.236	ft/year	2.47	ft/year	41.6	ft/year
v - high	1.94	ft/day	4.49	ft/day	0.58	ft/day	0.76	ft/day
	707.7	ft/year	1,638.9	ft/year	211.1	ft/year	275.9	ft/year

Note:
K Data for Layers 1 & 2 came from 1994 Remedial Investigation report
K Data for Layer 3 came from 2003-2004 slug testing
K Data for Layer 4 came from 1994 RI report and 2003-2004 slug testing
I Data came from April 2005 groundwater elevation measurements
K = hydraulic conductivity
n = porosity
I = horizontal hydraulic gradient
v = groundwater velocity using Darcy's flux equation (v = KI/n)
Only one gradient measurement is possible in Layer 4 based on the groundwater flow direction

Average Groundwater Velocity Measurements
FF/NN Landfill, Ripon, WI

	Layer 1 Wells		Layer 2 Wells		Layer 3 Wells		Layer 4 Wells	
	K (cm/sec)	*ft/day*	*K (cm/sec)*	*ft/day*	*K (cm/sec)*	*ft/day*	*K (cm/sec)*	*ft/day*
K	4.77E-03	1.35E+01	5.47E-03	1.55E+01	1.80E-03	5.10E+00	1.08E-02	3.06E+01
n	20%		20%		10%		10%	
I	0.004		0.004		0.002		0.002	
	April 2005 measurements		*April 2005 measurements*		*April 2005 measurements*		*April 2005 measurement*	
v	0.270	ft/day	0.310	ft/day	0.102	ft/day	0.321	ft/day
	98.71	ft/year	113.19	ft/year	37.25	ft/year	117.33	ft/year

Note:
K Data for Layers 1 & 2 came from 1994 Remedial Investigation report
K Data for Layer 3 came from 2003-2004 slug testing
K Data for Layer 4 came from 1994 RI report and 2003-2004 slug testing
I Data came from April 2005 groundwater elevation measurements
K = hydraulic conductivity
n = porosity
I = horizontal hydraulic gradient
v = groundwater velocity using Darcy's flux equation (v = KI/n)
Only one gradient measurement is possible in Layer 4 based on the groundwater flow direction

APPENDIX B
EXISTING INSTITUTIONAL CONTROLS

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
Scott Hassett, Secretary

101 S. Webster St.
Box 7921
Madison, Wisconsin 53707-7921
Telephone 608-266-2621
FAX 608-267-3579
TTY 608-267-6897

July 15, 2004

To: Wisconsin Licensed Well Drillers

Subject: Establishment of "Special Well Casing Pipe Depth Area"
Ripon FF/NN Landfill Site **& Surrounding Area**
Part of the Town of Ripon, Fond du Lac County, Wisconsin

Dear Wisconsin Licensed Well Driller:

A "Special Well Casing Pipe Depth Area" has been established for a 1-½ square mile area including the *Ripon FF/NN Landfill Site* and a surrounding area, located just northwest of the City of Ripon. This area includes portions of Sections 7, 8, 17 & 18, T16N, R14E, Town of Ripon, Fond du Lac County. Attached please find the memo describing in detail this new "Special Well Casing Pipe Depth Area" and its requirements. This area has been established as a result of contamination of several wells and the groundwater of this area with Volatile Organic Compounds (VOCs).

Effective August 15, 2004, the construction of new private wells and the reconstruction of existing private wells within this "Special Well Casing Pipe Depth Area" shall only be undertaken according to the standards specified in the attached memo. In addition, upon completion of any newly constructed or reconstructed well, the well water shall be sampled and analyzed for (VOCs) at a certified laboratory, also as indicated in the attached memo.

Consuming water containing VOCs has been shown to pose a hazard to human health. This "Special Well Casing Pipe Depth Area" has been established under the provisions of Section NR 812.12(3) and is designed to reduce the risk that new wells, constructed or reconstructed according to the requirements of this 'Area', produce water contaminated with VOCs.

Consultation with the Department's Northeast Region's Drinking Water Program Staff is recommended, prior to construction, to help determine if a proposed well will meet the more stringent standards of this area.

Sincerely.

Mark F. Putra, R.S. Chief
Private Water Systems Section
Bureau of Drinking Water & Groundwater
Attachments

cc: Statewide Drinking Water & Groundwater Program Staff
Fond du Lac County Health Department
City of Ripon

CORRESPONDENCE/MEMORANDUM

July 15, 2004

TO: **Wisconsin Licensed Well Drillers**

FROM: **Mark Putra – Chief, Private Water Systems Section**
Bureau of Drinking Water & Groundwater

SUBJECT: **"SPECIAL WELL CASING PIPE DEPTH AREA"**
***Ripon FF/NN* (County Highways) *Landfill Site* & surrounding area;**
Including parts of Sections 7, 8, 17 & 18, T16N, R14E, Town of Ripon, Fond du Lac County.

A "Special Well Casing Pipe Depth Area" is herewith established for the area including and surrounding the *Ripon FF/NN Landfill Site,* described in detail below. Within this area new wells shall be constructed or reconstructed to more stringent standards. In addition, a water sample shall be collected from each newly constructed or reconstructed well and the sample shall be analyzed at a certified laboratory for Volatile Organic Compounds, as indicated below. (Note: Compliance with the requirements of this "Special Well Casing Pipe Depth Area" does not alleviate the requirement to obtain a variance to construct a new well or reconstruct an existing well within 1,200 feet of this landfill.)

Effective Date: This "Special Well Casing Pipe Depth Area" becomes effective August 15, 2004.

This "Special Well Casing Pipe Depth Area" includes an area approximately 1-½ square miles in extent and includes parts of four Sections within T16N, R14E, Town of Ripon. This area is located just northwest of the City of Ripon. The establishment of this "Special Well Casing Pipe Depth Area" is based on contamination of the groundwater in this area, primarily by vinyl chloride and cis-1,2-Dichloroethylene (DCE). Both of these chemicals are Volatile Organic Compounds (VOCs). These compounds have been found in the groundwater of both the unconsolidated surficial aquifer and the bedrock aquifers in this area. This "Special Well Casing Pipe Depth Area" is located adjacent to and surrounding the Ripon landfill located near County Highways FF & NN. Included in this "Special Well Casing Pipe Depth Area" is the landfill itself and the area within the 1,200-foot distance radius established as a set-back requirement for landfills by the Fourth Edition of The State Private Well Code (then NR 112) in October of 1975. (The landfill proper is located just north of the centerline of the south boundary of the SE ¼ of Section 7, T16N, R14E, Town of Ripon.) The detailed description of the entire area included in this "Special Well Casing Pipe Depth Area" is listed below. (Also see enclosed map.)

This "Special Well Casing Pipe Depth Area" is established to reduce the risk wells constructed or reconstructed within this area produce water contaminated with these chemical compounds.
This area is established under the Department's authority provided by Section NR 812.12(3), Wis. Admin. Code (State Private Well Construction & Pump Installation Code).

LOCATION

This "Special Well Casing Pipe Depth Area" is subdivided into two primary segments as listed below. Each segment has specific well construction and water sampling requirements. (See Enclosed Map)
The **"Inner Area"** is a rectangular area located within Sections 7 and 18, T16N, R14E, Town of Ripon, Fond du Lac County and includes the following:

- The S ½ of the SE ¼ of Section 7;
- The N ½ of the NE ¼ of Section 18: and
- That portion of the S ½ of the NE ¼ of Section 18 lying north of both Silver Creek and S. Koro Road.
- That portion of the N ½ of the SE ¼ of Section 18 lying north of both Silver Creek.

The **"Outer Area"** is located within Sections 7, 8, 17, and 18, T16N, R14E, Town of Ripon, Fond du Lac County and includes:

- The S ½ of Section 7 except for the S ½ of the SE ¼ thereof;
- The W ½ of the SW ¼ of Section 8;
- That portion of the W ½ of the NW ¼ of Section 17 lying north of Silver Creek and west of Silver Creek's northern tributary;
- That portion of the NW 1/4 of Section 18 lying north of both Silver Creek & S. Koro Road and north of Highway 23/49; and
- None of the area described above within the "Inner Area" .

CONTAMINANTS

Vinyl chloride; cis-1,2-Dichloroethylene (DCE) and/or other Volatile Organic Compounds (VOCs).

WELL CONSTRUCTION SPECIFICATIONS AND SAMPLING REQUIREMENTS

Within this "Special Well Casing Pipe Depth Area" the construction of new wells and reconstruction of existing wells shall only be undertaken according to the following specifications:

Inner Area: The department does **not** advise the construction of new wells or the reconstruction of existing wells within this inner area. (Existing well water sample results indicate the Cambrian Sandstone layers are contaminated with VOCs throughout their vertical extent within much of this inner area.) Although not advised, construction of new wells and reconstruction of existing wells **is** allowed within this inner area, but only as indicated below.
The following types of well construction **are** allowed within this inner area:

- ***Unconsolidated aquifer wells.*** Wells completed in the unconsolidated surficial aquifer (primarily glacial drift) – lying above the first bedrock -- are allowed, but only if they are located outside the 1,200-foot radius of the landfill boundary. Such unconsolidated formation wells may be constructed according to the minimum requirements of NR 812.
- ***Precambrian bedrock wells.*** Precambrian bedrock wells are allowed if they are constructed to be cased and cement-grouted down to at least the top the Precambrian crystalline bedrock. In this area the Precambrian bedrock lies below the Cambrian Sandstone and will be encountered at depths exceeding 300 feet. This dense 'basement' bedrock does not usually yield sufficient quantities of water for a household so property owners should be made aware of this problem before attempting this type of well. Hydrofracturing of crystalline bedrock wells is **not** allowed in this area because this process can cause migration of contaminated water down into the Precambrian.

For any new well construction or existing well reconstruction within this "Inner Area", a water sample shall be collected and analyzed for VOCs at the time of construction and, thereafter, during each subsequent alternate year. The water sample shall be analyzed according to the requirements of an approved Safe Drinking Water Act analytical method in accordance with Section NR 809.725, Table B, Wis. Admin. Code. If the water sample is contaminated with VOCs, a water treatment device approved by the Wisconsin Department of Commerce shall be installed for the water supply. The installation of the device shall be approved by the Department; Or, as an alternative, the residence shall be connected to a bacteriologically safe & uncontaminated water supply. (Such a connection can be to either an existing Code-complying private water supply or to a community water supply, if available.)

Outer Area: Within this outer area the construction of new wells and the reconstruction of existing wells shall be accomplished as follows:
An attempt shall first be made to construct or reconstruct a well that withdraws water only from the unconsolidated, surficial (glacial) aquifer. Such an unconsolidated formation well may be constructed according to the minimum requirements of NR 812.

When an unconsolidated aquifer formation well does not produce a sufficient quantity of water or produces contaminated water, a well cased and cement-grouted at least to the top of the Cambrian Sandstone **may** be constructed or reconstructed, but only with prior written Department approval. Such Cambrian Sandstone wells will be allowed **only** as a secondary choice and shall have site-specific construction specifications provided by the Department, prior to construction or reconstruction.

(The Department does not advise the construction or reconstruction of bedrock wells extending into the Precambrian crystalline 'basement' bedrock in this outer area. This is because it is difficult to obtain water in a sufficient quantity from this bedrock. Further hydrofracturing the well, in an attempt to increase the yield of water, is **not** allowed in this area.)

All new wells constructed or existing wells reconstructed in this outer area shall also be sampled for VOCs at the completion of the well. The water sample shall be analyzed according to the requirements of an approved Safe Drinking Water Act analytical method in accordance with Section NR 809.725, Table B, Wis. Admin. Code.

(Within both the Inner & Outer Areas, the Department may -- for any specific well -- require additional well water sampling, water treatment or permanent abandonment of the well. At the time of future property transfer, disclosure of the information about the well, water quality, water sampling requirements or any maintenance requirements for water treatment equipment, is the responsibility of the property owner. Any cross-contamination of aquifer strata caused by migration from a contaminated well may be the responsibility of the well owner.)

JUSTIFICATION FOR ESTABLISHING THIS "SPECIAL WELL CASING PIPE DEPTH AREA"

Justification for establishing this "Special Well Casing Pipe Depth Area" is as follows:

- Vinyl chloride and cis-1,2-Dichloroethylene (DCE) and other Volatile Organic Compounds have been found in water samples from private supply wells and from monitoring wells in this area near the Ripon FF/NN (County Highways) Landfill. Concentrations of vinyl chloride in the water samples from several of these wells exceeded the State Groundwater (NR 140) Enforcement Standard of

0.2 µg/L. The highest concentration of vinyl chloride found in a private well was 7.0 µg/L, which is 14 times the Enforcement Standard.

- The approximate landfill boundary and its geographic location are indicated on the accompanying map. According to Department files, this site was operated as a licensed landfill from 1969 to 1983. The entire site (approximately 7.3 acres) was used for disposal of commercial, municipal and industrial solid wastes. Further, approximately 3.3 million gallons of processed sludge from the Ripon Wastewater Treatment Facility was disposed of in this landfill. The approved Landfill Abandonment Plan required testing of groundwater from five on-site monitoring wells. In 1984, vinyl chloride was detected in a residential well located 350 feet south of the landfill. Further testing of wells confirmed the presence of vinyl chloride with some concentrations exceeding the Groundwater (NR 140, Wis. Adm. Code) Enforcement Standard. (The City of Ripon acquired this property on February 13, 2004.)

- In 1989 a replacement well was constructed for a private residential property with funding from a grant from the Well Compensation Program. This well was installed to replace an existing contaminated well on this property. The existing well was contaminated with vinyl chloride. The new well was installed 450 feet south of the landfill. It was constructed with cement-grouted casing extending to a depth of 300 feet. Although the construction and grouting of this well went perfectly according to plan, water from this deeply cased & grouted well was also contaminated with vinyl chloride. This well subsequently had to be abandoned and the property was condemned since there was no alternate water supply available to serve the residence.

- The Ripon FF/NN Landfill was placed on the Superfund National Priorities list on May 31, 1994. A *Record of Decision* was issued on February 1996 to specify a requirement for remedial action. A new composite cap and additional monitoring wells were installed during this remedial action in the summer of 1996. A 5-year review was completed on May 22, 2001. In October and November of 2001, vinyl chloride was found in two down-gradient private wells. Both of these well owners were supplied with bottled water. In addition, water treatment systems were installed on the drinking water supply line of each of these wells. In November of 2002 a privately owned municipal water line was connected to each of these households, one located south of Koro road and the other located along Charles Street).

- This "Special Well Casing Pipe Depth Area" takes into account possible increased migration of the contaminant plume, within the aquifers, extending down-gradient from the landfill site to the south and west. This is possible due to increased pumping associated with a greater well density caused by future real estate development in this area.

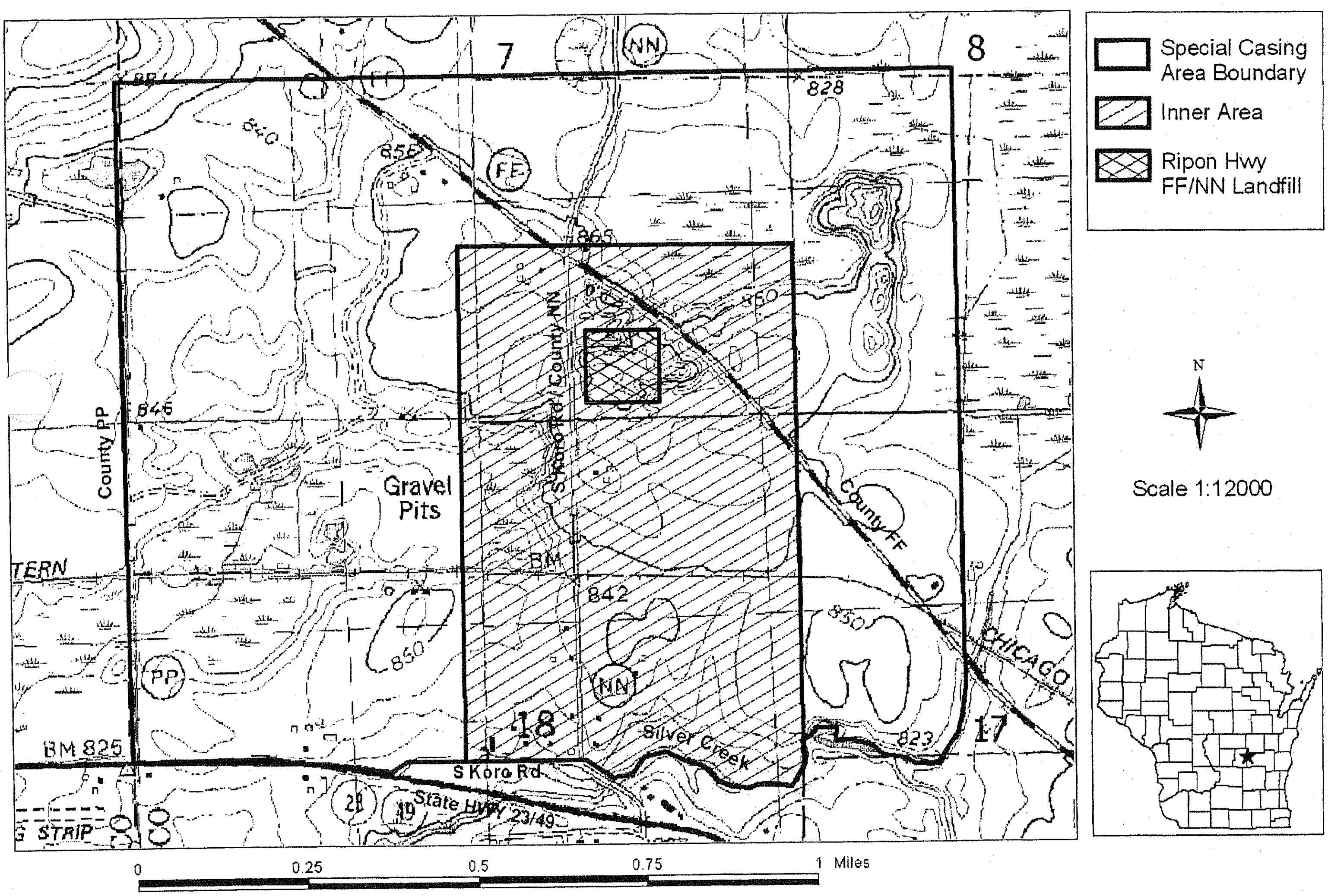
- This "Special Well Casing Pipe Depth Area" includes the entire area within the 1,200-foot radius 'set-back' well location requirement specified by s. NR 812.08(4)(g).

- Much of the area included in this "Special Well Casing Pipe Depth Area" contains gravel pits and wetlands. Volatile organic compounds were not detected in a sample of the surface water collected in this area.

Special Well Casing Depth Area

T16N, R14E, Town of Ripon, Fond du Lac County

July 15, 2004



CHAPTER 4.16 *
UNIFORM DWELLING CODE, BUILDING PERMITS AND FEES, AND RESTRICTIONS ON WATER SUPPLY WELLS

Sections:

4.16.01 Uniform Dwelling Code. As of the effective date listed below, the Town adopts the Wisconsin Uniform Dwelling Code.

4.16.01.1 Authority. These regulations are adopted under the authority granted by s. 101.65, Wisconsin Statutes.

4.16.01.2 Purpose. The purpose of this ordinance is to promote the general health, safety and welfare and to maintain required local uniformity with the administrative and technical requirements of the Wisconsin Uniform Dwelling Code.

4.16.01.3 Scope. The scope of this ordinance does not include any dwellings built before the effective date of this Ordinance. The scope of this Ordinance includes all new one- and two-family dwellings built after the effective date of this Ordinance. It also applies to all additions and alterations to such one- and two-family dwellings built after the effective date of this Ordinance, regardless of when such dwellings were built.

4.16.01.4 Wisconsin Uniform Dwelling Code Adopted. The Wisconsin Uniform Dwelling Code, Chs. Comm 20-25 of the Wisconsin Administrative Code, and all amendments thereto, is adopted and incorporated by reference and shall apply to all buildings within the scope of this 4.16.01, et seq., ordinance.

4.16.01.5 UDC Building Inspector. There is hereby created the position of Uniform Dwelling Code Building Inspector ("UDC Building Inspector"), who shall administer and enforce this 4.16.01, et seq. ordinance and shall be certified by the Division of Safety & Buildings, as specified by Wisconsin Statutes, Section 101.66(2), in the category of Uniform Dwelling Code Construction Inspector. Additionally, this or other assistant inspectors shall possess the certification categories of UDC HVAC, UDC Electrical and UDC Plumbing. The UDC Building Inspector shall be a separate position from the Town's Building Inspector, but applicable only for all buildings and other structures covered under this ordinance 4.16.01, et seq. Provided, however, at the Town's

* Amended October 11, 2004, and May 9, 2005 by Ordinance of the Town of Ripon.

discretion it may appoint the UDC Building Inspector to also act as the Building Inspector for non UDC building permits.

4.16.01.6 Building Permit Required. No person shall repair, alter, where such costs exceed $200.00 value for each such alteration in any twelve month period, build, add onto or alter any building within the scope of this ordinance without first obtaining a building permit for such work from the UDC building inspector. Any structural changes or major changes to mechanical systems that involve extensions shall require permits. Restoration or repair of an installation to its previous code-compliant condition as determined by the UDC building inspector is exempted from permit requirements. Residing, re-roofing, finishing of interior surfaces and installation of cabinetry shall include permit requirements if it exceeds the dollar amount as stated herein.

4.16.01.7 Building Permit Fee. The building permit fees shall be as determined under 4.16.02.

4.16.01.8 Penalties. The enforcement of this section and all other laws and ordinances relating to building shall be by means of the withholding of building permits, imposition of forfeitures and injunctive action. Forfeitures shall be as provided in Ordinance 4.17.

4.16.01.9 Effective Date. This ordinance under 4.16.01 shall be effective October 11, 2004, upon passage and publication as provided by law.

4.16.02 Building Permit Fee. A fee collected by the Town Building Inspector and paid to the Town Treasurer in an amount determined by the Town Board is required to be paid by the applicant for a building permit prior to commencement of building, or for a certificate of occupancy where no building permit was required. The fee shall be doubled if the building permit application occurs after commencement of building.

4.16.03 Board of Appeals Fee. A fee in an amount determined by the Town Board is required to be paid by the applicant for each application or appeal to the Board of Appeals, which fee shall be paid to the Town Treasurer and receipt therefor filed with the application. This fee shall not be required of any township officer acting in his official capacity. Provided, however, that for any appeal concerning the Uniform Dwelling Code under Ordinance 4.16.01, the Wisconsin Department of Commerce and not the Town of Ripon Board of Appeals shall be the forum to hear such appeals.

4.16.04 Zoning Ordinance Amendment or Variance Fee. A fee in an amount to be determined by the Town Board is required for any petition for the amendment or variance of zoning ordinances, which fee shall be paid to the Town Treasurer and receipt therefor filed with the application. This fee shall not be required of any town-ship officer acting in his official capacity.

4.16.05 Restrictions on Water Supply Wells. As of the effective date listed below, the Town adopts restrictions on water supply wells in the following described water supply protection area.

4.16.05.1 Findings. The following findings have been determined applicable to this Ordinance.

A. Some of the water supply wells serving some residents in the Town of Ripon who live on Charles Street and the north-south leg of S. Koro Road have been contaminated by one or more volatile organic compounds ("VOCs") in concentrations which the Wisconsin Departments of Natural Resources ("DNR") and Health and Family Services ("DHFS") have determined are sufficient to constitute a threat to the residents' health and welfare, necessitating the abandonment of the contaminated wells and the connecting of these residences to the public water supply extended into this area for that purpose.

B. Groundwater monitoring wells along the former railroad right-of-way east of South Koro Road have from time to time shown VOC contamination. Likewise, the groundwater monitoring well in the location of the former private water supply well serving the residence at the southwest corner of South Koro Road and Charles Street has recently shown contamination from a VOC above its enforcement standard.

C. The water bearing formation which serves the private water supply wells in the area south of the former railroad right-of-way and either side of South Koro Road is known to be in a stratum of bedrock in which the south/southwest direction of groundwater flow acquires a significant east to west flow vector.

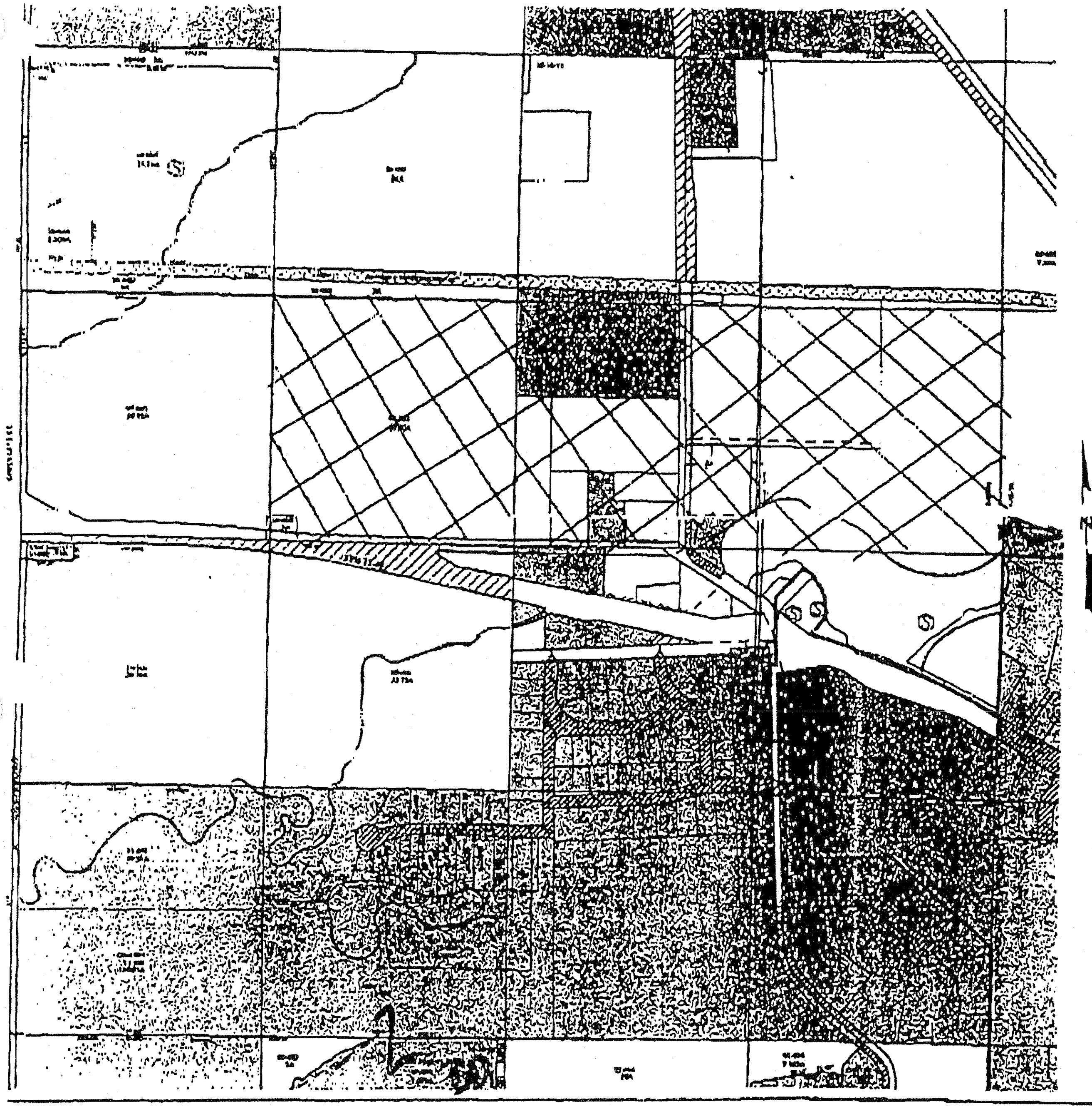
D. Public water supplies are monitored periodically for VOC contamination per the statutes and regulations enforced by the DNR and DHFS whereas private well owners have no such requirements.

E. Pumping of groundwater for household and other uses in a stratum where contamination is present or is periodically present can contribute to the spread of the contamination whereas public water supplies that serve the affected residences in the Area are drawn from deeper strata and are a substantial distance away and, thus, do not influence the direction of groundwater flow in the stratum with contamination.

F. Protecting persons from exposure to VOC contamination by requiring the use of a municipal water supply is necessary for those areas of the Town in which VOC contamination has already been detected, can be expected to be transported via known groundwater flow direction or has the reasonable potential to be drawn due to the influence of increased groundwater pumping associated with new private wells that would be constructed as a consequence of new residential or other development.

G. Such an area requiring protection of persons subject to disposal exists in the Town in the rectangular area bounded on the north by the former right-of-way of the Chicago and Northwestern Railroad; on the east by the section line running north and south between Section 18, Town 16 North, Range 14, and Section 17, Town 16 North, Range 14 East; on the south by the line running east and west between the north and south halves of Section 18, Town 16 North, Range 14, and, on the west by the line running north-south between the southeast ¼ and southwest ¼ of the northwest ¼ of Section 18, Town 16 North, Range 14. The area so bounded to be referred to herein as the Water Supply Protection Area is shown in the cross hatched area on the following map:

TOWN OF RIPON - Fond du Lac County, WI
1" = 400'
Section 18, Town 16, Range 14



H. Obtaining water from a contaminated water supply constitutes a threat to public health and safety; the spreading of contamination by pumping from a water supply that is contaminated or can draw contamination is a threat to the environment.

I. Connection to a public water supply system, particularly where contaminated groundwater is known to be present, or is reasonably likely to become present through groundwater flow or the influence of pumping wells will protect the public health and safety and the environment and will increase the value of the structures supplied by that public water supply system.

J. It is, therefore, in the public interest to prohibit in the Water Supply Protection Area the construction of new water supply wells or increased pumping by existing wells when the latter occurs to supply new construction, and for any building or other construction.

<u>4.16.05.2</u> <u>Restrictions</u>. Based upon the above Findings, the following restrictions are imposed:

A. A Water Supply Protection Area is hereby established in the area described in the Findings.

B. No person may construct or arrange for the construction of a new water supply well to serve any new structure in the Water Supply Protection Area.

C. No person may connect an existing water supply well to any new structure in the Water Supply Protection Area for any purpose, including but not limited to functioning as a private or community water supply well for such new structure.

D. For the purposes of this section a new structure is any structure on which construction commenced after the date of publication following adoption of this ordinance by the Town of Ripon Town Board.

<u>4.16.05.3</u> <u>Connection to City of Ripon Water System</u>. For all persons to whom subsection 4.16.05.2 applies, the following applies:

A. The City of Ripon, by resolution No. 2005, has agreed to extend and connect all properties located in the Water Supply Protection Area to City water by extending water service to such properties at the property owner's request without requiring annexation to the City of Ripon.

B. All City of Ripon costs and charges for extending City water to properties located in the Water Supply Protection Area shall be resolved between the City of Ripon and the property owner.

C. There shall be no such City extension to any property in the Water Supply Protection Area without the property owner and/or City of Ripon first complying with all applicable Town ordinances, including but not limited to obtaining a building permit pursuant to Town

Ordinance 4.16.02.

4.16.05.4 Effective Date. This ordinance under 4.16.05 shall be effective May 9, 2005, upon passage and publication as provided by law.

CHAPTER 4.17 *
GENERAL PENALTIES

Sections:

4.17.01 General Penalty. In all cases where a specific penalty has not been established by provisions of any other Town Zoning Ordinance, any person who shall violate any of the provisions of this Title 4 shall, at the discretion of the Town Board, be subject to a penalty, which shall be as follows:

A. First Offense--Penalty. Any person who shall violate any provision of any Town ordinance or part of an ordinance shall forfeit not less than one hundred dollars ($100.00) nor more than five hundred dollars ($500.00), together with the costs of prosecution, including reasonable attorney's fees (hereafter "costs of prosecution").

B. Second and Subsequent Offenses--Penalty. Any person who shall violate any Town ordinance or part of an ordinance who shall previously have violated the same ordinance within one year shall forfeit not less than two hundred fifty dollars ($250.00) nor more than one thousand dollars ($1,000.00) for the second and each such subsequent offense, together with costs of prosecution.

4.17.02 Continued Violations. Each day a violation continues or occurs shall constitute a separate offense.

4.17.03 Additional Remedies. In addition to the fines and other remedies imposed herein, the Town may maintain any appropriate action, including injuncture actions, to prevent or remove a

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* Amended February 12, 1996, by Ordinance of the Town of Ripon.

** Amended October 21, 1996, by Ordinance adopted by the Town of Ripon, effective upon publication on November 6, 1996.

APPENDIX C
FEDERAL REGISTER CITATION ON PROVIDING PUBLIC WATER

direct remedial or other response actions under subpart E of the NCP.

Remedy or remedial action (RA) means those actions consistent with permanent remedy taken instead of, or in addition to, removal action in the event of a release or threatened release of a hazardous substance into the environment, to prevent or minimize the release of hazardous substances so that they do not migrate to cause substantial danger to present or future public health or welfare or the environment. The term includes, but is not limited to, such actions at the location of the release as storage, confinement, perimeter protection using dikes, trenches, or ditches, clay cover, neutralization, cleanup of released hazardous substances and associated contaminated materials, recycling or reuse, diversion, destruction, segregation of reactive wastes, dredging or excavations, repair or replacement of leaking containers, collection of leachate and runoff, on-site treatment or incineration, provision of alternative water supplies, any monitoring reasonably required to assure that such actions protect the public health and welfare and the environment and, where appropriate, post-removal site control activities. The term includes the costs of permanent relocation of residents and businesses and community facilities (including the cost of providing "alternative land of equivalent value" to an Indian tribe pursuant to CERCLA section 126(b)) where EPA determines that, alone or in combination with other measures, such relocation is more cost-effective than, and environmentally preferable to, the transportation, storage, treatment, destruction, or secure disposition off-site of such hazardous substances, or may otherwise be necessary to protect the public health or welfare; the term includes off-site transport and off-site storage, treatment, destruction, or secure disposition of hazardous substances and associated contaminated materials. For the purpose of the NCP, the term also includes enforcement activities related thereto.

Remove or removal as defined by section 311(a)(8) of the CWA, refers to removal of oil or hazardous substances from the water and shorelines or the taking of such other actions as may be necessary to minimize or mitigate damage to the public health or welfare or to the environment. As defined by section 101(23) of CERCLA, remove or removal means the cleanup or removal of released hazardous substances from the environment; such actions as may be necessary taken in the event of the threat of release of hazardous substances into the environment; such actions as may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances; the disposal of removed material; or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release. The term includes, in addition, without being limited to, security fencing or other measures to limit access, provision of alternative water supplies, temporary evacuation and housing of threatened individuals not otherwise provided for, action taken under section 104(b) of CERCLA, post-removal site control, where appropriate, and any emergency assistance which may be provided under the Disaster Relief Act of 1974. For the purpose of the NCP, the term also includes enforcement activities related thereto.

Respond or response as defined by section 101(25) of CERCLA, means remove, removal, remedy, or remedial action, including enforcement activities related thereto.

SARA is the Superfund Amendments and Reauthorization Act of 1986. In addition to certain free-standing provisions of law, it includes amendments to CERCLA, the Solid Waste Disposal Act, and the Internal Revenue Code. Among the free-standing provisions of law is Title III of SARA, also known as the "Emergency Planning and Community Right-to-Know Act of 1986" and Title IV of SARA, also known as the "Radon Gas and Indoor Air Quality Research Act of 1986." Title V of SARA amending the Internal Revenue Code is also known as the "Superfund Revenue Act of 1986."

Sinking agents means those additives applied to oil discharges to sink floating pollutants below the water surface.

Site inspection (SI) means an on-site investigation to determine whether there is a release or potential release and the nature of the associated threats. The purpose is to augment the data collected in the preliminary assessment and to generate, if necessary, sampling and other field data to determine if further action or investigation is appropriate.

Size classes of discharges refers to the following size classes of oil discharges which are provided as guidance to the OSC and serve as the criteria for the actions delineated in subpart D. They are not meant to imply associated degrees of hazard to public health or welfare, nor are they a measure of environmental injury. Any oil discharge that poses a substantial threat to public health or welfare or the environment or results in significant public concern shall be classified as a major discharge regardless of the following quantitative measures:

(a) Minor discharge means a discharge to the inland waters of less than 1,000 gallons of oil or a discharge to the coastal waters of less than 10,000 gallons of oil.

(b) Medium discharge means a discharge of 1,000 to 10,000 gallons of oil to the inland waters or a discharge of 10,000 to 100,000 gallons of oil to the coastal waters.

(c) Major discharge means a discharge of more than 10,000 gallons of oil to the inland waters or more than 100,000 gallons of oil to the coastal waters.

Size classes of releases refers to the following size classifications which are provided as guidance to the OSC for meeting pollution reporting requirements in subpart B. The final determination of the appropriate classification of a release will be made by the OSC based on consideration of the particular release (e.g., size, location, impact, etc.):

(a) Minor release means a release of a quantity of hazardous substance(s), pollutant(s), or contaminant(s) that poses minimal threat to public health or welfare or the environment.

(b) Medium release means a release not meeting the criteria for classification as a minor or major release.

(c) Major release means a release of any quantity of hazardous substance(s), pollutant(s), or contaminant(s) that poses a substantial threat to public health or welfare or the environment or results in significant public concern.

Source control action is the construction or installation and start-up of those actions necessary to prevent the continued release of hazardous substances or pollutants or contaminants (primarily from a source on top of or within the ground, or in buildings or other structures) into the environment.

Source control maintenance measures are those measures intended to maintain the effectiveness of source control actions once such actions are operating and functioning properly, such as the maintenance of landfill caps and leachate collection systems.

Specified ports and harbors means those ports and harbor areas on inland rivers, and land areas immediately adjacent to those waters, where the USCG acts as predesignated on-scene coordinator. Precise locations are determined by EPA/USCG regional agreements and identified in federal regional contingency plans.

APPENDIX D
1994 FEASIBILITY STUDY EXCERPTS

without tearing up the landfill cap if leachate extraction was determined to be effective at some future date. Even though leachate extraction is currently not feasible, gas extraction may result in leachate accumulations in the wells due to the vacuum used to remove the landfill gas.

The pipe would be connected to a condensate trap to remove liquids. Condensate would be collected and disposed at the Ripon POTW.

The landfill gas emissions from the FF/NN landfill are expected to be below the proposed New Source Performance Standards (NSPS, 40CFR60) for existing landfills, since the FF/NN landfill is expected to be classified as "small" under the proposed rules for existing landfills. Therefore, a landfill gas collection and treatment system at the FF/NN Landfill is not expected to require a permit. However, a landfill gas collection and treatment system may be subject to the WDNR approval requirements under ch. NR419.07(2) (i.e. a ground water remediation system air permit form may need to be submitted to and approved by WDNR).

6.3.4.2 Effectiveness

Active LFG collection and treatment systems are commonly used to removed large quantities of LFG from municipal landfills. Active landfill gas removal systems are more effective in removing gas from a site than are passive systems. As many as eight gas probes will be installed in order to monitor performance of the full scale system.

The destruction efficiency of the enclosed flare for methane and VOCs is expected to be 99%.

6.3.4.3 Implementability

The construction of this alternative is readily implementable for the FF/NN Landfill since available equipment and labor would be used.

An O&M plan would be developed that identifies system maintenance requirements and provides a detailed monitoring plan. It is assumed that 10% of the total system costs would be required for repairs each year of an anticipated 30-year period.

6.3.4.4 Cost

The estimated cost associated with this alternative is:

Total Direct Costs:	$165,000
O&M Costs:	$19,000 per year
Present Worth:	$427,000

6.4 Shallow Ground-Water Pumping and Treatment Alternatives

There are four alternatives (J, K, L, and M) which all include the installation of a series of ground-water extraction wells to intercept the plume as it migrates downgradient of the landfill. Extracted ground water would be treated using an air stripper for removal of VOCs for Alternatives J, K, and L. The three alternatives differ only in their discharge of treated ground water; water is discharged to surface water for Alternative J, to an infiltration gallery for Alternative K, and to reinjection wells for Alternative L. The water extracted under Alternative M would be transported to the Ripon POTW via a low-head pipeline for treatment and disposal. The pumping and treatment of ground water is discussed below, and applies to each of Alternatives J, K, and L.

6.4.1 Shallow Ground-Water Extraction

6.4.1.1 Design Concepts

Ground-water extraction scenarios were modeled using DREAM, a program which models drawdowns based on the Theis equation. The Theis equation describes non-steady state radial flow in a confined aquifer. This modeling was used to determine a maximum continuous pumping rate. Once a maximum pumping rate had been established, ground-water pumping scenarios were modeled using the EPA modeling program WHPA to define capture zones. The shallow ground-water modeling results are presented in Appendix A.

Based on the results of the modeling, two 6-inch recovery wells would be installed south of the landfill. One well would be located near the 103 well nest. The other recovery well would be located near the northwest corner of the former Bosveld property. The wells would be installed to a depth of approximately 30 feet below the water table. This depth is approximately equal to the vertical extent of contamination in this area, and coincides with the top of the silty unit which is likely limiting the vertical migration of contaminants in this area. Each would be pumped at a rate of 10 gallons per minute.

6.4.1.2 Effectiveness and Implementability

Typically, 10 to 20 pore volumes of ground water are required to be removed from an aquifer before it is remediated. Based on the modeling, this quantity of shallow ground water cannot be removed from the site in a time frame of less than 50 years. To increase the quantity of water removed from the aquifer, the combined pumping rate would need to be higher. Increasing the pumping rate is not possible as the drawdown would exceed the depth of the wells. It is not practical to increase the total depth of the wells, thus allowing for greater drawdown, because the wells would then be extended beneath the silt confining layer, and would be extracting non-impacted water. Based on the results of the groundwater modeling, hydraulic control of the plume is expected within one year, and one pore volume of the impacted ground water would be captured within five years. As 10 to 20 pore volumes are often required to be pumped and treated to restore an aquifer, ground-water remediation may be necessary for 50 to 100 years. Ground-water extraction modeling results are included in Appendix A.

Interpretations of system effectiveness are limited by the available site data and by the assumptions inherent in the models. Capture zones delineated in the RESSQC model of the WHPA program are somewhat idealized, as they are valid for fully penetrating pumping wells screened in a two-dimensional homogeneous aquifer. The model also assumes steady state flow, which is representative of long-term average conditions in the aquifer, but may not be representative of short-term hydrologic conditions. Hence, ground-water pumping from the shallow aquifer does not appear to be effective within a reasonable period of time.

The construction of this alternative is readily implementable for the FF/NN Landfill.

6.4.2 Shallow Ground-Water Treatment

6.4.2.1 Design Concepts

An on-site treatment system would be constructed to treat ground water extracted from the shallow aquifer at the landfill. A total of approximately 20 gallons of ground water per minute would be extracted for treatment from the two downgradient shallow ground-water extraction wells in the shallow aquifer. As shown on Tables 3-12 and 3-13 the ground-water constituents which require treatment are vinyl chloride and cis-1,2-dichloroethene in order to meet the WDNR ch. NR140 Ground-Water Quality Enforcement Standards.

Typically, hardness is removed from water or treated with chemicals to keep it under control prior to removal of organic constituents in order to prevent fouling of the treatment equipment. The hardness in the ground water may be present in sufficient concentrations to warrant removal or chemical treatment to prevent clogging of the air stripper. A benchscale treatability test would be needed to determine if removal of hardness is required prior to air stripping. For cost estimating purposes, removal of hardness has not been assumed.

An equalization tank would be used to provide uniform quality and quantity of incoming ground water to the treatment system to maximize the effectiveness of the subsequent treatment equipment, and an in-line filter may be used to remove sediment from the ground water prior to treatment.

Removal of the organic constituents such as vinyl chloride and cis-1,2-dichloroethene would be performed with a low profile cascade-type air stripper since the compounds are amenable to air stripping. At a flow rate of 20 gpm ground water with up to 500 ppb organics and assuming 100% removal efficiency, it is expected that a maximum of 0.12 lb/day of organic compounds would be emitted from the stack of the air stripper and treatment of off-gases would not be required.

Since the FF/NN Landfill is not in a non-attainment area for ozone, the Clean Air Act (CAA) VOC emissions thresholds for major sources do not apply. Since VOC emissions will be below 100 tons per year under all scenarios, the New Source Review standards under Section 109 of the CAA also do not apply. A Title V Clean Air Act Amendments (CAAA) Permit for the proposed air stripper would not be required since the air stripper would be exempt under ch. NR407.03(1)(sm)(10.). However, the air stripper would still be subject to WDNR approval requirements under sec. NR419.07(2) (i.e. a ground water remediation system air permit form would need to be submitted to and approved by WDNR).

6.4.2.2 Effectiveness and Implementability

The ground-water treatment system employs equipment which is commonly used to remove these chemical constituents from water. The treatment standards of the treatment system are ch. NR140 Preventative Action Levels. The air stripper has an organic removal efficiency of about 99%.

The construction of this alternative is implementable for the FF/NN Landfill as available equipment and labor would be used.

6.4.3 Alternative J - Shallow Ground-Water Extraction, Treatment, and Discharge to Surface Water

6.4.3.1 Design Concepts

This alternative would be implemented in conjunction with the shallow ground-water extraction and treatment system discussed in sections 6.4.1 and 6.4.2. Treated ground water which meets ch. NR140 PALs would be discharged to a surface water body near the site pending approval by WDNR. The surface water body may include either wetlands approximately 300 feet southwest of the site (Alternative J1) or a drainage ditch which leads south to Silver Creek which is located approximately 1,500 feet south of the site (Alternative J2, Figure 6-3). Silver Creek discharges to Green Lake. Monthly sampling and analysis of the treated ground-water discharge would be required in order to maintain compliance with the WDNR discharge permit. Access to off-site property would have to be obtained to implement this alternative.

6.4.3.2 Effectiveness

The effectiveness of this alternative is limited by the rate of shallow ground-water extraction possible. Approximately five years is required to remove one pore volume of ground water; ground water may not meet ch. NR140 standards until 10 to 20 pore volumes have been pumped. While this alternative would provide hydraulic control of the shallow ground water and would prevent migration of the ground water which exceeds the ch. NR140 PALs and ESs, ground-water pumping from the shallow aquifer is not likely to result in ground-water contamination declining to or below ch. NR140 PALs within a reasonable period of time.

Discharging treated ground water to surface water in the vicinity of the landfill is an effective means of disposal.

6.4.3.3 Implementability

This alternative would require a Wisconsin Pollutant Discharge Elimination System (WPDES) permit before discharge of treated ground water could commence. Monthly sampling and analysis of the discharge water stream would probably be required in order to meet the requirements of the discharge permit. This alternative is readily implementable.

6.4.3.4 Cost

The estimated cost of Alternative J1 is:

Total Direct Costs:	$167,000
O&M Costs:	$50,000 per year
Present Worth:	$855,000

The estimated cost of Alternative J2 is:

Total Direct Costs:	$219,000
O&M Costs:	$50,000 per year
Present Worth:	$907,000

6.4.4 Alternative K - Shallow Ground-Water Extraction, Treatment and Discharge to an Infiltration Gallery

6.4.4.1 Design Concepts

This alternative would be implemented in conjunction with the shallow ground-water extraction and treatment system discussed in Sections 6.4.1 and 6.4.2. Treated ground water which meets ch. NR140 PALs may be able to be discharged to an infiltration gallery pending approval by WDNR.

An infiltration gallery would be comprised of a trench excavated off site, upgradient of the site. Ground water would be pumped to the infiltration gallery and discharged to a trench filled with a porous material such as gravel. The ground water would infiltrate down through the trench and back into the shallow aquifer. The top of the infiltration gallery would be covered with compacted clay in order to minimize the percolation of precipitation into the infiltration gallery.

It is anticipated that the infiltration gallery would be located approximately 1,000 feet upgradient of the proposed shallow ground-water extraction wells, and would be constructed in clean, native soil. Subsurface piping would be constructed in order to allow pumping of the treated ground-water discharge to the infiltration gallery. A surficial soil map which shows potential infiltration galleries in the vicinity of the FF/NN Landfill is shown on Figure 6-4. Based on soil types present immediately adjacent to the landfill, it is unlikely that an infiltration gallery could be constructed on site or on the former Bosveld property. Thus, access to off-site property would need to be obtained to implement this alternative.

6.4.4.2 Effectiveness

The effectiveness of this alternative is limited by the possible rate of shallow ground-water extraction. Approximately five years is required to remove 1 pore volume of impacted ground water, and the ground water may not meet ch. NR140 standards until 10 to 20 pore volumes have been pumped. While this alternative would provide hydraulic control of the shallow ground water and would prevent migration of the ground water which exceeds the ch. NR140 PALs and ESs, ground-water pumping from the shallow aquifer is not likely to result in ground-water contaminant concentrations declining to or below ch. NR140 PALs within a reasonable period of time.

This alternative may provide an effective disposal method for treated ground water. It is anticipated that 20 gpm of ground water could be readily discharged through the infiltration gallery. The actual size of the trench required would be determined by hydrogeologic modeling of the infiltration gallery. For costing purposes, it is assumed that the infiltration gallery is 10 feet deep, 10 feet wide, and 100 feet long.

6.4.4.3 Implementability

This alternative would require approval by WDNR of a WPDES permit to discharge to ground water. Monthly sampling and analysis of the discharge water stream would be required in order to meet the requirements of the discharge permit. Construction of this alternative is readily implementable. However, because of the high hardness of the ground water, the infiltration gallery is likely to clog over time with the buildup of chemical precipitate.

6.4.4.4 Cost

The estimated cost of this alternative is:

Total Direct Costs:	$170,000
O&M Costs:	$51,000 per year
Present Worth:	$872,000

6.4.5 Alternative L - Shallow Ground-Water Extraction, Treatment, and Discharge to Injection Wells

6.4.5.1 Design Concepts

This alternative would be implemented in conjunction with the shallow ground-water extraction and treatment system described in Section 6.4.1. and 6.4.2. Treated ground water which meets ch. NR140 PALs may be able to be discharged to injection wells pending approval by WDNR.

Hydraulically, ground-water discharge via ground-water injection wells is essentially the reverse process of ground-water extraction through ground-water extraction wells. Ground water would be pumped to several injection wells which were screened in the shallow zone. Ground water would pass through the screened zone of the wells and would enter the aquifer.

It is anticipated that the injection wells would be located approximately 1,000 feet upgradient of the proposed shallow ground-water extraction wells, on site, north of the landfill.

6.4.5.2 Effectiveness

The effectiveness of this alternative is limited by the rate of shallow ground-water extraction possible. Approximately five years is required to remove 1 pore volume of impacted ground water, and the ground water may not meet ch. NR140 standards until 10 to 20 pore volumes have been pumped. While this alternative would provide hydraulic control of the shallow ground water and would prevent migration of the ground water which exceeds the ch. NR140 PALs and ESs, ground-water pumping from the shallow aquifer is not likely to result in ground-water contaminant concentrations declining to or below ch. NR140 PALs within a reasonable period of time.

This alternative will require off-site access and may not provide an effective disposal method for treated ground water. It is anticipated that 20 gpm of ground water could be discharged through the injection wells. However, because of the high carbonate content of the ground water, the injection wells are likely to clog with the buildup of chemical precipitate, necessitating frequent pump maintenance and replacement. In addition, clogging of the soil medium surrounding the injection wells would necessitate the periodic replacement of wells in new locations.

6.4.5.3 Implementability

This alternative would require a variance from the WDNR before discharge of treated ground water through injection wells could commence. However, since other effective discharge alternatives are available, such a variance is unlikely. This alternative is not considered to be implementable.

6.4.6 Alternative M - Shallow Ground-Water Extraction/Off-Site Treatment and Discharge at Ripon POTW

6.4.6.1 Design Concepts

This alternative would be implemented in conjunction with the shallow ground-water extraction system discussed in Section 6.4.1. Ground water would be transported via a low-head pipeline at a distance of approximately 3/4 miles to the existing sewer which discharges at the Ripon POTW for off-site treatment and discharge. No on-site treatment of ground water would be conducted at the FF/NN Landfill..

The low-head pipeline would be comprised of a subsurface pipeline installed between the FF/NN Landfill and the Ripon POTW. The material of construction of the pipeline would be a material shown to be chemically resistant to the Ripon ground water. For costing purposes, it is assumed that polyvinyl chloride (PVC) piping would be used for the construction. The pipeline would be installed at a typical depth of 6 feet in order to minimize the potential impact of the freeze/thaw cycle.

The ground water would be transported through the pipeline to the Ripon POTW for treatment and disposal. A pump station would be used to supply the driving force for the water flow, although the pipeline would be configured to use as much of the effects of gravity flow as practicable.

6.4.6.2 Effectiveness

The effectiveness of this alternative is limited by the rate of ground-water extraction possible. Approximately 5 years is required to remove one pore volume of impacted ground water, and the ground water may not meet ch. NR140 standards until 10 to 20 pore volumes have been pumped. While this alternative would provide hydraulic control of the shallow ground water and would prevent migration of the ground water which exceeds the ch. NR140 PALs and ESs, ground-water pumping from the shallow aquifer is not likely to result in ground-water contaminant concentrations declining to or below ch. NR140 PALs within a reasonable period of time.

The Ripon POTW has indicated that it would be able to accept shallow ground water from the FF/NN Landfill pending chemical analysis of the ground water. The Ripon POTW would then treat and discharge of the ground water in conjunction with the existing waste water at the POTW, and permit requirements.

6.4.6.3 Implementability

This alternative would require permission from the Ripon POTW and may require approval from WDNR before a subsurface pipeline to the Ripon POTW could be constructed. Monthly sampling and analysis of the ground-water stream would probably be required in order to meet the requirements of the off-site treatment and disposal permit. This alternative is readily implementable.

6.4.6.4 Cost

The estimated cost of this alternative is:

Total Direct Costs:	$255,000
O&M Costs:	$46,000 per year
Present Worth:	$884,000

6.5 Alternative N - In-Situ Ground-Water Treatment Alternative

6.5.1 Air Sparging

6.5.1.1 Design Concepts

This alternative consists of in-situ ground-water treatment via air sparging. In-situ ground-water treatment via air sparging involves the injection of air under pressure below the water table. Sufficient air pressure is required to allow the injected air to enter both horizontally and vertically through the soil matrix displacing water. This injected air enhances physical removal of organic compounds via volatilization. Since the vapor densities of the materials to be removed is greater than that of air, the organics will have to be withdrawn via a soil vapor extraction system since they will not rise through the soil to the atmosphere.

It is anticipated that a total of 100 air sparging wells and 100 soil vapor extraction wells would be required, each constructed on approximate 100-foot centers. Actual spacing would be determined by pilot testing. Each air sparging well would be screened in the shallow ground-water aquifer and the soil vapor extraction wells would be screened above the ground water. Air from a blower would be used to force air through a subsurface piping system which would be connected to each of the air sparging wells and soil vapor extraction wells.

6.5.1.2 Effectiveness

This alternative would have very limited effectiveness at this site due to the depth of the impacted ground water at the site. The air sparging wells would need to be screened at depths greater than 60 feet bgs near the landfill. At these depths, there is too much uncertainty regarding the migration of entrained VOC vapors and the ability to capture impacted ground water without spreading the extent of impacts. Therefore, this alternative is not considered effective, and will not be further considered.

The present worth for each of the LFG alternatives are estimated to be as follows:

Alternative A: $455,000
Alternative H: $202,000
Alternative I: $427,000.

It should be noted that costs for Alternative A include ground-water monitoring which is not included in Alternatives H and I. The O&M costs for the gas monitoring in Alternative A are less than those of Alternatives H or I.
Table 8-2 provides a summary of the detailed analysis provided in Section 8.2.

8.3 Ground-Water Extraction and Treatment Summary

8.3.1 Overall Protection of Human Health and the Environment

Natural attenuation processes are expected to cause the plume to reach equilibrium within an undetermined period of time if the source of contaminants to the plume ceases to contribute VOCs. That is, No Action will attain the RAO of prevention of the migration of impacted ground water at some point in the future the effectiveness of source control will partially control the time required for equilibrium conditions to be obtained.

Alternatives J, K, and M include ground-water extraction from wells which would minimize the ground-water volume which requires extraction while maintaining hydraulic control of the ground water which contains the highest concentrations (greater than 11 ppb) of VOCs, thus providing additional protection from the migration of impacted ground water compared to Alternative A.

The discharge standards for Alternatives J and K are based upon the WACs, which are intended to protect human health and the environment. Alternative M relies on treatment and discharge at the POTW, which also is protective of human health and the environment.

Therefore, all of the pump and treat alternatives are equally protective of human health and the environment and are more protective than Alternative A.

If ground water in private wells is impacted by the FF/NN Landfill at concentrations above the ch. NR140 PALs, an alternative water supply will be provided to these residences. Coupled with regular monitoring of water supply wells, this insures the overall protection of human health as ch. NR140 PALs were established to be protective of human health.

8.3.2 Compliance With ARARs

Chapters NR102, 103, 104, 105, 106, 108, 112, 140, 200, 207, 214, 219, 220, and the Clean Water Act have been identified as potentially applicable to the FF/NN Landfill. These administrative codes pertain to all aspects of ground-water extraction, treatment, and discharge.

The Remedial Investigation Report (HSI, 1994) identifies ground water which exceeds ch. NR140 standards beyond the landfill boundary. Alternatives J, K, and M involve extraction and treatment of the highest observed concentrations of the impacted ground water. Some of the unextracted ground water (less than 11 ppb total VOCs) does exceed the WDNR ESs. However, ground-water extraction would intercept the source of the ground-water impacts near the landfill. Natural attenuation processes would remediate the remaining VOCs in the ground water.

Since the No Action Alternative will not result in meeting the ground-water standards within a reasonable period of time, it does not comply with ch. NR140. The pump and treat alternatives would achieve compliance with ESs over the long-term (in excess of 50 years) and thus result in eventual compliance with ch. NR140. However, the estimated time required to obtain compliance is not a reasonable period of time. It is not technically or economically feasible to achieve compliance with ESs over a shorter period of time.

Alternative J can meet all ground-water sampling, analysis, extraction, recovery, and discharge ARARs. The ground-water treatment standards for the extracted water may depend upon the surface water body at which the treated water will be discharged and the applicable requirements of Best Available Technology which are economically achievable.

Alternative K can meet all ground-water sampling, analysis, extraction, recovery, and discharge ARARs. The ground-water treatment standards for the extracted water depend upon the ch. NR140 ground-water standards and the applicable requirements of Best Available Technology economically achievable.

Alternative M can meet all ground-water sampling, analysis, extraction, recovery, and discharge ARARs. However, a permit would be required to discharge extracted ground water to the POTW. No treatment prior to discharge at the POTW is proposed under this alternative.

Based upon the above criteria, all of the ground-water extraction and treatment alternatives meet the threshold criteria of Overall Protection of Human Health and the Environment and Compliance with ARARs. The No Action Alternative does not meet the threshold criterion of Compliance with ARARs.

Table 7-1 provides a description of the federal and state ARARs for each of the remedial alternatives.

8.3.3 Long-Term Effectiveness and Permanence

Alternatives J, K, and M satisfy the primary balancing criterion of long-term effectiveness by improving the existing ground-water quality through treatment.

8.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternatives J, K, and M as well as the No Action Alternative include the natural attenuation processes such as dilution, dispersion, and degradation of contaminants in the ground water. Alternatives J, K, and M also include extraction and treatment of the ground water to meet the remedial action objective of restoration of ground-water quality to the WDNR cleanup standard. Alternatives J, K, and M would provide equivalent levels of protection over time.

Alternatives J, and K involve the same proposed ground-water treatment system consisting of an air stripper and possibly an in-line filter. A reduction in the toxicity of the ground water is achieved by removing VOCs via air stripping. Solids which are not contaminants of concern but may interfere with the air stripper may be removed by an in-line filter.

Discharge of air containing VOCs may be considered increasing the mobility of the VOCs. However, this discharge is not expected to increase the potential risks to human health and the environment because VOC concentrations are expected to be low (0.12 pounds per day). Solids removed by the in-line filter would form a sludge which would be disposed in a landfill.

8.3.5 Short-Term Effectiveness

Construction and implementation of Alternatives J, K, and M would generally not result in risks to human health and the environment from the waste or ground water. With any of the ground-water extraction and treatment alternatives, as with any construction project, physical risks would be present. These risks can be minimized with good construction practices and should not significantly affect the protection of human health or the environment. The clay cap covering the wastes will remain in-place and in good repair under all of the ground-water extraction and treatment alternatives and, therefore, there should be no direct contact with landfill wastes. Human exposure to impacted ground water would be minimized under all circumstances and should not significantly affect the protection of human health or the environment. Caution and appropriate health and safety precautions in compliance with all ARARs will be employed during any activities in which there is a potential for exposure to impacted ground water.

Because of the length of time required for ground water to achieve ch. NR140 standards, Alternatives A, J, K, and M could be considered only marginally effective in the short-term. However, Alternatives J, K, and M would provide hydraulic control as soon as ground-water extraction was initiated.

8.3.6 Implementability

Required materials, services, and equipment are available to construct each of these ground-water extraction and treatment alternatives. Alternative A involves no construction and therefore would be the simplest to implement. Alternatives J and K involve the construction of a ground-water extraction and treatment system which would be easily implemented from a technical standpoint. Alternative M involves only the installation of a ground-water extraction and transport system; it does not require on-site treatment. Thus, it would be the easiest to construct. Administratively, each of the ground-water extraction and treatment systems should not be difficult to implement since each is very similar.

The major differences related to the technical and administrative implementation of each of the alternatives concerns the discharge systems, as discussed below.

Discharge to the location specified in Alternative J2 would be the easiest to implement since the drainageway to Silver Creek has the greatest assimilative capacity for the discharge of treated ground water and is regulated by fewer ARARs than the wetland discharge (J1).

It should be noted that implementation of Alternatives J1 or J2 may require a hydrologic evaluation of the ability of the surface water discharge location to assimilate the proposed additional flow. The major focus of the hydrologic evaluation would be to determine the potential increased risk of flooding the surrounding areas.

Alternative K may be difficult to implement from a technical standpoint. This is because the available published data for the area was compiled prior to much of the quarrying in the area. The acceptable infiltration gallery locations noted on the map are located in areas which have recently been quarried. The potential infiltration gallery locations were selected based on published data pre-dating recent quarrying which indicates the absence of seasonally high water tables and the expected high percolation abilities of these areas.

Limitations on the construction of infiltration galleries with respect to their proximity to a roadway or surface water body further restrict the potential construction locations. A distance of 250 feet between an infiltration gallery and a surface water body or roadway is estimated to be necessary to minimize potential disturbances between the discharge location and these other areas. Additionally, access to property at which the infiltration gallery can be constructed may prove to be difficult. The area of the infiltration gallery is estimated to be about 10 feet wide by 100 feet in length but may be larger or smaller than this depending on the percolation rates of the selected gallery location.

Alternative M will likely be moderately easy to implement from an administrative standpoint. This is because the regulations which allow discharge to a POTW are well defined and dependant primarily on the POTW's capability to handle the increase in water quarterly for treatment. The Ripon POTW has indicated that they would have the capacity to treat discharge water from the site.

8.3.7 Cost

The estimated annual O&M cost for each of the ground-water extraction and treatment and discharge/reinjection alternatives are expected to range between $46,000 and $51,000. The reason for this narrow range of annual O&M costs is that the major O&M costs for each alternative are expected to be associated with ground-water extraction rather than water treatment and discharge.

Comparison of the present worth cost associated with each alternative is presented in the order of least relative expense to highest relative expense (Alternatives M, J1, J2, and K); Alternatives J, K, and M do not include the costs of monitoring the ground water as described in the landfill cap and monitoring alternatives (Alternatives A through E).

Alternative A, the No-Action Alternative, has an estimated net present worth of $455,000. However, the corresponding level of protection provided by this alternative is the lowest of the alternatives considered and will not provide compliance with ARARS.

The overall cost for the subsequent alternatives increases depending on the distance to the discharge location, whether or not on-site treatment of the ground water is required, and the complexity of implementing the discharge alternative.

The next least costly alternative is J1, Ground-Water Extraction, Treatment and Discharge of Ground Water to the pond and wetland to the southeast of the landfill. This alternative would require an air stripper and in-line filter for treatment. The estimated direct cost is $167,000 and the net present worth for this alternative is $855,000.

The next least costly alternative is K, Ground-Water Extraction, Treatment and Discharge of Ground Water to an Infiltration Gallery. This alternative would require the same treatment units as Alternatives J and J2. The estimated direct cost is $170,000 and the net present worth for this alternative is $872,000.

The next least costly alternative is M, Ground-Water Extraction and Transportation to the Ripon POTW for treatment and discharge of ground water. This alternative would require no on-site treatment unit. The estimated direct cost of this alternative is the largest at

$269,000 and the net present worth for this alternative is $898,000, which is more than the other pumping alternatives.

The most costly alternative is J2, Ground-Water Extraction, Treatment and Discharge of Treated Water to the drainageway into Silver Creek. This alternative would require the same treatment as J1. The estimated direct cost is $219,000 and the net present worth for this alternative is $907,000.

Table 8-3 provides a summary of the detailed analysis presented in Section 8.3.

FF/NN LANDFILL
ALTERNATIVE I - ACTIVE GAS COLLECTION AND TREATMENT SYSTEM
COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
Install Active Wells	4	each	$3,000	$12,000
Install Gas Header System	1,500	Linear Ft	$15	$23,000
Purchase and Install Compressor	1	each	$10,000	$10,000
Purchase and Install Enclosed Flare	1	each	$50,000	$50,000
Purchase and Install Gas Probes	8	each	$2,000	$16,000
Controller System	1	each	$3,000	$3,000
Electric Hook-Up	1	each	$3,000	$3,000
Mobilization/Demobilization	10% of Capital Costs			$12,000
	TOTAL CAPITAL COST =			$129,000

OTHER DIRECT COSTS

Permitting and Design	(10% of Total Capital Costs)	$13,000
Construction Oversight	(8% of Total Capital Costs)	$10,000
Contingency	(10% of Total Capital Costs)	$13,000
	TOTAL DIRECT COSTS =	$165,000

OPERATION & MAINTENANCE COSTS

Annual Discount Rate = 6.0%
Life of Project = 30 years

	Quantity	Unit Cost	Annual Cost	Present Worth
System Maintenance and Repairs	10% Capital Costs	$13,000	$13,000	$179,000
System Operation	1	$6,000	$6,000	$83,000
	ANNUAL O&M COSTS =		$19,000	
	PRESENT WORTH O&M COSTS =			$262,000

TOTAL DIRECT COSTS =	$165,000
PRESENT WORTH O&M COSTS =	$262,000
TOTAL PRESENT WORTH COSTS =	$427,000

FF/NN LANDFILL
ALTERNATIVE J - GROUND-WATER EXTRACTION, TREATMENT, AND DISCHARGE TO SURFACE WATER
POTENTIAL DISCHARGE LOCATION J1 - WETLANDS 300 FT. SW OF SITE
COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
GW Extraction/Treatment System	1	each	$80,000	$80,000
Outfall	300	feet	$30	$9,000
WPDES Permit Application	1	each	$20,000	$20,000
Property Access	1	Lump Sum	$10,000	$10,000
Mobilization/Demobilization	10% of Capital Costs			$12,000
	TOTAL CAPITAL COST =			$131,000

OTHER DIRECT COSTS

Permitting and Design	(10% of Total Capital Costs)	$13,000
Construction Oversight	(8% of Total Capital Costs)	$10,000
Contingency	(10% of Total Capital Costs)	$13,000
	TOTAL DIRECT COSTS =	$167,000

OPERATION & MAINTENANCE COSTS

Annual Discount Rate = 6.0%
Life of Project = 30 years

	Quantity	Unit Cost	Annual Cost	Present Worth
Ground-Water Extraction and Treatment System	1	$38,000	$38,000	$523,000
Monthly Water Discharge Sampling and Analysis	12	$1,000	$12,000	$165,000
	ANNUAL O&M COSTS =		$50,000	
	PRESENT WORTH O&M COSTS =			$688,000

TOTAL DIRECT COSTS =	$167,000
PRESENT WORTH O&M COSTS =	$688,000
TOTAL PRESENT WORTH COSTS =	$855,000

FF/NN LANDFILL

ALTERNATIVE J - GROUND-WATER EXTRACTION, TREATMENT, AND DISCHARGE TO SURFACE WATER
POTENTIAL DISCHARGE LOCATION J2 - SILVER CREEK 1,500 FT. S. OF SITE

COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
GW Extraction/Treatment System	1	each	$80,000	$80,000
Outfall	1,500	feet	$30	$45,000
WPDES Permit Application	1	each	$20,000	$20,000
Property Access	1	Lump Sum	$10,000	$10,000
Mobilization/Demobilization	10% of Capital Costs			$16,000
	TOTAL CAPITAL COST =			$171,000

OTHER DIRECT COSTS

Permitting and Design	(10% of Total Capital Costs)	$17,000
Construction Oversight	(8% of Total Capital Costs)	$14,000
Contingency	(10% of Total Capital Costs)	$17,000
	TOTAL DIRECT COSTS =	$219,000

OPERATION & MAINTENANCE COSTS

Annual Discount Rate = 6.0%

Life of Project = 30 years

	Quantity	Unit Cost	Annual Cost	Present Worth
Ground-Water Extraction and Treatment System	1	$38,000	$38,000	$523,000
Monthly Water Discharge Sampling and Analysis	12	$1,000	$12,000	$165,000
	ANNUAL O&M COSTS =		$50,000	
	PRESENT WORTH O&M COSTS =			$688,000

TOTAL DIRECT COSTS =	$219,000
PRESENT WORTH O&M COSTS =	$688,000
TOTAL PRESENT WORTH COSTS =	$907,000

FF/NN LANDFILL

ALTERNATIVE K - GROUND WATER EXTRACTION, TREATMENT AND DISCHARGE GROUND WATER TO INFILTRATION GALLERY

COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
GW Extraction/Treatment System	1	each	$80,000	$80,000
Excavate Soil for Infiltration Gallery	370	cu yd	$10	$4,000
Backfill Infiltration Gallery with Gravel	370	cu yd	$10	$4,000
Add Clay Cap over Infiltration Gallery	37	cu yd	$10	$0
Subsurface Pipeline to Infiltration Gallery	1,500	Linear Ft	$15	$23,000
Property Access	1	Lump Sum	$10,000	$10,000
Mobilization/Demobilization	10% of Capital Costs			$12,000
	TOTAL CAPITAL COST =			$133,000

OTHER DIRECT COSTS

Permitting and Design	(10% of Total Capital Costs)	$13,000
Construction Oversight	(8% of Total Capital Costs)	$11,000
Contingency	(10% of Total Capital Costs)	$13,000
	TOTAL DIRECT COSTS =	$170,000

OPERATION & MAINTENANCE COSTS

Annual Discount Rate = 6.0%

Life of Project = 30 years

	Quantity	Unit Cost	Annual Cost	Present Worth
Ground Water Extraction and Treatment System	1	$38,000	$38,000	$523,000
Maintenance of Infiltration Gallery	1	$1,000	$1,000	$14,000
Monthly Water Discharge Sampling and Analysis	12	$1,000	$12,000	$165,000
	ANNUAL O&M COSTS =		$51,000	
	PRESENT WORTH O&M COSTS =			$702,000

TOTAL DIRECT COSTS =	$170,000
PRESENT WORTH O&M COSTS =	$702,000
TOTAL PRESENT WORTH COSTS =	$872,000

FF/NN LANDFILL
GROUND-WATER EXTRACTION AND TREATMENT SYSTEM
COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
Install GW Extraction Wells	2	each	$7,000	$14,000
Install GW Header System	500	Linear Ft	$20	$10,000
Purchase/Install Submersible Pump	2	each	$3,000	$6,000
Automated Controller System	1	each	$3,000	$3,000
Electrical Hook-Up	1	each	$3,000	$3,000
Equilization Tank	1	each	$5,000	$5,000
In-Line Filter	1	each	$4,000	$4,000
Air Stripper + Blower	1	each	$15,000	$15,000
Pumps	2	each	$800	$2,000
Piping	1,000	Linear Ft	$10	$10,000
Concrete Pad	1	each	$1,000	$1,000
Mobilization/Demobilization	10% of Capital Costs			$7,000
	TOTAL CAPITAL COST =			$80,000

OTHER DIRECT COSTS

Permitting and Design	(10% of Total Capital Costs)	$8,000
Construction Oversight	(8% of Total Capital Costs)	$6,000
Contingency	(10% of Total Capital Costs)	$8,000
	TOTAL DIRECT COSTS =	$102,000

OPERATION & MAINTENANCE COSTS — Annual Discount Rate = 6.0%
Life of Project = 30 years

	Quantity	Unit Cost	Annual Cost	Present Worth
System Operation	1	$12,000	$12,000	$165,000
Equipment Inspection/Maintenance	52	$500	$26,000	$358,000
	ANNUAL O&M COSTS =		$38,000	
	PRESENT WORTH O&M COSTS =			$523,000

TOTAL DIRECT COSTS =	$102,000
PRESENT WORTH O&M COSTS =	$523,000
TOTAL PRESENT WORTH COSTS =	$625,000

FF/NN LANDFILL
ALTERNATIVE M - GROUND-WATER EXTRACTION, OFF-SITE TREATMENT, AND DISCHARGE AT RIPON POTW
COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
GW Extraction System	1	each	$36,000	$36,000
Subsurface Pipeline	4,000	Linear Ft	$30	$120,000
Pump Station with Wet Well	1	each	$25,000	$25,000
Property Access	1	Lump Sum	$10,000	$10,000
Mobilization/Demobilization	10% of Capital Costs			$19,000
	TOTAL CAPITAL COST =			$210,000

OTHER DIRECT COSTS

Permitting and Design	(10% of Total Capital Costs)	$21,000
Construction Oversight	(8% of Total Capital Costs)	$17,000
Contingency	(10% of Total Capital Costs)	$21,000
	TOTAL DIRECT COSTS =	$269,000

OPERATION & MAINTENANCE COSTS

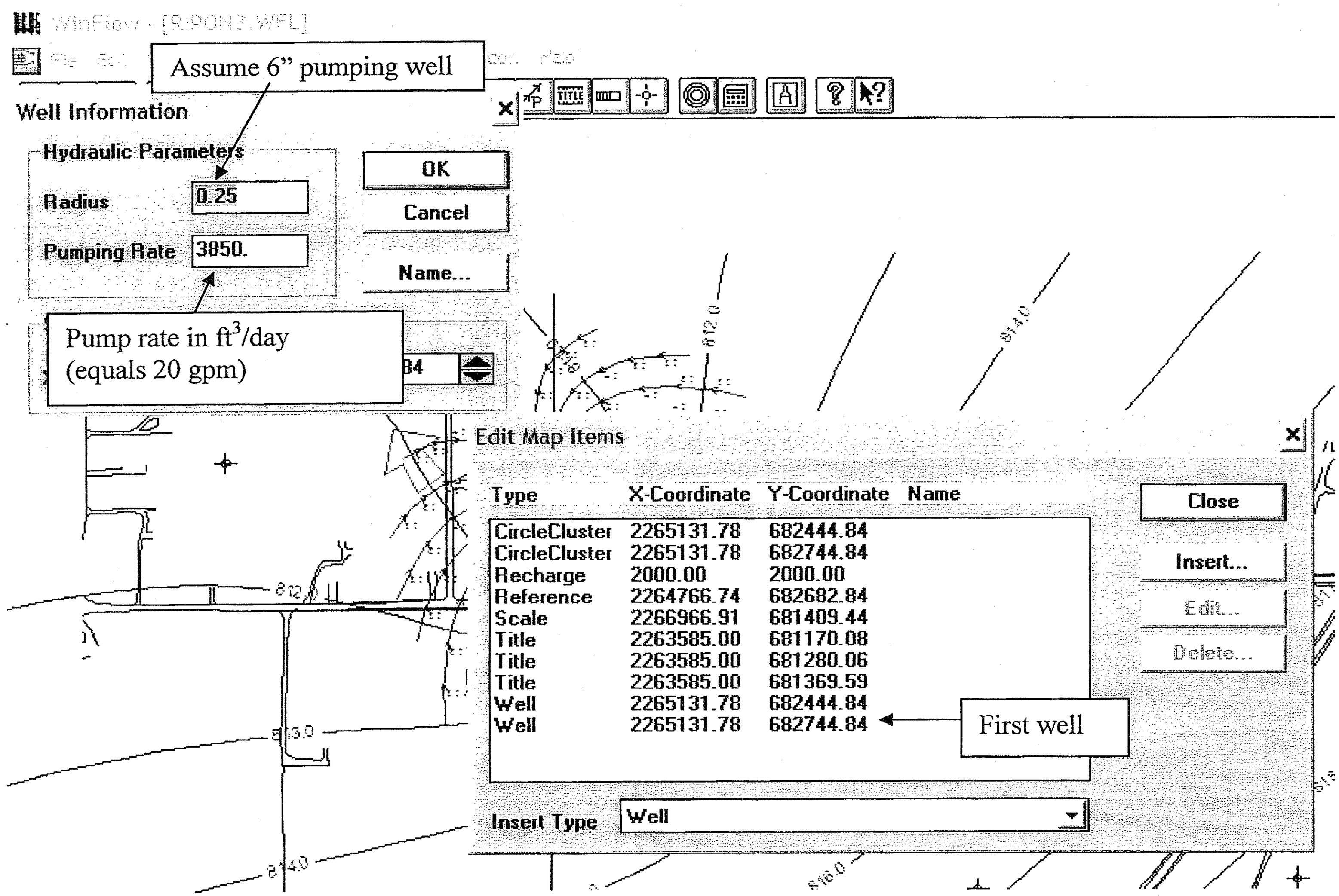
Annual Discount Rate = 6.0%
Life of Project = 30 years

	Quantity	Unit Cost	Annual Cost	Present Worth
System Operation	12	$12,000	$12,000	$165,000
System Maintenance	52	$250	$13,000	$179,000
Water Treatment	10.5 million gal	$1.48/750gal	$20,700	$285,000
	ANNUAL O&M COSTS =		$46,000	
	PRESENT WORTH O&M COSTS =			$629,000

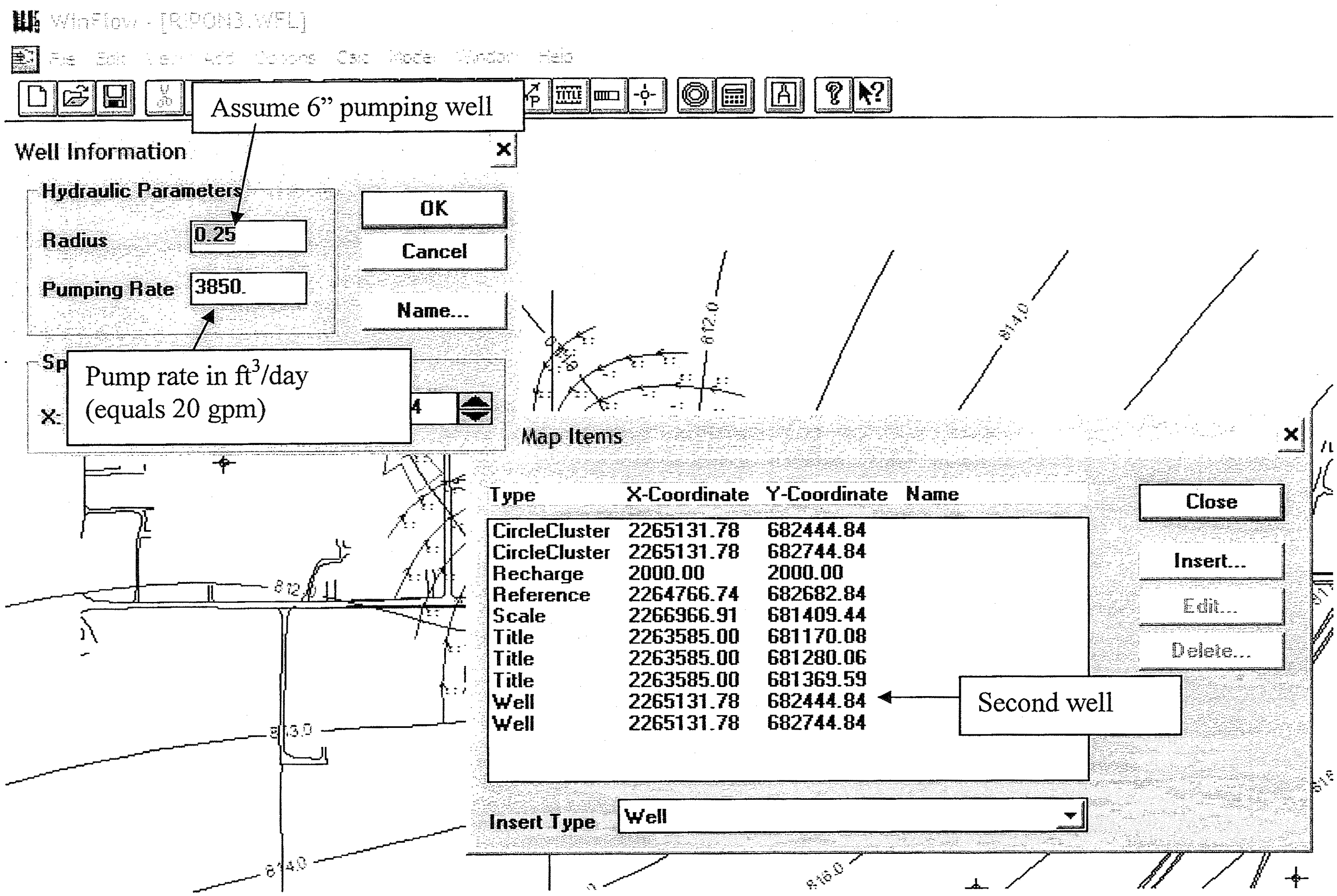
TOTAL DIRECT COSTS =	$269,000
PRESENT WORTH O&M COSTS =	$629,000
TOTAL PRESENT WORTH COSTS =	$898,000

APPENDIX E
GROUNDWATER MODELING

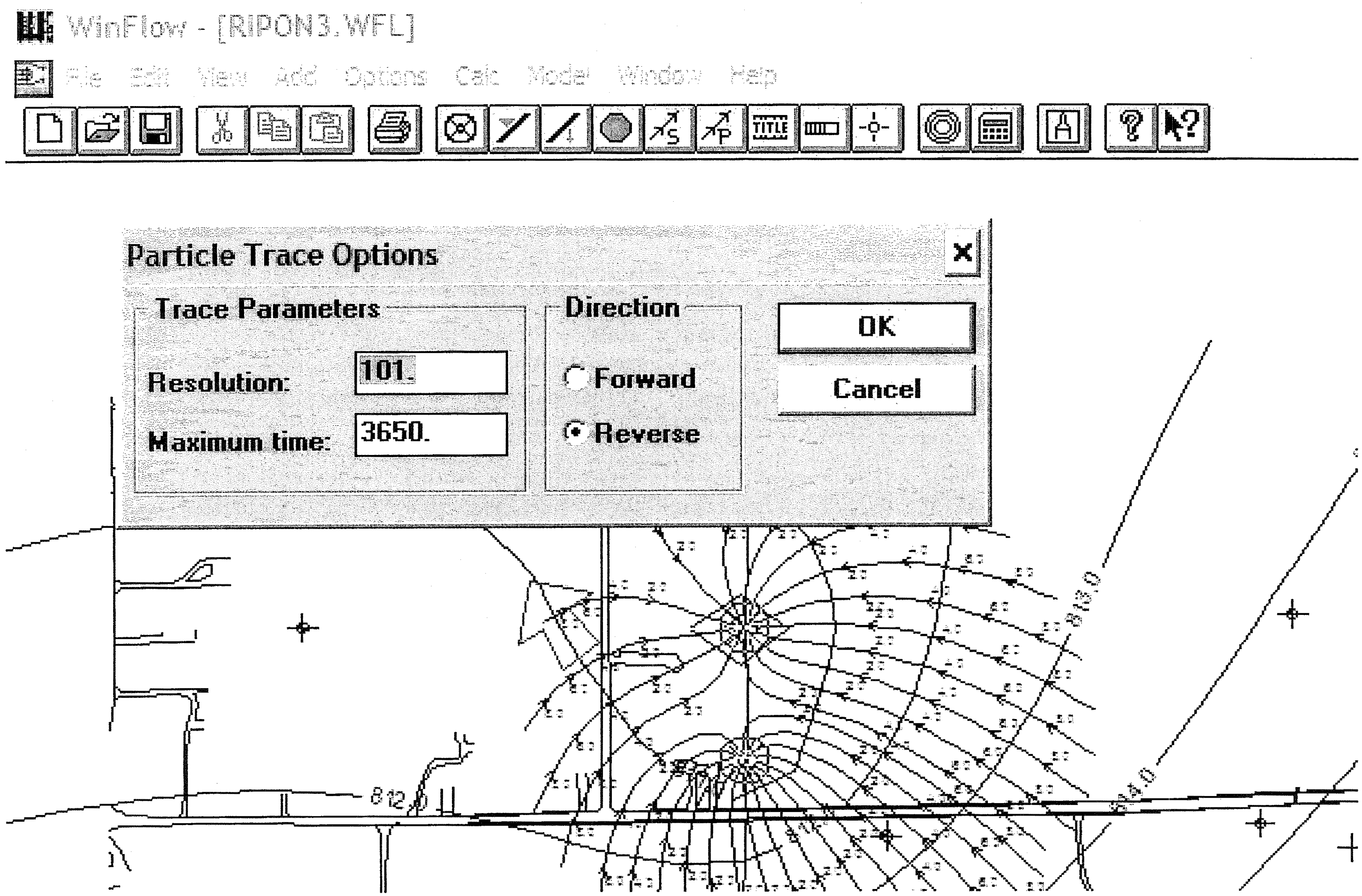
Well pumping parameters for WinFlow™ model



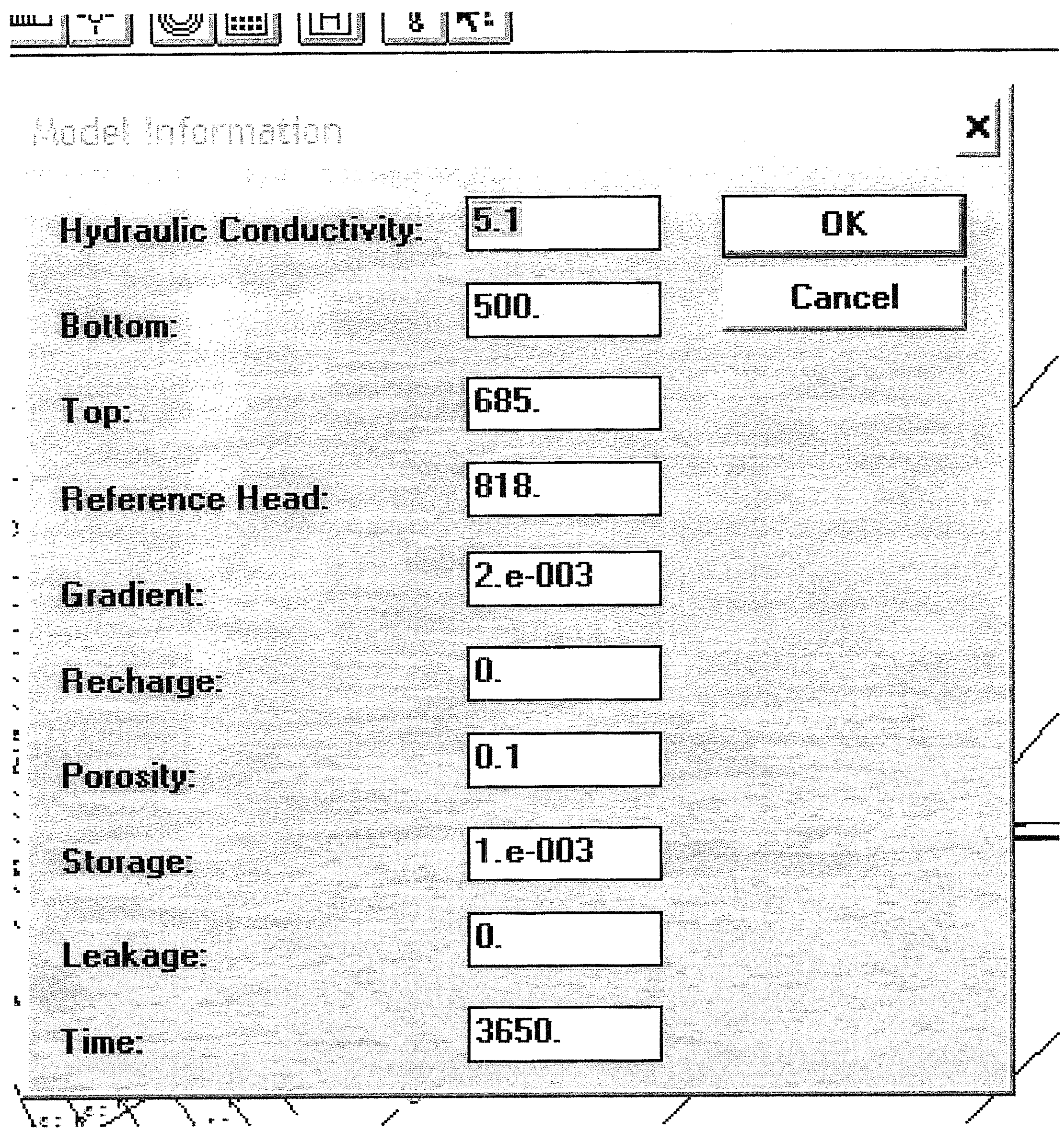
Well pumping parameters for WinFlow™ model



Particle tracking parameters for WinFlow™ model



Hydrogeologic Parameters for WinFlow™ model



WinFlow Assumptions

It is important to understand the many simplifying assumptions inherent in an analytical model before the model can be applied to a real-world problem. Chapter 5 described the equations that are solved in WinFlow. Chapter 6 verified that these equations are properly implemented in the WinFlow software. This chapter presents potential applications of WinFlow to the solution of ground-water problems. First, however, some important assumptions are discussed as they apply to practical application of WinFlow. For easy identification, the primary assumptions are underlined.

WinFlow is designed to solve two-dimensional ground-water flow problems in a horizontal plane. It is not designed for two-dimensional cross-sections (2D vertical plane). The two primary assumptions are that ground-water flow is horizontal and occurs in an infinite aquifer. WinFlow should not be applied to aquifers exhibiting strong vertical gradients unless the scale of the problem is such that horizontal flow can still be considered dominant. WinFlow can be used even in cases where there are significant vertical gradients if the horizontal scale of the model is much larger than the vertical scale, such as in regional studies.

Another assumption is that the aquifer hydraulic conductivity is assumed to be isotropic and homogeneous. The base of the aquifer is horizontal and fixed at a given elevation. In the steady-state and transient models, the top of the aquifer is also horizontal and fixed at a given elevation. In the steady-state model, however, unconfined conditions are simulated when the hydraulic head is below the top of the aquifer. In the transient model, the aquifer is always confined, even when the head falls below the top of the aquifer.

The reference head in the steady-state model is constant throughout all calculations. The reference head is analogous to a constant head boundary condition in a numerical model. It is therefore very important to keep the reference head far from the area of interest so that model predictions are not impacted.

The reference head in the transient model is only used in combination with the uniform gradient to compute an initial planar potentiometric surface. Drawdowns computed by either the Theis (1935) or the Hantush and Jacob (1955) methods are then subtracted from the planar potentiometric surface to obtain the resulting flow field. Drawdowns are also subtracted from the reference head in the transient model; however, there is an option that allows the user to keep the reference head constant in the transient model. This option should only be used when trying to compare the transient model to the steady-state model.

All pumping rates, linesink fluxes, pond recharge, and elliptical recharge rates are constant through time. In the transient model, all wells start pumping or injecting water at time zero.

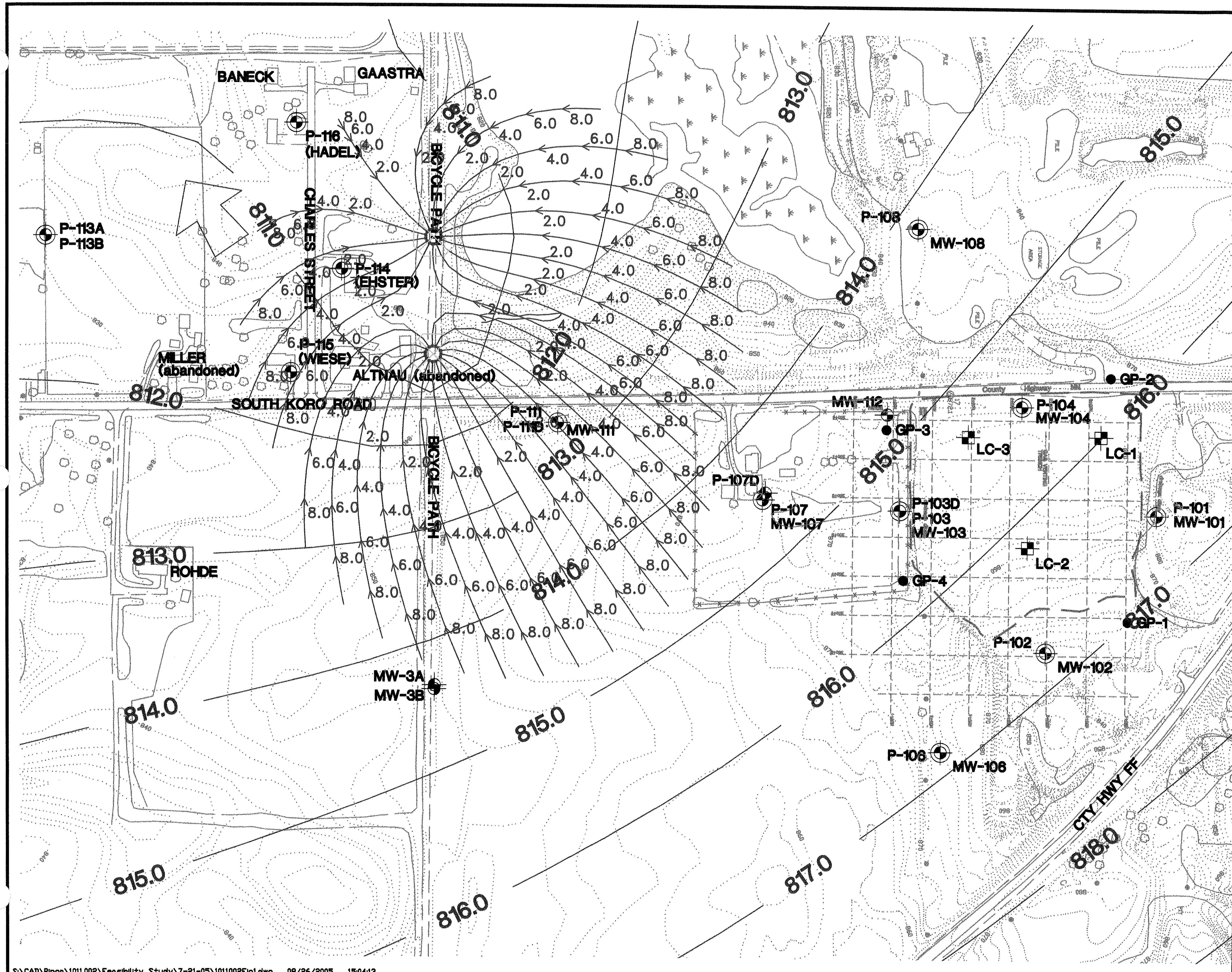
All wells are assumed to fully penetrate the aquifer. Wells are assumed to be perfectly efficient and linesinks are in perfect hydraulic communication with the aquifer. Both assumptions are rarely encountered in practice. There is often head loss around the well screen or stream bottom caused by clogging of the pore-space by fine-grained material (clay). There are two important consequences of imperfect hydraulic communication.

(1) Pumping rates predicted by WinFlow to achieve a desired response may not be attainable because more drawdown will be encountered in the actual well. The increased

drawdown encountered in the field is caused by inefficiency around the well screen. The same effect will happen using linesinks to simulate trenches or drains.

(2) The amount of water produced or injected by a linesink to maintain a specified head in the linesink will be overestimated if the actual drain has less than 100 percent efficiency.

Particle traces and streamlines are two-dimensional. In cases where the aquifer receives recharge, the capture zone of a pumping well will be large enough to capture the amount of recharge equaling the pumping rate of the well (Larson et al. 1987). In two-dimensional analyses, such as in WinFlow, the capture zone extends upgradient until encountering a ground-water divide or infinity. This is an important consideration in designing a containment system.



EXPLANATION

- P-104 / MW-104 — MONITOR WELL, PIEZOMETER LOCATION, DESIGNATION
- LC-2 — LEACHATE HEAD WELL LOCATION, DESIGNATION
- OUTLINE OF CLOSED LANDFILL
- GP-1 — GAS PROBE LOCATION AND DESIGNATION
- GROUNDWATER CONTOUR
- INDICATES PARTICLE TRACKING AT 2-YEAR INTERVALS
- ORIGINAL DIRECTION OF GROUNDWATER FLOW

N

SCALE

0 — 500

Feet

FF/NN LANDFILL
RIPON, WISCONSIN

GROUNDWATER PUMPING MODEL USING WINFLOW™

DATE:	8/26/05
DESIGNED:	MAM
CHECKED:	MRN
APPROVED:	MRN
DRAWN:	HJW
PROJ.:	1011.002

GeoTrans, Inc. A TETRA TECH COMPANY

Figure 1