λχ LITHOCHIMEIA, LLC

TO: ROBERT BLANZ, ADEQ
FROM: J. B. FISHER, PH. D.
SUBJECT: C&H HOG FARM LAGOON INVESTIGATION
DATE: JULY 11, 2016
CC: DANE SCHUMACHER, RICHARD MAY

Thank you for the opportunity to offer constructive commentary regarding the proposed borehole to be advanced to a depth of 30 meters (~ 98 feet) from a point ~ 75 meters northeast of the southwest corner of the electrical resistivity imaging (ERI) data collected by Dr. Todd Halihan along a transect identified as MTJ108 (a/k/a west transect). The purpose of advancing this borehole is to investigate the potential fracture feature identified by Dr. Halihan and to investigate the possibility that liquid hog waste or liquid hog waste components have leaked from the lagoons into the subsurface.

It is my understanding that, in outline, the proposed investigation envisions advancing a borehole using a hollow stem auger rig and collecting split spoon samples from the surface to total depth. It is further my understanding that, in the event that competent rock is encountered, the boring will be advanced by rock drilling techniques. Soils, sediments and rock recovered from the borehole will be documented on a standard geotechnical boring log, photographed and/or videoed and analyzed for various physical, chemical and biological parameters. Additionally, it is my understanding that any ground water entering the borehole will be collected and analyzed for various physical, chemical and biological parameters. ADEQ intends to advance the borehole in the presence of normal fluid levels in the waste lagoons, and intends to obtain and analyze fluids from the waste lagoons as well as groundwater wells on the site.

As presented by ADEQ, will engage an outside contractor from a list of approved contractors provided by the Office of Land Resources. As envisioned, the schedule for this project is accelerated, and contemplates that a Notice to Proceed will be issue in approximately 30 days, and that ADEQ anticipates that the contractor will mobilize for fieldwork within 30 days of receiving the notice to proceed.

In an effort provide transparency, ADEQ has engaged in scoping discussions with a number of entities, including a scoping discussion with the Buffalo River Watershed Alliance on July 8, 2016. One outcome of ADEQ's scoping discussion with the Buffalo

River Watershed Alliance was ADEQ's invitation to Buffalo River Watershed Alliance to submit a list of items to consider in more fully developing the scope of this investigation as well as producing the final written procedures and protocols to be used in executing this investigation. The items listed below are responsive to this invitation.

Spatial Sampling Frequency: ADEQ indicated that they were prepared to collect samples for analysis from every 1-ft interval from all split spoon samples. While it is certainly true that spatially detailed sampling is desirable, sampling at this spatial frequency may add costs to the project that might be better allocated elsewhere,. This is especially true when an extensive analyte list is planned. ADEQ might consider a less spatially intensive regularized sampling program with the provision that the on-site geologist could, based on visual, olfactory or other field observations, elect to take more spatially intensive samples from specific intervals.

Split Sampling: ADEQ indicated a willingness to split samples with outside entities. Although splitting samples might assist project transparency, ADEQ should consider the possible confusion that might arise from just the act of managing the split samples as well as from the lack of control that ADEQ and its contractors might have over the preservation and handling of these samples. It is suggested that ADEQ limit sample splitting and even then only split samples with organizations who are interested in funding unique or expensive analytical work.

Physical Sample Archive: ADEQ might consider maintaining an archive of physical samples from this borehole. These would be collected at the same time that samples were collected for physical, chemical and/or biological analyses. A small aliquot (e.g. 4 oz glass bottle) of the recovered material might be archived at a repository site for later inspection. Unless there was a compelling reason to retain them longer, these samples might be retained for inspection or additional analysis for some time certain, say 12 months, and then discarded.

Analytes: We are generally supportive of ADEQ's desire to collect a comprehensive suite of chemical data from the recovered samples. At a minimum, we believe that the major cationic (potassium, sodium, calcium and magnesium) and anionic (chloride, sulfate, bicarbonate, carbonate) constituency of any fluids expressed or extracted from the recovered soils should be collected. In addition, these fluids should be analyzed for pH, nitrate-nitrogen, total organic carbon, electrical conductivity and total soluble salts. ADEQ might consider measuring $\delta^{15}N$ for the recovered solids as well. Provided sample integrity under field conditions, it would likely be useful to assay the recovered solids for fecal coliform bacteria and swine-marker DNA.

Field and Laboratory QA/QC: Given the sensitivity of this project, we suggest that ADEQ fully communicate the field and laboratory QA/QC program to be

implemented. In particular, we suggest that ADEQ clearly discuss the criteria necessary for data usability. Further, should ADEQ elect to split samples, a pre-condition for splitting should be the submission of a data quality plan to ADEQ by the organization requesting the split. Since many of the chemical and/or biological parameters of interest are common in the environment, it is especially important that field and trip blanks be adequately used.

Competent Rock Sampling: In the event it is found necessary to penetrate competent rock, ADEQ might consider continuous core sampling of the competent rock. Depending on specific circumstances, this rock might be appropriate for and subject to physical, chemical and/or biological analysis, but in all cases would be collected and archived.

Drilling/Sampling/Lab Protocols: It is our understanding that ADEQ plans producing and publishing written protocols for all activities. We are strongly in agreement.

Extraction v Squeezing: It is our understanding that ADEQ is considering collecting water from the recovered solids by either squeezing or water extraction. Although squeezed pore fluids would be preferable, it is suggested that water extracts be collected and analyzed for all sampled intervals. The protocol for extraction could be a simple constant ratio of soil:extractant water. The motivation for extraction is to have a data set that is consistent across all samples. It would be a bonus if water can be expressed and analyzed as well.

Geophysical Logging: In order to extract the maximum amount of information possible from the borehole, it is our opinion that ADEQ should contemplate obtaining a suite of geophysical logs from the borehole. Of particular interest would be a natural gamma ray log, an electromagnetic induction log and a neutron-porosity log. A natural gamma ray log records the amount of natural gamma radiation emitted by the rocks surrounding the borehole. The most significant naturally occurring sources of gamma radiation are potassium-40 and daughter products of the uranium- and thorium-decay series. Clay- and shale-bearing rocks commonly emit relatively high gamma radiation because they include weathering products of potassium feldspar and mica and tend to concentrate uranium and thorium by ion absorption and exchange. An electromagnetic induction log records the electrical conductivity or resistivity of the rocks and water surrounding the borehole. Electrical conductivity and resistivity are affected by the porosity, permeability, and clay content of the rocks and by the dissolved-solids concentration of the water within the rocks. The electromagnetic-induction probe is designed to maximize vertical resolution and depth of investigation and to minimize the effects of the borehole fluid. A neutron porosity log works by bombarding a formation with high energy epithermal neutrons that lose energy through elastic scattering. The

neutron porosity log is predominantly sensitive to the quantity of hydrogen atoms in a particular formation, which generally corresponds to rock porosity.

Videography and Photography: ADEQ should consider gathering a complete record of all split spoon samples using still photography. It will be particularly important to identify the depth of recover of each split spoon photographed. To that end, it is recommend that a white marker board be used to identify each suite of split spoon photographs. To avoid an endless suite of video images, ADEQ might consider video recording each split spoon at the same time that it is photographed and then videotaping any sampling activities undertaken on each split spoon recovered. It is recommended that a detailed field log be maintained of photographs and videos made.

Groundwater: It is our understanding that the same analytical suite will be applied to any recovered groundwater as applied to expressed or extracted samples from recovered solids. We suggest that if water does enter the borehole that ADEQ consider a temporary completion of be borehole as a groundwater monitor well and that the water level rise (or lack thereof) be recorded over a period of 24 hours.

Decision Criteria and/or Decisions: it is our understanding that ADEQ will not request any action recommendations form any of the scientists involved in this project. Notwithstanding, ADEQ should consider *apriori* the criteria to me met that would indicate the leakage of swine waste from the lagoon and any follow-up actions that might be taken if this finding was reached. Likewise, ADEQ should consider *apriori* what evidence gathered from this borehole that would suggest the presence or absence of a geological instability (i.e. possibility of subsidence) at and/or surrounding the borehole location, and any follow-up actions that might be taken if a finding of instability is made.

The Buffalo River Watershed Alliance appreciates this opportunity to communicate their concerns to ADEQ in this matter.