

Unit E



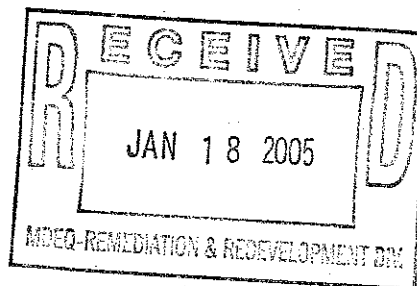
Life Sciences

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January 14, 2005

Ms. Sybil Kolon  
Department of Environmental Quality  
Jackson State Office Building  
301 E. Louis Glick Highway  
Jackson, Michigan 49201



**Re:** Work Plan

Dear Ms. Kolon:

Pall Life Sciences submits the enclosed Work Plan for Response Activities, Maple Road Area, Unit E Aquifer.

Should you have any questions regarding this Work Plan, please contact me at (734) 913-6130.

Sincerely,

*Farsad Fotouhi*

Farsad Fotouhi  
Vice President  
Corporate Environmental Engineering

cc: Mr. Robert Reichel, MDAG  
Mr. Alan Wasserman  
Mr. Michael Caldwell

## **WORK PLAN FOR RESPONSE ACTIVITIES**

### **MAPLE ROAD AREA**

### **UNIT E AQUIFER**

January 17, 2005

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## **INTRODUCTION**

Pall Life Sciences (PLS) is submitting this Work Plan for Response Activities ("Work Plan") to address the Unit E plume near Maple Road, Ann Arbor, Michigan. The Work Plan details the installation of two wells (one extraction and one injection), aquifer testing and analysis, installation of piping, and the installation of a treatment system.

## **DESCRIPTION OF AND AUTHORITY FOR PROPOSED RESPONSE ACTIVITIES**

The proposed Response Activities will involve the extraction of groundwater from a single well, treatment and the reinjection of the treated groundwater using two separate wells. One of the injection wells (IW-3) will be installed north of the extraction well to be installed. An existing well (TW-16) will be converted to the second injection well (IW-4). The new extraction well (TW-18) will be located to intercept the highest concentrations of 1,4-dioxane in order to satisfy the Court-mandated remedial objective of preventing groundwater with concentrations in excess of 2,800 microgram per liter ( $\mu\text{g/L}$ ) from migrating east of Maple Road. The proposed extraction and injection well locations are shown on Figure 1. With the proposed response activities, the total flux of groundwater through the plume cross section will not be changed since the same volume of groundwater will be removed and then, following treatment, reinjected back into the aquifer, within the plume itself. Consequently, the injection will not result in any material changes in the plume boundaries.

The initial extraction/injection rate will be 200 gpm. PLS will maintain this extraction/injection rate until further investigation indicates that a different rate is appropriate and approval for the rate change is obtained from either the MDEQ or the Court.

The proposed discharge to groundwater will not require PLS to obtain a groundwater discharge permit. Rather, PLS' reinjection of treated groundwater is authorized by an exemption to the general prohibition on groundwater discharges under the Part 31 rules. Specifically, the proposed discharge satisfies the conditions of R. 323.2110(u). Rule 2210(u) authorizes discharges associated with response activities as follows:

(u) Wastewater associated with an environmental response activity described in any of the following paragraphs if the discharge is to the plume of groundwater contamination, including an area 100 feet hydraulically upgradient of the edge of the plume, and any additive used in the treatment process that is not part of the contamination plume meets the standards of R 323.2222:

(i) A pump test discharge that does not change the physical dimensions of the plume in groundwater or, if the dimensions are

changed, the changes are accounted for in the design of the final groundwater remediation plan. (ii) A remedial investigation, feasibility study, or remedial action discharge that is at or below the residential criteria authorized by section 20101a(1)(a) of the act, if applicable, or section 21304(a) of the act, if applicable.

(iii) A discharge for a remedial investigation, feasibility study, or remedial action above the residential criteria authorized by section 20101a(1)(a) of the act, if applicable, or section 21304(a) of the act, if applicable, if a remediation investigation, feasibility study, or remediation plan has been approved by the department division that has compliance oversight. The remediation plan shall indicate that the treatment system is designed and will be operated so that contaminated groundwater will eventually meet the appropriate land use-based cleanup criteria authorized by section 20120a(1)(a) to (d) of the act, if applicable, or section 21304(a) of the act, if applicable.

This Work Plan demonstrates that the proposed discharge is authorized under Rule 2210(u)(ii). Reinjection will occur into the Unit E plume in areas where concentrations are above 85 ppb. This is the criterion established by the Michigan Department of Environmental Quality (MDEQ) under Part 201 as protective for drinking and is the applicable remedial standard for this site. Therefore, the discharge will be "to the plume of groundwater contamination" as required by Rule 2210(u). PLS' treatment system will also meet and exceed the treatment requirements of Rule 2210(u)(ii). Consequently, no further approvals are required to authorize the proposed discharge.

## **SUPPORTING INFORMATION**

In its September 1, 2004, Decision Document, the MDEQ at that time noted three concerns with reinjection as a disposal option: (1) the unknown capacity of the aquifer to accept the amount of water that would need to be extracted and reinjected; (2) the unknown effects on the plume due to the complex geology; and (3) fouling of injection wells (Decision Document, page 12 of 17). These concerns were raised in the overall context of using reinjection to handle the large volumes of water that would be generated with the MDEQ's alternative proposal. However, these concerns, to the extent they apply to the proposed Response Activities, are also addressed below.

### *General Information in Support of the Work Plan*

The proposed locations for the extraction well and two injection wells are based on interpretations of aquifer geometry, 1,4-dioxane distribution, the location of existing extraction wells, and site logistics. The Unit E hydrogeological and 1,4-dioxane distribution data indicate the area west of Maple Road would be a comparatively effective location for groundwater extraction. As the 1,4-dioxane plume migrates eastward, toward Maple Road, the plume is following a relatively defined channel with boundaries that have been mapped by several monitoring wells. Once east of Maple Road, the plume reduces in concentration by almost one order of magnitude, and the aquifer thins out and becomes more complicated. The locations were

chosen so that the reinjection will occur within the boundaries of the plume of groundwater contamination consistent with Rule 2210(u). The proposed locations shown relative to the 1,4-dioxane isoconcentration contour are shown on the attached Figure 1.

The proposed extraction and injection wells will be located in an area of the site where the Unit E aquifer is interpreted to range in thickness from approximately 60 to 80 feet. A cross section of this area is provided as Figure 2. Based on the July to September 2004 1,4-dioxane isoconcentration map for the Unit E aquifer (Figure 3), the proposed extraction well is near the axis of the Unit E plume, which has concentrations of 1,4-dioxane ranging between 1,000 and 2,000 µg/L. The proposed Response Activities will capture approximately 50 percent of the width of the plume and concentrate on the central core of the Unit E plume. The capture area will more than cover the area of 1,4-dioxane concentrations in excess of 2,800 ppb, and includes a significant zone of contamination between 1,000 and 2,000 ppb.

Data from MW-85, MW-87, MW-88, Maple Village Boring East, and Maple Village Boring West provides information regarding the vertical distribution of 1,4-dioxane in the proposed extraction well areas. The borehole logs for these five borings are provided as Attachment 1. Data encountered at MW-85 and MW-88 indicate the Unit E aquifer is approximately 60 feet thick in these areas and consists of sand, gravel, and cobbles. 1,4-Dioxane concentrations at MW-85 and MW-88 ranged from 14 to 1,731 µg/L and 2 to 973 µg/L, respectively.

At MW-87, the Unit E aquifer is approximately 80 feet thick and consists of sand, gravel, and cobbles with a clay lens encountered near the center of the Unit E aquifer. 1,4-Dioxane concentrations at MW-87 ranged from less than 1 to 1,355 µg/L.

#### *Information on Capacity of Aquifer and Ability to Accept 200 gpm*

PLS conducted an aquifer performance test in the Maple Village area using one of the proposed injection wells, TW-16, for the purpose of determining the hydraulic properties of the Unit E aquifer in that area. The aquifer transmissivity calculated in the area of TW-16 ranges from approximately 75,117 and 131,425 gallons per day per foot (gpd/ft), with average hydraulic conductivity values in the range of 600 to 2,300 gpd/ft<sup>2</sup>. Storativity values calculated from the test ranged between 0.000049 and 0.047502. Based on the observed hydraulic characteristics and general observations about the aquifer in this area made from analysis of boring log data, the aquifer appears to have more than sufficient capacity to accept injected water (100 gpm injected at two separate locations).

The 200 gpm extracted will be injected back into the aquifer at two separate locations and at similar depths. Localized mounds are expected to develop at the injection sites, but these mounds will be balanced by the hydraulic low created at the extraction site. Overall, there will be no net change in flux in the area, so there is no reason to expect the plume to expand in any material way as a result of the proposed Response Activities.

#### *Information on Impact of Reinjection on Plume Contour*

PLS submitted additional information in its response to the MDEQ's Decision Document. This included a memo and particle trace diagrams that were intended to answer the following questions. Would the proposed reinjection:

- Split the plume?
- Push contaminated groundwater farther downgradient faster?
- Slow the migration of more contaminated portions of the plume?
- Extend the duration of remedial activities?

A copy of the memorandum and particle trace diagram answering these questions in support of reinjection is provided as Attachment 2.

### *Information on "fouling"*

Injection wells are, by nature, prone to well screen fouling. Well screen fouling occurs when suspended particles, bacterial growth, and/or air bubbles plug the well screen openings and formation porosity. The reduction of the well screen opening and effective formation porosity requires an increase in pressure to inject the same volume of water into the formation. At some point, the injection head becomes too high, requiring a cleaning of the well screen and surrounding formation (rehabilitation) to restore the well's injection capacity.

PLS has operated two injection wells (IW-1 and IW-2), both completed in Unit E in the Evergreen Subdivision area. IW-1 was prone to plugging, which resulted in a high level of maintenance of the well. In contrast, IW-2 operated with significantly less maintenance. Specific reasons for why one well operated with less maintenance are not known, but well design and slight modifications in chemistry (pH adjustments) are believed to have been a factor.

PLS recognizes that operation of injection wells can require attention to maintenance and is prepared to dedicate the resources necessary to keep the injection wells in operation. It is anticipated that the injection wells will require periodic maintenance, including chlorination and acid washing. The frequency that this work will be performed will be determined by monitoring of the injection wells, specifically injection flow rates and system pressures.

If necessary, PLS will install additional injection wells to maintain the needed injection capacity. Such wells will be considered, if the frequency maintenance of the injection wells is high and downtime for the wells is becoming excessive.

## **WORK PLAN**

### **Test Boring(s)**

At each proposed well location, test borings will be drilled to confirm the selected locations are suitable for the extraction or injection well, and to collect the geologic information necessary to design the wells. If the conditions are not suitable for either of the wells, the boring(s) will be abandoned and an alternative location(s) will be tested. However, due to the available data near the site, it is not anticipated that alternative locations will be necessary.

The test boring(s) will be drilled using the hollow stem auger method and the proposed sampling methods are split spoon and Simulprobe for collection of soil and soil/groundwater samples, respectively. Split spoon sampling will be performed at a frequency of 10 feet, starting at

approximately 10 feet below ground surface (bgs) to a depth of approximately 90 feet bgs, or wherever the target aquifer is encountered. Split spoon sampling will be performed at a frequency of 5 feet throughout the aquifer and will revert to the 10-foot frequency beneath the aquifer, if applicable.

In water-bearing units, Simulprobe sampling will be performed at a maximum frequency of every 10 feet. Split spoon sampling will not be collected at the Simulprobe intervals, as soil sampling will be accounted for by the Simulprobe. If conditions warrant (coarse gravel or heaving sands), a temporary well screen with packer assembly will be used to collect groundwater samples. Selected soil samples will also be analyzed for grain size to aid in the selection of the test well screen.

Upon reaching the proposed target depth, the boring will be backfilled with sand through the target aquifer, and grouted with bentonite above the aquifer. This method will allow the borehole to be reentered for the installation of the test well.

The soil cuttings derived from the drilling and development water will be transported back to PLS.

### **Extraction and Injection Wells**

A total of two wells (one extraction (TW-18) and one injection well (IW-3) – the other injection well, IW-4 (formerly TW-16) already exists.) will be designed using the test boring data. From the test boring data, the screen zone and screen size will be determined. Both the extraction and the injection wells will be constructed of 8-inch-diameter steel casing. The screen for the extraction well will be 20 feet in length. The screen interval will be determined after a review of geologic and water quality data from the test boring. The injection well screen will also be 20 feet in length. The screen interval will be selected after a review of geologic and water quality data from the test boring. The well screens may be gravel packed, depending on the grain size of the material in the proposed screen intervals.

The wells will be grouted in accordance with Michigan Water Well Construction and Pump Installation Code (Part 127, Act 368, PA 1978 and Administrative Rules). Development of the well(s) will be performed using air-lifting techniques. Groundwater generated during the development will be transported to PLS for treatment and discharge.

A short-term aquifer test will be completed on the extraction well and the newly installed injection well. Each test will consist of pumping the well at a flow rate of approximately 200 gpm. Drawdown data will be collected from the test well and nearby monitoring wells. The proposed test time for each of the two wells is 4 to 8 hours. The groundwater will be pumped into a 20,000-gallon frac tank, then transported and disposed into the Red Pond at PLS.

Groundwater samples will be obtained during each of the aquifer tests. The samples will be analyzed for selected natural water chemistry parameters and 1,4-dioxane.

## **Well Infrastructure and Piping**

The injection wells will be equipped with packers and designed similar to PLS injection wells IW-1 and IW-2. The packers will allow for an increase in injection pressure greater than allowed for by elevation head. Additionally, the packers will minimize oxygen in the system.

The extraction well pump will be sized based on data collected from the short-term aquifer testing.

After completion of the short-term aquifer tests, the extraction well will be equipped with a pitless adapter and connected to the portable treatment building via double-cased fusion-welded high-density polyethylene piping. PLS will prepare engineering drawings for the underground infrastructure and submit the drawings to the MDEQ and other appropriate parties, as necessary. At this time, PLS anticipates the pipeline will consist of an 8-inch-diameter outer pipe with a 6-inch-diameter inner pipe. The water will flow through the 6-inch pipe, and the 8-inch pipe will act as a secondary containment in the event the 6-inch pipe fails. The injection wells will have pitless adapters, and will be connected to the portable treatment building via single-wall, 6-inch piping. The piping will be installed via trenching and/or horizontal drilling.

## **Treatment System**

A PLS mobile Ozone/Hydrogen Peroxide Treatment System will be utilized for the Response Activities. The system is designed to treat 1,4-dioxane at a flow rate of 200 gpm. Groundwater will be extracted at 200 gpm and treated, then the 200 gpm treated water will be injected back into the Unit E aquifer. The treatment system is supplied with two construction-type trailers. The supply trailer is where ozone is produced and hydrogen peroxide is stored. The treatment system is equipped with an advanced computer processor that operates and monitors the system during operations. The detailed information related to Pall Ozone/Hydrogen Peroxide System was submitted to MDEQ in various reports previously.

## **Performance Monitoring**

PLS will monitor the performance of the Response Activities by the collection of water level and water quality data from a network of wells. The proposed Performance Monitoring Wells are shown on Figure 4.

The following table identifies the wells, the purpose for selecting the well, and sampling frequencies.

Well Location	Purpose of Monitoring	Groundwater Quality and Water Level Frequency
TW-18	1	Weekly (water quality only)
IW-3 & IW-4	Operation and Maintenance Monitoring	Monitor Water Level/Pressure Daily
Treatment system Effluent	Compliance with Injection Rules	To be determined
MW-76s	2	Quarterly
MW-76i	2	Quarterly
MW-76d	2	Quarterly
MW-79	2	Quarterly
MW-81	2 and 3	Monthly for 3 Months then Quarterly
MW-83s	2	Quarterly
MW-83d	2	Quarterly
MW-84s	2	Quarterly
MW-84d	2	Quarterly
MW-85	2	Quarterly
MW-86	2	Quarterly
MW-87s	2	Quarterly
MW-87d	2	Quarterly
MW-88	2	Quarterly
MW-89	2 and 3	Monthly for 3 Months then Quarterly
MW-90	2 and 3	Monthly for 3 Months then Quarterly
MW-91	2	Quarterly

1 = Monitor water quality trends and calculate mass removed.

2 = Monitor for downgradient water quality changes.

3 = Monitor for lateral expansion of the Unit E plume.

Note: All samples will be analyzed for 1,4-dioxane by PLS.

PLS will provide all performance monitoring data in a tabulated and graphed format to the MDEQ in its Quarterly Report.

PLS is prepared to implement the Work Plan immediately upon approval by the MDEQ. The following are time estimates for various project tasks.

Major Project Tasks	Estimated Task Time	Comments
Find Location for Treatment System and Obtain Access from Property Owner(s)	Unknown	Finding access to a site to locate the treatment system is expected to be difficult. Land zoning may be an additional issue.
Discharge Authorization	Upon approval of this Work Plan by the RRD	
Access for Well Installation	Unknown	The proposed extraction/injection well locations are in the City of Ann Arbor right-of-way. PLS will seek access upon approval of the Work Plan.
Drilling/Well Installation	3 to 4 weeks	Work can begin upon approval of Work Plan and access.
Engineering Design of Pipeline	3 to 4 weeks	The level of design will depend on where a treatment system is located.
Approval of Pipeline Design by Appropriate Authorities	Unknown	Road crossings could result in significant increase in time.
Site Preparation	3 to 4 weeks	Can begin after site access is obtained.
System Installation and Startup	2 to 4 weeks	

PLS estimates that it could take between 3 and 12 months to implement the Response Activities after a treatment system site has been secured.

### List of Figures and Attachments

#### Figures

- Figure 1 Well locations, 1,4-dioxane isoconcentration
- Figure 2 Cross-Section
- Figure 3 July to September 2004 1,4-Dioxane Isoconcentration Map
- Figure 4 Performance Monitoring Locations

#### Attachments

- Attachment 1 Borehole logs for MW-85, MW-87, MW-88, Maple Village East, and Maple Village West
- Attachment 2 Response to MDEQ Decision Document - PLS Summary  
Comments - Response to Weston

## Figures

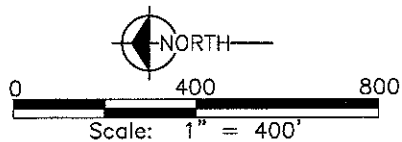
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SCIO TWP., WASHTENAW COUNTY, MICHIGAN  
**UNIT E - INTERIM RESPONSE  
WORK PLAN**

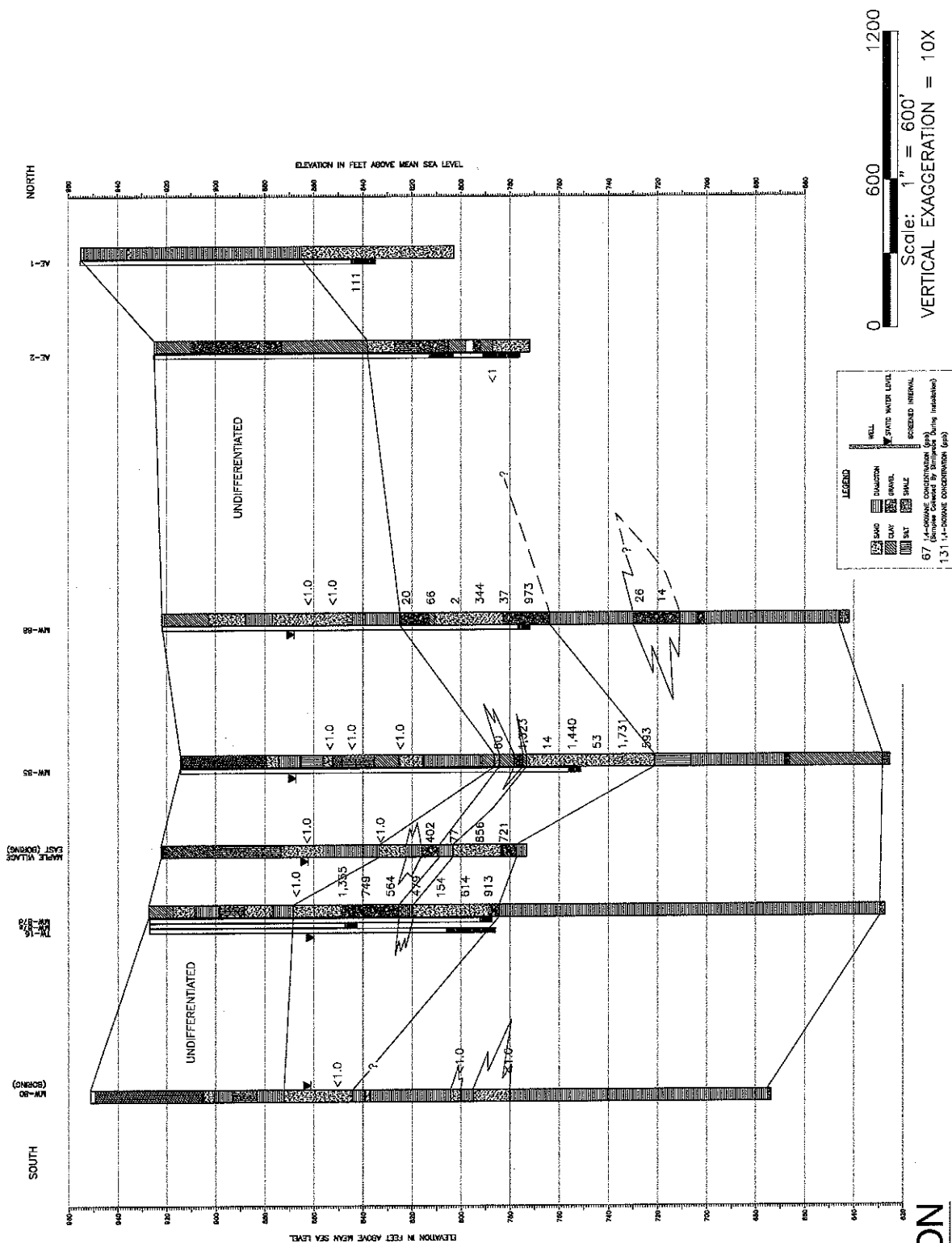
PROJECT NO.  
F96502  
FIGURE NO.

**1**

**LEGEND**

- PERFORMANCE MONITORING WELLS
- PROPOSED EXTRACTION WELL
- PROPOSED INJECTION WELL
- E1 1,4-DIOXANE ISOCONCENTRATION CONTOUR (ug/L) JULY-SEPTEMBER 2004
- E2 1,4-DIOXANE ISOCONCENTRATION CONTOUR (ug/L) JULY-SEPTEMBER 2004
- 1,4-DIOXANE CONCENTRATION (ug/L)
- DATA NOT USED

**PROPOSED  
EXTRACTION/INJECTION  
WELL LOCATION MAP**



# MAPLE ROAD

# CROSS SECTION

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SCIO TWP., WASHTENAW COUNTY, MICHIGAN

## UNIT E - INTERIM RESPONSE WORK PLAN

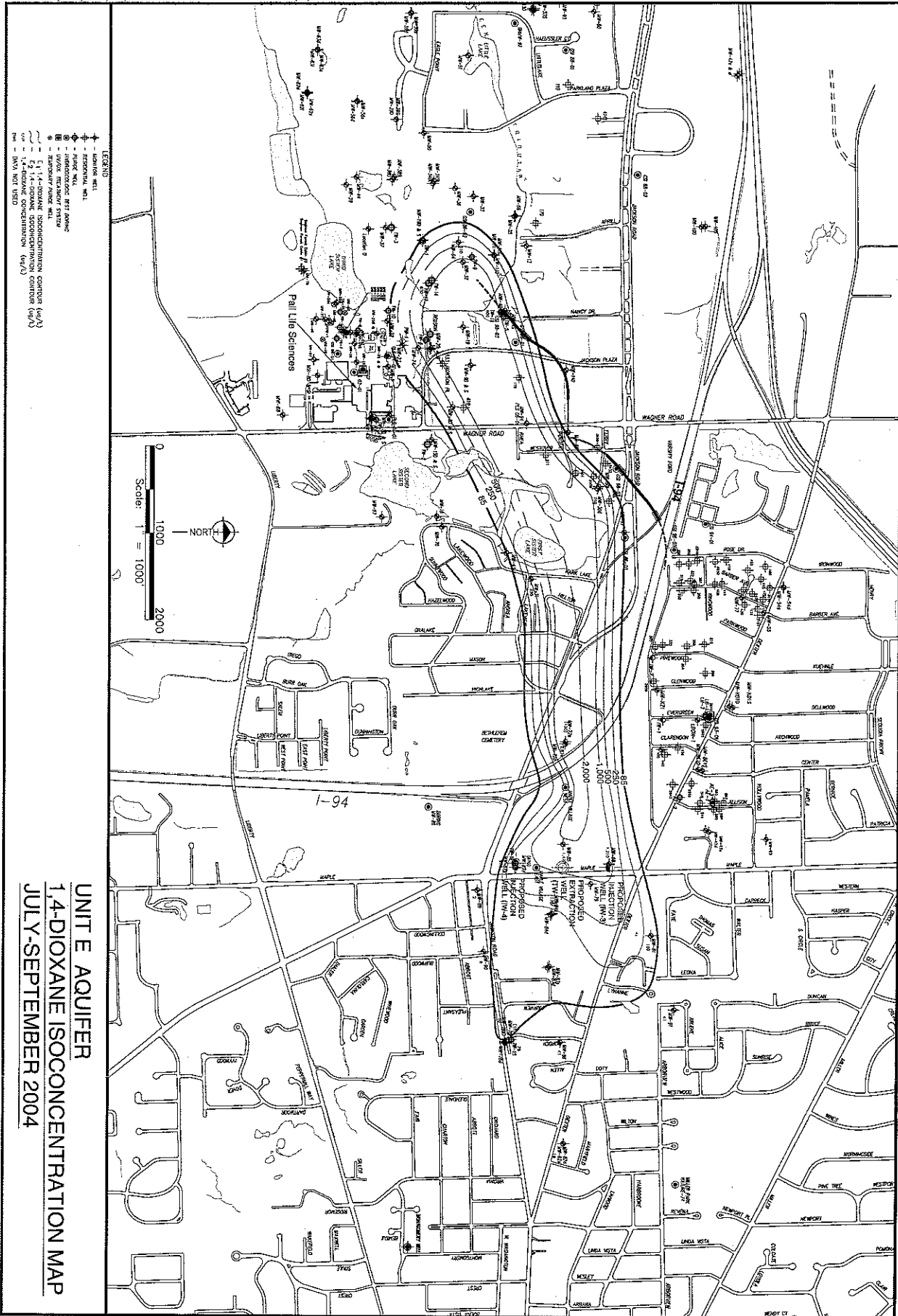
PROJECT NO.  
F96502  
FIGURE NO.

2

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# UNIT E AQUIFER

1,4-DIOXANE ISOCENTRATION MAP  
 JULY-SEPTEMBER 2004

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 SCIO TWP., WASHTENAW COUNTY, MICHIGAN  
 UNIT E - INTERIM RESPONSE  
 WORK PLAN



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- LEGEND**
- - PERFORMANCE MONITORING WELLS
  - - PROPOSED EXTRACTION WELL
  - - PROPOSED INJECTION WELL

- E<sub>1</sub> 1,4-DIOXANE ISOCONCENTRATION CONTOUR (ug/L) JULY-SEPTEMBER 2004
- E<sub>2</sub> 1,4-DIOXANE ISOCONCENTRATION CONTOUR (ug/L) JULY-SEPTEMBER 2004
- 1,437 - 1,4-DIOXANE CONCENTRATION (ug/L)
- (194) - DATA NOT USED

## PERFORMANCE MONITORING PLAN FOR UNIT E INTERIM RESPONSE PLAN



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**UNIT E - INTERIM RESPONSE  
WORK PLAN**

PROJECT NO.  
F96502  
FIGURE NO.

**4**

## Attachment 1



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Grand Rapids (616) 575-3824  
Lansing (517) 627-1141  
Kalamazoo (269) 375-3824  
Farmington Hills (248) 324-2090

## E-1 HOLE LOG

BORING/WELL ID: MW-85

TOTAL DEPTH (ft.): 289'

PROJECT: Pall Life Sciences Inc.

SITE LOCATION: Ann Arbor, Michigan

PROJECT NO.: F96502

PROJECT MANAGER: James W. Brode, Jr., C.P.G.

LOGGED BY: Brad Peuler

START DATE: 2-12-03

END DATE: 2-20-03

TOC ELEV.:

GROUND ELEV.: App. 917' AMSL

STATIC WATER LVL.: 47.92' btoc

DRILLING CO.: Stearns Drilling

DRILLER: Dennis/Ralph, Dick, Nick

RIG TYPE: CME 95

METHOD OF DRILLING: Hollow Stem Auger

SAMPLING METHODS: Split Spoon, Simulprobe

NOTES: Maple Village Shopping Center, West of Maple Road  
Field GPS Coordinates (N42.28296, W083.78168), Acc. 15'

Static Water Level

Page 1 of 4

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
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ASPHALT			0					
CLAYEY SAND: Sand, medium to coarse grained, with Clay, dark brown, moderately sorted, dry			2					
			4					
			6					
			8					
SANDY CLAY TO CLAYEY SAND: Clay, with fine to medium Sand (20%), dark brown to gray, moderately sorted, soft, dry			10	2.0'		2,2,3,4		Flush Mount Cover Sand Pack
			12					
			14					
			16					
			18					
SANDY CLAY: Clay, with fine Sand, and trace coarse Sand (10%), brownish gray, moderately sorted, medium stiff, dry			20	2.0'		3,5,8,10		Bentonite Grout
			22					
			24					
			26					
			28					
DIAMICTON: Clay, with fine Sand, trace coarse Sand, and trace fine Gravel, gray, poorly sorted, stiff, dry			30	2.0'		4,5,5,7		2" Galvanized Casing
			32					
			34					
SAND			36					
SAND: fine to medium grained, with trace coarse Sand, brown, moderately sorted, wet			38					
			40	2.0'		4,5,4,4		
DIAMICTON: Clay, with Silt, trace fine Sand (10%), trace fine Gravel (10%), brownish gray, medium stiff, dry			42					
			44					
			46					
			48					
SILT: Silt, with trace Clay (10%), trace fine Sand (10%), gray, moderately sorted, dry			50	1.7'		12,16,17,19		
			52					
			54					
			56					
SAND: medium grained, gray, very well sorted, wet			58					
			60	2.0'		0,0,0,0		Simulprobe sample 60-61.5' (<1 ug/L)
			62					
CLAY/SILT: Clay/Silt (slow drilling)			64					
			66					
SILTY SAND: Sand, fine grained, with Silt, brown, well sorted, wet			68					
			70	1.5'		7,10,13,17		Simulprobe sample 69-70.5' (<1 ug/L)
SILTY SAND: Sand, fine to coarse grained, with trace Silt (10%), trace Clay (10%), grayish brown, poorly sorted, wet			72					



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Kalamazoo (269) 375-3824  
Farmington Hills (248) 324-2090

# **E-BOREHOLE LOG** BORING/WELL ID: MW-85 TOTAL DEPTH (ft.): 289'

**PROJECT:** Pall Life Sciences Inc.  
**SITE LOCATION:** Ann Arbor, Michigan  
**PROJECT NO.:** F96502  
**PROJECT MANAGER:** James W. Brode, Jr., C.P.G.  
**LOGGED BY:** Brad Peuler

**START DATE:** 2-12-03  
**END DATE:** 2-20-03  
**TOC ELEV.:**  
**GROUND ELEV.:** App. 917' AMSL  
**STATIC WATER LVL.:** 47.92' btoc

**DRILLING CO.:** Stearns Drilling  
**DRILLER:** Dennis/Ralph, Dick, Nick  
**RIG TYPE:** CME 95  
**METHOD OF DRILLING:** Hollow Stem Auger  
**SAMPLING METHODS:** Split Spoon, Simulprobe

**NOTES:** Maple Village Shopping Center, West of Maple Road  
Field GPS Coordinates (N42.28296, W083.78168), Acc. 15'

Static Water Level Page 2 of 4

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
CLAY: Clay, with trace Silt, gray, well sorted, stiff, dry			74 76 78 80 82 84 86 88	1.0'			23,20,35	2" Galvanized Casing
SAND: medium to coarse grained, with Silt (10%), brown, moderately sorted, wet			90 92	0'			2,1,1,2	Simulprobe sample 89-90.5' (<1 ug/L)
Interbedded Clay and Sand			94 96 98					Bentonite Grout
DIAMICTON: Clay, with trace medium to coarse Sand, trace Silt, trace fine Gravel, gray, poorly sorted, stiff, dry			100 102 104 106 108	1.5'			6,10,11,13	
Interbedded Gravel (107-107.5')			110 112 114 116 118	2.0'			0,3,5,7	
Same As Above (soft)			120 122 124 126	2.0'			7,10,12,13	
SAND			128					
CLAY			130 132 134					
SAND: medium to coarse grained, with trace fine Sand, and trace fine Gravel, gray, moderately sorted, wet			136 138	0.5'			5,4,2,2	Simulprobe sample 129-130.5' (60 ug/L)
CLAY: Clay with Silt, moderately sorted, dry			140 142 144					
SAND AND GRAVEL			146	0.5'			20,100 (5")	Simulprobe sample 139-140.5' (1,323 ug/L)
CLAY: Clay, with medium to coarse Sand, and fine Gravel (20%), gray, poorly sorted, soft, dry								
SAND: with Gravel and Cobble fragments								Bentonite Grout



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## REHOLE LOG

BORING/WELL ID: MW-85

TOTAL DEPTH (ft.): 289'

PROJECT: Pall Life Sciences Inc.

SITE LOCATION: Ann Arbor, Michigan

PROJECT NO.: F96502

PROJECT MANAGER: James W. Brode, Jr., C.P.G.

LOGGED BY: Brad Peuler

START DATE: 2-12-03

END DATE: 2-20-03

TOC ELEV.:

GROUND ELEV.: App. 917' AMSL

STATIC WATER LVL.: 47.92' btoc

DRILLING CO.: Stearns Drilling

DRILLER: Dennis/Ralph, Dick, Nick

RIG TYPE: CME 95

METHOD OF DRILLING: Hollow Stem Auger

SAMPLING METHODS: Split Spoon, Simulprobe

NOTES: Maple Village Shopping Center, West of Maple Road  
Field GPS Coordinates (N42.28296, W083.78168), Acc. 15'

Static Water Level

Page 3 of 4

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
SAND: coarse grained, with trace medium Sand, trace fine Gravel (10%), trace Gravel and Cobble fragments, gray, poorly sorted, wet			148 150 152 154 156 158 160 162 164 166 168 170 172 174 176 178 180 182 184 186 188 190 192	0.5'			32,80 (6")	Simulprobe sample 149-150.5' (14 ug/L)  #7 Sand Pack
SAND: fine to coarse grained, with trace fine Gravel and Cobble fragments (10%), gray, poorly sorted, wet				1.0'			26,32,50 (1")	2" Stainless Steel Screen (10 Slot) Simulprobe sample 159-160.5' (1,440 ug/L)
Same As Above				0'			18,100 (6")	Simulprobe sample 169-170.5' (53 ug/L)
No Recovery. Drillers Comment: More Sand, Less Gravel				0'			100,50 (4")	Simulprobe sample 179-180' (1,731 ug/L)
SAND: medium to coarse grained, with trace fine to coarse Gravel, gray, moderately sorted, wet				0.5'			80,40 (6")	Simulprobe sample 189-190' (593 ug/L)
SILT			194 196 198 200 202 204 206 208					
SILT: with trace Clay (10%), gray, well sorted, dry				1.3'			13,27,100 (3")	
Large Cobble or Boulder (206-208')								
DIAMICTON: Clay, with Silt (10%), and trace fine Gravel (10%), gray, very stiff, dry			210 212 214 216 218	1.0'			22,48,80 (6")	



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## REHOLE LOG

BORING/WELL ID: MW-85

TOTAL DEPTH (ft.): 289'

PROJECT: Pali Life Sciences Inc.

SITE LOCATION: Ann Arbor, Michigan

PROJECT NO.: F96502

PROJECT MANAGER: James W. Brode, Jr., C.P.G.

LOGGED BY: Brad Peuler

START DATE: 2-12-03

END DATE: 2-20-03

TOC ELEV.:

GROUND ELEV.: App. 917' AMSL

STATIC WATER LVL.: 47.92' btoc

DRILLING CO.: Stearns Drilling

DRILLER: Dennis/Ralph, Dick, Nick

RIG TYPE: CME 95

METHOD OF DRILLING: Hollow Stem Auger

SAMPLING METHODS: Split Spoon, Simulprobe

NOTES: Maple Village Shopping Center, West of Maple Road  
Field GPS Coordinates (N42.28296, W083.78168), Acc. 15'

Static Water Level

Page 4 of 4

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
Same As Above			220	1.0'			NA	
			222					
			224					
			226					
			228					
DIAMICTON: Clay, with trace Silt, trace fine Sand, and trace fine Gravel, gray, very stiff, dry			230	0.5'			140 (6")	
			232					
			234					
			236					
			238					
Same As Above (Siltstone in bottom of Split Spoon)			240	0.5'			72,50 (1")	
			242					
			244					
GRAVEL AND CLAY			246					
CLAY: with Silt, and trace fine Gravel, gray, soft, poorly sorted, moist			248					
			250	1.3'			19,12,6,4	
			252					
Possible interbedded small Sand layers			254					
			256					
			258					
CLAY: with trace fine Gravel and trace fine Sand, gray, poorly sorted, stiff, dry			260	0.5'			15,110 (6")	
			262					
No Recovery. Drilling felt the same as above.			264	0'			100 (3")	
			266					
			268					
			270					
			272					
CLAY: with trace coarse Sand (10%), gray, soft, dry			274	0.25'			50,100 (1")	
			276					
			278					
			280					
CLAY: with trace coarse Sand, and trace Cobble fragments, bluish gray, soft, dry			282					
			284					
CLAY: with weathered Shale, bluish gray, dry			286	0.5'			37,50 (1")	
SHALE: weathered, bluish gray, dry			288	1"			50 (1")	
Same As Above (Platy, laminated)								



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# BOREHOLE LOG

DRILLING/WELL ID: MW-87S

TOTAL DEPTH (ft.): 85'

**PROJECT:** Pall Life Sciences Inc.

**SITE LOCATION:** Ann Arbor, Michigan

**PROJECT NO.:** F96502

**PROJECT MANAGER:** James W. Brode, Jr., C.P.G.

**LOGGED BY:** Todd C. Campbell

**START DATE:** 8-18-03

**END DATE:** 8-18-03

**TOC ELEV.:** 927.69' AMSL

**GROUND ELEV.:** App. 928' AMSL

**STATIC WATER LVL.:** 68.49'

**DRILLING CO.:** Stearns Drilling

**DRILLER:** Dennis, Bert, Nick

**RIG TYPE:** CME 95

**METHOD OF DRILLING:** Hollow Stem Auger

**SAMPLING METHODS:** NA - Des. based on MW-87

**NOTES:** Maple Village Shopping Center, West of Maple Road  
10' South-Southwest of MW-87, descriptions based on MW-87

Static Water Level

Page 1 of 1

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL-CONSTRUCTION DETAIL
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ASPHALT: Asphalt			0					
SANDY CLAY TO CLAYEY SAND: Clay with Sand, fine to coarse grained. Dark Brown/Brown, moderately sorted, medium dense, dry			2					
			4					
			6					
			8					
			10					
SAND: Sand, fine to coarse grained (95%); Gravel, fine (5%). Brown, moderately sorted, dry			12	1.8'			4,10,11,10	Flush Mount Cover Sand Pack
			14					
SILTY SAND: Sand, fine to medium grained with Silt and trace Clay. Brown, dry			16					
			18					
DIAMICTON: Clay; Silt; Sand, fine to coarse grained (10%). Gray, very stiff, dry			20	1.5'			4,10,10,10	Bentonite Grout
			22					
			24					
			26					
			28					
SILTY SAND: Sand, fine grained (60%); Silt (40%). Brown, well sorted, medium dense, dry			30	1.5'			4,8,14,18	2" Galvanized Casing
			32					
			34					
			36					
			38					
SAND: Sand, fine to medium grained (60%); Gravel, fine (40%). Brown, moderately sorted, medium dense, dry			40	1.3'			5,8,10,10	2" Galvanized Casing
			42					
			44					
			46					
Sand, fine to medium grained (60%); Gravel, fine (40%). Gray, moderately sorted, medium dense, dry			48					
			50	1.5'			5,6,8,8	
DIAMICTON: Silt with trace Clay. Gray, stiff, dry			52					
			54					
			56					
			58					
SAND: Sand, medium to fine grained (80%); Gravel, fine (10%); trace Silt. Gray, moderately sorted, loose, wet			60	1.2'			2,2,5,4	Simulprobe sample 59-60.5' (<1 ug/L)
Interbedded Clay, Silt, Sand, Cobbles from 63-67'			62					
			64					
			66					
			68					
SILTY SAND: Sand, fine to coarse grained (70%); Silt (20%); trace Clay (10%). Grayish brown, poorly sorted, loose, wet			70	2'			4,5,5,4	
			72					
			74					
			76					
			78					#6 Sand Pack
			80					
SAND AND GRAVEL: Sand, coarse to fine grained (70%); Gravel, fine to coarse (30%). Grayish brown, poorly sorted, loose, wet			82	1.2'			3,4,5,3	Simulprobe sample 79-80.5' (1,355 ug/L)
			84					2" Stainless Steel Screen (10 Slot)



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## BOREHOLE LOG

BORING/WELL ID: MW-87D

TOTAL DEPTH (ft.): 300'

PROJECT: Pall Life Sciences Inc.

SITE LOCATION: Ann Arbor, Michigan

PROJECT NO.: F96502

PROJECT MANAGER: James W. Brode, Jr., C.P.G.

LOGGED BY: Todd C. Campbell

START DATE: 4-14-03

END DATE: 4-22-03

TOC ELEV.: 927.34' AMSL

GROUND ELEV.: App. 928' AMSL

STATIC WATER LVL.: 66.81' btoc

DRILLING CO.: Stearns Drilling

DRILLER: Dennis, John, Duane

RIG TYPE: CME 95

METHOD OF DRILLING: Hollow Stem Auger

SAMPLING METHODS: Split Spoon, Simulprobe

NOTES: Maple Village Shopping Center, West of Maple Road  
Field GPS Coordinates (N42.28150, W083.78072), Acc. 20'

Static Water Level

Page 1 of 4

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
ASPHALT: Asphalt			0					
SANDY CLAY TO CLAYEY SAND: Clay with Sand, fine to coarse grained. Dark Brown/Brown, moderately sorted, medium dense, dry			2					
			4					
			6					
			8					
			10					
SAND: Sand, fine to coarse grained (95%); Gravel, fine (5%). Brown, moderately sorted, dry			12	1.8'			4,10,11,10	Flush Mount Cover Sand Pack
			14					
SILTY SAND: Sand, fine to medium grained with Silt and trace Clay. Brown, dry			16					
			18					
DIAMICTON: Clay; Silt; Sand, fine to coarse grained (10%). Gray, very stiff, dry			20	1.5'			4,10,10,10	Boring sealed with bentonite, moved approx. 10' East to set well
			22					
			24					
			26					
			28					
SILTY SAND: Sand, fine grained (60%); Silt (40%). Brown, well sorted, medium dense, dry			30	1.5'			4,8,14,18	Bentonite Grout
			32					
			34					
			36					
			38					
SAND: Sand, fine to medium grained (60%); Gravel, fine (40%). Brown, moderately sorted, medium dense, dry			40	1.3'			5,8,10,10	2" Galvanized Casing
			42					
			44					
			46					
Sand, fine to medium grained (60%); Gravel, fine (40%). Gray, moderately sorted, medium dense, dry			48					
			50	1.5'			5,6,8,8	
DIAMICTON: Silt with trace Clay. Gray, stiff, dry			52					
			54					
			56					
			58					
SAND: Sand, medium to fine grained (80%); Gravel, fine (10%); trace Silt. Gray, moderately sorted, loose, wet			60	1.2'			2,2,5,4	
			62					
Interbedded Clay, Silt, Sand, Cobbles from 63-67'			64					
			66					
			68					
SILTY SAND: Sand, fine to coarse grained (70%); Silt (20%); trace Clay (10%). Grayish brown, poorly sorted, loose, wet			70	2'			4,5,5,4	Simulprobe sample 59-60.5' (<1 ug/L)
			72					
			74					



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# BOREHOLE LOG

BORING/WELL ID: MW-87D

TOTAL DEPTH (ft.): 300'

PROJECT: Pall Life Sciences Inc.

SITE LOCATION: Ann Arbor, Michigan

PROJECT NO.: F96502

PROJECT MANAGER: James W. Brode, Jr., C.P.G.

LOGGED BY: Todd C. Campbell

START DATE: 4-14-03

END DATE: 4-22-03

TOC ELEV.: 927.34' AMSL

GROUND ELEV.: App. 928' AMSL

STATIC WATER LVL.: 66.81' btoc

DRILLING CO.: Stearns Drilling

DRILLER: Dennis, John, Duane

RIG TYPE: CME 95

METHOD OF DRILLING: Hollow Stem Auger

SAMPLING METHODS: Split Spoon, Simulprobe

NOTES: Maple Village Shopping Center, West of Maple Road  
Field GPS Coordinates (N42.28150, W083.78072), Acc. 20'

Static Water Level

Page 2 of 4

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
SAND AND GRAVEL: Sand, coarse to fine grained (70%); Gravel, fine to coarse (30%). Grayish brown, poorly sorted, loose, wet			76 78 80	1.2'			3,4,5,3	2" Galvanized Casing  Simulprobe sample 79-80.5' (1,355 ug/L)
Sand, coarse to fine grained (70%); Gravel, fine to coarse (30%). Grayish brown, poorly sorted, loose, wet			82 84 86 88 90	0.6'			85,74	Simulprobe sample 89-90' (749 ug/L)
Sand, coarse to fine grained (70%); Gravel, fine to coarse (30%). Grayish brown, poorly sorted, loose, wet			92 94 96 98 100	0'			64,120	Bentonite Grout  Simulprobe sample 99-100' (564 ug/L)
DIAMICTON: Driller notes Clay			102 104 106 108					Bentonite Grout
SAND: Sand, fine grained with interbedded Silt. Grayish brown, well sorted, dense, wet			110	1.5'			5,10,19,20	Simulprobe sample 109-110.5' (479 ug/L)
Silt/Clay with fine Gravel (based on driller's comments)			112 114 116 118 120	2'			18,40,95	Simulprobe sample 119-120.5' (154 ug/L)
Sand, fine to coarse grained; trace Silt. Grayish brown, moderately sorted, very dense, wet			122 124 126 128 130	0.4'			19,24,60	Simulprobe sample 129-130.5' (614 ug/L)
Driller notes interbedded Clays/Silts			132 134 136 138 140	0'			30,80	#6 Sand Pack 2" Stainless Steel Screen (10 Slot)  Simulprobe sample 139-140.5' (913 ug/L)
Infer Gravel/Sand			142					
DIAMICTON: Silt with Sand, fine to medium grained (30%); trace Clay (10%); trace fine Gravel. Grayish brown, hard, dry			144 146 148 150	0.5'			45,100	



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## BOREHOLE LOG

CORING/WELL ID: MW-87D

TOTAL DEPTH (ft.): 300'

PROJECT: Pall Life Sciences Inc.

SITE LOCATION: Ann Arbor, Michigan

PROJECT NO.: F96502

PROJECT MANAGER: James W. Brode, Jr., C.P.G.

LOGGED BY: Todd C. Campbell

START DATE: 4-14-03

END DATE: 4-22-03

TOC ELEV.: 927.34' AMSL

GROUND ELEV.: App. 928' AMSL

STATIC WATER LVL.: 66.81' btoc

DRILLING CO.: Stearns Drilling

DRILLER: Dennis, John, Duane

RIG TYPE: CME 95

METHOD OF DRILLING: Hollow Stem Auger

SAMPLING METHODS: Split Spoon, Simulprobe

NOTES: Maple Village Shopping Center, West of Maple Road  
Field GPS Coordinates (N42.28150, W083.78072), Acc. 20'

Static Water Level

Page 3 of 4

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
Silt with Sand, fine to medium grained (30%); trace Clay (10%); trace fine Gravel. Grayish brown, hard, dry			152 154 156 158 160 162 164 166 168				28,40,58	
Clay/Silt with Sand, fine grained; trace Gravel, fine. Grayish brown, hard, dry			170 172 174 176 178				16,32,35	
Clay/Silt with Sand, fine grained; trace Gravel, fine. Grayish brown, hard, dry			180 182 184 186 188				15,24,30, 32	
Clay/Silt with Sand, fine grained; trace Gravel, fine. Grayish brown, hard, dry			190 192 194 196 198				9,18,20,21	
Silt with trace Sand, fine grained; trace Clay. Grayish brown, hard, dry			200 202 204 206 208				9,13,19	
Clay/Silt with Sand, fine grained; trace Gravel, fine. Grayish brown, hard, dry			210 212 214 216 218				10,17,20	
Silt with Sand, fine grained; trace Gravel, fine; trace Clay. Grayish brown, moderately sorted, hard, dry			220 222 224				20,58,50 (2")	
Sand Lens at 211' (few inches thick)								
Silt with trace Clay. Grayish brown, moist								



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## BOREHOLE LOG

BORING/WELL ID: MW-87D

TOTAL DEPTH (ft.): 300'

**PROJECT:** Pail Life Sciences Inc.

**SITE LOCATION:** Ann Arbor, Michigan

**PROJECT NO.:** F96502

**PROJECT MANAGER:** James W. Brode, Jr., C.P.G.

**LOGGED BY:** Todd C. Campbell

**START DATE:** 4-14-03

**END DATE:** 4-22-03

**TOC ELEV.:** 927.34' AMSL

**GROUND ELEV.:** App. 928' AMSL

**STATIC WATER LVL.:** 66.81' btoc

**DRILLING CO.:** Stearns Drilling

**DRILLER:** Dennis, John, Duane

**RIG TYPE:** CME 95

**METHOD OF DRILLING:** Hollow Stem Auger

**SAMPLING METHODS:** Split Spoon, Simulprobe

**NOTES:** Maple Village Shopping Center, West of Maple Road  
Field GPS Coordinates (N42.28150, W083.78072), Acc. 20'

Static Water Level

Page 4 of 4

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
Driller notes Gravels/Cobbles in Clay Silt with trace Clay; Gravel, fine (<10%). Grayish brown, hard, dry			226 228 230 232 234 236 238				31,50 (1")	
Silt with trace Clay; Gravel, fine (<10%). Grayish brown, hard, dry			240 242 244 246 248	0.1'			120	
Silt with trace Clay; Gravel, fine (<10%). Grayish brown, hard, dry			250 252 254 256 258	0.5'			60, 50 (1")	
Silt with trace Clay; Gravel, fine (20%). Grayish brown, hard, dry			260 262 264 266 268	0.3'			100 (3")	
Sandy Silt with Gravel in shoe. Grayish brown, dry			270 272 274 276 278	0.4'			75,50 (1")	
Silt (50%); Sand, fine to medium grained (30%); Clay; Gravel, fine. Grayish brown, hard, dry			280 282 284 286 288	0.2'			150 (2")	
Clay; trace Gravel, fine; Sand, fine to medium grained. Bluish gray, hard, dry			290 292 294 296 298	0.1'			100 (1")	
SHALE: Shale, platy. Bluish gray, hard, dry			300	0.1'			50 (<1")	



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# REHOLE LOG

BORING/WELL ID: MW-88  
TOTAL DEPTH (ft.): 280'

**PROJECT:** Pall Life Sciences Inc.  
**SITE LOCATION:** Ann Arbor, Michigan  
**PROJECT NO.:** F96502  
**PROJECT MANAGER:** James W. Brode, Jr., C.P.G.  
**LOGGED BY:** Todd C. Campbell

**START DATE:** 4-23-03  
**END DATE:** 4-30-03  
**TOC ELEV.:** 920.74' AMSL  
**GROUND ELEV.:** App. 921' AMSL  
**STATIC WATER LVL.:** 51.20' btoc

**DRILLING CO.:** Stearns Drilling  
**DRILLER:** Dennis, John, Duane  
**RIG TYPE:** CME 95  
**METHOD OF DRILLING:** Hollow Stem Auger  
**SAMPLING METHODS:** Split Spoon, Simulprobe

**NOTES:** Maple Village Shopping Center, West of Maple Road  
Field GPS Coordinates (N42.28447, W083.78083), Acc. 25'

Static Water Level Page 1 of 4

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
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ASPHALT: Asphalt			0					
SANDY CLAY TO CLAYEY SAND: Clay with Sand, fine to coarse grained; Silt. Brown, very stiff, dry			2					Flush Mount Cover Sand Pack
			4					
			6					
			8					
			10	1.3'		4,10,14,12		Boring sealed with bentonite, moved approx. 10' South to set well
			12					
			14					
			16					
			18					
SAND: Sand, medium to fine grained with trace Gravel, fine. Brown, well sorted, medium dense, dry			20	1.5'		5,11,13,14		Bentonite Grout
			22					
			24					
			26					
Sand, fine to coarse grained (80%); Gravel, fine (20%). Brown, moderately sorted, medium dense, dry			28					
			30	0.9'		5,11,14,15		2" Galvanized Casing
			32					
DIAMICTON: Silt; Sand, fine grained. Brown, hard, moist			34					
			36					
			38					
			40	1.4'		8,16,17,10		
			42					
			44					
SAND: Sand, coarse to fine grained; Gravel, fine. Grayish brown, moderately sorted, medium dense, wet			46					
			48					
			50	1.3'		2,5,11,13		Simulprobe sample 49-50.5' (<1 ug/L)
			52					
			54					
			56					
			58					
Sand, coarse to fine grained; Gravel, fine. Grayish brown, moderately sorted, medium dense, wet			60	0.4		4,7,15		Simulprobe sample 59-60.5' (<1 ug/L)
			62					
			64					
			66					
			68					
As above, increasing Gravel			70	0.2'		12,17,30		Simulprobe sample 69-70.5' (<1 ug/L)
			72					
			74					



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# REHOLE LOG

BORING/WELL ID: MW-88  
TOTAL DEPTH (ft.): 280'

**PROJECT:** Pall Life Sciences Inc.  
**SITE LOCATION:** Ann Arbor, Michigan  
**PROJECT NO.:** F96502  
**PROJECT MANAGER:** James W. Brode, Jr., C.P.G.  
**LOGGED BY:** Todd C. Campbell

**START DATE:** 4-23-03  
**END DATE:** 4-30-03  
**TOC ELEV.:** 920.74' AMSL  
**GROUND ELEV.:** App. 921' AMSL  
**STATIC WATER LVL.:** 51.20' btoc

**DRILLING CO.:** Stearns Drilling  
**DRILLER:** Dennis, John, Duane  
**RIG TYPE:** CME 95  
**METHOD OF DRILLING:** Hollow Stem Auger  
**SAMPLING METHODS:** Split Spoon, Simulprobe

**NOTES:** Maple Village Shopping Center, West of Maple Road  
Field GPS Coordinates (N42.28447, W083.78083), Acc. 25'

Static Water Level Page 2 of 4

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
			76					2" Galvanized Casing
DIAMICTON: Silty Clay with Sand, fine to coarse grained. Grayish brown, hard, dry			78					
			80	0.3'			5,11,30,32	
SAND: Sand, based on driller's comments			82					
			84					
DIAMICTON: Silty Clay with Sand, fine to coarse grained. Grayish brown, hard, dry			86					
			88					
			90	0.2'			9,12,15,27	
SAND: Sand, based on driller's comments			92					
			94					
DIAMICTON: Driller notes Clay			96					Bentonite Grout
SAND AND GRAVEL: Sand, fine to coarse grained; Gravel, fine to coarse. Grayish brown, poorly sorted, dense, wet			98					
			100	0.9'			18,22,27,37	Simulprobe sample 99-100.5' (20 ug/L)
			102					
			104					
			106					Bentonite Grout
			108					
DIAMICTON: Clay; Silt; Sand, fine to medium grained. Grayish brown, hard, dry			110	0.4'			30,60,50 (2")	Simulprobe sample 109-110.5' (66 ug/L)
SAND: Sand, based on driller's comments			112					
			114					
			116					
			118					
Sand, medium to fine grained. Grayish brown, wet. Silt stringers throughout (approximately 2" thick)			120	1.9'			3,7,15,18	Simulprobe sample 119-120.5' (2 ug/L)
			122					
			124					
			126					
			128					
Sand, medium to fine grained (100%). Grayish brown, well sorted, wet			130	0.8'			8,13,26	Simulprobe sample 129-130.5' (344 ug/L)
			132					
			134					
			136					
			138					
SAND AND GRAVEL: Infer Sand and Gravel from bailer			140	0'			17,35,37	Simulprobe sample 139-140.5' (37 ug/L)
			142					
			144					#6 Sand Pack
			146					
			148					2" Stainless Steel Screen (10 Slot)
Large rock in Simulprobe sampler; infer Sand and Gravel			150	0.1'			23,48,55	



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# REHOLE LOG

BORING/WELL ID: MW-88  
TOTAL DEPTH (ft.): 280'

**PROJECT:** Pall Life Sciences Inc.  
**SITE LOCATION:** Ann Arbor, Michigan  
**PROJECT NO.:** F96502  
**PROJECT MANAGER:** James W. Brode, Jr., C.P.G.  
**LOGGED BY:** Todd C. Campbell

**START DATE:** 4-23-03  
**END DATE:** 4-30-03  
**TOC ELEV.:** 920.74' AMSL  
**GROUND ELEV.:** App. 921' AMSL  
**STATIC WATER LVL.:** 51.20' btoc

**DRILLING CO.:** Stearns Drilling  
**DRILLER:** Dennis, John, Duane  
**RIG TYPE:** CME 95  
**METHOD OF DRILLING:** Hollow Stem Auger  
**SAMPLING METHODS:** Split Spoon, Simulprobe

**NOTES:** Maple Village Shopping Center, West of Maple Road  
Field GPS Coordinates (N42.28447, W083.78083), Acc. 25'

Static Water Level Page 3 of 4

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
			152					Simulprobe sample 149-150.5' (973 ug/L)
			154					
			156					
			158					
DIAMICTON: Silt (50%); Sand, fine to medium; Gravel, fine; Clay. Grayish brown, hard, dry			160	0.8'			55,50 (2")	
			162					
			164					
			166					
			168					
Silt with Sand, fine to medium grained; Gravel, fine; Clay. Grayish brown, hard, dry			170	0.5'			105	
			172					
			174					
			176					
			178					
Clay/Silt with Sand, fine to medium grained; Gravel, fine. Grayish brown, hard, dry			180	2'			10,25,60	
			182					
			184					
			186					
			188					
Gravel/Cobbles in Clay			190	0'			100	
			192					
SAND: Sand, coarse to fine grained (95%); Gravel, fine (5%). Grayish brown, moderately sorted, very dense, wet			194					Simulprobe sample 194-195.5' (26 ug/L)
			196	1'			36,80	
			198					
			200					
			202					
Rock in Shoe			204					Simulprobe sample 204-204.5' (14 ug/L)
			206	0'			175	
			208					
			210					
DIAMICTON: Clay with Silt; Sand, fine to medium grained; trace Gravel, fine. Gray, hard, dry			212					
			214					
			216	0.8'			10,34,75	
			218					
SAND AND GRAVEL: Sand, fine to coarse grained; Gravel, fine grained. Gray, moderately sorted, very dense, wet			220	0.5'			26,65,72	Simulprobe sample 219-220' (water too muddy to analyze)
DIAMICTON: Driller notes Clay			222					
			224					



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# REHOLE LOG

BORING/WELL ID: MW-88  
TOTAL DEPTH (ft.): 280'

PROJECT: Pall Life Sciences Inc.  
SITE LOCATION: Ann Arbor, Michigan  
PROJECT NO.: F96502  
PROJECT MANAGER: James W. Brode, Jr., C.P.G.  
LOGGED BY: Todd C. Campbell

START DATE: 4-23-03  
END DATE: 4-30-03  
TOC ELEV.: 920.74' AMSL  
GROUND ELEV.: App. 921' AMSL  
STATIC WATER LVL.: 51.20' btoc

DRILLING CO.: Stearns Drilling  
DRILLER: Dennis, John, Duane  
RIG TYPE: CME 95  
METHOD OF DRILLING: Hollow Stem Auger  
SAMPLING METHODS: Split Spoon, Simulprobe

NOTES: Maple Village Shopping Center, West of Maple Road  
Field GPS Coordinates (N42.28447, W083.78083), Acc. 25'

Static Water Level Page 4 of 4

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
Silt with Sand, fine grained. Grayish brown, hard, dry			226 228 230 232 234 236 238				10,20,67	
Silt with Sand, fine to medium grained; trace Gravel, fine. Grayish brown, hard, dry			240 242 244 246 248	0.3'			100 (5")	
Silt with Sand, fine to medium grained; trace Gravel, fine. Grayish brown, hard, dry			250 252 254 256 258	0.3'			100 (4")	
Silt with Sand, fine to medium grained; trace Gravel, fine. Grayish brown, hard, dry			260 262 264 266 268	0.8'			20,100 (5")	
Silt with Sand, fine to medium grained; trace Gravel, fine. Grayish brown, hard, dry			270 272 274 276	0.3'			120 (4")	
SHALE: Shale, platy. Gray, hard, dry			276 278 280	0.5'			28, 130	



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# REHOLE LOG

BORING/WELL ID: MV East Boring

TOTAL DEPTH (ft.): 149'

PROJECT: Pall Life Sciences Inc.  
SITE LOCATION: Ann Arbor, Michigan  
PROJECT NO.: F96502  
PROJECT MANAGER: James W. Brode, Jr., C.P.G.  
LOGGED BY: Todd C. Campbell

START DATE: 7-28-03  
END DATE: 7-30-03  
TOC ELEV.:  
GROUND ELEV.:  
STATIC WATER LVL.:

DRILLING CO.: Stearns Drilling  
DRILLER: John, Ryan, Nick  
RIG TYPE: CME 1050  
METHOD OF DRILLING: Hollow Stem Auger  
SAMPLING METHODS: Split Spoon, Simulprobe

NOTES: Maple Village Shopping Center, East of National City  
North of MW-87

Static Water Level Page 1 of 2

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sampler/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
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ASPHALT			0					
SAND AND GRAVEL: Sand and Gravel Fill			2					
CLAYEY SAND: Sand, fine to medium grained; Clay; Gravel, fine. Brown, dry			4					
			6					
			8					
SANDY CLAY TO CLAYEY SAND: Sand, fine grained; Silt: Clay; trace Gravel, fine. Brown, very stiff, dry			10	1'		4,7,11,12		
			12					
			14					
			16					
Clay; Silt; Sand, fine to medium grained (10-20%). Gray, medium stiff, dry			18					
			20	2'		4,4,4,6		
			22					
SILTY SAND: Sand, fine grained (60%); Silt. Brown, well sorted, medium dense, moist			24					
			26					
Sand, fine grained (60%); Silt. Brown, well sorted, medium dense, moist			28					
			30	1.5'		3,6,7,6		
			32					
			34					
Sand, fine grained (60%); Silt. Brown, well sorted, medium dense, moist			36					
Silt Lens. Gray, moist			38					
			40	1.5'		8,19,16,10		
			42					
			44					
			46					
SAND: Sand, medium to fine grained. Brown, well sorted, medium dense, moist			48					
			50	1.7'		3,6,9,9		
			52					
Interbedded Sand and Silty Sand			54					
			56					
			58					
Sand, fine to coarse grained. Grayish brown, well sorted, loose, wet			60	1'		1,2,2,3		
			62					
			64					
			66					
DIAMICTON: Silt; Sand, fine to medium grained (30%); Clay. Grayish brown, medium stiff, moist			68					
			70	2'		3,4,4,6		
			72					
			74					

Boring Sealed with Bentonite Grout from 0-103' BGS  
Natural Collapse from 103' to total depth of boring

Simulprobe sample 59-60.5' (<1 ug/L)

## DRYHOLE LOG

BORING/WELL ID: MV East Boring

TOTAL DEPTH (ft.): 149'

PROJECT: Pall Life Sciences Inc.

**SITE LOCATION:** Ann Arbor, Michigan

PROJECT NO.: F96502

**PROJECT MANAGER:** James W. Brode, Jr., C.P.G.

LOGGED BY: Todd C. Campbell

START DATE: 7-28-03

END DATE: 7-30-03

TOC ELEV.:

GROUND ELEV.: \_\_\_\_\_

STATIC WATER LVL.:

**DRILLING CO.:** Stearns Drilling

DRILLER: John, Ryan, Nick

RIG TYPE: CME 1050

**METHOD OF DRILLING:** Hollow Stem Auger

**SAMPLING METHODS:** Split Spoon, Simulprobe

**NOTES:** Maple Village Shopping Center, East of National City  
North of MW-87

▼ Static Water Level

Page 2 of 2

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
Clay; Silt; Sand, fine grained (10%). Grayish brown, medium stiff, dry			76 78 80 82 84 86 88					
SAND: Sand, fine to coarse grained (100%). Grayish brown, moderately sorted, loose, wet Interbedded Silt and Sand (based on driller's comments)			90 92 94 96 98	1.7'			0,3,4,5	
Driller notes Sand			100 102 104	1'			2,2,1,5	Simulprobe sample 89-90.5' (<1 ug/L)
DIAMICTON: Clay; Sand, fine to medium grained (20%); trace Gravel, fine; Silt. Grayish brown, soft, dry			106 108 110 112 114 116 118	1.3'			0,2,2,4	
GRAVEL: Gravel, fine to coarse grained (75%); Sand, coarse to fine grained. Grayish brown, poorly sorted, loose, wet			120 122 124 126 128 130 132 134 136 138 140 142 144 146 148	0.3'			0,3,3,4	Simulprobe sample 109-110.5' (402 ug/L)
DIAMICTON: Clay; Silt; Sand, fine to medium grained (10%). Grayish brown, dry				2'			NA	
SAND: Sand, coarse to fine grained (70%); Gravel, fine (20%); Silt. Grayish brown, poorly sorted, loose, wet Sand, medium to fine grained with trace coarse grained; Gravel, fine (10%). Grayish brown, moderately sorted, medium dense, wet Sand, medium to fine grained; trace Gravel, fine. Grayish brown, well sorted, medium dense, wet				0.3'			1,1,2,3	Simulprobe sample 119-120.5' (77 ug/L)
				1.3'			7,12,14,20	
				1.2'			3,9,9,33	
				0'			8,38,84	Simulprobe sample 129-130.5' (856 ug/L)
Sand, medium to fine grained (100%). Grayish brown, well sorted, very dense, wet				2'			21,34,75 (3")	
				2'			4,4,6,4	
GRAVEL AND SAND: Gravel, fine (60%); Sand, coarse to fine grained (40%). Grayish brown, moderately sorted, very dense, wet Sand, fine to coarse grained (50%); Gravel, fine (50%). Grayish brown, moderately sorted, very dense, wet				0'			10,17,38	Simulprobe sample 139-140.5' (721 ug/L)
DIAMICTON: Silt; Sand, fine to medium grained. Grayish brown, hard, dry				1.2'			5,12,38,49	



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## B REHOLE LOG

BORING/WELL ID: MV West Boring

TOTAL DEPTH (ft.): 227'

**PROJECT:** Pall Life Sciences Inc.

**SITE LOCATION:** Ann Arbor, Michigan

**PROJECT NO.:** F96502

**PROJECT MANAGER:** James W. Brode, Jr., C.P.G.

**LOGGED BY:** Todd C. Campbell

**START DATE:** 7-7-03

**END DATE:** 7-11-03

**TOC ELEV.:** NA

**GROUND ELEV.:** App. 927' AMSL

**STATIC WATER LVL.:** App. 53'

**DRILLING CO.:** Stearns Drilling

**DRILLER:** John, Rich, Duane

**RIG TYPE:** CME 1050

**METHOD OF DRILLING:** Hollow Stem Auger

**SAMPLING METHODS:** Split Spoon, Simulprobe

**NOTES:** Maple Village Shopping Center, West side of KMart  
Field GPS Coordinates (N42.28321, W083.78405), Acc. 55'

▼ Static Water Level

Page 1 of 4

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
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ASPHALT			0					
SAND: Sand, fine to medium grained; trace Silt. Brown, well sorted, dry			2					
CLAYEY SAND: Sand, medium to fine grained; Clay. Grayish brown, moderately sorted, dry			4					
			6					
Sand, fine to coarse grained; Silt; Clay; Gravel, fine (10%). Brown, moist			8					
			10	1.1'		1,1,1,2		
			12					
			14					
			16					
Sand, fine to coarse grained; Silt; Clay; Gravel, fine (10%). Brown, wet			18					
DIAMICTON: Silt; Clay; Sand, fine to medium grained; trace Gravel, fine; Rock fragments. Gray, very stiff, dry			20	1.8'		5,10,10,9		
			22					
			24					
			26					
			28					
SAND: Sand, coarse to fine grained; Gravel, fine. Brown, poorly sorted, dense, wet			30	0.3'		10,14,17,21		
			32					
			34					
			36					
SILTY SAND: Sand, fine grained; Silt. Grayish brown, well sorted, very dense, dry			38					
			40	1.5'		10,21,31,34		
Interbedded Sand and Silty Sand			42					
			44					
			46					
			48					
			50	1.8'		8,11,24,24		
SAND: Sand, fine to medium grained. Gray, well sorted, dense, dry			52					
			54					
			56					



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## REHOLE LOG

BORING/WELL ID: MV West Boring

TOTAL DEPTH (ft.): 227'

**PROJECT:** Pall Life Sciences Inc.

**SITE LOCATION:** Ann Arbor, Michigan

**PROJECT NO.:** F96502

**PROJECT MANAGER:** James W. Brode, Jr., C.P.G.

**LOGGED BY:** Todd C. Campbell

**START DATE:** 7-7-03

**END DATE:** 7-11-03

**TOC ELEV.:** NA

**GROUND ELEV.:** App. 927' AMSL

**STATIC WATER LVL.:** App. 53'

**DRILLING CO.:** Stearns Drilling

**DRILLER:** John, Rich, Duane

**RIG TYPE:** CME 1050

**METHOD OF DRILLING:** Hollow Stem Auger

**SAMPLING METHODS:** Split Spoon, Simulprobe

**NOTES:** Maple Village Shopping Center, West side of KMart  
Field GPS Coordinates (N42.28321, W083.78405), Acc. 55'

Static Water Level

Page 2 of 4

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
Sand, coarse to fine grained; Gravel, fine (10%). Grayish brown, moderately sorted, medium dense, wet			58					
			60	1'			8,10,10,9	
			62					
			64	1'			10,14,14,15	
			66					
			68					
SAND AND GRAVEL: Sand, coarse to fine grained; Gravel, fine (20%). Grayish brown, moderately sorted, medium dense, wet			70	1.5'			16,19,25	
			72					
			74	1.3'			12,17,17,21	
			76					
			78					
			80	0'			10,21,34	
			82					
Sand, fine to coarse grained; Gravel, fine (10-20%); trace Silt. Grayish brown, moderately sorted, dense, wet			84	1'			14,19,24,32	
			86					
			88					
Sand, coarse to fine grained; Gravel, fine (20%); trace Silt. Grayish brown, moderately sorted, medium dense, wet			90	1.5'			4,7,11	
			92					
DIAMICTON: Clay; Silt; Sand, fine to coarse grained. Grayish brown, very stiff, dry			94	1'			4,9,13,15	
			96					
			98					
Interbedded Silt, Clay, Sand to 104'			100	1.9'			3,9,9,12	
			102					
Clay; Silt; Sand, fine to coarse grained. Grayish brown, very stiff, dry			104	2'			5,12,24,30	
			106					
			108					
			110	2'			1,2,2,3	
			112					
Driller notes softer drilling			114					
Clay; Silt; Sand, fine to coarse grained. Grayish brown, very stiff, dry								



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## E REHOLE LOG

BORING/WELL ID: MV West Boring

TOTAL DEPTH (ft.): 227'

**PROJECT:** Pall Life Sciences Inc.

**SITE LOCATION:** Ann Arbor, Michigan

**PROJECT NO.:** F96502

**PROJECT MANAGER:** James W. Brode, Jr., C.P.G.

**LOGGED BY:** Todd C. Campbell

**START DATE:** 7-7-03

**END DATE:** 7-11-03

**TOC ELEV.:** NA

**GROUND ELEV.:** App. 927' AMSL

**STATIC WATER LVL.:** App. 53'

**DRILLING CO.:** Stearns Drilling

**DRILLER:** John, Rich, Duane

**RIG TYPE:** CME 1050

**METHOD OF DRILLING:** Hollow Stem Auger

**SAMPLING METHODS:** Split Spoon, Simulprobe

**NOTES:** Maple Village Shopping Center, West side of KMart  
Field GPS Coordinates (N42.28321, W083.78405), Acc. 55'

Static Water Level

Page 3 of 4

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
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SAND AND GRAVEL: Sand, coarse grained; Gravel, fine. Grayish brown, very dense, wet			116	1'		1,4,9,9		
			118					
			120	2'		10,19,32, 50 (4")		
DIAMICTON: Silt; Sand, fine to coarse grained; trace Gravel, fine. Grayish brown, hard, dry			122					
			124					
			126					
			128					
GRAVEL AND SAND: Gravel, fine to coarse grained (rock fragments); Sand, coarse to fine grained. Grayish brown, poorly sorted, very dense, wet			130	1'		7,14,34, 50 (3")		
			132					
			134					
			136	1.3'		24,30,36, 40		
			138					
Gravel, fine to coarse grained (rock fragments); Sand, coarse to fine grained. Grayish brown, poorly sorted, very dense, wet			140	0.1'		10,14,16		
			142					
			144					
Sand, coarse to medium grained with trace fine grained; Gravel, fine to coarse grained. Grayish brown, poorly sorted, very dense, wet			146	0'		18,20,30, 34		
			148					
			150	0'		21,37,41		
			152					
Driller notes Cobbles throughout.			154	0'		9,47,50 (3")		
			156					
			158					
Sand, coarse to fine grained; Gravel, fine to coarse. Grayish brown, poorly sorted, very dense, wet			160	1'		52,110,84		
Driller notes Cobbles throughout			162					
			164	0'		60,100 (4")		
			166	0.6'		18,44,60, 60 (3")		
			168	0'		7,14,21,30		
			170	1'		31,120,75 (3")		
			172					



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## REHOLE LOG

BORING/WELL ID: MV West Boring

TOTAL DEPTH (ft.): 227'

**PROJECT:** Pall Life Sciences Inc.

**SITE LOCATION:** Ann Arbor, Michigan

**PROJECT NO.:** F96502

**PROJECT MANAGER:** James W. Brode, Jr., C.P.G.

**LOGGED BY:** Todd C. Campbell

**START DATE:** 7-7-03

**END DATE:** 7-11-03

**TOC ELEV.:** NA

**GROUND ELEV.:** App. 927' AMSL

**STATIC WATER LVL.:** App. 53'

**DRILLING CO.:** Stearns Drilling

**DRILLER:** John, Rich, Duane

**RIG TYPE:** CME 1050

**METHOD OF DRILLING:** Hollow Stem Auger

**SAMPLING METHODS:** Split Spoon, Simulprobe

**NOTES:** Maple Village Shopping Center, West side of KMart  
Field GPS Coordinates (N42.28321, W083.78405), Acc. 55'

Static Water Level

Page 4 of 4

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blows Counts	WELL CONSTRUCTION DETAIL
Sand, coarse to fine grained; Gravel, fine to coarse. Grayish brown, poorly sorted, very dense, wet			172				7,18,51,40	
			174					
			176				37,49,100 (3")	
			178				21,59,94, 100 (4")	
Sand, coarse to fine grained; Gravel, fine. Grayish brown, moderately sorted, very dense, wet			180				41,129	
DIAMICTON: Silt; Sand, fine to medium grained (20%); Gravel, fine (20%). Grayish brown, hard, dry			182					
			184					
			186					
			188					
			190				27,48,75 (3")	
			192					
			194					
			196					
			198					
Silt; Sand, fine to medium grained (20%); Gravel, fine (20%). Grayish brown, hard, dry			200				21,40,100 (3")	
			202					
			204					
Sand, coarse to fine grained from approximately 204-204.5'. Grayish brown, moderately sorted, moist			206				13,76,100 (3")	
			208					
Silt; Sand, fine to medium grained (20%); Gravel, fine (20%). Grayish brown, hard, dry			210				31,47,60 (2")	
			212					
			214					
			216					
			218					
Silt; Sand, fine to medium grained (20%); Gravel, fine (20%). Grayish brown, hard, dry			220				52,100 (3")	
			222					
			224					
			226					

## Attachment 2

 SIMULATED INJECTION WELL  
 SIMULATED EXTRACTION WELL  
 E 1.4-DIOXANE CONCENTRATION CONTOUR ( $\mu\text{g/L}$ )  
 JANUARY-MARCH 2004  
 PARTICLE TRACES  
 SIMULATED GROUNDWATER CONTOUR  
 EXTRACTION WELL CAPTURE ZONE  
 INJECTION WELL ZONE OF INFLUENCE



Scale: 1" = 500'

## MODEL SIMULATED INJECTION-EXTRACTION



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**Maple Road Interim Response Action**

PROJECT NO.  
F96502  
FIGURE NO.

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## **Response to WESTON Comments on PLS Maple Road Response Action**

### **Background**

As an interim response action, Pall Life Sciences (PLS) has proposed to extract 1,4-dioxane contaminated groundwater along the longitudinal axis of the Unit E plume in an area near Maple Road. This water would be treated and injected back into the same aquifer using two injection wells. PLS has proposed an extraction rate of 200 gallons per minute and an injection rate of 200 gpm (equally shared between two wells).

Weston Solutions of Michigan, Inc. (WESTON) raised potential concerns with this plan in their July 14, 2004 letter on the Feasibility Study. The concerns raised by WESTON are that the proposed interim response action could possibly:

- Split the plume
- Push contaminated groundwater farther downgradient faster
- Slow the migration of more contaminated portions of the plume
- Extend the duration of remedial activities

### **PLS Response**

The proposed interim response in the Maple Village area can reduce the threat to drinking water supplies and to the Huron River by reducing mass in the aquifer and accelerating the rate at which the aquifer will meet target criteria.

Because water is put back into the aquifer at the same rate it is extracted, there is no net change in the flux of groundwater in the area. As such, it is wrong to assume the aquifer cannot accept water, or there will be significant changes to the plume (other than concentration reduction) as a result of the proposed interim response.

To demonstrate the general response of the groundwater-flow patterns to the proposed interim response, an analytical model was developed for the area using the model AquiferWin32 Version 3.1. The model was constructed using data from the area of the proposed interim response. Numerous borings/wells have been drilled in the Maple Village area. Water samples have been collected and analyzed, water levels have been measured, and two aquifer performances tests have been conducted in the area. Consequently, the local hydrogeological conditions are reasonably well documented and allow reasonable constraints on the model input parameters.

The model is a reasonable representation of how the aquifer will respond to the proposed interim response, even though it relies on several simplified assumptions about the hydrogeology. PLS recognizes incorporating site specific conditions, such as aquifer heterogeneities and anisotropies, into a more complicated model may provide different results than those provided in this analysis. In the end, the results of such complicated modeling efforts might show that proposed interim response is slightly more, or slightly less, effective than shown by the modeling presented. However, the overall result of incorporating the complexities of the area not expected to be much different than those presented in this analysis.

### Model Input Parameters:

Aquifer Thickness (b) = 85 feet (ft) (from boring data)

Hydraulic conductivity (K) = 2,300 gallons per day per foot squared (gpd/ft<sup>2</sup>) = 307 feet/day (ft/d)  
(from the TW-16 aquifer test)

Hydraulic gradient (  $i$  ) = 0.0022605 feet per foot (ft/ft) (measured in the Maple Road area)

Injection Rate at Injection Wells = 100 gpm each (input as -19251.3 cubic feet per day (ft<sup>3</sup>/d))

Extraction Rate at Purge Well = 200 gpm (input as 38502.7 ft<sup>3</sup>/d).

Reference head set at 871 feet near MW-72 with the groundwater flow direction set at east-southeast (angle input as -6)

Line Particle traces were set perpendicular to groundwater flow direction slightly down gradient of the reference head. Circle particle traces were set at each injection well location.

## Discussion

Figure 1 shows the particle traces during the proposed injection-extraction. Figure 1 also shows the approximate Capture Zone (CZ) for the proposed extraction well and the approximate Area of Influence (AOI) for the proposed injection wells. For reference, Unit E plume isoconcentration contours from are shown on the map. These contours are not simulated by the model, and are presented for reference to the reader.

Figure 1 shows that the model derived CZ of the proposed extraction well will effectively capture areas of high 1,4-dioxane concentrations as the contaminated groundwater moves toward the extraction well. The RI of the injection wells suggests that while some groundwater will be displaced outward from the injection zones it will not significantly affect the margins of the plumes outer boundary. This is logical since the water injected from the aquifer is being balanced by the water removed from the aquifer. Further, one might anticipate that, because the injected water is "cleaner" than the ambient groundwater into which it is injected, a resulting dilution by mixing of the injected water will provide a beneficial impact on the ultimate fate of the ambient water in the existing Unit E plume.

*Split the Plume* - WESTON suggested that the Unit E plume may be split. Concerns for splitting the plume may have partial merit, however, the model simulated capture zone of the extraction well suggests that the majority mass of the 1,4-dioxane should be confined to areas west of Maple Road. This combined with the anticipated general dilution and dispersion of 1,4-dioxane plume downgradient of the injection wells will negate potential concerns for splitting of the plume, as well as, have the affect shortening rather than prolonging the duration of remedial activities.

*Push Contaminated Groundwater Farther Downgradient Faster* - We think this concern is unfounded. This suggests an overall displacement of the ambient groundwater by the injection waters. It seems more reasonable that the similarity of the overall physical-water properties (density, viscosity, etc.) between the injection and ambient groundwater should result in a mixing rather than a displacement. Assuming that a minor displacement could occur, this affect should rapidly decrease with distance from the injection point and dilution should be the primary causal effect. This result should benefit the water quality of the groundwater as a whole while it migrates downgradient.

*Slow the Migration of More Contaminated Portions of the Plume* - We agree that this remedial action will slow the migration of more contaminated portions of the plume. We interpret this to be a positive aspect of the proposed interim response.

*Extend the duration of Remedial Activities* - There is no plausible way that extracting/treating 200 gpm of water from the Unit E plume and injecting the treated water will extend the duration of the remedial activities.