PLS RESPONSE TO MDEQ JUNE 19, 2008 MEMO REGARDING REVIEW OF EVERGREEN SYSTEM CAPTURE EFFECTIVENESS

Pall Life Sciences

August 7, 2008

General Comment - The MDEQ, in this memo, indicates that the 2008 Evergreen System Valley Drive Area Investigation report was prepared by Fishbeck, Thompson, Carr & Huber, Inc. (FTC&H). Please note that this report was prepared by Pall Life Sciences. Other memos by Mr. Mandle have made a similar error. Please note this for future reference.

Comparison to Previous Capture Analyses

Calculations of the capture-zone widths of wells along Allison (AE-1, AE-2, and AE-3) and Evergreen Streets (LB-1, LB-2, and LB-3) have been completed on a number of previous occasions. In these analyses, different methods of analysis were utilized. These methods have ranged from simple analytical element modeling using a single aquifer layer to numerical modeling using multiple aquifer layers. The primary deficiencies in these previous analyses were that relatively-simple models were used to represent relatively-complex hydrogeological conditions, and the failure to properly calibrate the models that were developed. Model calibration is necessary to demonstrate that the choice of the model and the associated parameter values are reasonable for the hydrogeology of this area. As a result, a variety of conceptualizations and hydraulic parameter values have been used. In previous investigations, the hydraulic conductivity in the vicinity of Allison Street has ranged from 271 ft/day in early modeling analysis to 100 ft/day in more recent model submittals. All values in these previous capture-zone analyses are considerably higher than the values used in the present analysis. Referring to equation 3), it should be apparent that as the hydraulic conductivity decreases in these analyses, the pumping rate needed to achieve the same capture-zone width decreases in a proportional manner. As an example, as K decreases by one-half, the Q needed to achieve the same capture-zone width also decreases by one half. Also, if the pumping rate of the extraction well is reduced, the hydraulic conductivity of the aquifer being pumped can be reduced proportionally in order to achieve the same capture-zone width. This assumes that the hydraulic-head gradient and aquifer thickness are the same in both analyses. It should be apparent that it is not possible to attain the same calculated capture-zone width as shown on Figure 2 (from the AE Capture Zone report) using a pumping rate equal to 15 gpm and the previous estimates of hydraulic conductivity that had ranged from 100 ft/day to 271 ft/day.

Assessment of the Present Capture Analysis

Our concern with these calculations is the same that we've had with previous model analyses at this site. The present capture analysis is another in a series of analyses in which an uncalibrated model is used to show hydraulic containment of the contaminant plumes at this site. While there has been additional drilling in areas north, east, and south of Allison Street to define the geology and downgradient extent of contamination, other than the aquifer test at LB-1, there has been no additional hydraulic testing or model calibration to estimate the aquifer water-yielding capabilities (transmissivity and hydraulic conductivity) where the remaining AE well, AE-3, is located. This work is needed to support a reduction in hydraulic conductivity from values used in previous analyses. Without this additional work, we have no assurance that these model simulations are any more reasonable, or more accurate, than previous model simulations.

PLS Response – *The MDEQ raises three issues regarding PLS' current and past capture zone analyses: (1) the simplicity of these analyses; (2) the lack of model calibration; and (3) the appropriateness of the value PLS used for hydraulic conductivity (the K value).*

1. Accuracy of Capture Zone Analyses. PLS has used two basic types of models to calculate the capture zone for the Evergreen Area: analytical (WinFlow, capture zone equation) and numerical (MODFLOW). The MDEQ suggests the analytical models used by PLS are too simple to represent the relatively complex hydrogeological conditions, and the numerical models were not property calibrated. Yet, numerous times over the years, the MDEQ has approved capture zones using these same models. The MDEQ has also constructed its own model using MODFLOW, and conducted their own capture zone analysis (November 24, 1998, memo from Rick Mandle to Leonard Lipinski). In this analysis, the MDEQ indicated recognized that simple models, such as the ones that both PLS and the MDEQ created, are reliable if the model inputs are conservative: "This model should be viewed as a very simplified representation of the site. However, as also stated in the FTC&H capture zone analyses, we believe the specified model values are either representative of the site or are conservative. The modeling of the confined aquifer as a uniformly 75 feet thick is conservative, for example, because the aquifer appears to be more channel-like, with significant thinning of the aquifer noted to the south. Overstating the aquifer thickness would result in a smaller capture zone." (emphasis added)

Subsequent drilling data have further substantiated the MDEQ's previous findings that made the model simulations, specifically the analytical models provided by PLS, conservative. The analytical models used by PLS are conservative for the following reasons:1) drilling data indicate the modeled aquifer is not uniformly thick, rather thins to the north toward MW-92, and to the south toward MW-117 (as shown on a cross section 08-13 provided later in this document), 2) maximum aquifer thicknesses were used (75 feet in older models, and 90 feet in the recent capture zone submittal for AE-3, and 3) groundwater flow directions converge toward the LB/AE area, even under non-pumping conditions. Consequently, the analytical model PLS relied on in its recent April 2008 capture zone analysis understates the extent of the capture zone created by AE-3.

Consequently, MDEQ's more recent observation that the models used by PLS present a simplified representation of the actual aquifer conditions misses the point and is misleading. A simple model is still appropriate provided the input is either representative or conservative. As the MDEQ previously noted, the assumptions incorporated into PLS' analyses, including the recent CZA, lead to a conservative estimate of the capture zone and thus can be appropriately relied upon.

PLS recently submitted to MDEQ a simulated capture zone for AE derived using the capture zone equation. This well documented method of determining a capture zone for *well is widely used in the field of hydrogeology. Input into the equation were parameters that MDEQ identified as being "conservative" previous models. That is, they underestimate the capture of AE-3 rather than overestimate the capture.*

2. Model Calibration. PLS certainly recognizes the importance of calibrating numerical groundwater flow models and its models have always been appropriately calibrated. That is why PLS has routinely provided calibration statistics for the models it has submitted to MDEQ. PLS has also provide maps comparing the simulated vs measured potentiometric surface (to see how the models match flow directions), and has provided model mass balance information. Calibration data/statistics for PSL models were provided to MDEQ in reports dated February 2002, August 2002 and May 2002. The information provided to MDEQ demonstrate that the submitted models matched head data to residual levels generally considered acceptable by common modeling standards, reasonably represented known flow directions, and had acceptable mass balance errors.

It is revealing that the MDEQ used the MODFLOW model it created to conclude that "both of the simulation results shown in Figures 1 and 2 demonstrate that the additional purge well (AE) provides an overall wider capture zone, capturing most of the defined 1,4-dioxane plume in this region." MDEQ reached this conclusion even though the model it used was not calibrated. MDEQ's willingness to approve the CZA at issue based on an uncalibrated model reflects the reality that the degree of calibration needed is a matter of professional judgment and depends on a variety of factors.

PLS' recent submittal utilizes a capture zone equation. Analytical models like this analysis cannot be calibrated in the same way numerical models can. The results can, however, be compared to a measured potentiometric surface, which PLS did and provided to MDEQ.

3. Hydraulic Conductivity (K) Value. Significantly, the MDEQ never affirmatively concludes that the hydraulic conductivity (K) value used in PLS' recent CZA is inappropriate. Rather, the MDEQ asserts that the value used is inconsistent with past analyses and aquifer conditions in the area of the AE wells. The clear implication of the MDEQ's statements is that PLS purposely selected a lower K value in order to obtain the desired result. This suggestion is completely unsupported by the facts and insulting.

The range of K values PLS used in its April 2008 CZA is consistent with PLS previous submittals and representative of the actual aquifer conditions in the AE area. PLS provided the MDEQ with a numerical model in June 2006. The hydraulic conductivity (K) used for the AE area was 50 ft/d, which is consistent with that used for the most recent analysis (25, 50, and 75 ft/d). Prior to the June 2006 model, PLS used some higher hydraulic conductivity values to represent materials in the area of the AE wells. Over time, and during construction of the June 2006 model submitted to the MDEQ, PLS refined the K values for this area and determined that the K values previously used were not representative. The MDEQ has never expressed its disagreement with this change, which PLS believes represents an improvement to the accuracy of its groundwater model. The most recent capture zone submittal used a range of hydraulic conductivity values *that most certainly encompass the hydraulic conductivity range for the type of material encountered at AE-3. As PLS has indicated in its April 2008 capture zone analysis, AE-3 is completed in a portion of the Unit D2 aquifer that is considerably less transmissive than the area around the LB-series wells. This is obvious from a review of drilling logs, geophysical logs, and well capacity information collected by PLS at AE-1 and AE-3. An examination of these logs and a comparison to logs and data from the LB area confirms that the unconsolidated sediment materials around the AE extraction wells are much finer than those encountered around the LB extraction wells (as supported by the grain-size data provided with the Evergreen AE-3 Capture Analysis). It should be obvious to the MDEQ that the AE wells do not produce as much water as the LB wells. While the LB wells are capable of flow rates well over 100 gpm, the AE wells have never been able to produce more than 40 to 50 gpm. This is not a well design issue, it is simply another indicator of the much lower hydraulic conductivity due in large part to the fine-grained material in this area.*

PLS stands by its decision to use a range of K values between 25 and 75 ft/day to represent materials in the area of the AE extraction wells.

However, as with any other contamination site, the Michigan Department of Environmental Quality (MDEQ) does not rely solely on calculations to demonstrate hydraulic containment of a dissolved contaminant plume, even if a model was reasonably calibrated. We must rely on demonstrations of hydraulic containment, through the collection of hydraulic-head data and groundwater chemical data [Cohen and others (1994), Greenwald and others (2008), and the MDEQ (2006)] The following discussion starts with an assessment of the data and plume containment at Evergreen, followed by a similar discussion for the Allison Street wells.

***PLS Response** – PLS agrees that demonstration of hydraulic capture cannot be made solely on calculations. That is why PLS routinely collects and analyzed water level and quality data in accordance with an MDEQ-approved performance monitoring plan. These data confirm that PLS is meeting the Consent Judgment objective of capturing the leading edge of the Evergreen groundwater contamination. It should be noted that "plume containment" in the Evergreen Street area is not required by the Consent Judgment, which requires PLS to capture the leading edge of the groundwater contamination. Subject to a determination that the 1,4-dioxane in the vicinity of Allison Street is being drawn into this area from the Unit E to the south, the leading edge of the Evergreen plume is currently interpreted to be in the Allison Street area and is being captured by AE-3.*

Plume Containment at Evergreen

The primary means of plume containment in the designed remediation system has been the extraction wells at Evergreen Street, (LB-1, LB-2, and LB-3). Hydraulic-head and chemical data must be used to determine whether these extraction wells have been successful in containing the 1,4 Dioxane plume. That is, there should be changes to the hydraulic-head gradients and 1,4-Dioxane concentration trends that demonstrate that groundwater is moving toward the extraction wells over the area of contamination and that 1,4-Dioxane concentrations are decreasing with time. The challenge at this site is that there are an insufficient number of properly spaced monitoring wells or monitoring well nests in which to measure hydraulic heads and determine hydraulic gradients, and there has been no vertical sampling of the aquifer (with the exception of the sampling of the borehole drilled during the installation of LB-3) to determine the horizontal and vertical extent of 1,4-Dioxane concentrations that require containment at Evergreen or Allison Streets.

PLS Response – *(See the above comment regarding the appropriate compliance point for determining plume containment.)The MDEQ has already determined that the current monitoring well network is sufficient to evaluate the effectiveness of the Evergreen System extraction wells on numerous occasions. As discussed in more detail below, it is unlikely that additional monitoring points will be useful in delineating the precise extent of the cone of depression around the LB wells because of the extremely flat gradient, particularly between the LB and Allison Street extraction wells.*

In terms of the adequacy of the existing well network, investigations have been ongoing in the Evergreen area since the early 1990, and routine water level and groundwater quality data have been collected from this area. PLS has worked with the MDEQ to investigate and develop a monitoring network for the extraction systems. The current MDEQ-approved Evergreen Monitoring Plan outlines the agreed upon locations and sampling frequencies for Evergreen area wells. Even after the MDEQ's approval of that plan PLS has been receptive to technically justified requests from the MDEQ for additional monitoring points. PLS has recently installed MW-107 and MW-113 in the LB/AE extraction areas in response to MDEQ requests. Prior to these wells, the last specific request from MDEQ was in 2004 when the MDEQ asked for another well northeast of the AE well. PLS installed the well (MW-92) at the location specified by the MDEQ.
(http://www.deq.state.mi.us/documents/deq-rrd-GS-EQMay2004MemoEGCZA.pdf).

Although PLS remains open to specific suggestions for additional monitoring locations based on a critical evaluation of data, generalized and unsupported complaints about the inadequacy of the existing dataset are not useful and do not provide a basis for departing from the MDEQ-approved monitoring well network. It is not appropriate for the MDEQ to now simply declare that the MDEQ-approved monitoring well network is suddenly inadequate without specific technical justification and an explanation of why the approved network is inadequate.

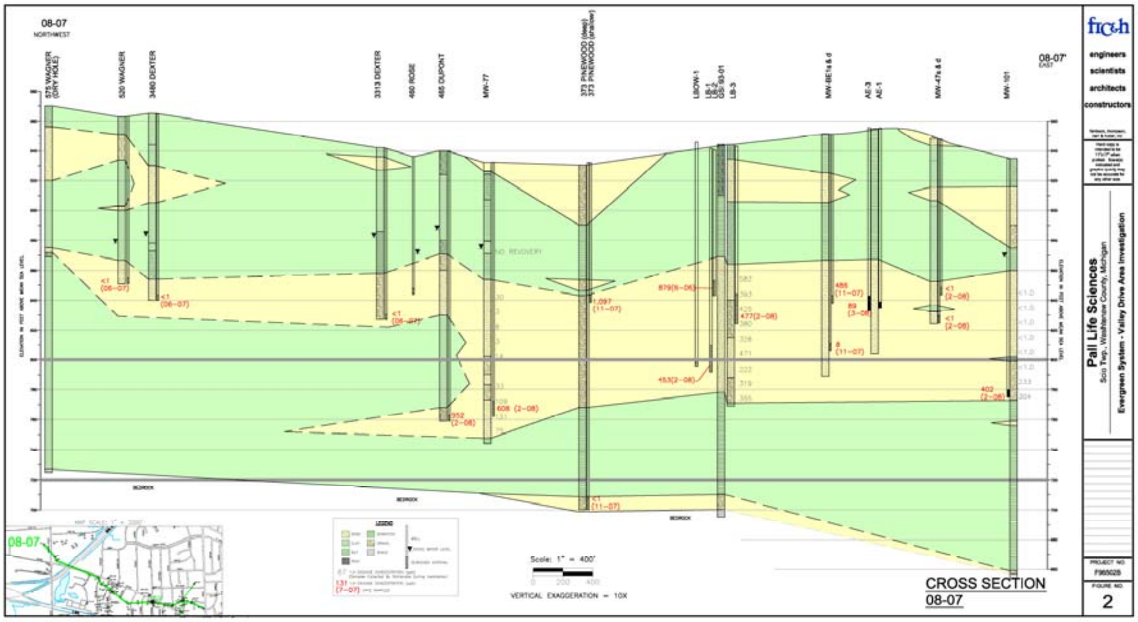
The MDEQ's assertion that "there has been no vertical sampling of the aquifer to determine the horizontal and vertical extent of 1,4-dioxane concentrations that require containment at Evergreen or Allison Streets" is simply wrong.

As MDEQ is well aware, PLS has done an extraordinary amount of vertical sampling as part of its site investigations. With very few exceptions, borings are routinely drilled to *the bedrock surface with vertical aquifer samples collected in all water bearing units. The ability (technology) to do such sampling accurately and efficiently to the depths sufficient to encounter bedrock has not always been available. At some historic locations, and with MDEQs full approval, PLS utilized the techniques then available, such as installing nested wells, to measure and monitor the vertical distribution of 1,4-dioxane in the aquifers. The locations and depths of the nested wells were selected only after a critical review of aquifer characteristics such as grain size distribution, aquifer thicknesses and 1,4-dioxane distribution information. PLS routinely discussed these screen placements with MDEQ before the wells were installed.*

Examination of Potentiometric Surface

An assessment of hydraulic gradients begins with an examination of hydraulic-head data or a potentiometric surface map. Figure 7 from the Valley Drive report shows the interpreted potentiometric surface of the "D2" aquifer. There are a couple of issues that we have with this map. The first is that head data from wells that are screened in zones that appear to be hydraulically-isolated from the aquifer within which the 1,4-Dioxane plume is found were used to prepare this potentiometric surface map. These data and the resulting potentiometric surface contours do not "make sense" given the contaminant migration direction of the 1,4-Dioxane plume that has been presented by FTC&H. The wells in question are found northwest of M-14 (along Wagner Road or Rose Drive) and along Valley Drive. It's our opinion that these wells reflect either "perched" or local flow conditions, or zones that are not well-connected to the "D2" aquifer. Focusing on the Evergreen wells, we do not believe that the potentiometric surface "high" centered on well MW-KZ1 is representative of heads or contaminant migration directions within the "D2" aquifer in this area. The relatively-high head measured in this well shows that there is significant resistance to groundwater movement between the screened interval in this well and the contaminated aquifer. This well appears to be screened in a zone that is not well-connected to the aquifer in which the contaminant plume is found. MW-KZ1 and MW-117 (discussed below), should not be used in preparing a potentiometric surface map for this aquifer. Taking these two wells out of the dataset used to map the potentiometric surface results in a surface that looks similar to the surface shown for the deeper "E" aquifer (see Figure 8 of the DuPont report, Unit E2 and Deeper DuPont Area Wells Potentiometric Surface Contour Map – February 25, 2008).

PLS Response *– The MDEQ suggests that wells MW-KZ1 and MW-117 are somehow disconnected or "perched" from Unit D2. The MDEQ has presented no data to support this opinion. PLS' interpretations of how these wells relate to various hydrofacies have been presented in various cross sections submitted to the MDEQ. These and other sections are provided again below. The MDEQ has never provided alternative interpretations or cross sections to those made by PLS that would explain how these two wells are isolated from the Unit D2. Therefore it is difficult for PLS to evaluate the basis for the MDEQ's new interpretation.*


08-07
NORTHWEST
575 WAGNER (DRY HOLE)
520 WAGNER
3480 DEXTER
3313 DEXTER
480 ROSE
465 DUPONT
MW-77
373 PINEWOOD (deep)
373 PINEWOOD (shallow)
LBOW-1
LB-1
LB-2
GS 93-01
LB-3
MW-BE1s & d
AE-3
AE-1
MW-47s & d
MW-101
08-07'
EAST
NO RECOVERY
BEDROCK
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Scale: 1" = 400'
0 200 400
VERTICAL EXAGGERATION = 10X
CROSS SECTION
08-07
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scientists
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Pall Life Sciences
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Evergreen System - Valley Drive Area Investigation
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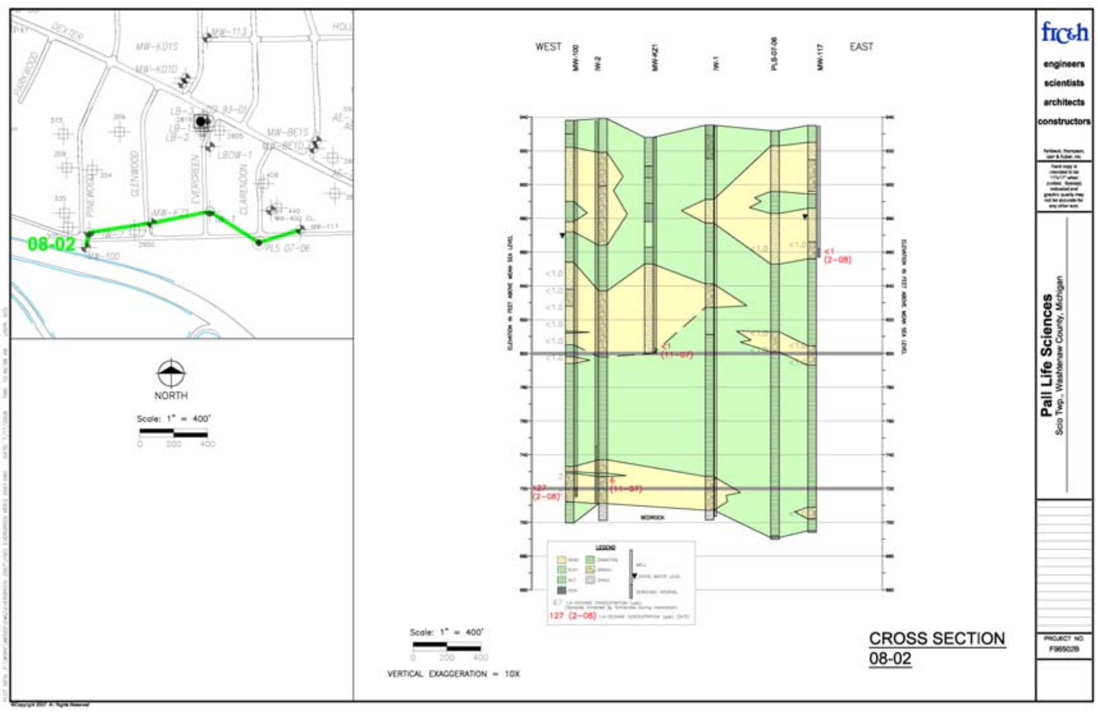
FIGURE NO.
2


08-02
DEXTER
PINEWOOD
GLENWOOD
EVERGREEN
CLARENDON
LBOW-1
PLS 07-06
NORTH
Scale: 1" = 400'
0 200 400
WEST
MW-100
IW-2
MW-KZ1
IW-1
PLS-07-06
MW-117
EAST
BEDROCK
LEGEND
Scale: 1" = 400'
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VERTICAL EXAGGERATION = 10X
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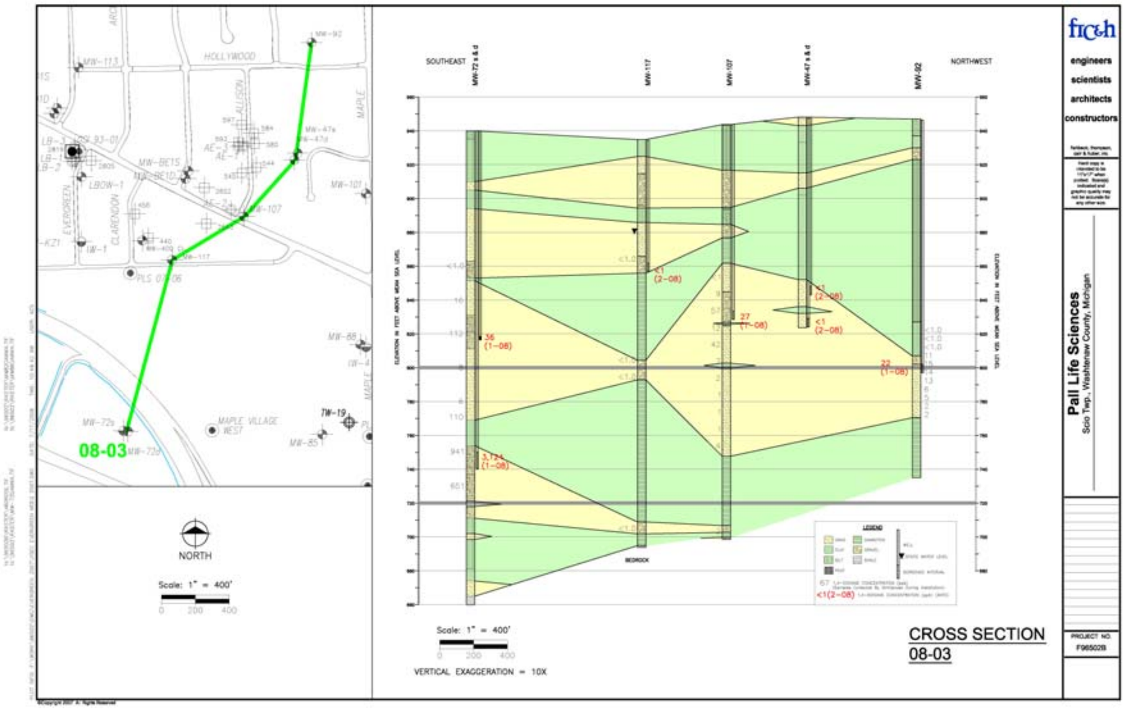
CROSS SECTION
08-03
SOUTHEAST
NORTHWEST
MW-72 s & d
MW-117
MW-107
MW-47 s & d
MW-92
08-03
NORTH
Scale: 1" = 400'
VERTICAL EXAGGERATION = 10X
BEDROCK
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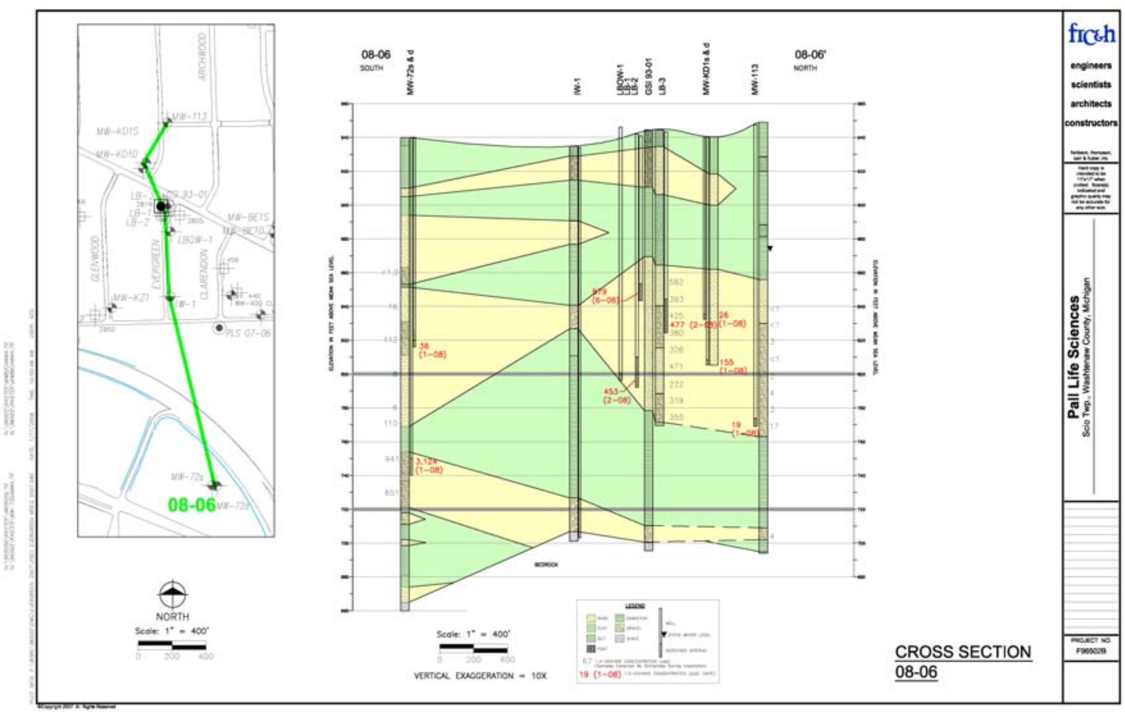
CROSS SECTION
08-06
08-06
SOUTH
08-06'
NORTH
MW-72s & d
IW-1
LBOW-1
LB-1
LB-2
GSI 93-01
LB-3
MW-KD1s & d
MW-113
NORTH
Scale: 1" = 400'
VERTICAL EXAGGERATION = 10X
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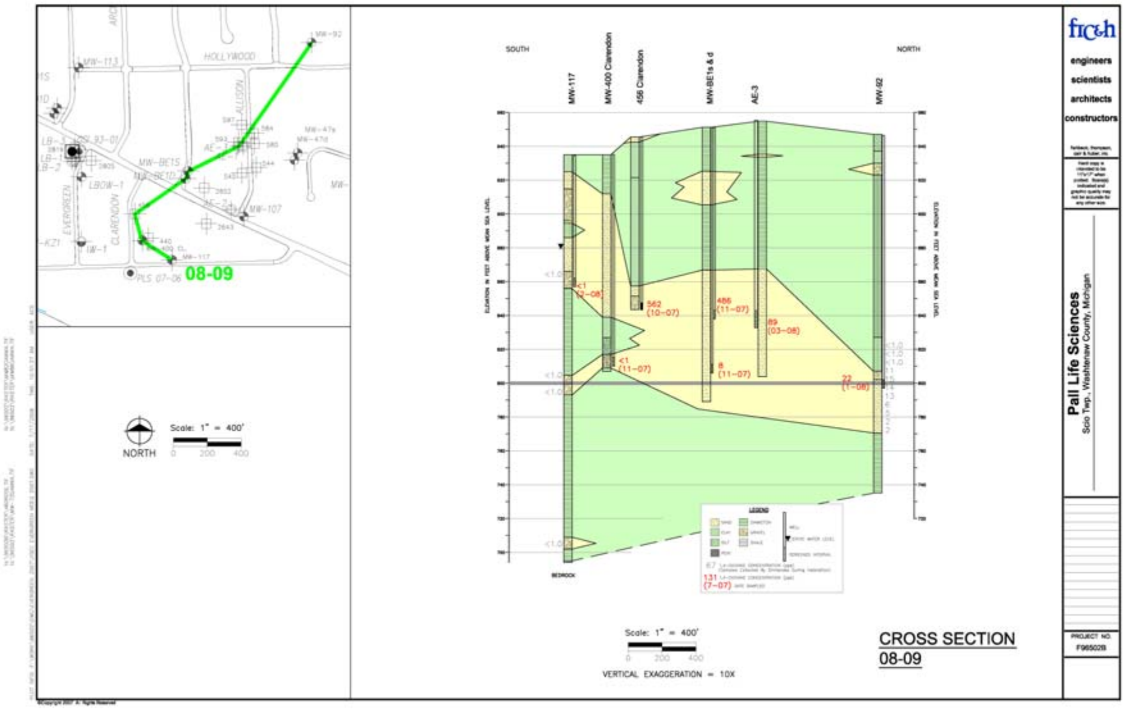


MW-KZ1 is completed at an elevation of 800 feet, the same depth as the LB-1 extraction well. Reasonable interpretations suggest this well is completed in the same aquifer as the LB-1 well. As such, PLS sees no justification for excluding water level data from this well.

The recently installed MW-117 is completed at a higher elevation (approximately 860 ft amsl). A review of cross section 08-09 indicates this well is completed slightly higher than the well at 546 Clarendon, which is obviously in the D2 aquifer based on the presence of 1,4-dioxane. When field decisions were being made regarding the completion of this well, it was decided to place it at this elevation to monitor the same zone as the contaminated well at 546 Clarendon. In our cross section interpretation, PLS has correlated this well to be hydraulically connected to the 546 Clarendon completion aquifer. Alternative interpretations to those made by PLS could result in MW-117 being completed in a hydrofacies above the one associated with Unit D2.

As interpreted on the cross sections 08-03 and 08-06, the hydrofacies associated with the Unit D2 plume to the north and the Unit E1 plume to the south are restricted in the area between MW-117 and IW-I. MDEQ ignores the presence of this important hydraulic feature, even though it appears to have an important role in separating the two plumes (as evidenced by the clear absence of 1,4-dioxane in this area) and as a possible explanation for the higher heads observed in this area.

Additionally, the MDEQ continues to assert that the boundary of the 1,4-dioxane plume is not defined; yet these cross sections clearly demonstrate that a boundary can be drawn between 456 Clarendon and MW-400 Clarendon and/or MW-117. This will be discussed later in this document.

Finally, the MDEQ suggests the potentiometric surface looks like that of the deeper E aquifer (Figure 8). In this case, the MDEQ is suggesting PLS compare two potentiometric surfaces in an area where there is a clear separation between these hydrofacies. The MDEQ fails to present a rationale for trying to associate these two aquifers in areas where they are clearly separated. Indeed, doing so would be inconsistent with the MDEQ's insistence that MW-KZ and MW-117 be excluded from PLS' analysis of the potentiometric surface/groundwater flow in this area.

In summary, PLS will continue to recognize the data from MW-KZ. Because there is a reasonable alternative for interpreting MW-117 in a shallower hydrofacies identified by PLS (not the MDEQ), PLS is willing to not contour water level data from this well in future maps. It should be noted, however, that PLS has provided many potentiometric surface maps of the Evergreen area without data from MW-117, a recently installed well. PLS interpretations regarding the capture of the Evergreen system will not change as a result of eliminating the data from this well in future maps.

The second issue is related to the drawing of a cone of depression (828-foot contour) around well LBOW-1, a non-pumping well. There does appear to be a "flattening" of hydraulic gradients in the vicinity of the LB wells, even after removing wells MW-KZ1 and MW-117. However, because the distribution of wells for monitoring hydraulic containment is not optimum or sufficient, it is difficult to determine whether a cone of depression is centered over the LB wells (the pumping wells), and whether there are hydraulic gradients toward wells LB-1 and LB-3, a necessary requirement to demonstrate hydraulic containment. The result is that the available data show no well-defined hydraulic gradients toward these extraction wells or hydraulic containment.

PLS Response – *(See the above comment regarding the appropriate compliance point for determining plume containment.) MDEQ suggests that there is no well defined hydraulic gradient toward the LB-1/3, but provides no support for this interpretation. In fact, there is a distinct gradient toward the LB wells from areas north and south of the LB extraction wells. Available data indicate that there is a hydraulic gradient from the MW-KD well nest, MW-113 and MW-KZ1 toward the LB area.*

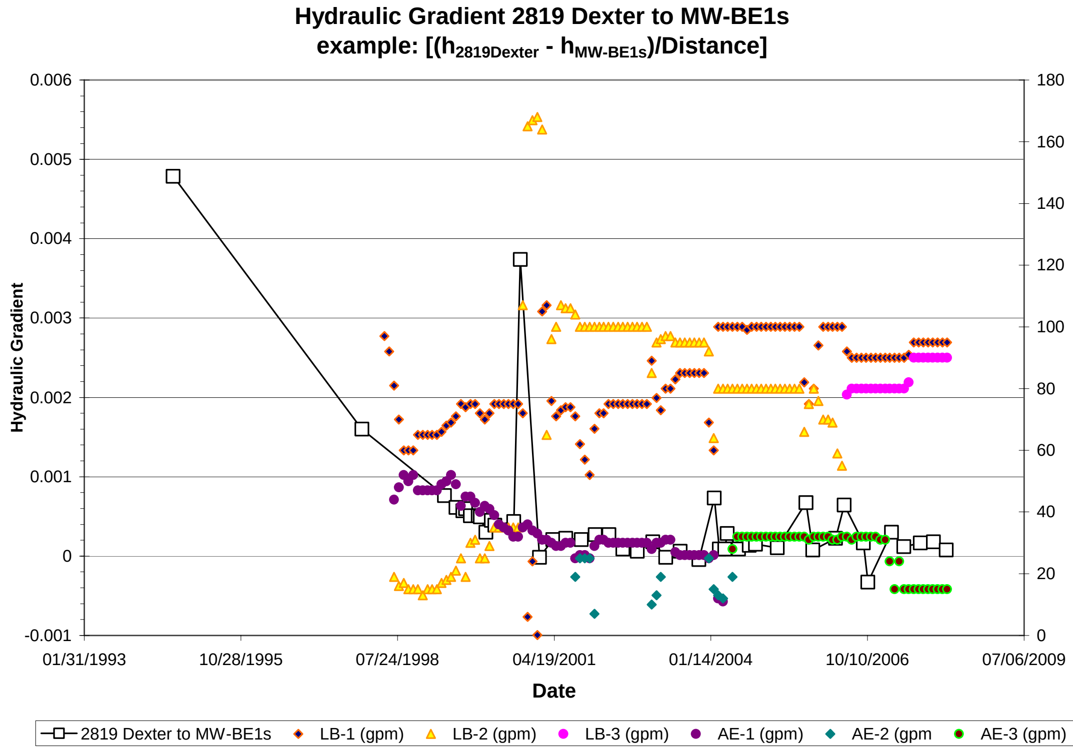
PLS and the MDEQ agree that the data indicate that there is a very flat hydraulic gradient in the area east of the LB wells, making it difficult to interpret the extent of capture in this direction solely from water level data. As discussed further below, this flattening of the hydraulic gradient is a result of years of continuous extraction and is an obvious indicator of the hydraulic influence that operation of the extraction wells has had on the aquifer (water levels in the Evergreen area have dropped up to 7 feet since operation of the Evergreen System). The flat hydraulic gradient is also created, in part, by the dual pumping of the LB and AE well sites, which sets up hydraulic competition *between the two purge locations. The absence of a well defined capture zone between the two extraction points is a result of the hydraulic characteristics of the aquifer, not the distribution or lack of measurement points. As explained below, it is unlikely that additional monitoring wells will provide greater definition of the capture zone east of the LB wells.*

Because the LB wells are pumping wells, and subject to hydraulic inefficiencies, PLS does not rely on head measurements from these wells (or show them on maps). The closest representative water level measurement locations for this area are 2819 Dexter (completed shallow in the aquifer) and LBOW-1 (completed deeper in the aquifer). Heads historically measured in the pumping wells are lower than either of these two wells. The water levels in these wells provide a conservative estimation of the actual drawdown created by extraction from the LB wells.

Comparing the water level data from 456 Clarendon and MW-400 Clarendon to the conservatively estimated water levels near the LB extraction wells indicate that there is an extremely flat hydraulic gradient between these two points. For instance, on December 6, 2007, the head difference between 2819 Dexter and 456 Clarendon (wells completed shallower in the aquifer) was approximately 0.02 feet (the head higher at 2819 Dexter). Considering the actual head in the pumping wells must be lower than 2819 Dexter by more than 0.02 feet, the actual gradient was_toward the LB area from 456 Clarendon.

It is easy to see from this analysis that the subtle head differences in the aquifer around the LB area make it difficult (if not impossible) to precisely define the capture area to the southeast toward 456 Clarendon and toward the MW-BE1 well nest. Even if more wells were available in this area, it is doubtful additional head data alone could be used to more precisely delineate the extent of capture for these areas. However, PLS interpretations that these areas fall within the capture of the Evergreen system is supported by the available data.

With the continued pumping of the LB wells, and the operation of the AE wells, the hydraulic gradient in this area has become nearly flat over time as the zone of influence created by these wells has increased in size. For example, the graph below shows how the hydraulic gradient between the LB area (2819 Dexter) and MW-BE1s has changed (decreased) over time and correlates to operation of the extraction wells, indicating that the influence of the LB wells has increased over time making it more likely that water from the MW-BE1s area will be captured by the LB wells.



Note: A positive number on the graph indicates the head in Well 1 > Well 2. For example, in the above graph, the head at 2819 Dexter is usually slightly higher than MW-BE1s so it plots above zero. If the number is negative, the head in Well 1 < Well 2. This convention applies to all similar graphs in this document.

This graph clearly shows that the magnitude of the hydraulic gradient has decreased between these two wells over time, and there is a direct correlation to the pumping regime.

A flat hydraulic gradient means very slow groundwater velocities and a limited potential for the migration of water (and the plume) from the extraction areas. A flat gradient also means a larger capture area for the extraction wells.

As PLS will present later in this document, the flat hydraulic gradients in the extraction well areas make groundwater velocities downgradient of the extraction wells extremely slow, especially between the LB and AE extraction wells. The MDEQ appears to overlook this basic hydrogeological fact in formulating its opinion that changes in 1,4-dioxane concentrations in selected wells are an indicator that the plume is migrating past the extraction wells. The 1,4-dioxane in this area isn't migrating anywhere to any measurable degree.

Evaluation of Groundwater Chemical Data

The 1,4-Dioxane concentration data from monitoring wells in the vicinity of, and including, LB-1, LB-2, and LB-3 were graphed and examined for temporal trends to determine whether the extraction wells have contained the contaminant plume, resulting in declining 1,4-Dioxane concentrations. The graphs of these data are shown in Figures 1 through 5 attached to this memorandum. Figure 1 shows the 1,4-Dioxane concentrations at the three LB extraction wells. From this figure, it should be apparent that these wells have removed 1,4-Dioxane contaminated groundwater from the aquifer, and that the concentrations of groundwater extracted by well LB-2 were considerably and consistently higher than either LB-1 or LB-3. Figure 2 shows the mass of 1,4-Dioxane removed per gallon of groundwater extracted (units are pounds per gallon). Since the pumping rates for each well were similar, the obvious conclusion is that the screened interval in well LB-2 was located closer to higher 1,4-Dioxane concentrations than the screens in either wells LB-1 or LB-3, and that well LB-2 was much more effective in removing 1,4-Dioxane from the aquifer than its replacement, LB-3.

Extraction well LB-2 was replaced by LB-3, a well that has a longer screen and is located to the north of LB-2. It is our opinion that the replacement well (LB-3) is not as effective as the well it replaced (LB-2) and that LB-3 is located farther from the highest 1,4-Dioxane concentrations that LB-2. We believe that this has resulted in less effective containment of the shallow contaminant plume and an increase in 1,4-Dioxane concentrations in monitoring wells that are east of Evergreen Street.

***PLS Response** – LB-1 and LB-2 were located approximately 20 feet apart; LB-2 being completed in the shallower portion of the Unit D2, and LB-1 being completed toward the base of the aquifer. Because 1,4-dioxane concentrations in the aquifer at that location are higher in the upper portion of the aquifer, LB-2 had higher mass removal rates than LB-1. However, it also had less available drawdown and eventually was unable to sustain its pumping rate and needed to be replaced.*

With the MDEQ's approval, PLS replaced LB-2 with a new well, identified as LB-3. Because there were increasing 1,4-dioxane levels on the northern boundary of the plume (1,4-dioxane concentrations at MW-KD-1d increased to above 85 µg/L), PLS and the MDEQ agreed that it would be prudent to place LB-3 slightly north of LB-2. There were also access issues making it difficult to install LB-3 right next to LB-2.

PLS agrees that LB-2 removed slightly more mass on a unit rate basis than its replacement well, LB-3. It does not necessarily follow, however, that LB-2 was closer to the higher concentrations of 1,4-dioxane. This observation could be explained by the fact that LB-3 utilizes a longer screen than LB-2. As a result, the replacement well draws water from a larger portion of the aquifer than LB-2 did, which may cause somewhat greater dilution of the highest concentrations as they are mixed with water from less concentrated areas.

Changes in 1,4-dioxane concentrations in individual wells east of the LB well DO NOT indicate that the pumping at LB-3 has resulted in "less effective containment" of the plume. Such changes are more likely attributable to shifts in the plume due to subtle hydraulic gradient changes around the extraction areas, as a result of moving the purge wells, or changing flow rates. Such changes would be reflected relatively quickly after LB-3 went into operation. As discussed further in other responses, 1,4-dioxane that was supposedly "released" by the shift from LB-2 to LB-3 cannot be the cause of the increased concentrations in monitoring wells east of Evergreen Street. The extremely slow groundwater flow velocities associated with the flat hydraulic gradient in this area rule out this possibility.

There are no data to indicate moving from LB-2 to LB-3 has reduced the capture effectiveness of the LB extraction wells.

Figures 3, 4, and 5 show 1,4-Dioxane concentrations at wells 2819 Dexter, 2805 Dexter, and MW-BE-1s, respectively. Also shown on these graphs are the pumping rates for LB-1, LB-2, and LB-3 (pumping rate on right-hand y-axes). From the plot of the extraction-well pumping rates, the time at which well LB-2 stopped pumping can be determined. As pumping rates in this well decreased and eventually stopped, the 1,4-Dioxane concentrations in nearby and downgradient monitoring wells increased, even though the replacement well, LB-3, pumps at a similar rate as LB-2. Keeping in mind that LB-3 is located to the north, it's our opinion, based on an examination of the existing dataset, that the greatest 1,4-Dioxane concentrations are probably located at LB-2 or to the south of LB-2. Turning off LB-2 appears to have allowed higher contaminant concentrations to move toward the well at 2819 Dexter Road and past Evergreen Street toward the wells at 2805 Dexter Road and MW-BE-1s. Lacking hydraulic-head data, it is not entirely clear whether or not the well at 2805 Dexter Road is within the extent of capture of the LB wells; however, since the increase in 1,4-Dioxane concentrations seen at the wells at 2819 and 2805 Dexter Road is observed at MW-BE-1s, we believe that this portion of the contaminant plume is not contained by the combined pumping by LB-1 and LB-3. We also do not believe that the contamination detected at MW-BE-1s can be contained by pumping the existing LB wells.

PLS Response *(See the above comment regarding the appropriate compliance point for determining plume containment.) 2819 and 2805 Dexter did appear to respond to LB-2 being taken offline and replaced by LB-3. This is not surprising since these are the closest wells to the LB wells. But again, this "response" is not an indication that the shift caused a portion of the plume to escape. Both of the Dexter wells are in the immediate vicinity of the LB extraction wells. These residential wells and any nearby 1,4-dioxane are certainly within the capture zone of the LB extraction wells, regardless of the configuration. Again, the changes in concentrations in these are undoubtedly attributable to shifts in the groundwater flow caused by the change in purge well locations and/or purge rates. These changes do not suggest that the plume has escaped.*

The increase at MW-BE-1s did not correlate to the LB-2/3 switch at all, since the increase occurred between October 27, 2005, and May 16, 2006, before LB-2 was taken offline.

The MDEQ indicates that "we do not believe that the contamination detected at MW-BE1s can be contained by pumping the existing LB wells," yet provides no basis for this opinion. Data provided in the recent capture zone analysis suggest the head difference between 2819 Dexter, next to the LB wells, and MW-BE1s is 0.05 foot (2819Dexter = 868.30 feet amsl, MW-BE-1s = 868.25 feet amsl). As discussed above, this almost certainly means that the groundwater flow is from MW-BE1s back toward the LB wells. Even if the MW-BE1s area is not "contained," as the MDEQ suggests, it is certainly in an area where the hydraulic gradient is extremely flat and flow velocities are minimal. (The actual groundwater velocity in this area is provided in a subsequent response later in this document.) Furthermore, this area is interpreted to be within the capture zone of AE-3, even under the most conservative modeling scenarios. To the extent MW-BE1s is not within the capture zone of the LB wells, that may be due to the extraction from the nearby AE-3 well.

Figure 6 shows the 1,4-Dioxane concentrations at the wells at 440 Clarendon and 456 Clarendon, along with pumping rate for the LB wells. Groundwater samples have been collected at 456 Clarendon since 1997 through the present, while sampling from the well at 440 Clarendon was stopped at the end of 2004. Data on this graph shows that concentrations of 1,4-Dioxane at 440 Clarendon and 456 Clarendon have continued to increase since 1997.

Pumping from LB-1 and/or LB-2 may have had an impact on stabilizing 1,4-Dioxane concentrations at 456 Clarendon (see graph between 2001 and 2005). We believe that the increase in concentrations from 2005 to the present at 456 Clarendon may be attributed to a reduction in pumping at LB-2 and shifting the pumping to LB-3, or simply a movement of contaminants from the west and south of the LB-series wells.

PLS Response – *(See the above comment regarding the appropriate compliance point for determining plume containment.) As reflected in the Stipulation regarding the AE-3 dispute resolution petition, the MDEQ and PLS recognized that the 1,4-dioxane detected at this well either originates within the Evergreen Subdivision area and is migrating south of the LB capture zone or is being drawn up from the Unit E1. The goal of the investigation was to determine which was occurring. Both explanations are plausible based on the currently available data. Regardless of the precise pathway of 1,4-dioxane to the Clarendon area, available data support that this area is within the capture of AE-3. This includes data from MW-107, which demonstrates elevated 1,4-dioxane concentrations in the Clarendon area are not moving east toward MW-101, as later suggested by the MDEQ.*

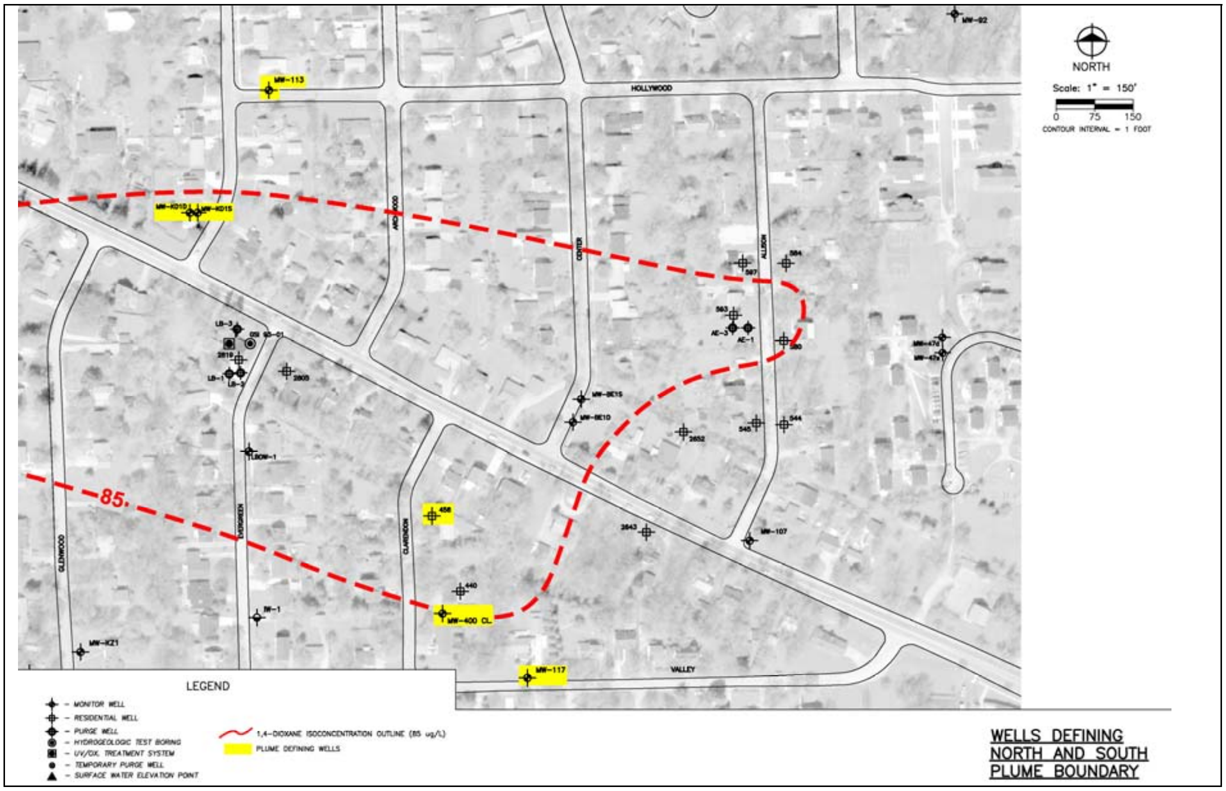
With the exception of the boring at LB-3, there has been no vertical sampling of the aquifer performed near the LB extraction wells or the delineation of the horizontal or vertical extent of the 1,4-Dioxane concentrations. As a result, we cannot determine the north-to-south horizontal extent of the contaminant plume, whether the contamination is limited to the shallow portion of the aquifer (as the data from monitoring well MW-BE-1s and d would suggest), and how much of the contaminant plume actually passes the LB-series extraction wells and migrates to the east. However, it is our opinion that the current extraction-well system (LB-1 and LB-3) does not contain all 1,4-Dioxane contaminant concentrations that exceed 85 micrograms per liter (ug/L). Also, replacing well LB-2 with LB-3 appears to have resulted in a loss of capture effectiveness.

PLS Response – *(See the above comment regarding the appropriate compliance point for determining plume containment.) Vertical aquifer sampling data would not have been useful in the decisions regarding the design of these wells. LB-1 is completed with a 20-foot screen at the base of the aquifer, and LB-2 was completed with a 10-foot screen at the top of the aquifer. The purpose of these wells was to capture the groundwater moving through this area and knowing the exact vertical distribution of 1,4-dioxane would not have affected the placement of these well screens.*

The MDEQ indicates that the north-south horizontal extent of the plume cannot be determined. This assertion has no technical basis and does not honor available data. PLS would like to point out the following. Please refer to the map below for reference:

1. *Approximately 225 feet north of the LB wells is the MW-KD well nest. The location of these performance monitoring wells were specifically installed to determine the northern boundary of the plume. The location of the wells and the methods used to install them were approved by the MDEQ prior to installation. More recently, MW-113 was drilled on the northern boundary of the plume. Both geological and water quality data from MW-113 correlates very well with the findings from the MW-KD well nest. That is, the geological data and the vertical distribution data from this well site match that found at the MW-KD well nest. It is obvious that the northern plume boundary lies somewhere between the MW-KD well nest and MW-113.*

2. *South of the LB wells, PLS has drawn the southern boundary of the plume at MW-400 Clarendon. VAS was performed at this well, MW-117, and boring PLS 07-06. North of MW-400 Clarendon is 546 Clarendon, a contaminated well. It is obvious there is sufficient control to the south to define the extent of the plume in that direction.*



Plume Containment at Allison

It is our understanding that the extraction wells at Allison Street (AE-1, AE-2, and AE-3) were installed to capture that portion of the 1,4-Dioxane plume not contained by the Evergreen wells. The extent of 1,4-Dioxane contamination and the locations and vertical screen placements for the AE-series extraction wells along Allison Street were based entirely on the sampling of residential wells, with no vertical aquifer sampling. Well AE-1 was installed in early 1998 and began pumping in mid-1998, and was eventually replaced by well AE-3 in early 2004. Well AE-2, located to the south along Allison Street near Dexter Road, was installed in 2001 and pumped only intermittently in 2001 and 2004.

***PLS Response** – MDEQs assertion that the screen placements of the AE-series were based entirely on sampling of residential wells is simply not correct. Placement of the screen zones for the AE wells was based on careful review of the geology and 1,4-dioxane distribution information from the nearby upgradient wells, specifically the MW-BE1 well cluster, which showed (and continues to show) that 1,4-dioxane concentrations in the AE area decreased with depth. This same observation (higher 1,4-dioxane concentrations shallower in the aquifer) has been made in the LB area and MW-107, immediately south of the AE wells, and MW-92, northeast of the AE wells.*

Knowing the specific vertical distribution of 1,4-dioxane at the AE location would not have changed the decision to install the well at its current depth. The wells needed to be *installed at the base of the contaminated portion of the aquifer in order to have sufficient available drawdown to make the extraction wells viable. If the wells were installed any shallower, they simply would not pump enough water to be effective.*

No data suggest 1,4-dioxane would migrate below the AE wells. Data from the MW-BE1 well nest, positioned upgradient of the AE area, clearly shows the plume travels toward the AE area in the upper portion of the aquifer, at the depth the AE wells have been screened. This similar distribution is observed in the LB area, at MW-107, south of AE, and at MW-92 to the north. Furthermore, even if there was 1,4-dioxane below the screen zone of the AE wells, it would be subject to the capture of the wells. In other words, a well does not have to be at the depth of the contamination in order to hydraulically capture it. PLSs recent capture zone analysis for the AE well assumes the aquifer is 90 feet thick.

Examination of Potentiometric Surface

Figure 2 from the AE Capture Zone report shows contours of the interpreted potentiometric surface of the "D2" aquifer and the calculated capture-zone widths for AE-3 discussed at the beginning of this memorandum. The contours on this figure are taken from Figure 7, a regional potentiometric surface map, found in the Valley Drive report. There are concerns with the data selected to create this surface and the contouring of the hydraulic-head data on this map. FTC&H states that there is a very favorable comparison between the calculated capture-zone widths and the potentiometric surface contours shown in Figure 2. We do not agree, primarily because we believe that the manner in which the hydraulic-head data are contoured is not correct. Specifically, the 868-foot contour is shown to curve to the northeast toward MW-92, emphasizing the appearance of hydraulic containment. There are no data north of MW-92 or MW-113 that would support this manner of contouring. The two available data point values support the drawing of this contour line much closer to well MW-113, at approximately one-third the distance between MW-113 and MW-92. This would follow a trend more in line with the contouring of the potentiometric surface for the "E" aquifer (Figure 8 in the DuPont Investigation report). In addition, the contouring presented in Figure 2 would suggest that the source of the low concentrations of 1,4-Dioxane found at MW-92 is located to the northwest of MW-92 and MW-113. Clearly, this contouring is not correct.

PLS Response *– The PLS interpretation of the potentiometric surface is not wrong. Where the 868 contour falls between the data points is subject to interpretation. As shown on the map below, the head between MW-92 and MW-110, wells completed in the same hydrofacies, decreases approximately 1 foot, indicating a southeast component of flow in the eastern portion of the Evergreen area. Recent data from the Rose Drive area clearly shows that groundwater flow in the Unit D2 equivalent hydrofacies is southeast toward Evergreen. Considering there is a southeast component of flow in both the western and eastern Evergreen areas, PLS' interpretation for the area near the AE wells is justified. MDEQs hypothetical interpretation does not appear to honor these data when suggesting that the 868 contour should be placed along a mathematical point* *closer to MW-113. PLS would welcome the opportunity to review the MDEQ's alternative contoured interpretation of these maps, if one is available.*

Furthermore, the MDEQ continues to suggest that the flow direction should be compared, or is related to the deeper Unit E flow, even though this aquifer is clearly separated from the shallower Unit D2 in portions of the Evergreen area. PLS sees no rationale for this comparison.

Another concern is in using the measured hydraulic-head data from wells MW-KZ1 and MW-117. This was discussed in previous paragraphs. It's our opinion that the relatively high hydraulic-head measurements from these wells give an erroneous picture of groundwater-flow directions, especially when combined with hydraulic-head data from wells screened in the "D2" aquifer in Evergreen. The inferred groundwater flow direction from Figures 2 (AE Capture Zone report) and 7 (Valley Drive report) in this area would be from MW-117 and MW-KZ1 to the north toward Dexter Road. If this was correct, the 1,4-Dioxane contamination found in the "D2" aquifer at 440 Clarendon and 456 Clarendon, or in the vicinity of Dexter Road, would have originated near Valley Drive. Clearly, MW-117 is not the source, since no 1,4-Dioxane was detected during the vertical profiling of this boring. In addition, from the geologic logs for MW-KZ1 and MW-117 it does not appear that there is a continuous aquifer or groundwater contamination present in this area. As stated above, these wells (MW-KZ1 and MW-117) should not be used in preparing a potentiometric surface map for this aquifer.

***PLS Response** – (See earlier comment regarding the use of MW-KZ1/MW-117 data.) As PLS indicated in its April 2008 report on the Valley Drive investigations, PLS current investigation has been unable to confirm or rule out the possibility that 1,4-dioxane migrates from the Unit E1 toward the LB extraction wells, either east or west of the MW-KZ1/MW-117 area.*

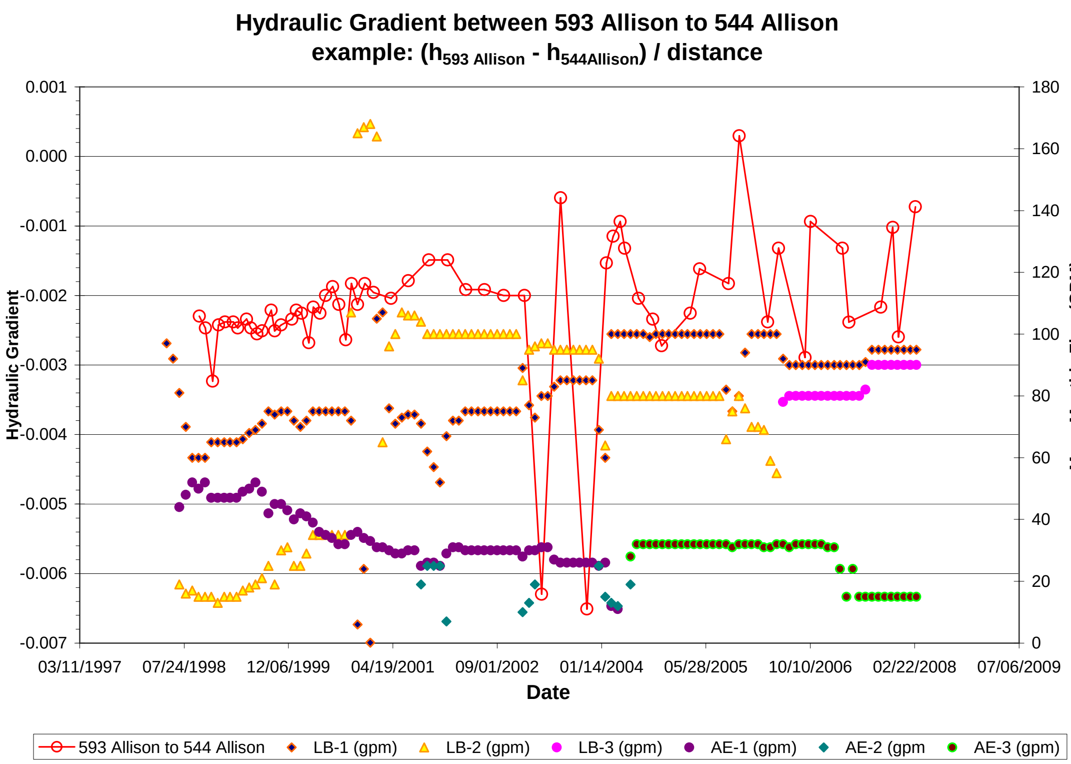
Finally, there are too few monitoring wells near Allison Street to assess hydraulic gradients or hydraulic containment in the vicinity of AE-3. The hydraulic-head data that are available do not show hydraulic containment at this well.

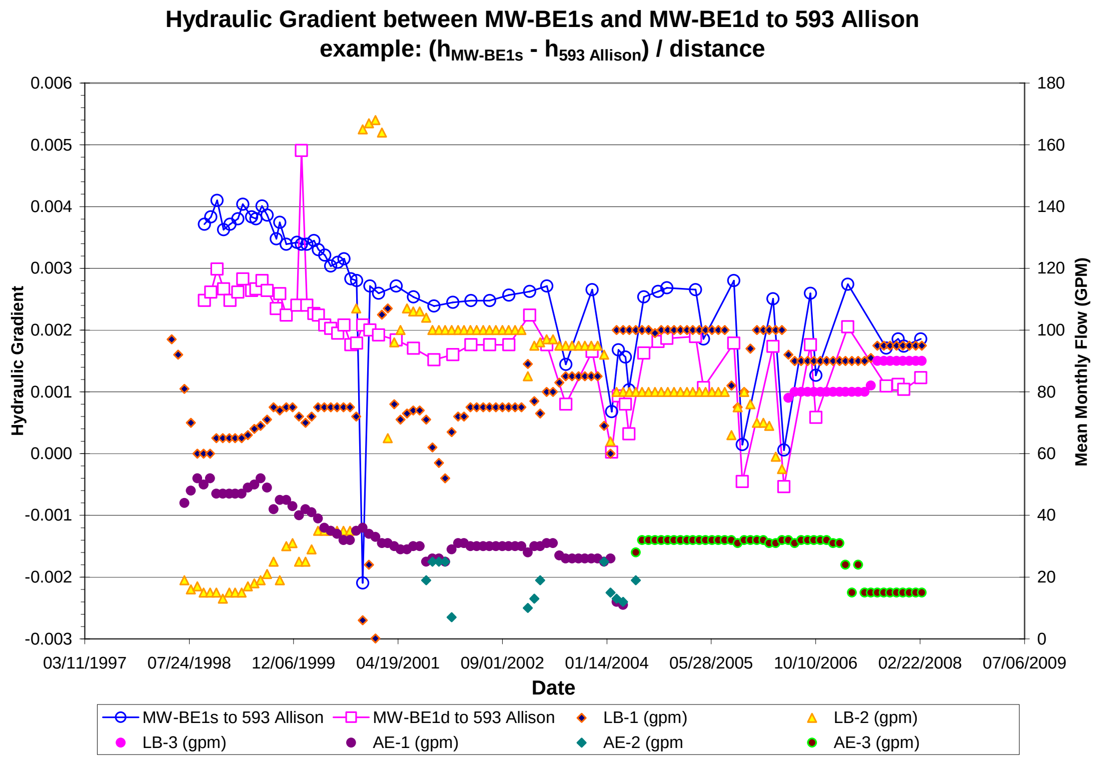
***PLS Response** – PLS agrees that the flat hydraulic gradients in the area of Allison Street make it difficult to demonstrate hydraulic containment solely through water level data. That is why PLS also relies on water quality data to confirm the capture zone predictions made through modeling. But PLS disagrees with the MDEQ's assertion that the hydraulic-head data that are available do not show hydraulic containment at this well. As mentioned earlier, use of pumping well data for head measurements is difficult due to hydraulic inefficiencies. As such, PLS does not routinely provide such measurements. The closest well to the AE pumping wells is 593 Allison, which is approximately 30-40 feet from AE-3. Obviously, under pumping conditions, the head in the purge wells would be less than at 593 Allison. This is also supported by water level data from the AE-3 when it was collected by PLS.*

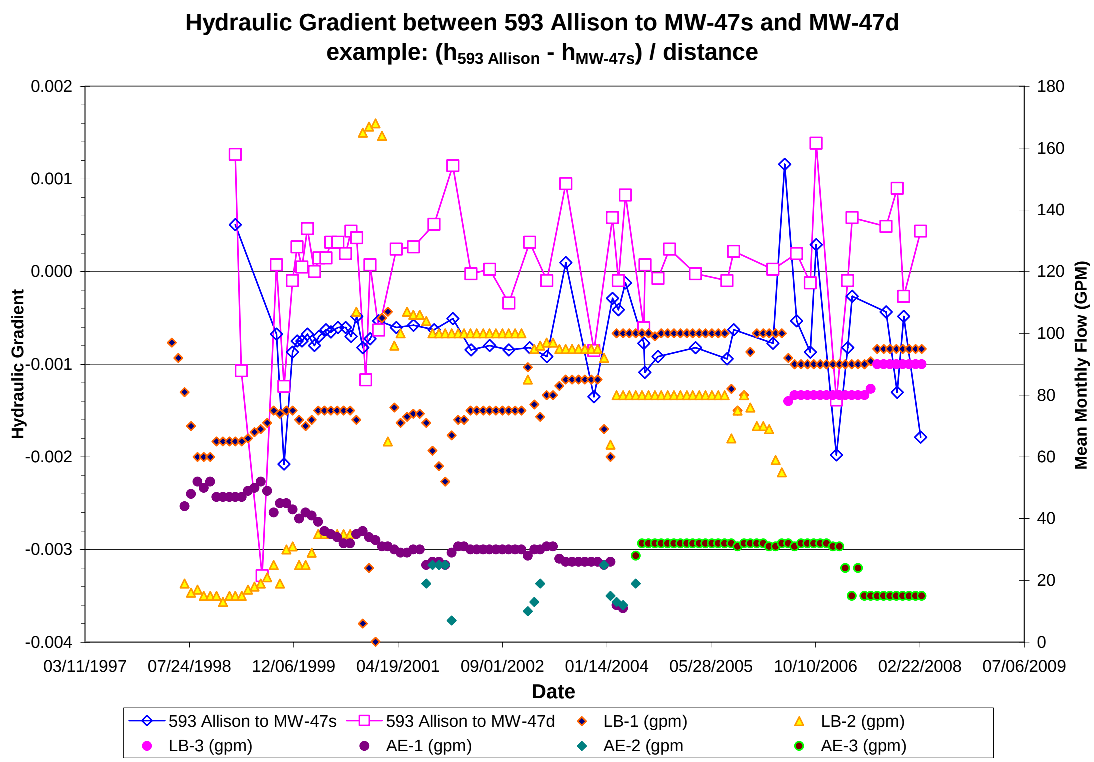
Water level data indicate there is a hydraulic gradient toward AE-3 from the MW-BE1 well nest. There has also been a consistent gradient toward AE-3 from 544 Allison. There has also consistently been a hydraulic gradient toward the AE-3 from MW-47s under pumping conditions. The direction of the gradient between 593 Allison and MW-47d has been mixed, but has mostly been toward 593 Allison. The direction of these hydraulic gradients are consistent with capture zone analyses submitted by PLS, including the recent analysis calculated using the capture zone equation.

It should also be noted the hydraulic gradients in the area of the AE wells are slightly steeper than around the LB wells. This is consistent with the fact that the aquifer is not as productive in this area.

The following graphs are provided to support the aforementioned statements and show how these gradients have changed through time in response to pumping.




Hydraulic Gradient between MW-BE1s and MW-BE1d to 593 Allison
example: (h_MW-BE1s - h_593 Allison) / distance
Hydraulic Gradient
Mean Monthly Flow (GPM)
Date
03/11/1997
07/24/1998
12/06/1999
04/19/2001
09/01/2002
01/14/2004
05/28/2005
10/10/2006
02/22/2008
07/06/2009
MW-BE1s to 593 Allison
MW-BE1d to 593 Allison
LB-1 (gpm)
LB-2 (gpm)
LB-3 (gpm)
AE-1 (gpm)
AE-2 (gpm
AE-3 (gpm)


Hydraulic Gradient between 593 Allison to MW-47s and MW-47d
example: (h_593 Allison - h_MW-47s) / distance
Hydraulic Gradient
Mean Monthly Flow (GPM)
Date
03/11/1997
07/24/1998
12/06/1999
04/19/2001
09/01/2002
01/14/2004
05/28/2005
10/10/2006
02/22/2008
07/06/2009
593 Allison to MW-47s
593 Allison to MW-47d
LB-1 (gpm)
LB-2 (gpm)
LB-3 (gpm)
AE-1 (gpm)
AE-2 (gpm)
AE-3 (gpm)

Evaluation of Groundwater Chemical Data

All 1,4-Dioxane concentration data from monitoring wells in the vicinity of, and including, AE-1, AE-2, and AE-3 were graphed and examined. The purpose of graphing these data is to determine whether the contaminant plume has been contained by the AE extraction wells or is migrating past Allison Street. These graphs are shown in Figures 7 through 10 attached to this memorandum. As with the area surrounding the Evergreen Street wells, there are no borings upgradient of, near, or immediately downgradient of the AE extraction wells, within which vertical aquifer sampling was performed. As a result, this makes an assessment of the horizontal or vertical extent of the contaminant plume and hydraulic containment on the basis of chemical analyses difficult, especially given the known vertical variability of 1,4-dioxane concentrations at this site.

***PLS Response** – The MDEQ has provided no credible evidence that the MW-BE and MW-47 well nests, installed at locations and with methods approved by the MDEQ, are not valid monitoring wells.*

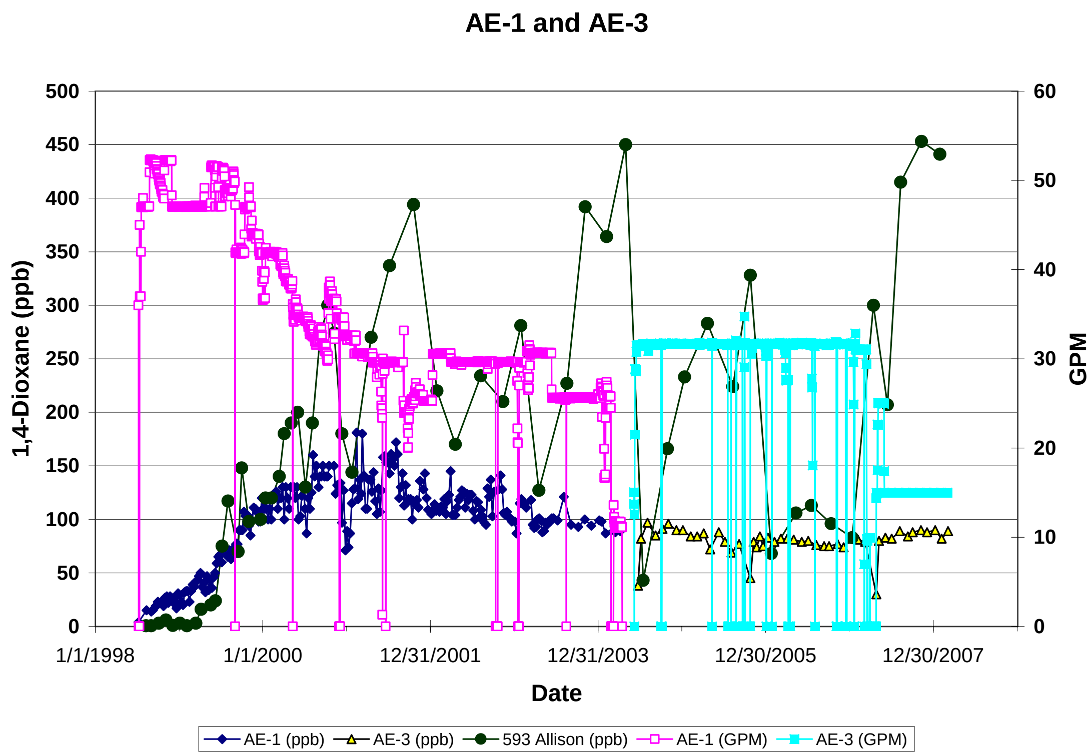
When the MW-BE well nest was installed, trace levels of 1,4-dioxane were detected in the wells. VAS would have provided little benefit in determining an appropriate screen depth for these wells. Nevertheless, it is clear that MW-BE-1s, completed at a depth similar to LB-2 and 456 Clarendon, is in the pathway of 1,4-dioxane. MW-BE-1d is positioned deeper in the aquifer and has detected only low levels of 1,4-dioxane. Decreasing 1,4-dioxane levels with depth is characteristic of the LB/Allison area. MW-107, located south of the AE wells and east of the LB wells, provides additional support that the vertical distribution of 1,4-dioxane decreases with depth in this area, and further supports that the vertical extent of the Unit D2 plume is being both captured and monitored effectively.

MW-47s/d were installed out in front of the plume June of 1999. VAS would have likely provided little benefit in determining an appropriate screen depth for these well since available data indicate 1,4-dioxane was not present at these locations when the wells were installed. Nevertheless, these wells are completed at the same depth and in the same aquifer as the AE wells are MW-BE1s. MDEQ participated in the selection of placement (location) of these wells and the methods used for the installation of these wells. They have been an important part of PLS' MDEQ-approved monitoring plan since they were installed.

Figure 7 shows 1,4-Dioxane concentrations in sampled wells between Evergreen and Allison and the pumping rate for well LB-2. After well LB-2 was shut-down, the 1,4-Dioxane concentrations in wells at 2805 Dexter, MW-BE-1s, and 593 Allison increased. It appears that the change in the LB-series well system has resulted in a release of higher concentration 1,4-Dioxane that has migrated to Allison Street.

***PLS Response** – (See the above comment regarding the appropriate compliance point for determining plume containment.) 2819 and 2805 Dexter did appear to respond to LB-2 being taken offline and replaced by LB-3. This is not surprising since these are the* *closest wells to the LB wells. But again, this "response" is not an indication that the shift caused a portion of the plume to escape. Both of the Dexter wells are in the immediate vicinity of the LB extraction wells. These residential wells and any nearby 1,4-dioxane are certainly within the capture zone of the LB extraction wells, regardless of the configuration. Again, the changes in concentrations in these are undoubtedly attributable to shifts in the groundwater flow caused by the change in purge well locations and/or purge rates. These changes do not suggest that the plume has escaped.*

Concentrations at 593 Allison have been sensitive to changes in purge rates of the AE extraction wells for the same reasons. A graph of 1,4-dioxane concentrations at this well location are shown below. It is clear that the concentrations at this location have varied considerably over time. The MDEQ has no scientific basis to relate any changes at this location to some "release of higher concentrations of 1,4-dioxane that has "migrated" to Allison Street." A simpler explanation is that the concentrations at 593 Allison correlate to extraction at the AE locations (note on the graph below that when AE-1 and AE-3 flow changes, there is a corresponding change in 1,4-dioxane concentrations at this well). This is another example of how subtle changes in hydraulic gradients, in this case by flow rate changes in the AE area, can cause a trend change. The MDEQ's interpretation that these changes are related to an escaping plume "migrating" from the LB area is fundamentally flawed and cannot be supported.

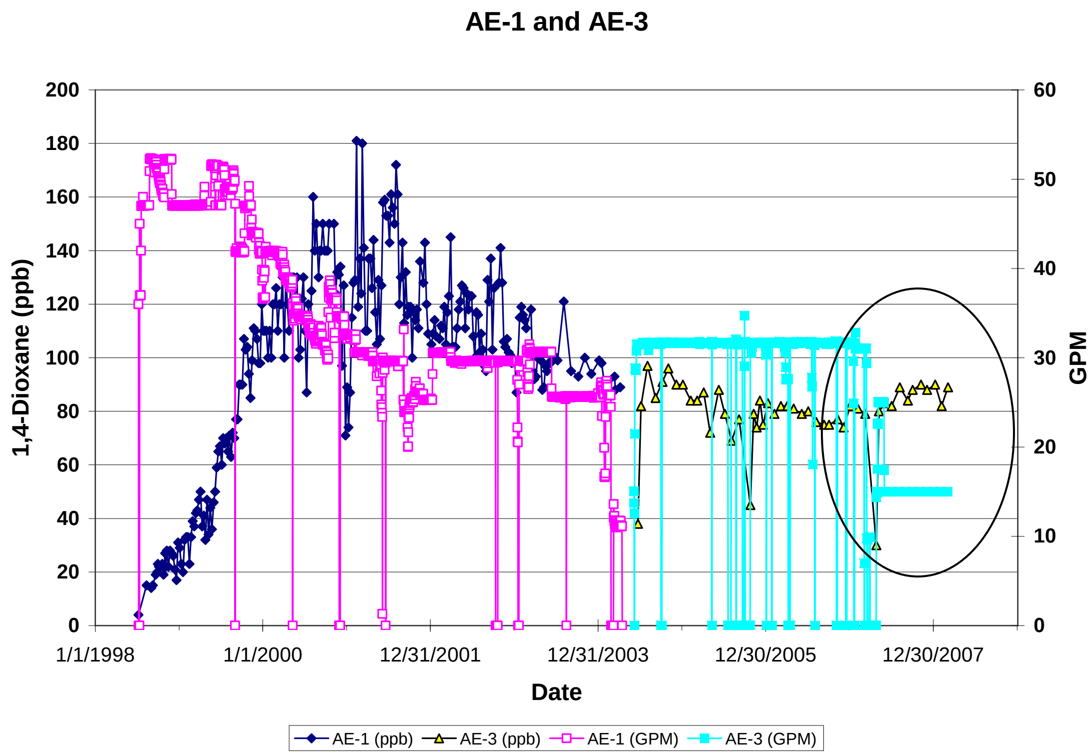


Furthermore, a review of water level data provided to the MDEQ clearly demonstrates a very flat hydraulic gradient between the LB area and MW-BE-1s as a result of purging and hydraulic "competition" between the LB and AE wells. On February 25, 2008, the *head in the LB area (2819 Dexter) was measured at 868.30 ft amsl. At MW-BE-1s, the head was 868.25 ft amsl, a difference of 0.05 in a distance of approximately 700 feet. This results in a hydraulic gradient of 0.05/700 = 0.000071 ft/ft. Using a hydraulic conductivity of 240 ft/day (a very conservatively high number derived from the LB-1 aquifer test), and a porosity of 25 percent, the groundwater velocity between these two points is approximately 0.068 ft/day. This calculation suggests it would take 10,294 days (28 years) for water to travel between these two locations. These calculations alone indicate the MDEQ's opinion that the increase in 1,4-dioxane concentrations at MW-BE-1s is a result of "higher concentrations of 1,4-dioxane migrating to Allison" is fundamentally flawed and implausible.*

The more plausible explanation for the observed changes would be subtle shifts in plume distribution in a hydraulically "stagnant" area of the plume, resulting from changes in flow rates (AE-3 changes) and changes in purge well locations (LB-2/3). This is clearly the case with 593 Allison.

The mass of 1,4-Dioxane removed per gallon extracted from the Allison-series wells is shown in Figure 8. The mass removal rate, while low, had been fairly consistent until mid-2003 when removal rates started declining. Throughout 2006, the removal rate remained fairly consistent and then started increasing in 2007. The concentrations of 1,4-Dioxane in the AE-series wells and the pumping rates at LB-2 and total LB-series pumping are shown in Figure 9. There has been an increase in 1,4-Dioxane concentrations at AE-3 since early 2007, and there had been a continuous increase in 1,4-Dioxane at AE-2 until sampling stopped in 2006. It's our opinion that the increase in mass removal rates and 1,4-Dioxane concentrations is the result of a partial loss of containment by the LB-series wells.

PLS Response – *The MDEQ's theory ignores the obvious explanation for the minor increased concentrations and mass removal rates observed in 2007. The flow rate of AE-3 was reduced during 2007. By reducing the flow rates, the concentration in AE-3 increased very slightly. Increases in contaminant concentrations are typical when flow rates in extraction wells since there is less dilution in the capture area (the influent concentration for purge wells is often inversely proportional to flow). This is illustrated in the graph below. The slight increase in 1,4-dioxane concentration simply resulted in a slightly increased mass removal efficiency (when normalized to gallons purged, as the MDEQ did in their analysis- lbs/day/gallon).*



Plot of Extraction Rate (gpm) and 1,4-Dioxane Concentration at AE-1 and AE-3

Figure 10 shows the 1,4-Dioxane concentrations in Allison Street residential wells. As shown in this figure, except for the residential wells at 544, 545, and 593 (shown in Figure 7) Allison, all other previously sampled wells have been dropped from the sampling network. There had been a steady increase in concentrations in wells at 580, 584, and 597 Allison between early 1997 and late 2003 or 2004 when sampling each of these wells stopped. The reason for this increase is not known. The 1,4-Dioxane concentrations at 544 Allison decreased between 2001 and 2003. However, since early 2005, the 1,4-Dioxane concentrations in the wells at 544 and 545 Allison have increased steadily. This increase appears to be the result of higher 1,4-Dioxane concentrations migrating past the LB-series wells toward Allison Street.

PLS Response – *(See the above comment regarding the appropriate compliance point for determining plume containment.) 544 and 545 Allison are still in low ppb range, and changes at these locations are not an indication that the plume is not contained by the LB or AE wells. Additionally, these "increases" started in spring 2005, long before LB-2 was taken offline. Therefore, that shift in purge locations cannot be the control mechanism.*

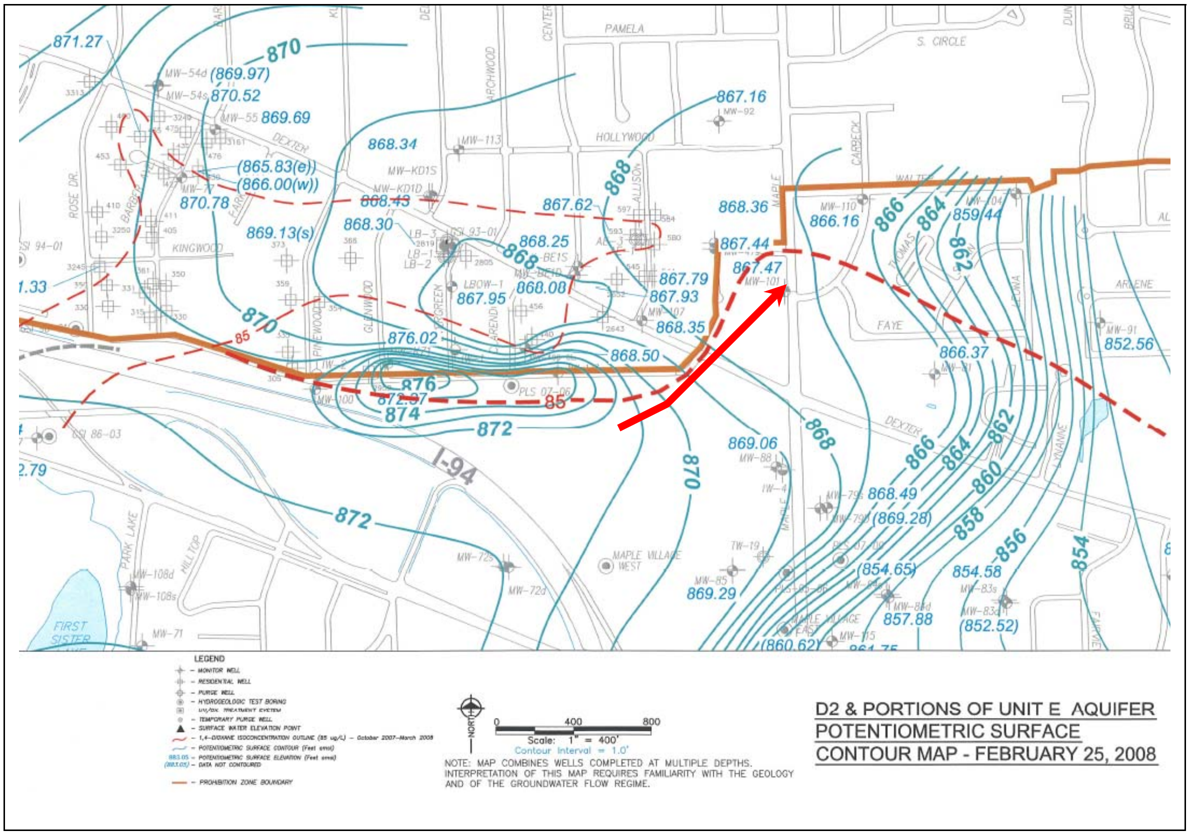
A simpler explanation for the increases at 544 and 545 Allison is that AE-3 began to operate more intermittently during that period (see earlier graph). Another plausible explanation is that any increase in the concentrations at these wells is due to contribution from the Unit E. Either of these explanations is more likely than the MDEQ's hypothesis.

As for the area near the AE-series wells, there has been no good long-term sampling network east of Allison Street. PLS has relied on sampling the monitoring well clusters MW-47s and d to demonstrate containment of the contaminant plume. However, as shown in cross sections 08-07 and 08-03 (Figures 2 and 4 in the Valley Drive report), these wells are very shallow and were not installed using vertical aquifer sampling techniques. We cannot be certain that these well screens are placed in the proper vertical location, especially given the downward hydraulic-head gradient at this location and the elevated 1,4-Dioxane concentrations detected in the vertical aquifer sampling in the borehole for LB-3 and at well MW-101 (see Figure 2 in the Valley Drive report). There is no demonstrated "clean zone" (as drawn by FTC&H in all previous investigation or sampling reports) that would indicate that the 1,4-Dioxane detected at MW-101 is not the result of 1,4-Dioxane moving from Evergreen toward this well.

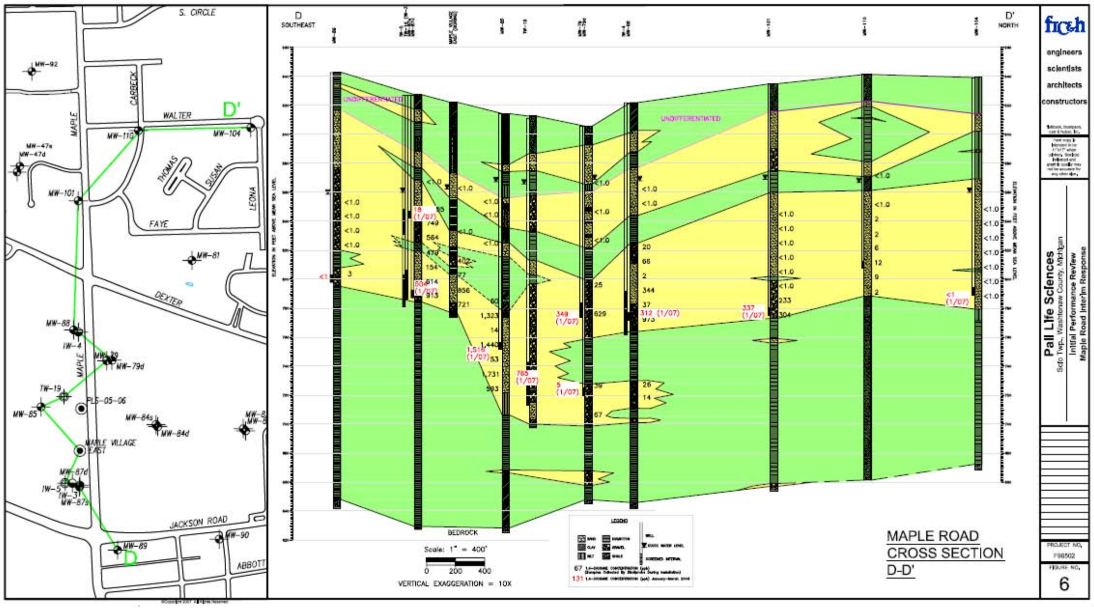
PLS Response *– The MDEQ's suggestion that there is "no long-term monitoring network east of Allison" ignores the existence of the Evergreen Monitoring Plan approved by the MDEQ.*

The MDEQ is suggesting that elevated 1,4-dioxane concentrations at MW-101 are related to Evergreen and not Unit E to the south. This speculation has no basis. The following is offered in response to this unsupported assertion:

1. *Groundwater flow in the combined Unit E/D2 hydrofacies is from the southwest, toward MW-101, suggesting the 1,4-dioxane at this location comes from Unit E to the southwest. This is shown on the map below:*

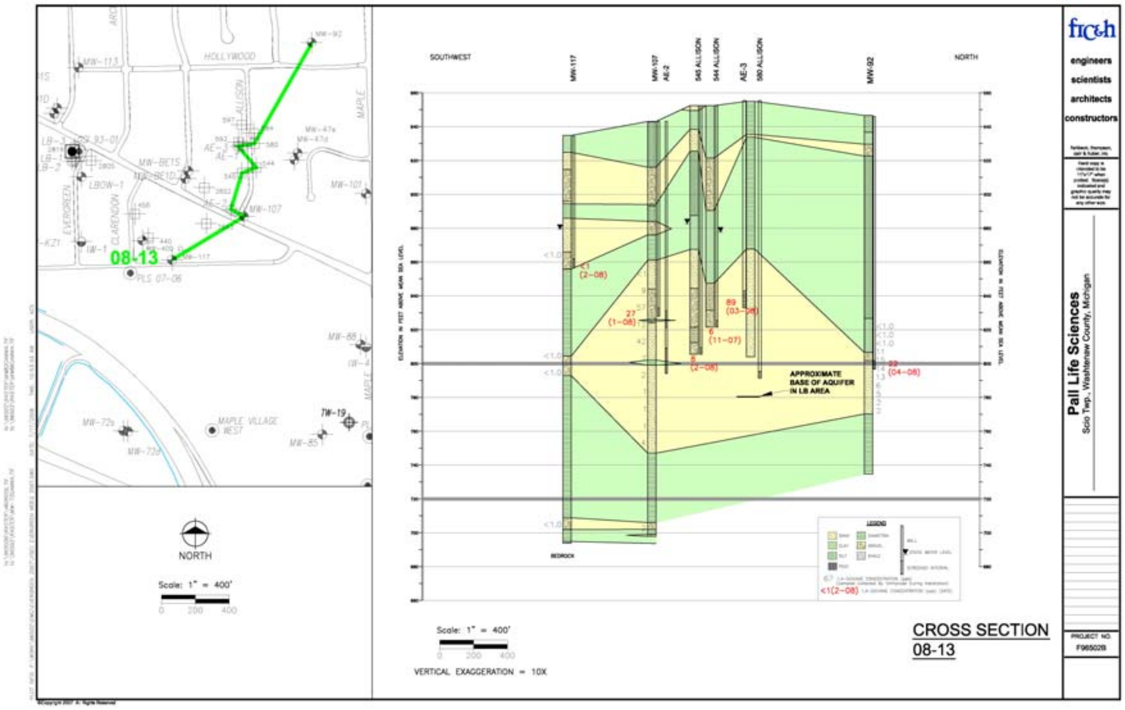


2. *VAS data from MW-101 clearly demonstrates that the highest 1,4-dioxane concentrations are at the base of the aquifer at this location. As pointed out by the MDEQ, 1,4-dioxane concentrations in the Evergreen area around the extraction wells are higher in the upper portion of the aquifer. The vertical distribution of 1,4-dioxane at MW-101 is more consistent with the distribution of 1,4-dioxane in Unit E monitoring well MW-88. This is shown on the cross section below:*



3. *VAS data from MW-107, slightly south of a line between the LB wells and MW-101, demonstrates that the highest 1,4-dioxane concentrations at that location are in the top portion of the aquifer. This is also consistent with data from MW-92 and the MW-BE well nest. It should also be noted that the aquifer is thick at MW-107 suggesting this area would be in a preferred flow path. 1,4-Dioxane concentrations at this MW-107 are decreasing and are below 85 µg/L.*

4. *Groundwater from domestic wells at 544 and 545 Allison has been sampled routinely and has not shown 1,4-dioxane concentrations in excess of 85 µg/L. Groundwater samples from 580 Allison were also below 85 ug/L. These wells are positioned north of MW-107, south or east of the AE wells, and are shown on the cross section below.*



These wells are completed at deeper depths than MW-107 and AE-3 and the data from these wells indicate that there are no elevated levels (greater than 85 ug/L) of 1,4-dioxane in the deeper portion of the Unit D2 aquifer at depths that correspond to the base or the aquifer in the LB well area and the elevation of the MW-101 well screen. It should also be noted that the driller's logs for these wells indicate an abundance of fine sands at these locations, consistent with PLS' observations at AE-1/3 and further support for the lower hydraulic conductivity used for capture zone calculations in the area of AE-1/3. It should also be noted that cross section 08-13 includes MW-107. The base of the aquifer at this location is lower than in the LB area (elevation of approximately 780 feet amsl) and the Maple Road area (770 to 780 feet amsl). As such, this cross section infers a greater thickness of aquifer under the AE area than likely exists.

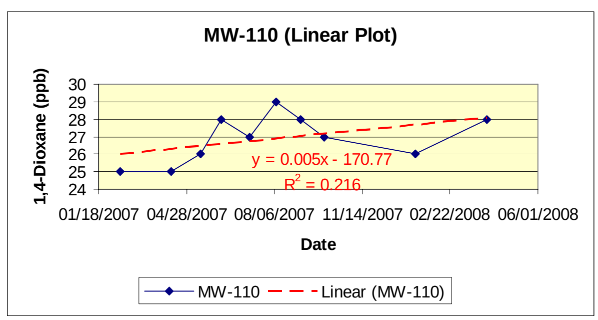
In summary, the MDEQ's implication that elevated concentrations of 1,4-dioxane at MW-101 relate to the Evergreen System is without basis and is affirmatively contradicted by all available data.

Figure 11 shows the 1,4-Dioxane concentrations in wells downgradient of Allison Street that were installed using vertical aquifer sampling, these are MW-92, MW-101, and MW-110. The concentrations in wells MW-101 and MW-110 have shown an increase since 2007. There has not been a similar increase observed at well MW-92. Wells MW-101 and MW-110 are located in a downgradient direction from extraction well AE-3. The increase in 1,4-Dioxane concentrations in these wells may be related to the increased 1,4-Dioxane concentrations migrating toward Allison Street from Evergreen and a decrease in pumping rates at AE-3 from approximately 30 gpm to 15 gpm. Only the concentrations at MW-101 exceed 85 ug/L.

***PLS Response** – The MDEQ's attempt to attribute supposedly rising concentrations at MW-101 and MW-110 to "increased 1,4-dioxane concentrations migrating toward Allison Street from Evergreen and a decrease in pumping rates at AE-3 from approximately 30 gpm to 15 gpm" is not credible. The so-called increasing trend in MW-110 is based on minor variations in concentrations that are easily explained by normal variability in sampling results, as explained below. The MDEQ certainly presents no evidence that this "trend" is an indication that the Evergreen plume is not being captured. Incredibly minor trends in monitoring results – all of which are well below the cleanup criterion – are not an indicator that concentrations above 85 µg/L has escaped the capture of the Evergreen System. MW-101 is the only well over 85 µg/L, and it is clear that 1,4-dioxane at this location is related to the Unit E plume to the south, not Evergreen (as discussed earlier in the previous response).*

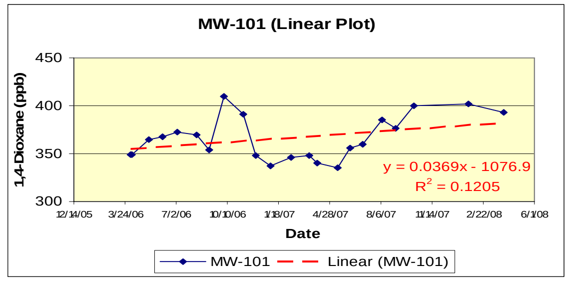
The table below shows the sampling results for MW-110 and a plot of these results. MW-110 has had a range in concentration values of approximately 4 µg/L, with initial concentrations at 25 µg/L (2/12/2007), the highest concentration at 29 µg/L (8/8/2007), and the most recent concentrations at 28 µg/L (4/4/2008). The very minor (4 µg/L) range of 1,4-dioxane concentration values at this location could be attributed to a variety of factors (e.g., sampling variation, analytical variation, seasonal trends, etc.), unrelated to changes in the Evergreen System.

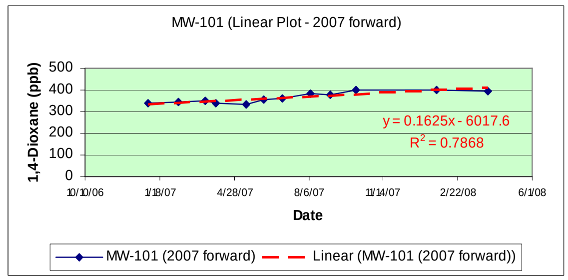
MW-110 Date Sampled	1,4-Dioxane Results (µg/L)
02/12/2007	25
04/11/2007	25
05/14/2007	26
06/07/2007	28
07/09/2007	27
08/08/2007	29
09/05/2007	28
10/02/2007	27
01/14/2008	26
04/04/2008	28
Historical	
Minimum	25.0
Maximum	29.0
Average	26.9
Standard Deviation	1.4



The table and graphs below depict the results for MW-101. Graphs showing both the historic 1,4-dioxane concentrations (4/4/2006 to 4/3/2008), and the year 2007 and *forward data are also provided. The concentration values have oscillated through the period of record through a total range 75 µg/L (maximum 410 µg/L; minimum 335 µg/L).*

MW-101 Date Sampled	1,4-Dioxane Results (µg/L)
04/04/2006	349
04/07/2006	349
05/09/2006	365
06/06/2006	368
07/05/2006	373
08/10/2006	370
09/05/2006	354
10/03/2006	410
11/10/2006	391
12/04/2006	348
01/02/2007	337
02/12/2007	346
03/20/2007	348
04/03/2007	340
05/14/2007	335
06/07/2007	356
07/02/2007	360
08/08/2007	385
09/04/2007	376
10/09/2007	400
01/24/2008	402
04/03/2008	393
Historical	
Minimum	335.0
Maximum	410.0
Average	366.1
Standard Deviation	22.5
2007 Forward	
Minimum	335.0
Maximum	402.0
Average	364.8
Standard Deviation	25.2

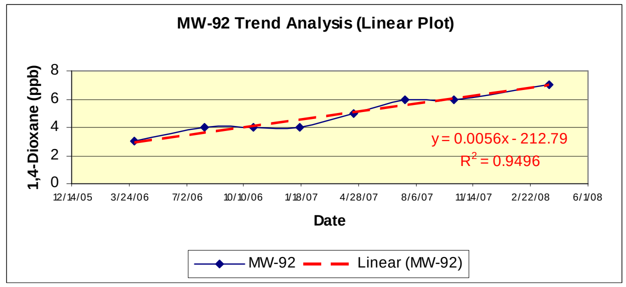


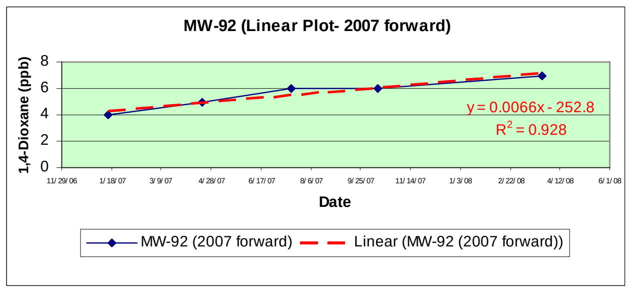


Any "trends" at this location are much more likely to be influenced by activities in the Maple Road area (extraction, injection), rather than by Evergreen.

The MDEQ states "The concentrations in wells MW-101 and MW-110 have shown an increase since 2007. There has not been a similar increase observed at well MW-92." We are confused by this statement, since the "trend" in the data at MW-92 is no different than the "trend" at MW-110. The 1,4-dioxane concentrations have "increased" from 3 µg/L on 4/3/2006 to 7 µg/L on 3/25/2008. Thus concentrations in this well increased by the same 4 µg/L increment as the MW-110 concentrations did. The slope is positive, *suggesting a generally increasing trend, although the concentration values have a total range in values of only 4 µg/L. As is the case with MW-110, this minor increase of approximately 4 µg/L could be attributed to a variety of factors (e.g., sampling variation, analytical variation, seasonal trends, etc.). The table below shows the sampling results for MW-92 and associated trend graphs.*

MW-92 Date Sampled	1,4-Dioxane Results (ppb)
04/03/2006	3
08/02/2006	4
10/27/2006	4
01/15/2007	4
04/19/2007	5
07/17/2007	6
10/12/2007	6
03/25/2008	7
Historical	
Minimum	3.0
Maximum	7.0
Average	4.9
Standard Deviation	1.4
2007 Forward	
Minimum	4.0
Maximum	7.0
Average	5.6
Standard Deviation	1.1





In reality, neither the MW-92 nor MW-110 exhibit any meaningful increasing trend, certainly nothing that is indicative of any failure of AE-3 to capture the leading edge of the Evergreen Plume.

On a larger scale perspective, the overall flux of contaminants through the plume areas is dynamic. There have been flow changes in distant purge centers, new wells coming on or going off-line etc. These changes are expected manifest themselves in the Evergreen area or at well locations downgradient of Evergreen, even though there is containment at Evergreen. This is offered as another plausible explanation for the subtle changes noted by MDEQ.