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Representative Adam Holmes
Via e-mail

RE: Why I am unable to accept the testimony of Dr. Bill Rish as to the safety of AquaSalina

Dear Rep. Holmes,

Your kind Legislative Aide, Kyle Miller has forwarded to me a paper written by Dr. Rish in the 2017 Society for Risk Analysis publication. I have also received Dr. Rish's Proponent Testimony for Senate Bill 165, March, 2018. Having read through them both, I find that I am not convinced as to the safety of the use of AquaSalina in Ohio's environment and certainly not in its uncontrolled and unmonitored use which would be the outcome of HB 545 if it were to pass. My concerns are not because I question Dr. Rish's credentials in the field of Risk Assessment. My concerns are far more basic and they center on the use of the field of Risk Assessment to determine the long term safety of the use of AquaSalina, or for that matter, any oil and gas brine as a road deicer and dust suppressant. I have three very basic reservations. They are as follows:

<u>The use of current exposure levels to project potential impacts over time</u>

Dr. Rish's assumptions are based on the fact that the current accepted safe exposure levels are the right ones; that safe exposure levels don't change over time. In point of fact, that's exactly what they do. I know this fact from both professional experience and from personal experience.

Earlier this century, I served as a technical adviser to the Citizen's Group involved in the cleanup of the Plum Brook Ordnance Works in Erie County, Ohio. Plum Brook Ordnance Works was built at the beginning of World War II to manufacture explosives for the war effort. Large areas of farm land were purchased and three manufacturing sites were built with supporting rows of explosion-reducing bunkers to store the manufactured explosives. After the war, the site was cleaned up but remained under the jurisdiction of the military. A nuclear reactor was also built on the site belonging to NASA's Lewis Research Center, (now named the John H. Glenn Research Center at Lewis Field.) By the 1980's, the level of the original clean-up was found to be inadequate as remaining contaminant levels were no longer considered safe so the entire site underwent another cleanup to new acceptable risk levels. By the beginning of this century, those 1980's levels in a number of areas were found to be still too high so the site, under the direction of the US Army Corps of Engineers, was once again undergoing a continuing risk-based cleanup. The risk assessment used for the cleanup level was the most rigorous one I have yet worked with. The site was to be cleaned up to be safe for a five-year old child who would live on a farm at the site, be there 24/7/365, play in the yard, eat food grown on the site, drink well water from the limestone aquifer under the site and basically behave like a five-year old, eating dirt, breathing dust, etc. US Army Corps of Engineers went forward with the most recent cleanup, knowing full well that at some point in the future, they would have to come back again because the "safe" exposure levels used to determine that the site was clean would at some point, sooner or later, be found, once again to be too contaminated for that five-year old child. According to the last monthly newsletter for the site, May 2016, a number of the cleanup efforts were still ongoing, this round.

I also know personally that "safe" exposure levels are a moving target. My father was a chemical engineer and the health and safety officer everywhere he worked. First trained in the early 1940s, he continued to work in the field until the mid-1980s. We just passed his 100th birthday. Most of his career he manufactured chemical agricultural fertilizer. He was rigorous in making sure that all of the workers at his plants stayed within the safe exposure levels for the chemicals that they were working with. His workers were not over exposed given the limits of exposures set at any given point in time. The problem was that the exposure levels kept being changed to lower and lower levels so what was safe in one year, might be 100 times too toxic three years later. All of his workers died young, most of them from cancer, in their sixties. My father, who did not smoke and who ate a very healthy diet thanks to my mother, lived on until he was almost 77. It took him nine years to die. He was down to one-half a kidney eight and one-half years before his colon cancer spread to his liver. We would have long discussions about his exposures and what was happening to his whole generation of chemical workers. We always thought that the triggers were simply chemical, possibly including the pesticides that were included in some of the manufacturing processes and products. It was not until long after he died that I stumbled on a US Geological Survey publication on coal and black shale radioactivity that included phosphate rock, the raw material for the P in the N-P-K formulation of basic fertilizer, as containing enough uranium to be mined as a low-grade uranium ore. So now I wonder if he and his co-workers didn't also suffer from radiation poisoning or exposures. We have known since about 1980, based on work by the Wisconsin Dept. of Health and their cancer registry, that farmers have one of the highest rates of cancer deaths of any occupation. They were all supposed to be safe, until they were not. My father died about 15-20 years sooner than we expected based on the typical life expediency of his relatives and ancestors going back to the 1600's. Figure 1 is a screen shot from one of my educational PowerPoints that captures the US Geological Survey graph.

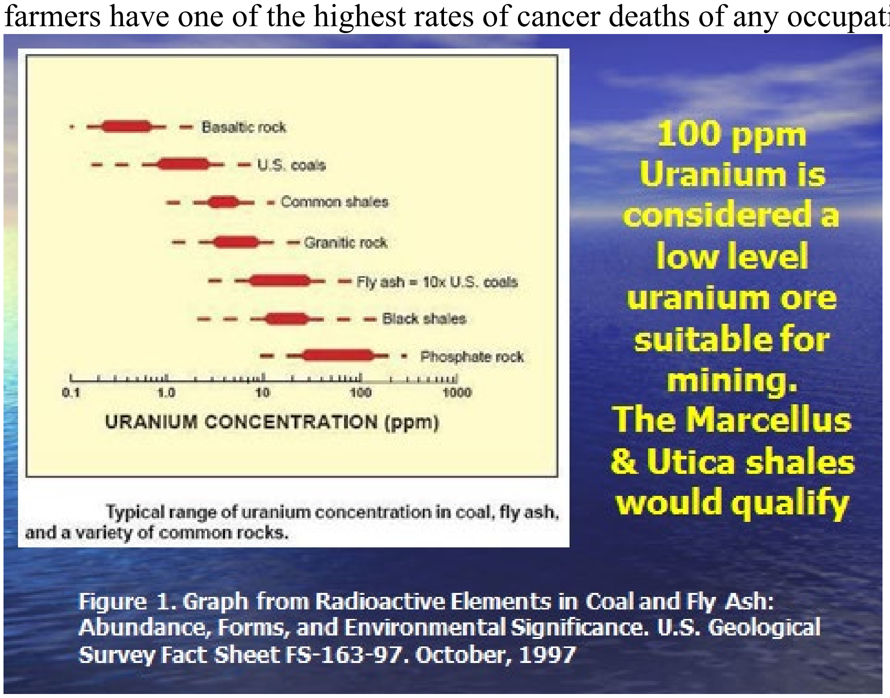


Figure 1. Graph from Radioactive Elements in Coal and Fly Ash: Abundance, Forms, and Environmental Significance. U.S. Geological Survey Fact Sheet FS-163-97. October, 1997

The accuracy of the underlying assumptions of the properties of the earthen materials in the models used for determining the ability of the earthen materials to absorb, attenuate, dilute, etc. the toxic and hazardous materials found in AquaSalina

Dr. Rish submitted a published paper, ***Bounding Analysis of Drinking Water Health Risks from a Spill of Hydraulic Fracturing Flowback Water,*** published in a 2017 issue of Risk Analysis. I have read the paper. I have absolutely no idea how he came to the conclusions that he came to because I cannot find the set of properties that he assigned to his earthen materials, his "vadose zone". I assume that these properties are built into the model(s) that he used, but I can't find them listed.

For instance, how thick is the vadose zone? What are the grain sizes and clay mineralogies of the materials that make up that vadose zone? Do earthen materials continue on to below the static high water level of the underlying aquifer? What do we know about the cation exchange capacity of the earthen materials? Are we assuming that the flow from the surface spill to the underlying aquifer is through primary porosity matrix flow or does the model recognize the critical importance of secondary porosity? Why does the analysis assume that the contaminants will be completely flushed in seven years? That does not agree with the findings in Morrow County after the brine spills from up to 60 years ago.

The reason that I raise these questions is that, starting in about the 1970s, Ohio hydrogeologists, geologists and Ohio EPA staff from the Division of Emergency and Remedial Response discovered that sties that were supposed to be cleaned up, protecting the underground aquifer, turned out not to be clean. Contaminants were found to move far faster to underlying aquifers than the accepted laboratory analyses and equations could predict and sites assumed to be free of contamination continued to deliver contamination, often quite rapidly, to underlying aquifers. Staff from ODNR Div. Oil and Gas and I made a similar discovery in the early 1980s when the Park Oil injection well storage tank in Ashtabula County, New Lyme Township, sprang a leak, emptying the whole tank all over the injection well site and then flowed through a culvert under the road to contaminate the pasture of Curtis Hill. ODNR immediately remediated the site, removing the saturated soils, tests were run to determine the underlying earthen materials were clean, samples were taken for laboratory analyses, including determining the matrix permeability of the earthen materials that the brine would have had to move through and it was determined that it would have taken hundreds of years before the brine could have reached Mr. Hill's well. In a matter of weeks, the brine was in his well.

These events kept happening over and over again, both here in Ohio and around the world. By 1993, my PhD Advisor, Dr. George Hall, decided that we, the scientists and soil and water engineers of Ohio had to figure out what else was happening that allowed the rapid travel of contaminants when they were not predicted and what prevented the assumed levels of attenuation that were expected. He established the "Ohio Fracture Flow Working Group" under the umbrella of the Ohio Academy of Science, calling together all the Federal and State agencies in Ohio who worked with soil and water and invited participation from colleges and universities, local governments and the private sector. As the State Soil Scientist for Cooperative Extension, he had the authority to create such a research group. At the height of the research effort, we included scientists as far afield as eastern Pennsylvania and west to Minnesota and eastern Iowa and the country of Denmark. By the mid-1990s, we recognized that matrix flow had almost nothing to do with water and contaminant transport in fine-grained settings. We began holding field days in 1997 at OSU's Molly Caren Farm Science Review site, began publishing on the topic in 2000 in our first special issue of The Ohio Journal of Science. More than 100 scientists and soil and water (agricultural) engineers were involved in the research and discovery process over a 50 year period of time (the soil scientists had found the fractures first but no one paid attention to them). We continue to research the topic and publish to a wider and wider audience. Over the years, Dr. Hall retired and, as his last graduate student, I took over the day to day running of the Research Group along with Dr. Ann Christy, Professor in the Depts. of Food, Agricultural and Biological Engineering and Engineering Education at OSU and Mike Angle, Chief, Div. Geological Survey, ODNR. The latest paper that we published on the topic was:

> Kim, E. K., Kang, Y. W., Christy, A. D. and J. Weatherington-Rice, 2017, Predicting fractures in glacially related fine-grained materials and a synthetic soil of bentonite and sand using soil texture in Journal of Engineering Geology, May 2017 Vol. 222, pages 84-91.

We have found that at least in the US Midwest from Ohio to Minnesota and eastern Iowa, a soil must contain more than 76% sand by USDA texture, to move water through it using only primary matrix porosity, assuming at least 6% silt content. Every setting finer-grained than that moves water and contaminants through the earthen materials by secondary macropore fracture flow, the finer-grained the materials, the more dominant the secondary permeability becomes. So it really doesn't matter what the matrix properties are, in most cases, the water and contaminants never see them. We have built this understanding into the more recently completed Ohio County Scale Ground Water Pollution Potential Mapping projects and as soon as the whole state is completed, ODNR's Div. of Geological Survey will update the older maps and reports as they develop a state-wide coverage. With these screening tools in place, a community will not have to undertake the rigorous research needed to establish whether they need to be concerned about secondary macropore flow for contaminants to protect their ground water aquifers. That information will already be built in. They can use the county reports as planning tools and for zoning.

But while we were working to find ways to protect Ohio's ground water, we were not rewriting the underlying logic of the computer models used in risk assessment. I have no idea what the underlying models assume that Dr. Rish used. He was publishing in 2017 at the same time that we had reached out to the worldwide engineering geology community. The Ohio team has not published our findings in any of the risk assessment publications. While our research is referenced in publications all over the world and is being duplicated for the unique characteristics in other earthen geologic locations, I have no idea if any of those efforts have made it into the underlying computer models used by people preforming risk assessment modeling. Over the years since 1997, we have held a number of field days and conferences here in Ohio and have spoken at a number of other events here in the State, in the Nation and Internationally so I have no way of knowing if our updated research has been incorporated into the standard risk assessment models. However, if it has not, the assumptions that drive the models will not generate reliable output. Therefore, since I don't have the ability or time to review a significantly greater level of documentation on the underlying assumptions of Dr. Rish's models, I cannot accept his assurances that everyone will be fine.

It would also be very useful to see the chemical analyses of the flowback materials studied and the laboratory analyses procedures used. It's one thing to state that specific chemical parameters were below "detection level" and quite something else to actually show what the detection levels were. Did these studies include radionuclides?

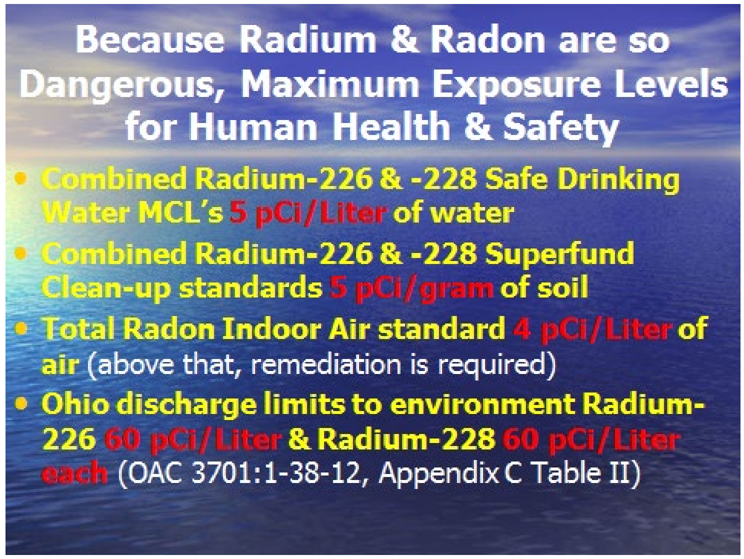
<u>Exposures to AquaSalina are being viewed in a vacuum as the only exposure that distance runner will encounter</u>

This is probably my greatest concern about the use of a risk assessment to determine if exposure to AquaSalina will result in adverse health impacts to the people who are being exposed. One of the most recognized and least controllable factors in determining which contaminants create health affects in an individual is how many factors combined to trigger a health problem. We know that it's not usually just an exposure to one factor that drives the health impacts. We know that it's usually a synergistic combination of exposures from a variety of sources, some found completely within nature and some man-made. There are exceptions where the specific exposure is so clear-cut that there is no question, for instance the experience of the "Radium Girls" early in the 20th Century who painted clocks and dials with luminescent radium paint and subsequently died of cancers. But few cases are so straightforward. Indeed, if it is true that AquaSalina, on its own is totally safe, how can we then be assured that it will not act synergistically with some other triggers in the environment? We can't because we don't know what all the other triggers are and we don't know how much of them there are at any one location. There are so many permutations of these combinations that would have to be tested and studied before we could make the assumption that spreading AquaSalina in the environment is safe. That work has not even begun to be undertaken. Without it, we simply do not know what the impacts will be.

<u>Borrowing from the medical profession, "First do no Harm"</u>

When there are so many unknown factors to be considered, we are best reminded to follow the dictates of the medical profession to "First do no Harm". We are best guided to limit our levels of adding contaminants to the environment by keeping them at or below Maximum Contaminant Levels (MCLs). These levels have been established, over time, by the US EPA and are also codified by law here in Ohio. The assumption is that if we do not add a contaminant to the environment that has a higher level of toxic and hazardous chemicals than what is deemed safe for exposure, the release of the chemicals will not require the earth to provide diluting powers. The materials released will already be released at "safe" levels. While we are aware that today's safe levels will not be tomorrow's safe levels, we will have significantly limited the amount of buffering that the earth will have to provide.

Since the center of our dialogue has been addressing the radioactive suite of elements, I will limit my discussion of exposure levels to radium and radon gas. However, had Dr. Rish presented a full set of all the chemical elements and compounds found in AquaSalina, it would be possible to search each one of them to determine if MCLs have been assigned to them and what these levels are. Even if we accomplished that level of review, we would still have the much more difficult chore of trying to understand what the synergistic impacts of those combinations would have on public health.



The Figure to the right is a screen shot from one of the PowerPoint presentations that I have developed over the years. US EPA has established an MCL of 5 pCi/L for Radium-226 and -228 in drinking water. They have established a Superfund clean-up standard of 5 pCi/g in the surface soil at a remediated site and a remediation threshold of 4 pCi/L in indoor air for the noble gas Radon. Therefore if we were to go forward with the position of "First do no Harm", nothing being released into the environment from the waste streams of the oil and gas industry should contain levels of Radium and Radon higher than that. Perhaps the most critical threshold number is Ohio's own (also mirrored by Federal requirements) which limits the discharge of liquids into the environment of Radium-226 and -228 to no more than 60 pCi/L each. Not 90 and 29 to be under 120, 60 each. So that's the discharge limit. Any vertical well brine or AquaSalina used as a deicer or dust suppressant that tests higher than those values exceeds the legal limit and should be considered a violation of the law.

Now I know that Ohio, with the wave of a hand, makes the argument that brine from oil and gas drilling is somehow magically exempt. The problem is, the science does not exempt the chemistry. Releasing brine or AquaSalina at higher levels into the environment creates exactly the same kinds of problems that releasing Radium from other sources creates which was why the limits were set and the laws were written in the first place.

Once we have a limit, then the questions of how the materials were tested arrives. What were the chemical analyses used? Did they follow MARLAP protocol? The laboratories that undertook the analyses, did they meet appropriate accuracy screening by the US DOE? The answer to all of those questions is "NO". In point of fact, we know that the numbers created for AquaSalina and ODNR's Division of Oil and Gas for their vertical brine study that began in 2017 underrepresent the actual radium values for the samples submitted. How much too low are they? We really don't know because no one has submitted split samples to the US DOE for a QA/QC assessment. But what we do know is that with the exception of only one sample on the ODNR list, every other sample tested, including all the AquaSalina tests that we have seen, exceed the 60/60 maximum release level. Therefore, at least scientifically, the applications of the vertical brines and AquaSalina as a deicing and dust suppressant, places an undue stress on the environment and creates a potentially negative health impact on humans in that environment. The science does not support the application of the brine or AquaSalina. Doing so has the potential to create "Harm".

Summary and Conclusions

The application of Dr. Rish's risk analysis to determine the safety of the application of AquaSalina, and also any vertical oil and gas brine, fails on at least four levels:

1. The "safe" exposure levels currently used are not static. They have varied in the past trending lower, and are expected to vary in the future. Therefore, using one set of values, while perhaps useful for current cleanup standards, are not predictive of long term human exposures over time into the future.
2. From the information presented, it is impossible to determine the properties assigned to the earthen materials in the models that Dr. Rish or others have applied to the analyses he cites. However, since those models were constructed at some point in the past and the scientists and engineers of Ohio (and around the world as well) are still refining those values, it would be impossible for them to adequately project the level of protection, or in this case, the lack thereof of the earthen materials. Therefore, how spills are expected to behave and how they actually behave is expected to be different, probably significantly different.
3. The exposure to AquaSalina is not occurring in a vacuum. It is being applied into an environment where there are already environmental stressors, some natural and some manmade. But those stressors were there first, AquaSalina is a new and added stressor. As with groundwater withdrawals, whoever was there first has already applied a burden on the environment and on human health. If a new stressor should overtop the levels that the environment and human health can tolerate, it should not be added to the mix.
4. The levels of Radium-226 and -228 in AquaSalina, and in vertical oil and gas brine for that matter, are higher, in many cases, by orders of magnitude than the levels allowed to be released into Ohio's environment. Releasing these radioactive wastes violates Ohio law.

Therefore, to go forward with HB 545 and to further remove any oversight to the commercial sales and application of AquaSalina is simply unsupportable. In point of fact, a bill should be introduced to forbid the application of all oil and gas brines to roads and into the environment for deicing and dust suppression.

Please think long and hard about the impact to the environment and public health that going forward with this bill would impart. This is not a legacy that any Ohio Legislator would want to be remembered for. Thank you for considering my scientifically supported discussion on this bill.

Respectfully submitted,

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