MEMORANDUM

TO: Mark Bohne, USACE PBOW Co-Chare and RAB members

FROM: Julie Weatherington-Rice

RE: Amendments to the Educational Review for the RAB of the Shaw Environmental March 2007 Draft "Feasibility Study for Groundwater TNT and Red Water Pond Areas" based on additional information provided at the May 31, 2007 RAB meeting

DATE: June 1, 2007

Per our current contractual arrangement with USACE which requires both a technical memorandum for each report and an educational explanation to the RAB, this memorandum constitutes the educational review of the Shaw Environmental March 2007 Draft "Feasibility Study for Groundwater TNT and Red Water Pond Areas" based on additional information provided at the May 31, 2007 RAB meeting. Please forward these comments to those who should receive them.

These comments are generated directly from an analysis of various bits of information that was provided by USACE, their contactors, and RAB members yesterday evening filtered through a screen of Ohio Geology. When viewed as a whole, they provide pieces of information that need to be collected, documented, and considered as part of the ground water clean up at the site. I have not specifically listed each person as the source of each comment but hopefully Helen Owens, in capturing the minutes for the meeting, was able to capture the various sources.

1. **Measurement of a Pumping and/or a Dewatering Cone of Influence**

Like Zeno's Paradox, the limits for cones of influence continue on forever. They are assumed to have reached equilibrium when either:

a) They can no longer be physically measured separately from the natural static water levels of the area. This is assumed to be 0.1 inch.

b) They can no longer be mathematically separated from the natural static water level. This is assumed to be 0.01 inch.

The dewatering cone(s) of the Wagner Quarry, the Reactor sump, and/or any other pumping and/or dewatering cone at and/or near the PBOW site affect the time-of-travel

of the ground water flow, which affects the time allowed for natural attenuation before the ground water leaves the facility boundaries, which affects how far the contaminants can move while they are still viable. Understanding these concepts will change the way we view the MODFLOW model output over time. It may also have major implications on which remediation techniques are chosen for the sites at PBOW. Therefore any portion of the PBOW site that has a physical impact of 0.1 inch as physically measured and/or 0.01 inch as mathematically measured on the natural static water level due to the dewatering cone of the Wagner Quarry and/or the Reactor sump and/or any other source, is within the cone(s) of depression of these sinks. Where are those boundaries?

This question does not immediately require remodeling the whole facility. It can be approximated by creating a (series of) cross section(s) of the water levels from the Wagner Quarry, the Reactor sump, and water levels in monitoring wells at the site. The Wagner Quarry sump elevation is fixed at about 460 feet above mean sea level. It should be possible to find the elevation of the Reactor sump. The water levels in the wells are measured on a regular basis. Where do the gradients change from well to well along the cross sections? Where are the static water levels steepened and where are they relatively flat?

2. Using the Water Chemistry of the Ohio Shale for Background Chemistry

Using the water chemistry of the Ohio and Plum Brook shales as the background for the "clean up" chemistry for the carbonates is simply NOT valid. It's like matching apples to meatloaf. If it was NOT possible to find background carbonate chemistry to the south and west on the PBOW site, wells should have been installed off site. USACE cannot allow Shaw to use the chemistry of the Ohio/Plum Brook shales to be used as the "clean" standard for carbonate wells in areas of thin and/or missing shale such as the Red Water ponds. The geochemical makeup of the two types of rock, their depositional conditions, and the chemistry of water within the formations are completely different. The shales are deposited in anaerobic/reducing conditions, not unlike the current Black Sea, which preserve the carbon, sulfur, and iron. The carbonates (at least the Delaware and Columbus limestones) are deposited in aerobic/oxidizing lagoon and reef conditions. The physical and chemical differences of these formations has historically been taught at Ohio State University in Geology 101, the introductory undergraduate course for geology majors. It is covered in the Ohio rocks laboratory and the field trip for the course.

3. Dry Wells

The Wagner Quarry is physically pumping over 1 million gallons per day out of the Quarry sump. The Delaware Limestone, the Columbus Limestone, and the Detroit River Group are considered and mapped as bedrock aquifers in Ohio by ODNR Division of Water, not aquitards. If a well is completed in the Delaware/Columbus/Detroit River Group and it is completed below the dewatering cone of the quarry and it DOES NOT make water, it DOES NOT mean that the formations are aquitards, it means that the well was designed and constructed incorrectly for the hydrogeological setting. The most

productive wells are located at the intersections of the two regional jointing systems, allowing water to travel to the well from both directions.

4. Modification of the MODFLOW Model

Depending on how the MODFLOW model was originally structured, the grid to the north can be simply modified with much bigger grid spacing. With the static water level information from the off-site monitoring well and the Wagner Quarry, two valid control points exist off-site. The cell for the Quarry can be as large as the Quarry itself (since the quarry occupies air space), as long as the sump is in the center of the cell so as not to violate the underlying rules of the model.

This effort would still create an averaged time-of-travel instead of the fastest time-of-travel which is required for contaminant transport, but the Quarry sump should begin to drive the model IF the model was constructed correctly. As an interim step, historic and future water level maps for the carbonate bedrock for the site should be (re)generated with the Quarry sump as a constant at 460 feet above mean sea level. While the depth of the Quarry sump and it's volume of pumping has changed in the last almost 100 years, the history of record of water levels at PBOW is relatively short and will not be significantly impacted by holding the quarry sump as a constant. Depending on how Shaw created these maps originally, this should be a fairly easy revision process by adding the locations and depths of the Wagner Quarry sump, the Reactor sump and any additional sumps and rerunning the static carbonate ground water surfaces through Surfer to see how the maps change with the new control points added. Once we can all view these new water level maps, we will have a much more useful place to continue this discussion of the site ground water remediation. Without this information, the accuracy of our decision making will have been limited by this critical lake of information.

5. The Ohio Shale as an Oil Shale

Mention was made last night about a deep rocket testing facility at the PBOW site where a large hole has been constructed in the bedrock formations under the facility and rocket engines are fired for testing. Firing a rocket creates heat, which must be dissipated from the test chamber. Mark Bohne located this test chamber on the PBOW site map for me. It is my understanding that the uppermost bedrocks at the site where it is located are the Ohio/Plum Brook shales.

The Ohio Shale is an oil shale. In the late 1970s and early 1980s, when Ohio still had a Department of Energy (ODE), Dr. Dick McClish, recently retired from Ohio EPA Surface Water (mapping section ?), headed the geologic section for ODE. Gene Johnson, MS, Geology OSU, worked directly for Dick. They conducted oil extraction experiments on the Ohio Shale. The Ohio Shale, when heated, liberates high quality, light petroleum suitable for refining. This is a completely different product than the very thick petroleum that drips naturally out of the Columbus Limestone.

If there are physical operations at the PBOW site that generate significant amounts of heat and if that surplus heat comes into contact with the Ohio Shale, the oil fraction in the shale can be cooked out in place. It is also possible to liberate the oil fraction chemically. Once the oil is liberated, it will move with the local ground water flow pattern, floating on top of the water. When searching for the source of the free product light oil that has been located at several wells on the site, this rocket testing facility needs to be considered. Additionally, locations where volumes of transforming chemicals such as acids were spilled also need to be considered.

This concludes my additional comments which were generated from information presented at the May 31, 2007 RAB meeting. Please distribute these educational comments to those who need them. If you have any questions and/or need further clarification on any portion of these additional comments, please feel free to contact me.