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March 28, 2006

USACE Huntington District
502 8th Street
Huntington, WV 25701-2070
Attn: Lisa Humphreys

RE: Additional comments on occurrences of thallium in Ohio settings and it's presence at the Plum Brook Ordnance Works

Dear. Ms. Humphreys:

Per comments in our memo report of December 8, 2005 Re: Review of the Draft Interim Soil Removal Action (ISRA) Report for the PBOW TNT Area B, October 2005, I have conducted an additional search of references both published and on the web to help to determine the source(s) of measurable thallium reported in the "Final Report for the Site Investigation of the Reservoir #2.2 Burning Grounds, Additional Burning Grounds Wastewater Disposal Plan #2, and the Power House #2 Ash Pit at PBOW, December 1997".

1. Thallium is a heavy metal that exists in trace quantities in several deposits in Ohio. A review of "Dana's Manual of Mineralogy" (Hurlbut 15th Edit, 1947) and "A Field Guide to Rocks and Minerals" (Pough, 1976) indicates that there are no natural occurring ores of thallium, rather the metal is found in trace amounts in other igneous metal ors. It also exists in trace amounts in sedimentary metal ores, especially iron pyrite and marcasite (both FeS_2) and is found as a trace element in Ohio coals and coal ashes.

2. There are deposits of iron pyrite and marcasite in the Plum Brook (Olentangy) Shale and the Ohio Shale found underneath the Plum Brook Ordnance Works, however, the amount of the pulverized iron sulfide ore that would be included in the glacial materials overlying the bedrock at the site would not be sufficient to leave measurable amounts of thallium, a trace metal in the iron sulfide ore, behind in the soils at the site. Therefore, it is our considered opinion that the thallium found at the site is not naturally occurring.

3. Thallium can be released in the burning of coal. It is commonly now measured in the resulting coal ash. However, historic coal fires that predate the requirements of bag house filters and scrubbers allowed portions of the ash, as particulates, to rise out of the smokestacks and distributed portions of the ash as fallout from the smoke on the surrounding landscape. The Power

House #2 activities predate the Clean Air Act and did not require the collection of fly ash during the burning of coal.

4. Thallium can also be released from the leaching of coal piles and coal ash piles that have been left at the site for extended periods of time. This is especially true when precipitation has a pH below 7.0. The pH of Ohio precipitation ranges from 5.5 to 5.0 and leaches heavy metals out of exposed coal and coal ash stockpiles in Ohio.

5. Thallium has also been noted to be released into the air as a byproduct of the roasting of iron pyrite for the formation of sulfuric acid. While we are not certain as to how sulfuric acid was produced at the Plum Brook Ordnance Works, this is another possible source of release of thallium into the background soils at the facility.

6. A review of the historical practices at the Plum Brook Ordnance Works indicates that the presence of thallium at the site in soils has an anthropogenic source and is probably spread by wind and possibly also by surface and/or ground water runoff.

7. Thallium has a very low Maximum Contamination Level (MCL) when measured in water. The MCL for thallium is 2 ug/l. Leaching of thallium from the area could result in surface and ground water contamination near or above the MCLs and needs to be monitored.

8. Currently thallium is held in the "A" horizon of the natural soils at the site by cation exchange capacity (CEC) on organic materials. The "A" horizon has a natural pH of below 7.0 and the effectiveness of the CEC of organic materials decreases as pH levels fall. The "B" horizon of the natural soils at the site holds the thallium through CEC on both organic materials and on the edges of clay minerals. The most common clay minerals at the site are illite, kaolinite, and chlorite. These three clay minerals have the lowest levels of CEC of all clay minerals. By the time the "C" horizon or "Parent Materials" are reached, very little organic material remains to hold the thallium (or any other heavy metal, such as lead). In these settings, virtually all the thallium is bound by CEC to the illite, kaolinite, and chlorite which are exposed along the fractures in the materials. This is a significantly lower volume of CEC availability than would be expected in a traditional CEC measurement.

9. Care needs to be taken to prevent the destabilization of thallium (and/or any other heavy metal at the site such as lead) by the lowering of the natural pH at the site during any of the remediation and/or clean-up processes.

This concludes our analysis of the "thallium issue" at the site. If you have additional questions and/or need further information, please feel free to contact me.

Respectfully submitted,
BENNETT & WILLIAMS ENVIRONMENTAL CONSULTANTS INC.

Julie Weatherington-Rice /KHS

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Sr. Scientist & Project Manager

JWR/jr

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PBOW RAB
File

References

Hurlbut Jr., Cornelius S, 1947, Dana's Manual of Mineralogy, 15th Edit, 6th Print, John Wiley & Sons, New York NY, 480 pages.

Pough, Frederick H., 1976, A Field Guide to Rocks and Minerals, 4th Edit, (The Peterson Field Guide Series), Houghton Mifflin Co., Boston MA, 317 pages.