RAMBOLL ENVIRON

ENVIRONMENT & HEALTH

Mr. Mostafa Mehran
Arkansas Department of Environmental Quality
5301 Northshore Drive
North Little Rock, Arkansas 72118

Re: Response to ADEQ Correspondence Dated July 15, 2015
Whirlpool Response to ADEQ May 20, 2015 Letter
Fourth Quarter 2014 Progress Report
Whirlpool Facility - Fort Smith, Arkansas
EPA No. ARD042755389
AFIN No. 66-00048
CAO LIS 13-202

Dear Mr. Mehran:

Ramboll Environ US Corporation (Ramboll Environ), on behalf of Whirlpool Corporation, is submitting this response to Arkansas Department of Environmental Quality's (ADEQ) July 15, 2015, comment letter on Ramboll Environ's response to comment letter dated June 25, 2015 regarding the Fourth Quarter 2014 Progress Report. The following are responses to the two issues identified in the ADEQ letter requiring further response:

1. *The sampling of new groundwater monitoring wells for MNA parameters.*

   Ramboll Environ Response: Whirlpool will sample all wells for VOCs and MNA parameters in the fourth quarter sampling event (October 2015) and subsequent quarters until ADEQ approves any proposed changes to the monitoring program. A formal request to modify the groundwater monitoring program will be submitted under separate cover since background conditions for various MNA parameters have been established for the north, south and northeast plumes.

   Whirlpool did not previously conduct this expanded sampling since we were waiting for ADEQ's response to our June 25, 2015 letter.

   Whirlpool respectfully maintains the technical approach excluding MNA parameters for new wells adjacent to existing monitoring wells as presented in the response to comments letter dated June 25, 2015. Although monitoring all wells for VOCs is important, Whirlpool does not feel that there is a strong technical justification for continued monitoring of all wells for MNA parameters.

Date August 4, 2015

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2. *The direction of vertical hydraulic gradient between the basal aquifer and the overlying silty-sand interval in the western portion of the northern plume. Original comment: "No evidence was provided to support the assertion that groundwater flow would be upward from the basal aquifer to the silty-sand interval. Comparisons should be made between groundwater elevations in deep wells and associated shallow wells to determine the direction and magnitude of the vertical hydraulic gradient. This comparison should be made on a quarterly basis in order to evaluate both vertical migration and seasonal variation. Please include this comparison in future reports."*

   Ramboll Environ Response: Ramboll Environ reported in the Fourth Quarter 2014 Progress Report that it is evident that water within the ¾ inch monitoring wells was connected to the basal transmissive zone and the shallower silty sand layers. This observation was based on the well construction diagrams for the ¾-inch wells and the logs for soil borings DP-63 through DP-67 completed in December 2014.

   Shallow monitoring wells were installed in January 2015 to further investigate shallow groundwater conditions, in accordance with the approved work plan, at locations near soil borings DP-63 through DP-67 and the associated report was included in the First Quarter 2015 Progress Report (Attachment C) dated May 11, 2015. Subsequently, the ¾ inch diameter wells were replaced in June 2015, in accordance with the approved work plan after access was obtained from property owners, and the associated report is included with the Second Quarter 2015 Progress Report (due for submittal on August 14, 2015).

   Full evaluation of the potential groundwater vertical gradients and the hypothesis regarding the connection of the shallow silty sandy zone and the basal transmissive zone (due to previous ¾ inch monitoring wells connecting these two zones) is not possible without several rounds of groundwater level measurements considering that:

   - Relevant water levels have only been measured in the new shallow monitoring wells during the Second and Third Quarters of 2015 (April 13 and July 20, 2015); and
   - The ¾ inch diameter monitoring wells were not properly abandoned and replaced with 2 inch diameter monitoring wells screened in the basal transmissive zone until the last week in June 2015.

   The comments from ADEQ on this topic regard the Fourth Quarter 2014 and First Quarter 2015 monitoring events when relevant water level information for the shallow groundwater monitoring wells was not available.

   Whirlpool will continue to evaluate the vertical gradient based on future quarterly monitoring of static water levels and include the results in the quarterly progress reports.

   A preliminary assessment of vertical gradients between shallow and basal transmissive zone wells has been performed. The well screen interval for shallow wells MW-174, MW-175, MW-176 and MW-179 are installed at depths ranging

between approximately 10 and 15 feet below ground surface (bgs) and the remainder of the shallow wells (MW-173, MW-177, MW-178, MW-180 and MW-181) have screened intervals between 5 to 8 feet bgs. A seam of silty clayey sand is present within the well screen interval at MW-174, MW-175 and MW-176 at 11 to 12.5 feet bgs, 13 to 14.5 feet bgs and 13 to 14 feet bgs, respectively. For the remainder of the shallow groundwater monitoring wells either the seam of silty clayey sand was not present (MW-178 through MW-180) or the screened interval for the shallow well was installed above the seam (MW-173, MW-177 and MW-181).

Comparisons were made between shallow and deeper wells to evaluate the horizontal and vertical hydraulic gradient (change in the hydraulic head between two points) in this area based upon water level measurements in April and July 2015 (second and third quarter monitoring events) (water levels were not recorded during the January 2015 monitoring event since the water levels in the wells had not stabilized). A positive vertical hydraulic gradient indicates that groundwater flow has an upward component and a negative gradient indicates that groundwater flow has a downward component. If a vertical gradient is present, groundwater could flow upward or downward between intervals in absence of impermeable materials impeding flow, especially through preferential pathways.

Groundwater elevations measured during the second and third quarter 2015 groundwater monitoring events at shallow groundwater wells MW-173 through MW-177 and MW-181 located along the north side of Jacobs Avenue and MW-178 through MW-180 located immediately south of Ingersoll Avenue were compared to groundwater elevations at nearby deeper monitoring wells to evaluate vertical gradient. Although shallow groundwater monitoring well MW-175 is not located near an associated deeper groundwater monitoring well, it is located approximately at the midpoint between deeper groundwater monitoring wells MW-46R and MW-56 allowing for a comparison between elevations at MW-175 and the combined average elevations at MW-46R and MW-56. Figure 1 presents the static groundwater elevations for the wells included in this evaluation.

Groundwater elevations from shallow groundwater wells MW-173 through MW-177 and MW-181 located along the north side of Jacobs Avenue and MW-178 through MW-180 located immediately south of Ingersoll Avenue decrease from west to east; from a high at MW-177/181 to a low at MW-173/174. The highest shallow groundwater elevations were measured MW-178, MW-179 and MW-180. These results suggest that the direction of shallow groundwater flow mimics the deeper groundwater flow direction to the east/northeast. The number and location of shallow groundwater monitoring wells limit this interpretation.

The vertical hydraulic gradients were calculated for four well pairs consisting of:

- MW-177/181 and RW-69/MW-70/MW-71;
- MW-176 and MW-46R;
- MW-178/179/180 and MW-83; and
- MW-173/174 and MW-63.

The vertical hydraulic gradients were assessed by calculating the change in hydraulic head divided by the vertical distance between the center of the well screens (i.e. [groundwater elevation for deeper well – groundwater elevation for shallower well]/[middle well screen elevation for shallower well – middle well screen elevation for deeper well]) (http://www.epa.gov/athens/learn2model/part-two/onsite/vgradient.html). An average of the groundwater elevations and middle screen elevations for MW-46R and MW-56R were used to calculate the vertical gradient at MW-175. Note that the middle of the screen was used in the calculations due to the variance in screen lengths for the wells included in the analysis. Table 1 presents the findings of the vertical gradient assessment which are summarized below:

- Second Quarter 2015
  - A downward vertical gradient was observed in three of the four well groupings (MW-177/181 and RW-69/MW-70/MW-71, MW-176 and MW-46R and MW-178/179/180 and MW-83);
  - An upward gradient was observed at the two western most well pairings (MW-175 and MW-46R/MW-56 and MW-173/174 and MW-63); and
  - Concentrations in the shallow wells were either non-detect or at concentrations less than the concentrations detected in the deeper shallow wells, with the exception of one pairing MW-176/MW-46R where the concentration in MW-176 was 528 µg/l and MW-46R was 483 µg/L.
- Third Quarter 2015
  - A downward vertical flow gradient was observed in two of the four well groupings (MW-177/181 and RW-69/MW-70/MW-71 and MW-178/179/180 and MW-83);
  - An upward gradient was observed at the western most well pairing (MW-173/174 and MW-63);
  - A slight gradient was observed in the two central well pairing along Jacobs Avenue (slightly upward at paring MW-176 and MW-46R and slightly downward at pairing MW-175 and MW46R/MW-56R);and
  - Analytical results for this quarter are not available at this time.

The observed vertical gradients suggest that:

- There is a downward component to groundwater flow between the shallow silty clayey sand and the lower basal transmissive zone;
- As the shallow seam of silty clayey sand becomes thinner and less sandy to the east there is a generally neutral to upward component to groundwater

flow between the basal transmissive zone and the silty clayey sand interval above;

- There are temporal variations in the observed vertical gradients; and
- Some evidence exists that the shallow zone and the basal transmissive zone are hydraulically connected as evidenced by similar horizontal gradients and presence of TCE contamination in both zones.

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Yours sincerely

Michael F. Ellis, PE
Principal

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List of Attachments

Table 1: Vertical Hydraulic Gradient Elevation
Figure 1: Static Water Levels

FILE: D:\GIS\PROJECTS\HIR\POOL\DOCs\2015\2015_misc\Figure 1 - Static Water Levels LS 20150730.mxd

0 150 300
Feet
1 inch = 150 feet

Monitoring Well - Static Water Levels
Monitoring Well Location
Approximate Property Boundary (2014)
County Assessor

Notes

Installed January 2015:
MW-31R, MW-32R and MW-33R.

Installed June 2015:
MW-34R, MW-36R, MW-40R, MW-39R, MW-41R, MW-50R, MW-55R, MW-56R, MW-58R, MW-57R, MW-60R, MW-61R, MW-62R, and MW-63R.

Brazil Ave
Brazil Ave
Ingersoll Ave
Ingersoll Ave
Jacobs Ave
Jenny Lind Rd
Boys Club Ln
Ferguson St

MW-50R MW-60R MW-61R MW-67R MW-66 MW-55R MW-58R MW-57R MW-68 MW-56R MW-40R IW-75 IW-72 IW-74 IW-73 MW-41R IW-76 MW-39R MW-82 MW-81 IW-77 MW-35R IW-80 MW-34R MW-36R MW-65 IW-78 IW-79 MW-31R MW-33R MW-32R MW-23 MW-27 MW-26 MW-84 MW-83 MW-24 ITMW-16 ITMW-13 ITMW-17 MW-38 ITMW-14 ITMW-3 MW-62R MW-97 MW-96 MW-90 MW-89 MW-88

MW-181 MW-70 MW-71 MW-177 RW-69 MW-176 MW-175 MW-46R MW-174 MW-173 MW-63R MW-180 MW-179 MW-178

Monitoring Well ID	Static Water Level Elevation (feet)	
	4/13/2015	7/20/2015
MW-181	467.56	468.35
MW-177	466.94	469.09
MW-70	464.16	465.32
MW-71	464.15	465.30
RW-69	463.83	464.97

Monitoring Well ID	Static Water Level Elevation (feet)	
	4/13/2015	7/20/2015
MW-176	463.81	464.66
MW-46R	462.82	464.88

Monitoring Well ID	Static Water Level Elevation (feet)	
	4/13/2015	7/20/2015
MW-173	457.61	462.63
MW-174	457.67	459.92
MW-63/MW-63R	459.36	462.29
Note: MW-63R was installed in June 2015		

Monitoring Well ID	Static Water Level Elevation (feet)	
	4/13/2015	7/20/2015
MW-175	460.25	463.71
Average of MW-46R & MW-56/56R	461.52	463.67

Monitoring Well ID	Static Water Level Elevation (feet)	
	4/13/2015	7/20/2015
MW-180	471.76	471.69
MW-178	471.94	471.94
MW-179	462.70	467.66
MW-83	462.98	464.21

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DRAFTED BY: KTS | DATE: 07/30/2015

STATIC WATER LEVELS

Whirlpool Facility - Fort Smith, Arkansas

Figure 1

PROJECT: 3437500A

TABLE 1
VERTICAL HYDRAULIC GRADIENT EVALUATION
Whirlpool Facility - Fort Smith, Arkansas

Location/ Well Pairs	Middle of Screen Elevation[1] (feet)		Static Water Level Elevation (feet)		Vertical Hydraulic Gradient[2] (feet/feet)	
			4/13/2015	7/20/2015	4/13/2015	7/20/2015
Shallow Wells MW-181 and MW-177						
MW-181	465.68		467.56	468.35		
MW-177	462.19		466.94	469.09		
MW-70	451.72		464.16	465.32		
MW-71	451.62		464.15	465.30		
RW-69	451.18		463.83	464.97		
MW-181/MW-177					-0.18	0.21
MW-177/MW-70					-0.27	-0.36
Shallow Well MW-176						
MW-176	451.96		463.81	464.66		
MW-46R	447.30		462.82	464.88		
MW-176/MW-46R					-0.21	0.05
Shallow Well MW-175						
MW-175	450.52		460.25	463.71		
Ave. of MW-46R & MW-56/56R	446.85	445.98	461.52	463.67		
MW-175/Ave. of MW-46R & MW-56/56R					0.35	-0.01
Shallow Wells MW-173 and MW-174						
MW-173	458.44		457.61	462.63		
MW-174	452.22		457.67	459.92		
MW-63/MW-63R	445.50	446.81	459.36	462.29		
MW-173/MW-174					0.01	-0.44
MW-174/MW-63					0.25	0.44
Shallow Wells MW-178, MW-179 and MW-180						
MW-180	469.13		471.76	471.69		
MW-178	468.19		471.94	471.94		
MW-179	463.16		462.70	467.66		
MW-83	451.49		462.98	464.21		
MW-180/MW-178					0.19	0.26
MW-180/MW-179					-1.52	-0.68
MW-178/MW-179					-1.84	-0.85
MW-180/MW-83					-0.50	-0.42
MW-178/MW-83					-0.54	-0.46
MW-179/MW-83					0.02	-0.30

Notes:

[1] MW-63R was installed in June 2015

[2] Negative gradient indicates downward gradient