Good morning. My name is Tom Pike. I am an environmental policy advocate with Protect PT, a local organization in Westmoreland County which fights for our neighbors' rights to clean air and water as acknowledged under the Pennsylvania Constitution, Article 1 Section 27.

I am not a scientist. For the science, I refer you to the testimony of Dr. Burgos and the extensive materials he provided prior to his testimony.

I am a policy analyst. It's my job to use the research of scientists like Dr. Burgos to identify the easiest and most expedient means of improving human health in Pennsylvania.

I work to identify issues that are low-hanging fruit. I consider a policy to be low-hanging fruit when it has a scientific mandate, a broad public consensus, and a clear and simple fix.

This issue meets those three criteria:

Firstly, the science is clear. As Dr. Burgos noted in his packet, in 2016, 11 million gallons of oil and gas waste were reported to be spread on roads in Pennsylvania. That's about **6% of the total wastewater volume** reported from conventional oil and gas wells in Pennsylvania that year. And yet his data also shows that, from 2008 to 2014, spreading oil and gas waste on roads released **over 4 times as much radium to the environment as oil and gas wastewater treatment facilities, and 200 times as much radium as spill events**.

Despite being a very small fraction of industry waste, road spreading is disproportionately responsible for negative impacts on human health.

The process of gas drilling brings radioactive material from underground to the surface. These are known as TENORMs, or technologically-enhanced naturally-occurring radioactive materials.

TENORMs include:

- Radon, which decays much faster than some of the other TENORMs, but is still the second leading cause of lung cancer in the United States.
- Radium 226, which has a half-life of 1600 years. To give you an idea of how long this will linger, if the Romans had disposed of gas industry waste on their roads, Italians would still be breathing in radium 226 today.
- Uranium 238, which has a 4.5 billion year half life. To give you an idea of how long that lingers, 4.5 billion years ago, the earth was formed.
- And thorium 232, with a half-life of 14 billion years. The universe is 13.7 billion years old.

When you take this stuff out of the ground and put it on roads, it's going to stay with us for a very long time.

The State of Pennsylvania already has a ban on the road spreading of unconventional gas industry waste, because it has long been acknowledged that unconventional waste is

dangerous. Conventional gas well waste is not regarded as quite as dangerous, but this is a misconception. Conventional gas well waste is not chemically distinct from unconventional waste.

To that point, I attached a study to my testimony titled, “Sources of Radium Accumulation in Stream Sediments near Disposal Sites in Pennsylvania: Implications for Disposal of Conventional Oil and Gas Wastewater”. This study specifically looked at the contamination of stream sediments at waste treatment disposal sites, but one of its conclusions is relevant:

> *"In order to prevent radionuclide accumulation in the environment, we suggest that disposal restrictions should apply to any type of Radium-rich water, regardless of source, and that current policies differentiating the treatment and disposal of conventional oil and gas waste from unconventional oil and gas waste should be reconsidered.”*

The takeaway is that we should regulate waste based on the chemicals it contains, not what process produced it.

Residents who drive drive their vehicles over gas industry waste get it on their tires. From their tires, it ends up in their garages. From garages, to shoes; from shoes, to homes.

Gas industry waste ends up in homes.

It is also not safe for the workers who do the spreading. Because this waste is improperly categorized as non-hazardous, the standards for transporting it are more lax. Workers often do not even know the chemicals they are being exposed to. The practice is a lawsuit waiting to happen.

And it’s not just the gas corporations that would be liable. Article 1, Section 27 of the PA Constitution states unambiguously that the State has a responsibility to its citizens:

> *“**The people have a right to clean air, pure water**, and to the preservation of the natural, scenic, historic and esthetic values of the environment. **Pennsylvania's public natural resources are the common property of all the people**, including generations yet to come.”*

When PA policy contradicts this legally-binding Amendment, they open the State up to legal liability in potentially-costly lawsuits. To avoid such costs, the fiscally responsible thing to do would be to not permit activity, such as spreading radioactive waste on roads, that so obviously contradicts the PA Constitution.

Pennsylvania’s government has studied this problem in the context of overall industry compliance and non-compliance. The “Lapsing statement” attached to my testimony is a report

from the previous governor's administration that documents the conventional industry's widespread failure to comply with reporting requirements and other regulations. Quote:

> *"Overall performance is so poor among operators with 11 or more conventional oil and gas wells that the failure to report seems to be an industry-wide rule rather than the exception. A significant change in the culture of non-compliance as an acceptable norm in the conventional oil and gas industry will need to occur before meaningful improvement can happen."*

If you respond to this crisis by only setting slightly stricter guidelines for road spreading, the track record of this industry indicates that the guidelines would not be followed. Only a full ban enforced with fines would be effective.

As I said, the second criteria I look for in determining which policies are low-hanging fruit is whether they have a broad public consensus. Such a consensus exists on this issue. I have yet to hear a single resident say they support road spreading of gas industry waste. The only people I know of who support this practice have a financial incentive to do so.

And the third criteria is also satisfied. The solution is clear: make the practice of road spreading of gas industry waste illegal, and **enforce it with fines**. We're not breaking new ground here. We're just closing a loophole.

In fact, there is already agreement at DEP that this loophole should be closed. As of Friday, June 7, DEP removed "brine co-product" as a legitimate category in their waste reporting system. This does not, however, make the issue moot. The industry found this loophole, and they may find another, or they may simply defy regulators.

I attached a letter from Pennfield, a brine spreading corporation, to my testimony. This document was obtained by the Better Path Coalition in a Right to Know. The document says, quote,

> *"Pennfield has obtained a Co-Product status instead of Waste with our brine. What this means is you don't have to report spreading and it can be spread all year round."*

This evidence shows that some road spreading was not being properly reported. Therefore, it is not unreasonable to wonder if a reduced amount of road spreading may continue in defiance of the new categorization by DEP. Regulatory changes are also impermanent as compared to laws. **The best way to be sure that road spreading of gas industry waste stops is to clearly define it, and to make violations punishable by fines under the Oil and Gas Act.**

As the action by DEP shows, road spreading of gas industry waste was never an intended use of their co-product program. It is a loophole that was never meant to exist, and has no coherent public policy purpose.

There are two problems with this use of the co-product program. The first is that it's self-certifying. Conventional operators have been able to claim their waste is a co-product, and only after it is used was DEP able to come in and review the certification documents to see if they were sufficient. In each case where they did review them, they found that they were not sufficient and did not meet the requirements of the co-product program. According to Better Path Coalition's Moratorium Morass report, which I have attached, there have been no consequences for this.

The second problem is that, under DEP's current interpretation, operators are not required to show that co-products are just as effective as the commercial product they are replacing. Penn State studies, included by Dr. Burgos, have shown that gas industry waste is not effective as dust suppressant and may even destabilize a road, leading to more dust coming off the road. An ineffective waste should not be used in place of an effective commercial product, which is a potential that can happen under this co-product program interpretation.

Some of you are from the Southeastern part of the state, and this industry is concentrated in the North and the West. Because of that, I ask you to take seriously the stories you have heard today from the scientists who study these impacts which you would not see in Philadelphia or Harrisburg. I assure you that the impacts are real, and the families affected are very real as well. This industry has not been a good neighbor to a lot of Pennsylvanians.

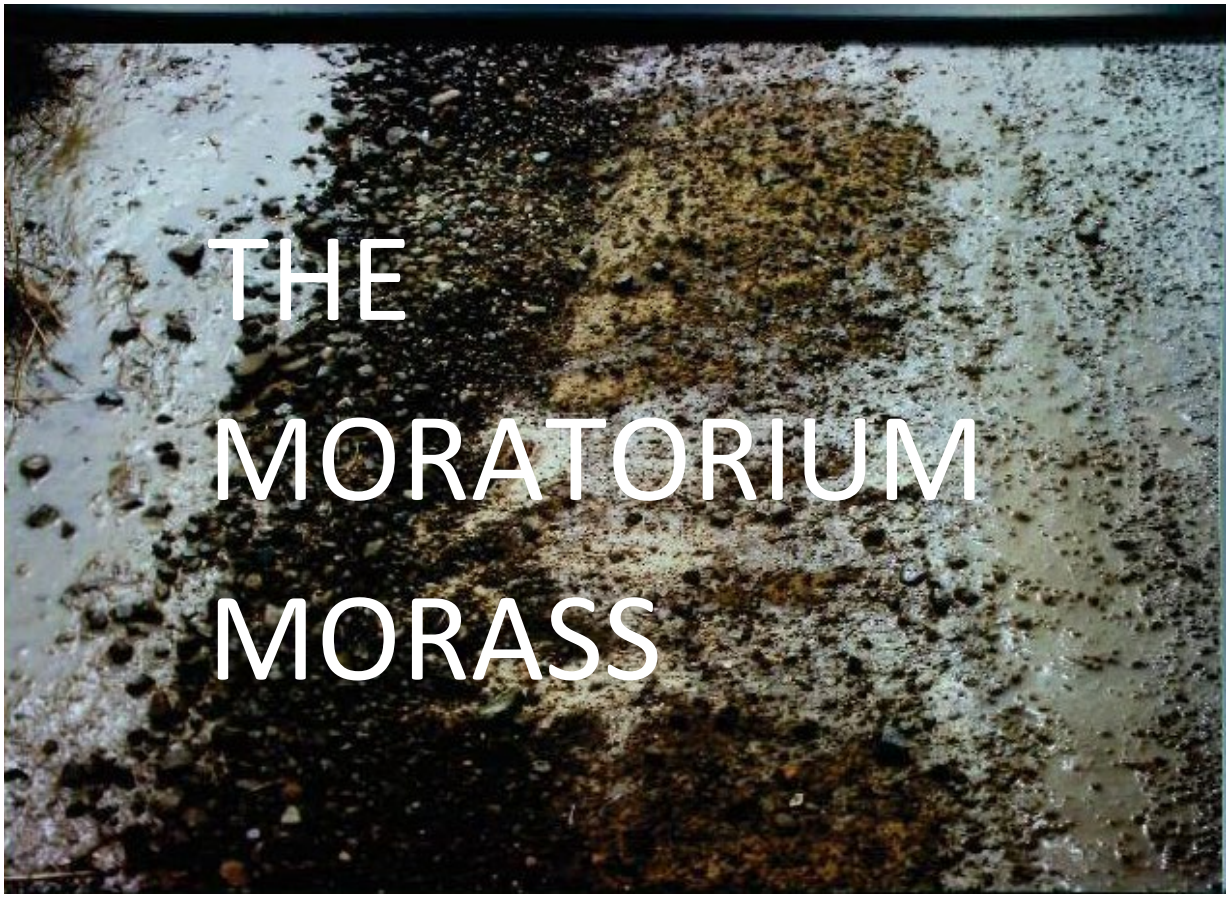
Lastly, I want to address the convenience of this waste for municipalities. It is true that the waste is cheaper than a commercial product. I'm sure it would be cheaper for any industry to dump their waste on the road instead of disposing of it properly. It would be cheaper for me, too, but instead of dumping my garbage in the street, I pay my waste bill and put it in a bin.

It's always cheaper to do something improperly than to do it properly. But that doesn't make it the right thing to do. If I dump my household waste in the street, it inconveniences and endangers all of my neighbors, and I get fined. All I'm asking is that you apply the same standards to the gas industry as you do to me.

You and I may disagree about various issues, but today I am only here about the road spreading of gas industry waste. **We should all be able to agree that dumping radioactive garbage in streets is bad policy.**

Thank you for your time.

BETTER PATH BRIEF **DECEMBER 2022**



HOW THE HALT TO ROAD SPREADING TOXIC OIL & GAS WASTEWATER MADE PENNSYLVANIANS LESS SAFE

2022 UPDATE

BETTER PATH COALITION

INTRODUCTION TO DECEMBER 2022 UPDATE

“Pennfield has obtained a Co-Product status instead of Waste with our brine. What this means is you don’t have to report spreading and it can be spread all year round. I know this is hard to believe because D.E.P. doesn’t make anything easy, but it’s true…,” the company told townships that were potential customers.

Titusville Oil & Gas Associates’ president wrote, “I do not currently supply any oil and gas produced water to these entities or any other entities for the purpose of treating dirt and gravel roads in Forest County and have not done so since the Department of Environmental Protection - Bureau of Waste Management (BWM) issued letters to multiple operators in the business of spreading produced water on dirt roads that their co-product determinations were largely inadequate.” The company reported spreading 1004.01 barrels of produced water in Forest County in 2021.

Tachoir Resources, a company that entered 278 records of road spreading a total of nearly 600 barrels of drilling waste in 2021 says it subcontracted the hauling to another company, Anderson Energy Services. Anderson also reporting road spreading of waste, 240 barrels of it, for the first time since 2017, told regulators in August, “Per our conversation we have not been disposing brine for spreading for well over a year and are not in the future.” Additionally, that same company routinely lists the same amount of waste spread for each of its entries in a county. It might explain why their client did the same. How much of its own waste and its client’s it actually spread is unknown.

These are among the discoveries the Better Path Coalition made in our review of records we obtained from the Pennsylvania Department of Environmental Protection’s Bureau of Waste Management in response to a Right-to-Know (RTK) request.

The records round out our collection of documents pertaining to the use of a loophole conventional drillers found in BWM’s Coproduct Determination program to legally continue the practice of spreading toxic, radioactive waste on unpaved roads in Pennsylvania after the Office of Oil & Gas Management put a moratorium on the practice. Collectively, the documents reveal that not one conventional driller reporting road spreading of waste from 2018 to the present submitted a coproduct determination report that met the regulatory requirements of the program.

What the most recent records, or lack thereof when companies simply ignored BWM’s request for coproduct determination reports, show is that even a year after the problems with the use of the coproduct determination loophole were brought to light, companies continue to spread waste, flouting the rules as they go. The records we report on in this update are those pertaining to eight companies that used the loophole in 2021 to spread waste for the first time since the moratorium.

As a result, conventional drillers reported spreading 23,277.89 barrels or 977,671.38 gallons of waste in 2021. Questions remain about how the waste is reported and how accurate the amounts listed are, so the real amount of waste being dumped on roads may be much higher. The Office of Oil & Gas Management’s inadequate reporting system provides no information when the waste was spread, how

close to water sources the spreading may have occurred, what weather conditions were like, and many other key details. Conventional drillers are only required to submit annual reports that aren't due until February of the following year, so no real time information on road spreading is available.

These are among the issues we discussed in *Moratorium Morass* one year ago. None of the issues we identified have been addressed nor have the recommendations we made been implemented. The following is our second update since publishing our brief last year.

BACKGROUND

One year ago, we published *Moratorium Morass*, a brief on the conventional drilling industry's use of a loophole to spread toxic, radioactive wastewater on unpaved roads as a dust suppressant. Drillers had turned to the program to find what they believed would be a legal way to continue spreading the waste after the Office of Oil and Gas Management put a moratorium on the practice in response to a 2017 Environmental Hearing Board appeal filed by Siri Lawson. While examining issues with the use of the loophole, we also identified numerous issues with the Oil and Gas Reporting Electronic (OGRE) system drillers use to submit waste disposal reports.

Our reporting on the use of the loophole was based on documents we obtained in response to our initial RTK request for coproduct determination reports owners of drilling waste had submitted to the BWM at the agency's request. We were advised at the time by Joseph Cigan, Director of the Office of Chief Counsel of the agency's General Law Division, that informal requests for information were preferred to RTK requests.

In August, we updated our brief based on the information on road spreading in 2021 that was submitted in annual waste reports that are due by February 15 of the following year. We noted that five companies that reported road spreading in 2020 did not report using that disposal method in 2021, but that eight companies reported road spreading for the first time since the 2018 moratorium, a net increase of three companies.

We submitted an informal request for the coproduct determination reports of the eight new companies on the list. We also asked if three companies that had not responded to the department's request for reports in 2020 had responded since our last communication. We received no response.

On September 27, we submitted a RTK request for coproduct determination reports for the eight companies. We received the documents pertaining to each of the companies on October 14.

This update looks only at the documents we received on October 14 and is appended to the original report and the August update.[i] We intend to file additional requests and review all 2022 road spreading reports after the submission deadline in February.

OVERVIEW OF DOCUMENTS RECEIVED

On April 13, the Bureau of Waste Management sent letters requesting coproduct determination reports from seven of the eight companies that reported using road spreading as a disposal method for the first time since the 2018 moratorium on the practice.

The same seven companies received follow up letters dated August 8 informing them that BWM had not yet received a report or that the report they received was insufficient. The results of the RTK include emails from companies that refer to conversations with BWM's Kevin Beer, Chief Compliance and Technical Support Section, Division of Municipal and Residual Waste or have responses from Beer in their threads.

The companies are:

Anderson Energy Services, LLC

Crowley Oil Company, LLC

Fork Run Oil & Gas, LLC

Medina Resource Development Company, LLC

Pennfield Energy, LLC

SLT Production LLC

Tachoir Resources, LLC

Titusville Oil & Gas Associates Inc.

Pennfield was the only company that did not receive the April 13 or August 8 letters. In fact, BWM sent the company a letter on April 28 that was much like the letter other companies wouldn't receive until August. That is because BWM first requested a report in 2021. Because of the exceptional circumstances surrounding Pennfield, we will discuss it first.

DISCUSSION

PENNFIELD ENERGY, LLC.

In *Moratorium Morass*, we noted that BWM had reached out to Pennfield in 2021 even though it had not reported any road spreading since 2017. When we looked at the company's activities more closely, we realized that BWM was justifiably concerned about the company's handling of waste.

As we wrote at the time, "Pennfield Energy LLC, the company that hasn't reported road spreading of waste since 2017 hasn't reported *any* form of waste disposal during that time. But the DEP's Oil & Gas

Well Production reports from 2018 through 2020 show that the company produced 10165.66 barrels of oil."

When asked to submit a report in 2021, the company sent an assortment of extraneous documents, like a copy of the regulations they were violating, a copy of a 2018 Penn State study, "Environmental and Human Health Impacts of Spreading Oil and Gas Wastewater on Roads," published in *Environmental Science and Technology*, and literature about LS25, the commercial product against which the company was presumably measuring their waste's qualifications as a coproduct.

Pennfield's self-determination also included lab results from 2018, which suggested they were planning to road spread some of the resulting waste. So what did they do with all their waste? Did they spread some of it on roads?

The answer may be in a document that was among the nine documents provided in response to the RTK. It is a letter Pennfield sent to townships in 2019 that says, "Pennfield has obtained a Co-Product status instead of Waste with our brine. **What this means is you don't have to report spreading and it can be spread all year round.** I know this is hard to believe because D.E.P. doesn't make anything easy, but it's true, you do need our brine analysis on hand and a copy of the D.E.P. regulation with Co-product determination. We will provide this to you once we you have completed and returned the enclosed agreement." (emphasis added)

The other documents we received include five emails from the company to BWM. The first email, dated May 9, states that one of the five attachments is documentation for their coproduct determination. It is a single-paged letter dated May 7 that points to three attachments that are Exhibits and a fifth that is Raw Materials Table. (The email says, "Also, we are in the middle of reporting 2021 production & brine but are having some issues with the website missing waste facilities and townships options needed." As we've said previously, the waste reports were due on February 15.)

The letter identifies Bruce Coffin Trucking's Brine Well ERIE- 53 as the produced Raw Material they used for their comparison in their 2022 coproduct determination. Exhibit A provides test results from 2011 for ERIE-53 for a handful of substances, including calcium, magnesium, potassium, sodium, and chlorides. Exhibit B is a lab report on samples from five Pennfield wells, all from 2018. Microbac, the same lab that tested ERIE-53's brine, tested Pennfield's brine for the same analytes with one exception. Three samples were tested for n-Hexane Extractable Material (HEM). The amounts found for two of the samples were at or below the reporting limit. The third was above the reporting limit. Exhibit C is the Agency for Toxic Substances and Disease Registry's (ATSDR) public health statement on n-Hexane. The fifth attachment, the Raw Materials Table, compares the results for ERIE-53 and Pennfield's wells.

The letter concludes, "These comparisons and documentation will show that Pennfield Energy wells produce brine that does not harm or present a threat of harm to public health, safety, welfare or the environment."

On May 11, Pennfield emails the BWM again to say that the company is getting requests for brine from townships and would like to know "where we stand." If they do not hear from BWM by May 13, the email continues, they will assume they are cleared to spread brine.

Although it is not included separately, the next Pennfield email from May 18 includes in its thread a response from Kevin Beer at BWM that indicates that the new coproduct determination Pennfield submitted is insufficient, as was the company's 2019 determination. He highlights an excerpt from 25 Pa. Code § 287.8(b)(2) that says an evaluation must be done of "total levels of hazardous or toxic constituents, including the constituents in 40 CFR Part 261."

Pennfield's May 18 response provides a list of testing parameters they've put together and asks for Beer's thoughts. The items they list are Heavy Metals, Radiologic, Petroleum Hydrocarbons, Calcium, Magnesium, Sodium, Potassium, Specific Gravity, Alkalinity, PH. (40 CFR Part 261 clearly lists hazardous and toxic constituents.)

Pennfield emails Beer again on May 23, requesting a response because they'll be "collecting brine samples on Wednesday" (May 25).

Pennfield's final email included in the RTK is also dated May 23 responding to a list Beer provided. They say, "Thank you. Microbac said it would be 21 working days to get results from the Radium testing so I'll get an updated determination letter as soon as I can. This is going to cost a boat load they said so I sure hope it does the trick."

The other documents we received are undated blank form sent to townships that have expressed interest in Pennfield's brine and an undated blank Brine Hauling Agreement.

No information is provided in the RTK that indicates what has happened since May 23, but the O&G Waste Report lists July 19 as the submission final date for each of its entries, five months after the reporting deadline and five years after its last report.

One entry lists that 50 barrels were spread in Rockland Township, Berks County in eastern Pennsylvania, but in the waste comment section says only "can't find". We contacted Rockland Township. They have no record of any road spreading and suspect the record is referring to Rockland Township in Venango County. The rest of the records indicate that the waste was spread in Crawford (58 records – 5975 barrels), Erie (24 records – 3745 barrels), Forest (2 records – 300 barrels) and Venango (1 record – 100 barrels) counties.

ANDERSON ENERGY SERVICES, LLC

The company responded on April 13 to the BWM letter they received that day, saying, "Attached please find the Co-product Determination for the little bit of spreading we did in 2021."

Burt Waite, a Pennsylvania Independent Oil & Gas Association representative who wrote two of the coproduct determinations (Howard Drilling, Inc. and LHS Production LLC.) covered in *Moratorium*

Morass, wrote Anderson's determinations as an independent geologist in May 2019. He represents his association on the Pennsylvania Grade Crude Development Advisory Council and once said in a meeting that drillers were 'nervous' when the DEP started requesting determination reports. In Moratorium Morass, we discussed Waite's reports under the category of extraneous information because of the testimonials he includes in place of the kind of analysis that would meet the regulatory requirements of the Coproduct Determination program.

When BWM responded on August 8 to say that the report was "insufficient to support a Coproduct Determination," Anderson responded the same day to say, "Per our conversation we have not been disposing brine for spreading for well over a year and are not in the future."

Anderson reported spreading a total of 240 barrels of brine in Warren County in its 10 entries in 2021.

Only two amounts – 34 and 14 barrels – are used. All of the 5 entries for Mead Township, list 14 barrels; all of the 5 entries for Pleasant Township list 34 barrels. We have noted elsewhere that several drillers repeat the same figures again and again. It's not clear if they are accurately reporting the amount spread, or hitting copy and paste to fill in the field on the spreadsheet they eventually upload into OGRE.

According to Zack Anderson's LinkedIn page,[ii] he is "self employed in the shallow conventional oil &gas regions of Warren, McKean, Forest, Venango, Erie, Crawford counties. Service rig work and Contract well tender." He went into business in March of 2016. However, there are no records of any form of waste disposal from 2016 through 2018. Road spreading is not among the disposal methods he listed in his reports in 2019 and 2020, so contrary to what he told BWM, he has *only* been disposing of brine for spreading for the past year unless he was spreading waste on roads from 2016 through 2018 and just not reporting it. That he hired Burt Waite to write a coproduct determination report for his company may indicate that he was road spreading believing he was spreading a product and not required to report it.

We received no record of further communications between Anderson and BWM.

CROWLEY OIL COMPANY, LLC.

An attorney for Crowley responded to BWM's April 13 letter on April 29 to say that the company had not spread waste on roads, but had generated some waste it was storing to spread once enough had accumulated. The company noted that the database once had a field for storing waste onsite. When the field was removed, Crowley commented in each of its entries, "Small quantity of brine generated & stored onsite in 2021, hope to roadspread once enough is accumulated." In order to complete the form so it would be accepted into the OGRE system, the company listed proposed sites for future spreading.

Three other waste owners appear to have used the category - STORAGE PENDING DISPOSAL OR REUSE. Why Crowley didn't use that category or see it on the dropdown as an option is not clear.

Their 52 entries totaled 19.29 barrels of produced water that were spread in Annin Township in McKean County. Four of the 52 entries are noted as not being their wells. 0.05 barrels was listed as having been spread for the first of the four wells they don't own. 0.01 barrels was listed for two of the wells. Only one of the four wells they don't own reported 0 barrels spread. According to Crowley's explanation for how it reported waste for future disposal, these figures are all aspirational, not hard data.

Prior to 2021, the company did not report road spreading from 2015 – 2020 except for 2017 when it was the only disposal method it reported for the 439 barrels it listed in 32 entries.

FORK RUN OIL & GAS, LLC.

BWM sent Fork Run both the April 13 letter and the August 8 follow-up. The company did not respond to either.

The Oil & Gas Waste Report includes 31 entries of road spreading for a total of 169.89 barrels of produced water in 2021. Fork Run listed 4.47 barrels for each of its 19 entries for Wetmore Township, McKean County and 7.08 barrels for each of its 12 entries for Mead Township, Warren County.

Prior to 2021, Fork Run reported waste in 2019 and 2020 in 92 entries that all indicated that the waste was being stored pending disposal or reuse. In 2019, that information was entered as a comment and no amount of waste was provided. In 2020, the information was provided in the disposal method section. The amount of waste reported in 2020 was 55.14 barrels. No waste disposal by any method nor any waste stored pending disposal was reported from 2015 through 2018.

We received no record of further communications between Fork Run and BWM.

MEDINA RESOURCE DEVELOPMENT CO., LLC.

Medina's office manager responded on April 13 to BWM's letter sent the same day to say that she's the one who fills out the reports, that they take the waste to the township, and that it's the township that decides where to use it.

The office manager sent a follow-up email on 4/30 to correct a typo in the first email and explained again that they take it to the township. She indicated that she tried to call but was having difficulty getting through and requested that BWM call her back. She provided two numbers, a work number and an after-hours number, where she could be reached.

There's no record of any further communication on this until BWM sent the follow-up form letter on August 8 to tell the company it had failed to submit a coproduct determination report.

Medina reported a total of 21.85 barrels of produced water in its 22 entries from 8 wells in Crawford and Erie Counties was spread in Amity Township, Erie County.

Prior to 2021, the company reported no waste disposal of any kind from 2017 through 2020. In 2015 and 2016, the company reported road spreading as it's only form of waste disposal. A total of 57,900 barrels was reported in 33 entries spanning two years.

According to production reports, Medina reported 1,261,880 mcf of gas in 1896 from 2017 through 2020.

SLT PRODUCTION, LLC.

On September 9, a manager emailed Kevin Beer at BWM to requesting an extension until September 26 to conduct its review and respond.

No record of further communication was provided in response to the RTK.

SLT reported spreading the same amount in each of its 81 records, 1.36 barrels, for a total of 110.16 barrels. All of SLT's waste was spread in Mercer County.

Between 2015 and 2017, SLT reported road spreading 2,610.74 barrels of waste in its 743 entries.

TACHOIR RESOURCES, LLC.

An email sent to Kevin Beer on April 14 in response to the April 13 letter thanks Beer for taking a call earlier that day. The email goes on to say that the company subcontracts all its brine hauling to Anderson Energy Services (see Anderson's report above). Anderson's coproduct determination report was attached, as was a lab report from May 26, 2021 on samples of production brine tested by White Oak Laboratory for Chloride, Calcium, Magnesium, and Sodium

The BWM sent its August 8 follow up letter to inform the company that its determination report was insufficient.

From 2015 through 2020, Tachoir did not report road spreading of any of its waste in its 2757 entries. It's not clear how long Tachoir has been subcontracting its brine hauling to Anderson and if any road spreading prior to 2021 went unreported because that work was contracted out.

Tachoir's 278 entries totaled 594.92 barrels of waste spread. All of the 139 entries for Forest County road spreading listed the same amount, 3.06 barrels. All of the 139 entries for Venango County listed 1.22 barrels.

Anderson reported road spreading in two counties, similarly using the same amount spread in each entry for a given county. Neither value matched the two values in Tachoir's report, so it appears that Anderson's report did not include any of the spreading they did on behalf of Tachoir.

TITUSVILLE OIL & GAS ASSOCIATES INC.

BWM sent both its April 13 and August 8 letters to Titusville. On August 9, Titusville's President William Henderson responded by email to say that he has never spread, but has supplied other companies with produced water. He does not name any of the companies, but claims that they have done their own coproduct determinations.

Henderson then says, "I do not currently supply any oil and gas produced water to these entities or any other entities for the purpose of treating dirt and gravel roads in Forest County and have not done so since the Department of Environmental Protection - Bureau of Waste Management issued letters to multiple operators in the business of spreading produced water on dirt roads that their coproduct determinations were largely inadequate. Further, I will not supply any of these entities with produced water going forward until such time that they have authorization from DEP to do so."

Titusville's 92 entries totaled 1004.01 barrels spread in Forest County in 2021. From 2015 through 2020, the company reported no road spreading in any of its 770 entries.

The letters Henderson refers to are those BWM sent in 2021 that we reported in the original Moratorium Morass brief to which this update is appended. As we reported, an affidavit from Kevin Beer in response to our first RTK explained that his office "issued letters to 16 Oil and Gas Operators starting in the Spring of 2021 seeking documentation supporting their coproduct determinations." For Mr. Henderson's claim to be true, all of the company's reported spreading would have to have occurred early in 2021.

One critical flaw in the DEP's reporting system is that waste owners are not required to list dates when road spreading occurred. Instead, a requirement that is fairly useless in the tracking of waste disposal is the spud date, or the date when drilling began on the well that produced the waste being reported. For example, several of Titusville's entries list spud dates from the 1970s and 80s.

RECOMMENDATIONS

Our first recommendation in the report we released a year ago was to ban road spreading of conventional waste. We stand by that recommendation. Our findings in our 2022 updates to our original report demonstrate that companies are ignoring the moratorium, not taking the regulatory requirements of the Coproduct Determination program seriously, failing to correct their inadequate coproduct determination reports even after receiving guidance from BWM, and failing to properly account for the waste the have spread when they *do* report it in OGRE. At the same time, recent studies have confirmed that road spreading of conventional drilling waste is harmful to health and the environment and that brine is not an effective dust suppressant.

In the three years before the moratorium, 114 companies reported road spreading. Between 2018 and 2021, 37 companies reported road spreading. The difference is 77 companies that may be spreading

waste without reporting it because of confusing and unclear reporting requirements. DEP should investigate how many conventional drillers in Pennsylvania that are not on the list of 37 that have reported road spreading since the moratorium.

Additionally, we recommend that the DEP inform the public about how little is really known about where, when, how, and by whom drilling waste has been disposed. The agency should commit to revamping the OGRE system so that the disposal of waste can truly be tracked. Further, the agency should commit to ending the Coproduct Determination program as it currently exists.

CONCLUSION

We updated *Moratorium Morass* in August, in part, because Governor Wolf ordered DEP to review the conventional industry's record of compliance with reporting requirements. We provided him with a copy of the report to assist in his review.

We learned on December 1 that the Pennsylvania Grade Crude Development Advisory Council (CDAC) may conduct its formal review a draft waste handling regulation that was posted in September and that the Shapiro/Davis administration will determine the schedule for considering the regulations. We know that the draft regulations fall far short of addressing the road spreading issue.

Although we remain encouraged that the Bureau of Waste Management is communicating with waste owners and stating clearly that their coproduct determinations are insufficient when they've been provided at all, we do not see evidence of any enforcement of the regulations or even a clear path to how the regulations can be enforced. The Coproduct Determination program is very loosely regulated. There are no permits involved. As a result, there are no permits to violate. But when a waste product doesn't pass the even the low bar the BWM has set for its program, it's not a coproduct, so the shortcomings of the program shouldn't matter. We see no evidence that the Office of Oil & Gas Management is taking action against companies that have violated the moratorium when BWM has confirmed that their coproduct determinations are inadequate and that what they're spread cannot be considered anything other than waste.

A year after our first report, we see no evidence of progress made in addressing the reporting inadequacies we've identified either. The facts that toxic, radioactive waste is being spread on our roads and that it's virtually impossible to know exactly when and where it's being spread, how much is actually being spread, and even who is doing the spreading only strengthens our call to expand the ban on road spreading of unconventional waste to include all road spreading.

We will provide a copy to Governor-elect Shapiro and his transition team for their review.

Karen Feridun, on behalf of the Better Path Coalition
December 2022

INTRODUCTION TO AUGUST 2022 UPDATE

In December 2021, the Better Path Coalition published our brief called The Moratorium Morass that looked at the issue of continued road spreading of conventional drilling waste despite a 2018 moratorium put on the practice by the Department of Environmental Protection's Office of Oil and Gas Management. Conventional drillers found a loophole in the Bureau of Waste Management's Coproduct Determination program that allowed for use of their drilling waste as a commercial product, namely a dust suppressant on unpaved roads.

In the course of researching our report, we had submitted RTK requests to the Bureau of Waste Management and met with Kevin Beer, Chief of the Compliance and Technical Support Section of the Division of Municipal and Residual Waste. He had been contacting companies availing themselves of the loophole to request the required self-determinations that must be submitted to the Bureau upon request. As of the publication of our brief, Beer had not heard back from a number of the companies he had contacted. Two had requested more time to submit their determinations. Others had submitted determinations, but none conformed to the residual waste requirements in Section 287.8 of the Pennsylvania Code.

The Oil & Gas division still required conventional drillers to report road spreading annually (unconventional drillers file monthly waste reports).The deadline to report is February 15 of the following year and it can take months, even years, for reports to be added to the system. Over the course of our investigation, we encountered several problems with many entries in the waste reports, with the design of the database, and with its maintenance.

This update, appended to our original report, looks at what happened in the year the Bureau of Waste Management started its own investigation of the drillers' use of the Coproduct Determination program and in the months since we identified problems with the use of the program and the deficiencies with the reporting process.

We contacted the Bureau of Waste Management with several questions about the status of their investigation of waste owners who spread waste between 2018 and 2020. We also asked if the investigation has been extended to waste owners who spread waste on roads in 2021. We have not received a response.

OVERVIEW OF 2021 RECORDS

Conventional drillers reported spreading 23,277.89 barrels or 977,671.38 gallons of waste in 2021. The total was calculated by tallying amounts reported in 1,107 records from nine counties submitted by 21 conventional drillers. The following chart shows the breakdown by county.

County	Number of Records	Amount spread (in Barrels) in 2021	Operator(s)
Butler	2	310	LHS
Clarion	6	70.1	Elder
Crawford	25	754.5	DJR (1) Energy Res (12) JMG (3) Medina (9)
Erie	14	92.35	Medina (13) Stedman Energy (1)
Forest	385	3448.93	Pennfield (15) Tachoir (278) Titusville (92)
McKean	71	104.22	Crowley (52) Fork Run (19)
Mercer	129	3868.4	DJR (35) Energy Res (32) JMG (24) McComb (23) Millennium (15)
Venango	310	13777.36	Elder (8) Energy Res (11) Howard (14) JMG (2) Pennfield (71) River Ridge (1) Vista (203)
Warren	164 (165 including Cameron)	762.12 (852.12 including Cameron)	Anderson (10) Fork Run (12) Missing Moon (61) SLT Prod (81) Cameron (1)*
Total	1106 (1107 including Cameron)	23187.89 (973,891.38 gallons) (23,277.89 [977,671.38 gallons] including Cameron)	20 (21 including Cameron)
Total – All Waste, Conventional Only		828176.07 (34,783,394.94 gallons) (828,266.07 [34787174.94 gallons] including Cameron) + 12884.37 tons of additional waste (produced fluids, contaminated soil, waste water treatment sludge, servicing fluid, synthetic liner material)	

* One record from Cameron under the category Reuse at a Conventional Well Site in PA where 12.88 of Produced Fluid was reported included a comment that said "Group #28- 90 barrels of water was spread on a privately owned parking lot but there is no place to report private property on the menu."

The list of waste owners, usually conventional drillers, underwent some changes in 2021 that are reflected in the chart below.

WASTE OWNERS REPORTING ROAD SPREADING SINCE 2018	LAST YEAR REPORTED	AMOUNT SPREAD IN BARRELS	WASTE OWNERS REPORTING ROAD SPREADING IN 2021	AMOUNT SPREAD IN BARRELS AS OF AUGUST 2022	2021 NOTES
BOBCAT WELL & PIPELINE LLC	2018	707			
CAMERON ENERGY CO	2020	269.93	X	90*	Not marked as road spreading because the waste was spread on a private road
CRS ENERGY LLC	2020	6944.6			
DIVERSIFIED OIL & GAS LLC	2018	10410			
DJR WELL SERVICES INC	2020	2322	X	984	
ELDER OIL & GAS CO	2020	440.01	X	190.01	
EMPIRE ENERGY E & P LLC	2019	405			
ENERGY RESOURCES OF AMER INC	2020	4285	X	2300	
ENERVEST OPR LLC	2019	2458.53			
G & G GAS INC	2020	168.7			
GASP INVESTMENT LLC	2018	0.04			
GLORIA J & ROGER S WENZEL	2020	3			
HEITER ROBERT & CAROL	2020	43			
HOWARD DRILLING INC	2020	1860.14	X	210	
JMG ENERGY LLC	2020	5313	X	1113	
L & B ENERGY	2019	4856			

WASTE OWNERS REPORTING ROAD SPREADING SINCE 2018	LAST YEAR REPORTED	AMOUNT SPREAD IN BARRELS	WASTE OWNERS REPORTING ROAD SPREADING IN 2021	AMOUNT SPREAD IN BARRELS AS OF AUGUST 2022	2021 NOTES
LLP					
LHS PROD LLC	2020	100	X	310	
LT OIL CO LLC	2020	95.79			
MCCOMB OIL INC	2020	675	X	480	
METZLER JEFFERY A	2018	50			
MILLENNIUM OIL & GAS INC	2019	182	X	326.4	
MISSING MOON OIL INC	2019	574.1	X	327	
PEMBROOKE OIL & GAS INC	2020	1096			
RIVER RIDGE GRAVEL CO	2020	107.8	X	0.45	
SAVKO JOHN A	2018	100.1			
STEDMAN ENERGY INC	2018	70	X	80	
VICTORY OIL & GAS CO	2018	205			
VISTA OPR INC	2020	10125.57	X	5006.91	
WB PROD MGMT CO	2019	250			
			ANDERSON ENERGY SERVICES	240	
			CROWLEY OIL CO LLC	19.29	
			FORK RUN OIL AND GAS LLC	169.89	
			MEDINA RES DEV CO LLC	21.85	
			PENNFIELD ENERGY LLC	9700	

WASTE OWNERS REPORTING ROAD SPREADING SINCE 2018	LAST YEAR REPORTED	AMOUNT SPREAD IN BARRELS	WASTE OWNERS REPORTING ROAD SPREADING IN 2021	AMOUNT SPREAD IN BARRELS AS OF AUGUST 2022	2021 NOTES
			SLT PRODUCTION LLC	110.16	
			TACHOIR RESOURCES INC	594.92	
			TITUSVILLE OIL & GAS ASSOC INC	1004.01	
TOTAL BARRELS SPREAD BY ALL OWNERS		55,517.62		2331740.04*	

BOLDFACE indicates companies that reported spreading during at least one year from 2018 – 2020 and spread again in 2021.

*The total reflects the 90 barrels Cameron spread on private roads and noted in the comment field of a produced fluid entry in addition to the 23187.89 barrels reported as Road Spreading by all waste owners in 2021.

Thirteen companies that had reported road spreading between 2018 and 2020 spread waste in 2021. Of them, 11 of them reported spreading in 2020. Two of them had not spread since 2019. In 2021, when the Bureau of Waste Management's began its outreach to waste owners using the Coproduct Determination loophole, its focus was road spreading that had occurred the previous year and remained as such through the publication of our brief in December of 2021. It's not known if the Bureau has since expanded its outreach to include companies that had not spread since 2019, nor is it known if it reached out to every waste owner who reported spreading in 2020.

Five waste owners that had spread in 2020 did not report spreading in 2021. That may be a result of the Bureau's efforts, although, as the chart shows, drillers have skipped years at times. Eight companies were new to the list in 2021, so there was a net increase from 2020 to 2021. Nevertheless, the amount of waste spread on roads decreased 57% from 2020 to 2021.

David Hess reported in his *PA Environment Digest* blog that, in April, the DEP sent letters to 18 municipalities where road spreading had occurred. The letters explained that the spreading had been done by waste owners that had not submitted self-determination documents that met the necessary residual waste requirements and were, therefore, spreading waste illegally. The waste owners named were CRS Energy, LLC, DJR Well Services, Energy Resources of America, Inc., Robert Heiter, Howard Drilling, JMG Energy, LLC, L&B Energy, LHS Production, McComb Oil, and Vista Resources, Inc.[iii]

Operators Cited in DEP Letters to Municipalities	Reported 2020 Road Spreading in Barrels	Reported 2021 Road Spreading in Barrels
DJR WELL SERVICES	2322	984
ENERGY RESOURCES OF AMER INC	1900	2300
HOWARD	1860.14	210
JMG	5313	1113
MCCOMB	675	480
VISTA	10125.57	5006.91
TOTAL	22,195.71	10,093.91

Six of the companies cited in the letter continued road spreading in 2021. Overall, they spread roughly 45% of the amount they had spread the previous year, although one company, Energy Resources of America, Inc., a company that had not responded to the Bureau of Waste Management as of December of 2020, increased the amount it spread by 400 barrels in 2021. The six companies are responsible for more than 43% of the waste spread in 2021.

Vista Resources posted 203 instances of road spreading in the 2021 waste report. Every one of the entries listed "Brine Co- Product (in Barrels)" as the waste type and included a comment that reads, "All produced fluids from this well are currently being managed as a 'waste product' and are being disposed of in accordance with applicable law." Saying it doesn't make it true.

Vista's records are interesting to read for another reason. In our original report, we questioned the quantity of waste spread because of an issue we found in many companies' records. Several drillers reported the same quantity of waste in multiple records. The problem persisted in 2021. Vista was one of the companies that reported identical quantities, but drew from a range of numbers. SLT Production used the quantity 1.36 barrels in each of its 81 records. Tachoir used only 2 amounts for its 278 records – 1.22 barrels (139 times) and 3.06 barrels (139 times). Below are a few examples.

Vista - 4.76 barrels 42 times, 9.52 barrels 10 times, 10 barrels 20 times, 15.38 barrels 26 times, 16.66 barrels 12 times, 20 barrels 20 times, 22.22 barrels 9 times, 23.07 barrels 13 times, 25 barrels 4 times, 26.98 barrels 3 times, 33.33 barrels 3 times, 45.94 barrels 21 times, 50 barrels 6 times, 100 barrels 1 time, 105.11 barrels 13 times.

Titusville - 2.37 barrels 38 times, 4.92 barrels 13 times, 12.8 barrels 10 times, 14.06 barrels 8 times, 19.19 barrels 8 times, 29.8 barrels 10 times, 31.33 barrels 3 times, and 32 barrels 2 times.

Crowley - repeats numbers, including 9 records that report 0 barrels. Other repeated numbers are 0.01 barrels 4 times, 0.25 barrels 15 times, 0.5 barrels 16 times, 0.75 barrels 2 times, and 1 barrel 6 times.

Fork Run –reports the same amount for each of its 19 McKean County records, 4.47 barrels, but 7.08 barrels in each of its 12 Warren County records.

Another reporting issue we noticed last time pertained to road spreading on private roads. River Ridge reported road spreading on private roads in the Comments field. In 2021, one record from Cameron under the category Reuse at a Conventional Well Site in PA where 12.88 of Produced Fluid was reported included a comment that said "Group #28- 90 barrels of water was spread on a privately owned parking lot but there is no place to report private property on the menu."

In reviewing the data gaps we identified in our original report, we didn't find any evidence that they have been addressed. We continue to be concerned that the issues we discovered with how road spreading is being reported indicates that we have no sense how of much waste was actually spread.

CONCLUSION

The problems we identified in our first report in 2021 have not been sufficiently addressed. Although we are encouraged that the Bureau of Waste Management appears to have continued its work to address the abuse of the Coproduct Determination program, we have not been able to get specific information from the department that indicate the scope and status of their efforts. We have seen no changes to the way road spreading is reported, no improvements to the reporting system itself, and no corrections made to data that was added incorrectly pertaining to road spreading in 2018 and 2020.

Since our original report was published, PennState researchers have announced its study that shows that road spreading adversely affects health and does not effectively control dust.[iv] The DEP said the study's impact would be "immediate, large and intense."[v] To date, no changes have been made, but the PA Grade Crude Development Advisory Council (CDAC) has balked at PennState's results and is calling for the study to be redone, this time including members of CDAC as co-authors.[vi]

This summer, Governor Wolf ordered DEP to review the conventional industry's record of compliance with reporting requirements, among others. We will submit this report to the Governor in hopes that it will assist him in his own review of the data.

Karen Feridun, on behalf of the Better Path Coalition
August 2022

MORATORIUM MORASS – DECEMBER 2021

As concerns mount regarding the environmental and health impacts of toxic, radioactive oil and gas drilling wastewater, so, too, do concerns regarding the Pennsylvania Department of Environmental Protection's oversight of its management and reporting. The agency halted one of the more controversial disposal methods, the practice of spreading the wastewater as a dust suppressant and deicer on Pennsylvania roadways, in response to a 2017 Environmental Hearing Board appeal filed by Siri Lawson, a Warren County resident. Lawson argued that brining was polluting the air and water near her Farmington Township home[1]. Documents obtained by the Better Path Coalition in response to a Right-to-Know request and our analysis of the agency's Oil and Gas Reporting Electronic (OGRE) system reveal significant policy and data collection failures that have left our air, water, and health less protected from the dangerous waste than they were before the moratorium went into effect.

COPRODUCT DETERMINATION LOOPHOLE

Conventional gas drillers spread 55,517 barrels or 2331740 gallons of toxic, radioactive drilling wastewater on Pennsylvania roads between 2018, when the Department of Environmental Protection (DEP) declared the moratorium, and the end of 2020. Another arm of the agency, the Bureau of Waste Management, provides drillers the loophole that has allowed them to keep spreading the waste.

It is a program called Coproduct Determination and it allows owners of a waste product to determine whether or not it can be beneficially used in place of a commercially available product. For instance, owners of glass waste may determine that it can be used as an aggregate rather than end up in a landfill. No waste products are prohibited from inclusion in the program, however, so when the Oil and Gas Division imposed the moratorium on road spreading, some owners of drilling waste turned to the Bureau of Waste Management for the solution to their predicament. According to Oil and Gas Waste Reports from 2018 through 2020, at least 29 owners presumably determined for themselves that the wastewater was on par with commercial dust suppressants and deicers and used that as justification for continued road spreading.

The DEP defines a coproduct as "a material generated by a manufacturing or production process, or a spent material, of a physical character and chemical composition that is consistently equivalent to the physical character and chemical composition of an intentionally manufactured product or produced raw material, if the use of the material presents no greater threat of harm to human health and the environment than the use of the product or raw material."[vii]

Given that the program is one that generally operates in good faith, the Bureau of Waste Management provided no oversight after the moratorium was in effect. Waste owners are required to document the self-determinations they conduct and must provide that documentation should the Department request

it.[viii] This spring, for the first time since drillers started availing themselves of the loophole, the Bureau of Waste Management requested documents from some drillers. Pennsylvania Independent Oil and Gas Association (PIOGA) representative Burt Waite said in his remarks to the PA Grade Crude Development Advisory Council (CDAC) in August that the DEP's action has left operators 'nervous'.[ix] He did not elucidate. Self-determination documents obtained through a RTK request by the Better Path Coalition may provide some clues.

RIGHT-TO-KNOW REQUEST

WASTE OWNERS REPORTING ROAD SPREADING SINCE 2018	LAST YEAR REPORTED	AMOUNT SPREAD IN BARRELS
BOBCAT WELL & PIPELINE LLC	2018	707
CAMERON ENERGY CO	2020	269.93
CRS ENERGY LLC	2020	6944.6
DIVERSIFIED OIL & GAS LLC	2018	10410
DJR WELL SERVICES INC	2020	2322
ELDER OIL & GAS CO	2020	440.01
EMPIRE ENERGY E & P LLC	2019	405
ENERGY RESOURCES OF AMER INC	2020	4285
ENERVEST OPR LLC	2019	2458.53
G & G GAS INC	2020	168.7
GASP INVESTMENT LLC	2018	.04
GLORIA J & ROGER S WENZEL	2020	3
HEITER ROBERT & CAROL	2020	43
HOWARD DRILLING INC	2020	1860.14
JMG ENERGY LLC	2020	5313
L & B ENERGY LLP	2019	4856
LHS PROD LLC	2020	100
LT OIL CO LLC	2020	95.79
MCCOMB OIL INC	2020	675
METZLER JEFFERY A	2018	50
MILLENNIUM OIL & GAS INC	2019	182
MISSING MOON OIL INC	2019	574.1
PEMBROOKE OIL & GAS INC	2020	1096
RIVER RIDGE GRAVEL CO	2020	107.8
SAVKO JOHN A	2018	100.1
STEDMAN ENERGY INC	2020	70
VICTORY OIL & GAS CO	2018	205
VISTA OPR INC	2020	10125.57
WB PROD MGMT CO	2019	250
TOTAL BARRELS SPREAD		54397.31

BOLDFACE indicates companies' documents provided in response to RTK

In October, Ali Tarquino-Morris, Director of the Bureau of Waste Management, said in an interview that the Department had requested self-determination documents from 17 drillers.[x] On October 8, the Better Path Coalition requested copies of all of the documents the drillers had submitted.[xi] On October 18, the DEP provided eight.[xii] Seven of the self-determinations came from owners found on the list of 29 identified in Oil and Gas Waste Reports. The eighth came from Pennfield Energy, LLC, a company that last reported spreading waste on roads in 2017, prior to the moratorium.

The coalition filed an appeal to get any documents that had not yet been provided. The DEP responded on November 24 with an affidavit from Kevin Beer, Chief of the Compliance and Technical Support Section of the Division of Municipal and Residual Waste, Bureau of Waste Management. According to Beer, his office "issued letters to 16 Oil and Gas Operators starting in the Spring of 2021 seekingdocumentation supporting their Coproduct Determinations." A 17th driller spread waste on roads in New York State. Since none of the waste was spread in Pennsylvania, "no coproduct determination is necessary and documentation supporting a coproduct determination had not been sought by the department."[xiii]

Beer stated that two drillers did not provide coproduct determinations because none of their produced fluids was being used as a dust suppressant. The remaining six had not responded by the time of our request. Beer's response did not name any of the companies it referred to.

Beer and Joseph Cigan, Director, Office of Chief Council in the agency's General Law Division addressed some unanswered questions in a meeting on December 7. Beer explained that the 17 operators he contacted had reported spreading waste on roads in 2020. Pennfield, as noted above, is the exception, having not reported waste disposal by any method since 2017. Beer did not explain its inclusion on the list. He initially contacted operators the day after the waste reporting deadline in February, but expanded the list as he identified more companies that had reported road spreading.

In a follow-up email on December 8, Beer provided the names of the companies he contacted and the current status of the responses to that outreach.[xiv] The table below provides the number of barrels companies reported road spreading in 2020 and the responses Beer has received. In his affidavit, Beer refers to a company that road spread in New York only, but that was not noted on the list. According to the list of operators Beer provided, CRS Energy LLC provided a "copy of a brine wastewater disposition report covering 2018 – 2020" that was not included in the documents provided in response to the RTK. The Coalition requested a copy of that report and is awaiting a response.

Operator	Reported 2020 Road Spreading in Barrels	Response to DEP
ELDER OIL & GAS CO.	440.1	No response to date
ENERGY RESOURCES OF AMER INC	1900	No response to date
G&G GAS INC	99.63	Working on compiling info after initial contact in October 2021
HEITER ROBERT & CAROL	43	Said no brine wastewater was provided for road spreading in 2020
L&B ENERGY	36	Said no brine wastewater was provided for road spreading in 2020
LT OIL CO LLC	95.79	No response to date
PEMBROOKE OIL & GAS INC.	1096	Requested additional time in October 2021
RIVER RIDGE GRAVEL CO	58.3	No response to date
STEDMAN ENERGY INC	70	No response to date

SELF-DETERMINATIONS

Section 287.8 of the Pennsylvania Code lays out five steps a waste owner must take in making the determination that their proposed coproduct does not "present a greater threat of harm to human health and the environment" than the product it seeks to replace. The requirements are as follows:

(1) An evaluation to determine which, if any, hazardous or toxic constituents are present in the proposed coproduct at levels exceeding those found in the material it is replacing.

(2) An evaluation of the total levels of hazardous or toxic constituents, including the constituents in 40 CFR Part 261, Appendix VIII (relating to hazardous constituents) as incorporated by reference in § 261a.1 (relating to incorporation by reference, purpose and scope), to determine whether the total levels of constituents contained in the proposed coproduct exceed the total levels found in the intentionally manufactured product or produced raw material it is replacing. Based on generator knowledge, if a hazardous or toxic constituent is not present evaluation of total levels is not required.

(3) An evaluation of the levels of leaching of hazardous or toxic constituents, including the constituents in 40 CFR Part 261, Appendix VIII as incorporated by reference in § 261a.1, to determine whether the levels of leaching from the proposed coproduct exceed the levels of leaching from the manufactured product or produced raw material it is replacing. A leaching procedure shall be performed that is appropriate for the intended use of the proposed product. Based on generator knowledge, if a hazardous or toxic constituent is not present evaluation of leaching levels is not required.

(4) The routes of exposure to humans and ecological receptors shall be identified. These routes of exposure shall include ingestion, inhalation, dermal contact, leaching to the groundwater, plant uptake and surface runoff potential. Mitigating circumstances, such as protective gear worn by workers to reduce exposure during processing or application of the proposed coproduct, shall be identified.

(5) The use of a 95% upper confidence interval, using the ''Test Methods for Evaluating Solid Waste'' (EPA SW-846), may be applied to the comparisons of constituent levels between the proposed coproduct and the intentionally manufactured product or produced raw material it is replacing.[xv]

The Department provides no further guidance on how the evaluations must be conducted. For instance, the requirements do not take into account inconsistencies in waste belonging to a single owner. The contents of oil and gas wastewater are not consistent from one well to another, yet no instruction is given on how take those differences into account.

None of the eight self-determinations submitted to the DEP comes close to meeting the Section 287.8 requirements. Lacking guidance on conducting the evaluations, drillers' self-determinations are an inconsistent mess of reliance on old data, irrelevant supporting documentation, and a lack of evidence of any thorough analysis. The following are examples:

- Outdated lab analyses
    - Cameron Energy submitted lab results from 2012 and early 2013 and, for purposes of comparison, included lab reports for the commercial product, LS-25, from 2010 and 2016.
    - Howard Drilling and LHS Production LLC's 2017 lab results used in 2019 determinations were not as outdated as Cameron's, but the LS-25 reports were from 2010.
- Extraneous information
    - Cameron Energy included in its exhibits a 2015 Safety Data Sheet for LS-25
    - Burt Waite, the Pennsylvania Independent Oil & Gas Association representative who claimed drillers were 'nervous' when the DEP started requesting self-determinations, wrote determinations as an independent geologist for two companies, Howard Drilling, Inc. and LHS Production LLC. Both submissions contained variations of a couple of form letters from several townships. Although the letters have no relevance to the self-determinations, most of them provide information about where the waste can be spread, something missing from OGRE. Waite also included as an endorsement an image of a torn piece of paper listing resolutions under consideration in 2019 by the Pennsylvania State Association of Township Supervisors calling for the legislature to pass a bill requiring DEP to allow road spreading that is marked SUPPORT.
    - Pennfield Energy LLC's submission includes a copy of 25PA Code § 287.7, a copy of a 2018 Penn State study, "Environmental and Human Health Impacts of Spreading Oil and Gas Wastewater on Roads," published in *Environmental Science and Technology*, an LS-

25 Product Sheet, the same 2015 LS-25 Safety Data Sheet Cameron included, and an LS-25 Material Safety Data Sheet, for good measure.
    - Vista Resources included a copy of a letter from a township claiming to have done its own favorable determination and a resolution passed by the township approving the use of production brine on roadways.
- Too little information
    - While none of the companies did the evaluations required under Section 287.8, DJR Well Services, Inc., JMG Energy LLC, and McComb Oil, Inc. submitted nothing more than lab reports.
- Self-determinations after the fact
    - JMG Energy LLC spread waste in each of the three years since the moratorium began, but the lab report they submitted as their self-determination was dated December 30, 2019 for a sample taken on December 19, 2019.
    - Vista Resources also spread waste all three years, but their lab report was dated February 11, 2020 for a sample taken on January 30, 2020.

Dr. John Stolz, Director of Duquesne's Center for Environmental Research and Education and Professor of Microbiology in the university's Bayer School of Natural and Environmental Sciences, reviewed the self-determinations and made the following observations:

- It appears that the DEP is only concerned with Calcium, Magnesium, and Sodium Chloride (the usual make up of de-icing salt). So most of the reports are for the Ca, Mg, Na, and Cl content.
- Additional tests included bromide, potassium, pH, conductivity (an indication of Total Dissolved Solids), and specific gravity (another indication of TDS)
- When toxic metals were included, such as Arsenic and Chromium, they were below detection limits and Not Detected (ND). Closer examination of the results, however, revealed that their detection limits were set higher than the EPA Maximum Contaminate Levels for several metals. The MCL for Arsenic is 10ppb (10 ug/L). PACE's limit said 50ppb; Cadmium is 5ppb, PACE is 30ppb (JMG Energy Brine report, page 2). The EPA action level for lead is 0.015 mg/L (or 15 ppb). PACE's reporting limit for lead is 500ppb.
- Sample collection protocols were not always followed. Sample collection dates and times were missing and samples were acidified only after arriving at PACE labs (i.e., JMG energy brine)
- Samples were often diluted 100-10,000X due to the high salinity. This runs the risk of diluting some constituents below detection limits.
- Spike and recovery amounts were high. Arsenic was spiked at 500ppb.
- PACE and Microbac were the most frequently used testing companies. It looks like Modern Testing Laboratory and FREE-COL Laboratories contracted out to PACE [xvi]

OGRE AND DATA GAPS

Although the agency has provided little oversight of road spreading since the moratorium, conventional drillers are required to report the disposition of their waste annually in the Oil & Gas Division's OGRE system. Despite the halt, road spreading is still a Disposal Method waste owners can select from a menu. Without that data, no record of road spreading since 2018 would exist. Still, critically important information is missing from OGRE.

One company, River Ridge Gravel Company, spread 107.8 barrels of drilling waste between 2018 and 2020, according to its entries identifying the disposal method as road spreading, but the company listed another 60.5 barrels under the vague category, Reuse Other Than Road Spreading. The Waste Facility field for those 110 entries listed Venango County Roadspreading – Cranberry Township. Subsequent fields requesting the address and GIS coordinates of the waste facility were left blank. Later, under Waste Comment, the company entered either 'Private Road waste spreading' or simply 'Private Roads'.

The River Ridge is but one example of significant problems with the OGRE system. By far, the most significant is that database does not track anything about where or when waste was spread. Among the other reporting issues are the following:

- The Waste Facility field shows the counties and townships where the waste was spread, but no addresses are provided and the GIS coordinate fields only allow one set of submissions. Although there is no facility, per se, when the disposal site is a stretch of roadway, GIS coordinates could be used to identify more than a starting point, assuming that is what those values currently represent, if additional fields were added to OGRE to capture coordinates for an end point.
- The fields for production period start and end dates provide no clues about when the waste was spread because they all start on January 1 and end on December 31, the dates that would be more correctly labeled as the reporting period.
- Unlike unconventional drillers who are required to file monthly reports, conventional drillers file reports annually.
- The Submission Final Date field shows that some reports took more than two years to finalize. The lack of access to year-to-date information is compounded by the lag in finalizing submissions. The system provides no information about how many reports may still be pending.
- Compliance with reporting is difficult to track. Pennfield Energy LLC, the company that hasn't reported road spreading of waste since 2017 hasn't reported *any* form of waste disposal during that time. But the DEP's Oil & Gas Well Production reports from 2018 through 2020 show that the company produced 10165.66 barrels of oil. Pennfield's self-determination included lab results from 2018, which suggests they were planning to road spread some of the resulting waste.
- Some fields are populated with vague options. "Reuse other than road spreading" tells the end user nothing about the disposal method. Owners using that option also select "Reuse without processing at a permitted facility" under Waste Facility Name.

- The Waste Quantity field displays numbers, but Units are provided in the next field where barrels and tons are both options, so the end user can't tabulate amounts without sorting lists and doing multiple calculations.
- Some operators report the same quantity of waste in all or most of their entries. Cameron Energy reported .87 barrels in 2018 and 2019. In 2020, they reported .87 or .47 barrels. LT Oil entered 1.03 barrels for each of its 93 records for the three years. Millennium Oil & Gas always used 14 barrels. Missing Moon used 3, 6.7, 8.5, or 14 barrels for all of its entries. Pembrooke alternated between 1.93 and 9.83 barrels. River Ridge alternated between 0.45 and 0.53 barrels. For Savko, who reported in tons, the two values were 3.64 and 4.62. WB Prod Mgmt reported either 25 or 40 barrels. Some of the other companies use the same values a lot, but not with the same regularity.
- Some problems reported go unresolved. "This is not our well" appears for years for the same well.
- Some entries may be misclassified. Cameron Energy asked in each of its 399 entries for a total of nearly 270 barrels of waste disposed of by road spreading during 2020 in McKean County, "Why is Warren County Private Road not an option this year?" It's unclear if additional waste went unrecorded or if the McKean entries were actually the ones for neighboring Warren County.

DISCUSSION

The 2018 moratorium on road spreading may have provided some relief to those concerned about the practice's dangerous effects. By prompting conventional drillers to find a virtually unregulated alternative, however, the moratorium has made our air, water, and health less protected than they were before.

Siri Lawson's appeal to the Environmental Hearing Board came after years of experiencing adverse impacts of road spreading. The DEP's announcement of the moratorium, while viewed as a concession, effectively punctuated the Board's proceedings. Lawson's attorney, Rose Monahan of Fair Shake Environmental Legal Services, told the *Post-Gazette*, "We think spreading oil and gas wastewater contributes to air and water pollution, and we do not have a decision by the board agreeing that's true." [xvii] She'd hoped the process would close loopholes in the brine spreading approval process. As we have seen, the abrupt end of the case only opened a new loophole.

Since the moratorium went into effect, the conventional drilling industry has been vocal in expressing its dissatisfaction and its desire to see the practice permitted once again. Several of the more vocal opponents of the moratorium can be found under the heading of public participation on the DEP's website. The page provides links to two advisory committees, the Oil and Gas Technical Advisory Board (TAB) and the PA Grade Crude Development Advisory Council (CDAC).[xviii]

Both groups are heavily populated with industry representatives. The public has no representation in either group. Instead, members include the Marcellus Shale Coalition, the Pennsylvania Independent Oil

& Gas Association, the Pennsylvania Independent Petroleum Producers, the Pennsylvania Grade Crude Oil Coalition, energy companies, like Shell and CONSOL, and consulting firms, like ECHELON Applied Geoscience Consulting and another firm it lists as an affiliate, Moody & Associates.[xix] [xx] Fred Baldassare, ECHELON's owner and principle scientist, spent years at the DEP and co-authored the study that claimed that the methane found in drinking water was naturally-occurring. He told the *Patriot Times*, "It's really irresponsible for [Duke] researchers to make those gross generalizations about Marcellus gas migrating up into the aquifer system. Hopefully this paper will make people understand that a little bit better."[xxi]

Those are the advisory committees that have been pressuring the DEP and the legislature to bring back road spreading. In the 2019-2020 session, the bill that sought to reinstate road spreading was SB790.[xxii] In early 2020, the road spreading provision was cut from the bill by the House Environmental Resources and Energy Committee. This session, HB1144 would reinstate road spreading on both unpaved and paved roads. SB790 co-sponsor Senator Scott Hutchinson is the Senate majority's representative on CDAC. HB1144 prime sponsor is Representative Martin Causer, CDAC's House majority representative.

The advisory committees continue to pressure the DEP, as well. Kurt Klapkowski, Director of the Bureau of Oil and Gas Planning and Program Management responded to CDAC at its August meeting, telling them, "We have to be able to defend our decisions with data. And that was the attempt, with working with Penn State, that's what we were attempting to do was to develop that data to be able to have a program that we could go to the Environmental Hearing Board and the Commonwealth Court and Supreme Court under the constitution and under the statutes that we administer, that would be defensible. I do not think we would have any objection to working with [the Council] and the Legislature to try to figure out a way to develop that data. I think we're hopeful that the study that we funded and expect to have finished will provide data that will allow us to have a program that we can defend in court. But that's really the bottom line for us, I mean we can only exercise the authority that we're given within the limitations that we have and that's what we're attempting to do."[xxiv] The study he refers to is a PennState study that was expected to be completed by the end of the year.

The following month, TAB asked to meet with authors of a different PennState study that looked at the efficacy of road spreading with drilling wastewater and found it to be far less effective than commercial products and, in some cases, performed worse than using no treatment.[xxv]

The efficacy study contributes to a growing body of research that has already found oil and gas wastewater to pose a threat to aquatic life and human health due to its toxic, radioactive contents.[xxvi] David Hess has written extensively about road spreading in *PA Environment Digest* and provides a good summary of the research.

Decades-old problems with the management and tracking of oil and gas wastewater spread on Pennsylvania's roads have made it impossible to know where it has been spread and in what quantities. Those problems have only deepened since drillers started availing themselves of the

virtually unregulated Coproduct Determination program. Science has shown the wastewater to be a toxic soup that threatens our air, our water, aquatic life, and human health. Yet the conventional drilling industry continues to pressure elected officials and regulators to reinstate the practice on unpaved roads and allow it on paved roads too. What should happen next?

RECOMMENDATIONS

- Ban road spreading – The DEP banned road spreading of waste from unconventional wells in 2016. The ban should be extended to include all oil and gas wastewater.

  According to PIOGA, "A traditional, conventional well is usually drilled into a sandstone formation that can range from as shallow as 1,500 feet to as much as 21,000 feet deep. Oil and gas are able to pass through these formations without hydraulic fracturing, but nearly all wells are stimulated through fracturing to improve production. Conventional wells have been drilled vertically, although a few operators are experimenting with horizontal drilling techniques in conventional formations." [xxviii]

  If the drilling techniques are the same, then the rules for handling wastewater should be the same. Conventional drillers might argue that the difference is in the geology, that theirs are shallow wells drilled in sandstone layers that sit atop the shale, but geologist Paul Rubin cautions regulators to recognize the relationship between the sandstone layers and the shale rock below.

  Says Rubin, "Operating Requirements fail to consider the provenance of shales and interbedded shales and sandstones that are geologically linked and exhibit similar geochemical signatures (e.g., black shales provide hydrocarbon-rich products that migrated upward into overlying sandstone reservoirs)."[xxix]

  "Essentially, the concentrations of brine parameters in Marcellus Shale produced water that PA DEP Operating Requirements state are not applicable for road spreading are **matched or exceeded** [emphasis added] by Bradford Group produced water chemistry concentrations. Based on chemical comparison of Marcellus and Bradford Group brines, there is no chemical/water quality basis for spreading contaminant-rich oil and gas field wastewater from either group where they will flow downward and degrade vulnerable surface and groundwater resources," Rubin concludes.[xxx]

- Reclassify oil and gas wastewater as hazardous – For more than 40 years, Pennsylvania has failed to break with the federal government's classification of oil and gas wastewater as a special waste and use the authority it has to reclassify it as hazardous. In 1980, the classification exempted the special wastes from regulation under the Resource Conservation and Recovery Act (RCRA). "Specifically, the Bentsen Amendment (section 3001(b)(2)(A)) exempted drilling

fluids, produced waters, and other wastes associated with the exploration, development, and production of crude oil or natural gas or geothermal energy,"[xxxi] according to the EPA.

- Restrict wastes eligible for coproduct determination – Without the flawed OGRE system, there would be no record at all of how much wastewater has been spread on roads by conventional drillers since 2018. The Coproduct Determination program was intended to keep waste that could safely be reused from ending up in landfills, but conventional drillers did not hesitate to exploit the program when it was the one way they could legally continue to dispose of wastewater by spreading it on roads. The DEP should determine which waste products are ineligible from inclusion in the program and require oversight by the Bureau of Waste Management before and during the coproduct determination process. Regulatory programs should never operate on good faith to the degree the Coproduct Determination program has.

- Require conventional drillers to file monthly reports – The DEP should have the same reporting requirements for conventional and unconventional drillers. Reports that are pending final approval should be posted and marked Pending. Waiting months or even years for reports to be posted in OGRE is unacceptable.

- Auditor General DeFoor should audit DEP's management of oil and gas wastewater and the OGRE system - In 2014, Auditor General DePasquale concluded that the DEP was "woefully unprepared" to monitor and regulate the shale gas boom after his office's audit of the agency. The obvious mismanagement of dangerous oil and gas wastewater should prompt another audit, this time focused on conventional drilling.

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[ii] LinkedIn page of Zack Anderson
[iii] http://paenvironmentdaily.blogspot.com/2022/05/dep-advises-18-municipalities-where.html
[iv] https://files.dep.state.pa.us/OilGas/BOGM/BOGMPortalFiles/PADEP_Final_Brine_Report.pdf
[v] https://www.bayjournal.com/news/pollution/study-drilling-waste-on-pennsylvania-roads-bad-for-health-land/article_0b4c5fe8-f649-11ec-8d26-efb4693c6348.html

[vi] http://www.paenvironmentdigest.com/newsletter/default.asp?NewsletterArticleID=56180&SubjectID=
[vii] 25 PA Code § 287.1
[viii] 25 PA Code § 287.8
[ix] Letter from Better Path Coalition to DEP Secretary Patrick McDonnell and Deputy Secretary for Oil and Gas Management Scott Perry, October 8, 2021
[x] 17 Conventional Oil & Gas Drilling Operators Under Review By DEP To Determine If They Comply With Program Allowing Road Dumping Of Drilling Wastewater, David Hess, PA Environmental Digest Blog, October 8, 2021
[xi] Right-to-Know request from Better Path Coalition, October 8, 2021
[xii] Coproduct Determinations received in response to RTK
[xiii] Affadavit from Kevin Beer
[xiv] Email from Kevin Beer
[xv] Ibid. ii
[xvi] Email from Dr. John Stolz
[xvii] DEP revokes permission to dump wastewater brine from drilling on dirt roads
[xviii] https://www.dep.pa.gov/pages/search.aspx
[xix] PA Grade Crude Development Advisory Council webpage (DCED website)
[xx] Oil and Gas Technical Advisory Board webpage (DEP website)
[xxi] New study of gas drilling and ground water shows gas is often in water before drilling begins
[xxii] PA Senate Bill 790 (2019-2020)
[xxiii] PA House Bill 1144 (2021-2022)
[xxiv] Ibid. iii
[xxv] Study finds drilling wastewater not usually best option for road treatment
[xxvi] Environmental and Human Health Impacts of Spreading Oil & Gas Wastewater on Roads
[xxvii] The Science Says: Spreading Conventional Drilling Wastewater On Dirt & Gravel Roads Can Harm Aquatic Life, Poses Health Risks To Humans - And It Damages The Roads
[xxviii] PIOGA website
[xxix] Disposal of Oil & Gas Field Produced Waters: A Hydrologic Case Study of PA Brine Spreading Practice
[xxx] Ibid. xviii
[xxxi] Special Wastes, EPA webpage

EXECUTIVE SUMMARY

As directed in Governor Wolf's lapsing statement for House Bill 2644, this report provides evaluations and recommendations regarding the Pennsylvania Department of Environmental Protection's (DEP or Department) oversight of the conventional oil and gas industry in Pennsylvania.

The conventional oil and gas industry's recent record of compliance is troubling and requires DEP's Office of Oil and Gas Management (OOGM) to explore new techniques for deterring violations and encouraging compliance with relevant statutory and regulatory provisions. Over the past five years, DEP's OOGM has identified significant non-compliance with laws and regulations in the conventional oil and gas industry, particularly regarding improper abandonment of oil and gas wells, as well as reporting requirements for hydrocarbon and waste production and mechanical integrity assessments.

Wells that are improperly abandoned may pose environmental and public health and safety threats and may become the responsibility of the Commonwealth to plug along with remediation and reclamation of the well sites. The reporting non-compliance denies DEP and the public critical information about the operating status of individual wells. Overall performance is so poor among operators with 11 or more conventional oil and gas wells that the failure to report seems to be an industry-wide rule rather than the exception. A significant change in the culture of non-compliance as an acceptable norm in the conventional oil and gas industry will need to occur before meaningful improvement can happen.

Although the recent compliance trends for the conventional oil and gas industry in Pennsylvania are troubling, the good news is that – if provided adequate resources, as detailed further below – DEP possesses the authority and tools necessary to take appropriate steps to begin to address these issues without significant additional program development efforts. These tools include the use of administrative orders, permit denials, civil penalty assessments, bond forfeiture, entry and docketing of liens, criminal referrals when appropriate, and increased scrutiny of permit transfer and regulatory inactive status requests. The Department is also currently drafting two proposed rulemakings to bring Pennsylvania's regulation of the conventional oil and gas industry in line with modern standards and could initiate other rulemakings if needed. However, to effectively administer increased oversight of the conventional oil and gas industry's compliance with Pennsylvania's environmental laws, DEP will require additional resources, especially in the Office of Chief Counsel and the Bureau of District Oil and Gas Operations, particularly more field inspectors and enforcement personnel such as Compliance Specialists as well as permitting geologists.

Part 1: Evaluation of the conventional industry's recent record of compliance with reporting requirements and performance requirements under existing law.

The primary statutory provisions that apply to the conventional oil and gas industry are codified in Title 58 of the Pennsylvania Consolidated Statutes, Chapter 32 (relating to development); for shorthand, this law is often referred to as "Act 13 of 2012" or Pennsylvania's "2012 Oil and Gas Act." The primary regulations applicable to conventional oil and gas development are located in 25 Pa. Code Chapter 78 (relating to oil and gas wells). Other Pennsylvania statutes and regulations, such as the Solid Waste

Management Act, the Clean Streams Law, the Dam Safety and Encroachments Act, the Air Pollution Control Act, and regulations developed under the authority of those statutes may also apply to conventional oil and gas operations in Pennsylvania, depending on the activity being conducted.

DEP's OOGM develops and collects significant data concerning the oversight of and enforcement against the conventional oil and gas industry. In this section of this report, DEP outlines the historical compliance data for the conventional oil and gas industry over the past five calendar years, 2017 through 2021. Because calendar year 2022 is not yet complete, data from 2022 is not included in this report, but current trends suggest that the numbers for 2022 will be in line with the data from 2017 through 2021. Table 1 demonstrates that OOGM's significant inspection efforts – including more than 63,000 inspections conducted on conventional wells from 2017 through 2021 – uncovered more than 16,000 violations and that significant numbers of conventional oil and gas operators were cited for violations of the applicable statutes and regulations.

Table 1. Summary of conventional well inspections/violations from 2017 through 2021.

Calendar Year	2017	2018	2019	2020	2021	Total
Count of unique operators that had conventional wells inspected	630	627	607	615	645	1,512
Count of unique conventional wells inspected	11,888	10,447	8,919	7,692	8,780	34,812
Count of total inspections conducted on conventional wells	15,254	13,422	12,101	10,500	11,749	63,026
Count of total violations cited on conventional wells	3,286	3,072	1,784	3,957	4,469	16,568
Count of unique operators with a violation cited for conventional wells	176	158	131	239	202	503
Count of unique conventional wells with a violation cited	1,108	1,326	453	1,039	980	4,083
Percent of conventional wells inspected with violations	9.3%	12.7%	5.1%	13.5%	11.2%	11.7%
Percent of operators that had conventional wells inspected with violations	27.9%	25.2%	21.6%	38.9%	31.3%	33.3%

Of significant concern to the Department is the general lack of compliance with reporting requirements in the 2012 Oil and Gas Act and Chapter 78. Section 78.121 states:

> § 78.121. Production reporting.
>
> (a) The well operator shall submit an annual production and status report for each permitted or registered well on an individual basis, on or before February 15 of each year. When the production data is not available to the operator on a well basis, the operator shall report production on the most well-specific basis available. The annual production report must include information on the amount and type of waste produced and the method of waste disposal or

reuse. Waste information submitted to the Department in accordance with this subsection is deemed to satisfy the residual waste biennial reporting requirements of § 287.52 (relating to biennial report).

(b) The production report shall be submitted electronically to the Department through its web site.

In addition to production reporting, conventional oil and gas operators are also required to report on the mechanical integrity of their wells. The annual reporting requirement is established in subsection (e), but the entire section is included to highlight the critical nature of this information for protecting the environment and public health and safety:

§ 78.88. Mechanical integrity of operating wells.

(a) Except for wells regulated under Subchapter H (relating to underground gas storage) and wells that have been granted inactive status, the operator shall inspect each operating well at least quarterly to ensure it is in compliance with the well construction and operating requirements of this chapter and the act. The results of the inspections shall be recorded and retained by the operator for at least 5 years and be available for review by the Department and the coal owner or operator.

(b) At a minimum, inspections must determine:

(1) The well-head pressure or water level measurement.

(2) The open flow on the annulus of the production casing or the annulus pressure if the annulus is shut in.

(3) If there is evidence of gas escaping from the well and the amount escaping, using measurement or best estimate of quantity.

(4) If there is evidence of progressive corrosion, rusting or other signs of equipment deterioration.

(c) For structurally sound wells in compliance with § 78.73(c) (relating to surface and coal protective casing and cementing procedure), the operator shall follow the reporting schedule outlined in subsection (e).

(d) For wells exhibiting progressive corrosion, rusting or other signs of equipment deterioration that compromise the integrity of the well, or the well is not in compliance with § 78.73(c), the operator shall immediately notify the Department and take corrective actions to repair or replace defective equipment or casing or mitigate the excess pressure on the surface casing seat or coal protective casing seat according to the following hierarchy:

(1) The operator shall reduce the shut-in or producing back pressure on the casing seat to achieve compliance with § 78.73(c).

(2) The operator shall retrofit the well by installing production casing to reduce the pressure on the casing seat to achieve compliance with § 78.73(c). The annular space surrounding the production casing must be open to the atmosphere. The production casing shall be either

cemented to the surface or installed on a permanent packer. The operator shall notify the Department at least 7 days prior to initiating the corrective measure.

(3) Additional mechanical integrity tests, including, but not limited to, pressure tests, may be required by the Department to demonstrate the integrity of the well.

(e) The operator shall submit an annual report to the Department identifying the compliance status of each well with the mechanical integrity requirements of this section. The report shall be submitted on forms prescribed by, and available from, the Department or in a similar manner approved by the Department.

As Table 2 shows, non-compliance with sections 78.88(e) and 78.121(a) is widespread in the conventional oil and gas industry in Pennsylvania. In order to exclude home use wells (a subset of conventional wells used by homeowners or businesses for consumptive use on the property where the well is located and typically operated by non-industry persons) from this analysis, the reporting compliance analysis presented in Table 2 was limited to include only those operators with 11 or more conventional oil and gas wells. The results are consistently disappointing – only around 30% of such operators report their production or mechanical integrity assessments on time. Even including operators who do eventually submit information after the compliance date, the annual compliance rate fails to climb above 50%.

Table 2. Conventional oil and gas industry reporting non-compliance.

Production/Waste data submissions by operators with 11 or more conventional wells						
Calendar Year	**2017**	**2018**	**2019**	**2020**	**2021**	**Total**
Count of conventional well operators that submitted data by reporting deadline	194	193	177	167	172	903
Percentage of conventional well operators that submitted data by reporting deadline	**28.5%**	**28.7%**	**26.5%**	**25.3%**	**26.4%**	**27.1%**
Count of conventional well operators that submitted data but did not meet the reporting deadline	121	106	130	109	77	543
Percentage of conventional well operators that submitted data but did not meet the reporting deadline	**17.8%**	**15.8%**	**19.5%**	**16.5%**	**11.8%**	**16.3%**
Count of conventional well operators that failed to submit data	366	373	361	383	403	1,886
Percentage of conventional well operators that failed to submit data	**53.7%**	**55.5%**	**54.0%**	**58.1%**	**61.8%**	**56.6%**
Total count of conventional well operators	681	672	668	659	652	3,332
Mechanical Integrity Assessment data submissions by operators with 11 or more conventional wells						
Calendar Year	**2017**	**2018**	**2019**	**2020**	**2021**	**Total**
Count of conventional well operators that submitted data by reporting deadline	197	184	202	192	188	963
Percentage of conventional well operators that submitted data by reporting deadline	**28.9%**	**27.4%**	**30.2%**	**29.1%**	**28.8%**	**28.9%**
Count of conventional well operators that submitted data but did not meet the reporting deadline	69	82	86	76	76	389
Percentage of conventional well operators that submitted data but did not meet the reporting deadline	**10.1%**	**12.2%**	**12.9%**	**11.5%**	**11.7%**	**11.7%**
Count of conventional well operators that failed to submit data	415	406	380	391	388	1,980
Percentage of conventional well operators that failed to submit data	**60.9%**	**60.4%**	**56.9%**	**59.3%**	**59.5%**	**59.4%**
Total count of conventional well operators	681	672	668	659	652	3,332

The widespread reporting non-compliance by the conventional oil and gas industry denies DEP and the public critical information about the operating status of individual wells, the overall industry, and, in the case of mechanical integrity assessments, may pose a threat to public health and safety and the environment.

Table 3 breaks down conventional oil and gas violations from 2017 through 2021 by violation type, with a further distinction between "environmental/health/safety" and "administrative" violations. Most disturbingly, the most frequent "environmental/health/safety" violation that DEP has noted is the violation of requirements in the 2012 Oil and Gas Act and Chapter 78 for the proper abandonment of oil and gas wells. Section 3220 of the 2012 Oil and Gas Act states in relevant part (emphasis added):

> § 3220. Plugging requirements.
>
> (a) General rule.--***Upon abandoning a well, the owner or operator shall plug it in the manner prescribed by regulation of the department to stop vertical flow of fluids or gas within the well bore, unless the department has granted inactive status for the well or it has been approved by the department as an orphan well***. If the department determines that a prior owner or operator received economic benefit, other than economic benefit derived only as a landowner or from a royalty interest, after April 18, 1979, from an orphan well or an unregistered well, the owner or operator shall be responsible for plugging the well. In the case of a gas well penetrating a workable coal seam which was drilled prior to January 30, 1956, or which was permitted after that date but not plugged in accordance with this chapter, if the owner or operator or a coal operator or an agent proposes to plug the well to allow mining through it, the gas well shall be cleaned to a depth of at least 200 feet below the coal seam through which mining is proposed and, unless impracticable, to a point 200 feet below the deepest mineable coal seam. The gas well shall be plugged from that depth in accordance with section 13 of the act of December 18, 1984 (P.L.1069, No.214), known as the Coal and Gas Resource Coordination Act, and the regulations of the department.

The Department's conventional oil and gas well plugging regulations are codified in 25 Pa.Code §§ 78.91 – 78.98 and 78.111. Section 3203 of the 2012 Oil and Gas Act defines the term "abandoned well" as:

> "Abandoned well." Any of the following:
>
> (1) A well:
>
> (i) that has not been used to produce, extract or inject any gas, petroleum or other liquid within the preceding 12 months;
>
> (ii) for which equipment necessary for production, extraction or injection has been removed; or
>
> (iii) considered dry and not equipped for production within 60 days after drilling, redrilling or deepening.
>
> (2) The term does not include wells granted inactive status.

This definition also highlights the importance of the production reporting violations, noted above. Without accurate production reporting, DEP cannot determine if a well has been "used to produce, extract or inject and gas, petroleum or other liquid within the preceding 12 months." If a well is not so used, it is defined as abandoned and must be plugged.

Proper plugging of conventional oil and gas wells at the end of their economic life is critical for protecting public health and safety as well as the environment. Unplugged or improperly plugged wells can cause a myriad of problems, including gas migration into occupied structures, water supply impacts, surface water impacts, hazardous air pollutant emissions, methane emissions, and soil and groundwater contamination. Improperly plugged wells have been tied to fatal explosions in Pennsylvania and other states, so this is a category of potentially significant violations.

Failure to properly plug an abandoned well also means that the task of properly plugging the abandoned well might fall to the Commonwealth – "the plugger of last resort" – with the costs to do so passed along to Pennsylvania taxpayers. The issue of plugging obligations passing to the Commonwealth is especially critical for wells abandoned today but drilled before April 15, 1985, as these wells have no bonds that could be forfeited to cover at least a portion of the cost of plugging them (*see*, Act 57 of 1997, the original waiver through Administrative Code amendments of bonding requirements for such oil and gas wells; Act 87 of 2012, Fiscal Code amendments that retained the provisions of Act 57 of 1997; and Act 96 of 2022, which amended the 2012 Oil and Gas Act to continue this waiver).

Other frequent violations include improper management of residual wastes and failure to properly manage production fluids. Both violations can be directly related to environmental harm, impacts to drinking water supplies and potential threats to public health and safety.

Table 3. Ten most frequent environmental/health/safety (EHS) and administrative violations associated with conventional wells for calendar years 2017 through 2021.

Violation Code	Violation Type	Count
OGA3220(A) - PLUGGING REQUIREMENTS - Failure to plug the well upon abandoning it.	EHS	3,123
SWMA 301 - MANAGEMENT OF RESIDUAL WASTE - Person operated a residual waste processing or disposal facility without obtaining a permit for such facility from DEP. Person stored, transported, processed, or disposed of residual waste inconsistent with or unauthorized by the rules and regulations of DEP.	EHS	608
78.57(a) - CONTROL, STORAGE AND DISPOSAL OF PRODUCTION FLUIDS - Operator failed to collect the brine and other fluids produced during operation, service and plugging of the well in a tank, pit or a series of pits or tanks, or other device approved by the Department or Operator discharged brine or other fluids on or into the ground or into waters of the Commonwealth.	EHS	551
78.54 - GENERAL REQUIREMENTS - Operator failed to control and dispose of fluids, residual waste and drill cuttings, including tophole water, brines, drilling fluids, drilling muds, stimulation fluids, well servicing fluids, oil, and production fluids in a manner that prevents pollution of the waters of the Commonwealth.	EHS	359
78.73(a) - GENERAL PROVISION FOR WELL CONSTRUCTION AND OPERATION - Operator failed to construct and operate the well in accordance with 25 Pa. Code Chapter 78 and ensure that the integrity of the well is maintained and health, safety, environment and property are protected.	EHS	262
SWMA 610(1) - UNLAWFUL CONDUCT - Person dumped or deposited, or permitted the dumping or depositing, of solid waste onto the surface of the ground or underground or into the waters of the Commonwealth, without a permit for the dumping of such solid wastes from DEP.	EHS	228
78.91(a) - PLUGGING - GENERAL PROVISIONS - Upon abandoning a well, the owner or operator failed to plug the well to stop the vertical flow of fluids or gas within the well bore under 25 Pa. Code §§ 78.92—78.98 or an approved alternate method.	EHS	217
SWMA 302(A) - DISPOSAL, PROCESSING AND STORAGE OF RESIDUAL WASTE - Person disposed, processed, stored, or permitted the disposal, processing or storage of residual waste in a manner which is contrary to the rules and regulations of DEP or to any permit or to the terms or conditions of any permit or any order issued by DEP.	EHS	217
OGA3259(1) - UNLAWFUL CONDUCT - Drilling, altering or operating a well without a permit. Failure to comply with rules or regulations adopted under the 2012 Oil and Gas Act, DEP order, or a term or condition of the well permit.	EHS	216
102.4(b)1 - EROSION AND SEDIMENT CONTROL REQUIREMENTS - Person conducting earth disturbance activity failed to implement and maintain E & S BMPs to minimize the potential for accelerated erosion and sedimentation.	EHS	197
Total	EHS	**5,978**
78.121(A) - WELL REPORTING – PRODUCTION REPORTING – Conventional operator failed to submit annual conventional production and status report for permitted or registered well.	Admin	1,827
78.88(e) - OPERATING WELLS - MECHANICAL INTEGRITY OF OPERATING WELLS - Operator failed to submit an annual report to the Department identifying the compliance status of each well with the mechanical integrity requirements for structurally sound wells in compliance with 25 Pa. Code Section 78.73(c).	Admin	1,773
OGA3211(H) - WELL PERMITS - LABELING - Failure to install, in a permanent manner, the permit number on a completed well.	Admin	1,674
OGA3211(G) - WELL PERMITS - POSTING - Failure to post the well permit number and the operator's name, address and phone number at the well site during construction of the access road, site preparation and during drilling, operating or alteration of well.	Admin	831
78.121(B) - WELL REPORTING – PRODUCTION REPORTING – Operator failed to electronically submit production and status report to the Department through its web site.	Admin	722
78.88(a) - OPERATING WELLS - MECHANICAL INTEGRITY OF OPERATING WELLS - Operator failed to inspect each operating well quarterly for compliance with the well construction and operating requirements.	Admin	500
78.88(A) - OPERATING WELLS - MECHANICAL INTEGRITY OF OPERATING WELLS - Operator failed to record inspection results and retain records for at least 5 years for review by the Department.	Admin	141
78.122(A) - WELL REPORTING – WELL RECORD – Operator failed to keep a detailed drillers log at well site or submit a complete well record, on a form provided by the Department, within 30 days of cessation of drilling or altering.	Admin	60
78.124(A) - WELL REPORTING – CERTIFICATE OF PLUGGING – Owner or Operator failed to submit a certificate of plugging to the Department and each coal operator, lessee or owner who was sent notice, by certified mail, of intent to plug, within 30 days after well has been plugged.	Admin	55
102.4(b)8 - EROSION AND SEDIMENT CONTROL REQUIREMENTS – E & S plan, inspection reports and monitoring records were not available at the project site during all stages of earth disturbance activity.	Admin	54
Total	Admin	**7,637**

In response to this non-compliance, the Department has undertaken significant efforts to force compliance or penalize operators for their non-compliance. Over $1.3 million in penalties were collected from conventional oil and gas operators over the five-year period and 44 administrative orders were issued or consented to.

Of particular note in Table 4 are the rows indicating eight Petitions to Enforce and five Petitions for Contempt filed by the Department. Petitions to Enforce represent DEP's efforts to request that courts enforce DEP orders that have not been complied with while Petitions for Contempt represent DEP's efforts to have courts enforce their own court orders that have not been complied with. All enforcement actions require dedication of resources, but filing such Petitions is a significant undertaking for the Department and involve extensive counsel and enforcement staff effort and resources. In the case of a Petition for Contempt, the Department is dealing with an operator who has:

1. Violated a provision of the statute or regulations;
2. Not corrected the violation in response to receiving a Notice of Violation;
3. Was issued an administrative order to correct the violations;
4. Not complied with the administrative order;
5. Was subject to a Department Petition to Enforce filed with an appropriate court, and ordered to comply by that court;
6. Not complied with the order of that court to correct the violation; and,
7. Is subject to a Petition for Contempt to enforce the court's order.

Table 4. Summary of enforcement actions from 2017 through 2021 that were associated with conventional wells violations.

Count by Enforcement Type	2017		2018		2019		2020		2021		Grand Total	
	Count of Enforcements	Total Penalty Collected	Count of Enforcements	Total Penalty Collected	Count of Enforcements	Total Penalty Collected	Count of Enforcements	Total Penalty Collected	Count of Enforcements	Total Penalty Collected	Total Enforcements	Total Penalty Collected
ADORD - Administrative Order	4		13		3		4		3		27	**$0**
BDFT - Bond Forfeiture	1	$25,000							1	$25,163	2	**$50,163**
CACP - Consent Assessment of Civil Penalty	16	$503,490	18	$195,178	8	$121,050	9	$269,589	7	$34,783	58	**$1,124,090**
CDEC - Consent Decree					1						1	**$0**
CMPOR - Compliance Order	3		6		2		2		1		14	**$0**
COA - Consent Order and Agreement	5	$16,300	3		5	$85,900	2		2		17	**$102,200**
CPA - Civil Penalty Assessment			1	$70,000	2						3	**$70,000**
CTORD - Court Order	3	$5,000	3		9		2				17	**$5,000**
EHBO - Environmental Hearing Board Order					1	$1,950					1	**$1,950**
NOV - Notice of Violation	228		207		136		304		264		1,139	**$0**
PTCON - Petition for Contempt	3				1		1				5	**$0**
PTNEN - Petition to Enforce	2		5		1						8	**$0**
VIOIN - Violation Inquiry							1				1	**$0**
Grand Total	**265**	**$549,790**	**256**	**$265,178**	**169**	**$208,900**	**325**	**$269,589**	**278**	**$59,946**	**1,293**	**$1,353,403**

Part 2: Evaluation of using existing authority, including increased exercise of civil penalty authority and forfeiting conventional oil and gas well bonds and requiring submission of replacement bonds, as methods to deter and motivate conventional operators to address abandoned wells and violations of the applicable law.

Clearly, there is significant non-compliance with relevant laws in the conventional oil and gas industry in Pennsylvania. The bad news is that the resources and enforcement tools and techniques available to the Department have not made an appreciable dent in compliance rates and numbers over the past five years. The good news is that with some additional resources, streamlined processes, and focused efforts, the Department's existing tools might be used in a way that will provide effective deterrence from non-compliance by the conventional oil and gas industry. However, a significant change in the culture of non-compliance as an acceptable norm in the conventional oil and gas industry will need to occur before meaningful improvement can happen.

In January 2015, the Department adopted an update to the technical guidance document titled, "Standards and Guidelines for Identifying, Tracking, and Resolving Oil and Gas Violations" (Enforcement Policy). This guidance document provides direction to DEP staff in following a consistent approach to identifying, tracking, and resolving violations of laws applicable to the oil and gas industry in Pennsylvania. This includes direction on determining appropriate actions to resolve violations, including enforcement, and to bring about compliance. This Enforcement Policy also provides the regulated industry and the public with information on the Department's approach to ensuring compliance with the law. All the recommendations in this report are well within the processes and boundaries established by the Enforcement Policy, so DEP is not recommending any specific changes to the Enforcement Policy at this time.

Administrative Orders to Plug Improperly Abandoned Wells

First, an administrative order is a basic and important enforcement tool for the Department to obtain compliance with the Commonwealth's statutes and regulations, particularly relating to improper abandonment of an oil or gas well. The Department recommends that OOGM should work with DEP's Office of Chief Counsel to develop "template" administrative orders requiring plugging of a well within a defined timeframe along with direction that such orders be issued whenever an OOGM inspector issues a Notice of Violation for failure to properly abandon and plug a well. Doing upfront work to prepare a "base" order that can be used with minimal review time should allow for these documents to be moved through internal review processes relatively efficiently. Given the significant potential for threats from abandoned, unplugged wells to the environment and public health and safety, as well as the potential fiscal impacts to the Commonwealth's taxpayers, this appears to be a prudent step for the Department to take in these cases. Finally, as discussed below, when there are violations of administrative orders, the Department is granted the authority to deny additional well permits under section 3211(e.1) and block permit transfers under sections 3211(k) and 3223 of the 2012 Oil and Gas Act.

Bond Forfeiture

Second, bond forfeiture is another enforcement tool available to the Department. As noted above, due to the adoption of Act 57 of 1997, a significant number of active conventional oil and gas wells are not subject to ***any*** bonding requirements. These are conventional wells drilled prior to April 18, 1985 and make up around 60% of the active conventional wells in Pennsylvania. Even those conventional oil and gas wells that are subject the bonding requirements in section 3225 of the 2012 Oil and Gas Act only have a maximum bond of $25,000 for all conventional oil and gas wells in Pennsylvania.

Forfeiture of bonds is available as a compliance and enforcement measure, but involves significant expenditure of limited legal resources. Historically, DEP has generally not forfeited bonds due to the relatively small amount of money in question. In the last three years, however, OOGM has moved to forfeit bonds when conventional oil and gas wells are improperly abandoned. These steps have not resulted in a noticeable improvement in conventional oil and gas operator compliance rates, but, when used in conjunction with the other tools outlined in this report, may begin to address the underlying culture of improper well abandonment. Section 3225(c) of the 2012 Oil and Gas Act states, in relevant part (emphasis added):

> (a) General rule.--The following shall apply:
>
> (1) Except as provided in subsection (d), upon filing an application for a well permit and before continuing to operate an oil or gas well, the owner or operator of the well shall file with the department a bond covering the well and well site on a form to be prescribed and furnished by the department. ***A bond filed with an application for a well permit shall be payable to the Commonwealth and conditioned upon the operator's faithful performance of all drilling, water supply replacement, restoration and plugging requirements of this chapter***…
>
> * * * * * *
>
> (c) Noncompliance.--***If a well owner or operator fails or refuses to comply with subsection (a), regulations promulgated under this chapter or conditions of a permit relating to this chapter, the department may declare the bond forfeited*** and shall certify the same to the Attorney General, who shall proceed to enforce and collect the full amount of the bond and, if the well owner or operator has deposited cash or securities as collateral in lieu of a corporate surety, the department shall declare the collateral forfeited and direct the State Treasurer to pay the full amount of the funds into the Well Plugging Restricted Revenue Account or to sell the security to the extent forfeited and pay the proceeds into the Well Plugging Restricted Revenue Account. If a corporate surety or financial institution fails to pay a forfeited bond promptly and in full, the corporate surety or financial institution shall be disqualified from writing further bonds under this chapter or any other environmental law administered by the department. A person aggrieved by reason of forfeiting the bond or converting collateral, as provided in this section, shall have a right to appeal to the Environmental Hearing Board in the manner provided by law. Upon forfeiture of a blanket bond for a violation occurring at one or more well sites, the person whose bond is forfeited shall, within ten days of the forfeiture, submit a replacement bond to cover all other wells of which the person is an owner or operator. Failure

to submit the replacement bond constitutes a violation of this section as to each of the wells owned or operated by the person.

Regarding bond forfeiture, the Enforcement Policy states (emphasis added):

> Bond Forfeiture
>
> Depending on the circumstances, ***the Department will normally initiate bond forfeiture at the same time that it issues an administrative order*** or files a court action, or only after attempts at other enforcement actions have been pursued.
>
> The District Program Manager will prepare and forward to the Bureau Director a recommendation to forfeit an operator's bond. The recommendation should include a summary of events in the history of enforcement actions leading to the decision. The District Office will prepare the Forfeiture Order and should require a replacement bond be submitted within 10 calendar days of the date the bond is declared forfeited to cover all wells under the forfeited bond.
>
> If the operator does not appeal the bond forfeiture action to the EHB, or after an operator's appeal is dismissed, the Bureau Director will notify DEP's Division of Certification, Licensing, and Bonding to proceed with collecting the bond.

The Department recommends that OOGM work with the Office of Chief Counsel to develop a template "Notice of Intent to Forfeit" letter to be issued to operators at the same time that the Department issues the template administrative order to properly plug abandoned wells; this letter commences the bond forfeiture process. The Department will need sufficient resources to carry the process to its conclusion, forfeiting the bond and requiring replacement as a condition of continued operation of conventional oil and gas wells. For other violations, the Department recommends continuing to follow the standard approach outlined in the Enforcement Policy outlined above.

Civil Penalty Assessments

Third, OOGM should work with DEP's Office of Chief Counsel to develop a standard assessment of civil penalties for violations relating to improper abandonment of conventional oil and gas wells. Assessment and collection of civil penalties for violations can provide a significant deterrence effect if they are used consistently for significant violations such as improper abandonment. Section 3256 of the 2012 Oil and Gas Act establishes the Department's authority to assess civil penalties against conventional oil and gas operators, and states, in relevant part (emphasis added):

> § 3256. Civil penalties.
> ***In addition to other remedies available at law or in equity for a violation of this chapter, a regulation of the department, a departmental order or a permit condition, the department, after a hearing, may assess a civil penalty regardless of whether the violation was willful. The penalty shall not exceed $25,000 plus $1,000 for each day during which the violation continues*** or, in the case of a violation arising from the construction, alteration or operation of an unconventional well, $75,000 plus $5,000 for each day during which the violation continues.

> ***In determining the amount, the department shall consider willfulness of the violation, damage or injury to natural resources of this Commonwealth or their uses, endangerment of safety of others, the cost of remedying the harm, savings resulting to the violator as a result of the violation and any other relevant factor***. When the department proposes to assess a civil penalty, it shall notify the person of the proposed amount of the penalty. The person charged with the penalty must, within 30 days of notification, pay the proposed penalty in full or file an appeal of the assessment with the Environmental Hearing Board…

Within the context of section 3256 of the 2012 Oil and Gas Act and appropriate policies, the Department should consider more routine assessments of civil penalties against conventional oil and gas operators, particularly for improper abandonment.

Liens

Fourth, in addition to the direct deterrence impact of civil penalty assessments, failure to pay such assessments or appeal to the Environmental Hearing Board also gives the Commonwealth the ability to enter and docket liens. Section 3256 of the 2012 Oil and Gas Act states, in relevant part (emphasis added):

> Failure to comply with the time period under this section shall result in a waiver of all legal rights to contest the violation or the amount of the penalty. The civil penalty shall be payable to the Commonwealth and collectible in any manner provided at law for collection of debts. ***If a violator neglects or refuses to pay the penalty after demand, the amount, together with interest and costs that may accrue, shall become a lien in favor of the Commonwealth on the real and personal property of the violator, but only after the lien has been entered and docketed of record by the prothonotary of the county where the property is situated. The department may transmit to the prothonotaries of the various counties certified copies of all liens. It shall be the duty of each prothonotary to enter and docket the liens of record in the prothonotary's office and index them as judgments are indexed, without requiring payment of costs as a condition precedent to entry***.

Regarding liens, the Enforcement Policy states:

> Lien
>
> In general, liens are filed by DEP attorneys assigned to the particular District, or in Central Office. Liens are filed for final penalty assessments or Court judgments which are unpaid. In some cases, liens are filed as part of a negotiated settlement, and are documented in a CO&A or Consent Decree. In all cases, liens are filed in a Pennsylvania County Court of Common Pleas, and in any other state as appropriate.
>
> Section 3256 of the Oil and Gas Act establishes a procedure for imposing liens. DEP's Office of Chief Counsel should be consulted in this process.

OOGM should work with the DEP Office of Chief Counsel to ensure that the Department routinely enters and dockets liens on the real and personal property of conventional oil and gas operators when valid civil penalty assessments are not paid.

Criminal Referrals

Finally, the Department can refer oil and gas operators to the Office of Attorney General or a county District Attorney for criminal enforcement. In addition to other statutory provisions relating to criminal penalties such as the Solid Waste Management Act and the Clean Streams Law, section 3255 of the 2012 Oil and Gas Act contains the following language:

> § 3255. Penalties.
>
> (a) General violation.--A person violating a provision of this chapter commits a summary offense and, upon conviction, shall be sentenced to pay a fine of not more than $1,000 or to imprisonment of not more than 90 days, or both. Each day during which the violation continues is a separate and distinct offense.
>
> (b) Willful violation.--A person willfully violating a provision of this chapter or an order of the department issued under this chapter commits a misdemeanor and, upon conviction, shall be sentenced to pay a fine of not more than $5,000 or to imprisonment of not more than one year, or both. Each day during which the violation continues is a separate and distinct offense.
>
> (c) Authority.--The department may institute a prosecution against any person or municipality for a violation of this chapter.

Regarding criminal referrals, the Enforcement Policy states:

> K. Criminal Action
>
> The Department will consider referring violations that meet the requirements of the procedures established with the Office of Attorney General for criminal investigation and prosecution. Criminal referrals require the highest degree of confidentiality and are made through the Office of Chief Counsel.

The Department recommends that OOGM should continue to review enforcement cases with the DEP Office of Chief Counsel and consider referral of appropriate cases to the Office of Attorney General for criminal prosecution under the environmental statutes.

Part 3: Recommendations for increased scrutiny of conventional oil and gas operators' requests for regulatory inactive status approval, permit transfers and new applications for permits to drill and operate a well.

In addition to taking enforcement actions to require correction of non-compliance and deter future violations, the Department also engages in several administrative functions that may lessen the likelihood of operators improperly abandoning non-economic oil and gas wells. Primarily, these

functions concern conventional oil and gas well permit transfers from better- to lesser-capitalized entities, and review and approval of regulatory inactive status requests, which enable operators to cease producing wells without plugging them and reclaiming the well site. In addition, the Department has the authority to deny new permits for non-compliance with final actions or issue permit suspension and revocation orders in particular cases.

Permit Transfers

Permit transfers are a routine and appropriate part of conducting business in the conventional oil and gas industry and the Department's oversight of the industry. Regarding permit transfers, several provisions of the 2012 Oil and Gas Act control this practice. First, section 3211(k) states:

> (k) No transfer permitted.--No permit issued under this section or registration issued under section 3213 (relating to well registration and identification) may be transferred without prior approval of the department. A request for approval of a transfer shall be on the forms, and in the manner, prescribed by the department. The department shall approve or deny a transfer request within 45 days of receipt of a complete and accurate application. The department may deny a request only for reasons set forth in subsection (e.1)(4) and (5). Approval of a transfer request shall permanently transfer responsibility to plug the well under section 3220 to the recipient of the transferred permit or registration.

There are several important provisions in this subsection. First, the statute makes it clear that a permit transfer is only effective if approved by the Department. Second, on its face, this subsection appears to limit the Department's consideration of the transfer to the reasons set forth in subsection 3211(e.1)(4) and (5); those paragraphs state:

> (e.1) Denial of permit.--The department may deny a permit for any of the following reasons:
>
> * * * * * *
>
> (4) The requirements of section 3225 (relating to bonding) have not been met.
>
> (5) The department finds that the applicant, or any parent or subsidiary corporation of the applicant, is in continuing violation of this chapter, any other statute administered by the department, any regulation promulgated under this chapter or a statute administered by the department or any plan approval, permit or order of the department, unless the violation is being corrected to the satisfaction of the department. The right of the department to deny a permit under this paragraph shall not take effect until the department has taken a final action on the violations and:
>
> (i) the applicant has not appealed the final action in accordance with the act of July 13, 1988 (P.L.530, No.94), known as the Environmental Hearing Board Act; or
>
> (ii) if an appeal has been filed, no supersedeas has been issued.

Therefore, the only grounds for the Department to deny a permit transfer are inadequate bonding under section 3225 and failure to comply with a final action of the Department, which includes an

administrative order. By routinely issuing administrative orders requiring plugging when improper abandonment of a conventional oil and gas well occurs, the Department will either: (1) obtain compliance with the plugging and reclamation requirements; or (2) be entitled to block the transfer of permits from the violator to a third party.

This second piece is particularly critical given the final sentence of section 3211(k), as well as section 3223 of the 2012 Oil and Gas Act, which together transfer the obligation to plug the well under section 3220 to the third-party transferee. Operators should not be entitled to benefit from their non-compliance and avoid their plugging obligation through a permit transfer. Although the tools in the 2012 Oil and Gas Act available to the Department regarding permit transfers are limited, issuing administrative orders to plug wells will allow the Department to exercise its authority to deny permit transfers if the plugging order has not resulted in compliance.

Finally, the Department recommends that OOGM "revamp" its transfer application forms. When an operator requests to transfer permits, it is an appropriate time for the Department to gather useful information that would be critical later if the wells are improperly abandoned. This information should include operating agreements and identification of well owners and corporate structures so that OOGM can identify who actually controls and/or manages the wells in question.

Inactive Status

As noted above, section 3220 allows an operator of a conventional oil and gas well to avoid responsibility for plugging a well even if the well is not producing so long as the Department grants inactive status approval to the operator. While inactive status approval can be reasonable in certain circumstances, such as fluctuations in commodity prices, it should not be used as a means of delaying proper plugging until the operator can transfer the well or otherwise avoid their plugging responsibilities. Section 3214 of the 2012 Oil and Gas Act and the Department's regulations in 25 Pa. Code §§ 78.101 – 78.105 govern the standards to qualify a well for inactive status and the operator's ongoing responsibilities regarding the well while it is in inactive status. Of particular importance to qualification for inactive status and this discussion, section 3214(a)(3) states:

> § 3214. Inactive status.
>
> (a) General rule.--Upon application, the department shall grant inactive status for a period of five years for a permitted or registered well, if the following requirements are met:
>
> * * * * * *
>
> (3) the operator anticipates construction of a pipeline or future use of the well for primary or enhanced recovery, gas storage, approved disposal or other appropriate uses related to oil and gas well production…

Section 78.102(4) of the Department's regulations states:

> § 78.102. Criteria for approval of inactive status.
>
> To obtain inactive status, the applicant shall affirmatively demonstrate to the Department's satisfaction that:
>
> * * * * * *
>
> (4) The applicant shall certify that the well is of future utility and shall ***present a viable plan for utilizing the well within a reasonable time***. In addition to providing information to demonstrate compliance with paragraphs (1) and (2), the application for inactive status shall include the following:
>
> (i) ***A plan showing when the well will be used***.
>
> (ii) A certification identifying that one of the following applies:
>
> (A) Significant reserves remain in place and the operator plans to produce the well.
>
> (B) The well will be used as a disposal well.
>
> (C) The well will be used as a storage well.
>
> (D) The well will be used as an observation well.
>
> (E) The well will be used as a secondary or tertiary recovery injection well or that the well will be used for other purposes specified by the applicant.
>
> (iii) Other information necessary for the Department to make a determination on inactive status.

In the past, the Department was not as aggressive in requiring detailed plans to be submitted by conventional oil and gas operators demonstrating the future utility of the well in detail, relying instead on certifications of future utility made by the operator. Table 5 outlines the number of regulatory inactive status requests approved by the Department since 2017.

Table 5. Count of conventional well inactive status requests approved each calendar year by District.

Year	2017	2018	2019	2020	2021	Total
Eastern District Office	0	9	5	2	6	22
Northwest District Office	58	31	3	3	3	98
Southwest District Office	15	0	31	1	1	48
Total	73	40	39	6	10	168

In 2018, the Department updated its Inactive Status request form. One of the changes to the form was to require additional data and plans relating to the future utility of the well, which is critical for separating legitimate inactive status applications from attempts to defer plugging responsibilities. The Department should continue to request this information from inactive status applicants and only grant inactive status applications where the operator has met the burden of proving future utility.

Permit Denial

As noted above, section 3211(e.1) of the 2012 Oil and Gas Act establishes conditions under which the Department may deny a permit application to drill or operate a conventional well. As noted in the Permit Transfer discussion above, issuing administrative orders to plug wells will allow the Department to exercise its authority to deny new well permit applications if the plugging order has not resulted in compliance. Operators should not be entitled to benefit from their non-compliance and still obtain permits to drill new wells. The Department should consider issuing plugging orders when improper abandonment occurs, and base denials of new well permit applications if the plugging orders do not result in compliance to the satisfaction of the Department.

Permit Suspension or Revocation

Permit suspension or revocation is authorized under section 3253(b) of the 2012 Oil and Gas Act, which states:

> (b) Suspension and revocation.--
>
> (1) The department may suspend or revoke a well permit or well registration for any well:
>
> (i) in continuing violation of any of the following:
>
> (A) This chapter.
>
> (B) The act of June 22, 1937 (P.L.1987, No.394), known as The Clean Streams Law.
>
> (C) The act of July 7, 1980 (P.L.380, No.97), known as the Solid Waste Management Act.
>
> (D) Any other statute administered by the department; and
>
> (ii) the likely result of a violation is an unsafe operation or environmental damage.

The Enforcement Policy discusses when it might be appropriate for a well permit to be suspended or revoked by OOGM staff:

> E. Suspension or Revocation of Permit or Registration
>
> Suspension or revocation of a permit or registration is accomplished by an order of the Department. The Oil and Gas Act establishes procedures for the Department to follow before issuing the suspension or revocation order (58 Pa. C.S. § 3253). This involves (1) notifying a well operator explaining the reasons for the action, using citations to specific statutory provisions, regulations or other reasons, and including the relevant facts, and (2) providing an opportunity for a conference.
>
> A permit suspension is the temporary withdrawal of the privilege to conduct an activity under a specific permit or registration. The suspension may be for a fixed period of time or indefinitely until the Department is satisfied with progress towards compliance or resolution of the violation(s). A permit suspension would be issued to temporarily halt activity where a permit was based on erroneous, correctible information or where a well or other facility is causing a

condition that can be remedied. Failure to comply after permit suspension could result in revocation of the permit. A suspension order terminates automatically once the violation is corrected to the Department's satisfaction, upon written confirmation by the Department following notice by the operator.

A permit revocation is the permanent termination of the privilege to conduct an activity under a specific permit or registration. A revoked permit or registration should not be reinstated using the original application materials. A new application would be required.

Revoking a permit or registration is an action of last resort where a well or other facility is malfunctioning or incapable of being repaired, or the permit or registration was based on false or deficient information that cannot be remedied, or the operator displays a lack of intention or ability to comply with the law.

Although not appropriate for all violations, the Department should consider moving to suspend or revoke operating permits and order wells to be plugged if the conditions of section 3253(b) are met.

Part 4: Recommendations for regulatory reform to comprehensively regulate conventional drilling according to modern best practices and industry standards.

There are several reforms that can be undertaken to regulate the conventional oil and gas industry in Pennsylvania according to modern practices.

Surface Activities Rulemakings

First, the Department currently has two proposed rulemakings in the process of development that would primarily address surface activities at conventional oil and gas well sites. These two rulemakings propose to amend Chapter 78 to update the environmental protection performance standards related to oil and gas activities (i.e., environmental protection and waste management). The purpose of these rulemakings is to update the performance standards for surface activities at conventional well sites to ensure that these activities are conducted in a manner that protects the health, safety, and environment and property of Pennsylvania citizens consistent with the environmental laws that provide authority for these rulemakings and the Pennsylvania Constitution. These rulemakings represent the first updates to rules governing surface activities associated with the development of conventional oil and gas wells in Pennsylvania since 2001.

Major areas of the proposed environmental protection standards rulemaking include public resource impact screening and water supply replacement standards (including pre-drill surveys). Other parts of the environmental protection standards rulemaking will include standards for well development impoundments, site restoration, borrow pits, underground injection control well permitting, and well development (fresh or otherwise approved water) impoundments.

Major areas of the proposed waste management rulemaking include: waste management and disposal (including a process for the closure or waste permitting for wastewater impoundments and onsite wastewater processing); establishing requirements for identification, select monitoring, and

remediation of wells proximal to hydraulic fracturing activities (area of review); and standards for reporting and remediating spills and releases. The Department anticipates this proposed rulemaking will be silent as to the practice of roadspreading of conventional oil and gas well brine, but that practice could potentially be addressed through this rulemaking.

Since 2016, OOGM has worked with Pennsylvania Grade Crude Development Advisory Council (CDAC) on potential legislation and proposed regulations relating to conventional oil and gas wells. Specifically, OOGM staff discussed proposed rulemaking concepts at several CDAC meetings throughout 2016, 2017 and 2018. In April 2018, program staff and CDAC members met at the DEP Moshannon District Mining Office and developed a scoping document outlining where agreement could be reached on potential legislative or regulatory language.

In 2018 and 2019, program efforts on this issue centered more directly on legislative language with the hope that regulatory development could commence once the proposed Conventional Oil and Gas Wells Act ("COGWA") passed. Those discussions reached an impasse and Governor Wolf vetoed COGWA/Senate Bill 790 on November 25, 2020.

Given the lack of progress on COGWA, the Department restarted the rulemaking process to address these issues in 2020. OOGM staff discussed the proposed regulations at CDAC meetings throughout 2020 and 2021 and at meetings of the Department's Oil and Gas Technical Advisory Board (TAB) in 2020, 2021, and 2022. The proposed environmental protection standards rulemaking was the primary focus of the April 2022 CDAC meeting and the May 2022 TAB meeting. CDAC vigorously opposed adoption of the majority of the environmental protection standards rulemaking and adopted a report detailing CDAC's concerns with the proposed rulemaking. The proposed waste management rulemaking will be considered in detail by CDAC and TAB in 2023. The Department should continue to move these proposed rulemakings forward to the Environmental Quality Board (EQB) for consideration and public comment.

Subsurface Activities Rulemakings

There are several rulemakings addressing well plugging and construction/operation issues that the Department could develop. Pennsylvania's plugging regulations have not been updated since 1994. Conventional industry representatives have called out conflicts between the Coal and Gas Coordination Act and Act 13 of 2012 in terms of plugging requirements. The well construction and operation regulations were last updated in early 2011, and the Department now has more than a decade's experience in implementing those regulations. The five general categories of proposed changes to the subsurface regulations include:

– Regulations that were not modified substantively as part of the 2011 rulemaking (e.g., well plugging)

– Subjects that have not historically been addressed through rulemaking (e.g., coalbed methane wells)

– Minor modification/clarification regarding sections that were changed substantively in the 2011 rulemaking

– Consistency between chapters (e.g., discrepancies between Chapter 78 and Chapter 79)

– New/substantively enhanced subjects associated with field data analysis and observation

Bonding

As for conventional oil and gas well bonding, the General Assembly, as noted above, has significantly limited the EQB's authority to change bond amounts for conventional wells drilled after April 18, 1985 or even require bonds for wells drilled before that date. There might be other avenues to make improvements to Department programs designed to reduce future orphaned well burdens, such as alternative funding mechanisms for orphaned well programs to protect taxpayers from assuming additional liabilities, and reforms to programs relating to well transfer or temporary abandonment, as noted above. The Department should compile information regarding how other states approach these issues and make recommendations for any reasonable legislative or regulatory changes that might assist in avoiding improper abandonment.

Conclusion

The conventional oil and gas industry's recent record of compliance with Pennsylvania law is simply not good, particularly with regard to improper abandonment of wells. This record of non-compliance will require DEP to further develop and refine its techniques for deterring violations and encouraging compliance with relevant statutory and regulatory provisions. A significant change in the culture of non-compliance as an acceptable norm in the conventional oil and gas industry will need to occur before meaningful improvement can happen.

Wells that are improperly abandoned may pose environmental and public health and safety threats and may become the responsibility of the Commonwealth to plug along with remediation and reclamation of the well sites. The reporting non-compliance denies DEP and the public critical information about individual wells and the overall industry and has become so widespread among operators with 11 or more conventional oil and gas wells as to be the rule rather than the exception.

Although the recent compliance trends for the conventional oil and gas industry in Pennsylvania are troubling, DEP does possess, as laid out in this report, the necessary authority and tools needed to take appropriate steps to address these issues. These tools include the use of administrative orders, permit denials, civil penalty assessments, bond forfeiture, entry and docketing of liens, criminal referrals when appropriate, permit suspension and revocation, and increased scrutiny of permit transfer and regulatory inactive status requests. The Department is also currently developing two rulemakings to bring Pennsylvania's regulation of the conventional oil and gas industry in line with modern standards and could initiate other rulemakings if needed.

It cannot be emphasized strongly enough, however, that increased oversight of the conventional oil and gas industry and enforcement will require additional resources for the Department, especially in

the DEP Office of Chief Counsel and the Bureau of District Oil and Gas Operations. Developing a stable funding source to fund these efforts will be critical to successfully altering the current course of widespread non-compliance in the conventional oil and gas industry in Pennsylvania.

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Sources of Radium Accumulation in Stream Sediments near Disposal Sites in Pennsylvania: Implications for Disposal of Conventional Oil and Gas Wastewater

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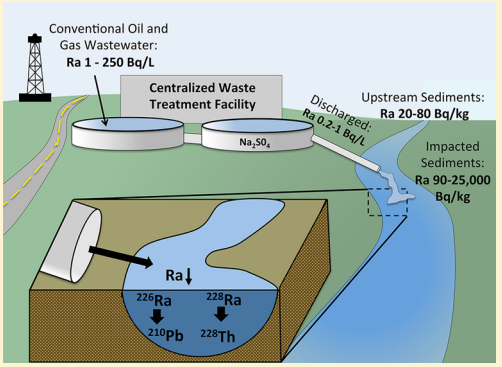
Supporting Information

ABSTRACT: In Pennsylvania, Appalachian oil and gas wastewaters (OGW) are permitted for release to surface waters after some treatment by centralized waste treatment (CWT) facilities. While this practice was largely discontinued in 2011 for unconventional Marcellus OGW at facilities permitted to release high salinity effluents, it continues for conventional OGW. This study aimed to evaluate the environmental implications of the policy allowing the disposal of conventional OGW. We collected stream sediments from three disposal sites receiving treated OGW between 2014 and 2017 and measured ^{228}Ra, ^{226}Ra, and their decay products, ^{228}Th and ^{210}Pb, respectively. We consistently found elevated activities of ^{228}Ra and ^{226}Ra in stream sediments in the vicinity of the outfall (total Ra = 90−25,000 Bq/kg) compared to upstream sediments (20−80 Bq/kg). In 2015 and 2017, ^{228}Th/^{228}Ra activity ratios in sediments from two disposal sites were relatively low (0.2−0.7), indicating that a portion of the Ra has accumulated in the sediments in recent (<3) years, when no unconventional Marcellus OGW was reportedly discharged. ^{228}Ra/^{226}Ra activity ratios were also higher than what would be expected solely from disposal of low ^{228}Ra/^{226}Ra Marcellus OGW. Based on these variations, we concluded that recent disposal of treated conventional OGW is the source of high Ra in stream sediments at CWT facility disposal sites. Consequently, policies pertaining to the disposal of only unconventional fluids are not adequate in preventing radioactive contamination in sediments at disposal sites, and the permission to release treated Ra-rich conventional OGW through CWT facilities should be reconsidered.



INTRODUCTION

The large-scale development of unconventional shale gas in the Appalachian Basin has been associated with different types and mechanisms of water contamination, including the management and disposal of the oil and gas wastewater (OGW) that is comprised of flowback fluids and produced waters.[1−3] Flowback and produced waters from the Appalachian Basin are highly saline and enriched in naturally occurring radioactive materials (NORM).[4−7] Previous studies have demonstrated that NORM in formation waters mainly consists of radium-226 ($t_{1/2}$ = 1600 years) and radium-228 ($t_{1/2}$ = 5.8 years) from the uranium and thorium decay series.[7−9] Total Ra (^{228}Ra+^{226}Ra) activities have been measured in Appalachian Basin formation waters up to hundreds of Becquerels per liter (Bq/L; up to 660 Bq/L and 250 Bq/L for Marcellus and conventional produced waters, respectively)[7] that exceed by several orders of magnitude the activities typically measured in fresh surface waters (0.5- 20 mBq/L for ^{226}Ra).[10] Elevated ^{228}Ra and ^{226}Ra may pose environmental and human health risks if released to the environment, as they are carcinogenic,[11] bioaccumulate (concentration factors between sediment and aquatic plants and fish of 0.014 and 2.3−700, respectively),[12−17] persist in the environment due to their relatively long half-lives, and decay into a suite of other radioactive elements including ^{222}Rn, ^{210}Pb, and ^{210}Po.

Due to their high salinity, unique chemistry, and immense volume, OGW pose significant management challenges when brought to the surface with hydrocarbons. In Pennsylvania, 43 million bbl of unconventional and 6.6 million bbl of conventional OGW were produced in 2014. A large fraction of this OGW (64% of unconventional OGW and 5% of conventional OGW; > 50% of the combined total) was reused for hydraulic fracturing operations.[18] A major option for disposal is injection underground via EPA Class II deep-well injection wells, but since there are a relatively limited number of these disposal wells in Pennsylvania, the OGW is often transported to neighboring states for disposal. Therefore, alternative disposal options in Pennsylvania consist of spreading on roads as a deicing agent or dust suppressant and treatment

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by wastewater treatment plants, including centralized waste treatment (CWT) facilities.[18] Treatment of OGW at these facilities has been described previously[19−21] and often includes the addition of Na_2SO_4 to promote the precipitation of metals, as well as Ra, before the treated OGW is discharged to local surface waters.

Due to concerns of contamination, in the spring of 2011 the Pennsylvania Department of Environmental Protection (PADEP) requested that unconventional well operators cease sending Marcellus OGW to wastewater treatment facilities that were allowed to discharge high-saline effluents. Although participation was voluntary, treatment of Marcellus waste at many wastewater treatment plants in Pennsylvania nearly ended by the fall of 2011.[22] However, these facilities continued to receive, treat, and dispose conventional OGW to the local streams.[18]

Several studies addressing this issue were published in 2013, relatively soon after Marcellus OGW treatment and discharge was discontinued. These studies showed that the releases of highly saline effluents cause direct contamination of the streamwater at disposal sites,[19,20,23,24] and also increase the risk of the formation of disinfection byproducts in downstream communities.[25] In addition to degrading water quality, Warner et al.[20] found that the release of treated OGW to Blacklick Creek, a tributary of the Allegheny River in Josephine, PA, resulted in the accumulation of Ra (^{226}Ra activities of 544-8,759 Bq/kg) in stream sediments in close vicinity (<200 m) to the outfall. Skalak et al.[26] found no increase in ^{226}Ra in stream sediments downstream of effluent sites from five wastewater treatment facilities. In two facilities, Skalak et al.[26] also collected sediments at the disposal sites, one of which was found to have ^{226}Ra activities slightly elevated (73 Bq/kg) above background (40 Bq/kg). These investigations, however, were conducted during the time period that Marcellus OGW was treated and discharged (2008−2011), or relatively soon after this practice was discontinued, and consequently the Ra accumulation in sediments has been attributed to contamination from the time period of high volumes of Marcellus OGW discharge.[20]

While much attention has been paid to understanding and mitigating contamination from unconventional OGW, the environmental impact from disposal of conventional OGW from CWT facilities has not been thoroughly investigated. Previous research has shown that conventional OGW from the Appalachian basin is also enriched in both ^{226}Ra and ^{228}Ra, with total Ra activities reaching 250 Bq/L (median 27 Bq/L).[7] Accordingly, we hypothesized that in spite of Marcellus OGW no longer being sent to wastewater treatment facilities, long-term release of conventional OGW by CWT facilities would still result in Ra accumulation in stream sediments at disposal sites.

In this study, we collected stream sediments from three disposal sites in PA receiving treated OGW. These include sediments from Blacklick Creek in Josephine, the Allegheny River in Franklin, and McKee Run in Creekside (Figure 1). Stream sediments were collected between 2014 and 2017 while the CWT facilities were not receiving Marcellus OGW but did report receipt of conventional OGW.[18] The objectives of this study were to (1) assess Ra accumulation and the ingrowth of Ra decay nuclides in sediments of streams receiving treated conventional OGW; (2) use the U−Th series disequilibrium to constrain the timing of Ra accumulation and determine whether the Ra in stream sediments reflects ongoing conventional OGW disposal or legacy disposal of Marcellus OGW; and (3) use the data to evaluate the environmental implications of current policies that solely regulate and restrict unconventional fluids and allow continued disposal of treated conventional OGW to the environment.

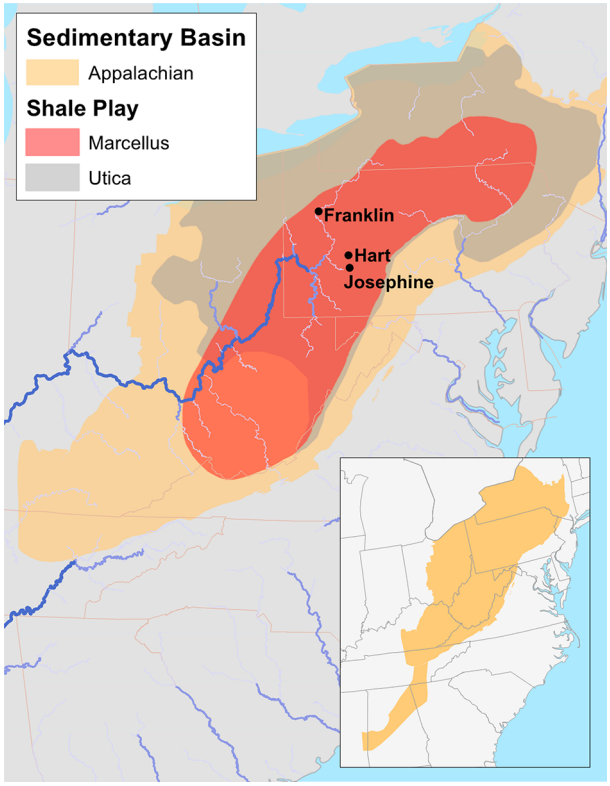

Figure 1. A map of the northern Appalachian Basin and major shale plays in the eastern United States. Inset map shows the entirety of the Appalachian Basin, that extends from New York southward through Pennsylvania, Maryland, Ohio, West Virginia, Virginia, Kentucky, and Tennessee before terminating in Alabama. The location of the three CWT facilities investigated in this study are also shown.

MATERIALS AND METHODS

Site Selection. We investigated three sites where OGW effluents were released to surface waters from CWT facilities (Figure 1). The CWT facilities that were chosen are defined by Standard Industrial Classification (SIC) codes that only relate to oil and gas wastes. Although the possibility that these facilities received other undocumented wastes during the study period is unknown, we are not aware of any other NORM-rich wastewater sources in the study area. These facilities include (1) the Pennsylvania Brine Treatment Josephine Facility ("Josephine Facility") in Josephine, PA which discharges treated OGW to Blacklick Creek; (2) the Pennsylvania Brine Treatment Franklin Facility ("Franklin Facility") in Franklin, PA, which discharges to the Allegheny River; and (3) Hart Resource Technologies Creekside Facility ("Hart Facility") in Creekside, PA, which discharges to McKee Run (Figure 1).

In 2010, the PADEP issued regulations that required effluents from wastewater treatment plants have total dissolved solid (TDS) levels below 500 mg/L. However, the Josephine, Franklin, and Creekside facilities were 3 of initially 27 facilities grandfathered in to previous regulations that do not strictly limit the TDS of effluents.[27] These three investigated facilities also reported that they stopped receiving unconventional OGW by the end of 2011, following PADEP request that well

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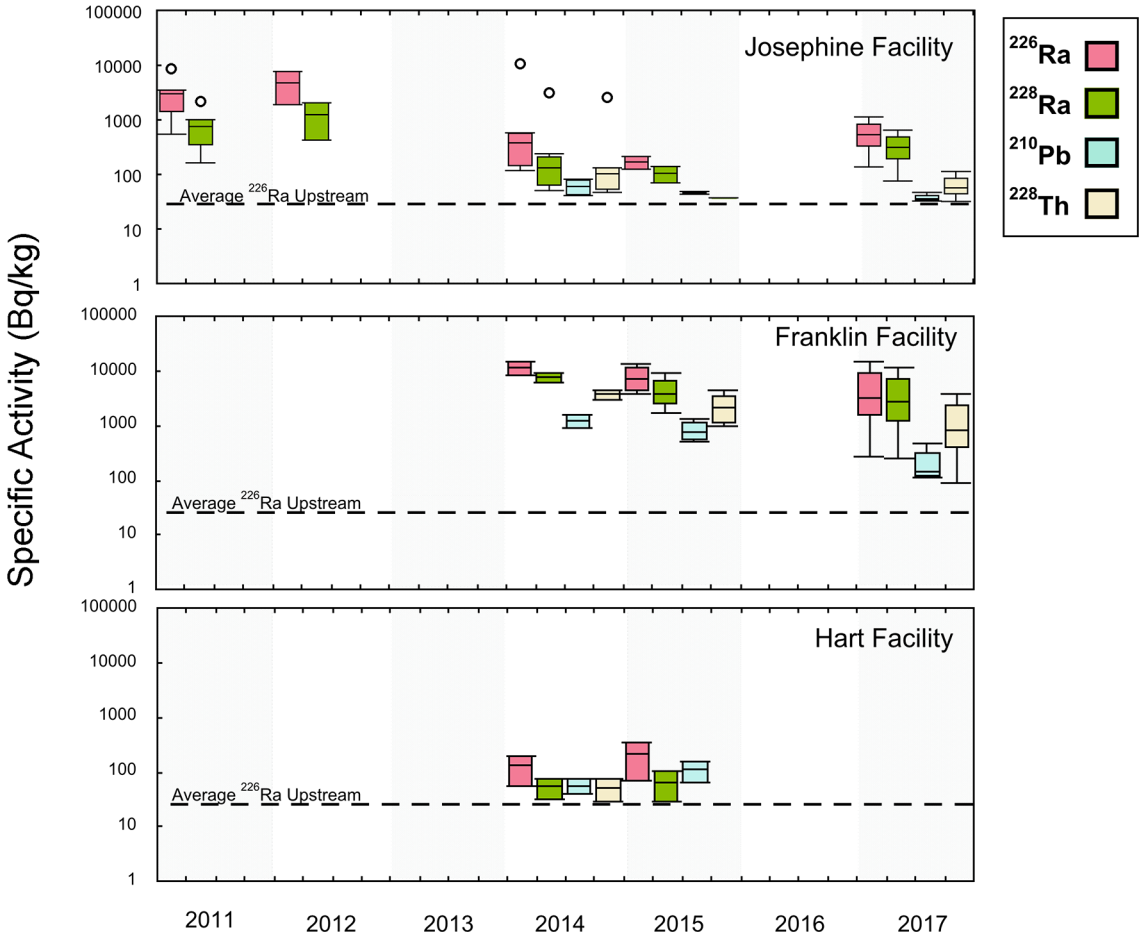

Figure 2. ^{226}Ra, ^{228}Ra, ^{210}Pb, and ^{228}Th activities in sediments collected from three streams receiving OGW discharged by CWTs in 2014, 2015, and 2017. Josephine data from 2011 and 2012 were compiled from the literature.[18] The boxplots indicate the middle 50% and the median of the data. Boxplot whiskers indicate the minimum and maximum values, excluding outliers which are indicated by open circles. Dashed lines show the average ^{226}Ra activity of upstream samples, assumed to be unaffected by treated OGW effluents. Elevated activities were measured at all three effluent sites compared to upstream sites.

operators voluntarily stop sending unconventional OGW to wastewater treatment facilities grandfathered in to the less stringent TDS standards.[22,27] Total conventional and unconventional wastes sent to CWT facilities investigated in this study were compiled from the PADEP oil and gas reporting website for the years 2010−2016.[18] These data confirm that treatment of unconventional wastes at these three facilities diminished by 2012, while treatment of conventional waste and discharge of high salinity waters continued at consistent rates (SI Figure S1). Average annual discharge rates from 2012 to 2017 were of 236 ± 61 × 10^6 L per year at the Franklin Facility and 174 ± 29 × 10^6 L per year at the Josephine Facility.[28]

In each of the sites, effluents from the CWT facilities discharge to the local streams. The stream sediments in these areas are common to northern Appalachian watersheds. Grain size distribution analyses indicate that the stream sediments consistently range from 5 to 15% silt and clay across all streams. The remainder of the size fraction is fine to very coarse sand. Results in this study refer to the bulk sediments without analysis of selective grain-size fractions.

Sample Collection. Grab stream sediments were collected in May 2014 (Franklin n = 2, Josephine n = 7, Hart n = 2), June and August 2015 (Franklin n = 4, Josephine n = 2, Hart n = 2), and June 2017 (Franklin n = 4, Josephine n = 3) from the three effluent sites. Approximately 100 g of the top 2−4 cm of sediment were scooped with a shovel and stored in a polypropylene jar. Multiple sediment samples were similarly collected from various points upstream of the disposal site over the course of the sampling campaigns (Franklin n = 5, Josephine n = 7, Hart n = 6). Upstream sediments are assumed to be unaffected by effluents and therefore are used as reference sites. However, other upstream sources such as coal mine discharges and other CWT facilities could potentially influence the "background" levels.

One effluent sample was also collected from the Franklin Facility in 2015. The sample was collected unfiltered, prior to contact with streamwater. The effluent was diluted with freshwater to a specific conductivity less than seawater (<50 mS/cm) and passed through two sequential plastic columns each containing 10 g of MnO_2 coated acrylic fibers that efficiently adsorbs Ra.[29−36] The flow rate through the columns was monitored periodically and kept at less than 1 L/min. Fibers were rinsed with DI water, hand squeezed to remove particulates and excess moisture, and stored in separate plastic bags prior to laboratory processing.

Radionuclide Analyses. Approximately 40−60 g of sediment were oven-dried at 105 °C and, if necessary, ground with a mortal and pestle to a diameter less than 5 mm. Samples were packed and weighed in plastic snap close Petri style dishes (6.5 cm in diameter and 2 cm in height) that were then sealed

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with electrical tape and coated in wax to prevent the escape of gaseous ^{222}Rn ($t_{1/2}$ = 3.8 days) and ^{220}Rn ($t_{1/2}$ = 55 s). The MnO_2 coated fibers from the Franklin Facility were compressed and then packaged and incubated similarly to the sediment samples. The two fibers were packaged and analyzed separately to monitor for potential Ra bleed through that would result in underestimation of Ra activities.[34]

Sealed samples incubated for a minimum of 21 days to allow ^{226}Ra to reach radioactive secular equilibrium (i.e., the activity of the parent nuclide is equal to the activity of decay product) with ^{222}Rn along with other decay products, ^{214}Bi ($t_{1/2}$ = 19.9 min) and ^{214}Pb ($t_{1/2}$ = 27 min). This holding time also allows ^{228}Th to reach radioactive secular equilibrium with ^{224}Ra ($t_{1/2}$ = 3.6 days) and the succeeding short-lived radionuclides including ^{212}Pb ($t_{1/2}$ = 10.6 h) and for ^{228}Ra to reach radioactive secular equilibrium with its immediate decay product ^{228}Ac ($t_{1/2}$ = 6.1 h). If radioactive secular equilibrium is assumed in these sections of the U and Th decay series, ^{228}Ra, ^{226}Ra, and ^{228}Th can be measured through their decay products[36−39] when direct measurement is not feasible (e.g., the significant interference of ^{235}U (54% yield) on the 186 keV peak).

Following incubation, samples were counted on a Canberra Broad Energy 5030 Germanium Gamma detector surrounded by 10 cm of lead shielding. Samples typically counted for 6- 48 h so that counting errors (2σ) were less than 10%. ^{226}Ra activities were measured through the 351 keV energy peak of ^{214}Pb. ^{228}Ra activities were measured through the 911 keV energy peak of ^{228}Ac. ^{228}Th activities were measured through the 239 keV energy peak of ^{212}Pb. Finally, ^{210}Pb ($t_{1/2}$ = 22 years) activities were measured directly through the 47 keV energy peak. The detector efficiencies were determined using a U−Th reference ore material (DL-1a) prepared by the Canadian Certified Reference Materials Project (CCRMP) that was packaged and incubated in a container identical to the samples. Background and efficiency checks were performed routinely prior to and during the time frame of sample analyses.

We accounted for attenuation of gamma photons by the sample itself at each energy investigated in this study using U and Th point sources according to methods described in Cutshall et al.[40] At low energies (<200 keV; ^{210}Pb), differences in sample density and composition between the standard and samples of interest resulted in significant attenuation differences. However, we found at higher energies (>200 keV), these differences were generally minor (i.e., within statistical counting error) for our sample set.

RESULTS AND DISCUSSION

Accumulation of Ra and Decay Products in Sediments at OGW Disposal Sites. At all three investigated sites, we consistently find elevated Ra activities in stream sediments collected near effluent pipes at the outfall sites (^{226}Ra = 57−14,949 Bq/kg; n= 26) compared to upstream sediments (^{226}Ra = 9−41 Bq/kg; n = 18) (Figure 2). Sediments from the Franklin effluent site had ^{226}Ra activities ranging from 269 to 14 949 Bq/kg (n = 10), sediments the Josephine effluent site had ^{226}Ra activities ranging from 119- 10,747 Bq/kg (n = 12), and sediments from the Hart effluent site had ^{226}Ra activities ranging from 57- 351 Bq/kg (n = 4). We did not observe any apparent trends in activities increasing or decreasing with time.

Because Ra is significantly higher in sediments from disposal sites compared to sediments from upstream sites (up to ∼650 times compared to the average ^{226}Ra background activity at the Franklin Facility), combined with direct evidence for water contamination from OGW effluents in the streamwater,[20,41] we suggest that the CWT facility discharges are the source for the elevated Ra in the impacted stream sediments. While total Ra activities in conventional OGW can be found up to 250 Bq/L, low ^{226}Ra activities in the discharged effluents from Josephine site were reported by Warner et al.[20] (0.13−0.19 Bq/L), which indicate substantial Ra removal as part of the CWT treatment. Similarly, we found relatively low activities of ^{226}Ra and ^{228}Ra (0.4 Bq/L and 0.6 Bq/L, respectively) in effluents collected from the Franklin Site in 2015. In spite of the large removal of Ra from the treated effluents, Ra in sediments collected from the disposal sites was still elevated. These data suggest that the release of low Ra effluents can potentially result in high Ra accumulation in sediments at the disposal sites. However, we cannot exclude the possibility of infrequent pulses of high Ra effluents to the streams as a major contributor to the Ra activities measured in sediments from the disposal sites.

We conducted mass-balance calculations to evaluate the possibility that the ongoing release of low-Ra effluents is responsible for the elevated Ra observed in the sediments near the discharge sites. Our model (see SI for details) takes into account the Ra loading to the stream (based on the Ra activities and volume of the discharge effluents), variable salinity ranges that control the Ra adsorption coefficient (K_d),[42] and the volume of impacted sediments. We find that the Ra activities in impacted stream sediments modeled from these mass-balance calculations are similar to the actual measured Ra activities in the sediments, supporting the notion that Ra accumulation at the levels observed in this study is possible from long-term discharge of treated OGW effluents even with low Ra activities. Our model does not account for any sediment losses from the system due to continuous downstream transport. A previous study estimated sedimentation rates at 5−8 cm per year in a location downstream of the discharge site of Blacklick Creek,[43] suggesting that there is likely some transport of sediments to and from the discharge sites, which could effectively be "diluting" the Ra activities in sediments at the discharge sites.

The retention of Ra in stream sediments following OGW disposal can be obtained by (1) Ra adsorption to clays and/or manganese and iron oxides;[42,44,45] (2) incorporation of Ra into secondary minerals such as barite ($(Ba,Ra)SO_4$) that could be generated upon the blending of Ba-rich OGW with high-sulfate river water;[46] and/or (3) episodic or ongoing addition of extremely fine-grained barite particles that were generated during the treatment process, suspended in the liquid effluents, and then transported to the stream sediments. While determining the mechanism of Ra accumulation in sediments is outside the scope of this study, future research should investigate whether Ra is incorporated into sediments in these streams through adsorption, authigenic barite formation, or effluent-transported solid barite particles. Such a distinction could have important implications for mitigating future contamination.

In addition to ^{226}Ra and ^{228}Ra, elevated activities of Ra decay products, ^{210}Pb and ^{228}Th, were detected in the sediments collected from two CWT disposal sites at substantially elevated activities compared to the upstream sediments (Figure 2). Sediments from the Franklin site had ^{228}Th activities ranging from 91 to 4591 Bq/kg and ^{210}Pb activities ranging from 117 to 1593 Bq/kg, and sediments the Josephine effluent site had ^{228}Th activities ranging from 32 to 2614 Bq/kg and ^{210}Pb

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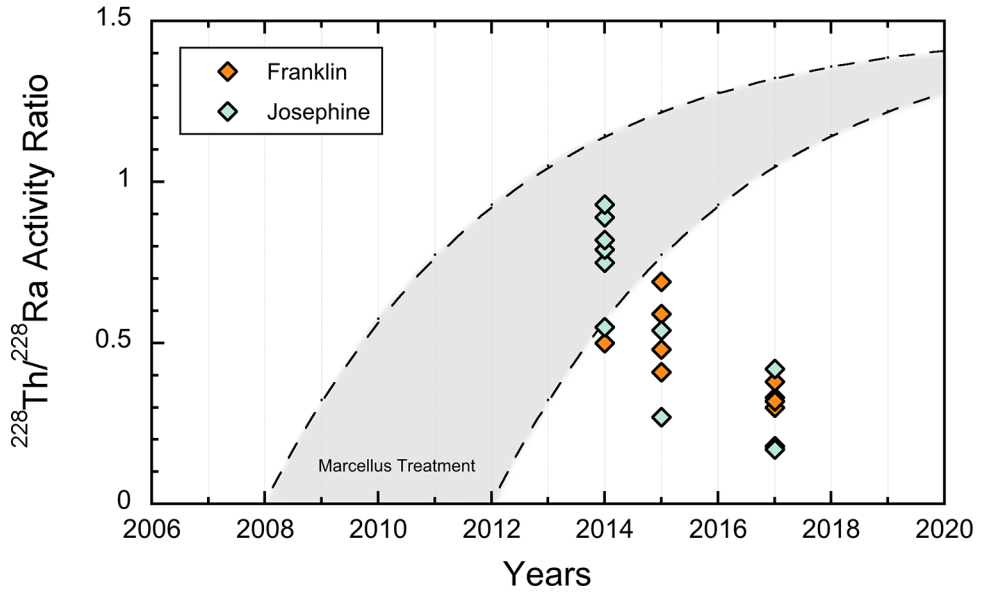

Figure 3. ^{228}Th/^{228}Ra activity ratios in sediments collected from the Franklin and Josephine CWT facilities in 2014, 2015, and 2017. Ratios that fall within the gray band reflect contamination that can be dated to the time period of high discharges of treated unconventional Marcellus OGW (2008−2011). Sediments collected in 2015 and 2017 had ^{228}Th/^{228}Ra activity ratios that fall below the expected range if contamination was solely from Marcellus OGW contamination. These relatively low ratios suggest that at least a portion of the Ra that has accumulated in the sediments is from relatively recent releases of conventional OGW.

activities ranging from 33 to 82 Bq/kg. Upstream ^{228}Th and ^{210}Pb activities ranged from 9 to 38 Bq/kg and 14−81 Bq/kg, respectively, at both sites. Given the low solubility of Th and Pb and their negligible levels in OGW,[8] we assume that the accumulation of ^{228}Th and ^{210}Pb in the stream sediments is likely due to Ra decay and subsequent ingrowth in situ, rather than the transport and addition of these nuclides via retention from discharged effluents.

Source and Age Constraints of Radionuclide Accumulation. Determination of the timing of Ra accumulation has important implications for assessing the source of Ra contamination in the investigated streams. If elevated Ra activities are found to be solely due to legacy contamination from Marcellus OGW treatment and disposal, then the end of this practice in 2011 should have prevented any additional contamination from OGW disposal after 2011. However, if the age of the contamination is relatively recent, then the elevated Ra activities in stream sediments at the disposal sites can be attributed to continued disposal of treated conventional OGW.

The ^{228}Th/^{228}Ra activity ratios have been previously used to determine the age and source of OGW spills and radioactive barite associated with oil and gas development.[38,47,48] Unsupported ^{228}Ra decays into ^{228}Th, and the ^{228}Th/^{228}Ra activity ratio can serve as a chronometer of contamination events[8,38,47,49] due to the insolubility and suitable 1.9 year half-life of ^{228}Th.[45,50−52] With time, ^{228}Th approaches transient equilibrium with ^{228}Ra, and the ^{228}Th/^{228}Ra activity ratio will approach ∼1.5 after about 15 years. Changes in the ^{228}Th/^{228}Ra activity ratio with time can be modeled according to eq 1.

$$\frac{228Th}{228Ra} = \frac{\lambda_{Th228}}{\lambda_{Th228} - \lambda_{Ra228}}\left[1 - e^{(\lambda_{228Ra} - \lambda_{Th228})t}\right] \quad (1)$$

Previous studies have typically employed this ^{228}Th/^{228}Ra dating technique on relatively specific events,[38,47,48] while its application to dating contamination events derived from OGW effluents that have been released over multiple years is less established. Here we develop the use of the ^{228}Th−^{228}Ra disequilibrium to constrain the age of ongoing contamination from discharging effluents. If all the excess Ra measured in the sediments from the disposal sites was solely accumulated between 2008 and 2011, when the Marcellus OGW was discharged, then observed ^{228}Th/^{228}Ra activity ratios would fall within the range of 0.8−1.2 in 2015 and 1.1−1.3 in 2017 (Figure 3). However, the relatively low ^{228}Th/^{228}Ra activity ratios (0.3−0.7 in 2015 and 0.2−0.4 in 2017) found in impacted sediments at the Franklin and Josephine sites indicate that at least a portion of the measured Ra has accumulated during the ∼0.5 to 3 years prior to sample collection. These relatively low ^{228}Th/^{228}Ra activity ratios observed in the stream sediments rule out the possibility that the elevated Ra activity in the sediments is entirely derived from legacy contamination from documented Marcellus OGW, and rather suggests that at least a portion of the excess radioactivity in sediments from the disposal sites is derived from recent disposal of conventional OGW.

^{228}Th/^{228}Ra age dating assumes a closed system with no losses of ^{228}Ra or external source of ^{228}Th in the impacted sediments. Adsorption/desorption is heavily controlled by the ionic strength of the fluid, among other parameters such as pH and the cation exchange capacity (CEC) of the sediment.[42,44,45,53] For example, in groundwater systems, the sediment partition coefficient (K_d; the ratio of the adsorbed nuclide to the nuclide in the dissolved phase) for Ra exponentially increased from 1.4 at TDS ∼ 200 000 mg/L to >500 at TDS < 1000 mg/L.[42] We posit that the dilution of highly saline OGW with streamwater following discharge permits Ra adsorption to stream sediment. Subsequent desorption of Ra or ingrown ^{228}Th is possible following fluctuations in salinity or pH. However, Th is far less mobile than Ra,[52,54] and losses to the system from desorption would more heavily affect Ra rather than Th. In such a case, the ^{228}Th/^{228}Ra activity ratios measured in this study would be

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artificially high and derived age constraints would be artificially old (i.e., indicating even younger ages than our evaluation assuming no Ra lost). Additionally, $^{228}Th/^{228}Ra$ age dating in this system assumes a fixed sediment substrate despite potential transport of sediments downstream. Regardless, the results from this study indicate that contamination has occurred on a recent time scale and cannot solely be attributed to discharges of Marcellus OGW from 2008 to 2011.

Age constraints determined from the $^{228}Th/^{228}Ra$ activity ratios can be corroborated with $^{228}Ra/^{226}Ra$ activity ratios, which also suggest that Ra is being continually introduced to the stream sediments from the disposal of conventional OGW. While distinctly low $^{228}Ra/^{226}Ra$ activity ratios (typically less than 0.3) characterize OGW from the Marcellus Shale, higher $^{228}Ra/^{226}Ra$ (~1) activity ratios have been reported for OGW from conventional formations.[6,7,55] The $^{228}Ra/^{226}Ra$ activity ratios in the impacted sediments are expected to mimic the ratios of the OGW, combined with the decay of ^{228}Ra over time. Following the retention of Ra to the stream sediments, unsupported ^{228}Ra decays with a half-life of 5.8 years, while ^{226}Ra is relatively unchanged over this time scale. Therefore, the $^{228}Ra/^{226}Ra$ activity ratio in contaminated sediment is expected to decrease with time according to eq 2, where lambda is the ^{228}Ra decay constant (0.12 yr^{-1}) and t is time.

$$\frac{^{228}Ra}{^{226}Ra} = \left(\frac{^{228}Ra}{^{226}Ra}\right)_o e^{-\lambda_{Ra228}t} \quad (2)$$

Therefore, if all excess Ra accumulated in the sediments during the period of Marcellus OGW disposal (2008 to 2011), we would expect $^{228}Ra/^{226}Ra$ activity ratios to be well below 0.3 as ^{228}Ra decays with time. Instead, we observed $^{228}Ra/^{226}Ra$ activity ratios ranging from 0.4 to 0.9 in sediments collected in 2015 and 2017, which are higher than typical Marcellus $^{228}Ra/^{226}Ra$ ratios (<0.3), suggesting that Ra in the sediments was derived from relatively recent conventional OGW with a relatively high $^{228}Ra/^{226}Ra$ activity ratio of ~1 (Figure 4).

Policy Implications for Disposal of Conventional OGW from CWT Facilities. Previous[20] and new data presented in this study indicate that the disposal of OGW to the environment results in the accumulation of Ra and Ra-decay products in the upper section of impacted stream sediments. Our data indicate that in spite of the removal of a large fraction of Ra from treated OGW, the discharge of effluents results in accumulation of Ra (^{226}Ra up to 15 000 Bq/kg) in impacted sediments. This observation is supported by a Ra mass-balance model (see Supporting Information (SI) for details) that shows that the modeled Ra accumulation in the stream sediments is similar to the observed Ra activities in the impacted sediments. While there is no federal regulation, several states have developed limits for solids containing NORM, which typically range from 185 to 1850 Bq/kg (5 pCi/g to 50 pCi/g).[56] Our data indicate that the disposal of treated OGW results in elevated NORM activities in impacted stream sediments above the 1850 Bq/kg threshold. Waste materials with ^{226}Ra above 1850 Bq/kg should be transferred to a licensed radioactive waste disposal facility that has strict requirements related to site location and the following features: (1) lined walls, back up lining, and a cover, (2) a leachate collection system, and (3) leak detector systems.[57]

Relatively low $^{228}Th/^{228}Ra$ and high $^{228}Ra/^{226}Ra$ activity ratios measured in sediments collected from two CWT discharge sites in PA indicate that at least a portion of the Ra measured in sediments has accumulated in recent (0.5−3) years when no Marcellus OGW was reportedly discharged, suggesting that conventional OGW discharges are a noteworthy source of radium accumulation. Accordingly, data from this study indicate that restricting treatment to only conventional OGW at CWT facilities does not prevent the large accumulation of Ra in stream sediments from disposal sites. Our data and previous data[20] also suggest that the large Ra removal from the disposed effluents potentially does not mitigate the high NORM accumulation in sediments at the disposal sites, although we cannot rule out the possibility of infrequent pulses of high-Ra effluents as a major contributor of Ra to the sediments rather than long-term discharge and accumulation from low-Ra effluent.

In addition to treatment at wastewater treatment plants, unconventional OGW is also prohibited from being used as a deicing agent or dust suppressant on roads, whereas untreated conventional OGW is permitted for application to roads.[26] While the fate of NORM following the use of OGW as deicing agents and dust suppressants remains a major question, data from this study suggests that permission of conventional OGW will not protect the environment from radioactive contamination. In an initial assessment, Skalak et al.[26] found elevated Ra (1.2×), Sr, Ca, and Na in roadside sediments in Vernon County, PA, where OGW was applied to roads for dust suppression when compared to background sites. Future research addressing the application of OGW to roads as a deicing agent and dust suppressant is important to fully understand the impact of OGW related NORM on soils and sediments and the human and environmental health implications of this practice.

Overall, this study shows consistently elevated activities of Ra and decay products in stream sediments at three disposal sites of CWT facilities in PA receiving conventional OGW, up to five years after unconventional Marcellus OGW was no longer discharged. The $^{228}Th/^{228}Ra$ and $^{228}Ra/^{226}Ra$ activity ratios in the sediments suggest that at least a portion of the Ra has accumulated in recent years when no Marcellus OGW was reportedly discharged, indicating that permitting CWT facilities

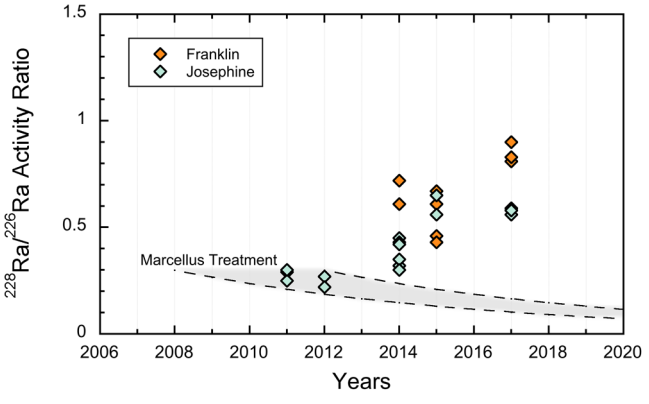

Figure 4. $^{228}Ra/^{226}Ra$ activity ratios in sediments collected from the Franklin and Josephine CWT facilities in from 2011 to 2017. 2011 and 2012 data are compiled from Warner et al. (2013).[20] Ratios that fall within the gray band reflect the ratios that would be expected from Marcellus OGW contamination from 2008 to 2011. Sediments from this study collected in 2014, 2015, and 2017 had $^{228}Ra/^{226}Ra$ activity ratios above the Marcellus range, suggesting that at least some of the contamination is sourced from conventional OGW with a relatively higher $^{228}Ra/^{226}Ra$ activity ratio (~1).

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to treat and release only conventional OGW does not prevent radioactive contamination and accumulation in the upper portion of sediments at disposal sites. In order to prevent radionuclide accumulation in the environment, we suggest that disposal restrictions should apply to any type of Ra-rich water, regardless of source, and that current policies differentiating the treatment and disposal of conventional OGW from unconventional OGW should be reconsidered.

■ ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available free of charge on the ACS Publications website at DOI: 10.1021/acs.est.7b04952.

Expanded information on the Ra mass balance calculations, 1 figure, and 1 table (PDF)

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Notes

The authors declare no competing financial interest.

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PENNFIELD ENERGY

4/01/2019

RE: Brine for spreading

Dear Township,

Pennfield Energy is an oil production company with an Erie address but our wells are mainly in Venango County.

Pennfield has been offering to townships free brine in efforts to reduce our expense of taking it to a waste treatment facility. The only charge to townships is trucking which is $75.00 per hour.

This has been a substantial savings for townships therefore a win, win for both of us. In addition to this mutual benefit, reporting regs with D.E.P. have gotten easier.

Pennfield has obtained a Co-Product status instead of Waste with our brine. What this means is you don't have to report spreading and it can be spread all year round.

I know this is hard to believe because D.E.P. doesn't make anything easy, but it's true, you do need our brine analysis on hand and a copy of the D.E.P. regulation with Co-product determination. We will provide this to you once we you have completed and returned the enclosed agreement.

Townships currently using our brine under the Co-Product determination for your reference are:

East Mead Township- Bruno 814-724-8970
Randolph Township- Joi Foltz 814-789-3000
Deerfield Township- Brenda Gibson 814-723-4277

We look forward to hearing from you.

Sincerely,

Penny Duckett
Office Manager

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