RAMBOLL ENVIRON

ENVIRONMENT & HEALTH

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

Re: Response to ADEQ Comments Dated March 15, 2016
Two Year Technical Review Report – January 2016
Whirlpool Corporation
Fort Smith, Arkansas
EPA No. ARD042755389
AFIN No. 66-00048
CAO LIS 13-202-001

Dear Mr. Mehran:

Date April 15, 2016

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Ramboll Environ US Corporation (Ramboll Environ), on behalf of Whirlpool Corporation, is submitting this response to Arkansas Department of Environmental Quality's (ADEQ) March 15, 2016, comment letter on Ramboll Environ's Two Year Technical Review Report dated January 2016 (the ADEQ comment letter was received on March 15, 2016). ADEQ comments are provided in italics below and the respective Whirlpool response follows:

1) **Executive Summary, Site Overview, Fourth Paragraph:** *The report repeatedly cites "incidental releases of trichloroethene (TCE)" as the source of the contamination at the site. Please explain how "incidental releases of TCE" would produce the high volume of contamination in the soil and groundwater in the source area at the site.*

Ramboll Environ Response: Based on interviews with past workers the degreasing operations involved placement of parts into the vapor degreasing equipment which consisted of a tank of TCE, which when heated created a vapor for degreasing parts, followed by condensing the vapor and returning to the tank. Dating back to approximately 1967 (when the degreaser building was constructed), equipment degreasing operations utilizing TCE were performed in the former degreaser building. Degreasing operations ceased in the mid 1980's, therefore, upwards of 15 to 20 years of operations using TCE have occurred at the site. Although not formally documented, as discussed in Section 3.1 of the Two Year Technical Review Report, incidental releases may have included:

- Drips of TCE from the cleaned parts after their removal from the vapor degreaser and placement either on the floor of the degreaser building or drips exterior of the degreaser building before the cleaned parts were returned to the former manufacturing building;
- Incidental drips on the degreasing building floor while managing TCE (i.e. filling or TCE removal from the former vapor degreaser);

- Rinsing of the degreaser building floor during general housekeeping purposes and discharge of the water through the overhead doors; and
- Discharge of mop water from the degreaser building containing detergent or surfactant discharged outside of the degreaser building to the drainage trench.

As presented in the report, based on site specific data, the combined estimated quantity of TCE remaining in unsaturated and saturated soil and groundwater associated with the site is approximately 20 to 70 gallons of TCE (i.e. approximately 1 to 4 gallons released per year[1] over a 15 to 20 year period of operation representing incidental releases totaling 3 to 12 teaspoons per day conservatively assuming a single eight hour shift per day and 250 days of operation per year). This estimated quantity of TCE in soil and groundwater is consistent with volumes that might be found after use of TCE for degreasing in the degreaser building, incidental releases associated with degreasing operations, and daily cleaning and mopping of the cleaning room over the 20 year period that TCE was approved for use at the site. No releases are known to have occurred in the last 30 years, after cessation of the degreaser operation.

As previously discussed and in the Two Technical Review Report, the source area and plumes are at or approaching late stage based upon: the age of the plume (30 to 50 years old); lack of free phase product (see discussion in response to Comment #3 below); current maximum TCE concentrations detected in soil and groundwater; and, decreasing TCE concentration trends in groundwater in the source area and north and south plumes (see response to Comments #5 and #6 for further discussion regarding regression analysis performed for the north and south plumes).

2) 3.1 Source of Impact, Third Paragraph, First Sentence: *Considering the historical groundwater detections of TCE as high as 553,000 micrograms per liter (µg/L) (half the solubility limit of TCE) and detections of TCE in the soil as high as 3,300 milligrams per kilograms (mg/kg), it seems unlikely that the contamination at the Whirlpool site has originated from the "incidental spills and releases". It should also be noted that the observed rebound following three in-situ chemical oxidation (ISCO) treatments at the monitoring well MW- 86 has resulted in the concentration of TCE at above 100,000 µg/L (approximately 10% of the TCE solubility limit). Please discuss other possible origins for the TCE contamination at the site.*

Ramboll Environ Response: The discussion of incidental releases is presented in the response to Comment #1.

Although, the historical groundwater and soil data may be relevant to assess historical incidental releases, these referenced concentrations for specific groundwater and soil samples are no longer expected to be present due to the

[1] The current reportable quantity (RQ) for TCE is 100 pounds (40 CFR Part 302.4, Table 302.4) which converts to a volume of approximately 8 gallons (density of TCE is 12.2 pounds per gallon). Therefore, a spill of 8 gallons or more of pure TCE is defined as a reportable release, which triggers reporting obligations. A release of a mixture or solution of TCE would require calculation of the total quantity of TCE released to assess whether a reportable release has occurred.

ISCO performed to reduce TCE concentrations in groundwater and saturated soil (the referenced soil sample above was collected at a depth of 18.5 to 19 feet and is a saturated soil sample) and soil removal actions performed targeting previous locations where higher TCE concentrations were detected in soil.

There are no historical records or recollections that identify any specific spills or release incidents. Incidental releases that may have occurred based upon known operations are described in the response to Comment #1. It is unknown if any spills or releases occurred during the period of operations 1961 to 1966 when Norge Corporation owned and operated the facility.

Rebound is discussed in the response Comment #17.

3) **3.1 Source of Impact, Fifth Paragraph, First Sentence:** *Although the current groundwater maximum concentration of 131 milligrams per liter (mg/L) is 0.01% of one liter of water, this concentration represents 12% of the maximum possible concentration of TCE in the groundwater. Please provide further clarification regarding the matter discussed.*

Ramboll Environ Response: For reference the subject sentence follows, *The incidental releases are expected to have consisted of solutions of TCE mixed with surface water and floor rinse water or mop water; therefore, little if any free phase TCE is anticipated to have been released at the Site to cause a potential high concentration source areas in the linear drainage feature [i.e. the current highest concentrations of TCE detected in groundwater or vadose zone soil only represent 0.01% to 0.03% TCE concentrations, respectively [131,000 µg/L at MW-86 and 270 milligrams per kilogram (mg/kg) at DP-07].*

Little or no free product is anticipated to have been released based upon the incidental releases and presumed processes or procedures in which the incidental releases occurred (as described in the response to Comment #1 and Section 3.1 of the Two Year Technical Review Report). The detected concentrations are well below concentrations suggesting free product was initially released versus solutions of TCE in water or mop water.

The comment regarding solubility of TCE in water is noted, but this does not change the conclusion regarding the original incidental releases and the estimated quantities of the original incidental releases.

4) **4.0 Fate and Transport, Second Paragraph, Second Sentence:** *Please explain how the northeast plume will mimic the natural attenuation occurring in the north plume when the two most up-gradient monitoring wells (MW-87 and MW-91) both display increasing TCE concentration trends.*

Ramboll Environ Response: As discussed below in the response to Comment #7, TCE concentrations at both MW-87 and MW-91 appear to be stabilizing. Based upon the last four quarters of data generated by sampling of well MW-89, TCE trends are decreasing. Regression analysis performed for the data at MW-89 yields a slope of -0.16 yr-1 which is consistent with the average regression slope of -0.15 yr-1 calculated for the northern plume. Therefore, the trends for reduction of TCE

concentrations in the northeast corner are anticipated to be similar to the north plume.

The regression analysis and resultant degradation rate/slope is used to calculate the observed half-life with the formula:

observed half-life = LN (2)/slope

The slope of the trend line fit to the model results (i.e. projected trend) for the northern plume indicates a slope value of -0.14 yr-1 calculated as an observed TCE half-life value of approximately 1,800 days. The degradation rate/slope at MW-89 is -0.16 yr-1 which equates to an observed TCE half-life value of approximately 1,600 days. The slight variance in the calculated slopes and half-lives is well within the typical variability one finds in analyzing data from individual wells with a plume of VOCs such as TCE.

5) **4.2 Plume Stability, Second Paragraph, First Bullet:** *While it has been shown that the southern plume is decreasing in over-all concentration, the six wells with stable TCE trends and three wells with increasing TCE trends show that the plume (especially at the distal portion of the plume away from the source area) is continuing to display areas of expansion. Please explain how the southern plume can be considered stable while several monitoring wells display increasing concentrations.*

Ramboll Environ Response: As of the fourth quarter of 2015, 89% of the wells in the southern plume indicate little to no TCE or a stable or decreasing statistical trend. Of the few wells which do indicate an increasing statistical trend for the south plume:

- MW-38 is a source area well with a high TCE concentration of 6,970 µg/L in October of 2014 and since that time concentrations have fluctuated as would be expected given the ISCO injections in this area but TCE concentrations have decreased overall with a current first quarter concentration of 3,680 µg/L;
- ITMW-6 TCE concentrations have been primarily non-detect at less than 5 µg/L. When detections have been reported, they have ranged from 2.7 to 4.7 µg/L over the time period of October 2013 through January 2016. The current TCE concentration for the first quarter of 2016 is 4.2 µg/L. This variability, once again, is typical if not endemic to isolated or individual wells within a VOC (TCE) plume. These are not increases. They merely reflect that this plume is not homogeneous and concentration may vary slightly in water samples drawn over time or in locations that may be only a handful of feet apart; and
- ITMW-10 will continue to be monitored regarding increasing TCE trends.

ITMW-10 shows a statistically increasing concentration over the recent time period of 2014 through 2016. ITMW-10 is almost 600 feet from the nearest property boundary and there are many wells installed around and downgradient of ITMW-10 to act as boundary wells. If these boundary wells show increasing concentrations in the future there will be adequate time to discuss appropriate supplemental

remedial alternatives, if necessary, prior to any elevated plume concentrations approaching or reaching a site boundary in accordance with the pending groundwater monitoring plan as described in the Response to ADEQ Comments on the Fourth Quarter Progress Report (April 8, 2016) and as discussed in the response to Comment #10.

As presented in *Appendix E Regression Analysis* (February 26, 2016), six wells in the source area and the south plume were considered for the regression analysis (regression analysis was performed for nine other wells with decreasing concentration trends in the source area and the south plume, but the data was excluded due to ISCO, residuals bias, or the slope not being significant). The decreasing concentrations trends in these six wells has occurred over a period of time ranging from three to 15 years and the average time range for decreasing concentrations is eight years for these wells (these periods of time are through October 2014 prior to ISCO; therefore, the actual periods of time would be longer if evaluated through the end of 2015). Therefore, the decreasing concentration trend has been occurring within the south plume for a considerable period of time, and each of these decreasing concentration trends occurred before any remedial activities occurred at the site.

In addition, ERM concluded in June 2007 *Final Risk Evaluation Report* that wells in the Southern Flow Regime appear to have generally decreasing or stable trends, indicating that the groundwater plume is stable or shrinking.

6) **4.2 Plume Stability, Second Paragraph, Third Bullet:** *While the data shows that the northern plume is decreasing in over-all concentration, nine wells show stable TCE trends and six wells indicate increasing TCE trends especially at the distal portion of the plume away from the source area. This indicates the plume is expanding. Please explain how the northern plume can be considered stable while several wells display increasing TCE concentrations.*

Ramboll Environ Response: Consistent with our "Response to ADEQ Comments on the Fourth Quarter 2015 Progress Report" (April 8, 2016), as of the fourth quarter of 2015, 36 of 42 (86%) of the wells in the northern plume indicate little to no TCE or a stable or decreasing statistical trend (stable concentration trends is **not** an indication of plume expansion). This unquestionably is a statistically significant percentage of the well network. Of the few wells which ostensibly do not indicate a decreasing statistical trend for the north plume:

- MW-56R has maintained somewhat stable TCE concentrations including a high of 590 µg/L in October 2013 to a first quarter 2016 result of 408 µg/L;
- MW-61R TCE concentrations have decreased from a high of 16.5 µg/L in September 2015 to 3.9 µg/L in the first quarter of 2016;
- MW-66 has TCE concentrations that are fairly stable, ranging from a high of 3.5 µg/L in March 2014 to a three year low of 0.53 µg/L in the first quarter of 2016;

- MW-67R has predominantly had TCE concentrations that were at non-detect levels, with three current quarters (July 2015 through January 2016) of non-detected values;
- MW-55 has shown continued decrease in TCE concentration since 2013 (13 µg/L). The current concentration in the first quarter of 2016 is 0.26 µg/L; and
- MW-57 appears to be stabilizing with TCE concentrations ranging from 400 to 422 in the time period of July 2015 through January 2016.

As presented in *Appendix E Regression Analysis* (February 26, 2016), 19 wells in the north plume were included in the regression analysis. The decreasing concentrations trends in these 19 wells has occurred over a period of time ranging from three to 17 years and averages eight years for these wells (these periods of time are through May 2014 prior to ISCO; therefore, the actual periods of time would be longer if evaluated through the end of 2015). Therefore, the decreasing concentration trend has been occurring within the north plume for a considerable period of time, and each of these decreasing concentration trends occurred before any remedial activities occurred at the site.

In addition, ERM concluded in June 2007 *Final Risk Evaluation Report* that wells in the Northern Flow Regime appear to have generally decreasing or stable trends, indicating that the groundwater plume is not migrating.

7) 4.2 Plume Stability, Second Paragraph, Fourth Bullet: *The two most up-gradient monitoring wells in the northeast (NE) plume, MW-87 and MW-91, display increasing TCE trends. Please explain how the northeast plume can be considered stable while these monitoring wells display increasing TCE concentrations.*

Ramboll Environ Response: Monitoring has been completed at wells MW-87 and MW-91 since June of 2014. If trends are evaluated for the last four quarters (April 2015 through January 2016), TCE concentrations at both wells appear to be stabilizing. Concentrations at MW-87 during this time period were 758, 758, 708, and 757 µg/L with a field duplicate concentration of 781 µg/L in January 2016. Concentrations at MW-91 during this time period were 438, 411, 405 (with a duplicate of 442), and 413 µg/L (with a duplicate of 422 µg/L) in January 2016. Both of these wells will continue to be monitored during future events.

The response to Comment #4 discusses the regression analysis performed for MW-89 and the basis for expecting the northeast plume to mimic the natural attenuation occurring in the north plume.

8) 4.3 Natural Attenuation, Chemical Lines of Evidence, First Paragraph: *Although the analytical results for volatile organic compounds (VOCs) in groundwater demonstrate that natural attenuation of TCE is occurring, only minor amounts of daughter products have been detected. These daughter products account for 5% or less of the total chlorinated ethenes (generally 1% to 2% for the northern plume) and do not represent viable rates of natural attenuation (NA). Many of the wells away from the source area which do have decreasing trends in TCE concentration have calculated half-lives for TCE from few years to tens of years. Please explain how this*

extremely slow NA rate will prevent the plume from expanding beyond its current boundary over the next decades.

Ramboll Environ Response: Consistent with our "Response to ADEQ Comments on the Fourth Quarter 2015 Progress Report" (April 8, 2016), the chemical, geochemical and microbial results provide evidence that natural attenuation of TCE is occurring via various mechanisms in many areas of the northern, northeastern and southern plumes. Regression analysis was performed for the data from wells in the north and south plumes to estimate a representative regression slope that characterizes the "average or representative" rate of reduction in the concentrations. The historical TCE concentration trends at a given location are a function of various factors: Groundwater velocity, flow direction, retardation, concentration distribution, reaction rates, etc. The regression lines were fit to the site data for the respective wells in each plume and the slopes reflect the combined influence of all these site-specific factors.

The average regression slope calculated for the north and south plumes was determined to be -0.15 yr-1. The average regression slope calculated for the source area was -0.04 yr-1. This is a conservative evaluation of the source area since the regression analysis excludes an alternate regression analysis for MW-25 based upon evaluation of only the last approximate four years of data prior to performance of ISCO. As discussed in the "Response to ADEQ Questions Regarding the Fate and Transport Model" (March 3, 2016), the average regression slope of -0.04 yr-1 is significantly more conservative when compared with the regression slope at MW-25 of -0.67 yr-1 if only the data from November 2010 through May 2014 is evaluated (data immediately prior to performance of ISCO). The regression slope from late 2010 through mid-2014 indicates that significant reductions in TCE concentration trends was occurring at MW-25 prior to ISCO.

The average degradation rate calculated for the north plume based upon regression analysis indicates that the maximum contaminant levels (MCLs) are expected to be achieved within timeframes considered appropriate by USEPA (i.e. 30 to 35 years) and the south plume is anticipated to remain on the Whirlpool property. The fate and transport modeling was performed to illustrate and depict visually these prospective conditions based upon the regression analysis. Supplemental remedial actions will be proposed if future monitoring data unexpectedly indicates that these project conditions and specific objectives for the north and south plumes will not be achieved (see discussion of action plan below).

Based upon existing groundwater monitoring data for each of the plumes, we expect the predominant number of wells within these plumes to continue to exhibit stable to decreasing TCE concentration trends. Degradation rates at specific well locations vary and we agree that the average rate may require tens of years to achieve the MCLs for the north plume. We conclude the timeframe to achieve MCLs in the north plume is reasonable based upon:

- USEPA guidance;

- Demonstrated plume stability in a majority of the monitoring wells (see response to Comment #4 for further discussion of plume stability supporting a remedial decision for monitoring natural attenuation);
- Lack of complete exposure pathways regarding the north plume (monitoring is proposed to continue to confirm incomplete exposure pathways);
- Filing of deed restrictions precluding use of shallow groundwater for the north plume;
- Settlements with residential property owners regarding decreases in property values, according to the County appraiser, as a result of the TCE impacts in groundwater; and
- Commitment by Whirlpool to continue appropriate groundwater monitoring at the site with corresponding review and oversight of the monitoring results by ADEQ.

Groundwater monitoring is proposed to continue for all of the plumes (north, south and northeast) to re-confirm on an ongoing basis the plume stability, plume boundaries and future temporal trends consistent with historic data. A groundwater monitoring plan will be submitted under separate cover which will include an action plan as requested in the initial ADEQ comments on the "Two Year Technical Review Report." The action plan consists of preparation of a work plan for review by ADEQ to implement additional monitoring, investigation and/or supplemental remediation as necessary in the event significant, unexpected changes occur in the groundwater plume boundaries (at any of the three plumes) or other unanticipated changed groundwater conditions give rise to potential human health risks associated with a complete exposure pathway that presently does not exist. The action plan is triggered in the event that plume expansion is confirmed by increasing constituent concentrations at a boundary well location exceeding the removal action levels (RALs) during two consecutive monitoring events; or other unanticipated changed condition that occurs during two consecutive monitoring events that may cause potential human health risks associated with a newly complete exposure pathway.

9) **4.3 Geochemical Lines of Evidence:** *Please include in the discussion of geochemical lines of evidence the distribution and low concentrations of total organic carbon (TOC) as well as elevated concentrations of dissolved oxygen (DO) and their effects on biologically driven reductive dechlorination.*

Ramboll Environ Response: Consistent with our "Response to ADEQ Comments on the Fourth Quarter 2015 Progress Report" (April 8, 2016), microcosms of biological activity are present in the north, south and northeast plumes. Although low levels of TOC or elevated DO levels may exist in groundwater inhibiting biodegradation in certain locations, other chemical, geochemical as well as microbial natural attenuation processes will be relied upon to continue to provide indisputable evidence that natural attenuation of VOCs is occurring in the plumes. Consistent with previous responses to comments regarding slow degradation rates which may be attributable to low levels of TOC and elevated DO levels, groundwater monitoring will continue for the north, south and northeast plumes to

assess plume stability, plume boundaries and future temporal trends and the action plan will be implemented if plume expansion occurs (see Comment #10).

10) **Natural Attenuation, Microbial Lines of Evidence:** *With the exception of MW-38, the detection of Dehalococcoides (DHC) at concentrations greater than 30 cells/milliliter (mL) [<100 cells/mL is generally consider too low to be viable for NA (ESTCP-Guidance Protocol: Application of Nucleic Acid-Based Tools for Monitoring MNA, Biostimulation, and Bioaugmentation at Chlorinated Solvent Site, Env. Restoration Project ER-0518, January 2011, p. 4)] occurred only sporadically at 17 of the 76 wells sampled. Please discuss the sparsity of DHC relative to the observed rate of reductive dechlorination occurring at the site.*

Ramboll Environ Response: As discussed above, microcosms of biological activity are present in the north, south and northeast plumes. Although low levels of DHC may exist in groundwater inhibiting biodegradation in certain locations, other chemical, geochemical as well as microbial natural attenuation processes will be relied upon to continue to demonstrate continued results providing strong evidence that natural attenuation of VOCs is occurring in the plumes. Consistent with previous responses to comments regarding slow degradation rates, groundwater monitoring will continue for the north, south and northeast plumes to assess plume stability, plume boundaries and future temporal trends and the action plan will be implemented if plume expansion occurs.

11) **4.3 Natural Attenuation, Summary of Natural Attenuation Results:** *It is readily apparent from the minor amounts of daughter products present in the source area and plumes, as well as the low levels of TOC and elevated levels of DO that minimal amounts of biologically driven reductive dechlorination is occurring at the site. Please explain how the NA at the site will contain the plumes within their current boundaries.*

Ramboll Environ Response: See response to Comment #8.

12) **4.4 Plume Regression and Modelling, First Paragraph, Last Sentence:** *The regression-based trend analysis resulted in the TCE degradation half-lives of years to tens of years (not the 110 days used in the model) for the northern plume. Please explain the rationale for reducing the calculated TCE degradation half-lives from years to days.*

Ramboll Environ Response: As stated in the “Response to ADEQ Comments on the Fourth Quarter 2015 Progress Report” (April 8, 2016), the observed half-life for the northern plume is 4.6 years or approximately 1,700 days. The chemical reaction process half-life value only addresses the rate of degradation of TCE in the dissolved phase. The chemical reaction process half-life value is determined through an iterative process such that the future overall decay rate of the plume matches the calculated historical trend determined from the regression based trend analysis. The best fit to historical trends for the north plume was observed when setting the chemical reaction process half-life value to 110 days. This chemical reaction process half-life was applied throughout the model domain so the modelled attenuation rates are matched to the overall trend.

It is important to emphasize that the chemical reaction process half-life value of 110 days for the north plume does not reflect the continual regeneration of dissolved TCE from the equilibrium reaction and thus appears rapid relative to the observed half-life value of 1,700 days, which incorporates all processes including desorption.

For the north plume, the 30 to 35 year timeframe to achieve the MCLs is based upon the TCE observed half-life value of 1,700 days based upon regression analysis of the historical data and is supported by the TCE observed half-life value of 1,800 days from the illustrative model based upon the projected TCE concentration trends.

13) 4.4.1 Regression Analysis, Eighth Paragraph, Fourth Sentence: *This sentence implies that because cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride (VC) concentrations from a predominant number of wells are non-detect, decreasing or stable TCE daughter products are being degraded faster than they can accumulate indicating a lack of "stalling." It is just as likely that these daughter products are not being produced to any great extent due to the lack of reductive dechlorination at the site. Please cite evidence for the "lack of stalling" (i.e. accumulation of large quantities of ethene).*

Ramboll Environ Response: We agree that daughter products may not be produced to any great extent as commented above. This agreement is stated in the Two Year Technical Review, Section 4.4.1, eighth paragraph as follows:

"The concentrations of cis-1,2-DCE and VC in groundwater were below the MCLs at all locations during the October 2015 monitoring event excluding onsite wells at the northwest corner of the former manufacturing building consisting of: ITMW-17, MW-25, MW-86, MW-93 and MW-95, and offsite well location MW-176 where the cis-1,2-DCE concentration exceeded the MCL[2]; therefore, conclusions that no unacceptable current or future exposures to cis-1,2-DCE and VC in groundwater (or vapor from groundwater) remain valid."

The "lack of stalling" phrase in the Two Year Technical Review Report indicates that degradation at the site is not stalling at cis-1,2-DCE. We agree that DCE concentrations are low; therefore, there is no evidence that DCE stall is occurring.

14) 4.4.2.1 Transport Model Development, Second Paragraph, Fourth Sentence: *The report states the best fit for the model occurs with a half-life of 110 days instead of 4.6 years. The model inputs have been set so that the short half-life is necessary to have the contaminants of concern (COCs) to be reduced to the maximum contaminant level (MCL) within the 35 years indicated by the regression determined 4.6 year half-life. Adjustment of the model inputs may permit greater agreement between the model required and the regression derived half-life values. Please explain how*

[2] At offsite locations, only cis-1,2-DCE has been detected at a concentration exceeding the MCL at offsite well MW-176. Soil vapor monitoring at VP-9 and VP-10 (adjacent to MW-176) did not detect cis-1,2-DCE in soil vapor. VC was detected in soil vapor at VP-9 and VP-10 at concentrations below risk thresholds. In addition, cis-1,2-DCE and VC have not been detected in outdoor, crawl space or indoor air during monitoring events at the residence near MW-176.

adjustments in the model input to attain a best fit with 4.6 year half-life would affect the model outcome.

Ramboll Environ Response: The model for the north plume is based upon regression analysis of the historical data. The chemical reaction process half-life value in the model was adjusted (as is customary and necessary) until the projected trend (i.e. slope of trend line fit to model results) at the representative location (MW-46R) matched the average, historical regression trend. The best fit to historical trends for the north plume was observed when setting the chemical reaction process half-life value to 110 days. The slope of trend line fit to the model results (i.e. projected trend) indicates a slope value of -0.14 yr-1 calculated as an observed TCE half-life value of approximately 1,800 days (i.e. observed half-life = LN (2)/slope). The model illustrates the observed half-life value of 1,800 days for the north plume (based upon the iterative process to match model predicted future groundwater concentrations with the regression analysis of existing data) and the anticipated future plume boundaries during the next 30 to 35 years.

As discussed in the Two Year Technical Review Report, sensitivity analysis was performed by adjusting the chemical reaction process half-life value by increasing and decreasing by 25% (noting the sensitivity analysis was performed regardless of the regression analysis based upon the historical data from the site). When the chemical reaction process half-life value is decreased and increased 25%, the model illustrates the plume will achieve MCLs in 26 years and 40 years, respectively.

15) **7.1 Conclusion, First Paragraph, Second Bullet:** *It is stated "there are no unacceptable exposures to offsite residents, offsite routine workers or offsite utility maintenance workers." Please update these statements with the language similar to those presented in Section 6.0 - Offsite; specifically stating, "Currently, there are no unacceptable exposures to offsite residents, routine workers or utility maintenance workers. Periodic monitoring will continue to insure that potential risk from vapor intrusion into offsite properties remains within acceptable exposure levels."*

Ramboll Environ Response: The text in the noted section will be updated as requested.

16) **7.1 Conclusions, First Paragraph, Fourth, Fifth and Sixth Bullets:** *Although there may be minor amounts of reductive dechlorination, the regression determined half-lives indicate the plumes will likely spread beyond their current boundaries before MCLs are reached. Continued sampling of the groundwater monitoring network will be necessary to verify the modeling results.*

Ramboll Environ Response: The regression analysis does not indicate the north or south plumes will likely spread beyond their current boundaries.

As discussed in the response to Comments #1 and #2, the incidental releases occurred 30 to 50 years ago which has resulted in groundwater plumes at or approaching late stage. As discussed in the responses to Comments #5 and #6, the stable or reducing concentration trends in a majority of the wells in the north and south plumes has been demonstrated on average for eight years.

Plume instability simply is not indicated by the extensive and long-running monitoring performed to date.

We agree that monitoring should continue in accordance with the previously discussed groundwater monitoring plan and accompanying action plan. Monitoring will continue to refine the regression analysis and the illustrative model results. The action plan is triggered in the event that plume expansion is confirmed by increasing constituent concentrations at a boundary well location exceeding the RALs during two consecutive monitoring events; or other unanticipated changed condition occurring during two consecutive monitoring events, give rise to a potential human health risk associated with a complete exposure pathway that presently does not exist.

17) **7.1 Conclusions, Second Paragraph, Second Sentence:** *Given the observed rebound in the source area (Area 1), since the last ISCO treatment in that area (e.g. from a low TCE concentration of 132 µg/L following the third treatment, TCE concentration at MW-85 has rebounded to 12,000 µg/L), additional ISCO treatment may be necessary. Please provide the methodology Whirlpool proposes to use to determine when additional ISCO treatments are required based on observed rebound of contaminate concentrations.*

Ramboll Environ Response: As discussed in the June 29, 2015, letter submitted to ADEQ titled “Methods for Assessment of Constituent Concentration Rebound” by Ramboll Environ, rebound is an expected condition and is known to be a common occurrence when using ISCO as a source area remedy. A rebound condition does not mean that the ISCO injection event has failed. Rebound can be an indication of the positive effects of the transfer of contaminants to the more treatable aqueous phase.

It is premature to assess rebound in any of the source area wells because localized groundwater conditions have not yet stabilized (sodium persulfate concentrations, contaminant concentrations and certain field parameters have not stabilized to within a range of variability of 10% or less over three consecutive monitoring events) in source area wells MW-85, MW-86, ITMW-11 and MW-25. Stabilization is a key component of the “Methods for Assessment of Constituent Concentration Rebound."

The source area and south plume monitoring well data have been included in the statistical trend analysis, regression analysis and the illustrative fate and transport model. The statistical analysis, as discussed above, indicates a large majority of the TCE concentration trends were stable to decreasing prior to performing ISCO; and therefore, no effects from an area exhibiting higher TCE concentrations or a source area are expected to impact the stability of the plume. Consistent with previous responses, groundwater monitoring will continue to assess plume stability, and the action plan is triggered in the event that plume expansion is confirmed by increasing constituent concentrations at a boundary well location exceeding the RALs during two consecutive monitoring events; or other unanticipated changed condition occurring during two consecutive monitoring events, give rise to a potential human health risk associated with a newly complete exposure pathway.

18) **7.1 Conclusions, Final Paragraph:** *ADEQ believes that a more appropriate path forward of monitoring is to continue quarterly for a period of two years. Whirlpool can propose a reduced number of wells to be sampled and a reduced parameter list to be analyzed. At the end of two years, a second two-year review report can then be prepared with a proposed path forward.*

Ramboll Environ Response: Groundwater monitoring is proposed to continue for all of the plumes (north, south and northeast) to re-confirm on an ongoing basis the plume stability, plume boundaries and future temporal trends compared with historic data. We appreciate ADEQ's implicit recognition that some reductions in the monitoring are warranted, given the large database already compile. Consistent with previous responses, a groundwater monitoring plan will be submitted under separate cover which will include an action plan as requested in the initial ADEQ comments on the "Two Year Technical Review Report". The action plan consists of preparation of a work plan for review by ADEQ to implement additional monitoring, investigation, and/or supplemental remediation as necessary in the event significant, unexpected changes occur in the groundwater plume boundaries (at any of the three plumes) or other unanticipated changed groundwater conditions give rise to potential human health risks associated with a complete exposure pathway that presently does not exist. The action plan is triggered in the event that plume expansion is confirmed by increasing constituent concentrations at a boundary well location exceeding the RALs during two consecutive monitoring events; or other unanticipated changed condition that occurs during two consecutive monitoring events that may cause potential human health risks associated with a newly completed exposure pathway.

We conclude the groundwater monitoring plan and accompanying action plan are sufficient to manage groundwater conditions at the site. Compilation of the groundwater data from 2016 and 2017 is not necessary to assess future groundwater conditions, and utilizing a more traditional five year schedule seems more appropriate in this instance based upon:

- Regression analysis performed for the north and south plumes confirming the decreasing concentrations on average for the past eight years for both plumes;
- Demonstrated plume stability in a majority of the monitoring wells;
- Lack of complete exposure pathways regarding the north plume (monitoring is proposed to continue to confirm incomplete exposure pathways);
- Filing of deed restrictions precluding use of shallow groundwater for the north plume;
- Settlements with residential property owners regarding decreases in property values, according to the county appraiser, as a result of the TCE impacts in groundwater; and
- Commitment by Whirlpool to continue appropriate groundwater monitoring at the site with corresponding review and oversight of the monitoring results by ADEQ.

19) **General Comment:** *Due to the presence of contaminated subsurface soils in the linear drainage feature (source area), Section 6A of the November 2015 Remedial Action Decision Document (RADD) states "if the December 2015 technical review reveals Whirlpool's action have not achieved the soil remedy goals defined in 2013 RADD, Whirlpool should initiate the soil remedy within 45 days of written notice by ADEQ." The two year technical report does not make reference to Section 6A of the RADD. Since there are wells with increasing trends in the neighborhood, the extent of soil impact has either not been determined or not addressed adequately. The contamination in the groundwater in the southern plume appears to be rebounding in certain areas demonstrating the source area either was not identified or not adequately addressed. Please provide documentation the soils have been remediated to the extent required by the RADD.*

Ramboll Environ Response Regarding the soil remedy goals defined in 2013 RADD: The 2015 RADD requires additional soil remediation if the agency determines that Whirlpool has not achieved the 2013 soil remedy goals. Although the 2013 RADD identifies the RAL for TCE in soils as being 0.129 mg/kg, the 2013 RADD does not mandate or even suggest that the soil remedy goal is to achieve the RAL. In fact, the selected remedy for soils in the 2013 RADD is clearly stated as in-place containment (See, Section 10(A) 2013 RADD). This remedy was carefully selected by ADEQ and justified at Section 9(A) of the 2013 RADD, as follows:

"A containment based corrective measure would provide protection of human health and the environment since it reduces the exposure to the impacted soils. In addition, containment would reduce and prevent the downward migration of water through the contaminated soils; thus reduces the concentration of TCE transferred from soil to groundwater. This reduction mobility of TCE bound in soil will assist the groundwater remedy in meeting the RALs."

TCE impacted soil is not present at offsite locations north. The soil characterized with TCE concentrations exceeding the soil RAL in the RADD exist in the source area, Area 1 and beneath the building. All of these areas are paved with concrete (save for the extreme northwest corner of Area 1 and the rail line in Area 1 are not entirely paved with concrete). The concrete pavement and building provide containment for the impacted soil in accordance with the remedy selection in the 2013 RADD. To further ensure all impacted soils are fully contained, we propose to pave over the small portions of Area 1 not currently paved.

Ramboll Environ Response Regarding the North Plume: As noted in the RADD and confirmed by soil sampling data (DP-01 through DP-04), TCE impacted soil at concentrations exceeding the RAL presented in the RADDs (or a modified RAL based upon the correct length of the source area as discussed the Two Technical Review Report and discussed below) is not present at offsite locations north of the property in the residential area.

In its response to comments on the revised RADD, ADEQ acknowledged that groundwater in the north plume is not impacted by the source area, and that the northern and southern flow regimes are separated by a groundwater gradient divide (hydraulic divide). The divide trends east to west just north of the northwestern portion of former manufacturing building and extending to the east

based upon source area groundwater monitoring which commenced in the 1990s. North of this hydraulic divide the groundwater gradient is directed generally to the north/northeast. South of this hydraulic divide the groundwater gradient is directed primarily to the southeast except for a southwestern gradient in the southwestern quadrant of the property. Plume separation has been demonstrated to exist, and this separation is continuing to expand based upon the ISCO performed in the neck area and the hydraulic divide present immediately north of the source area. No current or potential future impact to the north plume from the source area is anticipated based upon the hydraulic barrier and the ISCO performed in the neck area.

Ramboll Environ Response Regarding the South Plume: The 2015 RADD requires additional soil remediation if the agency determines that we have not achieved the 2013 soil remedy goals. As stated above, we believe the 2013 soil remedy goal of containment has been met. In addition to the entire impacted soil area being covered with concrete pavement, the following facts specific to the south plume, source area and Area 1 further suggest that containment and monitored natural attenuation are the appropriate continued remedies for impacted soil:

- No unacceptable exposures to impacted soil exist because the impacted soil is contained under an impermeable cement cap and the building. Furthermore, a restrictive covenant prevents soil, concrete or asphalt in the impacted area without the prior consent of the ADEQ.
- There are no unacceptable exposures to offsite residents, offsite routine workers or offsite utility maintenance workers.
- Soil and groundwater in the linear drainage feature or source area no longer cause or contribute to groundwater impacts in the north plume based upon (i) the groundwater divide identified during groundwater monitoring efforts performed for the last 20 to 25 years, and (ii) ISCO injection events in the neck area and Areas 2 and 3 which have eliminated or significantly reduced TCE concentrations in these areas to initially create the separation of the north and south plume followed by the October 2015 ISCO event to further expand and sustain the plume separation.
- Analytical results for VOCs in groundwater demonstrate that natural attenuation of TCE is occurring via chemical, geochemical and biological mechanisms in areas of the southern, northern and northeastern plumes as demonstrated by the presence of the reductive dechlorination byproducts cis-1,2-DCE and VC.
- Groundwater monitoring for the south plume has been performed for 20 to 25 years providing a valuable data base. TCE concentration trends are predominantly stable to decreasing for 89% (31 of 35 wells) of the wells in the south plume based on the data base. These stable and decreasing TCE concentration trends demonstrate that natural attenuation processes are effectively remediating groundwater impacts at the Site. The decreasing and stable concentration trends for cis-1,2-DCE and VC in a predominant

number of the monitoring wells is similar to the continuing decreasing concentrations trends for TCE in the southern wells.

- The regression analysis demonstrates that TCE concentrations are decreasing in monitoring wells in the source area and Area 1 (i.e. MW-25 and ITMW-19) prior to performance of remediation activities. TCE concentrations in groundwater in the source area (i.e. MW-25) decreased more than 50% during the last four years prior to remediation activities that commenced in October 2014. These substantial TCE concentrations reductions demonstrate that TCE impacts in vadose zone soil are not substantially contributing to groundwater impacts in the source area.
- The fate and transport model projects groundwater in the south plume will not migrate offsite beyond the property boundaries at concentrations above the MCL. TCE breakdown constituents (e.g. cis-1,2-DCE and VC) are expected to degrade in a similar manner and timeframe as TCE in the south plume based upon regression analysis of site specific data.
- Whirlpool has made significant progress in the redevelopment of the property during the past two years. The warehouse was sold to Spartan Logistics in September 2014 and Whirlpool remains in continued discussions with multiple interested buyers for the remainder of the property. Whirlpool is optimizing the interior space of the former manufacturing building for warehousing purposes, and is planning to subdivide western portions of the property for further development for industrial and commercial purposes.
- If future data collections indicate that there is an unacceptable exposure risk to onsite workers, maintenance workers or construction workers, such future risks will be managed by means of the existing deed restriction (future site use designated as commercial/industrial and use of groundwater is not allowed), engineering controls, monitoring and proper work practices and protective gear or equipment. Indoor air monitoring and sub-slab soil vapor testing is planned to occur during February 2016 to facilitate planned interior building activities including equipment removal and selective demolition of the mezzanine level to optimize potential future use of the building (indoor air monitoring has been completed and indoor air concentrations are below screening levels for commercial/industrial workers).

Because the conclusions above rest firmly upon: site specific data collected over the last 20 to 25 years; remediation activities that have resulted in significant reductions in concentrations of constituents of concern; and, demonstration that the south plume will remain on the site while constituent concentrations continue to decrease due to MNA, there is no need at this time for further remedial action beyond continued containment of impacted soil monitored natural attenuation. The need for further remedial actions can be reassessed, if and as warranted, during subsequent five year remedy reviews in light of future data collection.

Therefore, Whirlpool respectfully requests that the remedy for impacted soils continue to be containment, rather than achieving the soil RAL in the RADD.

The basis for the request is based upon demonstration of decreasing TCE concentrations in the source area and Area 1 groundwater even though soil exhibiting concentrations greater than the RAL in the RADD were present at these locations (i.e. the soil RAL is intended to be protective of groundwater). Other factors supporting the continued reliance on containment include:

- The Two Year Technical Review Report indicated that source length parallel to groundwater flow was not 379 meters (m) as indicated in the Site Specific Risk-Based Protection of Groundwater Soil Screening Level (ERM Risk Evaluation Report, June 2007). In the "Response to ADEQ Comments on the Fourth Quarter 2014 Progress Report" (May 2015) and in the Two Year Technical Review Report, the source area width is identified as 10 feet. Therefore source length parallel to groundwater flow is 10 feet or 3 m (i.e. the source is not the entire length of the groundwater plume as assumed by ERM). Adjustment of the soil RAL calculated by ERM in 2004 using the appropriate length of the source parallel to the groundwater flow direction (3 m versus 397 m) adjusts the calculated soil RAL to range from 1 mg/kg to 10 mg/kg based upon the range of hydraulic conductivities measured for the south plume.
- The soil characterized with TCE concentrations exceeding the soil RAL in the RADD exist in the source area, Area 1 and beneath the building and all of these areas are paved with concrete (the extreme northwest corner of Area 1 and the rail line are not entirely paved with concrete). The concrete pavement and building provide containment for the impacted soil in accordance with the remedy objectives presented in the 2013 RADD.
- The source area and Area 1 are specially designated in the deed restriction and this designation precludes development in these areas and grants Whirlpool access to these locations in the future (in the event the property is sold). Access to implement future soil remedies, if necessary based upon future data collection is available.

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Yours sincerely,

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