

**EVERGREEN SYSTEM**  
**VALLEY DRIVE AREA INVESTIGATION**

**PALL LIFE SCIENCES**  
**ANN ARBOR, MICHIGAN**

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## **INTRODUCTION**

This report summarizes recent investigations Pall Life Sciences (PLS) has completed in the Evergreen System – Valley Drive area, as proposed in two work plans. PLS proposed an investigation in a work plan dated August 3, 2007, the purpose of which was to further examine the linkage between the Unit D<sub>2</sub> plume in the Evergreen Subdivision and Unit E (E<sub>1</sub> plume), south of the Evergreen Subdivision. PLS also proposed an investigation of the Evergreen area in a work plan dated June 29, 2007, the primary purpose of which was to further evaluate the LB-1/LB-3 capture zone.

## **DATA COLLECTION**

### **BORING AND MONITORING WELL INSTALLATION**

In November-December 2007 and January 2008, PLS installed one boring (PLS 07-06) and two monitoring wells (MW-117 [PLS-08-01] and MW-113 [PLS-07-08]). PLS-07-06 and monitoring well MW-117 were installed in the vicinity of the Valley-Evergreen/Valley-Clarendon intersections for the purposes of evaluating water quality and levels in this area. Monitoring well MW-113 was installed near Hollywood and Dellwood to evaluate/further define the northern margin of the Evergreen Plume. Figure 1 shows the locations of the boring(s)/well(s).

Hollow-stem auger drilling methods were used at each boring well location. Each boring/well was drilled to a depth sufficient to encounter bedrock. Soil samples were collected using split-spoon techniques at 10-foot intervals, beginning at ground surface to a depth approximately 10 feet below the uppermost water-bearing zone. Simulprobe sampling was performed at a maximum frequency of 10 feet in water-bearing intervals and continued until bedrock was encountered. All soil samples were described/classified based on their physical characteristics by an onsite geologist during the drilling of each boring.

Each boring was vertically sampled during drilling. Groundwater samples were collected using the Simulprobe and analyzed for 1,4-dioxane by PLS.

On reaching the total depth of the boring, as determined by the onsite geologist, the borehole was geophysically logged using a natural gamma tool. This data supplements the formation samples and provides additional information regarding site geological conditions.

Boring PLS-07-06 was grouted from total depth to the surface using bentonite grout. MW-117 was installed approximately 6 feet west of test boring PLS-08-01, and PLS-08-01 was plugged using bentonite grout. MW-113 was installed 5 feet east of test boring PLS-07-08, and PLS-07-08 was plugged using bentonite grout.

Both monitoring wells were constructed of galvanized steel casings equipped with 5-foot stainless-steel well screens. The well screen was installed at the depth corresponding to the highest 1,4-dioxane level. Wells were gravel packed, grouted, and completed as flush mounts equipped with locking caps and locks.

Soil cuttings derived from the drilling and development water were containerized and transported back to PLS for appropriate management. Boring and gamma logs of each boring/well are provided in Appendix 1. Analytical results for vertical samples during drilling are annotated on each boring/well log. Table 1 shows the depth and screen interval construction details for each boring/well.

**Table 1 • Construction Details for New Borings/Wells**

Boring/Well ID	E.O.B. (ft bgs)	Screen Depth (ft bgs)	T.O.C. (ft amsl)	Ground Elevation (ft amsl)	Completion Date
PLS-07-06	245	NA	NA	ND	11/13/2007
MW-113 (PLS-07-08)	255	175 - 180	944.36		12/4/2007
MW-117 (PLS-08-01)	240	73 - 78	930.26		1/29/2008
Notes: E.O.B. = end of boring T.O.C = top of casing NA = not applicable ND = not determined ft bgs = feet below ground surface ft amsl = feet above mean sea level					

## **SURVEYING, WATER LEVEL, AND WATER QUALITY DATA COLLECTION**

PLS retained Atwell-Hicks (AH) of Ann Arbor, Michigan, to update survey data for the Evergreen area. This was necessitated from the fact that the hydraulic gradients in portions of the Evergreen area are relatively flat.

AH surveyed the wells to both U.S. Geological Survey datum and North American Vertical Datum, 1988 (NAVD88). Wells previously not in NAVD88 have been converted to the NAVD88 datum, and the PLS database has been updated. Adjustments were made to several wells as a result of the survey update. In particular, the recent survey work indicates there was an elevation error for previous top-of-casing at MW-400 Clarendon. The new survey data indicates there is no hydraulic high at this location. The recent survey work also identified that the top-of-casing elevation at 2819 Dexter was not correct (too low). This resulted in an artificially low head at this well, which has been corrected on the new map. Updated elevation data are provided in Appendix 2.

Monitoring wells MW-113 and MW-117 were installed for the primary purpose of obtaining representative water quality and water level data. Both MW-113 and MW-117 have been incorporated into PLS' routine water level/quality monitoring programs. Analytical data reports for MW-113 and MW-117, which include all recent data collected from these wells, are provided as Appendix 3. These data include water level data collected at MW-113 on December 6 and 11, 2007, January 28, 2008, and February 5, 2008, and from MW-117 on February 14, 2008. Analytical and water level data for each well will be reported, along with other data in the quarterly reports, to the Michigan Department of Environmental Quality (MDEQ).

PLS collected an extensive round of water level data on February 25, 2008, as part of the Dupont Area investigation. These data are also relevant to this investigation and are provided in Appendix 4.

# DATA INTERPRETATION

## GEOLOGY/HYDROGEOLOGY

Boring, well, and analytical data from this investigation have been incorporated into several cross-sections. Previous cross-sections that were augmented with new well data (e.g., MW-117, etc.) have been reinterpreted for presentation here. A map showing the location of each cross-section is embedded within each cross-section figure. Hydrostratigraphic units are grouped based on hydraulic properties (i.e., aquifer/aquitard). Strata composed predominantly of fine-grained materials (e.g., silts and clays) are shaded in green and generally represent low hydraulic conductivity material that constitute aquitard units for the area. Strata composed predominantly of coarse-grained materials (e.g., sands and gravels) are shaded in yellow and generally represent material having higher hydraulic conductivity and form aquifer units for the area. Significant features of each cross-section are described below.

Cross-Section 08-07 (Figure 2) extends through the Evergreen Subdivision area, beginning west of the Dupont Circle area, then generally following the longitudinal axis of the Unit D<sub>2</sub> aquifer and plume through the Evergreen area. A review of Cross-Section 08-07 indicates at least three aquifers are present in the Evergreen Subdivision: Unit D<sub>2</sub>, a shallower aquifer above Unit D<sub>2</sub>, and a lower aquifer (Unit E<sub>2</sub>) below Unit D<sub>2</sub>.

As shown on Cross-Section 08-07, the aquifer thickness of Unit D<sub>2</sub> remains relatively uniform along its longitudinal axis from MW-77 and the 373 Pinewood well, then eastward through LB-1, LB-2, and MW-BE1s&d, toward MW-47 and MW 101. Westward from 373 Pinewood, Cross-Section 08-07 shows Unit D<sub>2</sub> becomes divided in the general vicinity of Dupont Circle, west of MW-77, where an intervening confining layer splits Unit D<sub>2</sub>.

Cross-Section 08-02 (Figure 3) generally parallels Cross-Section 08-07 along Valley Drive. Beginning at MW-100, Cross-Section 08-02 follows longitudinally along the south margin of Unit D<sub>2</sub> and the Evergreen plume, through IW-2, MW-KZ1, IW-1, the new boring PLS-07-08, and ending at MW-117. The base of Unit D<sub>2</sub> on Cross-Section 08-02 is generally at an elevation of 800 ft amsl. Review of Cross-Section 08-02 shows a significant sand development in PLS-07-08 and MW-117 in the upper sand unit above Unit D<sub>2</sub>. Approximately 10 feet of D<sub>2</sub> sands were encountered at PLS-07-08 and MW-117.

Cross-Sections 08-03 and 08-06 (Figures 4 and 5) are constructed generally perpendicular to Units E and D<sub>2</sub> to provide profile views of these hydrogeologic units. Both cross-sections extend northward from MW-72. Cross-Section 08-03 traverses through MW-117 to MW-107 and MW-47s&d, to MW-92. Cross-Section 08-06 traverses through IW-1, to LB-1 and MW-KD1d, to MW-113 (the latter being located along the north side of Unit D<sub>2</sub>).

Historic interpretations of the aquifer geometry characterize the sand intervals at MW-72s and MW 72d as the upper Unit E (E<sub>1</sub>) and lower Unit E (E<sub>2</sub>), respectively. Correlations shown on Cross-Sections 08-03 and 08-06 indicate the upper Unit E sand in MW-72s is laterally equivalent to D<sub>2</sub> aquifer sand (D<sub>2</sub>/E<sub>1</sub>) present in the Evergreen Subdivision.

Cross-Section 08-09 (Figure 6) was prepared using boring logs from MW-400 Clarendon, 456 Clarendon, MW-BE1s&d, and AE-3. Each well encountered Unit D<sub>2</sub> sands. Review of the cross-section suggests MW-400 Clarendon was completed in fine silts associated with the confining unit below Unit D<sub>2</sub>. The sand development in the MW-400 Clarendon well suggests a merger of the upper portion of Unit D<sub>2</sub> with sands of the aquifer above Unit D<sub>2</sub>, as described when discussing Cross-Section 08-07. Screen intervals in the 456 Clarendon, MW-BE1s&d, and AE-3 wells are within Unit D<sub>2</sub>.

As a final comment, comparisons of correlations shown on these cross-sections indicate the deeper Unit E sand (Unit E<sub>2</sub>) is present at IW-1, IW-2, MW-117 (Figure 3), and 373 Pinewood-deep, the latter found on Cross-Section 08-07 (Figure 2). It is important to note that the lower Unit E sand interval has not been contaminated by 1,4-dioxane in the Evergreen area, except for trace levels in the IW wells.

## **GROUNDWATER FLOW**

A potentiometric surface map for portions of Unit D<sub>2</sub>, Unit E, and Unit D<sub>0</sub> for data collected February 25, 2008, is provided as Figure 7. Water level data was obtained from selected wells in the site area to get a regional perspective of groundwater flow. This map includes the new wells, along with data for the Dupont area and areas northwest of the Evergreen Subdivision.

The map was constructed with a 1-foot contour interval and has a similar overall potentiometric surface pattern seen in previously provided maps contouring similar wells. The following key observations relative to the Valley Drive area are noted:

- A hydraulic high is observed in the area of MW-117. This hydraulic high appears to extend eastward to about half-way between Clarendon and the intersection of Dexter and Valley.
- The hydraulic gradient in the area of the LB-2,3 extraction wells and Allison Street is very flat as a result of the long standing extraction. Given the flat gradient, there is very little potential for the plume to migrate further east.

## **WATER QUALITY**

1,4-Dioxane was not detected in vertical sampling at the borings at PLS 07-06 and MW-117. These data suggest that 1,4-dioxane is not likely migrating northward from the Unit E<sub>1</sub> along this portion of Valley Drive. Although not conclusive, the absence of 1,4-dioxane at these locations also suggests 1,4-dioxane is not migrating past the LB extraction zone to the south.

1,4-Dioxane data from MW-113, installed near Dellwood and Hollywood, defines the northern edge of the Evergreen plume and confirms the plume migrates east, not northeast, in this area.

Water quality trends in other wells in the Evergreen area are shown on graphs provided in Appendix 6. Water quality data for key wells east of the Evergreen extraction demonstrate the Evergreen System has been effective in halting the migration of the plume at concentrations above 85 microgram per liter (µg/L). These wells include MW-47sd, MW-107, and residential wells 545 Allison, and 2652 and 2643 Dexter.

1,4-Dioxane concentrations at some wells in the vicinity of the Evergreen extraction show increasing trends. These wells include 2819 Dexter, 2805 Dexter, 593 Allison, and MW-BE-1s. The increases in 1,4-dioxane concentrations at these wells do not evidence further migration of the plume, but rather appear to correlate to changes in the purge well operation, including the installation and operation of LB-3.

Water quality data for key wells east of the Evergreen extraction demonstrate the Evergreen System has been effective in halting the migration of the plume at concentrations above



85 µg/L. These wells include MW-47sd, MW-107, and residential wells 545 Allison, and 2652 and 2643 Dexter. Data sheets for these wells are provided in Appendix 5.

## **SUMMARY OF FINDINGS**

Following are key findings from this investigation:

- Water level data suggest the presence of a hydraulic high in the area of MW-117.
- 1,4-Dioxane is not migrating from south of Valley to north of Valley in the area of Clarendon Street. This is consistent with the presence of a hydraulic high in this area. Although the migration of 1,4-dioxane to the north from Unit E<sub>1</sub> may be occurring in areas east and west of this hydraulic high, PLS' investigation to date has not confirmed the location of such migration.
- It had proven more difficult than anticipated to locate where 1,4-dioxane migrates north from the Unit E<sub>1</sub> into the Evergreen Subdivision, or to rule out that possibility.
- It is very difficult to precisely interpret the capture of the LB/AE extraction wells by solely reviewing water level data, since the hydraulic gradient in this area is extremely flat. However, water quality data for key wells east of the Evergreen extraction demonstrates the Evergreen System has been effective in halting migration of the plume.
- MW-113 defines the northern boundary of the Evergreen plume and confirms the plume's migration direction is east, not northeast.
- The startup of LB-3 resulted in an increase in 1,4-dioxane concentrations at several wells, most likely resulting from a shift in the plume configuration as the capture of this zone developed.

## RECOMMENDATIONS

- PLS proposes to continue purging from LB-1 and LB-3 at current extraction rates (LB-1, 95 gallons per minute [gpm] and LB-3, 90 gpm), while PLS and the MDEQ evaluate potential modifications to the remedial objective for this system. There is no indication the plume is advancing east of Allison Street under current operating conditions. PLS will also operate AE-3 (15 gpm) when practical during this period. This course of action is preferable to performing further investigation, given the pending discussions between PLS and the MDEQ regarding a more integrated solution to the Evergreen/Maple Village areas and the difficulty in determining the location(s) where 1,4-dioxane may be drawn north from Unit E<sub>1</sub> into the Evergreen Subdivision (or to rule out that possibility). The appropriate purge rates for the Evergreen System will be reevaluated once the parties agree on an appropriate remedial strategy.