

Radioactive Waste—Chemung County Landfill

<http://dcbureau.org/201105101335/Bulldog-Blog/new-york-state-dismisses-radiation-threat-from-gas-drilling-cuttings.html>

As they prepare final rules for high-volume hydrofracking of natural gas wells in New York, state environmental regulators are brushing aside warnings from scientists and public health organizations that radioactive drill cuttings from Marcellus Shale wells pose serious environmental risks.

The New York State Department of Environmental Conservation already allows three western New York landfills operated by Casella Waste Systems to import Marcellus well cuttings from Pennsylvania. And a landfill owned and operated by Steuben County is poised to become New York's fourth cuttings importer, also with the DEC's blessing.

"This stuff is so innocuous that under law and regulation and good environmental practice, it could be [buried] at the drill site," Scott Foti, a DEC official, testified in January. "It could be left right there."

The DEC expects an exponential increase in drill cuttings after the agency begins granting permits for high-volume hydrofracking of horizontal Marcellus Shale wells in New York, possibly as soon as this fall. Foti said the agency is weighing whether to allow drillers the option of disposing of cuttings at municipal landfills or at well sites.

Both those options alarms scientists, public health officials and environmental activists, who note that the Marcellus tends to be rich in naturally occurring radioactive material, or NORM.

"That's not appropriate," said Conrad Volz, an assistant professor at the University of Pittsburgh's Graduate School of Public Health. "I don't have a problem with cuttings from lots of other shale formations, but the Marcellus is unique. It's highly enriched in radium isotopes and thorium. Cuttings from horizontal wells in the Marcellus should be taken to low-level radiological waste disposal sites."

Volz noted that radiation levels in the Marcellus formation may vary widely from region to region and even from well to well within neighborhoods. For that reason alone, he said, each batch of cuttings should be tested before choosing a disposal option.

That is the stance the New York State Conference of Environmental Health Directors took in a December 2009 letter to the DEC, which said:

"The idea that NORM is not a problem with drill cuttings is based on two samples. This is clearly not sufficient. Since the major disposal option is burial at local landfills, NORM sampling should be done for each batch of drill cuttings prior to transport and disposal, at least until a large-scale sampling program establishes the safety of such materials."

Instead of following that advice, the DEC has chosen to generalize based on a handful of samples, most of which were gathered and analyzed by a contractor hired by Casella, the disposal company.

The agency has acknowledged conducting its own tests on rock samples from two vertical Marcellus wells drilled in Western New York. Gamma ray spectrography analysis of rocks from those two wells revealed "essentially background values" for NORM, according to the DEC's 2009 draft of rules for high-volume hydrofracking.

The agency plans to release a new version of the drilling rules this summer or fall. After it holds public hearings and makes the rules final, it plans to begin issuing horizontal Marcellus well permits promptly.

In order to clarify whether the agency has conducted other tests beyond the two wells mentioned in its 2009 draft of drilling rules, DCBureau.org asked the agency to specify the exact total number of Marcellus wells it had tested.

Agency officials took three weeks to respond and then declined to provide a specific number. Instead, they wrote in an email that the agency was “satisfied with the breadth and objectivity of the sampling” and believed that disposal of Marcellus cuttings in municipal landfills “does not pose an environmental concern.”

The DEC’s conclusion, the email said, “is based on analysis performed on Marcellus Shale rock samples from the New York State Museum collection and from the known properties of shale formations.” The email went on to cite a “comprehensive study” conducted for Casella by CoPhysics Corp., which “further supported the DEC position” that Marcellus cuttings are harmless.

The CoPhysics report has been sharply criticized by Volz and other scientists for weaknesses in its methodology, its relatively small sample size and its failure to report test results for alpha and beta emissions as well as gamma emissions.

Both the DEC and CoPhysics tests relied on measurements of gamma ray emissions. Volz called the decision to test exclusively for gamma rays “ridiculous” in light of the fact that the main threat in Marcellus cuttings is radium, an alpha-particle emitter. Alpha particles make up 96 percent of the radiation emitted by radium, while gamma rays make up only 4 percent.

“To look for radium, you have to test for alpha,” said Marvin Resnikov, senior associate at Radioactive Waste Management Associates in New York City. “CoPhysics tested for gamma, not alpha.”

Stephen Penningroth, executive director of the Community Science Institute in Ithaca, N.Y., a state-licensed water tester, agreed with Volz and Resnikov. “The low gamma readings may be correct,” Penningroth said. “But the other part of the problem is alpha and beta, and that’s where the NORM is.”

While Geiger counters detect gamma rays effectively, they’re not much use picking up alpha particle emissions, which travel only a few centimeters and may be blocked by thin clothing or even layers of dead skin.

But alpha-emitting materials are very dangerous when they are ingested as liquids or breathed in with dust in the air.

“When alpha-emitters get in the body, they can set up business next to cells and bombard them with nuclei,” Volz said. The main dangers from NORM-contaminated drill cuttings are dust, radon and any water that leaches away from them after they are buried.

The DEC confirmed that the Marcellus Shale in New York tends to have dangerous levels of NORM when it tested the brine from all 12 of the state’s conventional Marcellus wells in 2008 and 2009. It found levels of Radium 226, a dangerous alpha-emitter, to be far above allowable limits for drinking water (5 picocuries/liter) or for release into the environment (60 picocuries/liter). The DEC’s readings for Radium 226 in brine from four of the tested wells exceeded 10,000 picocuries/liter.

Radium 226 has a half-life of about 1,600 years and decays into radon gas, the world’s second leading cause of lung cancer. Only smoking causes more.

That’s why Dr. Earl Robinson, a pulmonologist from Elmira, and others who live near to the Chemung County landfill were upset to learn Marcellus drilling wastes from Pennsylvania were being dumped near their homes.

New England Waste Services of New York, a unit of Casella that operates the Chemung Landfill under a 25-year, \$90-million contract, began accepting Marcellus wastes from Pennsylvania early last year, even before notifying the DEC.

Robinson leads a citizens group that has mounted a legal challenge to Casella’s authority to bring radioactive waste into a landfill that is not licensed to handle it. An administrative law judge at the DEC heard evidence last summer, but he is still considering the matter -- seven months after an attorney for Casella filed a motion for an expedited ruling.

As the months have ticked by without a ruling, the Chemung Landfill and other Casella-operated New York State landfills in Painted Post and Angelica have continued to import Marcellus cuttings from Pennsylvania.

Several months ago, Steuben County began to consider accepting Marcellus cuttings at its municipal landfill.

Vince Spagnoletti, the county's public works commissioner, said that he studied the environmental issues carefully and decided to recommend that county officials vote to accept between 10,000 and 15,000 tons of Pennsylvania cuttings a year-- two or three dump trucks a day -- beginning later this summer. That vote could come in June, he added.

That volume of cuttings would generate more than \$300,000 in fees for the county, Spagnoletti said in a recent interview. And the county might eventually triple that volume, he said.

Casella has no involvement in the Steuben initiative, though Spagnoletti said he has drawn on data and advice from two contractors hired by Casella, CoPhysics and Barton & Loguidice of Syracuse.

The CoPhysics report was introduced in the Chemung Landfill case and is public record. A study by Barton & Loguidice, a follow-up to the CoPhysics report that has not been made part of the public record, is based on the samplings taken for the CoPhysics report.

CoPhysics analyzed drill cuttings taken from four Marcellus wells in Bradford and Tioga counties in Pennsylvania, cuttings transported to Casella's Chemung, Painted Post and Angelica landfills, and "local background soil and rock" from the same three Casella landfills.

The CoPhysics report concluded that "rock cuttings from the gas drilling operations, as sampled during this project, have radionuclide levels that do not pose any environmental health problem even if they were deposited in areas accessible by the general public. Therefore, they are certainly acceptable for landfill disposal."

At a public hearing Feb. 3, several Steuben County residents expressed skepticism about the conclusion. They also took issue with the DEC's (and Spagnoletti's) willingness to accept them at face value despite the fact that they were paid for by Casella, which stands to gain financially from a conclusion the cuttings are harmless.

At a public meeting in Steuben County on January 11, Foti acknowledged that questions might be raised about reliance on data from potentially biased private sources, but he dismissed the concern, saying:

"There were some people who were concerned about this technique of a company who has an interest in the outcome being involved in paying for the samples," Foti testified. "We'll, I've got to tell you, it's very, very routine. ...I do trust the data."

Foti also wrote a Feb. 14 letter to Spagnoletti that said the DEC had determined that disposal of Marcellus drill cuttings in non-hazardous-waste landfills "is consistent with regulatory requirements and the protection of the environment."

That finding was based on the DEC's conclusion that for purposes of regulation, Marcellus drill cuttings were neither "hazardous waste" nor "industrial waste" nor "radioactive waste," Foti explained.

Cuttings are neither hazardous nor industrial waste because statutes exempt wastes from natural gas development from those categories, no matter how contaminated. Neither can the drill cuttings be regulated as "radioactive waste," he said, because NORM is exempt from the definition of radioactive waste unless it has been "processed and concentrated."

The DEC confirmed in its recent email that it had concluded that the drill cuttings are never "processed and concentrated" and therefore do not fall under the regulatory definition of radioactive waste.

Three expert witnesses in the Chemung Landfill case -- Volz, Resnikov and Tony Ingraffea, a Cornell University professor of rock fracture mechanics -- disputed that interpretation of the regulation. But as long as the Chemung Landfill case remains stalled within the DEC, the agency's interpretation holds.

“The DEC plays with regulations. They’re not charged with looking after public health. They’re not trying to prevent disease,” said Volz, who plans to leave the University of Pittsburgh to write a book on the environmental costs of extracting oil and natural gas worldwide.

The DEC’s interpretation that Marcellus drill cuttings cannot be regulated as radioactive waste because they are not “processed and concentrated” raises questions about the agency’s authority to regulate Marcellus brine, a confirmed health risk that is no more “processed and concentrated” than the cuttings.

In fact, the DEC has downplayed the results of its own tests of Marcellus brine, even as other agencies have expressed alarm about them.

For example, the New York City Department of Environmental Protection said the data “raise serious issues for public health.” The city’s top environmental officer, Steven W. Lawitts, wrote the DEC in 2009, saying the agency was obliged to do further testing. “Such an analysis must be completed before any activity that is likely to generate radioactive waste can move forward.” The DEC rejected that advice, saying it would wait and see the results of actual drilling in the New York Marcellus.

The regulatory loopholes that restrain the DEC from taking a more rigorous look at waste from Marcellus gas wells have drawn the attention of two members of the New York General Assembly.

Assemblyman Alan Maisel (D-Brooklyn) has introduced a bill that would place a moratorium on the importation from other states of all Marcellus wastes, both liquid and solid, until the U.S. Environmental Protection Agency reports on the public health effects of high-volume hydrofracking. There is no companion bill in the state Senate.

Meanwhile, Assemblyman Robert Sweeney (D-Lindenhurst), the chair of the Assembly’s Environmental Conservation Committee, is sponsoring a bill that would remove the oil and natural gas industries’ special exemption from the regulation as hazardous waste. A similar bill has been introduced in the state Senate.

“There is no compelling reason why waste produced from oil and natural gas activities that meets the definition of hazardous waste, should not be subject to the same laws regarding generation, transportation, treatment, storage and disposal as other hazardous wastes,” Sweeney said in a memo explaining the bill’s purpose.

DEC officials declined to comment on the Maisel and Sweeney bills, saying the agency does not take a position on pending legislation. Yet the DEC drafts and actively sponsors bills that it favors, such as this year’s proposed overhaul of the state’s water withdrawal rules.

Although the controversy over Marcellus drill cuttings has focused on NORM, some environmental advocates raise concerns about other potentially hazardous substances that may be headed to the landfills with the solid waste.

In his testimony before Steuben legislators Jan. 11, Foti described cuttings as dry rock chips that were less radioactive than the marble counters in his kitchen at home.

But in his Feb. 14 letter to Spagnoletti, he acknowledged that ground-up rock cuttings emerge from natural gas wells in a slurry of rocks and drilling mud, which is added to facilitate drilling and the removal of cuttings. That mixture is saturated with naturally-occurring brine.

A dewatering process removes most of the liquids, and the remaining rocky residue is then bulked up with sawdust in preparation for disposal.

But municipal landfills are permitted to accept the cuttings even if they contain up to 20 percent liquids.

Kate Bartholomew, the chair of the Schuyler County Environmental Management Council in Watkins Glen, N.Y., said she was concerned about the residual drilling mud and brine disposed of with the cuttings.

In horizontal wells such as those used to tap the Marcellus Shale, drillers use an oil-based mud that includes potentially dangerous chemicals, she noted. While some batches of the rock-liquid mix may be innocuous, she said, others may be so contaminated that they belong in landfills specially licensed to handle hazardous waste or radioactive waste.

Mary wrote:

In my opinion, in the dSGEIS the NYSDEC had a tendency to draw sweeping conclusions based on little or no data, and the issue of radioactive drill cuttings is a case in point.

If you look at pp. 5-31 & 5-32 of the dSGEIS, you will see data presented there for radioactivity in Marcellus cuttings. The paragraph preceding the tables of data states: "The results, which indicate levels of radioactivity that are essentially background values, do not indicate an exposure concern for workers or the general public associated with Marcellus cuttings." But when you look at the tables of data, you will see that gamma ray spectroscopy readings were obtained for samples taken from just two Marcellus wells, one in Madison County and one in Steuben County. In addition, Geiger counters were used to take readings from ten Marcellus core samples from the NYS museum in Albany (they don't say precisely where these museum samples were collected or how long ago they were collected). There are also Geiger counter readings from six Marcellus outcrops, and from 28 Marcellus well sites in the west-central part of the state.

This is not a large dataset. It is also not necessarily a representative dataset, because the sampling is anything but systematic. For example, if shale gas extraction is permitted in NY, Broome County is expected to experience heavy drilling, but there is just one sample--from a well site--for Broome County. There is just one sample for Tioga County, again, from a well site. There is just one sample, from a well site, for Chenango County. In the case of some counties (e.g. Delaware, Tompkins, Sullivan), there are no samples at all.

This is lazy, sloppy, haphazard work; it is not science. In my honest opinion, it is not even something that would be deserving of a good grade if it were presented in a high school science fair (and I have judged a few high school science fairs). It is not just the lack of data; the bigger problem is that the DEC either didn't seem to understand or else didn't care that they did not have enough data to justify their conclusion. I think that if the revised dSGEIS does not include vastly more data on drill cuttings, then any conclusions it draws on the safety of the cuttings will be worthless.

Maybe the cuttings are safe, maybe they're not safe. But I think the DEC needs to do a lot more work to make the determination, either way. Maybe they don't have the resources for that work; if so, they should admit that, not try to fudge their conclusions. If, after all of the comments it received on the dSGEIS, the DEC is still treating the cuttings issue this casually, then I think that does not bode well for other aspects of the revised dSGEIS.

<http://www.garyabraham.com/ChemungLF.html>

Chemung County Landfill

Until 2005 the Chemung County Landfill was a county landfill. The county generates 60,000 to 80,000 tons of solid waste for disposal per year, and all of that went to the landfill, very little came to the landfill from anywhere else. In 2005 the county leased its integrated waste management operations --the landfill, a recycling facility, transfer stations and several other facilities-- to a subsidiary of Casella Waste Systems of Vermont, New England Waste Systems of New York (NEWSNY). Since then the county has made no progress achieving its DEC-approved recycling rate, half the county's waste is shipped to other NEWSNY landfills in New York, and now the landfill accepts over 100,000 tons of waste per year, most of it from out of the county, including Canada, New York City and Pennsylvania.

Marcellus shale drilling wastes

In early fall 2009 NEWSNY began accepting Marcellus shale drilling wastes from Pennsylvania. They did not notify DEC until December, and DEC approved the practice on January 21, 2010. By March and April of 2010 over half the total waste receipts for the landfill were Marcellus shale drilling wastes, a rate of over 60,000 tons per year. Also in March and April of 2010 NEWSNY accepted about 180 tons of contaminated soil from Marcellus shale drilling site in PA, contaminated by spills of frac fluid. Both kinds of waste are at least 25 times more radioactive than background at the surface.

In April 2010, after learning about disposal of the drilling wastes, Residents for the Preservation of Lowman and Chemung (RFPLC) filed a petition to intervene in a DEC permit proceeding, initiated by NEWSNY to obtain permission to increase its waste acceptance rate from 120,000 to 180,000 tons per year. RFPLC argues that the tonnage increase is part of a larger plan the county committed to in its lease agreement with NEWSNY, to obtain progressive tonnage increases up to 417,000 per year, and is specifically intended to take advantage of lucrative contracts with more Pennsylvania shale gas developers to take their waste. NEWSNY's attorney also represents some of the Pennsylvania drillers.

RFPLC's evidence that Marcellus shale drilling wastes can be 1,000 times more radioactive than naturally occurring background radiation at the surface was recently ruled irrelevant to the legality of expanding the landfill to take more such waste. This is discussed further below.

Substandard landfill engineering

The Chemung County Landfill emerged from a gravel pit in the 1960s, without bottom liners of any kind and without a siting study as would be routine today. It is located in an environmentally and historically sensitive area surrounded by farms, a growing rural population and the Newtown Battlefield, one of the most important pre-Revolutionary War battlefields in the nation. The landfill is few hundred feet from the Chemung River, in the Chesapeake Bay watershed, and few feet from (if not directly over) an unconfined primary aquifer. If the landfill is allowed to continue dumping radioactive Marcellus shale drilling wastes, a containment failure at the landfill could have catastrophic consequences. Even routine operations pose the risk of leaks and exposure of landfill workers and others who come in contact with wet, leaking drilling waste to excessive levels of radioactivity from concentrated, naturally occurring Radium-226 and its byproducts, such as radon, a known cause of lung cancer.

DEC permit proceeding for Chemung County Landfill tonnage increase

The DEC proceeding reviewing these issues resulted in a ruling from the hearing officer on September 3, 2010, posted below. NEWSNY disclosed in the proceeding that it has been disposing Marcellus shale drilling wastes in Angelica (Hyland Landfill) and Painted Post (Hakes C&D Landfill) as well as Chemung. This is occurring after comments in 2009 by New York State Department of Health, USEPA, and a number of environmental scientists and organizations called on DEC to study the waste management needs of Marcellus shale gas development. DEC is studying the issues, but that study is not done, nevertheless, today DEC allows disposal of Pennsylvania shale gas wastes in New York landfills. The September 3 ALJ Rulings find that the radioactivity of the waste is irrelevant to whether NEWSNY should be allowed to increase its rate of disposal of such wastes.

Several documents submitted to DEC in the Chemung County Landfill proceeding are posted (on the website). These are listed in chronological order, since in general each subsequent submission responds to one or more submissions that precede it. This proceeding will determine whether DEC should prohibit disposal of Marcellus shale drilling wastes at the Chemung County Landfill, as RFPLC requests.

G. Abraham memo to Legislators, Disposal of low-level radioactive Marcellus shale drilling waste in New York landfills, dated September 8, 2010.

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September 8, 2010

TO: Concerned lawmakers and policymakers

SUBJECT: Disposal of low-level radioactive Marcellus shale drilling waste in New York landfills

The New York State Department of Environmental Conservation (DEC) recently completed an issues conference on an application to expand landfilling at the Chemung County Landfill, leased to and operated by a subsidiary of Casella Waste Systems of Rutland, Vermont. The purpose of the conference was to determine whether further evidence should be considered regarding issues proposed by an intervening party, Residents for the Protection of Lowman and Chemung (RFPLC).

I represent the environmental organization RFPLC, which has raised the issue, whether it is legal to dispose of low-level radioactive Marcellus shale drilling waste in the landfill, because the waste is 25 to 1,000 times more radioactive than background, and because the radioactivity in the waste originates mainly from Radium-226 (Ra-226), which can be fatal when ingested or inhaled. An administrative law judge within DEC has issued a decision rejecting the issue, with the result that there will be no hearing on evidence of the harmfulness of this waste. This memo summarizes the arguments and evidence offered in support of this issue made by RFPLC. Details are provided in submissions to DEC provided by RFPLC, Casella, and DEC Staff, posted on my website¹ and referenced further below.

Although DEC has yet to finalize its analysis of the environmental impacts of Marcellus shale gas development, including the impacts associated with managing drilling wastes from such development, in January 2010 regional DEC Staff approved disposal of Marcellus shale gas drilling wastes in the landfill, without any analysis of its radioactivity or the manner in which the waste is generated. Months before the approval, Casella began accepting such wastes at three New York landfills it operates (Hakes C&D in Painted Post, Hyland Landfill in Angelica, and Chemung County Landfill). In fact, today Casella has diverted most municipal solid waste away from the Chemung County Landfill in order to devote most of its permitted disposal limit, or about 2,000 tons per week, to shale drilling wastes. Its application to DEC seeks to expand the disposal limit by another 50 percent to take in even greater volumes of such wastes.

DEC regulations prohibit disposal of low-level radioactive waste in a landfill if it is also "processed and concentrated."² In that case, the waste must be managed at a licensed low-level radioactive waste landfill. If not processed and concentrated, DEC Staff's position is that it does not matter how radioactive the waste is; in that case it may be transported to and disposed in any New York landfill.

Drilling wastes produced by developing a Marcellus shale well site include drill cuttings (pulverized rock), naturally occurring brine, and drilling fluid.³ The radionuclide of concern in the waste is Ra-226, a decay product of Uranium-238 which occurs naturally in the shale. Radium in Marcellus shale is about 25 times more radioactive than the level of radioactivity in the surface environment, which is naturally occurring and historically elevated primarily due to atomic fallout.⁴ Because Ra-226 is highly water-soluble, the brine and drilling fluid can be 500 to 1,000 times more radioactive than background, having leached Radium from the shale.⁵ Ra-226 has a half-life of 1,600 years.⁶ As a practical matter, therefore, the surface environment will host this newly introduced radioactivity forever.

Drilling wastes from a Marcellus shale gas well site are dewatered by means of a "shale shaker," an industrial centrifuge, or by discharging the wastes into a sloped separation pit that allows the solids to collect at one end.⁷ However, the dewatered waste continues to contain a substantial amount of liquid, and may look like sludge. New York regulations governing the landfilling of waste allow sludge to be disposed if it is "dewatered to 20 percent solids."⁸ The Chemung County Landfill permit prohibits disposal of non-municipal wastes containing "free liquids, sludges, slurries, chemical or industrial wastes which are less than 20% solids."⁹ Thus, up 80% of the volume of landfilled sludge or industrial waste can be liquid.

"Ra-226 is a carcinogen¹⁰ and, when ingested or inhaled, concentrates in the bone and can cause leukemia."¹¹ At the current rate of disposal in the Chemung County Landfill, Casella could be disposing 312 trillion picocuries (pCi) of radium per year in the landfill.¹² Ra-226 decays to radon gas. "As an inert gas, the landfill gas combustion device cannot control radon."¹³ EPA has set a recommended radon action level of 4 pCi per liter of air in residences.¹⁴ EPA has set a soil concentration limit for Ra-226 of 5 pCi per gram in the first 15 centimeters of soil and 15 pCi/g in deeper soil.¹⁵ This limit assumes that control of land cannot be assured for more than 1,000 years and, because of the long life of Ra-226, eating radium contamination in food grown on the land 1,000 years from now would result in substantial excess

cancer.¹⁶

In the present, transport trucks can be expected to leak radioactive liquid. "The leaking liquid is particularly radioactive and, over time, can be expected to contaminate local roadways and roadways inside the landfill."¹⁷ Inhalation of dust contaminated with Ra-226 is of most concern because internal exposure can result in leukemia.

In addition, because Ra-226 is highly water-soluble, it will be present in the landfill's leachate.¹⁸ In the event of a catastrophic failure of the landfill's containment system, large volumes of contaminated liquid and waste could be discharge to the Chemung River, a few hundred feet downslope from the landfill. Under normal conditions, several thousand gallons of leachate per day are sent to the Elmira water treatment plant, which discharges treated waste water to the Chemung River. However, the plant is not equipped to (and is not permitted to) remove radioactive contaminants from waste water. All the radioactive contaminants in the leachate will therefore be discharged into the river.

From: Conrad (Dan) Volz, DrPH, MPH

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Re; Evaluation of Co Physics Report Regarding Suitability of Cuttings Waste Disposal at Chemung County Landfill

Dear Mr. Abraham:

You have asked me to review the April 6, 2010 Co-Physics report regarding the radionuclide content and environmental public health consequences of disposal of cuttings and associated waste from gas drilling sites, which are being landfilled or are slated for landfill at Chemung County Landfill in the State of New York. First let me state clearly that the report is not specific regarding the waste generated being from the Marcellus Shale formation itself. Stated another way, while the report contains language stating that the operator gave the Co-Physics sampling team data on the depth and lateral distance from the well head; there is absolutely no data in the report to indicate the lateral distance within the Marcellus Shale layer itself that samples were taken from or for which portable gamma measurements were taken. As a result I can only conclude that the radionuclide levels reported are from commingled waste and not waste from any particular horizontal distance within the Marcellus Shale layer itself. Additionally, the waste is diluted with water and additives used in the drilling process. The samples collected are thus not scientifically representative of waste that originates from the horizontal portion of a Marcellus Shale drilling operation, which is known to be enriched in various naturally occurring radionuclides in the uranium-238 decay chain.

My experience observing Marcellus Shale drilling operations as well as extensive experience in human and ecological exposure assessment and fate and transport of radionuclides allows me to comment on this matter as an expert witness. I would be most interested in providing testimony regarding my comments and further analysis in any upcoming proceedings relative to this matter. I have over 30 years experience in occupational-environmental health, and received my initial training in Public and Occupational Health in the Department of Occupational Health at the University of Pittsburgh's, Graduate School of Public Health (GSPH) on a fellowship from the U.S. National Institute for Occupational Safety and Health (NIOSH) where I also received both a Master's and Doctorate degree in Public Health.

I am Principal Investigator and Director of the Center for Healthy Environments and Communities (CHEC) at the GSPH. CHEC has multiple projects related to Marcellus Shale Gas Extraction (MSGE) relating to cation/anion characterization of wastes including produced and

flowback water and also documentation of community and behavioral impacts resulting from field development. As a result of these projects I have had the opportunity to observe "on site" MSGE activities at a PA Game Commission site located north and east of State College PA and also observe numerous MSGE activities as an "off-site" observer in an area currently undergoing intensive operations near Hickory PA in Washington County.

My experience in radionuclide contamination is highlighted by being a co-investigator on the Consortium for Risk Evaluation with Stakeholder Involvement (CRESP) II project commissioned by the Department of Energy, National Nuclear Security Agency. In this project I was project manager for the Amchitka Independent Assessment, a project aimed at determining baseline radionuclide contamination in biota and fresh and marine waters from underground thermonuclear explosions performed in the 1960's and early 70's. I am a named co-author of the report to the DOE/NNSA and also a co-author and first author on numerous peer-reviewed scientific articles relative to this study including radionuclide safety and health. Additionally, in my role as co-investigator on this study, I was part of a team giving advice and technical support to the DOE concerning Risk-Based End State visions for radionuclide and toxic organic contaminant clean-up of former Manhattan project sites throughout the United States; my attached CV also contains peer reviewed scientific articles on this subject. Furthermore as an Assistant Professor in the Department of Environmental and Occupational Health I teach or lecture in numerous courses pertaining to radionuclide issues—these include Environmental and Occupational Exposure Assessment; Fate and Transport of Environmental Contaminants; Environmental Contaminant Risk Assessment; and Environmental Health Preparedness. I was elected to the Omicron Chapter, Delta Omega Honor Society, National Public Health Honor Society in 2006 and recently received the endowed, Dr James Craig Award for Teaching Excellence at GSPH for the year 2008-2009.

The conclusions that are offered below in bulleted format are thus informed by experience, technical training and scientific work done both on MSGE activities and radionuclide contamination safety and health work.

- As outlined in the first paragraph of this letter the report given by Co Physics does not give enough locational information regarding hand held or subsequent in-depth gamma spectroscopy to determine if in fact the reported results are from primarily the Marcellus Shale layer. Although depths were recorded and accompany findings of activity there is no indication in the report as to the interval in the Marcellus Shale layer itself — specifically the horizontal interval that was sampled. Without separating out a specific interval within the shale layer itself that is a known lateral distance there is no way to evaluate the Co Physics findings relative to cuttings and waste coming from the Marcellus Shale layer itself. From the information I reviewed it is entirely possible that very little of the Marcellus Shale layer itself was included in those samples labeled "Marcellus". These could have come from vertical drilling into the shale layer and thus would only represent a fraction of the Marcellus Shale waste itself with significant amounts of commingled waste from the general drilling procedure. If this were the case than the samples taken are not representative of the Marcellus Shale layer itself- however there is not enough information provided in the report to make any conclusions relative to exactly what matter was sampled and is not helpful in my view in establishing risk based exposure and therefore health outcomes for workers or the public regarding radionuclide concentrations and activity in the Marcellus Shale portion of the drill waste.
- The Co Physics report focused entirely on gamma analysis and gamma spectroscopy for determining concentrations of Radium 226, Thorium-232 and Potassium-40. While I in no way doubt the accuracy of these measurements and agree that the laboratory is using the appropriate standards for instrument calibration; I am very concerned that radon gas was not measured in a laboratory setting from these drilling waste samples. Radon, a noble gas with no stable isotopes, is directly formed by alpha decay of Radium-226 and radon itself decays by alpha elimination to Polonium-218. Since the fate and transport characteristics of radon (it being a gas) both within the Marcellus Shale formation and in geological structures nearby differs from these other radionuclides and the fact that it decays by alpha particle formation (not gamma release) a more complete study to inform the decision to accept this waste in the listed landfill would in my opinion include an assessment of radon activity of the cuttings in a closed volume, under equilibrium conditions. Radon has been attributed to causing lung cancer in occupational cohorts and

risk based calculations based on those studies shows it to be an important contributor to lung cancer risk to the public in general.

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