WARZYN

Report
15151

Work Plan for Supplemental Soil and Groundwater Investigation Mobil Bulk Plant No. 48-356 Merrill, Wisconsin

Prepared for:
Mobil Oil Corporation
Schaumburg, Illinois

Prepared by:
Warzyn Inc.
Madison, Wisconsin

Rcvd 9/23/91 WR

September 1991

WARZYN

September 18, 1991

Mr. Kenneth Markart
Wisconsin Department of Natural Resources
North Central District Headquarters
P.O. Box 818
Rhinelander, Wisconsin 54501

Re: Work Plan for Supplemental Soil and Groundwater Investigation
Mobil Bulk Plant No. 48-356
Merrill, Wisconsin

Dear Mr. Markart:

On behalf of Mobil Oil Corporation (Mobil), attached for your review and comment is one copy of the above referenced report for Mobil Bulk Plant No. 48-356 in Merrill, Wisconsin. The Work Plan was developed in response to concerns raised in a Wisconsin Department of Natural Resources (WDNR) letter dated September 7, 1990, which recommended an assessment of contamination beyond the site property limits, and an investigation of a sewer line trench as a potential pathway for contaminant movement. The sewer line trench borders the property to the south and was blasted into shallow granitic bedrock to a depth of approximately 15 ft.

Warzyn proposes to investigate the sewer line trench as a potential contaminant pathway by performing a soil gas survey and sampling groundwater with a Hydropunch (or equivalent) in the trench fill. Soil sampling indicated that petroleum contaminated soil was predominantly limited to the area near the fill pipe valves southeast of the aboveground tanks. The competent bedrock surface was encountered at depths of 1.5 to 8 ft in this area.

Subsurface contaminant movement in soil above the bedrock surface toward the southern property boundary would be intercepted by the more permeable sewer line trench fill. Further movement across the trench to the south is likely prevented by the granitic bedrock wall on the south side of the sewer trench. To evaluate the role of the sewer line trench as an impediment to migration to the south, Warzyn also proposes to sample off-site soil gas and groundwater (if possible) south of the sewer line trench.

As described in the Work Plan, Mobil has indicated to Warzyn that other issues raised by the WDNR in the September 7, 1990 WDNR letter regarding improvements to the bulk storage facilities, soil remediation and evaluation of the 12-in. PVC well are the responsibility of the present facility operator.

THE PERFECT BALANCE BETWEEN TECHNOLOGY AND CREATIVITY

MADISON
ONE SCIENCE COURT
P.O. BOX 5385
MADISON, WI 53705
(608) 231-4747
FAX (608) 273-2513

As requested, also enclosed is a signed copy of the monitoring well construction form, which was inadvertently left unsigned in the Warzyn July 1990 Report titled "Soil Investigation, Mobil Bulk Plant No. 48-356, Merrill, Wisconsin."

Mobil is prepared to schedule field activities upon your approval of the Work Plan. Your expedient review of the enclosed Work Plan is appreciated.

Sincerely,

WARZYN INC.

Kevin D. Swanson (DJB)

Kevin D. Swanson
Project Hydrogeologist

Douglas J. Bach, P.E.
Project Manager

KDS/ccf/DJB/TFL
[mad-109-72]
15151.00

Enclosures: As Stated

cc: Terry Jagiello, Mobil Oil Corporation (w/encl.)

Work Plan for Supplemental Soil and Groundwater Investigation Mobil Bulk Plant No. 48-356 Merrill, Wisconsin

September 1991

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INTRODUCTION

This Work Plan was developed by Warzyn Inc. for Mobil Oil Corporation (Mobil) and outlines measures for further investigation of the extent of possible soil and groundwater contamination at Mobil Bulk Plant No. 48-356 in Merrill, Wisconsin. The Work Plan is being submitted to address concerns raised by the Wisconsin Department of Natural Resources (WDNR) pertaining to the site. The Work Plan has been organized under the following headings:

- Site background information;
- Geologic and hydrogeologic setting;
- Sampling plan; and
- Site management plan

SITE BACKGROUND INFORMATION

Mobil Bulk Plant No. 48-356 is located on South Park Street, one block south of U.S. Highway Business 51 in Merrill, Wisconsin (Drawing 15151-A1). The site is located in an industrial area and is bordered by Wisconsin Central Limited railroad track to the north; vacant property to the east; a gravel drive and lumber storage shed to the south; and an abandoned Standard Oil Bulk Plant to the west. Surface topography slopes to the south, towards the Wisconsin River, which is located approximately 100 yards from the site.

Above ground storage tanks are used at the site to store fuel oil and gasoline. Background information provided to Warzyn indicated that approximately 400-gal of fuel oil spilled from one of the tanks in June 1985. The tank was removed and affected soils were excavated on June 28, 1985. A Twin City Testing Corporation (TCT) report indicated that the final excavation was 10 ft deep and that the floor of the excavation consisted of igneous rock. A well constructed with 12-in. diameter PVC pipe with vertical saw cut perforations was placed in the excavation prior to backfilling with sand. TCT reported that on July 2, 1985, water in the well was at a depth 5.1 ft below ground surface and that a trace of product was noted in a sample collected from the well. On August 9, 1985, water in the well was reported to be at a depth 7.3 ft below ground surface but no product was noted in the sample collected.

Mobil subsequently retained Target Environmental Services (Target) which performed a soil gas survey on August 8, 1989. The Executive Summary from the Target report and the drawings which summarize the soil gas survey results are included in Appendix A. Target concluded:

- Total volatiles were highest along the northern and southern survey boundaries, with more moderate concentrations south and east of the above ground tanks. Occurrences that were wholly within the survey boundaries were relatively minor compared to occurrences affecting the perimeter of the property.
- Chromatograms revealed a variety of signatures that were not clearly indicative of any particular product except for one sample near the northeast corner of the site which appeared to be gasoline.
- Map patterns, concentration gradients, and chromatographic data indicate that petroleum hydrocarbons entered the subsurface at the tank field, although the most significant contaminant concentrations delineated by the survey were along the northern and southern property boundaries and may have originated offsite.

On March 5 and 6, 1990, an initial investigation was conducted by Warzyn to evaluate possible petroleum contamination of soil and groundwater at the Bulk Plant. The initial Work Plan proposed to install both monitoring wells and soil borings. However, due to the shallow igneous bedrock conditions encountered at the time of drilling, only soil borings could be conducted.

Thirteen soil borings were drilled and soil samples were collected for laboratory analysis of total petroleum hydrocarbons (TPH); benzene, ethylbenzene, toluene and xylenes (BETX); and polynuclear aromatic hydrocarbons (PAH).

Analytical results indicated soil with significant concentrations of petroleum hydrocarbons were generally limited to the area south of the above ground tanks and beneath the pipe fill valves. Warzyn's field observations and previous investigation reports indicated that a thin layer of groundwater occurs intermittently above shallow granitic bedrock. When present, it is possible that this groundwater drains to a backfilled sewer trench which has been blasted into bedrock along the southern edge of the site (refer to Geologic and Hydrogeologic Setting Section for discussion).

After reviewing Warzyn's Soil Investigation Report, Mr. Kenneth Markart (WDNR-North Central District hydrogeologist) developed a series of recommendations presented in a September 7, 1990 letter to Mr. Craig LaBelle of Mobil.

Mobil has indicated to Warzyn that several of Mr. Markart's recommendations are the responsibility of the present facility operator (Radlinger Oil Company), and should be directed as such. These recommendations include:

- Updating the bulk storage facility to prevent future fuel component releases to the environment.
- Remediating contaminated soil to the current cleanup guidance level of 5 ppm TPH or less for fuel component contamination.
- Evaluating the 12-in. PVC pipe (formerly used for monitoring) at the site as a potential pathway for surface water contamination to the groundwater.

This Work Plan for supplemental investigation was developed to address the remainder of the concerns raised by the WDNR. Specifically, this Work Plan is designed to investigate the potential pathways for offsite groundwater contamination.

At this time, there is no evidence that impacted groundwater from the site has been discharged to the Wisconsin River (approximately 100 yards to the south). The installation of offsite, bedrock monitoring wells to investigate this concern would be impractical for the following reasons:

- The occurrence of shallow groundwater in site borings has been inconsistent. There is little evidence to suggest that drilling into the upper portion of the granitic bedrock would intercept the groundwater table.
- Because of the nature of granitic aquifers, it is likely that a high proportion of the borings would exist within monolithic bedrock structures and would yield no water.

- Even if bedrock monitoring wells intercepted fractures and indicated contamination, the source of contamination would likely be ambiguous due to the many industrial facilities in the area and the complexity of flow in fractured media.
- Available information on the topography of the bedrock surface suggests that any water existing above the bedrock is likely intercepted by the sewer trench blasted into rock south of the site.

GEOLOGIC AND HYDROGEOLOGIC SETTING

The Mobil Bulk Plant site is located in an area of moderate relief, where glacial drift overlies Precambrian crystalline bedrock. The bedrock is a southern extension of the Precambrian Canadian Shield and consists of igneous and metamorphic rock. The thickness of the glacial drift ranges from zero to over 100 feet in the Merrill area. The drift consists of outwash and ice-contact sand and gravel deposits as well as ground moraine till. Warzyn field observations indicate drift soils do not extend beyond 6 ft in depth in most areas of the site.

Groundwater supplies all communities and most rural domestic needs in the region. Nearly all wells draw water from the glacial drift. The bedrock yields very little water, although it is tapped locally for small domestic supplies where glacial drift is thin. According to the U.S. Department of the Interior United States Geological Survey publication, Water Resources of Wisconsin Upper Wisconsin River Basin (1975), groundwater flow within the glacial drift soil in the vicinity of the site is likely towards the south.

A blasted sewer line trench extends along the southern boundary of the site (Drawing 15151-B3). In discussions with the City of Merrill Engineering and Water Departments, it was learned that the sewer trench extended to a depth of approximately 14 or 15 ft. Competent bedrock is present at the base of the trench and the trench is backfilled with sand and gravel. Due to the lower elevation of the trench and the difference in permeability between the trench backfill and surrounding bedrock, groundwater flowing south from the site may be intercepted by the sewer trench.

The City of Merrill Water Department repaired the sewer pipe in the vicinity of the site during March 1990. City employees who entered the excavation did not detect petroleum product odors within the sewer trench.

INVESTIGATION PLAN

The principal objectives of the investigation are to evaluate the horizontal and vertical extent of soil contamination within the sewer line trench as well as to determine if water within the trench has been affected by petroleum products. Mobil will contract with Target to perform the tasks associated with the Work Plan.

Task 1: Soil Gas Survey
Soil gas samples will be collected by Target at a total of 17 locations as indicated in Drawing 15151-B3. Samples will be collected at each location at depths of approximately 4 ft and 8 ft below ground surface. If shallow, competent bedrock south of the sewer trench prohibits penetration of the drive rod to sufficient depth, the deeper soil gas sample will not be collected. When necessary, an electric hammer drill will first be used to penetrate any asphalt present. A drive rod will then be used to create a 1/2-in. hole necessary for sampling.

The sampling system will be purged according to standard Target field protocol and a sample will be collected using a stainless steel probe inserted to the full depth of the hole. Samples will be collected in a pre-evacuated glass vials and stored for laboratory analysis. Quality Assurance/Quality Control (QA/QC) samples will be collected according to standard Target protocol.

Prior to conducting the day's field activities, all sampling equipment will be decontaminated by washing with soapy distilled water and rinsing with distilled water. Internal surfaces will be flushed dry with pre-purified nitrogen and external surfaces wiped clean with paper towels.

All air samples collected will be analyzed according to EPA Method 602 on a gas chromatograph equipped with a flame ionization detector (GC/FID), but by using the direct injection method instead of purge and trap. Samples will be analyzed for the following petroleum volatile organic compounds (PVOCs):

- methyl tert-butyl ether (MTBE);
- benzene;
- toluene;
- ethyl benzene;
- ortho-, meta-, and para-xylene;
- 1,2,4-trimethylbenzene; and
- 1,3,5-trimethylbenzene.

Task 2: Sampling of Water within the Trench

Water samples from within the sewer line trench will be collected by Target at a total of 5 locations as indicated in Drawing 15151-B3. If the water table exists in unconsolidated deposits above the bedrock surface south of the trench, 3 additional groundwater samples will be collected south of the trench at the locations indicated on Drawing 15151-B3. Groundwater samples will be analyzed for volatile organic compounds (VOCs) using EPA Method 8021. The VOCs analyzed will include those listed in the WDNR Analytical Guidance for leaking underground storage tanks (WDNR, PUBL-SW-130, June 1991). Two samples will be collected near the fill pipe valves because previous investigations suggest this location poses the highest potential for contamination.

Water samples will be collected by use of a HydroPunch groundwater sampling device (or equivalent) as described in the technical and product information contained in Appendix B. The City of Merrill Engineering Department will be requested to be onsite to observe the collection of samples near the sewer pipe. During Warzyn's initial site investigation, one soil boring (B5) was accidentally placed within the sewer trench. Depth to water in the boring was estimated at 12 ft. As previously discussed, the depth of the sewer line is approximately 14 to 15 ft below ground surface allowing approximately 2 ft of saturated thickness for sampling. If the HydroPunch cannot penetrate to a sufficient depth, water samples will not be collected.

Between each sampling location, the HydroPunch sampling device will be decontaminated by washing with soapy distilled water and rinsing with distilled water. Each sample hole will be backfilled with bentonite and the surface patched after completion (if necessary).

SITE MANAGEMENT PLAN

Site Health and Safety

All sampling activities at the site will be conducted in accordance with a Site Health and Safety Plan developed by Target. The plan will be designed specifically for field work at the site with the potential for petroleum product contamination.

Waste Management Plan

It is not anticipated that soil or groundwater wastes will be generated during the proposed site investigation activities. If necessary, a 55-gal drum will be available to store investigation derived wastes for appropriate disposal. Any investigation derived waste will be disposed of in accordance with applicable regulations.

NMC/ccf/KDS/TFL
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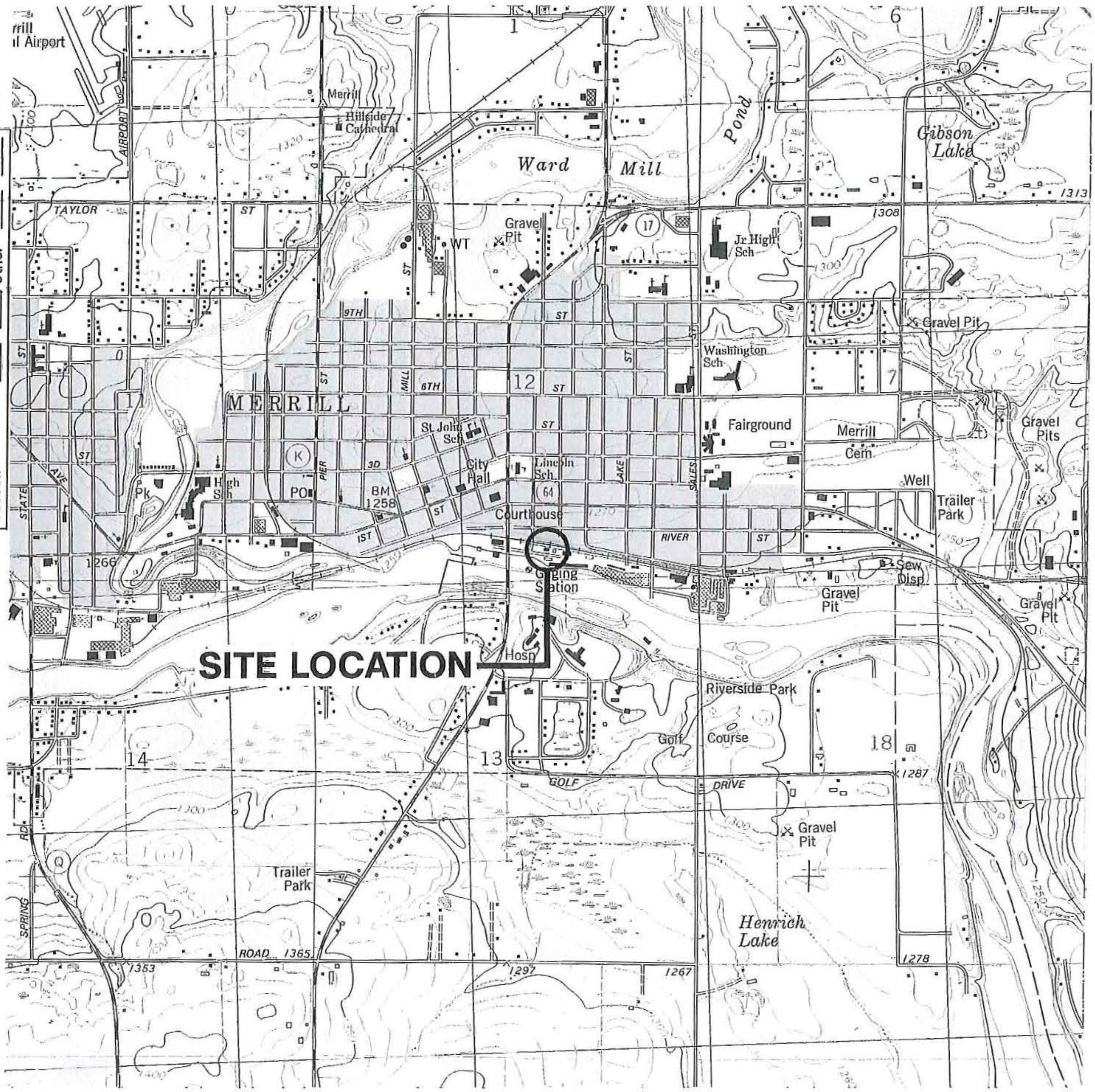

QUALITY CONTROL

	Initials	Date
Drafting Standards	KDS	7-12-90
Lead Professional		
Section		
PM	DJB	7-12-90
Division		
Other		

NOTES

1. SITE LOCATION MAP DEVELOPED FROM THE MERRILL, WISCONSIN 7½ MINUTE U.S.G.S. TOPOGRAPHIC QUADRANGLE MAP, DATED 1982.

north

0 2000 4000

SCALE IN FEET

WARZYN	SITE LOCATION MAP	Drawn DLF	Checked KDS	App'd. DJB
	SOIL INVESTIGATION MOBIL BULK PLANT NO. 48-356 MERRILL, WISCONSIN	Revisions		Date 7/13/90 15151 A1

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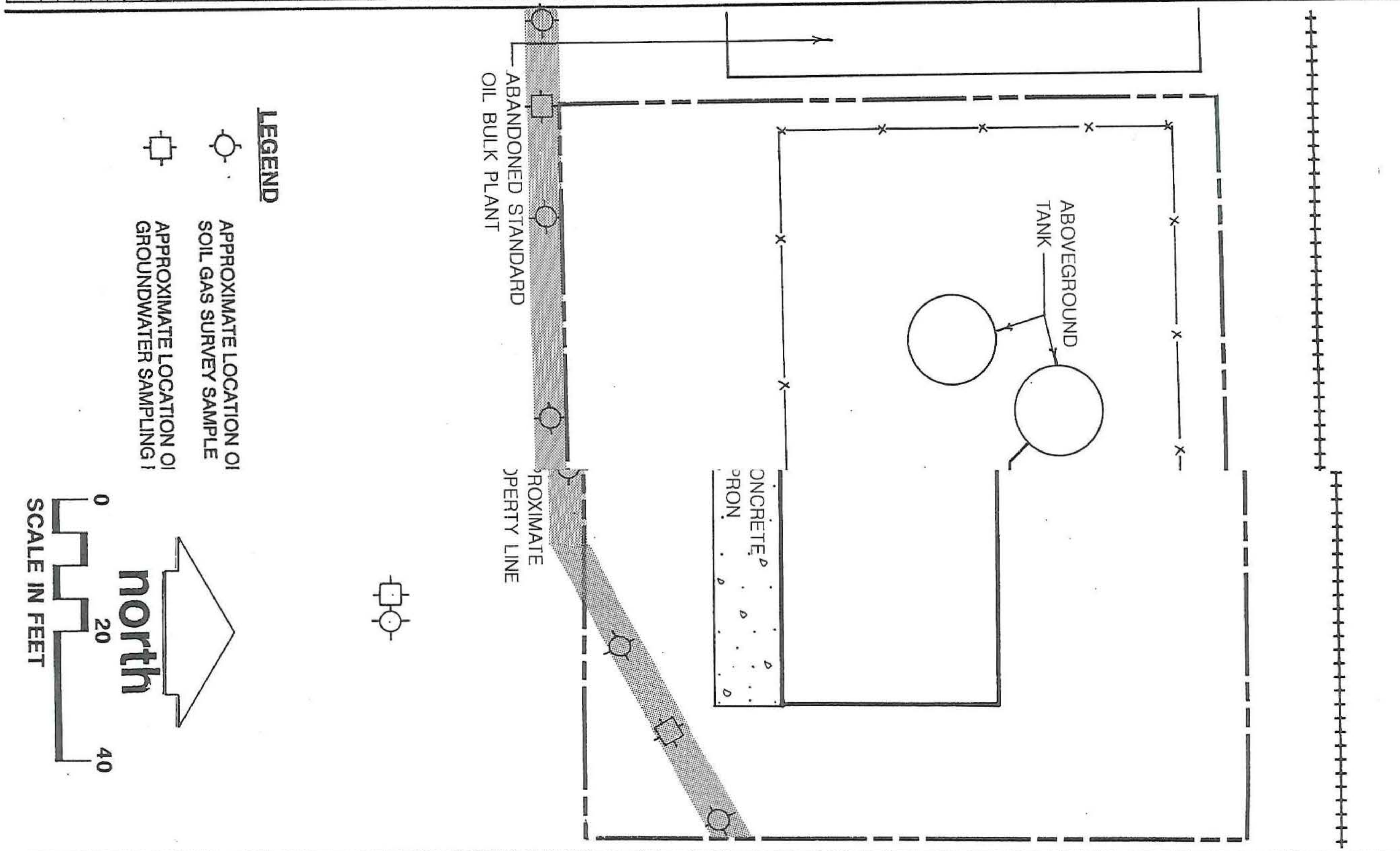


Project Number 15151 B3 WARZYN	**SAMPLING LOCATION PLAN** SOIL INVESTIGATION MOBIL BULK PLANT NO. 48-356 MERRILL, WISCONSIN	Revisions: ⚠1 ADDED ADDITIONAL SAMPLE LOCATIONS. — Date • By • App'd.: 9.17.91. DLF. DJB	**WARZYN** WARZYN ENGINEERING INC.
Designed By:	Drawn By: DLF, HLH	Checked By: NMC	
Approved By: [signature]	Date: 2/26/91	Reference:	

APPENDIX A

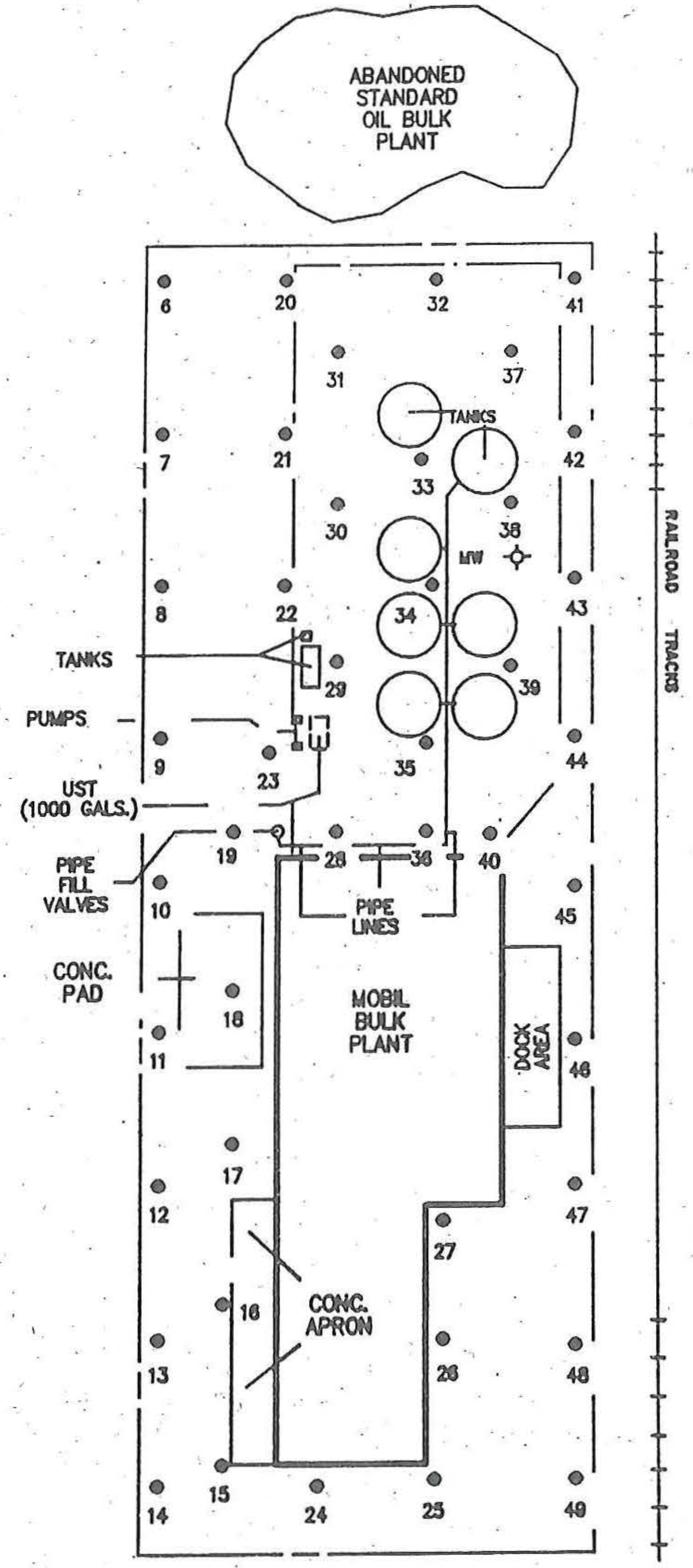
Summary of Target's Soil Gas Survey

EXECUTIVE SUMMARY

On August 8, 1989, **TARGET** Environmental Services, Inc. (**TARGET**) conducted a soil gas survey at the Mobil Bulk Plant on South Park Street, Merrill, Wisconsin. Analysis of the samples by GC/FID revealed the presence of hydrocarbons in the subsurface.

Total Volatiles were highest along the northern and southern survey boundaries, with more moderate concentrations south and east of the tanks. Chromatograms revealed a variety of signatures that are not clearly indicative of any particular product, except for one sample near the northeastern corner of the site, which appears to be gasoline.

Map patterns, concentration gradients and chromatographic data suggest that petroleum hydrocarbons entered the subsurface at the tank field, but the major occurrences delineated by this survey are along the northern and southern property boundaries and may have originated off-site. The occurrences that are wholely within the survey boundaries are all relatively minor compared to the occurrences affecting the perimeter of the property.



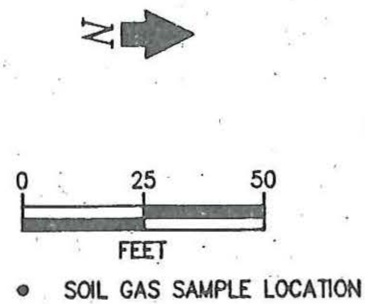


FIGURE 1. Sample Locations

MOBIL BULK PLANT
MERRILL, WISCONSIN

TARGET ENVIRONMENTAL SERVICES, INC.

This map is integral to a written report and should be viewed in that context.

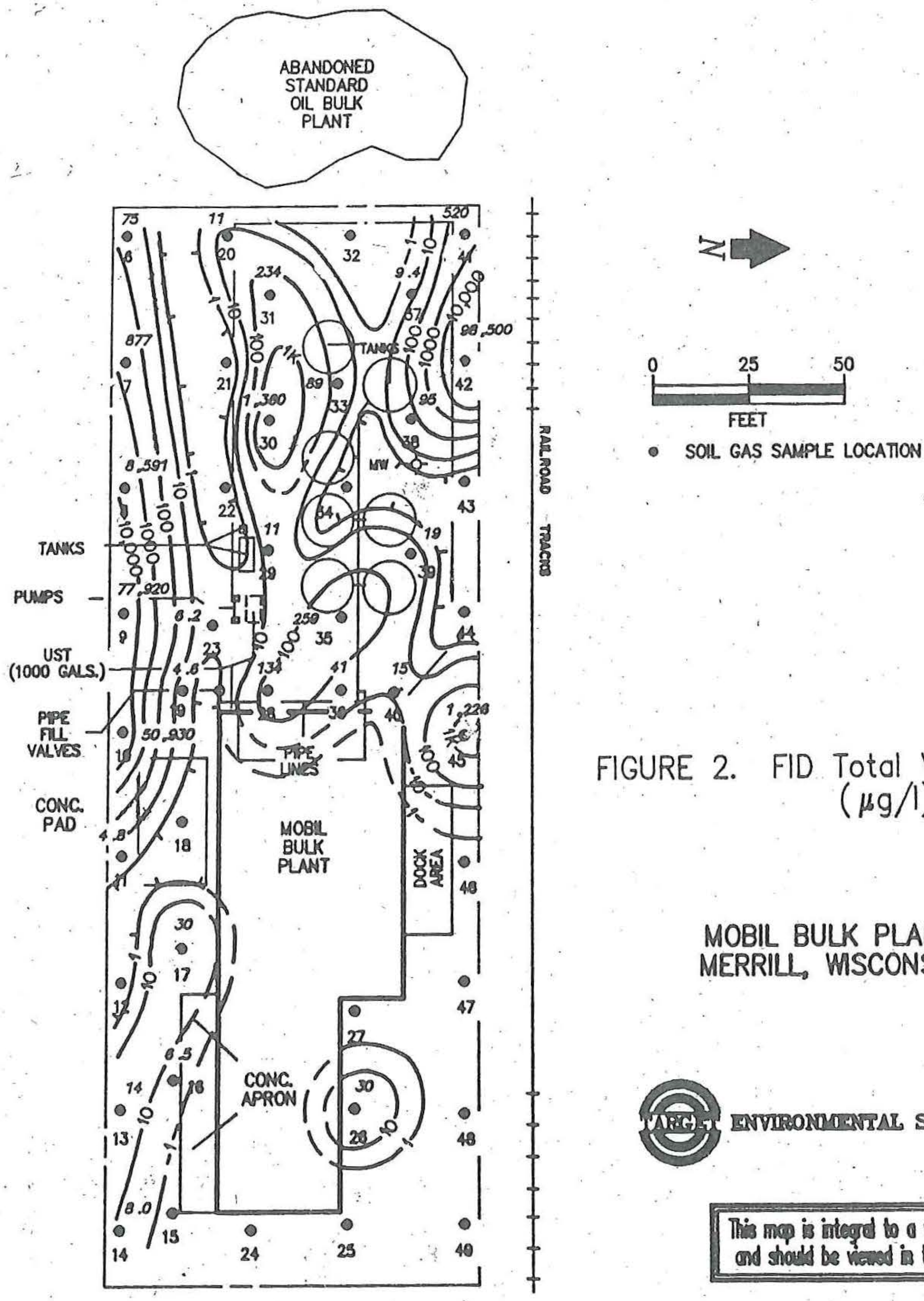
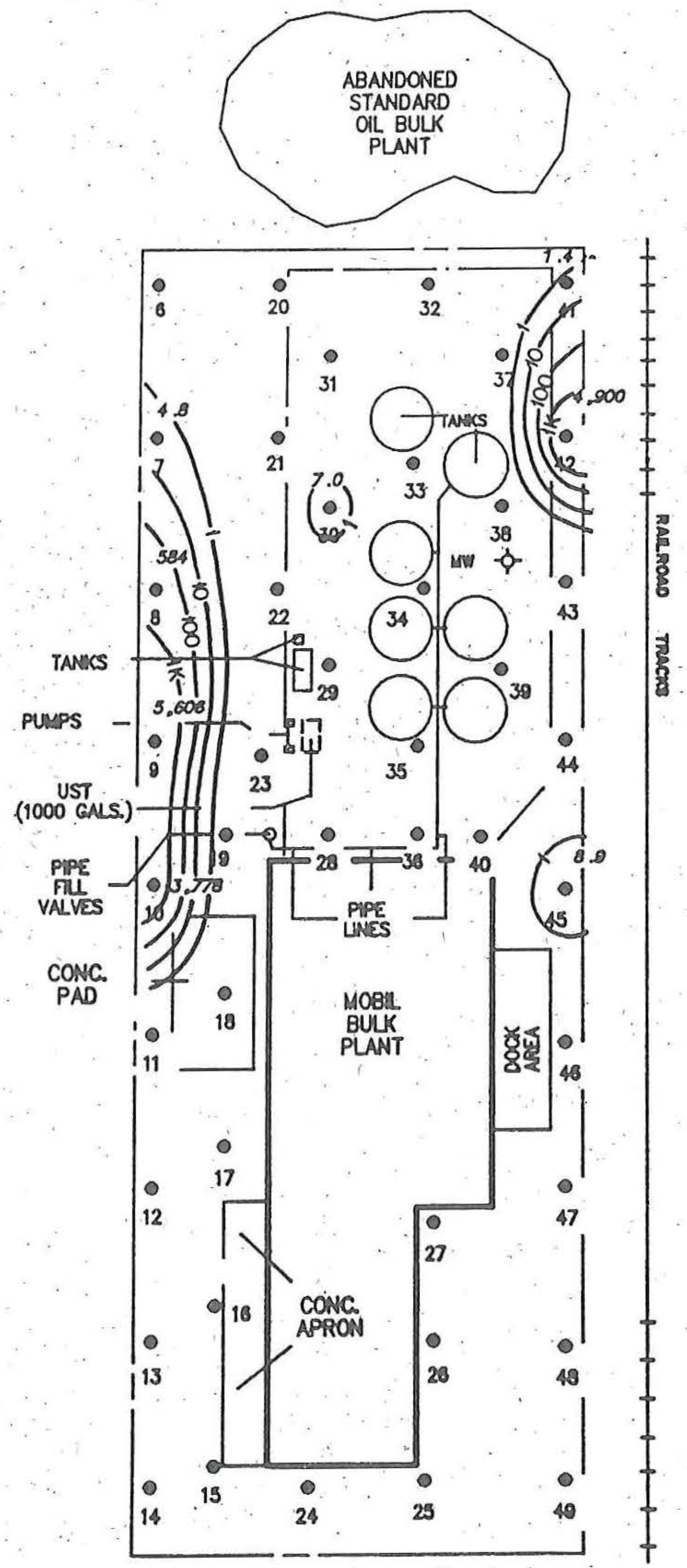


FIGURE 2. FID Total Volatiles (µg/l)

MOBIL BULK PLANT
MERRILL, WISCONSIN

TARGET ENVIRONMENTAL SERVICES, INC.

This map is integral to a written report and should be viewed in that context.



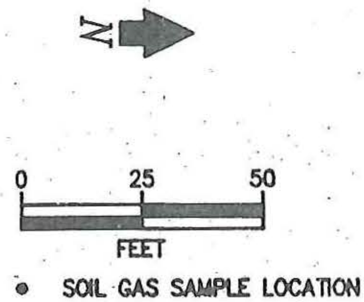


FIGURE 3. MTBE/Pentane (μg/l)

MOBIL BULK PLANT
MERRILL, WISCONSIN

TARGET ENVIRONMENTAL SERVICES, INC.

This map is integral to a written report and should be viewed in that context.

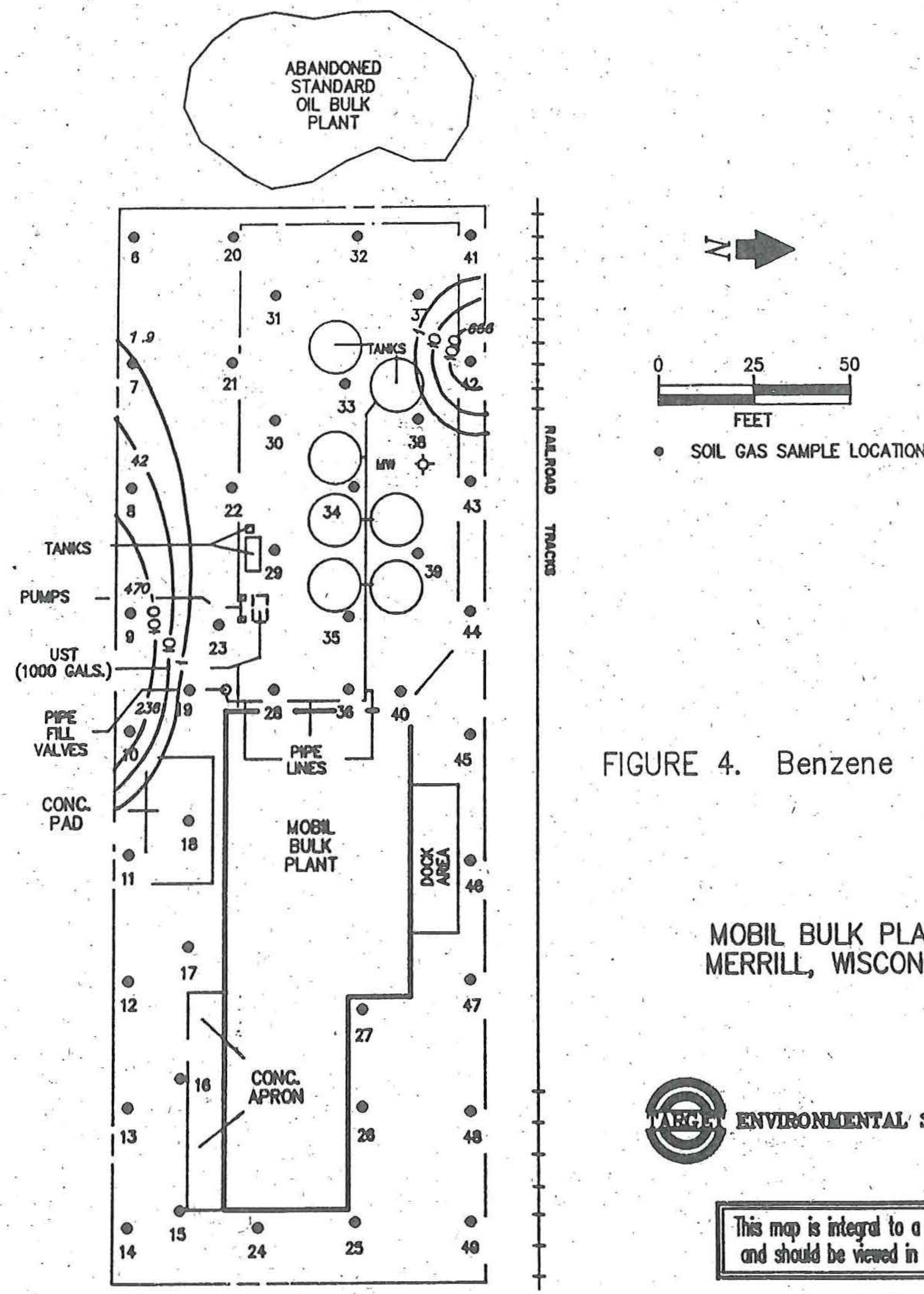


FIGURE 4. Benzene (µg/l)

MOBIL BULK PLANT
MERRILL, WISCONSIN

TARGET ENVIRONMENTAL SERVICES, INC.

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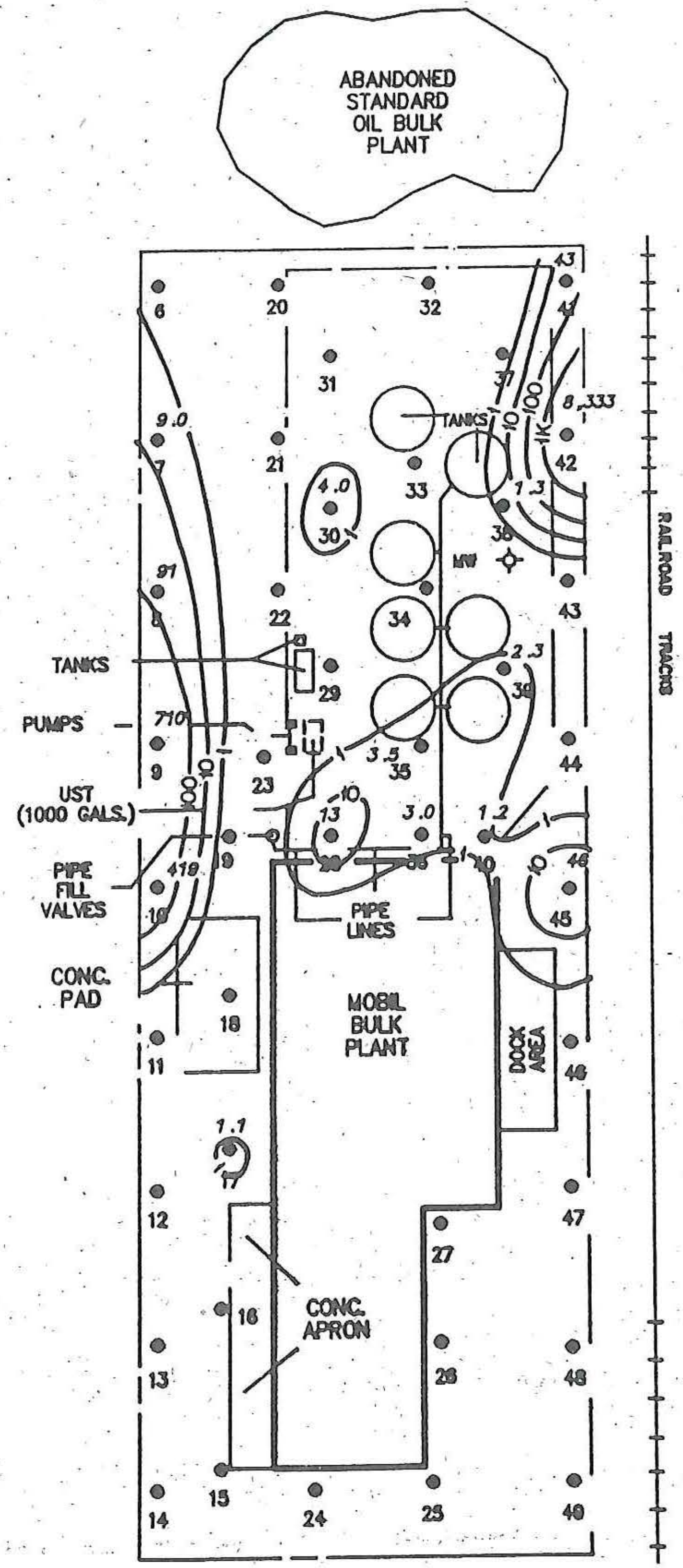

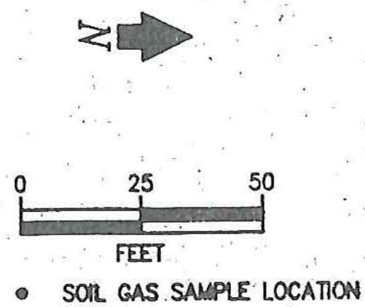

FIGURE 5. Toluene (μg/l)

MOBIL BULK PLANT
MERRILL, WISCONSIN

TARGET ENVIRONMENTAL SERVICES, INC.

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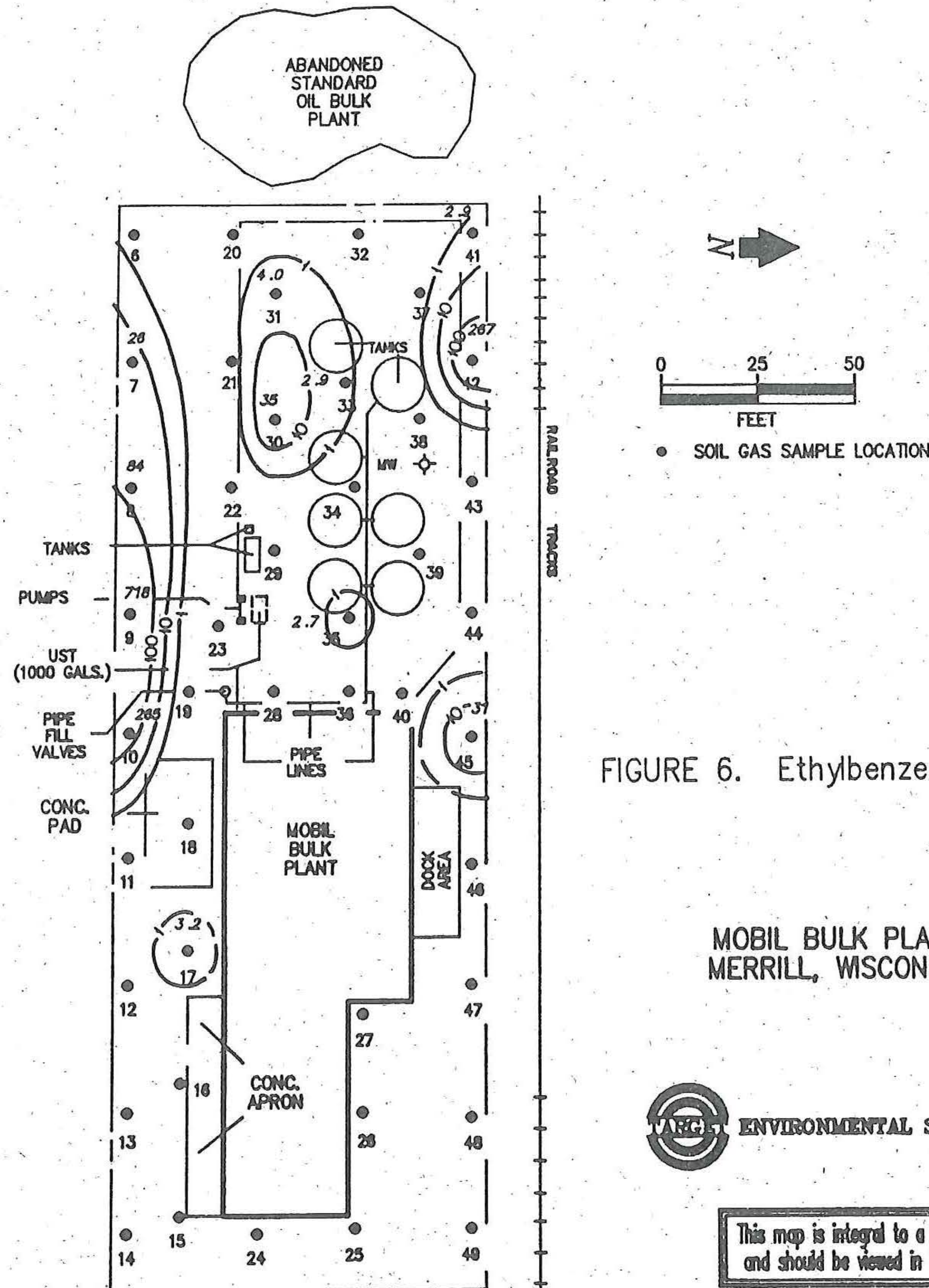

FIGURE 6. Ethylbenzene (µg/l)

MOBIL BULK PLANT
MERRILL, WISCONSIN

TARGET ENVIRONMENTAL SERVICES, INC.

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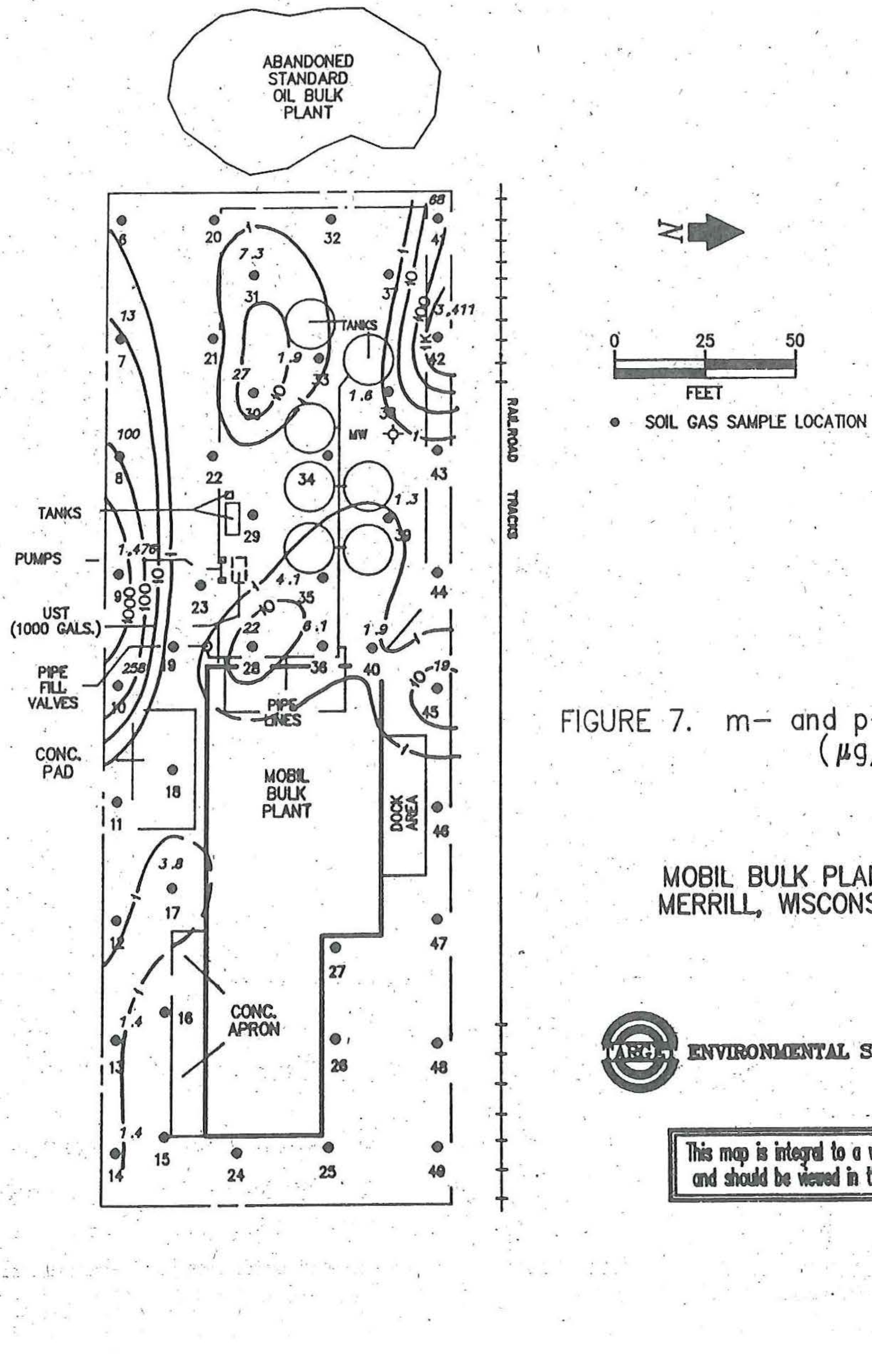

FIGURE 7. m- and p- Xylene ($\mu g/l$)

MOBIL BULK PLANT
MERRILL, WISCONSIN

TARGET ENVIRONMENTAL SERVICES, INC.

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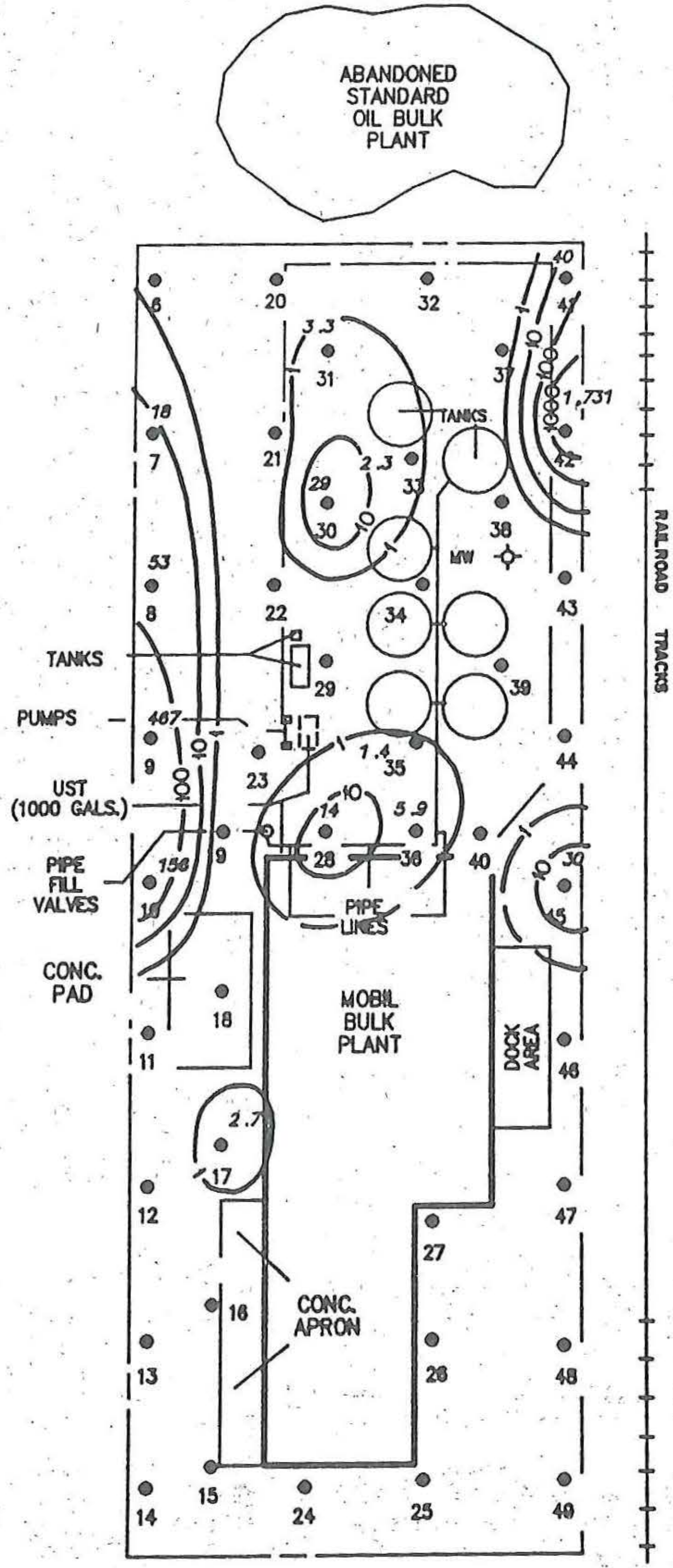


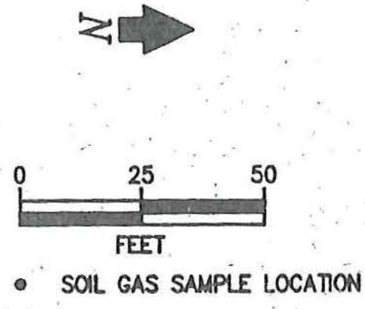


FIGURE 8. o-Xylene (µg/l)

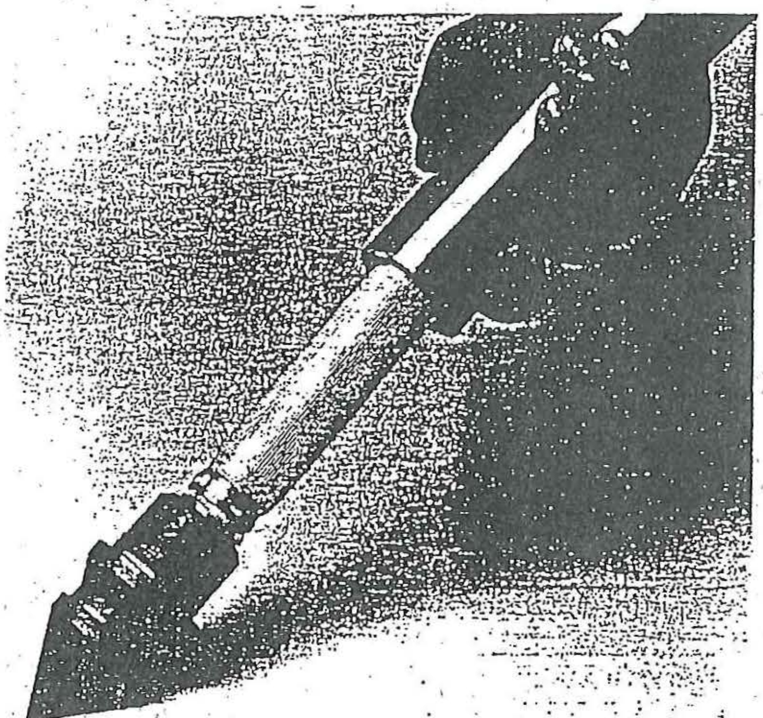
MOBIL BULK PLANT
MERRILL, WISCONSIN

TARGET ENVIRONMENTAL SERVICES, INC.

This map is integral to a written report and should be viewed in that context.

APPENDIX B

Technical and Product Information
Pertaining to Sampling of
Groundwater using a HydroPunch



Technical Information & Application Guidelines

HYDROPUNCH™

Groundwater Sampling Without Wells

INTRODUCTION

The HydroPunch™ is a stainless steel and Teflon* sampling tool. The HydroPunch provides a rapid, cost effective means to collect chemically representative ground water samples without the installation, development, and sampling of a ground water monitoring well. The resulting data can be used to help determine the vertical and horizontal extent of contamination and to accurately quantify the concentration of pollutants in the ground water. Ground water samples collected by the HydroPunch can be used to eliminate unnecessary ground water monitoring wells and to minimize the number of wells that are ultimately required for permanent ground water monitoring purposes. Savings of up to seventy percent (70%) of the cost of conventional well sampling have been reported.

Cost Comparison

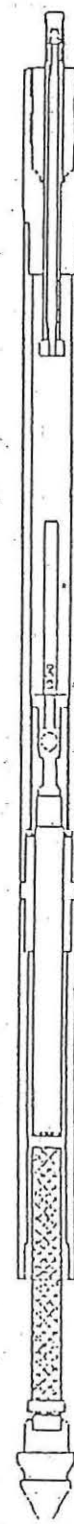
Activity	Conventional Well Installation	HydroPunch with Penetrometer Rig	Hydropunch with Drill Rig
Mobilization	$ 200	$ 100	$100
Drilling & Well Installation*	3,200	800	1,200
Well Development	500	—	—
Field Supervision	1,000	400	600
Sampling	600	425	425
Total Cost	$5,500	$1,725	$2,325
Total Time	3 days	1 day	1.2 days

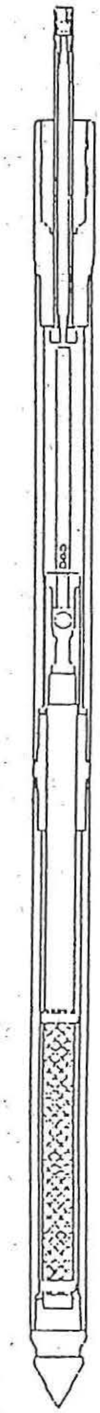
*Number of Groundwater Wells - 5 Depth to Groundwater - 25 feet

GENERAL TECHNICAL INFORMATION

The HydroPunch ground water sampling tool can be used in two modes, utilizing either cone penetrometer equipment or conventional drilling equipment to push or drive the tool to the desired sampling depth. The sampler is constructed entirely of stainless steel and Teflon, is easily cleaned in the field, and will collect approximately 500 ml of sample. The HydroPunch has a stainless steel drive point, a perforated section of stainless steel pipe for sample intake, a stainless steel and Teflon sample chamber, and an adapter to attach the unit to either penetrometer push rods or standard soil sampling drill rods.

As the unit is pushed or driven through the soil, the sample intake pipe is shielded in watertight housing that prevents contaminated soil or ground water from entering the unit. The shape of the sampler and its smooth exterior surface prevent the downward transport of the surrounding soil and liquid as the tool is advanced. When the desired sampling depth is reached, the sampler is retracted approximately 1.5 feet; the perforated intake pipe is exposed to the water-bearing zone, permitting ground water to flow through the screen and into the sample chamber. During sampling, no foreign materials (i.e., gravel pack, drilling fluid or cuttings) are introduced into the zone being sampled, minimizing the contaminants.





PLEASE NOTE:
HydroPunch samples and groundwater samples collected from monitoring wells installed in same borehole. Site referenced is a landfill located in N. California. Some variables exist between samples: 1) Samples were not collected from the HydroPunch and well concurrently, consequently chemical conditions may have changed between samples; 2) HydroPunch and well samples ˑre not collected from exactly the ˑie intervals. Screened intervals were 10-30 feet, while HydroPunch collects a sample from approximately a two-foot interval.

As the sample is collected, the drive cone and the sample chamber are flush against the borehole walls, serving as packers which isolate the intake screen from ground water above and below the zone being sampled. The sample is collected under in-situ hydrostatic pressure with no agitation. Once the sample chamber is filled, the HydroPunch is pulled towards the surface. This increases the hydrostatic pressure in the unit, which closes the two Teflon check valves and retains the sample within the sample chamber. Upon retrieval, the cone is removed and a simple stainless steel and Teflon sample discharge device is inserted for transferring the groundwater sample to a sample container.

Unlike geophysical monitoring techniques or soil gas sampling, which are sometimes used to screen for ground water contamination plumes, the HydroPunch provides a ground water sample consistent with sampling requirements for all priority pollutants. The sample provided by the HydroPunch is not subject to extraneous influences (i.e., changes in soil type, vadose zone contamination, etc.) which can affect the remote sensing techniques and often complicate the data interpretation. In addition, the potentiometric surface of the aquifer being sampled can be determined from the stabilized water level inside the rods used to drive or push the HydroPunch.

Comparison of HydroPunch and Monitoring Well Water Samples

Well Number	A-1		A-2		A-3		A-4		A-5		A-6	
Source of Sample	HydroPunch	Well	HydroPunch	Well	HydroPunch	Well	HydroPunch	Well	HydroPunch	Well	HydroPunch	Well
Depth of Sample (Feet)	35	40	121	101-131	125-127	105-135	81.5-83.5	55-85	140	134-144	124.5-126	122-132
Volatile Priority Pollutants (Concentration µg/l)												
Benzene	0.3	0.1	12	20	5	12	0.1	ND	0.1	0.1	1.2	0.3
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.3	ND
Dibromochloromethane	ND	ND	4.5	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.1	0.1	ND	ND	ND	ND	0.3	0.2	ND	ND	ND	1
1,1—Dicloroethane	0.1	0.1	30	45	22	42	0.2	0.8	ND	ND	4.7	8.4
1,2—Dichloroethane	ND	ND	2.5	2.5	ND	ND	ND	ND	ND	0.3	0.5	0.5
1,1—Dichloroethene	ND	ND	2.5	2.5	ND	ND	ND	0.1	ND	ND	ND	0.1
1,2—Dichloropropane	ND	ND	2.5	2.5	ND	2.5	ND	ND	ND	ND	ND	1
Ethylbenzene	0.2	ND	ND	ND	ND	ND	ND	ND	0.1	0.1	0.1	ND
Methylene Chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	15	10
Tetrachloroethene	0.6	0.7	23	48	28	42	0.6	1.5	2.3	3.	5.5	12
Toluene	1.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	0.2.	ND	ND	ND	ND	ND
1,1,2,-Trichloroethane	0.1	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethane	0.2	0.3	16	30	ND	25	0.1	0.3	0.2	0.2	2.8	5.3
Vinyl Chloride	ND	ND	ND	32	ND	ND	ND	ND	ND	ND	ND	ND
ˈrane-1,2-Dichloroethene	ND	ND	ND	2.5	ND	5	ND	ND	ND	ND	0.2	0.2
ɔlatile Non-Priority Pollutants												
m,p—Xylenes	0.7	0.1	ND	2.5	ND	2.5	0.1	ND	0.3	0.1	0.3	ND
o—Xylene	0.1	ND	ND	2.5	ND	ND	ND	ND	0.1	ND	ND	ND
cla-1,2-Dichloroethene	2.4	2.6	48	75	38	65	ND	ND	0.3	0.3	4.2	2.3

GEOLOGIC GUIDELINES FOR USING THE HYDROPUNCH

General Application

The HydroPunch is a ruggedly constructed sampling tool designed to be pushed or driven into position. Although the HydroPunch is designed for durability, some basic guidelines should be followed to maximize the usage life of this tool.

As a general rule, the HydroPunch can be driven into position in formations where a standard 2 inch split barrel (spoon) soil sampler can be driven. Suitable geologic materials would include unconsolidated clays, silts, sands and fine gravels. It is often helpful to drive a split barrel sampler immediately above the zone where the HydroPunch sample is to be collected. This permits an estimate of the permeability of the formation to be made from the textural characteristics of this soil sample and also provides an estimate of the resistance to driving the HydroPunch.

Blow counts of over thirty (30) blows per six inches with the 2 inch split barrel sampler may indicate that damage might occur while driving the HydroPunch. This would be more likely to occur if very hard materials (i.e., cobbles, rock layers, etc.) were mixed in with a matrix of softer material than if the HydroPunch is being advanced through a uniformly dense material. In dense formations it is better to drive the HydroPunch using frequent blows with a standard 140 pound hammer than to increase the hammer weight. This is because the length of the tool (5.38 ft.) will be left unsupported and the heavier hammer may induce more lateral stress on the unit, resulting in bending of the body. The deeper the body of the HydroPunch is in the soil, the less likely bending is to occur. This same principle is true for pushing the HydroPunch. As a general rule it is not a good idea to push the HydroPunch from the surface into the soil with the entire barrel unsupported. If thrust moves out of the vertical plane or an obstruction is encountered, the unit may be damaged by bending.

Hydrologic Considerations

An important feature of the HydroPunch is that it is designed to fill using the aquifer's hydrostatic pressure. Consequently the HydroPunch will only fill as fast as the formation will yield water. The discrete sampling intake of the HydroPunch (the area between the drive cone and the body when the tool is in the open position) must be in hydraulic contact with a water bearing zone for a sample to be collected.

The location of the sample chamber above the intake requires that the HydroPunch be pushed a minimum of five (5) feet below the static water level for a sample to be collected. Attempts to collect samples with less than five feet of penetration into the aquifer will likely result in very slow fill times, inadequate sample volume or improper function of check valves, due to extremely low hydrostatic pressure.

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The Hydropunch™: An In Situ Sampling Tool for Collecting Ground Water from Unconsolidated Sediments

by Russel W. Edge and Kent Cordry

Abstract

The Hydropunch™ is a stainless steel and Teflon® sampling tool that is capable of collecting a representative ground water sample without requiring the installation of a ground water monitoring well. To collect a sample, the Hydropunch (Patent #4669554) is connected to a small-diameter drive pipe and either driven or pushed hydraulically to the desired sampling depth. As the tool is advanced, it remains in the closed position, which prevents soil or water from entering the Hydropunch. Once the desired sampling depth is obtained, the tool is opened to the aquifer by pulling up the drive pipe approximately 1.5 feet (0.46m). In the open position, ground water can flow freely into the sample chamber of the tool. When the sample chamber is full, the Hydropunch is pulled to the surface. As the tool is retracted, check valves close and trap the ground water in the sample chamber. At the surface the sample is transferred from the Hydropunch to an appropriate sample container. The tool is a fast, inexpensive alternative for collecting ground water samples from a discrete interval. It is excellent for vertical profiling or defining the areal extent of a contaminant plume.

Introduction

Increased public awareness and concern over toxic chemicals in our ground water resources has resulted in dramatic increase in the number of ground water investigations being conducted in the United States. The cornerstone of these investigations is the ground water monitoring well. Monitoring wells are used to determine if ground water contamination exists at a selected location, to quantify the concentration of contaminants in the ground water, and to define the vertical and horizontal extent of contamination. During the past decade, improved analytical techniques and a better understanding of ground water monitoring requirements have made the installation, development, and sampling of ground water monitoring wells increasingly more sophisticated. Increased sophistication has resulted in a corresponding increase in the cost and time required to complete the typical ground water monitoring well. It has been estimated that the average cost of drilling and installing a single ground water monitoring well has increased approximately $2000 to more than $6000 in the last 10 years. This figure does not include well development and sampling costs. At sites where ground water and soil are classified as hazardous and must be containerized and transported to suitable locations for disposal, costs for well installation, development, and sampling will be substantially higher. These increased costs are due in part to the volume of material to be disposed of, increased health and safety requirements, detailed sampling protocol, and more stringent QA/QC.

In addition to increased cost, the time between the installation of a ground water monitoring well and the time when a ground water sample is actually collected can become quite lengthy. For small investigations (using five or fewer relatively shallow wells drilled with hollow-stem augers, as an example) it is typically a matter of days or weeks between the time drilling is initiated to when ground water samples are collected. It has been the authors' experience on medium- and large-scale investigations (six or more monitoring wells) that weeks or months pass between the initiation of drilling and ground water sampling. This is primarily a result of scheduling the drilling, development, and sampling crews in the most efficient manner. Ideally, all monitoring wells are installed, then developed and finally sampled. For a project involving numerous ground water monitoring wells it requires a considerable period of time to receive meaningful geochemical and hydrogeologic data.

The exploratory nature of hydrogeologic investigations often results in many wells which for one reason or another are only sampled once. Often the wells are found to be misplaced either horizontally or vertically in relationship to the contaminant plume. At sites with a complex hydrogeologic environment, and where little hydrogeologic data are available, sometimes as many as half of the initial monitoring wells installed can be improperly located. Another problem associated with misplaced monitoring wells is that once the well is installed, the temptation exists to continue to sample the well regardless of the usefulness of the data.

Due to the cost and time associated with ground water monitoring wells, many investigators have used secondary detection techniques (i.e., geophysical methods and soil-gas sampling) in an attempt to define the horizontal extent of contaminant plumes. At sites where the hydrogeologic and contaminant conditions are suitable, secondary detection methods have proved to be quite valuable. Unfortunately, at many sites where conditions are less than ideal, the results were found to be confusing. Occasionally, little or no correlation can be made between the concentrations derived from indirect detection methods and contaminant concentrations found in monitoring wells that were subsequently installed.

In December 1984, a conceptual model was developed for a tool that would enable investigators to quickly collect a ground water sample without requiring the installation, development or sampling of a ground water monitoring well. The goal was to devise a fast, inexpensive method to collect a single ground water sample suitable for priority pollutant analysis. If successful, the tool would reduce the number of monitoring wells needed to complete a ground water investigation and would provide more accurate, quantifiable ground water contaminant concentrations than existing secondary detection methods. The first prototype of such a sampler, later called the Hydropunch, was completed in March 1985.

Overview of the Hydropunch Components and Their Functions

The Hydropunch ground water sampling tool was designed to be used in two modes, utilizing either cone penetrometer equipment or conventional drilling equipment, to push or drive the tool to the desired sampling depth. The sampler is constructed entirely of stainless steel and Teflon, is easily cleaned in the field, and will collect approximately 5ml of sample. The Hydropunch has a stainless steel drive point, a perforated section of stainless steel pipe for sample intake, a stainless steel sample chamber, and an adapter to attach the unit to either penetrometer push rods or standard soil sampling rods (Figure 1).

As the unit is pushed or driven through the soil, the sample intake tube is retained in the sample chamber (in a watertight housing), which prevents contaminated soil or ground water from entering the unit. The shape of the cone and its smooth exterior surface prevents the

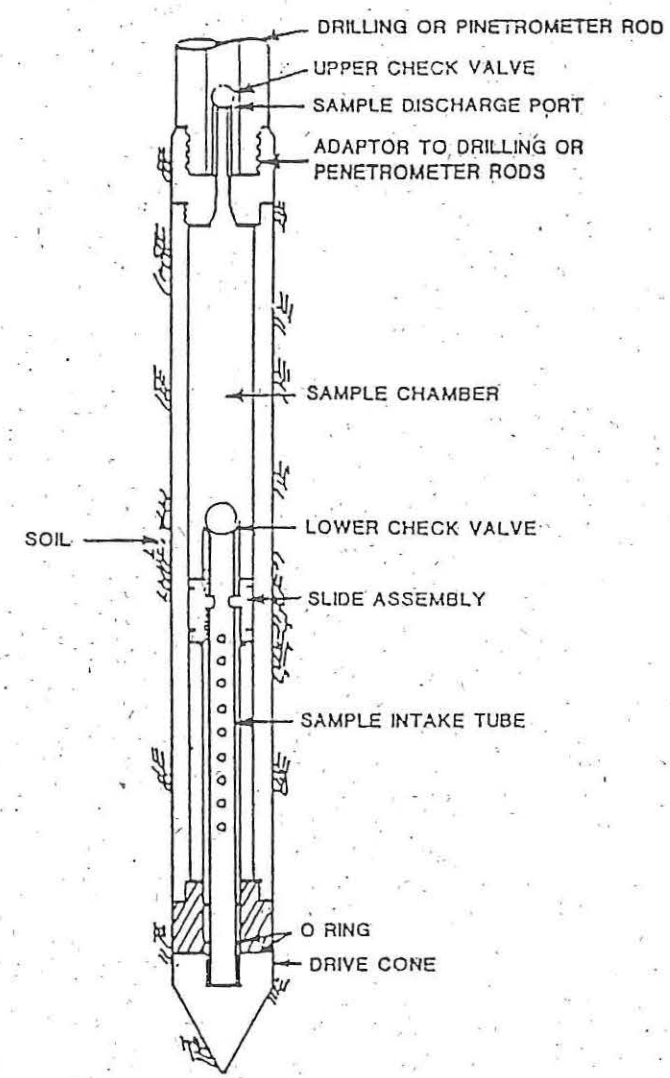


Figure 1. Hydropunch schematic.

downward transport of the surrounding soil and liquid as the tool is advanced. When the desired sampling depth is reached, the sample chamber is withdrawn approximately 1.5 feet (0.46m). The drive cone, which is attached to the intake tube, is held in place by soil friction. As the sample chamber is retracted, the drive cone pulls the perforated intake tube from inside the sample chamber and exposes it to the water-bearing zone (Figure 2). Once exposed, ground water flows through the intake tube and into the sample chamber. Unlike monitoring wells, no foreign materials (i.e., gravel pack, drilling fluid or cuttings) are introduced into the zone being sampled, minimizing the possibility of sample quality being influenced by extraneous contaminants. As the sample is collected, the drive cone and the sample chamber are flush against the borehole walls, sealing the intake tube from ground water above and below the zone being sampled. This permits ground water samples to be collected from a discrete vertical interval. The sample is collected under in situ hydrostatic pressure with no aeration and minimal agitation. Once the sample chamber is filled, the Hydropunch is retrieved. Similar to a bailer, the upward movement of the sampler increases the hydrostatic pressure in the unit, which closes the two check valves and retains the sample within the sample chamber. Upon retrieval, the push rods

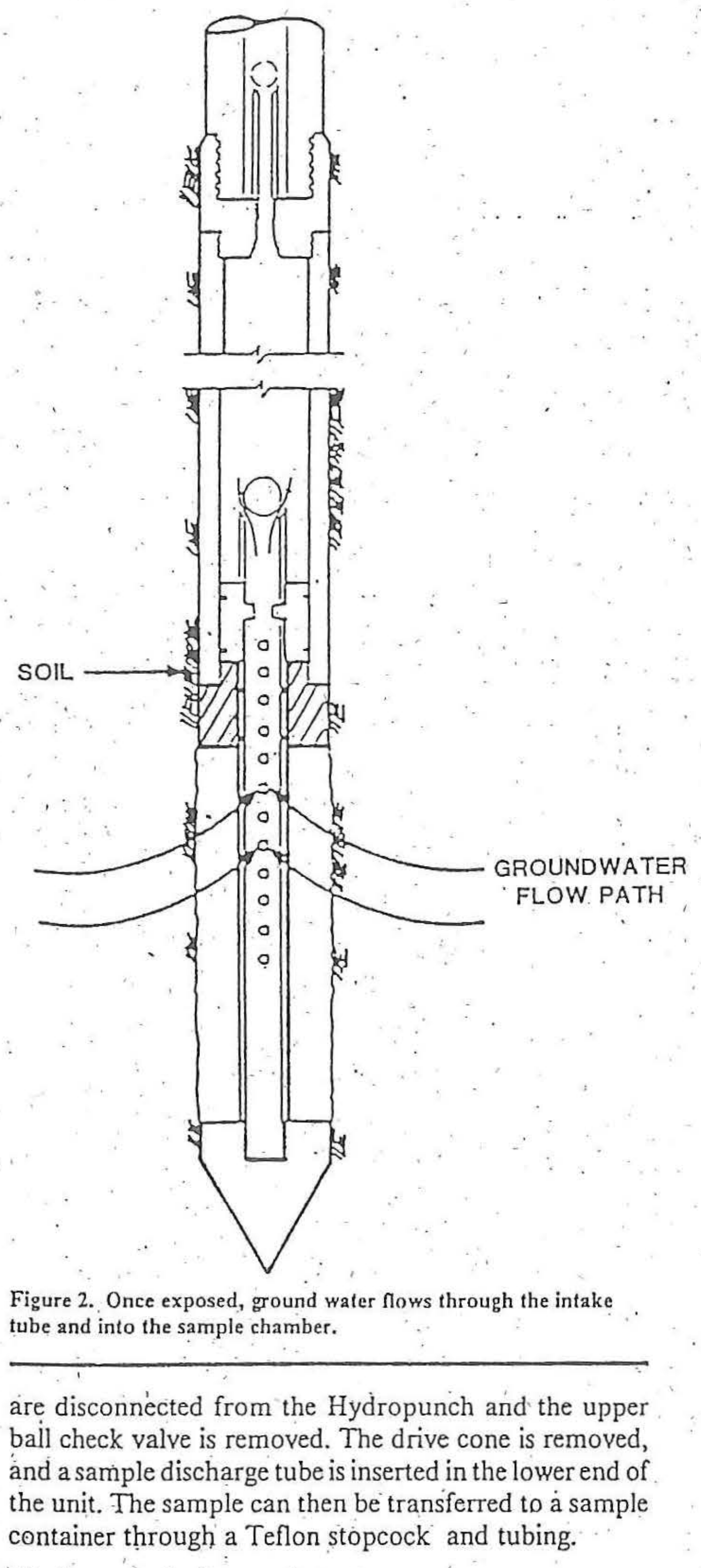


Figure 2. Once exposed, ground water flows through the intake tube and into the sample chamber.

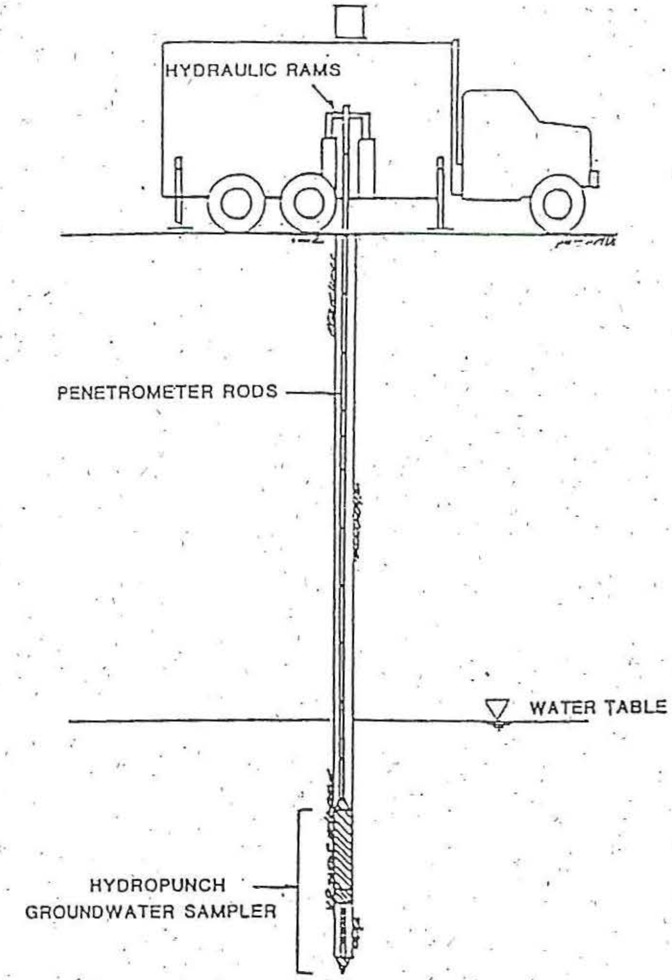


Figure 3. By replacing the standard cone with the sampling tool, the investigator can push the tool into the target area.

are disconnected from the Hydropunch and the upper ball check valve is removed. The drive cone is removed, and a sample discharge tube is inserted in the lower end of the unit. The sample can then be transferred to a sample container through a Teflon stopcock and tubing.

Hydropunch Operations

Where the geologic conditions are suitable for cone penetrometer soundings (normally characterized by relatively soft, fine- to medium-textured soils), the Hydropunch can be rapidly pushed to the desired sampling depth by a cone penetrometer rig. Since the late 1930s, geotechnical investigations have used the cone penetrometer system to determine in situ soil characteristics. Simply described, the cone penetrometer system consists of a cone approximately 1.5 inches in diameter attached, point down, to a series of rods with approximately the same diameter. The cone is forced down ... push the soil by a heavy truck or drill rig equipped with large hydraulic rams. The changes in the force required to advance the cone are recorded and correlated to changes in soil stratigraphy. The system is very fast compared to conventional drilling and soil sampling techniques and can reach depths of 140 feet in suitable geologic environments.

By replacing the standard cone with the Hydropunch ground water sampling tool, the investigator can rapidly push the tool into the target aquifer and collect ground water samples to verify contamination and to define the extent of the contaminant plume (Figure 3). The authors have collected ground water samples with a Hydropunch and cone penetrometer from 15 feet to more than 70 feet below the ground surface in approximately one hour. The cost for each sample typically ranges from one-half to one-tenth the cost of installation, development, and sampling of a conventional ground water monitoring well.

When used with a penetrometer rig, the sampling operation results in minimal impact to the surrounding environment. Drill cuttings and development water are not produced, thus eliminating the need for disposal of contaminated soil and water and minimizing cleanup and decontamination requirements. The clean, fast operation of the system is also valuable when ground water samples are needed with a minimum of disturbance to the surrounding environment.

Where geologic conditions are not suitable for use with a cone penetrometer rig, the Hydropunch can be substituted for soil sampling tools such as split barrel or California-type samplers are used with conventional drill rigs to provide chemically representative ground water samples as drilling proceeds. The sampling tool can be connected to the soil sampling rods and driven or pushed below the borehole into a zone unaffected by the drilling process. When the desired sampling depth is reached, the tool is opened, permitting a ground water sample to be collected (Figure 4). Similar to cone penetrometer sampling, the cone and sample chamber isolate the sample intake ports from fluids above and below the zone being sampled, thus formation development is not required prior to sample collection. The discrete vertical sample interval enables the Hydropunch to collect numerous samples at different depths from a single borehole.

Sampling during drilling provides a fast, economical means to investigate sites where little is known of the hydrogeology and/or where multi-aquifer systems exist. Conventional drilling and soil sampling methods can be used to define soil stratigraphy and to identify water-bearing zones. When a ground water sample is desired, a soil sampler is removed and replaced with the Hydropunch. The Hydropunch is driven into the target aquifer past the zone disturbed by the drilling process. The unit is then opened to the formation, permitting a ground water sample to be collected. Thus, a single boring can provide discrete ground water quality and piezometric data for each water-bearing zone encountered without the construction of multilevel monitoring wells. The resulting data can be used to quickly and cost-effectively determine the hydrogeologic and geochemical conditions of the study area.

Depending on the number of ground water samples collected per boring and the type of drilling equipment used, the authors have found the system to be approximately one-half to one-fourth as costly as conventional investigations using monitoring wells to collect ground water samples.

Case Histories

Northern California Municipal Landfill

The Hydropunch was used in 1985, 1986, and 1987 while conducting a ground water investigation at a landfill in northern California. The landfill was suspected of leaking low levels of volatile organic contaminants (VOCs) into the ground water. The landfill is located in a section of unconsolidated, well sorted, quartzose, brown-to-red, fine, silty sand of eolian origin containing isolated lenses of silt and clay. Underlying the sand are poorly indurated layers of sandy silt and clay interbedded with thin layers or lenses of fine-to-medium grained, silty sand. The first major aquifer encountered typically occurred 20 to 30 feet above the contact of the fine sand and the underlying silty clay. Due to the extreme topographic relief of the site, the depth to ground water ranged from 25 to more than 150 feet below the surface. The upper aquifer was the primary zone of VOC contamination at the site.

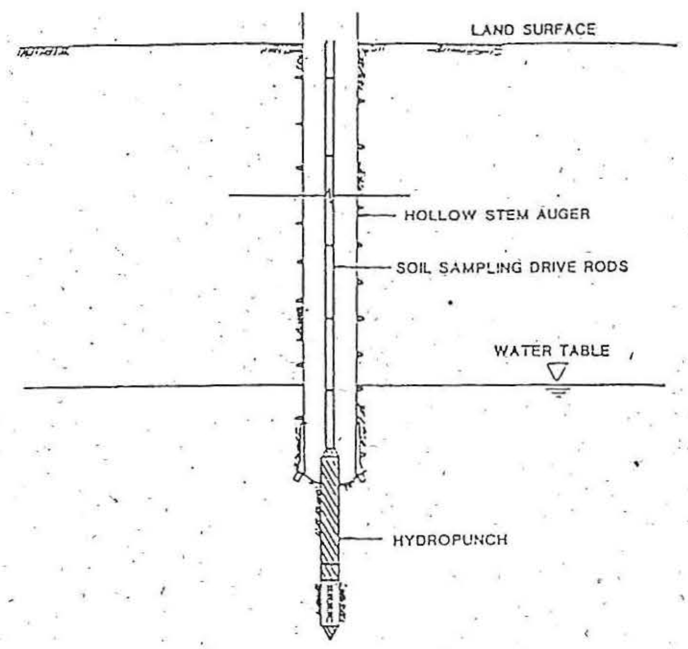


Figure 4. When the sampling depth is reached, the tool is opened.

the facility to determine if the landfill was the source of contamination and to define the extent of the contaminant plume. The Hydropunch was used in conjunction with a hollow-stem auger drilling rig to provide ground water samples as drilling proceeded.

A portable field gas chromatograph was used to provide immediate analytical results. If elevated levels of ground water contamination were found in the Hydropunch sample, a permanent monitoring well was installed in the test boring. Hydropunch samples were collected from depths ranging from 30 to 150 feet below ground surface.

By the end of the investigation it was apparent that a strong correlation could be made between contaminant concentrations found in the Hydropunch and those found in monitoring wells. The comparison may be seen in Table 1 and is discussed later. Multiple Hydropunch samples collected at various vertical intervals from the same borehole indicated that the highest contaminant

TABLE 1
Cost Comparison

Activity	Conventional Well Installation	Hydropunch with Penetrometer Rig	Hydropunch with Drill Rig
Mobilization	$ 200	$ 100	$ 100
Drilling and well installation[a]	3200	800	1200
Well development	500	—	—
Field supervision	1000	400	600
Sampling	600	425	425
Total cost	$5500	$1725	$2325
Total time	3 days	1 day	1.2 days

[a]Number of ground-water samples — 5

concentrations were found in the upper portion of the aquifer. Subsequent installation of monitoring wells at various vertical intervals confirmed these findings. As the investigation progressed, one very useful feature of using the Hydropunch was the capability to have geochemical results from a borehole on the same day, or at the longest within two days. This enabled the investigation to be directed based on contaminant concentrations while the drilling contractor was on-site, accelerating the progress of the investigation. As a comparison, analytical results from monitoring wells installed during the investigation were not available until approximately two months after the conclusion of the drilling program.

Southern California Schoolyard

In the spring of 1986 the Hydropunch was used with a cone penetrometer rig to confirm the presence of benzene, toluene, and xylene contamination beneath a playground at a preschool in Los Angeles, California. Ground water occurred in alluvial deposits of fine silty sand and fine sand, typically 3- to 5-feet thick, interbedded with layers of low-permeability silts and clays. The depth to ground water ranged from 6 to 10 feet below the site. The investigation required that five ground water samples be collected from a depth of about 10 to 25 feet below grade. The total field effort had to be completed over a two-day weekend to minimize the disruption of the preschool activities. By using the cone penetrometer rig to push the Hydropunch, the investigation was completed in one day, with no disruption to the school yard. The only impact to the playground produced by the sampling was five 1.25-inch-diameter holes, which were immediately backfilled with cement and bentonite and topped with an asphalt patch.

Table 1 shows a comparison between the estimated costs for a conventional well installation program at the site, an estimate of costs for a Hydropunch investigation using a hollow-stem auger drill rig, and the actual cost incurred using the Hydropunch with a cone penetrometer rig. These costs represent field costs only for collection of a single ground water sample. Total costs of the field investigation using the Hydropunch with a cone penetrometer rig were less than one-third the estimated cost associated with conventional well installation procedures. If the Hydropunch had been used with a hollow-stem auger drill rig to conduct the same investigation, it is estimated that field costs would have been less than one-half the cost of a conventional well installation.

Louisiana Petrochemical Plant

The southeastern Louisiana gulf coastal area is a region where the Hydropunch has been used effectively. Commonly, sediments encountered in this area are a reflection of a series of transgressive and regressive deltaic sequences. They are soft, unconsolidated and, in places, significantly thick. The lithologies are generally various combinations of clays, silts, and sands.

The soft sediments and shallow water table (less than 10 feet commonly) lend themselves to rapid sample acquisition. The Hydropunch has delivered as many as 12 samples in a 10-hour day. These samples were collected from as shallow as 12 feet (3.6m) and as deep as 65 feet (19.8m) below the surface.

The technique was to auger to the water table (commonly two 5-foot flights or less); remove the center plug, drive or push the Hydropunch 3 feet or more past the bottom of the auger; open the Hydropunch; allow it to fill; retrieve and collect the samples; and resume augering. Use of two Hydropunches in tandem, one to be driven into position while the other unit was being decontaminated, was very time-efficient. For vertical delineation of a plume, samples were usually collected at 5-foot increments. Fill time for the Hydropunch was found to vary with the permeability of the interval being sampled. In plastic, low-permeability clays, the fill time was 45 minutes or longer. Occasionally, clayey formation fines completely plugged the intake tube openings and no sample was obtained at all. In more permeable material, the Hydropunch filled in as little as five minutes. Generally speaking, in fine-grained sediments, the shallow samples would require a longer fill time, due to a less significant potentiometric head than deeper samples. Sample volume is contingent upon permeability of the formation and, correspondingly, the length of time the Hydropunch is allowed to fill.

During the early part of 1988, the Hydropunch was used while conducting a ground water investigation at a petrochemical facility in south Louisiana. Low levels of various chlorinated organics were suspected of being present in the ground water underlying the site. The Hydropunch was used in conjunction with a hollow-stem auger drilling rig to provide ground water samples for vertical and areal plume delineation.

The petrochemical facility provided its own laboratory services for quick gas chromatographic analysis of the ground water samples. Hydropunch samples were collected from depths ranging from 11.5 feet (3.5m) to 72 feet (21.9m) below surface. Ninety-nine ground water samples were collected from various elevations below a ground surface in 12 working days for an average of eight samples per day. Each working day consisted of approximately 10 hours. Two Hydropunches were used in tandem as described earlier. In general, with increasing sample depth, more time and effort were required. Two zones of contamination were identified. Based upon information gathered with the Hydropunch, a subsequent recovery system is in the planning stages.

Practical Considerations

Over the past three years, the Hydropunch has been used throughout the United States in a variety of hydrogeologic environments. Samples have been collected using cone penetrometer rigs and various types of drilling rigs. The design of the unit has been continuously modified to correct problems encountered during its use. A quick summation of the major problems encountered to date and the mitigative measures taken includes:

Problem—Physical deformation of sampler.

Solutions

- Do not attempt to drive sampler through extremely hard material, i.e., weathered granite, cobbles, etc. (a general rule of thumb is, if a 2-inch split-spoon sampler cannot be used, a Hydropunch sampler should not be attempted).

- Redesigned unit for greater rigidity during driving.
- Loosened internal tolerances to permit operation if minor deformation does occur.

Problem—Failure to lower check valve to close resulting in loss of sample.

Solutions

- Redesigned check valve for more positive seating.
- Reduced screen mesh size over intake tube to minimize sediment interference with check-valve operation.

Problem—Failure of intake tube to telescope into open position due to fine sand and binding moving components.

Solution

- Change locations of "O" ring seals to prevent sand from working into housing during driving.

Problem—Failure of intake tube to telescope into open position due to insufficient soil friction on drive cone.

Solution

- Reduce friction of internal moving parts to enhance sliding action.
- Lengthen and change the shape of the drive cone to increase soil friction and improve "holding" characteristics in low cohesion soils.

At present, the most common problem encountered with the use of the Hydropunch occurs when a sample is collected from a low-permeability formation. As shown in Figure 2, the interval from which the ground water sample is collected is located above the drive cone and below the body of the sampler when in the open position. This represents approximately 16 linear inches of intake area (0.4m). Consequently, fill time for the Hydropunch is directly related to the permeability of the zone exposed to the intake tube. In plastic, low-permeability clays, the time required to collect a sample has been 45 minutes or longer. In permeable soils, the Hydropunch may fill in as little as five minutes. On occasion, clay has completely plugged the intake tube openings and no sample was collected. A small-diameter electric water-level probe is lowered into the drive rods to determine when the sample chamber is full. Although slow fill times can be frustrating, some initial estimates of the zone's relative permeability can be made from the slow fill rate.

Experience has also shown that collection of samples immediately below the water table requires a longer fill time than samples collected at greater depths. This is due to a smaller potentiometric head between the sampler and the aquifer at the shallow depths.

When collecting Hydropunch samples in rapid succession (i.e., during vertical profiling or shallow ground water sampling), it is cost-effective to have two or more Hydropunches available. The use of multiple units permits decontamination of one unit while the other is in use.

Finally, as in the case with any geotechnical tool, the more experience the operator has with the Hydropunch, the better the results. It has been found that after using the Hydropunch for several days, an experienced technician can rapidly make adjustments in the field for specific hydrogeologic or drilling conditions encountered and maximize the effectiveness of the tool.

In summary, the Hydropunch has been used to detect ground water contamination and to delineate the vertical and horizontal extent of ground water contamination at sites throughout the United States. Numerous design changes have corrected mechanical problems encountered in early phases of use but factors such as low soil permeability, low hydraulic head, and operator experience will still influence the performance of the Hydropunch.

Comparison of Monitoring Well and Hydropunch Data

Table 2 shows a general comparison of water-quality data derived from Hydropunch samples and ground water samples collected from monitoring wells installed in the same borehole. The data shown in Table 2 were generated from a landfill located in northern California. The authors acknowledge that numerous variables exist between the samples. Samples were not collected from the Hydropunch and the well concurrently (there was approximately a two-month period between sampling events); consequently, chemical conditions may have changed between samples. Wells and Hydropunch samples were not collected from exactly the same intervals. Screened intervals for monitoring wells were 10 to 30 feet while the Hydropunch collects a sample from an interval of approximately 2 feet.

Detection limits and dilution ratios for sample analyses may also vary. Even with these variables, it can be seen from Table 2 that a good correlation can be made between the contaminant concentrations found in the Hydropunch samples and those found in the ground water samples from monitoring wells. Similar results have been found at other sites. In the authors' experience, the correlation provides a level of confidence that is suitable for detailed plume delineation programs.

Summary

The Hydropunch ground water sampling tool has been developed to provide ground water samples suitable for priority pollutant analysis without the installation of ground water monitoring wells. The sampler is designed to be used in two modes. A cone penetrometer rig can be used to rapidly push the unit to the desired sampling depth, or the Hydropunch can be connected to soil sampling rods permitting ground water samples to be collected during conventional drilling and soil sampling operations.

Ground water samples provided by the Hydropunch can be used to define the vertical and horizontal extent of ground water contamination and to characterize hydrogeologic conditions, enabling the investigator to eliminate unneeded monitoring wells and to correctly design and locate those wells that are required for permanent monitoring purposes.

Advantages over conventional ground water investigative techniques include:

- Ground water samples can be quickly collected (two to 10 times faster than conventional monitoring well installation and sampling).
- Ground water samples can be economically collected, typically 40 to 90 percent less costly than

TABLE 2
Comparison of Hydropunch and Monitoring Well Water Samples

Well Number	S-19		S-20		S-21*			S-23		F-2		S-12	
Source of Sample	Hydro-punch	MW	Hydro-punch	MW	Hydro-punch	Hydro-punch	MW	Hydro-punch	MW	Hydro-punch	MW	Hydro-punch	MW
Depth of Sample	35 feet	40-50 feet	121 feet	101–131 feet	119–121 feet	125–127 feet	105–135 feet	81.5–83.5 feet	55–85 feet	140 feet	134–144 feet	124.5–126 feet	122–132 feet
Volatile Priority Pollutants	Concent. μg/L	Concent. μg/L	Concent. μg/L	Concent. μg/L	Concent. μg/L	Concent. μg/L	Concent. μg/L	Concent. μg/L	Concent. μg/L	Concent. μg/L	Concent. μg/L	Concent. μg/L	Concent. μg/L
Benzene	0.3	0.1	12	20	12	5	12	0.1	ND	0.1	0.1	1.2	0.3
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloro-methane	ND	ND	4.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.1	0.1	ND	ND	ND	ND	ND	0.3	0.2	ND	ND	ND	1
1,1-Dichloroethane	0.1	0.1	30	45	92	22	42	0.2	0.6	ND	ND	4.7	8.4
1,2-Dichloroethane	ND	ND	2.5	2.5	ND	ND	ND	ND	ND	ND	0.3	0.5	0.5
1,1-Dichloroethane	ND	ND	2.5	2.5	2.5	ND	ND	ND	0.1	ND	ND	ND	0.1
1,2-Dichloropropane	ND	ND	2.5	2.5	ND	ND	2.5	ND	ND	ND	ND	ND	1
Ethylbenzene	0.2	ND	ND	ND	ND	ND	ND	ND	ND	0.1	0.1	0.1	ND
Methylene chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	15	10
Tetrachloroethene	0.6	0.7	23	48	75	28	42	0.6	1.5	2.3	3	5.5	12
Toluene	1.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloro-ethane	ND	ND	ND	ND	ND	ND	ND	ND	0.2	ND	ND	ND	ND
1,1,2-Trichloro-ethane	0.1	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethane	0.2	0.3	16	30	48	ND	25	0.1	0.3	0.2	0.2	2.8	5.3
Vinyl chloride	ND	ND	ND	32	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trans-1,2-Dichloroethene	ND	ND	ND	2.5	ND	ND	5	ND	ND	ND	ND	0.2	0.2
Volatile Non-Priority Pollutants													
m,p-Xylenes	0.7	0.1	ND	2.5	ND	ND	2.5	0.1	ND	0.3	0.1	0.3	ND
o-Xylene	0.1	ND	ND	2.5	ND	ND	ND	ND	ND	0.1	ND	ND	ND
cls-1,2-Dichloroethene	2.4	2.6	48	75	158	38	65	ND	ND	0.3	0.3	4.2	2.3

*Two Hydropunch samples were collected.

monitoring well installation and sampling methods.

- Sample quality is suitable for priority pollutant analyses and, unlike other secondary detection techniques, provides a sample that quantifies pollutant concentrations in the ground water.
- The Hydropunch is a clean sampling system, minimizing cleanup and decontamination requirements.
- With suitable drilling techniques, the Hydropunch can provide a ground water sample from a discrete vertical interval by preventing water above and below the intake screen from entering the sampler. By collecting numerous samples from a single borehole, a vertical water-quality profile can be developed for multi-aquifer systems or stratification of contaminants can be defected within a single aquifer system.

The Hydropunch has been used with both cone penetrometer and hollow-stem auger drill rigs and has proved to be cost-effective in both applications. If a gas chromatograph or other analytical equipment is available on-site, the sampling can be adjusted in the field to maximize the use of the water-quality and hydrogeologic data as they are generated. As a result, ground water investigations can be completed in a fraction of the time and cost of investigations using conventional well installation and sampling methodologies.

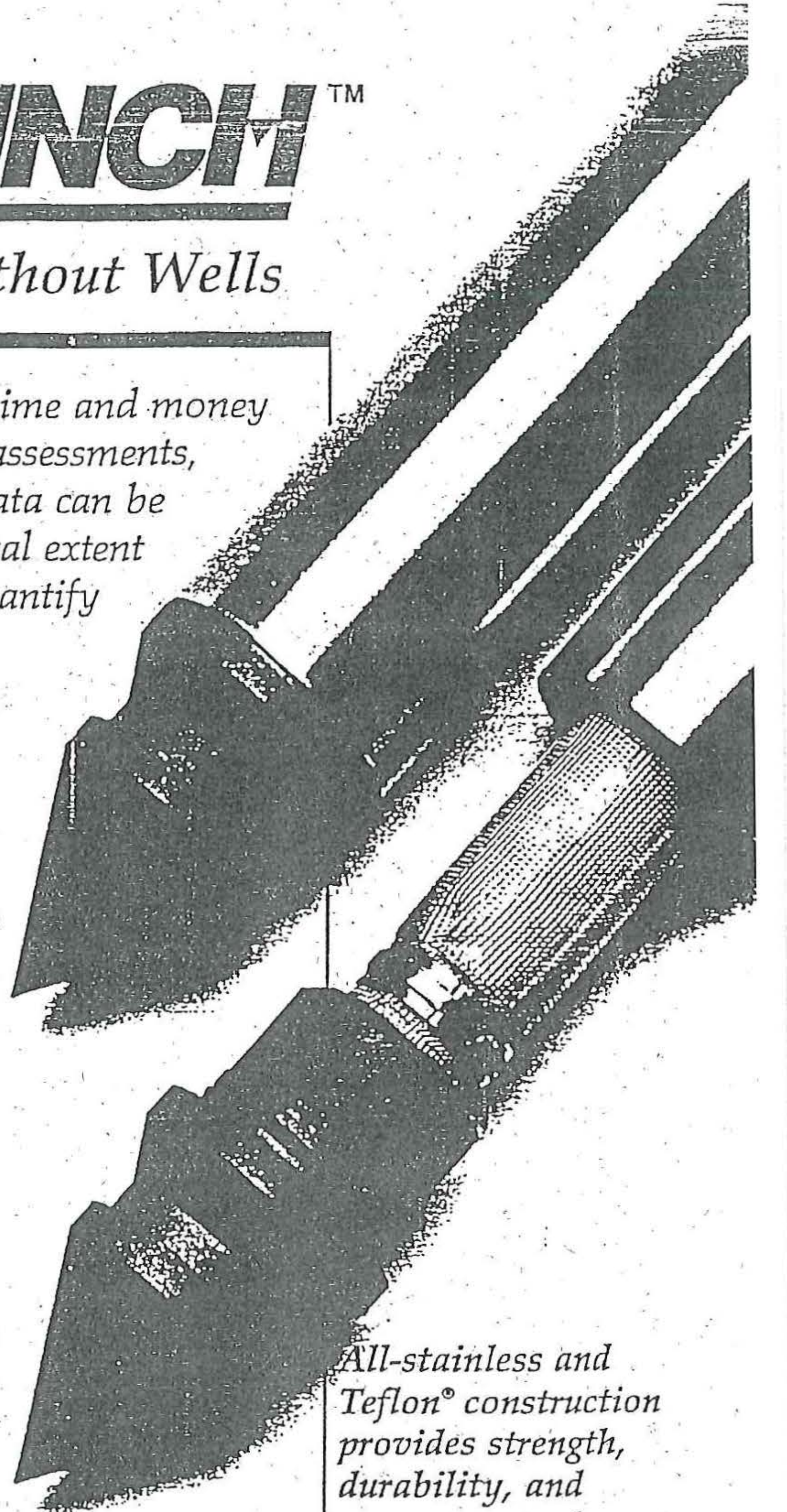
Biographical Sketches

Kent Cordry is currently manager of northern California GeoStore operations and staff hydrogeologist for the Longyear Co. During the development and testing of the Hydropunch, Cordry was employed by James M. Montgomery Consulting Engineers Inc. in Walnut Creek, California, as a senior hydrogeologist. While at Montgomery, Cordry was responsible for the design and management of hydrogeologic field investigations. He has 10 years of experience in the design and installation of ground water monitoring and vadose zone sampling systems, working both as a consultant and as a contractor. He holds a B.S. degree in geology and is a certified professional geologist with the American Institute of Professional Geologists.

Russel W. Edge is currently a hydrogeologist for Roy F. Weston Inc. in Albuquerque, New Mexico. Edge has used the Hydropunch in a number of studies in various industrial settings in the Gulf Coast region and in southern California. He is responsible for designing and implementing hydrogeologic field investigations, data interpretation, report preparation, and regulatory interfacing. He holds a B.S. degree in geology from West Texas State University and has completed graduate course work at Oklahoma State University. He is a member of the National Water Well Association and the New Mexico Hazardous Waste Society.

HYDROPUNCH™

Groundwater Sampling without Wells



The HydroPunch™ drastically reduces time and money spent on groundwater monitoring site assessments, by collecting samples without wells. Data can be used to determine vertical and horizontal extent of contamination, and to accurately quantify pollutant concentration.

Samples in as little as one hour

The HydroPunch (U.S. Patent No. 4,669,554) is easily used with cone penetrometer or conventional drilling equipment. It collects up to 500 ml of groundwater at the desired depth in unconsolidated soil, and under many conditions can be used to sample multiple water-bearing zones in one operation. The HydroPunch can be visualized as working like a "driven" bailer.

·ave 70% or more on site assessment costs

Extremely cost-effective, the HydroPunch has proven in field use to cost as little as 1/10 the price of drilling, casing, and developing a conventional well. The HydroPunch can also help determine optimum location for dedicated wells when they are required. More effective placement can minimize the number of permanent wells needed, providing long-term savings.

High-quality samples for accurate assessments

Samples are unaltered and uncontaminated by drilling fluids or cuttings. All-stainless and Teflon® construction makes the unit chemically inert, preventing contamination. In use, the HydroPunch is driven to the desired depth and then partially withdrawn, opening the inlet and isolating the collection zone from layers above and below. Replaceable inlet screen cartridges keep soil materials from entering the sample chamber.

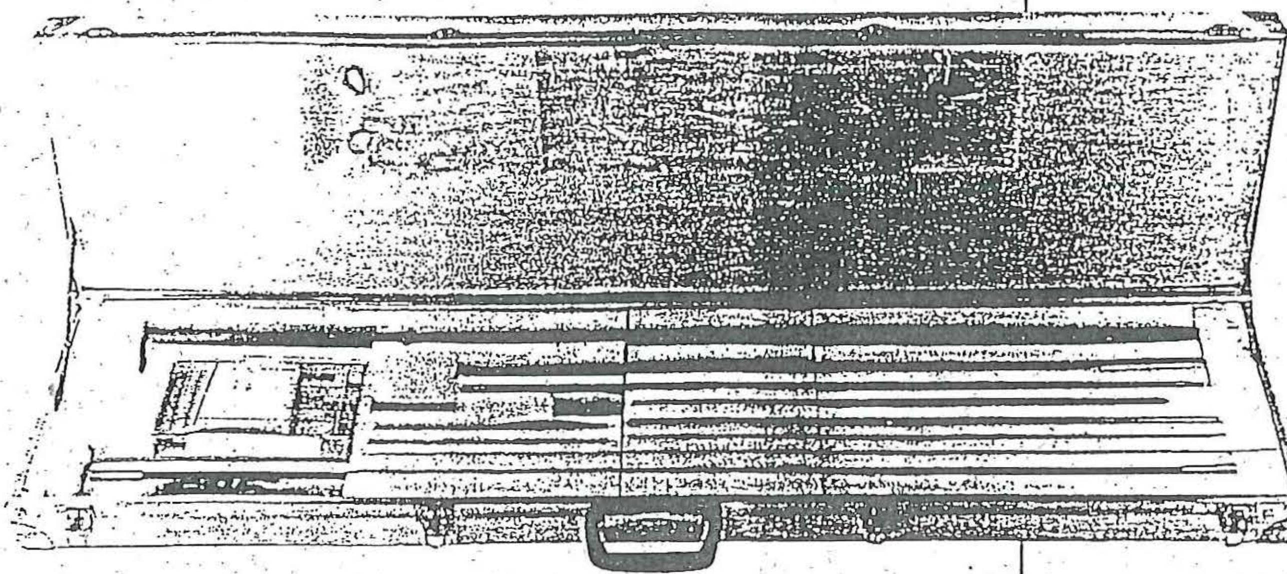
HydroPunch samples are consistent with requirements for all priority pollutants, unlike indirect site assessment techniques (i.e., soil gas sampling or geophysical monitoring). Samples are not affected by changes in soil type or other complicating factors. Easy field cleaning expedites repetitive sampling.

All-stainless and Teflon® construction provides strength, durability, and accurate samples uncontaminated by the testing procedure.

Environmentally safe

The HydroPunch can be operated with minimal disturbance to environmentally ·ensitive areas. There's no need to dispose of well development water, or of con-taminated drill cuttings when used with a cone rig. The technique is unobtrusive and won't interfere with normal site operations.

Environmental



Complete HydroPunch kit in heavy-duty carrying case

Specifications:

The HydroPunch™ is equipped with an "AW" box thread. Any sub-adapter or drive rod used with HydroPunch must have a minimum of 9/16" inside diameter by 4" deep above top of HydroPunch to allow clearance for top check. A number of adapters are available, allowing use of the HydroPunch with different types of drive rods.

The basic kit (shown above) includes one HydroPunch with barbed point in a sturdy, protective carrying case. The kit comes complete with water sample discharge device (w/Teflon® tubing and stopcock), cleaning brush set, extra O-ring and screen sets, extra stainless steel check balls, and all other accessories needed for use.

Maximum diameter: 1.75"   Length: Closed—64.50"   Open—76.50"

Weight (HydroPunch only): 24 lbs.   Shipping weight: 44 lbs.

Sample volume: 500 ml (nominal)

Guidelines for use:

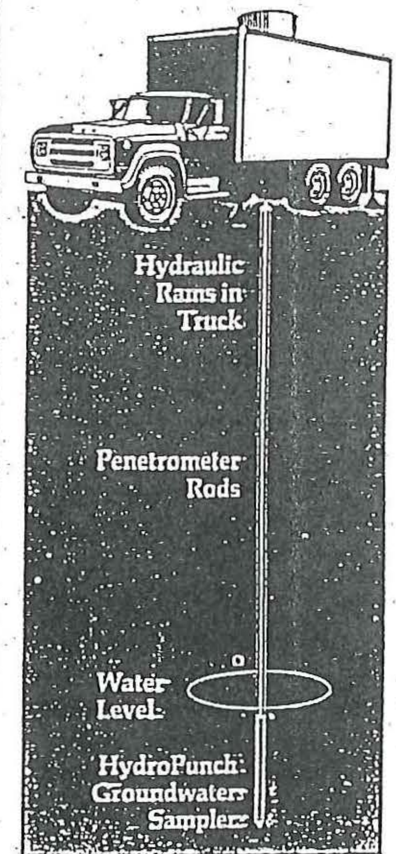
General applications

The HydroPunch is a groundwater sampling tool designed to be pushed or driven to the desired depth for sample collection. It is manufactured for durable performance, with rugged construction of stainless steel and Teflon®. Following a few basic guidelines will maximize the usable life of your HydroPunch.

In general, the HydroPunch can be pushed or driven into position in the same types of formations suitable for a standard 2" split barrel (spoon) soil sampler. Suitable geologic materials include unconsolidated clays, silts, sands, and fine gravels. Driving a split barrel sampler immediately above the desired HydroPunch sampling zone is helpful. This provides an estimate of soil permeability, and predicts the formation's resistance to driving the HydroPunch.

Hydrologic considerations

The HydroPunch fills using the aquifer's hydrostatic pressure, similar to the way a bailer fills; thus the formation thickness and yield determine the fill rate. The sample inlet area of the HydroPunch must be in hydraulic contact with a water-bearing zone to collect a sample. Because the sample chamber is above the inlet, the HydroPunch point must be driven to a minimum of 5 ft. below the static water level so that hydrostatic pressure is high enough to assure normal fill times and adequate sample volumes.



Typical application using HydroPunch with cone penetrometer equipment