MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

INTEROFFICE COMMUNICATION

TO: Sybil Kolon, RRD, Jackson District

FROM: Rick Mandle, RRD, Lansing

DATE: April 21, 2009

SUBJECT: Review of "Report on Water Level Testing Under Reduced Flow Conditions Pall Life Sciences – Evergreen Area"

We have completed our review of the above referenced report, dated March 2009. This report describes the results of an investigation that attempts to measure the response of groundwater levels to incremental reductions in groundwater pumping rates in the LB and AE series extraction wells. The purpose of this investigation was to assess the degree to which groundwater levels and groundwater flow directions in the Evergreen Area might change as a result of a reduction in pumping rate. The concern was that reduction in pumping rates would allow 1,4-Dioxane-contaminated groundwater to migrate to the northeast under reduced or no pumping by the Evergreen Area extraction wells. The focus of this investigation is on assessing groundwater flow directions in the area in relatively close proximity to the Evergreen Area extraction wells. Groundwater flow directions in areas outside the influence of the Evergreen extraction wells were not addressed in this investigation. The following is a brief summary of the investigation and its findings, and our assessment of the groundwater flow directions inferred from the data collected during this investigation.

Monitoring Well Installation

Prior to beginning the investigation, monitoring wells were installed in areas where data were lacking. The new monitoring wells are MW-120s, MW-120d, MW-121s, MW121d, MW-122s, and MW-122d. The vertical placement of well screens was determined through analysis of groundwater samples obtained during vertical sampling of the aquifer. These wells were used along with existing monitoring wells in the Evergreen Area for monitoring the changes in groundwater levels and determining groundwater flow direction.

Water Level Testing Investigation

The investigation, which consisted of three phases, began on January 21, 2009, and ended February 16, 2009. The work closely followed a work plan (December 10, 2008) that had been approved by the Michigan Department of Environmental Quality (MDEQ). The first phase, the pre-test period, started on January 21, 2009, and ended January 29, 2009. During this phase of the investigation extraction wells LB-1, LB-3, and AE-3 were reported to be pumping at rates of 100, 85, and 15 gallons per minute (gpm), respectively. The pumping rates for these wells were reduced to 50, 50 and 0 gpm, respectively, during the second phase of the investigation. This phase took place between January 29, 2009, and February 5, 2009. Finally, for the third investigation phase, all pumping was terminated and groundwater levels were allowed to recover between February 2 and February 16, 2009. During these three test phases, groundwater levels, and groundwater gage or absolute pressure were measured in 18 and 21 wells, respectively. Wells in which absolute pressure was recorded were corrected to gage

pressure using barometric pressure data that were collected continuously over the entire duration of the test. At selected wells in which gage or corrected absolute pressure were measured, hand measurement of groundwater levels was performed to "calibrate" the pressure data. The data were presented in hydrograph, tabular, digital, and map format.

Investigation Findings

The report conclusions state that data show that a reduction or termination of pumping will not cause a significant change in groundwater flow direction in what is now referred to as the "shallow aquifer" (D2). The report also states that there were no data that were gathered during this investigation that would suggest that reducing or terminating Evergreen pumping rates will cause groundwater to move to the north or northeast. The report further states that the 1,4-Dioxane contaminant plume that is beyond the extent of capture of the Evergreen Area wells will presumably migrate to the east where it will merge with the deeper Unit E plume, and contamination found at MW-100 is thought to be migrating to the east as evidenced by the lack of 1,4-Dioxane at MW-120d, MW-121d and MW-122d. The report finally concludes that there are no data from either the shallow or deeper aquifers that suggest the contaminant plume is currently migrating to the northeast, or will migrate to the northeast if the pumping rate of the Evergreen extraction wells is reduced or terminated.

Discussion

From our review of this report, it appears that the work tasks outlined in the work plan were completed and that the data were collected and analyzed properly. The only exception is that well MW-55, listed in the Work Plan, was not utilized during this investigation.

Vented and non-vented pressure transducers were used during this investigation. One measures gage and the other measures absolute pressure. It is necessary to apply a correction to the absolute pressure readings so that they may be used with the gage pressure data. The correction of the absolute pressure recorded by the non-vented pressure transducers to gage pressure using barometric pressure is appropriate and appears to have been done correctly. This correction is performed using software provided by the pressure transducer vendor and was not developed by Pall Life Sciences (PLS) or Fishbeck, Thompson, Carr &Huber.

The magnitude of the groundwater-level fluctuations that were observed during this investigation, as barometric pressure changed, is significant. In many wells there were changes in groundwater levels that were as much as 0.5 feet as the barometric pressure changed. This may have great significance during quarterly monitoring events in areas where hydraulic gradients are relatively flat and groundwater levels measured over a lengthy or multi-day time interval. It may be necessary to make sure all groundwater levels are measured during a relatively-short time period to insure that there is no inordinate impact by changes in barometric pressure.

The report noted that there were some problems with storm water infiltrating selected wells (MW-100, MW-101, MW-113, MW-120d, MW-120d, MW-121, MW-122d, and MW-47d were specifically mentioned) during the testing. We cannot state with certainty whether any of the data from these wells is suspect. Water levels and temperature seemed to recover after these events suggesting that the influence of these infiltration events had passed and the groundwater levels are representative of aquifer conditions and not the infiltration event. What is troubling is that water from the surface entered the well and the aquifer during the test. This may have an effect on chemical analyses of groundwater samples, especially if collected after storm events in

which there is surface runoff to low lying areas. More importantly, these wells allow any contaminants in storm water at land surface to enter the aquifer. Appropriate measures should be taken to prevent this from happening in any future testing.

The groundwater flow direction inferred from each of the potentiometric maps for the shallow aquifer (Figures 2, 4, 6, and 8 from the March 2009 report) is principally from west to east. It is important to point out that this inferred flow direction is influenced to a large extent on the observed groundwater elevation at MW-120s. That is, without this single well, the data from this investigation would show declining groundwater elevations from southwest to northeast and east, inferring the potential for a groundwater flow direction to the northeast and east. This is one of the wells in which there was observable storm water infiltration. We had some concern about the groundwater levels measured in this well. An examination of groundwater levels and temperature after the infiltration event appears to indicate that the well had recovered from this infiltration event prior to the measurement of groundwater levels on February 16th.

As stated in the report, the groundwater levels measured on January 21 (Figure 2) and February 10 (Figure 4) in LB-1 were not corrected for drawdown resulting from well losses. These levels were displayed on the figures, but it does not appear that they were used in the drawing of contour lines.

It is also important to point out that the potentiometric surface for February 16, 2009 (Figure 8) appears to show that groundwater levels in the vicinity of the LB-series wells may not have fully recovered by the end of the test. It may be that additional time is needed to observe full recovery.

Measured groundwater level recovery (January 21 through February 16, 2009) that occurred as a result of terminating pumping from the Evergreen Area wells was plotted versus distance from the LB-series (see Figure 1). The purpose was to determine whether all wells measured during this investigation were screened in the same aquifer. In a laterally continuous aquifer, wells closest to the pumping wells will show the greatest water level recovery and those farthest from the pumping well will show the least amount of recovery. Wells that are not screened in the same aquifer and without a hydraulic connection will not show a response to the reduction or termination of the pumping. The recovery data plotted in Figure 1 show that almost every well responded as if the aquifer in which it is screened is part of a laterally continuous aquifer. The exceptions were wells MW-KZ1, MW-117, MW-100 and MW-72s&d. The remaining wells that responded in a manner consistent with a single laterally continuous aquifer had previously been designated as being screened in either the D2 or E aquifer; however, because of the similar manner in which they responded as a group, this demonstrates that they are actually screened in the same aquifer, some at different depths. The fact that the wells do not all plot along a line is an indication that there is horizontal and vertical heterogeneity in the aquifer.

There was no observable response in wells MW-KZ1 and MW-117 as noted by PLS. These wells are screened in intervals that are not connected to the contaminated aquifer from which the Evergreen Area wells pump. The MDEQ has long held this position and has tried to prevent these wells from being used to depict groundwater flow directions or the extent of 1,4-Dioxane concentrations. Data from these two wells should not be included in any future maps showing the groundwater flow directions or extent of contamination in this area.

Also, the level of recovery at MW-100 and MW-72s & d is less than would be expected if these wells were screened in an aquifer that had good hydraulic connection to the aquifer in the

Evergreen Area. The presence of clay and silt rich sediment located between these wells and the Evergreen Area may be the reason for the lower rate of response.

There was measurable groundwater level recovery in wells MW-120s and MW-120d between January 21 and February 16 in a manner that is consistent with other wells that are located at a similar distance from the LB-series wells (MW-88, MW-79s, MW-110, MW-54s&d), indicating that both MW-120s and MW-120d are hydraulically connected to the same aquifer from which the Evergreen Area wells extract groundwater. We have no technical reason for dismissing the data from MW-120s&d; however, we would not make a decision regarding pumping rates in the Evergreen Area without confirming the flow pattern inferred on Figures 4, 6, and 8, or without further monitoring to the north-northeast.

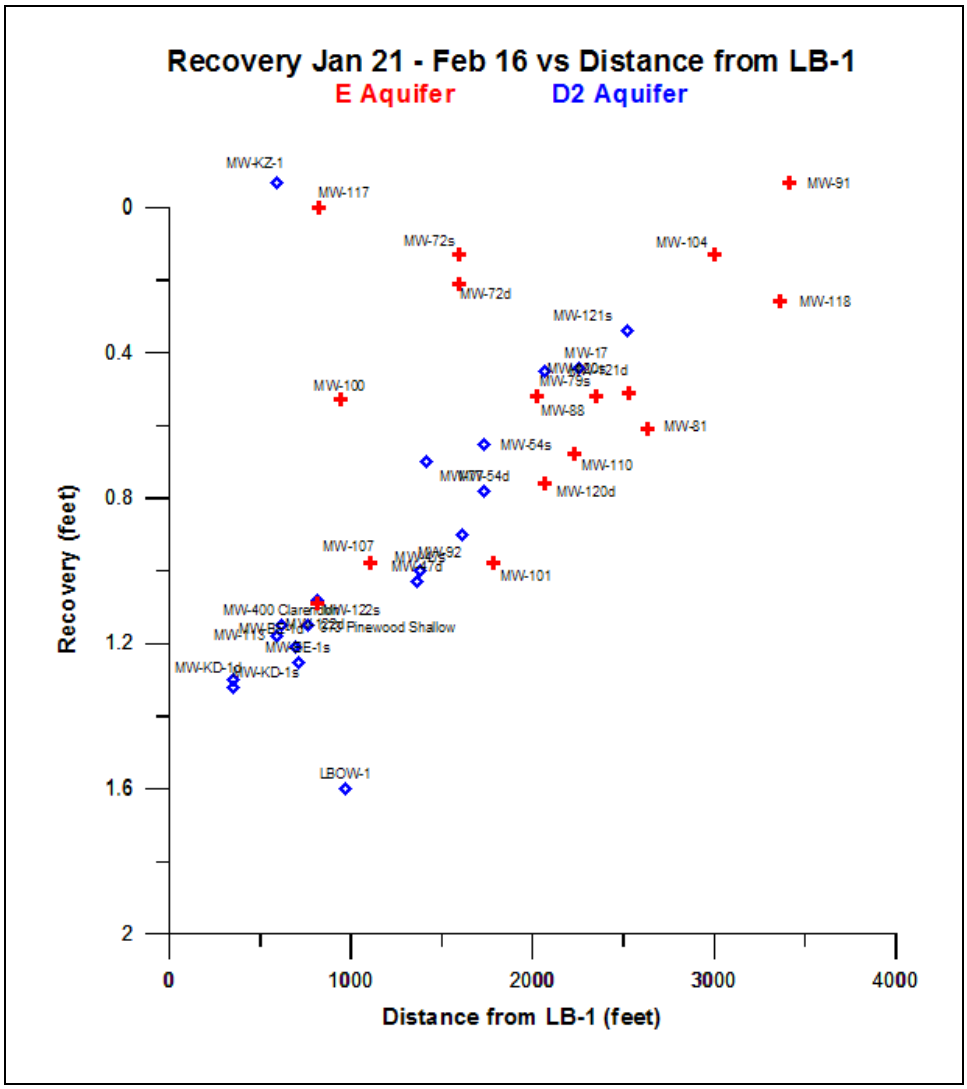

Figure 1 – Groundwater level recovery versus distance from LB-1.

Recommendations

The inference of groundwater movement from west to east through the Evergreen Area is influenced to a large extent by the groundwater levels measured in MW-120s. Without this singe data point, the inferred direction of groundwater flow is to the northeast. It is necessary to measure groundwater levels at additional locations in order to verify the direction of groundwater flow in this area. To accomplish this, we recommend the installation of two additional well clusters in the area between MW-120s and MW-92, as access allows. Groundwater levels measured in these two well clusters by themselves will not be sufficient to determine groundwater flow directions. It will be necessary to measure groundwater levels in several wells, not just any new monitoring wells, in order to verify the groundwater flow directions depicted in the PLS report. We recommend that, in addition to the new recommended monitoring wells, groundwater levels be measured in the following wells: MW-121s, MW-121d, MW-54s, MW-54d, MW-122s, MW-122d, MW-KD1S, MW-113, MW-BE1S, MW-BE1D, MW-107, MW-47s, MW-47d, MW-101, MW-110, MW-92, MW-120s, and MW-120d. These new measurements will reflect groundwater flow directions at a time when the Evergreen Area extraction wells are pumping, and will help verify the groundwater levels measured in MW-120s and MW-120d. Since the Evergreen Area extraction wells are now pumping, it is recommended that the contouring of this additional data be compared to the potentiometric surface contours as shown in Figure 2, the potentiometric surface measured on January 21, 2009, at which time the Evergreen Area extraction wells were in operation.

This investigation of the influence of pumping from the Evergreen Area extraction wells on the direction of groundwater assesses whether it is feasible to consider a change in pumping rates from these wells. If a change in pumping rates is considered, additional monitoring wells, located northeast and east of the Evergreen Area and spaced more closely together, will be needed to verify groundwater and contaminant migration directions.

You may contact me at mandler@michigan.gov or (517) 241-9001 to discuss these review comments.