Memoranda

Date: - October 7, 2019

From: - Dr. Carl Bolster, Agricultural Research Service, U.S. Department of Agriculture, Bowling Green, KY

- Mr. Charles Taylor, Water Resources Section Kentucky Geological Survey University of Kentucky, Lexington, KY

- Dr. Martin J. Shipitalo, Retired, Agricultural Research Service, U.S. Department of Agriculture, Ames, IA

- Mr. Mark Rice, Retired, Department of Biological and Agricultural Engineering, North Carolina State University, Raleigh, NC

To: – Dr. Mark J. Cochran, Vice President for Agriculture, University of Arkansas, Little Rock, AR

Re: – Report from Expert Panel – C&H Farms Research Project

In September 2019 a review panel consisting of Carl Bolster (USDA-ARS), Mark Rice (North Carolina State University, retired), Charles Taylor (University of Kentucky), and Martin Shipitalo (USDA-ARS, retired) with expertise in hydrology, water quality monitoring, animal waste and soil management reviewed the draft report "Monitoring the Sustainable Management of Nutrients on C&H Farm in Big Creek Watershed" provided by the Big Creek Research and Extension Team (BCRET). The impetus for the study and the subsequent report was to assess the potential impact of a newly permitted and established concentrated hog feeding operation upstream from the Buffalo National River Watershed in an area with karst geology.

The BCRET in consultation with the outside reviewer panel, including Final Report review team members Bolster, Rice, and Shipitalo, devised a multi-faceted approach with three objectives:

1. Monitor the fate and transport of nutrients and bacteria from land-applied swine effluent to pastures.
2. Assess the impact of farming operations (effluent holding ponds and land-application of effluent) on water quality adjacent to the farm including springs, ephemeral streams, creeks and ground water.
3. Determine the effectiveness and sustainability of alternative manure management techniques, including solid separation, to increase the export of nutrients out of the watershed.

We offer the following comments on the appropriateness of the methodology, interpretation of the results, and conclusions and offer suggestions on how the report can be improved.

Methodology

In general, the team found that the methodology was appropriate for each of the objectives. In particular, the BCRET used a combination of periodic, grid soil sampling and testing, and surface runoff monitoring on three pastures with contrasting soil types. Two of the fields received swine slurry and one received mineral fertilizer at appropriate rates to address Objective #1. The soil sampling protocols were guided in part by a Ground Penetrating Radar (GPR) evaluation of soil depth in each of the three monitored fields.

As part of Objective #2 the BCRET monitored the properties of the slurry stored in the two holding ponds used by the CAFO with time and with depth, an onsite deep well, a nearby spring and ephemeral stream to assess potential leakage from the holding ponds. Additionally, an interceptor ditch was installed down slope from the ponds to assess potential seepage as well as overland flow originating from the holding ponds. This monitored ditch was particularly suitable in areas such as this with a high potential for preferential flow. The review team, however, requests additional information on how the geology of the site was assessed and summary information on the results of any dye tracing experiments that have been conducted in the area that might be applicable to the interpretation of the results.

The BCRET used analysis of the composition of the slurry with depth to suggest that segregation of the slurry by depth could be used to reduce the potential for nutrient buildup (mainly P) in the fields where slurry was applied in furtherance of Objective #3. Likewise, they used the soil testing data to determine where nutrient buildup is or has occurred to refine application zones within fields. The BCRET mentions in the report that locally sourced limestone and hydrated lime were investigated as potential flocculants to concentrate solids and P in the slurry. Scant information on the methodology used to perform these tests is presented in the draft report. The review team suggests that this information be included in the revision or that justification for not providing these details as well as the results of these experiments be included.

Interpretation

Objective #1. The results of the soil testing of the pastures and monitoring of surface runoff were evaluated using appropriate statistical techniques. We agree with the conclusion that available soil P test levels are increasing as a result of slurry application. In some this increase in available P predated slurry application and was related to animal movement and feeding areas - not slurry management. The analysis of P saturation levels document that P levels are still well below levels that research has shown to be of concern.

The loss of nutrients in surface runoff was more related to a few extreme runoff events during the monitoring period than to slurry management practices. This interpretation was supported by the observation that nutrient losses were similar from the pasture that received mineral fertilizer and one of the slurry-amended fields. Furthermore, the rates of nutrient losses were of similar magnitude to those observed in other studies with similar experimental conditions.

Sampling of Big Creek upstream and downstream from C&H Farm combined with two robust methods of trend analysis revealed that flow-adjusted P concentrations decreased while flow-adjusted N concentrations increased upstream and downstream during the monitoring period. We concur that there is insufficient evidence to link these increases to operations associated with C&H. Moreover, comparison of water quality of this reach of Big Creek to other streams in the region further support a finding of limited impact of C&H operations on water quality.

Objective #2. The BCRET documented slight but significant increases in nitrate nitrogen in the well and ephemeral stream associated with the holding ponds, but not in the interceptor ditch. While statistically significant, the increases were small and not at a level that would raise water quality concerns at the present. We agree with the BCRET that the lack of a concurrent increase in chloride levels or electrical conductivity at these sites could be interpreted as indicating that potential leakage from the holding ponds was not a major contributor to the observed increase in nitrate-N. However, given the presence of karst, an alternative interpretation could be made raising the question of whether discrete preferential flowpaths in the subsurface is allowing potential nutrients to bypass these sampling locations. It would be useful if the team could provide information or speculation on other land use practices in the area that might have contributed to the increased levels of nitrate.

Objective #3. As mentioned in our comments on Methodology, additional quantitative information on the results of the treatment of the holding pond slurry with lime and hydrated lime are desirable to augment the interpretation by the BCRET that such treatments are likely to be unfeasible as a method of reducing available P prior to slurry application to pastures.

General Comment Regarding the Relevance of Karst Hydrogeology

One limitation in the report, is the lack of a detailed discussion about how specific karst characteristics present at the site were factored into the monitoring/sampling plan design and were considered in analysis and evaluation of the results. Information presented in Appendix D (ground penetrating radar surveys) is particularly relevant, as is information that can be gleaned from a number of previous tracer test studies of the karst hydrogeology in the watershed area cited in the references. The paper by Brahana and others (2014), referenced below, is particularly relevant and detailed, and should be very helpful. Finally, there was no specific discussion in the report about water-chemistry and flow characteristics at the spring sampling site (Site 5), even though field and laboratory water-chemistry data from that site is included in Appendix I. An evaluation of the spring's discharge characteristics may provide significant insights about the nature of karst development at the site and its possible impacts on contaminant transport. This information should be synthesized and discussed in the report in a way that describes a conceptual model of the karst, discusses how the presence of karstic drainage characteristics (both surface and subsurface) affected the choice of groundwater sampling site locations and techniques, and evaluates the possible uncertainties the presence of karst may have on the interpretation of the water-quality analytical results. For example, the report could benefit from inclusion of:

1. A map showing the locations of any identified sinkholes or sinking streams, and given the presence of mantled karst, the thickness of soils, and areas of bare rock outcrop, relative to the locations of potential contaminant source areas, and especially, locations of the spring and well sampling sites. This information would be useful in assessing the adequacy of sampling locations with

regard to on-site locations potentially most susceptible to rapid infiltration and/or internal drainage of concentrated surface runoff.

2. A map showing plotted dye flow vectors (inferred from previously reported dye-tracer tests) relative to locations of source areas and groundwater (well and spring) sampling sites. This information would be helpful in assessing the effectiveness of sampling site locations and evaluating possible uncertainties relative to existence of preferential karst or fracture flowpaths in the aquifer, possible interbasin water transfer, etc---all which are mentioned and discussed briefly or in general terms in the text.

In considering needed additional content and to how to frame the discussion in this section of the report, the following papers would be helpful to consult:

Brahana, Van, Nix, Joe, Bitting, Carol, Bitting, Chuck, Quick, Ray, Murdoch, John, Roland, Victor, West. Amie. Robertson, Sarah, Scarsdale, Grant, and North, Vanya, 2014, CAFOs on karst—Meaningful data collection to adequately define environmental risk, with specific application from the southern Ozarks of northern Arkansas: in Kuniansky, E.L., and Spangler, L.E., eds., U.S. Geological Survey Karst Interest Group Proceedings, Carlsbad, New Mexico, April 29-May 2, 2014, U.S. Geological Survey Scientific Investigations Report 2014-5035, p. 87-96.

Ewers, R.O., 2006, Karst aquifers and the role of assumptions and authority in science: Geological Society of America Special Papers 404, p.235-242 doi: 10.1130/2006.2404(19).

Field, M.S. 1990, Transport of chemical contaminants in karst terranes: outline and summary: in Simpson, E.S., and Sharp, J.M. Jr., International Association of Hydrologists, Selected Papers on Hydrogeology from the 28th International Congress, Washington, DC, USA, July 9-19, 1998, v. 1, p.17-27.

Quinlan, J.F., 1989, Groundwater monitoring in karst terranes: recommended protocols and implicit assumptions. Las Vegas Nevada: U.S. Environmental Protection Agency Report EPA/600/X-89-050.

<u>Conclusions</u>

The review team, based on the findings presented in the draft report, concurs with the conclusions reached by the BCRET. Namely that at present there is no evidence that the operations associated with C&H Farms has significantly impacted the quality of the ground or surface waters associated with the holding ponds or the fields where slurry has been applied. There is a potential, however, that long-term continued application of slurry to pastures in excess of nutrient requirements may contribute to degradation in water quality absence the use of techniques to reduce nutrient availability in the slurry. Acceptance of these findings by the scientific community at large is further evidenced by publication of portions of the report in peer-reviewed journals.