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PALL Pall Corporation

Life Sciences
600 South Wagner Road
Ann Arbor, MI 48103-9019 USA

734.665.0651 phone

April 22, 2013

Ms. Sybil Kolon
Environmental Quality Analyst
Department of Environmental Quality
Jackson State Office Building
301 E. Louis Glick Highway
Jackson, MI 49201-1556

Re: Extraction Well Flow Modifications

Dear Ms. Kolon:

Please find enclosed the Analysis of Water Level and Quality Changes after Extraction Well Flow Modifications.

Should you have any questions or concerns regarding this plan, please contact me at 734-913-6130.

Sincerely,

Farsad Fotouhi

Farsad Fotouhi
Vice President
Corporate Environmental Engineering

cc: Ms. Celeste R. Gill, MDAG
Michael Caldwell, Esq.

Gelman Sciences - Analysis of Water Level and Quality Changes after Extraction Well Flow Modifications – Prepared April 2013

Recent amendments to the Gelman Sciences Consent Judgment (CJ) allow for extraction well flow rates to be modified providing certain conditions in the CJ can be met. Consistent with the terms of the CJ, flow rates have been modified two times: May 2011 and mid-August 2012. These changes are noted below in Table 1.

Table 1 – Extraction Well Flow Rate Modifications

Extraction Well	Aquifer	System Area	Pre May 2011 (Initial) Flow Rate (gpm)	May 2011 Flow Rate (gpm)	Mid-August - 2012 Flow Rate (gpm)
LB-1	D2	Eastern	100	60	60
LB-3	D2	Eastern	40	40	40
HW-S	D2	Western	25	0	0
TW-2 (Dolph)	C3	Eastern	49	25	10
TW-3	C3	Western	0	0	0
TW-5	D2	Western	82	78	25
TW-9	D2	Western	84	60	25
TW-10	C3	Western	81	68	0
TW-11	E	Western	50	37	25
TW-14	C3	Western	88	0	
TW-17	E	Western	88	0	0
TW-18	E	Eastern (per CJ)	133	99	150
TW-19	E	Eastern	100	100	50
TW-20	C3	Western	59	50	50
TW-21	D2	Eastern (per CJ)	130	98	50
SW-Comb	SW	Western	33	34	33
PW-1	Marshy	Western	4	5	3
Total Flow (gpm)			**1146**	**752**	**521**

Note – Flow rates are approximate and may vary month to month.

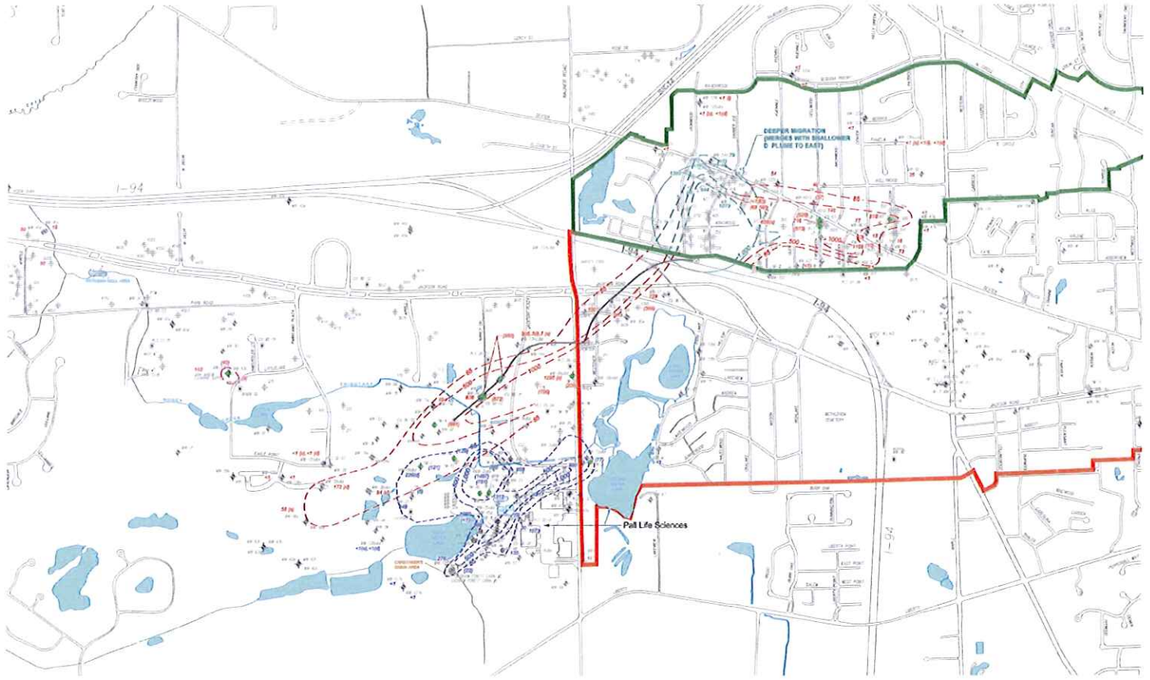
Water level and groundwater quality samples have been routinely collected to monitor changes resulting from flow modifications. This monitoring has been done in accordance with monitoring plans developed in conjunction with the Michigan Department of Environmental Quality (MDEQ).

To compare and contrast water level and water quality changes from conditions prior to flow adjustments and current, a series of drawings have been prepared. These drawings are provided in Attachment A. These drawings show maps prepared with data collected prior to flow modifications with the most recent semi-annual maps (prepared April 2013). Key changes between the two data sets have been noted on the drawings along with a summary of observations.

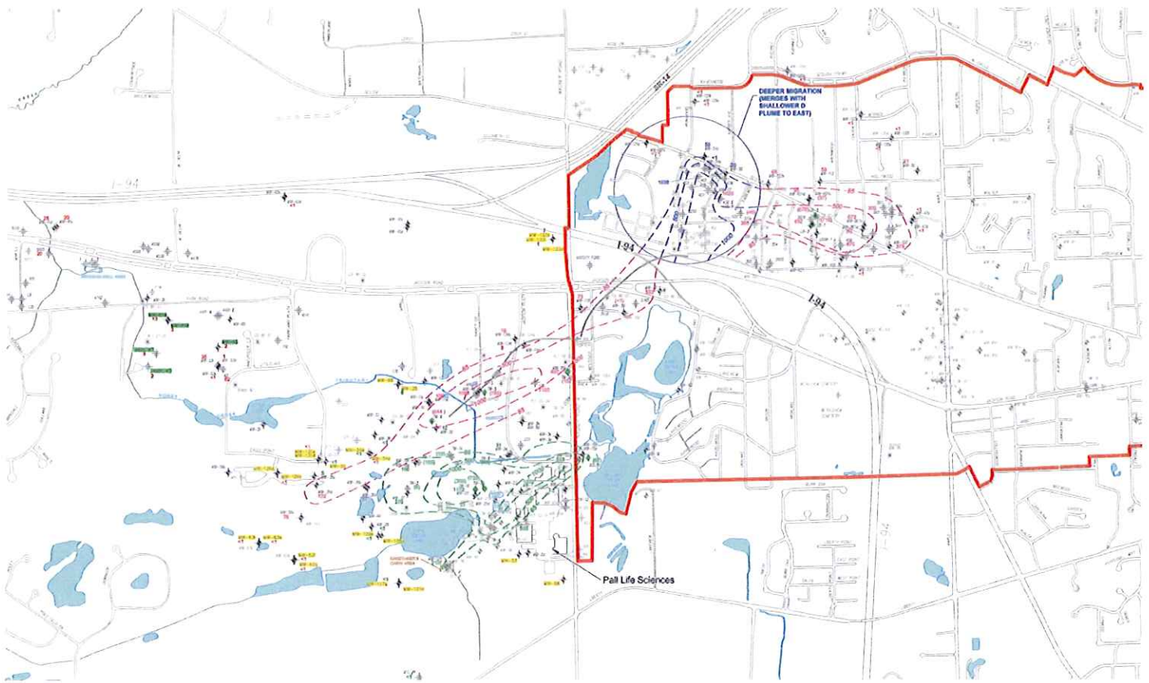
Attachment A

(Comparison Maps)

(8)0413__D0,2,C3_ISO Comp\rlckg 041213



MARCH 17, 2011 DATA



MARCH 15, 2013 DATA

NORTH

0 2000 4000

SCALE IN FEET

General Observations - C3 1,4-Dioxane Distribution and Concentrations

1. No notable changes in the overall plume configuration or extent.
2. Concentrations in the plume have generally reduced over time.

Summary of these Observations

The footprint of the C3 plume has been very stable. 1,4-Dioxane concentrations have decreased at most well locations with few exceptions. None of the data suggest an expansion of the footprint of this plume.

General Observations - D2 1,4-Dioxane Distribution and Concentrations - Western Area System

1. No notable changes in the overall plume configuration or extent.
2. Concentrations in the plume have generally reduced over time, especially in the area of TW-18.

Summary of these Observations

The D2 plume in the Western System continues to decay. Extraction at TW-18 significantly reduced the core concentrations of this portion of the plume. MW-118 has fallen to below 85 ug/L, shrinking the border of the plume in that area. None of the data suggests and expansion of the footprint of this plume.

General Observations - D2 1,4-Dioxane Distribution and Concentrations - Eastern Area System

1. There has been a slight broadening of the plume in along its northern border in the Evergreen Subdivision area. The plume has continued to migrate as expected and remains well within the Prohibition Zone boundary along its eastern border in the Evergreen area.
2. Concentrations within the plume have generally reduced over time with the notable exceptions being the areas where the plume is advancing.

Summary of these Observations

1,4-Dioxane levels in the Evergreen area are generally declining except where the plume has broadened slightly to the north and in the area of MW-107. 1,4-Dioxane concentrations at 465 Dupont and MW-77 continue to increase with 465 showing some leveling off. These trends reflect the migration a deeper front of 1,4-dioxane that has migrated into the Evergreen area later than the initial wave that migrated earlier into the LB area. Data continue to support this deeper 1,4-dioxane migration eastward from the Dupont area toward the LB extraction wells, well within the Prohibition Zone boundary.

General Observations - D0 1,4-Dioxane Distribution and Concentrations - Little Lake System

1. 1,4-Dioxane in the Little Lake System Area have continued to decline. There are currently no locations where 85 ug/L is exceeded.

Summary of these Observations

The data continue to support the remaining plume in the Little Lake System is a decaying and not connected to the contamination in the Western Area System.

NOTES:
MAP COMBINES WELLS COMPLETED AT MULTIPLE DEPTHS. INTERPRETATION OF THIS MAP REQUIRES FAMILIARITY WITH THE GEOLOGY AND OF THE GROUNDWATER FLOW REGIME.

POTENTIOMETRIC SURFACE ELEVATION DATA IS MEASURED IN FEET NAVD88.

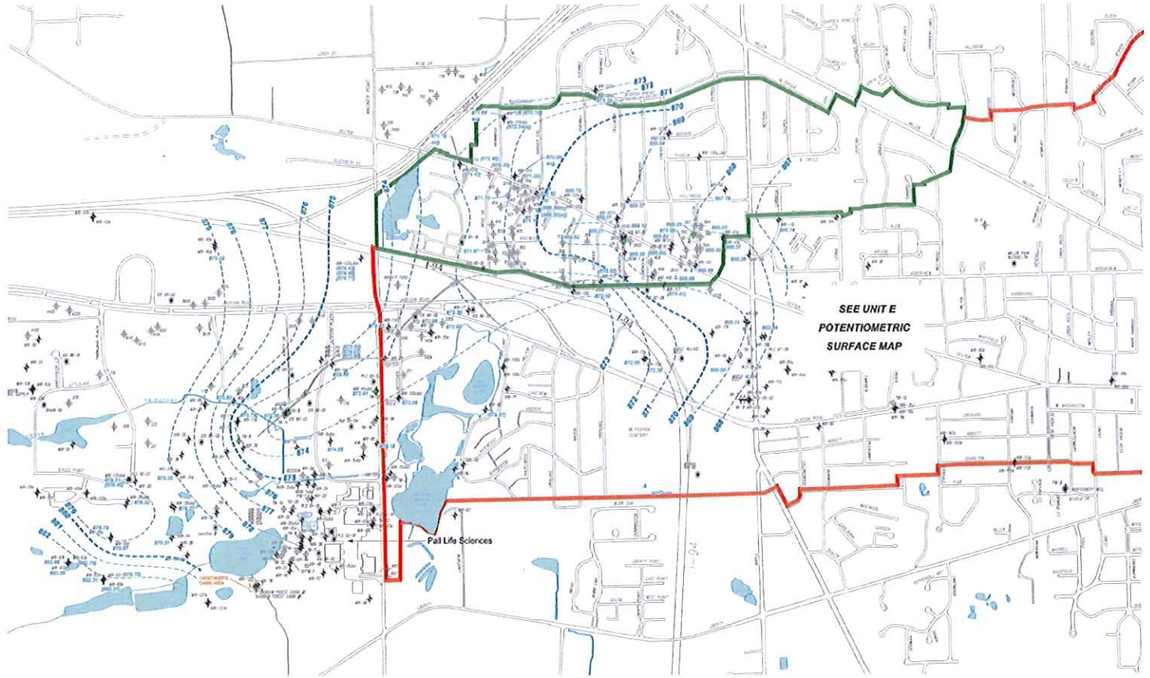
PALL LIFE SCIENCES
WASHTENAW COUNTY, MICHIGAN

ISOCONCENTRATION MAP COMPARISON
UNITS C_3, D_0, D_2 & SW
MARCH 17, 2011 TO MARCH 15, 2013

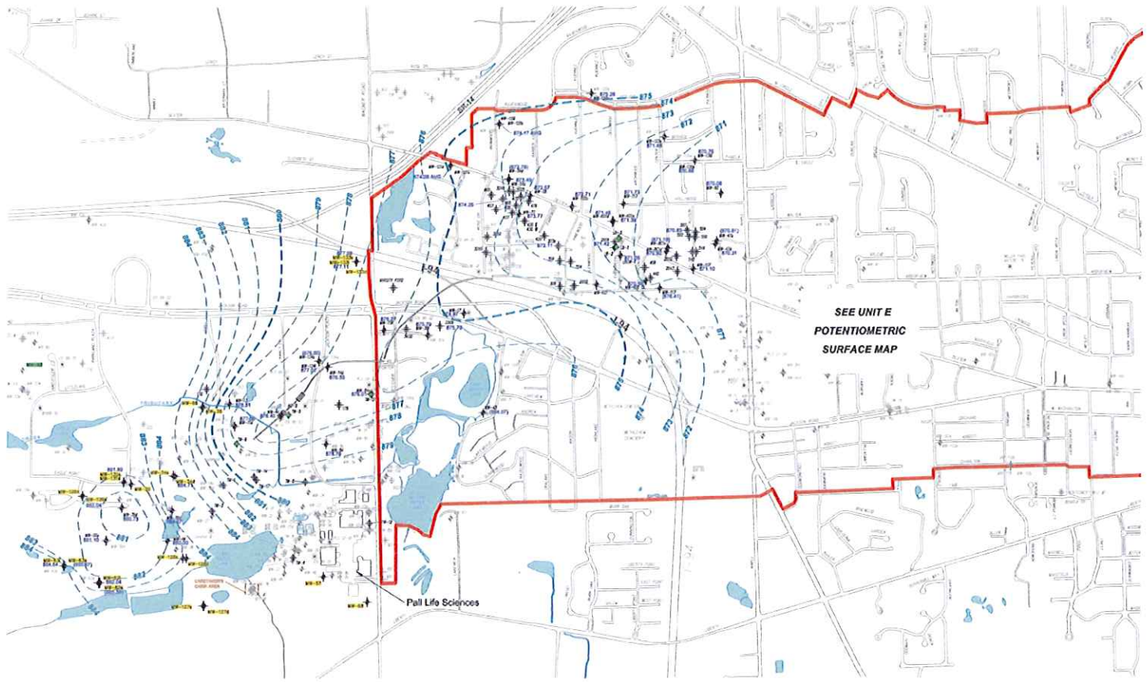
2013 SHEET 1 OF 1 806500

FLEIS & VANDENBRINK ENGINEERING, INC.

(8)0413_D2 & E_PSC Comp\rlckg 040813



MARCH 17, 2011 DATA



MARCH 15, 2013 DATA

NORTH

0 2000 4000

SCALE IN FEET

General Observations - D2 Potentiometric Surface

1. There have been no significant changes in directions in groundwater flow.
2. Water levels in the PLS site area have risen approximately 5 feet, with the exception of the MW-38/MW-39 area which experienced less of an increase.
3. Water levels in the Evergreen area have risen by approximately 3 feet.
4. Water levels in the Maple area have risen by approximately 3 feet.
5. The hydraulic gradients between Wagner Road and the Evergreen Area have increased.
6. The hydraulic gradient toward the area of MW-38 and MW-39 has increased considerably.

Summary of these Observations

The general groundwater flow direction in this area has not changed. Water levels in the site are have risen approximately 5 feet, while water level rises in Evergreen and Maple have been approximately 3 feet. As observed in Unit E, what may be the most significant change is the increased hydraulic gradient between Wagner Road and the Evergreen area. This increased gradient will increase groundwater velocities in this area. Prior pumping had "stagnated" this area. This change should be expected to result in an increase of the flux of 1,4-dioxane from this area.

The hydraulic gradient toward the area of MW-38, MW-39 and MW-56 has increased. This increases the potential for the migration of water from the C3/D2 into the Unit E.

None of these changes are expected result in an expansion of the plume.

NOTES:
MAP COMBINES WELLS COMPLETED AT MULTIPLE DEPTHS. INTERPRETATION OF THIS MAP REQUIRES FAMILIARITY WITH THE GEOLOGY AND OF THE GROUNDWATER FLOW REGIME.

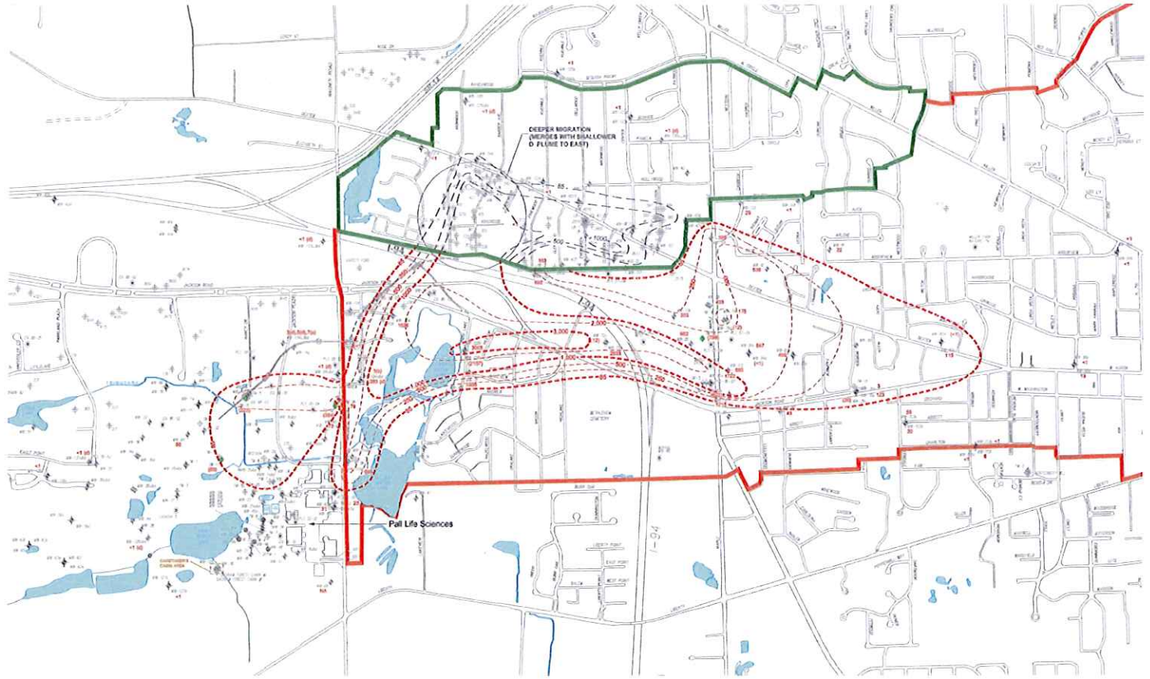
POTENTIOMETRIC SURFACE ELEVATION DATA IS MEASURED IN FEET NAVD88.

PALL LIFE SCIENCES
WASHTENAW COUNTY, MICHIGAN

POTENTIOMETRIC SURFACE COMPARISON
UNITS D_2 & E
MARCH 17, 2011 TO MARCH 15, 2013
2013 SHEET 1 OF 1 806500

FLEIS & VANDENBRINK ENGINEERING, INC.

(8)0413_E_ISO Comp\rlckg 041213



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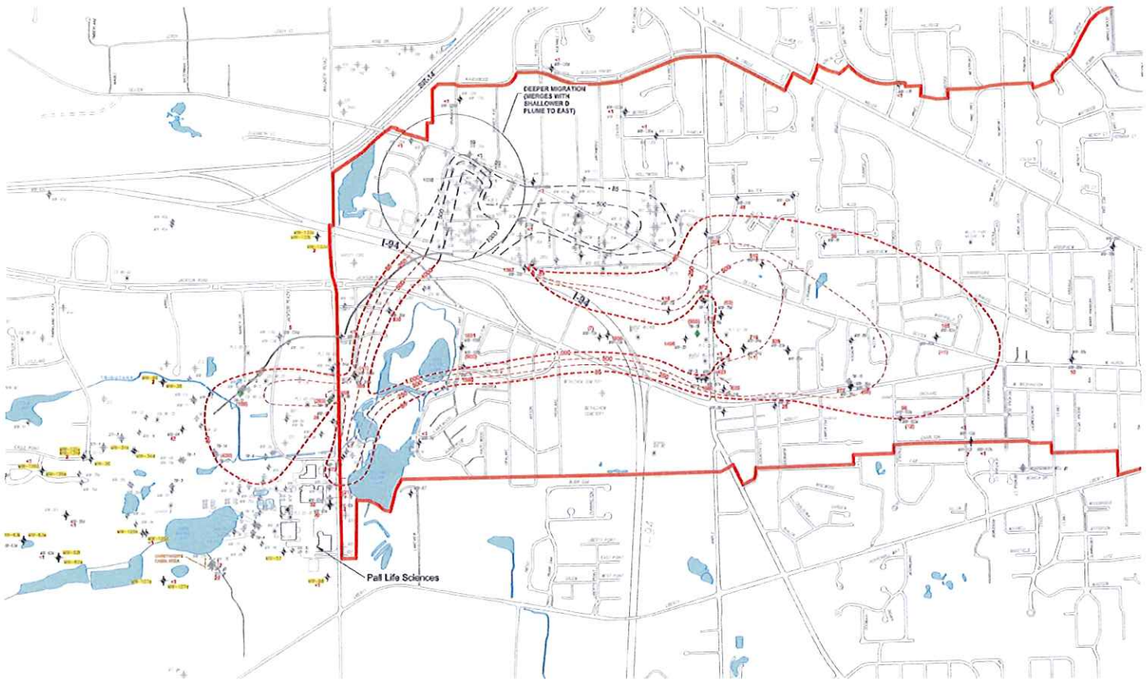


MARCH 15, 2013 DATA

NORTH

0 2000 4000

SCALE IN FEET

General Observations - Unit E 1,4-Dioxane Distribution and Concentrations - Western System Area

1. No notable changes in the overall plume configuration or extent.
2. 1,4-Dioxane concentrations have generally reduced.

Summary of these Observations

Groundwater extraction in this area and the natural groundwater flow to the east has significantly reduced Unit E 1,4-dioxane levels in the Western System area. None of the data suggest the footprint of the plume is expanding.

General Observations - Unit E 1,4-Dioxane Distribution and Concentrations - Eastern System Area

1. In the area between Wagner and Maple Roads, there have been no notable changes in the overall plume configuration. 1,4-Dioxane concentrations at wells along the axis of the plume (MW-108d and MW-72d) have been declining.
2. 1,4-Dioxane concentrations in MW-100 have continued to increase. Levels at nearby IW-2 have also increased but have dropped more recently.
3. 1,4-Dioxane concentrations have been increasing in the area of the MW-103 cluster. 1,4-Dioxane concentrations in groundwater sampled from MW-103s is now over 85 ug/L.

Summary of these Observations

The data support a shift in the plume toward the east as predicted by groundwater flow. Plume concentrations are generally decreasing in the west portion of this plume, and increasing to the east (Maple Village area and west). As the plume migrates to the east, dispersion has resulted in the plume boundary moving slightly south as evidenced by data from the MW-103 cluster. The main axis of the plume is still to the north of this area. PLS has increased the groundwater monitoring in this area to track these changes, but does expect the plume to continue migrating easterly within the Prohibition Zone boundary.

NOTES:
MAP COMBINES WELLS COMPLETED AT MULTIPLE DEPTHS. INTERPRETATION OF THIS MAP REQUIRES FAMILIARITY WITH THE GEOLOGY AND OF THE GROUNDWATER FLOW REGIME.

POTENTIOMETRIC SURFACE ELEVATION DATA IS MEASURED IN FEET NAVD88.

PALL LIFE SCIENCES
WASHTENAW COUNTY, MICHIGAN

ISOCONCENTRATION MAP COMPARISON
UNIT E
MARCH 17, 2011 TO MARCH 15, 2013
2013 SHEET 1 OF 1 806500

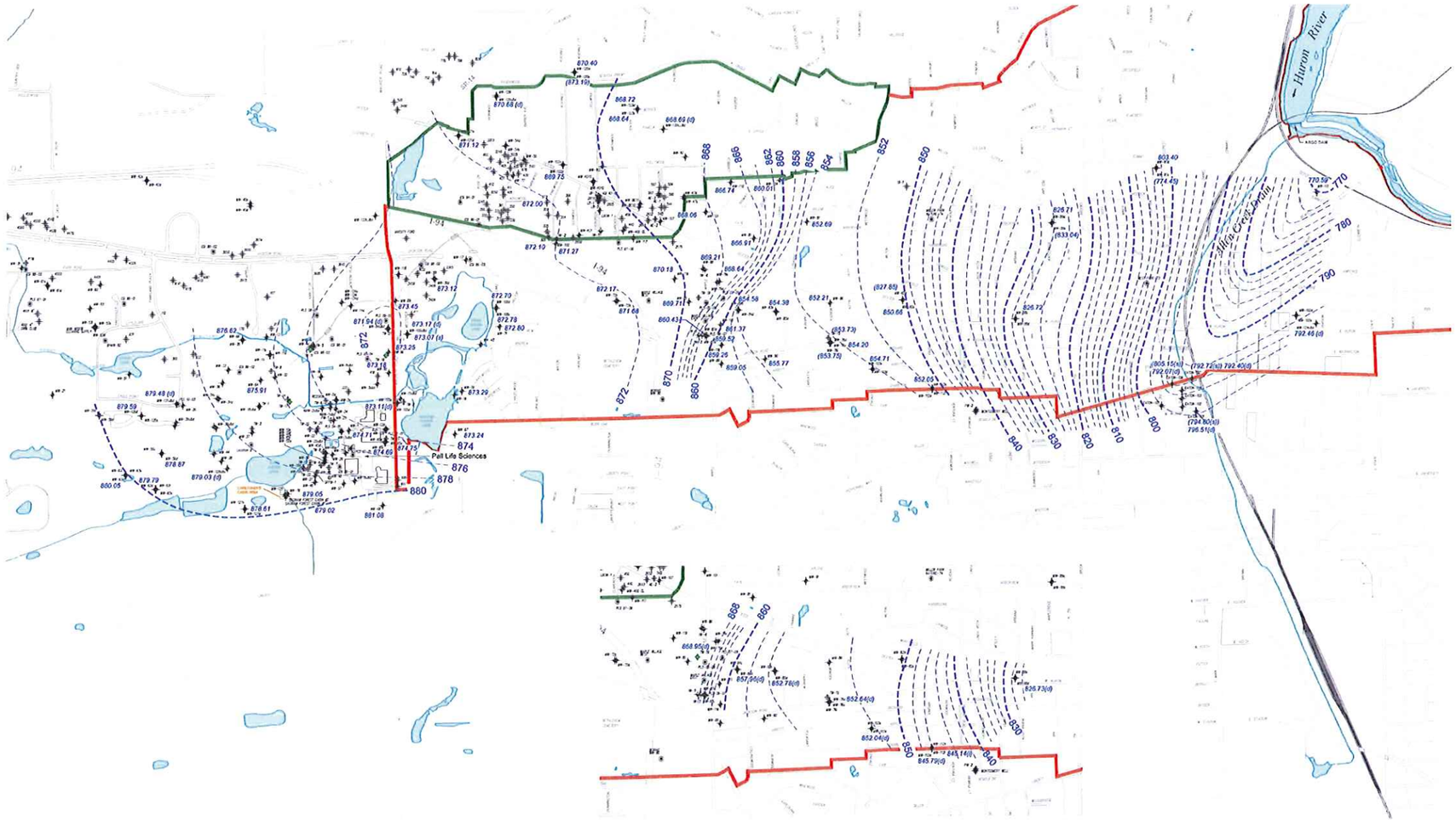
FLEIS & VANDENBRINK ENGINEERING, INC.

(8)0413_E_PSC Comp 1\rickg 040813

NORTH

0 2000 4000

SCALE IN FEET



SEE SHEET 2 OF 2

DEEPER UNIT *E* WELLS IN SELECT AREA.

MARCH 17, 2011 DATA

NOTES:
MAP COMBINES WELLS COMPLETED AT MULTIPLE DEPTHS. INTERPRETATION OF THIS MAP REQUIRES FAMILIARITY WITH THE GEOLOGY AND OF THE GROUNDWATER FLOW REGIME.

POTENTIOMETRIC SURFACE ELEVATION DATA IS MEASURED IN FEET NAVD88.

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WASHTENAW COUNTY, MICHIGAN

POTENTIOMETRIC SURFACE COMPARISON
UNIT E
MARCH 17, 2011 TO MARCH 15, 2013
SHEET 1 OF 2

2013 806500

FLEIS & VANDENBRINK ENGINEERING, INC.

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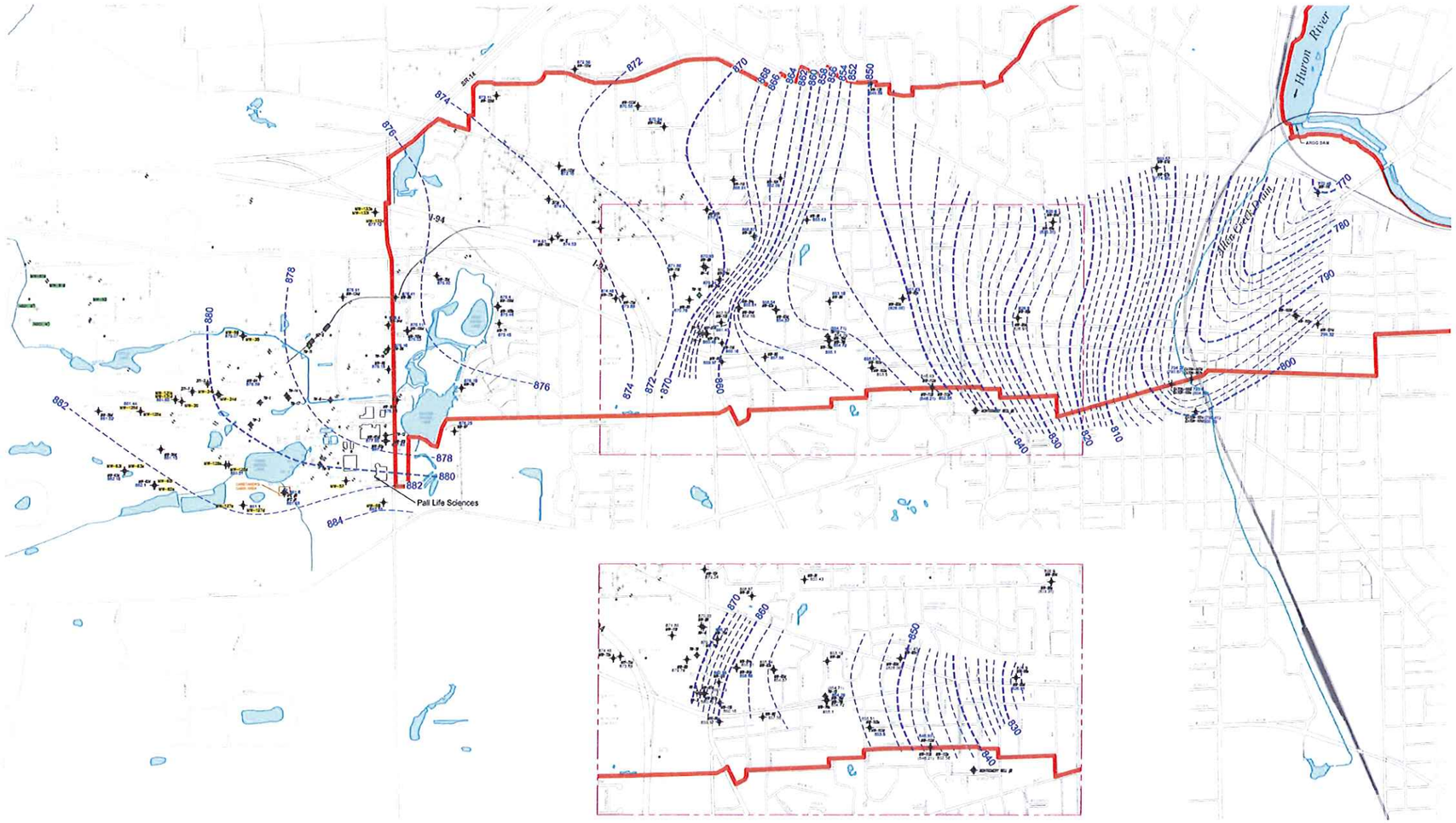


DEEPER UNIT *E* WELLS IN SELECT AREA.

MARCH 15, 2013 DATA

NORTH

0 2000 4000

SCALE IN FEET

General Observations - Unit E Potentiometric Surface

1. There have been no significant changes in directions of groundwater flow.
2. Water levels in the PLS site area have risen 2.5 - 3 feet.
3. The hydraulic depression around TW-18/TW-21 has diminished somewhat.
4. The hydraulic gradient between the area of Wagner Road and Evergreen has increased.
5. Water levels in the Evergreen area have risen 2 feet.
6. Water levels in areas to the east (east of Veterans Park) did not rise (rebound).

Summary of these Observations

The general groundwater flow direction in this area has not changed. Water levels in the site area have risen 2.5-3 feet. Such a rise was not noted to the east (east of Veterans Park), where little or no notable change occurred. What may be the most significant change is the increased hydraulic gradient between Wagner Road and the Evergreen area. This increased gradient will increase groundwater velocities in this area. Prior pumping had "stagnated" this area. This change should be expected to result in an increase of the flux of 1,4-dioxane from this area.

None of these changes are expected result in an expansion of the plume in the western area.

NOTES:
MAP COMBINES WELLS COMPLETED AT MULTIPLE DEPTHS. INTERPRETATION OF THIS MAP REQUIRES FAMILIARITY WITH THE GEOLOGY AND OF THE GROUNDWATER FLOW REGIME.

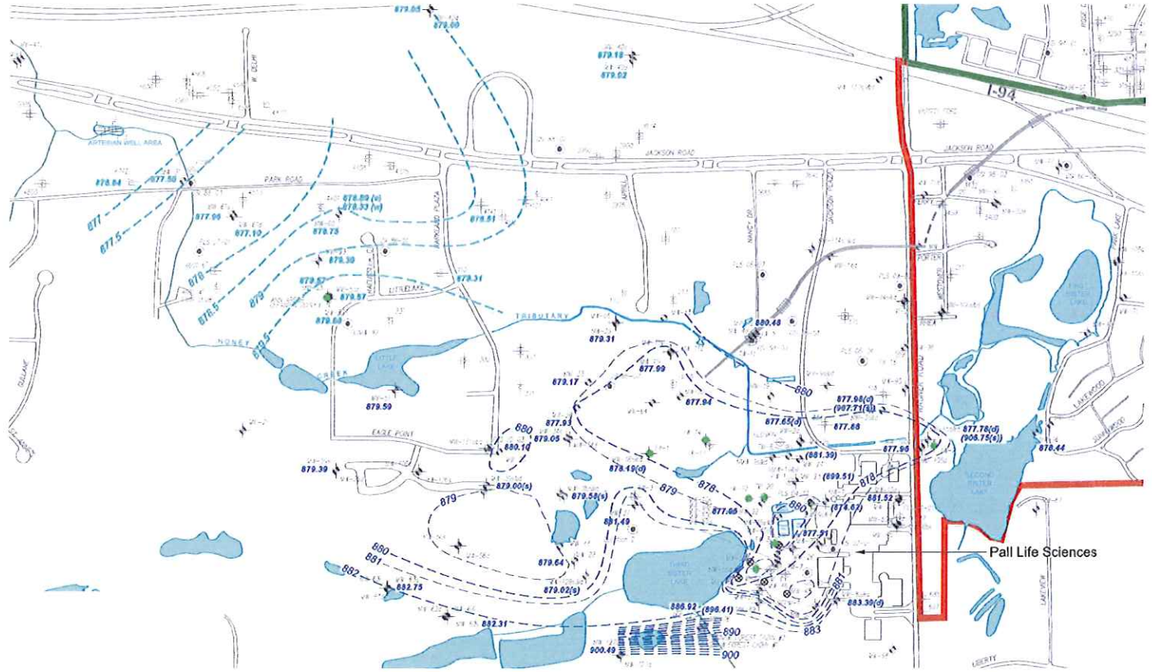
POTENTIOMETRIC SURFACE ELEVATION DATA IS MEASURED IN FEET NAVD88.

PALL LIFE SCIENCES
WASHTENAW COUNTY, MICHIGAN

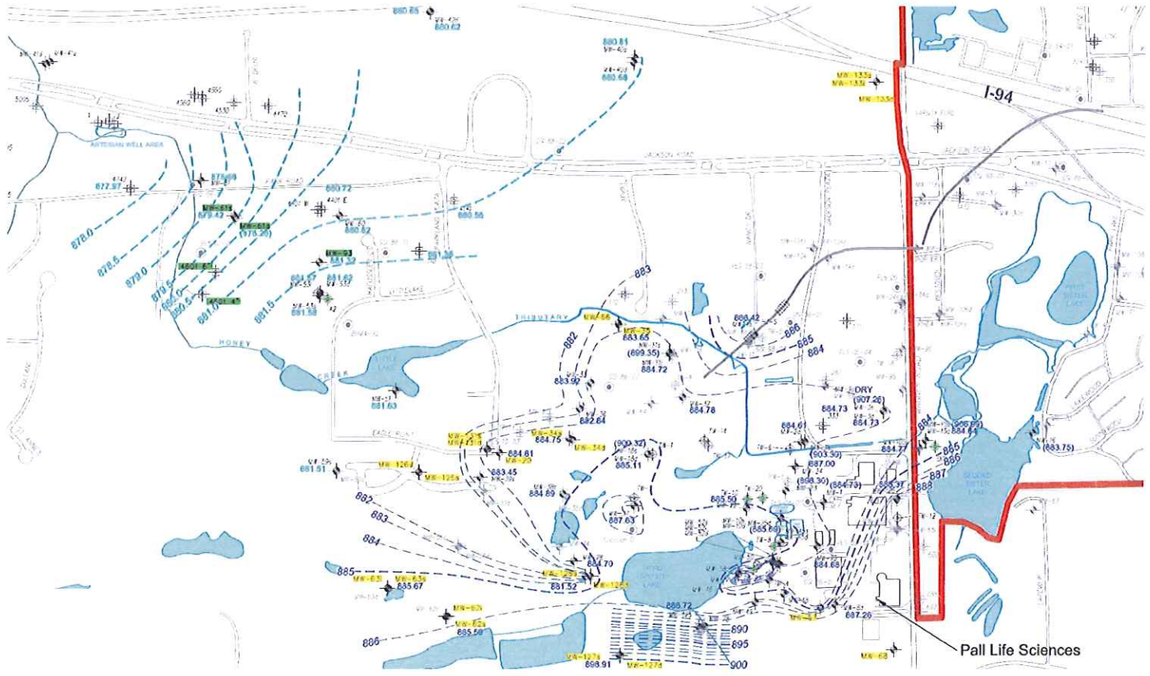
POTENTIOMETRIC SURFACE COMPARISON
UNIT E
MARCH 17, 2011 TO MARCH 15, 2013
2013 SHEET 2 OF 2 806500

FLEIS & VANDENBRINK ENGINEERING, INC.

(8)0413_SW_D0 & C3_PSC Comp\rlckg 041113



MARCH 17, 2011 DATA



MARCH 15, 2013 DATA

NORTH

0 1200 2400

SCALE IN FEET

General Observations - C3 Potentiometric Surface

1. Water levels in the C3 have generally risen between 5 and 6 feet.
2. Water levels south of Third Sister Lake have experienced less of an increase.
3. Water levels in the MW-4 area raised the most (approximately 6 feet). This rise has increased the hydraulic gradient toward the south from this area.
4. There has been an increase in water levels relative to the Little Lake System Area. Water levels in the western portion of the Western System are now approximately 2 feet higher than those in the eastern portion of the Little Lake System Area.
5. The hydraulic gradient between the MW-20 area and the MW-59 area has become considerably steeper.

Summary of these Observations

Water levels in the C3 in the site area have rebounded considerably when pumping was reduced. This aquifer experience the largest water level increase when compared to other (deeper) aquifers.

The water levels C3 are now higher than they are in the Little Lake area, which increases the potential for flow in that direction. That said, there remains a strong downward hydraulic gradient in the western site area that competes with the horizontal gradient. Historical and current groundwater quality data continue to support the downward solute migration in the area of MW-56 and MW-39. This hydraulic depression is very evident on potentiometric surfaces maps for C3 and D2. As a result of this downward flow potential, no further horizontal expansion of the plume is expected to occur.

General Observations - D0 Potentiometric Surface- Little Lake System Area

1. No significant changes in the directions of groundwater flow.
2. Water levels in the Little Lake System Area have increased by approximately 2 feet.
3. The hydraulic gradient in this area has increased.
4. The hydraulic gradient between the area of MW-40 and areas to the west has decreased.

Summary of these Observations

The general groundwater flow direction in this area has not changed. The hydraulic gradient has increased because water levels in the eastern portion of the area have increased more than the western portion. This would indicate groundwater flow velocities have increased. The hydraulic gradient between MW-40 and areas to the west is likely a result of water levels in the area rising more in the area of the Ann Arbor Supply Well relative to the MW-40 area. None of these changes are expected result in an expansion of the plume.

Historical and current water quality data continue to support the Little Lake System is decaying and not connected to the contamination in the Western Area System.

NOTES:
MAP COMBINES WELLS COMPLETED AT MULTIPLE DEPTHS. INTERPRETATION OF THIS MAP REQUIRES FAMILIARITY WITH THE GEOLOGY AND OF THE GROUNDWATER FLOW REGIME.

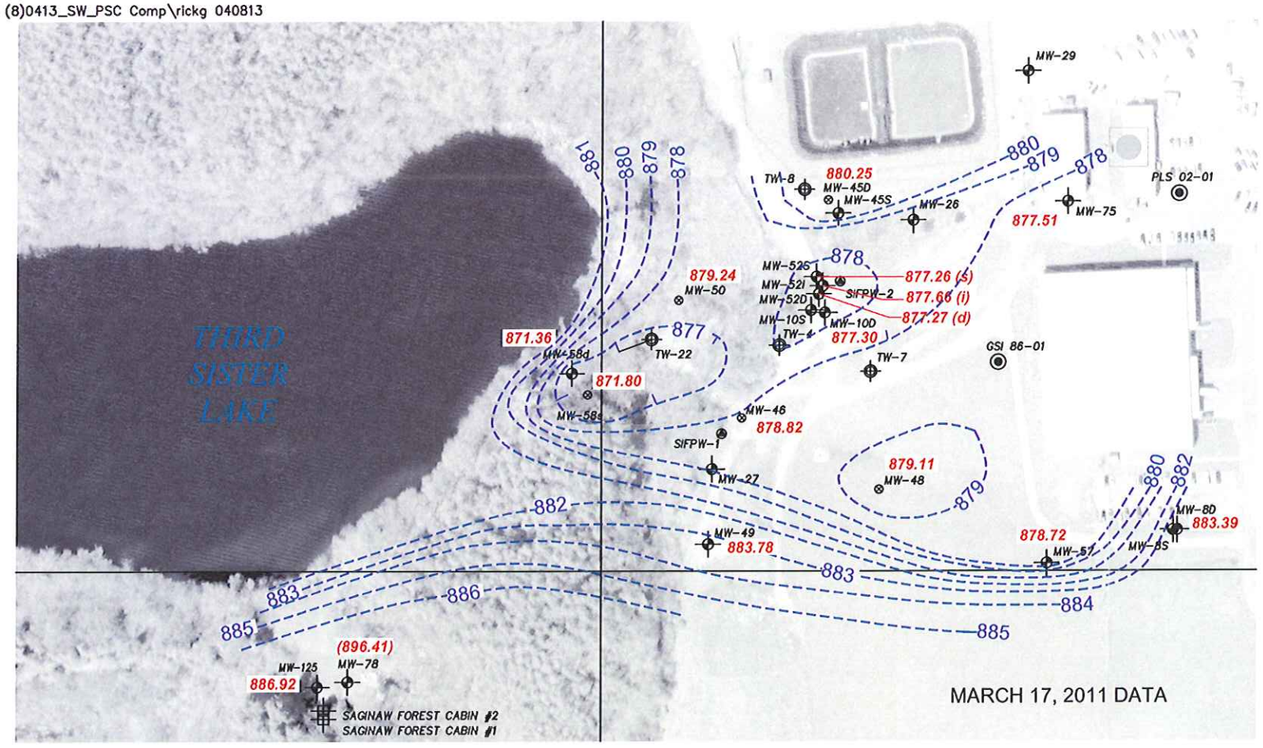
POTENTIOMETRIC SURFACE ELEVATION DATA IS MEASURED IN FEET NAVD88.

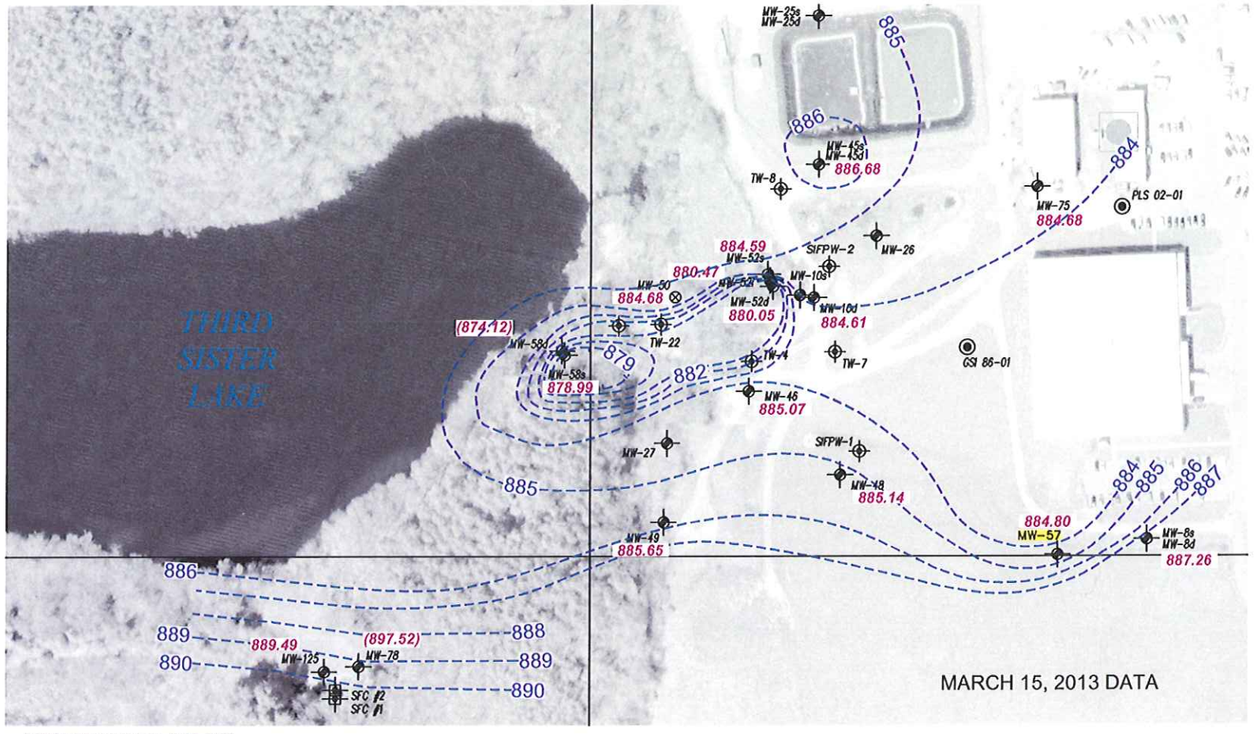
PALL LIFE SCIENCES
WASHTENAW COUNTY, MICHIGAN

POTENTIOMETRIC SURFACE COMPARISON
D_0 & C_3 AQUIFERS
MARCH 17, 2011 TO MARCH 15, 2013
2013 SHEET 1 OF 1 806500

FLEIS & VANDENBRINK ENGINEERING, INC.

(8)0413_SW_PSC Comp\rickg 040813





AERIAL PHOTO TAKEN: APRIL 2002

NORTH

0 200 400

SCALE IN FEET

General Observations - Southwest Potentiometric Surface

1. There have been no significant changes in directions in groundwater flow.
2. Water levels in the PLS site area have risen 2 to 7 feet.
3. The hydraulic gradient from south to north (MW-49 to north) has decreased substantially.

Summary of these Observations

The overall direction of groundwater flow has not changed in this area despite the significant increase in groundwater levels. None of these changes are expected result in an expansion of the plume.

NOTES:
MAP COMBINES WELLS COMPLETED AT MULTIPLE DEPTHS. INTERPRETATION OF THIS MAP REQUIRES FAMILIARITY WITH THE GEOLOGY AND OF THE GROUNDWATER FLOW REGIME.

POTENTIOMETRIC SURFACE ELEVATION DATA IS MEASURED IN FEET NAVD88.

PALL LIFE SCIENCES
WASHTENAW COUNTY, MICHIGAN

POTENTIOMETRIC SURFACE COMPARISON
SOUTHWEST PROPERTY
MARCH 17, 2011 TO MARCH 15, 2013

2013 SHEET 1 OF 1 806500

FLEIS & VANDENBRINK ENGINEERING, INC.

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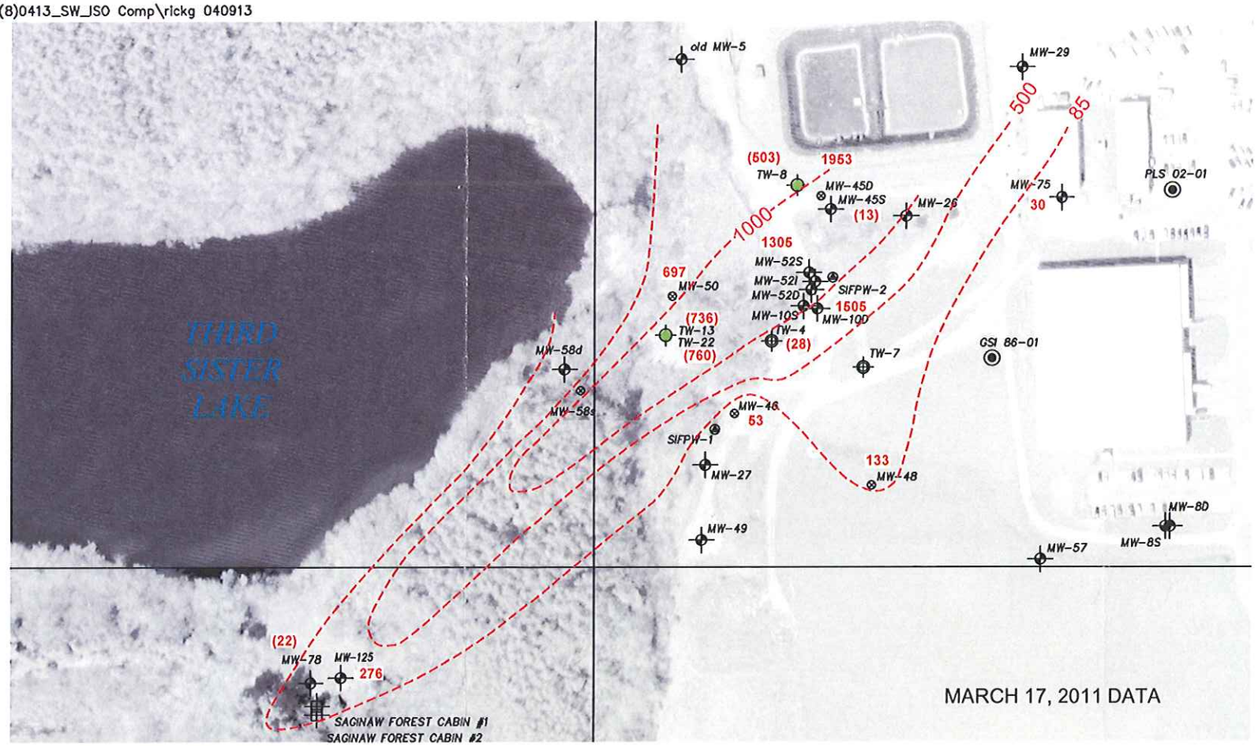

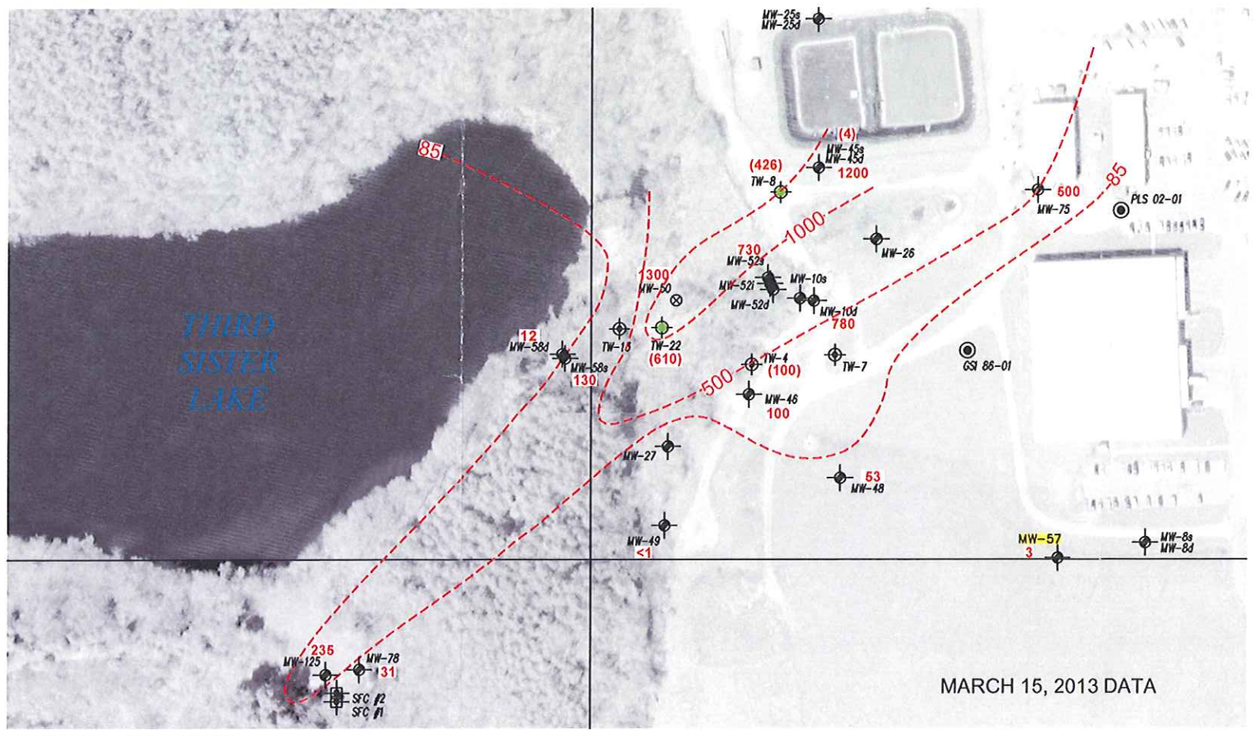

AERIAL PHOTO TAKEN: APRIL 2002

FLEIS & VANDENBRINK ENGINEERING, INC.

NORTH

0 200 400

SCALE IN FEET

General Observations - Southwest Area 1,4-Dioxane Distribution and Concentrations

1. No notable changes in the overall plume configuration or extent.
2. 1,4-Dioxane concentrations have remained fairly stable.
3. 1,4-Dioxane concentrations at MW-75 have increased.

Summary of these Observations

The overall extent of the plume footprint in the Southwest area has not changed and 1,4-dioxane levels in this area have remained fairly stable. 1,4-Dioxane concentrations in MW-75 have increased, but similar increases have been observed in the past. Historical levels at this location have been as high as 1,001 ug/L.

NOTES:
MAP COMBINES WELLS COMPLETED AT MULTIPLE DEPTHS. INTERPRETATION OF THIS MAP REQUIRES FAMILIARITY WITH THE GEOLOGY AND OF THE GROUNDWATER FLOW REGIME.

POTENTIOMETRIC SURFACE ELEVATION DATA IS MEASURED IN FEET NAVD88.

PALL LIFE SCIENCES
WASHTENAW COUNTY, MICHIGAN

ISOCONCENTRATION MAP COMPARISON
SOUTHWEST PROPERTY
MARCH 17, 2011 TO MARCH 15, 2013

2013 SHEET 1 OF 1 806500