UCC Response to Comments: WVDEP and EPA Review of Union Carbide Corporation (UCC). Pore Water Confirmation Sampling Presentation, dated September 11, 2017.

Response to comments received from Kenan Cetin, PhD, West Virginia Department of Environmental Protection, on September 1, 2017.

1) In the cross-sections, C-C' and D-D' I note that there are 4 pore water locations shown on sand and gravelly sand, with only one in sandy clay.

   A) How is the lithology at pore water sampling location determined? Is it simply a horizontal lateral projection of a lithology passed/crossed in a well toward the river until it reaches it? Or is a grab or core sample taken at the sampling location at the same time?
   B) In the general application of the pore water sampling in the environmental remediation work, does the sampling for pore water involve obtaining a core or grab sediment/rock sample in the very vicinity of the pore water sample location?
   C) Even if the answer to the question in B is negative, I see significant utility in knowing the exact lithology at the point of sampling; preferably in the form of a core. Would you not agree?

   Response: The objective of the pore water sampling at the UCC Institute Facility is to determine if VOCs in onshore groundwater are migrating to Kanawha River pore water at concentrations that may pose unacceptable risk to ecological receptors. As presented in the September 11, 2017 presentation to WVDEP and EPA, the biologically active zone (BAZ) is the upper portion of the hyporheic zone, typically 0-6-inches below sediment surface. The BAZ is the targeted zone to assess potential risk to ecological receptors. As a result, knowing the specific lithology within this zone is not needed to answer the primary objective. The lithology presented on the cross section was based upon the wells and borings installed near the Kanawha River. Although sediment cores were not collected as part of the Trident Prober sampling, sediment sampling results performed adjacent to the UCC Institute Facility were consistent with the lithological projections presented on the cross sections provided.

2) In cross-section, D-D, using the horizontal scale, one can calculate that sampling locations, INS-0315 and INS-306 are only about 70 feet and 90 feet, respectively, from the groundwater sample location INS-78B with 120,00 microgram/L of benzene nearly entirely in sand. Toward D in the cross-section, there is clearly highly contaminated GW probably with greater than 50,000 micrograms of benzene. With only sand, in between this location (INS-78B) and the pore water sampling locations down gradient, how do you explain and reconcile 1U for benzene? Straight shot laminar GW flow to nothingness!

   Response: As presented to WVDEP and EPA during the September 11, 2017 teleconference call, there is evidence within onshore groundwater of orders of magnitude decreases in benzene between wells near the Tank 1010 source area and the shore line over similarly short distances. Biodegradation of benzene appears to be occurring based on the available

data and likely accounts for a portion of the observed decrease in concentration between onshore wells and pore water. Furthermore, as the groundwater VOC plume reaches the groundwater surface water interface, further attenuation is occurring, possibly due to mixing between groundwater and surface water thereby creating aerobic conditions in the pore water. The GSI is characterized as not simply groundwater and not simply surface water; the chemical, biological, hydrological, and metoblic characteristics are specific to this mixing zone. As discussed on September 11, 2017 presentation to WVDEP and EPA, Dow is evaluating collecting additional data to further assess biodegradation of benzene in groundwater at this site.

3) I lived right by Kanawha river for 4 years in a row. The river traffic, especially coal barge traffic, is constant and relatively heavy when a barge is full and when barges meet or come side by side. Also, the river's water volume, flow energy and speed is rather significant from time to time, especially in the fall for a few months when the Summerville Dam is drawn down. In other words, it is a river where actual scour/erosion as well as settlement/deposition of sediments take place, just like in totally natural, unconfined, wild rivers. As a side note, I must add that I suspect that in some areas of Kanawha rive this sand size fill on the river bottom surface might be coal that ends up in the in the river water from various historical transportation modes and activities on or around the river. No matter what the sand material is, the question I have is this: Presuming that the sand lithology over which the porewater sampling has been confirmed (as is shown in the cross-sections), what kind of a reconciliation, if any, has been done to ensure that the sand is not simply some recent loose sand fill deposited on the river bottom surface that is completely saturated with river water at worst, or at least significantly diluted by it. In other words, is the sand native or in situ, more simple way to ask the longer question?

   Response to comments: Whether or not the river bottom is comprised of recently deposited sand (either naturally or through anthropogenic activities) does not have an influence on the objectives of the pore water investigation. The primary objective is to determine if unacceptable concentrations in onshore groundwater are migrating to the Kanawha River pore water at concentrations that may pose unacceptable risk to ecological receptors. Benthic macroinvertebrates within the BAZ will be present whether native sediment or recently deposited sediment is present.

4) I do not know that there is enough difference between GW and river water geochemistry near the interface at river bottom in boundary waters, that you can tell dilution in pore water samples. What has been done to show that there is no dilution, or at least no significant dilution? Or could there have been any efforts that would help us in this way make the "no dilution" argument?

   Response: Groundwater at the Institute site and surface water in the Kanawha River have significantly different geochemical conditions and can be readily distinguished from one another. For example, dissolved oxygen and the oxidation reduction potential are both much lower in groundwater based on site-specific data. As presented in RTC #2, the GSI is a mixing zone comprised of both surface water and groundwater. The Trident Probe is equipped with an adjustable stopper/seal plate that rests on the sediment surface during sampling. This seal plate provides a barrier to prevent surface water from being drawn down into the sampling port during

sampling. During sampling, the Trident Probe analyzes water quality parameters (conductivity, temperature, pH, ORP, and dissolved oxygen) from the pore water sampler and surface water and compares them to ensure that pore water is being sampled and surface water is not being drawn into the pore water sampling port.

5) It seems to me that if the sampling location does not have enough clay/organic sediment material to kind of trap the pore water from coming into direct contact with river water so it is truly "resident" pore groundwater and not diluted by river water, then there is a risk at best of dilution and, at worse, straight river water being sucked into the sample chamber during the sampling, the risk being dependent on exact sampling conditions such as depth into the sediment, the volume of water collected, the size of the flange, successful operation of the apparatus, etc. etc. Why choose sand or sandy locations as opposed to locations with a clay rich layer present? Or am I missing part of the picture? Please elaborate.

   Response: See RTC #4 regarding measures to ensure pore water is sampled and RTC #3 regarding sediment type at sample locations.

6) Could you please provide an SOP or a QAPP that contains details that would perhaps illuminate some of my concerns above?

   Response: The pore water sampling procedures are outlined in detail in the HPH and Tank 1010 Pore Water Characterization Report, October 2013 (including an SOP for Trident Probe sampling). Details regarding the Trident Probe and sampling procedures were also recently presented to WVDEP and EPA via teleconference call on September 11, 2017 ; the presentation is attached

   In an extremely strictly and demonstrably controlled environment, a result of 1U might be relatively easy to believe. However, in 15-20 feet of water in the relatively murky waters of a river and in the absence of independent line of evidence (such as what Erich had requested or some others perhaps out there) the argument for a MNA will have a significant credibility problem. Not just here at Institute but also at South Charleston facility and elsewhere. Please let us know if you can think of ways to change the pore water sampling program/protocol in ways that would ease and alleviate some of my concerns above.

   Response: As discussed during the September 11, 2017 teleconference call with WVDEP and EPA UCC has agreed to conduct additional analyses in upcoming pore water sampling and groundwater sampling events to further assess the role of biodegradation of benzene. Dow is presently evaluating the appropriate analyses which may include methane and other parameters.

Response to comments received from Erich Weissbart, P.G., USEPA Region III on August 28, 2017.

1) Since the belief is benzene is naturally degrading between Tank 1010 and groundwater discharge to the river would it make sense to analyze for degradation products? Certainly the lack of benzene is a line of evidence as is the geochemistry of groundwater, but if possible I believe the quantification of degradation products would clinch the natural attenuation argument. As to what

those are I do not know, nor do I know the difficulty in sampling pore water for them but I want to hear opinions.

Response: See response to RTC #6 above.