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PILOT TEST WORK PLAN
LANDFILL GAS
EXTRACTION SYSTEM
FF/NN LANDFILL
RIPON, WISCONSIN

March 23, 2005

Prepared for:

FF/NN Landfill Group

Prepared by:

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1.0 INTRODUCTION

This work plan describes the methods and procedures for conducting a pilot test to evaluate the feasibility of active landfill gas extraction from the FF/NN Landfill in Ripon, Wisconsin.

1.1 Background

Methane gas concentrations have been measured at gas probes and monitor wells around the FF/NN Landfill, and methane exceeds 25% of its lower explosive limit at several locations outside of the limits of the landfill. In addition, vinyl chloride was detected in groundwater at the site, and recent analysis of landfill gas samples has indicated that vinyl chloride is present in some of the landfill gas samples. For these reasons, the Wisconsin Department of Natural Resources has asked the FF/NN Landfill PRP Group to consider the feasibility of active landfill gas extraction at the site.

A composite cap (clay and HDPE plastic membrane) was constructed on the landfill in 1996. A passive landfill gas system was constructed beneath the cap at that time. The passive gas system consists of piping within stone-filled trenches in a grid pattern across the surface of the landfill. Twelve vertical gas vents emit landfill gas from the trenches to the atmosphere; each of these vents is located at the intersection of collection piping. The layout of the passive gas system, as well as the location of gas probes and monitor wells near the site is provided on Figure 1. Construction details of the passive vents are provided on Figure 2. Construction logs for the leachate head wells are provided in Appendix A.

1.2 Pilot Test Objectives

The overall objective of the pilot test is to determine the feasibility of active methane extraction. The specific objectives of this pilot test are to determine whether: 1) the existing passive gas collection piping can be effectively used as an active gas extraction system; and 2) the leachate head wells either alone or in combination with the passive gas collection piping can function as an active gas extraction system. If active gas extraction from the passive vent system and the leachate head wells is not sufficient, then extraction from outside of the landfill will also be evaluated. The specific tasks include:

- Determining whether each of the extraction system configurations is capable of inducing a vacuum throughout the landfill and at gas probes outside of the landfill;
- Determining methane concentrations in exhaust gases to evaluate whether a flare would be self-sustaining, or whether energy recovery using a microturbine is feasible (at least 35% methane is needed for either alternative); and
- Determining VOC and vinyl chloride concentrations in exhaust gases to estimate annual emissions that would be expected from an active gas extraction system.

Most active landfill gas collection systems consist of large diameter vertical gas extraction wells within the wastes of a landfill. Construction of such wells at the FF/NN Landfill would require that the composite cap be compromised and penetrated by drilling. This risks damage to the plastic membrane, and also allows for infiltration of precipitation into the landfill during construction, generating leachate and potential groundwater impacts. Because the passive gas vent system was designed for possible conversion to an active system, and because the landfill is relatively small (7.3 acres) and quite old (operational from 1967 until 1983), it is thought that the existing passive vents and possibly leachate head wells may be used for gas extraction, rather than drilling additional wells through the cap.

1.3 Estimated Landfill Gas Generation

The current landfill gas generation rate was estimated using two methods provided in the US EPA report, *Turning a Liability into an Asset: A Landfill Gas-to-Energy Project Development Handbook* (September 1996). Calculations are provided as an attachment to this work plan. The estimates of gas generation range from 15 to 40 standard cubic feet per minute (SCFM). This gas generation rate is estimated to be only about 15% of the generation rate at the time the landfill closed in 1986.

2.0 PILOT TEST WORK PLAN

2.1 Equipment Specifications

The pilot test will be carried out using a skid mounted rental unit provided by Schrader Environmental Services of Ithica, Michigan. The unit consists of the following:

- Duroflow 3006 positive displacement blower;
- 3 horsepower, single phase, 230 volt, 60 hertz, explosion-proof motor;
- Inlet particulate filter and exhaust silencer;
- Moisture knock-out tank, approximately 20 gallon capacity;
- High level shutdown switch for knockout tank;
- 1-inch diameter manual drain valve;
- Control panel with on-off switch, motor starter and overload;
- Vacuum gauge on inlet;
- ERDCO direct reading flow meter; and
- Dilution air valve (after flow meter).

The skid mounted unit will be transported to the site on an open trailer. The blower curve is provided in Appendix C. The blower is capable of providing a vacuum of 68-inches of water column (5-inches of mercury) at an air flow rate of 190 SCFM at 3500 rpm.

A vacuum gauge with a quick coupler will be connected to each of the gas probes, monitor wells, and leachate head wells for periodic pressure drop measurements.

2.2 Pilot Test Preparation

Prior to conducting the pilot test, the following work will be performed by GeoTrans:

- The rotating ventilators on each of the passive gas vent pipes will be replaced with a 4-inch diameter schedule 80 PVC end cap. Each end cap will have a universal push type pneumatic quick coupler inserted into a drilled hole. An air pressure gauge or a methane gas meter will be connected to the coupler for measurements;

- The covers on the leachate head wells will be replaced with 4-inch diameter PVC end caps with quick couplers; and
- The gas probes currently have 2-inch diameter PVC end caps with quick couplers installed.

2.3 Pilot Test Operation

The pilot testing will be conducted over a 3-day period. The system will run for 6 to 8 hours each day, allowing the site to return to pre-testing conditions overnight. During the first day, the vacuum blower will be connected to two of the vents of the existing passive gas system, GV-1 and GV-3. These vents were selected because they are nearest to the off-site migration of gas, and are above the deepest part of the landfill. During the second day, the vacuum blower will be connected to leachate head wells LC-1 and LC-3. During the third day, the vacuum blower will first be connected to the Gas Probe GP-3, and will then be connected to LC-1, LC-3, GV-1 and GV-3, which will be manifolded together. The testing procedures will be the same for each of the tests.

Electricity to run the motor for the blower will be provided by a portable generator.

Before turning on the power to the blower motor, the air bleed valve on the inlet to the air/water knock-out tank will be opened and the extracted air inlet valve will be closed. The power will then be turned on to the system. The blower motor will then be started and the air bleed valve will be gradually closed to achieve a vacuum of about 5-inches of mercury, as measured by a vacuum gauge. Once the vacuum has stabilized, the inlet valve will be gradually opened to start the pilot test. The air bleed valve will be adjusted to provide an initial vacuum of about 5-inches of mercury. The vacuum may be varied depending on observations of pressure drop at various locations in the system or oxygen concentrations in extracted gases during the test. Oxygen concentrations in gases extracted from the landfill will be maintained within 3 % of their initial level to prevent drawing oxygen into the landfill. Drawing excessive oxygen into the landfill could potentially cause a landfill fire if not managed properly.

2.4 Monitoring

2.4.1 Extraction System Exhaust Discharge

The pilot testing phase of the methane extraction system includes monitoring and analysis of air emissions exhausted by the system. Monitoring of exhaust discharge is necessary to satisfy several data needs. Collection of samples allows identification and quantification of hazardous and/or regulated compounds in the exhaust stream. The WDNR has established maximum discharge limits for total VOCs as well as specific compounds (See Section 2.5.3 Air Emissions Permitting). Analysis of the exhaust stream will be used to determine if a flare can be self sustaining, and whether microturbines would be feasible for electrical power generation (i.e., a sustained methane concentration of at least 35%).

A Landtec GA90 Gas Analyzer will be used to determine methane concentrations in the exhaust gas. Methane concentrations will be measured and recorded at the beginning of each test, and approximately every hour throughout the tests. Exhaust gas levels of carbon dioxide and oxygen will be measured and recorded at the same time as methane. The intent of methane concentration testing over time is to determine whether methane concentrations are constant or declining; constant concentrations indicate that the gas extraction rate of the blower could possibly be increased, while declining concentrations indicate that the extraction rate should be decreased.

A Summa canister will be used to collect air emission samples near the end of each day of the test. The Summa canister sample will be analyzed for VOCs using method TO-14. A sample collected near the end of the day is the most representative sample for the long-term operation of a gas extraction system. The purpose of collecting Summa canister samples is to estimate annual air emissions of VOCs from a proposed extraction system.

Draeger tubes will be used to analyze emission samples for vinyl chloride at the beginning, middle and end of each test. Draeger tubes for vinyl chloride can detect it at a concentration of 0.5 ppm (see information provided in Appendix D), and some of the concentrations measured in the gas probes at the site in September 2004 and January 2005 are greater than 0.5 ppm. It was originally envisioned that Draeger tubes could be used to sample concentrations of Total Hydrocarbons, Halogenated Hydrocarbons or Petroleum Hydrocarbons at intervals during the pilot tests. However, based on the analytical results from samples collected in September 2004 and January 2005 at the site, the concentrations of these materials are expected to be too low as compared to the detection limits for their specific Draeger tubes (100 ppm for Halogenated Hydrocarbons, 10 ppm for Petroleum Hydrocarbons and 1,000 ppm for Total Hydrocarbons; see Appendix D). Because Draeger tubes cannot be used, a Photoionization Detector will be used to provide relative concentrations of total VOCs at the beginning, middle and end of each test.

2.4.2 Vacuum and Methane Measurements

The applied vacuum at the extraction location and the induced vacuum at the observation locations will be used to determine the radius of influence of the applied vacuum. During each pilot test, the vacuum at the extraction well, as measured by a vacuum gauge, will be visually monitored on a continuous basis to ensure proper operation.

At the observation locations, the induced pressure drop will be recorded in the first hour, and at least twice more during the duration of the pilot test. The following are the locations where the vacuum will be measured on a regular basis throughout the testing:

GP-1	GP-2	GP-3	GP-7
GP-8	GP-6	LC-1	LC-2
LC-3	GV-1	GV-2	GV-3
GV-9	GV-12	MW-103	MW-104

Vacuum will not be measured in the other gas vents because they are all interconnected with piping. The induced vacuum will be measured at the more distant gas probes at least once during each test.

Methane concentrations, as well as oxygen and carbon dioxide, will be measured at the same times and locations as the pressure drop testing (above). The frequency of methane sampling at a location will be reduced or discontinued if methane is not present at any particular sampling location.

The vacuum induced at the observation locations will be measured using a Dwyer Slack-Tube manometer with a quick-connect hose. The Slack-Tube manometer is able to detect a pressure drop of less than 1-inch of water column (0.074 inches of mercury).

Barometric pressure and temperature will be recorded at the beginning, middle and end of each day.

2.5 Permitting and Waste Handling

2.5.1 Condensate Discharge

During each pilot test, recovered condensate will be accumulated in the 20 gallon knock-out tank connected to the blower unit. Approximately 10 gallons per day of condensate is expected to be generated. A 55-gallon barrel will be available for transport of condensate as needed to the Ripon wastewater treatment plant for disposal.

2.5.2 Air Emissions

Pilot tests are exempt from WDNR Air Management permitting and notification requirements and hourly emissions limits provided the test volume is limited to a maximum of 150,000 SCF. For three days of testing, we expect a total air flow of less than 110,000 SCF. Given the levels of contaminants in the landfill gas, we do not anticipate exceeding any of the discharge levels in NR406.04 for the pilot test.

The WDNR has established several air emission limits that may apply to sources of VOCs. NR406.04(2)(c) of the Wisconsin Administrative Code limits the maximum amount of volatile organic compounds that can be emitted to the ambient air without an air pollution control permit to 5.7 pounds per hour. NR419.07(4)(b) limits maximum emissions with a permit to 9 pounds per hour. These limits apply to extended pilot testing (significantly greater than three days) or operation of systems for remediation, and these do not apply to this pilot test.

Section NR 419.07 (WAC) requires air emission controls for a landfill gas extraction system if VOC emissions exceed 216 pounds per day (see ch. NR 445, Table 3). The Lowest Achievable Emission Rate is required if a source emits more than 300 pounds per year of vinyl chloride. Assuming an extraction rate of about 100 cubic feet per minute and an average vinyl chloride concentration of 7 ppmv (average for the four samples collected in September; equivalent to 18 mg/kg), the estimated average emission rate for vinyl chloride would be 0.007 lb/hr or 0.05 lb for a 7-hour day. This is approximately 61 lb/year for a system that is operating continuously. Based on these calculations, air emissions controls for VOCs or vinyl chloride are not expected to be needed for the pilot test, nor for long-term operation of a proposed extraction system. Controls may be needed for the emissions of methane if an active landfill gas extraction system is installed.

2.6 Data Analysis and Report

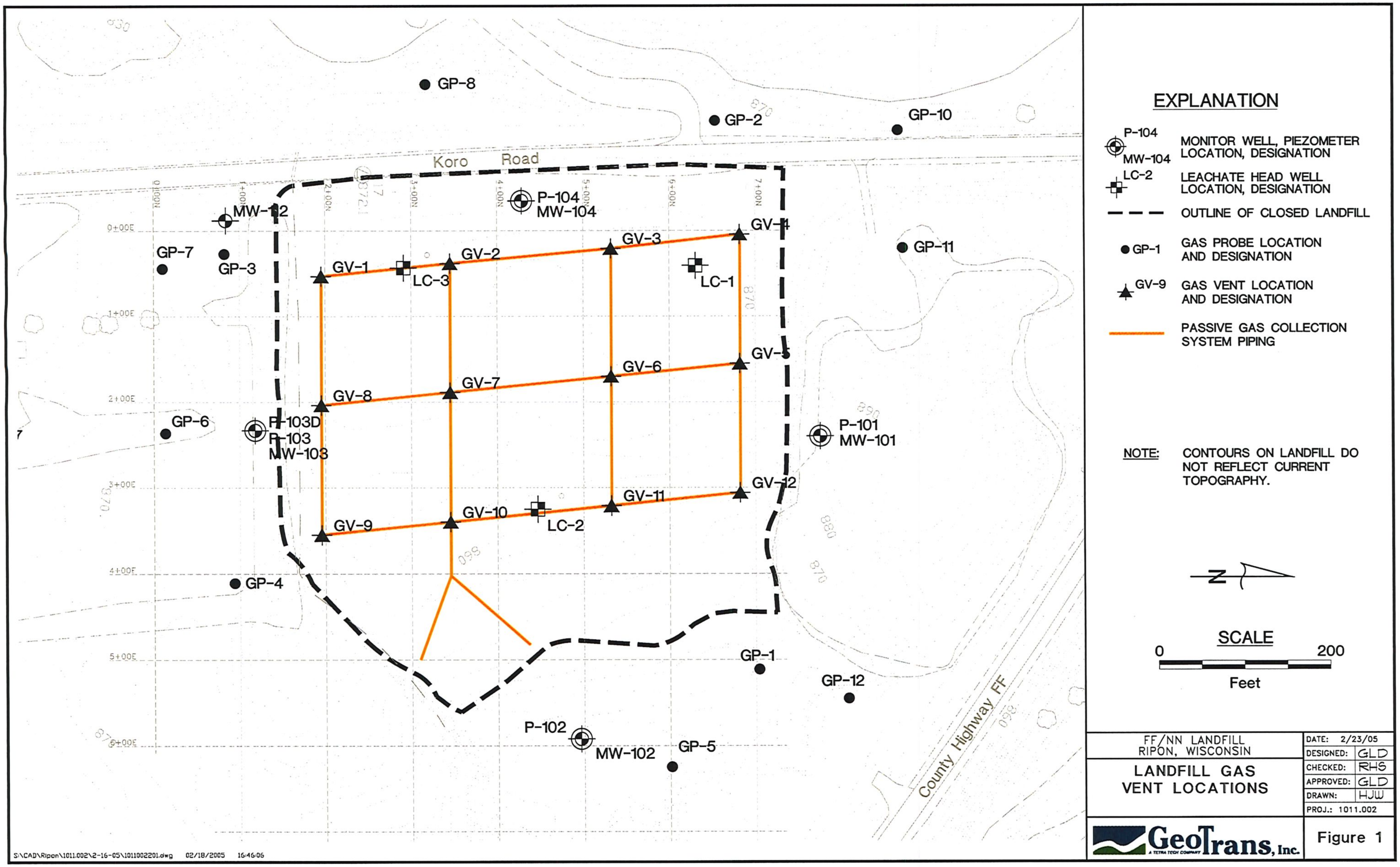
A final report will be prepared at the conclusion of the pilot test. The report will include field data of methane, VOC and vinyl chloride concentrations and vacuum readings. Calculations will be made to determine contaminant mass emissions. The report will also include a conclusion as to whether the existing collection system can effectively and economically be used to remove landfill gas from the landfill.

Based on the pilot test results, a conceptual design for an active gas extraction system may be presented, including emission control requirements. The conceptual design will be assessed for cost- effectiveness as well as feasibility as part of the Focused Feasibility Study, which is being prepared for the site.

3.0 SCHEDULE

This work plan will be implemented within four weeks of receipt of WDNR approval. The pilot testing will take approximately one week to complete. The pilot test report will be completed five weeks following completion of the field work.

FIGURES


GP-8
GP-2
GP-10
Koro Road
P-104
MW-104
MW-12
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-9
GV-10
LC-2
GV-11
GV-12
GP-4
GP-1
GP-12
P-102
MW-102
GP-5
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
NOTE: CONTOURS ON LANDFILL DO NOT REFLECT CURRENT TOPOGRAPHY.
N
SCALE
0
200
Feet
FF/NN LANDFILL
RIPON, WISCONSIN
LANDFILL GAS
VENT LOCATIONS
DATE: 2/23/05
DESIGNED: GLD
CHECKED: RHS
APPROVED: GLD
DRAWN: HJW
PROJ.: 1011.002
GeoTrans, Inc.
A TETRA TECH COMPANY
Figure 1
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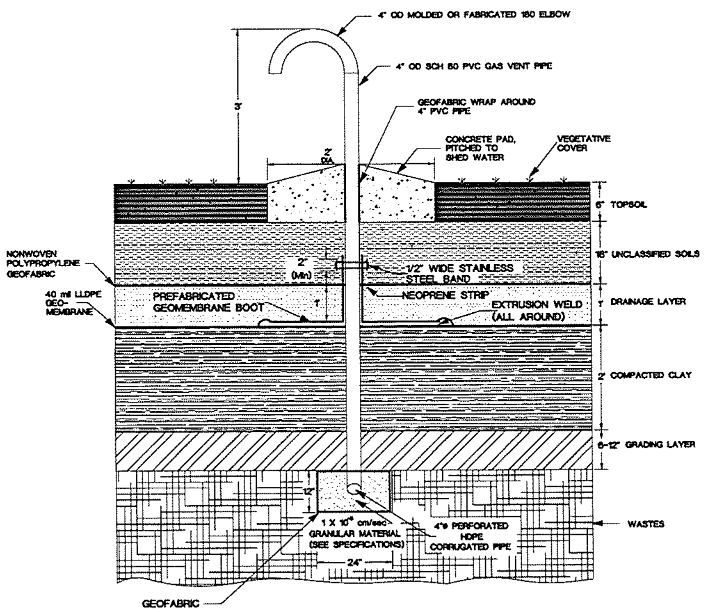
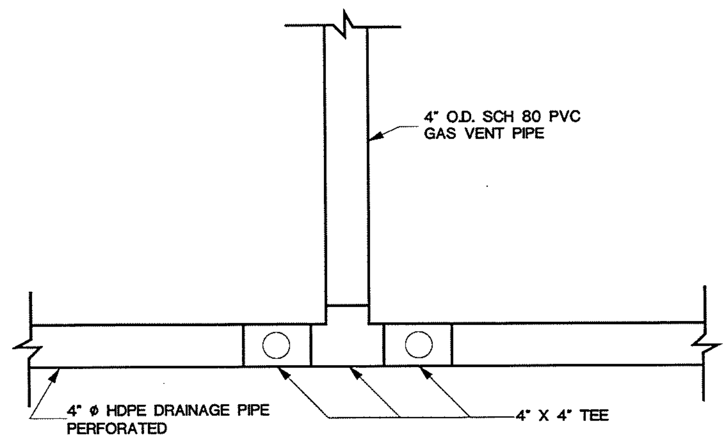


A

Passive Vent Detail

NTS



B

Gas Vent Piping Detail

NTS

FF/NN LANDFILL RIPON, WISCONSIN	DATE: 2/16/05
	DESIGNED: GLD
GAS VENT DETAILS	CHECKED: RHS
	APPROVED: GLD
	DRAWN: HJW
	PROJ.: 1011.002
GeoTrans, Inc. A TETRA TECH COMPANY	Figure 2

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GAS EXTRACTION PILOT TEST SCHEDULE

PROJECT: FF/NN LANDFILL, Ripon, WI
PREPARED BY: GeoTrans, Inc.
PREPARED FOR: FF/NN Landfill Group

TASK DESCRIPTION	Week 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Submit Work Plan to WDNR	X																																			
WDNR Review of Work Plan		X	X	X	X																															
Order and Ship Pilot Test Equipment						X	X	X	X																											
Conduct Pilot Test										X																										
Laboratory Analysis											X	X	X																							
Report Preparation											X	X	X	X	X																					

Comments:

TABLES

Table 5A: Methane
FF/NN Landfill Gas Screening
Ripon, Wisconsin

	% 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 5A: Methane
FF/NN Landfill Gas Screening
Ripon, Wisconsin

	% Methane (CH4)					
Well/Vent #	07/30/03	10/21/03	04/28/04	06/16/04	10/12/04	01/28/05
LC-1	2.4	0	0.6	not monitored	1.6	6.9
LC-2	6.6	2.3	3.4	not monitored	0	5.5
LC-3	17.2	0	31.2	not monitored	0	3.8
MW-101	0	0	0	not monitored	2.9	2.2
MW-102	2.8	0	0	not monitored	0	0
MW-103	3.9	0	3.3	not monitored	6.2	1.8
MW-104	11.1	0	11.5	not monitored	22.4	10.1
MW-112	0.8	0	2.6	not monitored	4.6	1.1
GV-1	0	0	0	not monitored	0	0
GV-2	1	0	0	not monitored	0	0
GV-3	0	6.1	0	not monitored	2.5	7.6
GV-4	0	0	0	not monitored	17.5	1.9
GV-5	0	0	0	not monitored	16.1	0
GV-6	0	2.1	0	not monitored	22.1	6.3
GV-7	1.6	0	0	not monitored	0	9.0
GV-8	0.6	0	0	not monitored	0	0
GV-9	19.9	0	0	not monitored	0	15.5
GV-10	0	0	21.3	not monitored	0	0
GV-11	1	0	0	not monitored	0	0
GV-12	0	2.1	6	not monitored	0	0
GP-1			43.6	28.7	29.7	17
GP-2				24.7	23.6	22.5
GP-3			13.6	13	18.6	9.1
GP-4				0	0	0
GP-5		installed fall 2004			0	0
GP-6		installed fall 2004			0	0
GP-7		installed fall 2004			5.9	1.7
GP-8		installed fall 2004			4.2	0
GP-10		installed fall 2004			0	NT
GP-11		installed fall 2004			0	0
GP-12		installed fall 2004			0	0
Background	0	0	0	NR	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 6: Landfill Gas Analytical Results
FF/NN Landfill, Ripon, WI

Sampling Point ID	Date	Benzene	Chlorobenzene	Chloroethane	Chloromethane	Dichlorodifluoromethane	1,1-Dichloroethene	cis-1,2-dichloroethene	trans-1,2-Dichloroethene	1,2-dichloro-1,1,2,2-tetrafluoroethane	Total Hydrocarbons as gas	Tetrachloroethene	Toluene	Trichloroethene	Vinyl Chloride
GP-1	9/29/04	31.2		208		2,980									
	1/28/05				0.6								1.8		
GP-2	9/29/04	61.1	58.1	70.6	73	347		343	22.5	220		23.1		72.8	410
	1/28/05					270		470		190	4,600				
GP-3	9/29/04	102		689		909	110	6,660	229	131				205	25,400
	1/28/05			450		590		4,500			4,800				12,600
LC-1	9/29/04			9.1		70.8				9.5					
	1/28/05					553		1,080		178	10,400				130

Values in ppbv (parts per billion by volume)
Analyzed using EPA Method TO-14A

APPENDIX A
LEACHATE HEAD WELL CONSTRUCTION LOGS

State of Wisconsin
Department of Natural Resources

MONITORING WELL CONSTRUCTION
Form 4400-113A 8-89

Facility/Project Name: Ripon FF/NN Landfill
Facility License, Permit or Monitoring Number:

Grid Location: 682615.7696 ft. ☒ N. ☐ S.
2297559.2462 ft. ☒ E. ☐ W.

Well Name: LC-1
Wis. Unique Well Number / DNR Well Numb

Type of Well: Water Table Observation Well ☐ 11; Piezometer ☐ 12 — leachate head well

Section Location: SE 1/4 of SE 1/4 of Section 7,
T 16 N, R 17 ☒ E ☐ W

Date Well Installed: 05/05/93 (mm dd yy)

Distance Well Is From Waste/Source Boundary: 0 ft.

Well Installed By: (Person's Name and Firm) Eric Schoenbus WTD

Is Well A Point of Enforcement Std. Application? ☐ Yes ☐ No

Location of Well Relative to Waste/Source: ☐ Upgradient ☐ Sidegradient ☐ Downgradient ☐ Not Known

A. Protective pipe, top elevation _______ ft. MSL
B. Well casing, top elevation 873.50 ft. MSL
C. Land surface elevation 871.14 ft. MSL
D. Surface seal, bottom _____ ft. MSL or ____ ft.

12. USCS classification of soil near screen:
☐ GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐ SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐ Bedrock — refuse

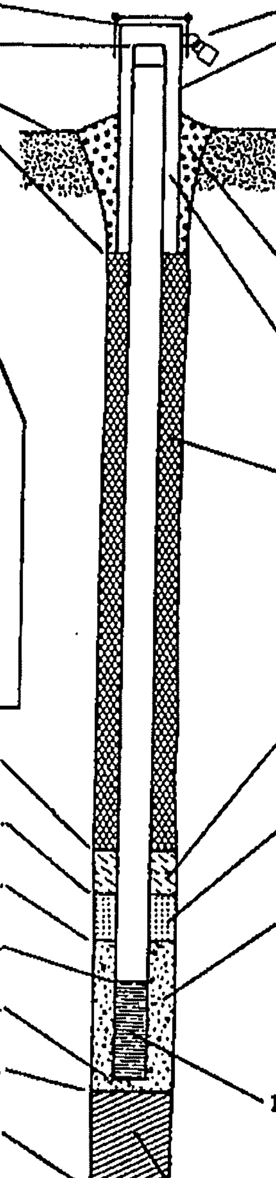
13. Sieve analysis attached? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☒ 41; Other ☐

15. Drilling fluid used: Water ☐ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No
Describe ________

17. Source of water (attach analysis): N/A



1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
   a. Inside diameter: 6.0 in.
   b. Length: 7.0 ft.
   c. Material: Steel ☒ 04; Other ☐
   d. Additional protection? ☒ Yes ☐ No
   If yes, describe: 3 bumper posts
3. Surface seal: Bentonite ☒ 30; Concrete ☐ 01; Other ☐
4. Material between well casing and protective pipe: Bentonite ☒ 30; Annular space seal ☐; Other ☐
5. Annular space seal: None — Granular Bentonite ☐ 33
   ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
   ____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
   ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
   ____ Ft^3 volume added for any of the above
   How installed: N/A — Tremie ☐ 01; Tremie pumped ☐ 02; Gravity ☐ 08
6. Bentonite seal: Bentonite granules ☐ 33
   ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite pellets ☐ 32
   Bentonite chips — Other ☒
7. Fine sand material: Manufacturer, product name and mesh size
   Badger Fine Sand
   Volume added: 1 bag
8. Filter pack material: Manufacturer, product name and mesh size
   Red Flint #30
   Volume added: 16 bags
9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☒ 24; Other ☐
10. Screen material: same as casing
   Screen type: Factory cut ☒ 11; Continuous slot ☐ 01; Other ☐
   Manufacturer: Timco
   Slot size: 0.010 in.
   Slotted length: 19.3 ft.
11. Backfill material (below filter pack): None ☐ Other ☒
   Bentonite Chips

E. Bentonite seal, top 871.1 ft. MSL or 0.0 ft.
F. Fine sand, top 866.1 ft. MSL or 5.0 ft.
G. Filter pack, top 865.1 ft. MSL or 6.0 ft.
H. Well screen, top 864.1 ft. MSL or 7.0 ft.
I. Well screen, bottom 844.1 ft. MSL or 27.0 ft.
J. Filter pack, bottom 841.1 ft. MSL or 30.0 ft.
K. Borehole, bottom 837.1 ft. MSL or 34.0 ft.
L. Borehole, diameter 10.3 in.
M. O.D. well casing 4.50 in.
N. I.D. well casing 3.79 in.

I hereby certify that the information on this form is true and correct to the best of my knowledge.

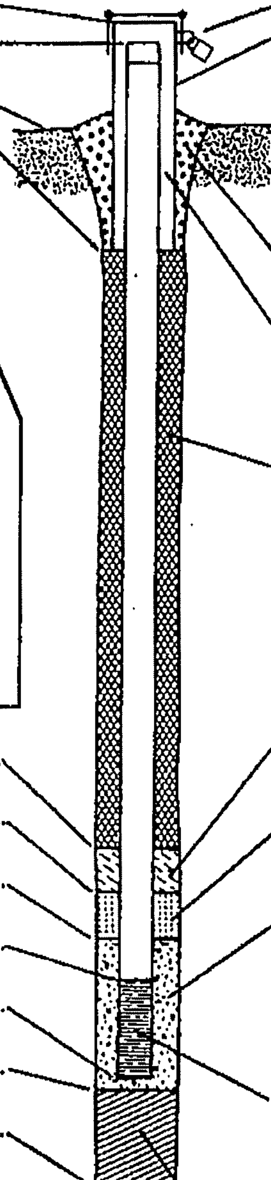
Signature: [signature] Firm: Simon Hydro-Search

Please complete and return both sides of this form as required by chs. 144, 147 and 160, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with ch. 144, Wis Stats., failure to file this form may result in a forfeiture of not less than $10, nor more than $5,000 for each day of violation. In accordance with ch. 147, Wis. Stats., failure to file this form ...

tate of Wisconsin
)epartment of Natural Resources

MONITORING WELL CONSTRUCTION
Form 4400-113A 8-89

acility/Project Name: Ripon FFINN Landfill	Grid Location: 682,431,6113 ft. [X] N. [ ] S.	Well Name: LC-2
acility License, Permit or Monitoring Number:	229,784,3224 ft. [X] E. [ ] W.	Wis. Unique Well Number / DNR Well Numb
ype of Well: Water Table Observation Well [ ] 11; Piezometer [ ] 12 — chate well	Section Location: SE 1/4 of SE 1/4 of Section 7, T 16 N, R 17 [X] E [ ] W	Date Well Installed: 05/26/93 (mm dd yy)
istance Well Is From Waste/Source Boundary: 0 ft.	Location of Well Relative to Waste/Source: [ ] Upgradient [ ] Sidegradient [ ] Downgradient [ ] Not Known	Well Installed By: (Person's Name and Firm) Eric Schoenbos - WTD
Well A Point of Enforcement Std. Application? [ ] Yes [ ] No		



. Protective pipe, top elevation ______ ft. MSL

. Well casing, top elevation 863.91 ft. MSL

. Land surface elevation 861.61 ft. MSL

. Surface seal, bottom ______ ft. MSL or ____ ft.

2. USCS classification of soil near screen:
[ ] GP [ ] GM [ ] GC [ ] GW [ ] SW [ ] SP
[ ] SM [ ] SC [ ] ML [ ] MH [ ] CL [ ] CH
[ ] Bedrock Refuse

3. Sieve analysis attached? [ ] Yes [X] No

4. Drilling method used: Rotary [ ] 50; Hollow Stem Auger [X] 41; Other [ ]

5. Drilling fluid used: Water [ ] 02 Air [ ] 01; Drilling Mud [ ] 03 None [X] 99

6. Drilling additives used? [ ] Yes [X] No

Describe ______

7. Source of water (attach analysis): N/A

Bentonite seal, top 861.6 ft. MSL or 0.0 ft.

Fine sand, top 849.6 ft. MSL or 12.0 ft.

Filter pack, top 847.6 ft. MSL or 14.0 ft.

Well screen, top 845.6 ft. MSL or 16.0 ft.

Well screen, bottom 835.6 ft. MSL or 26.0 ft.

Filter pack, bottom 834.6 ft. MSL or 27.0 ft.

Borehole, bottom 834.6 ft. MSL or 27.0 ft.

Borehole, diameter 10.3 in.

O.D. well casing 4.50 in.

I.D. well casing 3.79 in.

1. Cap and lock? [X] Yes [ ] No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.0 ft.
c. Material: Steel [X] 0; Other [ ]
d. Additional protection? [X] Yes [ ] No
If yes, describe: 3 bumper posts

3. Surface seal: Bentonite [X] 3; Concrete [ ] 0; Other [ ]

4. Material between well casing and protective pipe: Bentonite [X] 3; Annular space seal [ ]; Other [ ]

5. Annular space seal: None — Granular Bentonite [ ] 3
____ Lbs/gal mud weight . . . Bentonite-sand slurry [ ] 35
____ Lbs/gal mud weight . . . . . Bentonite slurry [ ] 3
____ % Bentonite . . . . . Bentonite-cement grout [ ]
____ Ft³ volume added for any of the above
How installed: N/A — Tremie [ ] 0; Tremie pumped [ ] 02; Gravity [ ] 08

6. Bentonite seal: Bentonite granules [ ] 33
[ ] 1/4 in. [ ] 3/8 in. [ ] 1/2 in. Bentonite pellets [ ] 32
Bentonite Chips Other [X]

7. Fine sand material: Manufacturer, product name and mesh size
Badger Fine Sand
Volume added 1 bag ft³

8. Filter pack material: Manufacturer, product name and mesh size
Red Flint #30
Volume added 3 bags ft³

9. Well casing: Flush threaded PVC schedule 40 [ ] 23; Flush threaded PVC schedule 80 [X] 24; Other [ ]

10. Screen material: Same as casing
Screen type: Factory cut [X] 11; Continuous slot [ ] 01; Other [ ]
Manufacturer Timco
Slot size: 0.010 in.
Slotted length: 10' 9.6 ft.

11. Backfill material (below filter pack): None [X]; Other [ ]

ereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
[signature]	Simon Hydro-Search

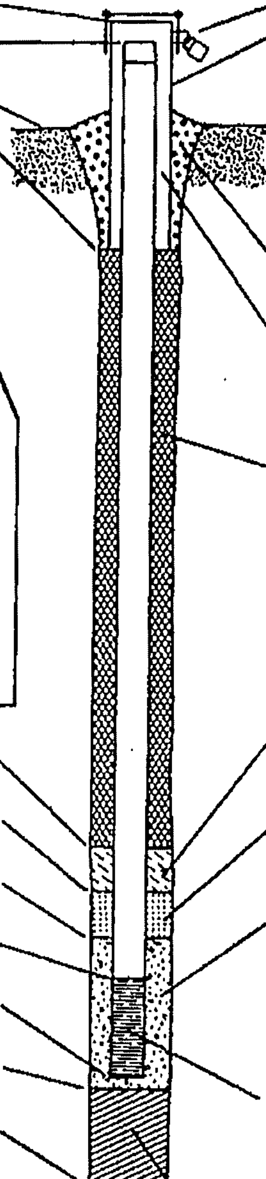
ise complete and return both sides of this form as required by chs. 144, 147 and 160, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with 144, Wis Stats., failure to file this form may result in a forfeiture of not less than $10, nor more than $5,000 for each day of violation. In accordance with ch. 147, Wis. Stats., failure to file this form may result in a forfeiture of not more than $10,000 for each day of violation.

State of Wisconsin
Department of Natural Resources

MONITORING WELL CONSTRUCTION
Form 4400-113A 8-89

Facility/Project Name: Ripon FF/NW Landfill
Facility License, Permit or Monitoring Number: ________
Grid Location: 682,276.5047 ft. ☒ N. ☐ S.; 229,756.7058 ft. ☒ E. ☐ W.
Well Name: LC-3
Wis. Unique Well Number / DNR Well Number

Type of Well: Water Table Observation Well ☐ 11; Piezometer ☐ 12; Leachate headwell ☒
Section Location: SE 1/4 of SE 1/4 of Section 7, T 16 N, R 17 ☒ E ☐ W
Date Well Installed: 05/04/93 (m m d d y y)
Distance Well Is From Waste/Source Boundary: 0 ft.
Well Installed By: (Person's Name and Firm) Eric Schoenberg WTD
Location of Well Relative to Waste/Source: ☐ Upgradient ☐ Sidegradient ☐ Downgradient ☐ Not Known
Is Well A Point of Enforcement Std. Application? ☐ Yes ☐ No



A. Protective pipe, top elevation ______ ft. MSL
B. Well casing, top elevation 874.44 ft. MSL
C. Land surface elevation 872.08 ft. MSL
D. Surface seal, bottom ______ ft. MSL or ____ ft.

12. USCS classification of soil near screen: ☐ GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐ SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐ Bedrock — Refuse
13. Sieve analysis attached? ☐ Yes ☒ No
14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☒ 41; Other ☐
15. Drilling fluid used: Water ☐ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☒ 99
16. Drilling additives used? ☐ Yes ☒ No
Describe N/A
17. Source of water (attach analysis): N/A

E. Bentonite seal, top 872.1 ft. MSL or 0.0 ft.
F. Fine sand, top 871.1 ft. MSL or 1.0 ft.
G. Filter pack, top 871.1 ft. MSL or 1.0 ft.
H. Well screen, top 865.1 ft. MSL or 6.0 ft.
I. Well screen, bottom 846.1 ft. MSL or 26.0 ft.
J. Filter pack, bottom 847.1 ft. MSL or 26.0 ft.
K. Borehole, bottom 832.1 ft. MSL or 40.0 ft.
L. Borehole, diameter 10.3 in.
M. O.D. well casing 4.50 in.
N. I.D. well casing 3.79 in.

1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.0 ft.
c. Material: Steel ☒ 04; Other ☐
d. Additional protection? ☒ Yes ☐ No
If yes, describe: 3 Bumper posts
3. Surface seal: Bentonite ☒ 30; Concrete ☐ 01; Other ☐
4. Material between well casing and protective pipe: Bentonite ☒ 30; Annular space seal ☐; Other ☐
5. Annular space seal: none — Granular Bentonite ☐ 33
____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
____ Ft^3 volume added for any of the above
How installed: N/A — Tremie ☐ 01; Tremie pumped ☐ 02; Gravity ☐ 08
6. Bentonite seal: Bentonite granules ☐ 33; ☐ 1/4 in. ☐ 3/8 in. ☒ 1/2 in. Bentonite pellets ☐ 32; Bentonite Chips Other ☒
7. Fine sand material: Manufacturer, product name and mesh size: Badger Fine sand
Volume added 1 bag ft^3
8. Filter pack material: Manufacturer, product name and mesh size: Red Flint #30
Volume added 16 bags ft^3
9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☒ 24; Other ☐
10. Screen material: Same as casing
Screen type: Factory cut ☒ 11; Continuous slot ☐ 01; Other ☐
Manufacturer Timco
Slot size: 0.010 in.
Slotted length: 19 ft.
11. Backfill material (below filter pack): None ☐; Other ☒ Bentonite Chips

I hereby certify that the information on this form is true and correct to the best of my knowledge.
Signature: [signature] Firm: Simon Hydro-Search

Please complete and return both sides of this form as required by chs. 144, 147 and 160, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with ch. 144, Wis Stats., failure to file this form may result in a forfeiture of not less than \$10, nor more than \$5,000 for each day of violation. In accordance

APPENDIX B

METHANE GAS GENERATION CALCULATIONS

BY GZD DATE 2/21/05 PROJECT FF/NN Landfill, Ripon SHEET NO. 1 OF 2
CHKD. BY DLM DATE 3/8/05 PROJ. NO. 1011.002

Estimate of Landfill Gas Generation Rate

Reference: USEPA "Turning a Liability into an Asset: A Landfill Gas-to-Energy Project Development Handbook

Method A. Simple Approximation

Annual LFG generation (cf) = 0.10 cf/# × 2000 lb/ton × tons waste

Estimate of in-place waste volume is

$$7.2 \text{ acres} \times \frac{43{,}560 \text{ ft}^2}{\text{acre}} \times \frac{32' \text{ thick}}{2} = 5\times10^6 \text{ CF wastes}$$

$$\frac{5\times10^6 \text{ CF} \times 1{,}100 \text{ \#/CY}}{27 \text{ CF/CY}} = 200\times10^6 \text{ \# wastes}$$

$$200\times10^6 \text{ \#} \times \frac{0.10 \text{ CF}}{\text{yr}\cdot\text{\#}} \times \frac{1 \text{ yr}}{365 \text{ d}} \times \frac{1 \text{ d}}{24 \text{ hr}} \times \frac{\text{hr}}{60 \text{ min}}$$

$= \underline{39 \text{ SCFM}}$ ✓

Method B. First Order Decay Model

$$LFG = 2 L_0 R \left(e^{-kc} - e^{-kt}\right)$$

L_0 = 2.5 cf/# of wastes
k = 0.1 /yr
t = time since landfill opened = 2005 - 1973 = 32 yrs
c = time since landfill closed = 2005 - 1986 = 19 yrs
R = Average waste acceptance rate, #/year
200×10^6 # / 13 years = 15×10^6 #/yr

$$LFG = 2\left(\frac{2.5 \text{ cf}}{\text{\# wastes}}\right)\left(15\times10^6 \frac{\text{\# wastes}}{\text{yr}}\right)\left(e^{-(0.1)(19)} - e^{-(0.1)(32)}\right)$$

0.150 ✓ .041 ✓

$= 8.2\times10^6$ CF/year ✓

$$(8.2\times10^6 \text{ CF/yr}) \frac{1 \text{ yr}}{365 \text{ days}} \times \frac{1 \text{ day}}{24 \text{ hrs}} \times \frac{1 \text{ hr}}{60 \text{ min}}$$

$= \underline{15.6 \text{ SCFM}}$ ✓

An Original gas generation rate ~~was~~ is estimated at

$$2(2.5)(15\times10^{6})\left(e^{0} - e^{-(0.1)(13)}\right)$$

(e^{0} = 1 ✓, $e^{-(0.1)(13)}$ = 0.27 ✓)

$$= \sout{48}\ 54.75 \times 10^{6}\ CF/yr$$

$$8.7/\sout{48}\ 54.75 = \sim 0.\sout{17}\ .15$$

The current gas generation rate is only about ~~17~~ 15% of the gas generation rate the day the landfill closed, which was its estimated maximum generation rate.

APPENDIX C
PILOT TEST EQUIPMENT SPECIFICATIONS

FAXED

SCHRADER ENVIRONMENTAL SERVICES, INC.
212 S. PINE RIVER
ITHACA, MI 48847
OFFICE (989) 875 6500
FAX (989) 875-8880

FAX PROPOSAL

PROPOSAL NUMBER CI122904-5

ATTN: GERALD DeMERS

DATE: December 29, 2004

TO: GeoTrans
175 N. Corporate Dr.
Brookfield, WI 53045

PHONE: (262) 792-1282
FAX: (262) 792-1310

RE: Rental/Purchase of SVE System
SITE: Unknown

Item:	Description:	Quantity:	Item cost:	Total:
1	**Rental of Soil Vapor Extraction System (skid mounted)**	1	$1,145.00 up to 1 month	
	Includes: PUROFLOW 3006 - ~~Sutorbilt 3LP~~ positive displacement blower - Approx. 200 SCFM @ 3" Hg vacuum - 3 hp 115/230/1/60 motor - Inlet particulate filter and exhaust silencer - Approx. 20 gallon vertical mount moisture knock-out tank - High level shutdown switch - 1" dia manual drain w/valve Control Panel - On/off switch w/motor starter & overload - Relay for high level shutdown switch		— MOTOR IS EXP. UL-LISTED — VACUUM GUAGE ON INLET — EROCO DIRECT READ CFM FLOWMETER — DILUTION AIR VALVE AFTER FLOWMETER	
2	**Mobilization of equipment to**	1	~~to be determined~~ $462.00 MAX	
3	**Demobilization from**	1	~~to be determined~~ $462.00 MAX	

Note: forklift required for loading/unloading equipment by others

Note:
50% of all rent paid may be applied towards the purchase price of the above equipment.
Purchase price of the above system: $5,895.00

DELIVERY: Estimated at 2-3 weeks from placement of order, pending availability.
RENTAL TERMS: Due with order plus mobilization and a signed rental contract.
MODIFICATION OF RENTAL EQUIPMENT: Any modification (removal or replacement) either mechanical or electrical for site specific applications that require SES re-work before or after the rental period will be billed.
1½% per month finance charge will apply to any invoices over 30 days.
The above pricing does not include any applicable sales tax.

ACCEPTANCE:
Accepted by: ______________________ Company: ______________________

Printed Name & Title: ______________________

Purchase Order #: ______________________ Date: ______________________

Thank you for the opportunity to quote your environmental equipment/service needs.
Sincerely,
Schrader Environmental Services, Inc.

Craig Irish

Gardner Denver

DATA SHEET: D-2-348
DATED: 4-3-96
SUPERSEDES: B-2278

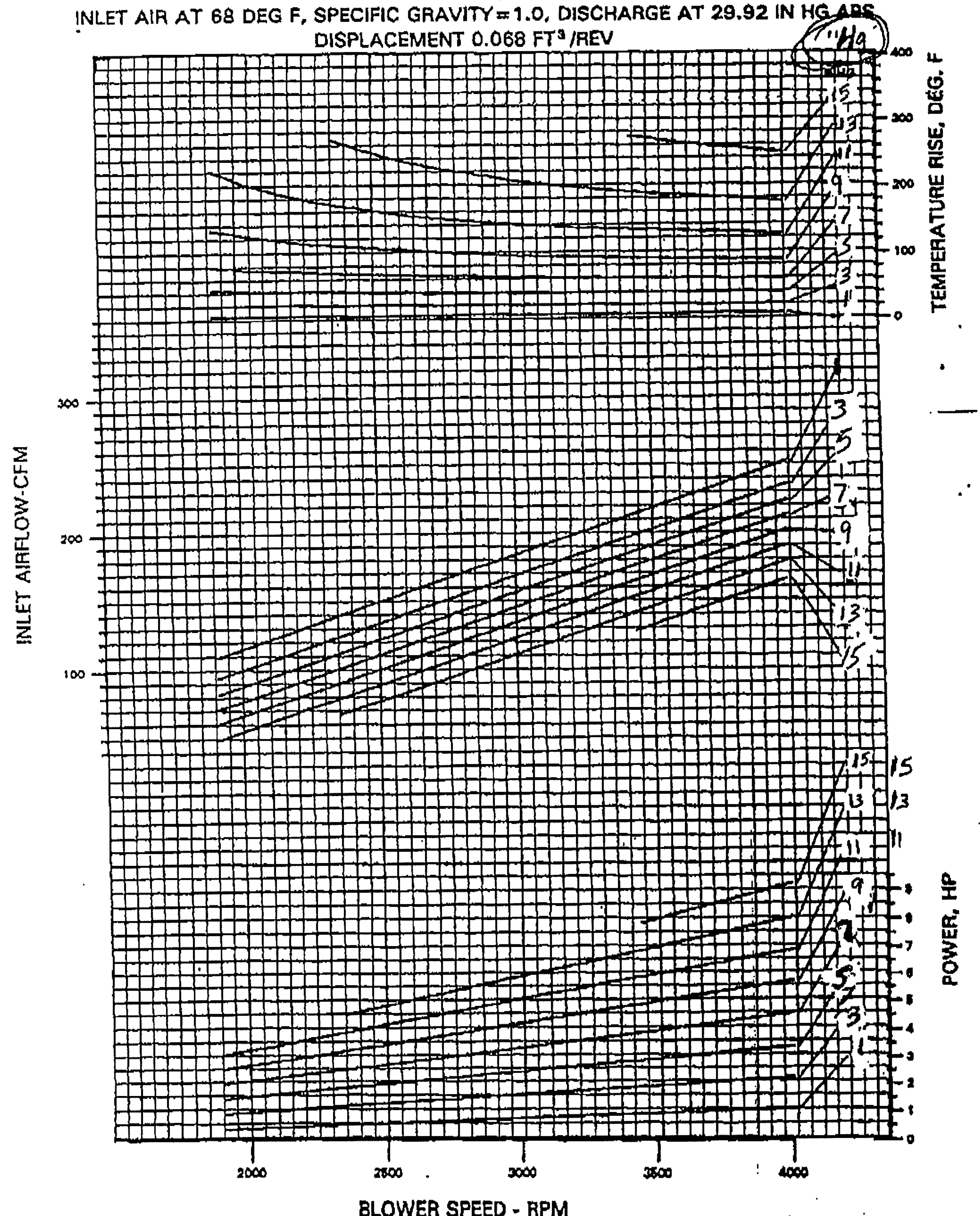
DuroFlow®

MODEL 3006

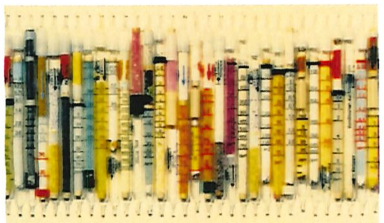
VACUUM PERFORMANCE CURVE

INLET AIR AT 68 DEG F, SPECIFIC GRAVITY = 1.0, DISCHARGE AT 29.92 IN HG ABS

DISPLACEMENT 0.068 FT³/REV



APPENDIX D
DRAEGER TUBE INFORMATION



Accurate

Not all detector tubes are created equal! Draeger-Tubes® with the accuro pump deliver the most accurate results. Many Draeger tubes offer a +/- 10% standard deviation on the results. This is a result of our 60+ years of manufacturing colorimetric tubes and the consistent volume delivered by the bellows pump design. Quality assurance is accomplished by individually calibrating each batch of Draeger-Tubes®. Then every batch is tested at regular intervals, throughout the two year shelf life, to guarantee accuracy over the entire life of the tubes.

Easy to Read

See the difference for yourself! The wider diameter of the Draeger-Tubes® makes it easier to read. Well-spaced graduation marks enable distinct and decisive measurement results. Color changes to the reagents are well defined over the entire length of the stain. Many Tubes offer a dual calibrated scale so that you can interpret the results without using multiplication factors.

Fast

One stroke tubes are not always faster! Though many Draeger-Tubes® require more than one stroke,they often provide measurement results in less time. Not only do you get the benefit of a quicker analysis; the larger sample volume provides better statistical accuracy.

Flexible

Draeger-Tubes® simply deliver more! More gases and more measuring ranges than any other manufacturer. Draeger offers over 200 tubes for accurately measuring over 500 different gases. You can measure ambient air for health and safety levels, optional equipment allows you to measure stack gases, motor vehicle exhaust components, pressurized gas line samples, compressed air contaminants, and solvents in water samples. Other specialized tubes measure over a period of hours or a complete work shift to indicate daily exposure levels.

Draeger-Tubes®

Leading detection

Specific

Reagents used in Draeger-Tubes® are chosen to provide not only the most accurate, but also most specific results possible. Our use of prelayers on many tubes (like benzene) remove other potential interfering gases (e.g. aromatic hydrocarbons) so you measure only the targeted chemical, getting only the results you want. This design enables you to measure specific gases in a complex ambient background found in the measurement area.

Draeger-Tubes on Time

We can deliver to most locations in continental North America within 24 hours.

Hard-Side Kit

Hard-Side Kit 4056443

Soft-Side Kit

Soft-Side Kit 4053473

Deluxe Kit

Deluxe Pump Kit 4053474
accuro Pump 6400000
Spare Parts Kit 6400220S

accuro 2000

accuro 2000 Kit 4500200

HazMat Simultest Kit

HazMat Simultest Kit 4056098
HazMat Simultest Kit (w/o pump) 4056447

Accessories

(1) Deluxe Tube Opener 6400010
(2) Motor Vehicle Probe CH00214
(3) Hot Air Probe CH00213
(4) Extension Hose 3m 6400077
10m 6400078
15m 6400079

Simultaneous Test Set

Simultaneous Test Set I (inorganic) 8101735
Simultaneous Test Set II (inorganic) 8101736
Simultaneous Test Set III (organic) 8101770

Represented By:

Model 31

Model 31 Pump 6726065
Spare Parts Kit 6727211S

accuro pump kits

Trusted Technology

Maintenance Free

Draeger has made gas detection easy. Unlike a piston pump, the accuro pump requires no lubrication. The accuro® is constructed of non-metallic, corrosion resistant materials. It can't be bent by rough treatment and it withstands harsh chemical environments. Draeger-Tubes® are pre-calibrated for two years. The only requisite on Draeger-Tubes® is that they are stored out of direct sunlight and at a temperature of less than 25 °C (77 °F). Any temperature-controlled office meets these conditions.

Quantimeter 1000

Quantimeter 1000 4600231
Universal Charger 6806430

Draeger Safety, Inc

101 Technology Drive
Pittsburgh, PA 15275-1057
1-412-787-8383
Fax: 1-412-787-2207
Customer Service: 1-800-858-1737
Fax: 1-800-922-5519
Technical Support: 1-888-794-3806
Fax: 1-888-794-3807
www.draeger.com

Draeger Canada Ltd.

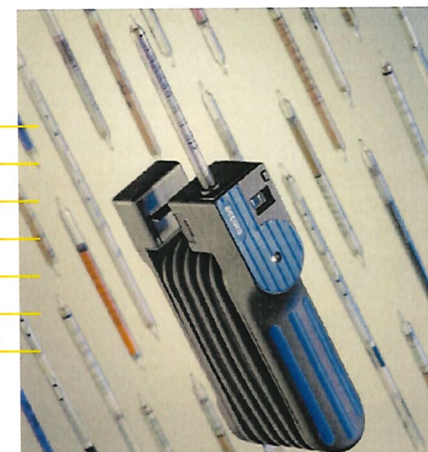
7555 Danbro Crescent
Mississauga, ON L5N 6P9
1-905-821-8988
Fax: 1-905-821-2565
Customer Service: 1-877-372-4371
Fax: 1-800-Fax-Tube

Draeger Safety | Dräger

Draeger-Tubes® and accuro® Pump

Trusted Technology that's ahead of its time

- Accurate
- Easy to read
- Flexible
- Fast
- Specific
- Easy to use
- Maintenance free
- Multi-Gas Detector



What is the Draeger-Tube® System?

Draeger-Tubes® are glass vials filled with a chemical reagent that reacts to a specific chemical or family of chemicals. A calibrated 100 ml sample of air is drawn through the tube with the Draeger accuro® bellows pump. If the targeted chemical(s) is present the reagent in the tube changes color and the length of the color change typically indicates the measured concentration. The Draeger-Tube® System is the world's most popular form of gas detection.

Draeger: Leading Detection

Ever since 1937 when we introduced our first detector tube, Draeger has been the world leader in the analysis of gases and vapors in the industrial workplace. Over the years we have developed more tubes and detection devices for more applications than anyone else! Our leading edge technology has kept us on the forefront of colorimetric detector tubes thus providing the most accurate and specific results available.

accuro® pump

One handed operation

Most Trusted

Draeger-Tubes® have been leading the way in gas detection for over 60 years.

Widest Range

Over 200 different Draeger-Tubes® are available for measuring over 500 gases and vapors.

Hassle-Free Operation

No calibration, no lubrication, no special maintenance. Always ready to go.

Draeger Short-term Detection Tubes

Description	Measuring Range	Order Code
Acetaldehyde 100/a	100-1,000 ppm	67 26 665
Acetic Acid 5/a	5-80 ppm	67 22 101
Acetone 100/b	100-12,000 ppm	CH 22901
Acid Test	Qualitative	81 01 121
Acrylonitrile 0.5/a (5)	0.5-20 ppm	67 28 591
Air Current Tube Kit		4054388S
Air Current Tubes		CH 25301
Alcohol 25/a	50-4,000 ppm Isopropanol 25-5,000 ppm Methanol	81 01 631
Alcohol 100/a	100-3,000 ppm	CH 29701
Amine Test	Qualitative	81 01 061
Ammonia 0.25/a	0.25-3 ppm	81 01 711
Ammonia 2/a	2-30 ppm	67 33 231
Ammonia 5/b	2.5-100 ppm	81 01 941
Ammonia 5/a	5-700 ppm	CH 20501
Ammonia 0.5%/a	0.05-10 Vol.%	CH 31901
Aniline 0.5/a	0.5-10 ppm	67 33 171
Aniline 5/a	1-20 ppm	CH 20401
Arsenic Trioxide 0.2/a	0.2 mg/m3	67 28 951
Arsine 0.05/a	0.05-60 ppm	CH 25001
Benzene 0.5/a	0.5-10 ppm	67 28 561
Benzene 0.5/c (5) specific	0.5-10 ppm	81 01 841
Benzene 2/a (5)	2-60 ppm	81 01 231
Benzene 5/b	5-50 ppm	67 28 071
Benzene 15/a	15-420 ppm	81 01 741
Carbon Dioxide 100/a	100-3,000 ppm	81 01 811
Carbon Dioxide 0.1%/a	0.1-6 Vol.%	CH 23501
Carbon Dioxide 0.5%/a	0.5-10 Vol.%	CH 31401
Carbon Dioxide 1%/a	1-20 Vol.%	CH 25101
Carbon Dioxide 5%/A	5-60 Vol.%	CH 20301
Carbon Disulfide 3/a	3-95 ppm	81 01 891
Carbon Disulfide 30/a	32-3,200 ppm	CH 23201
Carbon Monoxide 2/a	2-300 ppm	67 33 051
Carbon Monoxide 5/c	5-700 ppm	CH 25601
Carbon Monoxide 8/a (only for CO in H2)	8-150 ppm	CH 19701
Carbon Monoxide 10/b	10-3,000 ppm	CH 20601
Carbon Monoxide 0.3%/b	0.3-7 Vol.%	CH 29901
Carbon Monoxide 200/a + Carbon Dioxide 2%/a	200-2,500 ppm CO 2-12 Vol. % CO2	67 18 301
Carbon Pretubes		CH 24101
Carbon Tetrachloride 0.2/b	0.2-70 ppm	81 01 791
Carbon Tetrachloride 1/a (5)	1-15 ppm	81 01 021
Carbon Tetrachloride 5/c	5-50 ppm	CH 27401
Chlorine 0.2/a	0.2-30 ppm	CH 24301
Chlorine 0.3/b	0.3-10 ppm	67 28 411
Chlorine 50/a	50-500 ppm	CH 20701
Chlorobenzene 5/a (5)	5-200 ppm	67 28 761
Chloroform 2/a (5)	2-10 ppm	67 28 861
Chloroformates 0.2/b	0.2-10 ppm	67 18 601
Chloroprene 5/a	5-60 ppm	67 18 901
Chromic Acid 0.1/a (9)	0.1-0.5 mg/m3	67 28 681
Cyanide 2/a	2-15 mg/m3	67 28 791
Cyanogen Chloride 0.25/a	0.25-5 ppm	CH 19801
Cyclohexane 100/a	100-1,500 ppm	67 25 201
Cyclohexylamine 2/a	2-30 ppm	67 28 931
Diethyl Ether 100/a	100-4,000 ppm	67 30 501
Dimethyl Formamide 10/b	10-40 ppm	67 18 501
Dimethyl Sulfate 0.005/c (9)	0.005-0.05 ppm	67 18 701
Dimethyl Sulfide 1/a (5)	1-15 ppm	67 28 451
Epichlorohydrin 5/b	5-50 ppm	67 28 111
Ethyl Acetate 200/a	200-3,000 ppm	CH 20201
Ethyl Benzene 30/a	30-600 ppm	67 28 381
Ethylene 0.1/a (5)	0.2-5 ppm	81 01 331
Ethylene 50/a	50-2,500 ppm	67 28 051
Ethylene Glycol 10 (5)	10-180 mg/m3	81 01 351
Ethylene Oxide 1/a (5)	1-15 ppm	67 28 961
Ethylene Oxide 25/a	25-500 ppm	67 28 241
Ethyl Glycol Acetate 50/a	50-700 ppm	67 26 801
Fluorine 0.1/a	0.1-2 ppm	81 01 491
Formaldehyde 0.2/a	0.2-5 ppm	67 33 081
Formaldehyde Activation tube (for use only in conjunction with 0.2/a tube)	extend to 0.04 ppm	81 01 141
Formaldehyde 2/a	2-40 ppm	81 01 751
Formic Acid 1/a	1-15 ppm	67 22 701
Halogenated Hydrocarbons 100/a	100-2,800 ppm	81 01 601
Hexane 100/a	50-3,000 ppm	67 28 391
Hydrazine 0.2/a	0.2-10 ppm	67 33 121
Hydrazine 0.25/a	0.1-10 ppm	CH 31801
Hydrocarbons 0.1%/b	0.1-1.3 Vol. %	CH 26101
Hydrocarbons 2	3-23 mg/l	CH 25401
Hydrochloric Acid 1/a	1-10 ppm	CH 29501
Hydrochloric Acid 50/a	50-5,000 ppm	67 28 181
Hydrochloric Acid/Nitric Acid 1/a	1-10 ppm (HCL) 1-15 ppm (HNO3)	81 01 681
Hydrocyanic Acid 2/a	***2-150 ppm***	***CH 25701***
Hydrogen 0.2%/a	0.2-2 Vol. %	81 01 511
Hydrogen Fluoride 0.5/a	0.5-90 ppm	81 03 251
Hydrogen Peroxide 0.1/a	0.1-3 ppm	81 01 041
Hydrogen Sulfide 0.2/a	0.2-5 ppm	81 01 461
Hydrogen Sulfide 0.2/b	0.2-6 ppm	81 01 991
Hydrogen Sulfide 0.5/a	0.5-15 ppm	67 28 041
Hydrogen Sulfide 1/d	1-200 ppm	81 01 831
Hydrogen Sulfide 2/a	2-200 ppm	67 28 821
Hydrogen Sulfide 2/b	1-60 ppm	81 01 961
Hydrogen Sulfide 5/b	5-600 ppm	CH 29801
Hydrogen Sulfide 100/a	100-2,000 ppm	CH 29101
Hydrogen Sulfide 0.2%/A	0.2-7 Vol.%	CH 28101
Hydrogen Sulfide 2%/a	2-40 Vol.%	81 01 211
Hydrogen Sulfide + Sulfur Dioxide 0.2%/A	0.02-7 Vol.%	CH 28201
Mercaptan 0.1/a	0.1-2.5 ppm	81 03 281
Mercaptan 0.5/a	0.5-5 ppm	67 28 981
Mercaptan 20/a	20-100 ppm	81 01 871
Mercury Vapor 0.1/b	0.05-2 mg/m3	CH 23101
Methyl Acrylate 5/a	5-200 ppm	67 28 161
Methyl Bromide 0.5/a	0.5-30 ppm	81 01 671
Methyl Bromide 5/b	5-50 ppm	CH 27301
Methylene Chloride 100/a	100-2,000 ppm	67 24 601
Natural Gas Test (Methane)(5)	Qualitative	CH 20001
Nickel 0.25/A	0.25-1.0 mg/m3	67 28 871
Nickel Tetracarbonyl 0.1/a (9)	0.1-1 ppm	CH 19501
Nitric Acid 1/a	1-50 ppm	67 28 311
Nitrogen Dioxide 0.5/c	***0.5-25 ppm***	***CH 30001***
Nitrogen Dioxide 2/c	2-100 ppm	67 19 101
Nitroglycol 0.25/a	0.25 ppm	67 18 201
Nitrous Fumes 0.5/a	0.5-10 ppm	CH 29401
Nitrous Fumes 2/a	2-100 ppm	CH 31001
Nitrous Fumes 20/a	20-500 ppm	67 24 001
Nitrous Fumes 50/a	50-2,000 ppm	81 01 921
Nitrous Fumes 100/c	100-5,000 ppm	CH 27701
Oil Mist 1/a	1-10 mg/m3	67 33 031
Olefins 0.05%/a	0.06-3.2 Vol.% Propylene 0.04-2.4 Vol.% Butylene	CH 31201
Organic Arsenic Compounds and Arsine	3 mg org. arsenic/m3	CH 26303
Organic Basic Nitrogen Compounds	1 mg/m3	CH 25903
Oxygen 5%/C	5-23 Vol.%	81 03 261
Ozone 0.05/b	0.05-1.4 ppm	67 33 181
Ozone 10/a	10-300 ppm	CH 21001
Pentane 100/a	100-1,500 ppm	67 24 701
Perchloroethylene 0.1/a	0.1-4 ppm	81 01 551
Perchloroethylene 2/a	2-300 ppm	81 01 501
Perchloroethylene 10/b	10-500 ppm	CH 30701
Perchloroethylene 50/A	50-10,000 ppm	81 01 851
Petroleum Hydrocarbons 10/a	10-300 ppm (n-Octane)	81 01 691
Petroleum Hydrocarbons 100/a	100-2,500 ppm (n-Octane)	67 30 201
Phenol 1/b	1-20 ppm	81 01 641
Phosgene 0.02/a	0.02-1 ppm	81 01 521
Phosgene 0.25/c	0.25-15 ppm	CH 28301
Phosphine 0.01/a	0.01-1 ppm	8101 611
Phosphine 0.1/a	0.1-4 ppm	CH 31101
Phosphine 1/a	1-100 ppm	81 01 801
Phosphine 25/a	25-10,000 ppm	81 01 621
Phosphine 50/a	15-1,000 ppm	CH 21201
Phosphoric Acid Esters 0.05/a (Dimethyldichlorovinylphosphate)	0.05 ppm	67 28 461
Polytest	Qualitative	CH 28401
Pyridine 5/A	5 ppm	67 28 651
Styrene 10/a	10-200 ppm	67 23 301
Styrene 10/b	10-250 ppm	67 33 141
Styrene 50/a	50-400 ppm	CH 27601
Sulfur Dioxide 0.1/a	0.1-3 ppm	67 27 101
Sulfur Dioxide 0.5/a	0.5-25 ppm	67 28 491
Sulfur Dioxide 1/a	1-25 ppm	CH 31701
Sulfur Dioxide 20/a	20-2,000 ppm	CH 24201
Sulfur Dioxide 50/b	50-8,000 ppm	81 01 531
Sulfuric Acid 1/a (9)	1-5 mg/m3	67 28 781
Tetrahydrothiophene 1/b (5)	1-10 ppm	8101 341
Thioether	1 mg/m3	CH 25803
Toluene 5/b	5-300 ppm	81 01 661
Toluene 50a	50-400 ppm	81 01 701
Toluene 100/a	100-1,800 ppm	81 01 731
Toluene Diisocyanate 0.02/A (9)	0.02-0.2 ppm	67 24 501
o-Toluidine 1/a	1-30 ppm	67 28 991
Trichloroethane 50/d (5)	50-600 ppm	CH 21101
Trichloroethylene 2/a	2-250 ppm	67 28 541
Trichloroethylene 10/a	50-2,000 ppm	CH 24401
Triethylamine 5/a	5-60 ppm	67 18 401
Vinyl Chloride 0.5/b	0.5-30 ppm	81 01 721
Vinyl Chloride 100/a	100-3,000 ppm	CH 19601
Water Vapor 0.1/a	0.05-1 mg/L	81 01 321
Water Vapor 1/a	0.5-18 mg/L	81 01 081
Water Vapor 1/b	1-40 mg/L	81 01 781
Water Vapor 3/a	3-60 lbs/mmcf	81 03 031
Water Vapor 50/a	50-1,000 lbs/mmcf	81 03 021
Xylene 10/a	10-400 ppm	67 33 161

Number in parenthesis indicates tests per box.
Bold/Italic font indicates SEI Certification

Consult the VOICE® software or local Draeger representative for Extension of Range for tubes.

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