# Hydraulic Fracturing, Radioactive Waste, and Inconsistent Regulation

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*J.D. Candidate, 2019, University of Colorado Law School. The author would like to thank Travis Weiner and Alula S. Mazengia, without their invaluable feedback and support publication of this Note would not have been possible. Additional thanks to the *Colorado Natural Resources, Energy & Environmental Law Review* members for their hard work in reviewing and preparing this Note for publication.

# INTRODUCTION

Innovation in hydraulic fracturing and the shift from traditional drilling to advanced hydraulic fracturing has changed the face of oil and gas production in the United States, resulting in a boom in production. The increase in production also means an increase in hydraulic fracturing waste.[1] Ninety-eight percent of oil and gas waste is produced water—a radioactive by-product of the hydraulic fracturing industry. This wastewater contains concentrated radioactive materials known as Technically Enhanced Naturally Occurring Radioactive Materials ("TENORM"). However, TENORM is not regulated under federal law, because of broad exemptions by the Environmental Protection Agency ("EPA"). Exemptions that carved out protections for a small industry, where nearly seventy percent of wells produced about ten barrels of oil per well per day,[2] have now grown large enough to exempt wells that can produce as much as 1,100 barrels of oil per day.[3] These outdated exemptions do not address the threat radioactive hydraulic fracturing waste presents to public health and the environment.

Because of the federal exemptions, the radioactive waste is stored in open pits, dumped in landfills, and is injected into disposal wells. These disposal wells are exempt from regulation under the Safe Drinking Water Act ("SDWA"), leaving aquifers unprotected.[4] Disposal wells are not the only threat to water systems: thousands of hydraulic fracturing wells are also located within close proximity to public drinking water systems.[5] In

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1 John Flesher, *AP Exclusive: Drilling Boom Means More Harmful Waste Spills*, ASSOCIATED PRESS (Sept. 9, 2015), https://apnews.com/39786bbf509e412a9feb9b58a6534a36/drilling-boom-brings-rising-number-harmful-waste-spills.

2 OFFICE OF TECHNOLOGY ASSESSMENT, OTA-BP-O-82, MANAGING INDUSTRIAL SOLID WASTES FROM MANUFACTURING, MINING, OIL AND GAS PRODUCTION, AND UTILITY COAL COMBUSTION 67 (Mar. 1992), https://repository.library.georgetown.edu/bitstream/handle/10822/708031/9225.PDF?sequence=1&isAllowed=y [hereinafter MANAGING INDUSTRIAL WASTE].

3 *How Much Oil?*, NIOBRARA NEWS (Apr. 10, 2011), http://www.niobraranews.net/how-much-oil.

4 Letter from Amy Mall, Senior Policy Analyst, Nat. Res. Def. Council, to The Honorable Gina McCarthy, Administrator, U.S. Envtl. Prot. Agency, 10–11 (Mar. 23, 2016), https://www.epa.gov/sites/production/files/2016-09/documents/sdwa._petition16-000-6065_mall_nrdc_aquifer_exemption_003.pdf [hereinafter Letter to EPA I].

5 OFF. OF RES. & DEV., EPA, EPA/600/R-15/047A, ASSESSMENT OF THE POTENTIAL IMPACTS OF HYDRAULIC FRACTURING FOR OIL AND GAS ON DRINKING WATER RESOURCES, at ES-5 to ES-6 (June 2015), https://www.epa.gov/sites/production/files/2015-06/documents/hf_es_erd_jun2015.pdf [hereinafter ASSESSMENT OF HYDRAULIC FRACTURING].

2013, nearly 6,800 public water systems were estimated to have at least one hydraulic fracturing well within a mile radius.[6] Of the 9.4 million people living within a mile of the hydraulic fracturing wells, nearly 8.6 million people in 2013 likely used water from the public water systems.[7] In addition, a study has also shown that between 2009 and 2014, there were in excess of 21,000 spills from overflowing storage tanks, ruptured pipes, and other accidents or deliberate dumping[8] that released 175 million gallons of waste in eleven states.[9] These studies indicate that stricter regulations are required to protect public health and the environment. Thus, to protect public health and the environment, the EPA should classify hydraulic fracturing waste as hazardous waste by amending the Resource Conservation and Recovery Act ("RCRA") and regulate the waste from extraction to disposal.

The purpose of this Note is to analyze the issues related to hydraulic fracturing waste and the importance of updating waste classification for proper regulation of the waste. The Note begins with an overview of the waste management problems related to hydraulic fracturing waste. Section I delves into the history of oil and gas production, the hydraulic fracturing process, the waste it produces, and the risk of exposure to humans and the environment. Section II looks at why the waste is not classified as hazardous and the exemptions under federal law preventing the EPA from regulating the industry. Section III proposes amending the RCRA to classify TENORM as hazardous waste and looks at how the amendment would allow regulation of radioactive wastewater under the SDWA.

## I. HYDRAULIC FRACTURING AND WASTE MANAGEMENT

### *A. Oil and Gas Production and Radioactive Waste*

Oil and gas is found in the earth's crust, where there used to lie prehistoric seas that are now decayed sea life turned to oil.[10] Oil and gas

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6 *Id.* at ES-6.

7 *Id.* at ES-5 to ES-6.

8 Flesher, *supra* note 1.

9 Lindsey Konkel, *Salting the Earth: The Environmental Impact of Oil and Gas Wastewater Spill*, 124 (12) ENVIRON. HEALTH PERSPECT. A230 to 31 (Dec. 1, 2016), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5132645.

10 *TENORM: Oil and Gas Production Wastes*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/radiation/tenorm-oil-and-gas-production-wastes (last visited Sept. 26, 2018) [hereinafter *TENORM: Oil and Gas Waste*].

is also found in aquifers which contain brine or salt water.[11] Historically, most wells were drilled vertically to extract the oil and gas from the earth's crust.[12] Modern-day hydraulic fracturing began in the 1990s when a new technique combined hydraulic fracturing and horizontal drilling,[13] enabling the extraction of oil and gas from shale formations.[14] These shale formations are resistant to free-flowing gas, as the shale is not easily permeable and porous.[15] Horizontal drilling involves first drilling a vertical well until the target formation is reached; the well is then drilled horizontally at 90 degrees, where the borehole could extend anywhere between 3,000 feet to 6,000 feet.[16]

Horizontal drilling increased in popularity because it enables drilling and draining of large areas from a single drill pad[17] to access targets that cannot be reached vertically.[18] This increases the "pay zone" in the target rock, which increases productivity and allows for better control of production wells by sealing or relieving pressure.[19] Consequently, hydraulic fracturing allows for previously impossible installation of

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11 *Id.*

12 Hobart M. King, *Directional and Horizontal Drilling in Oil and Gas Wells,* GEOLOGY.COM, https://geology.com/articles/horizontal-drilling (last visited Nov. 1, 2017). Horizontal drilling increases the amount of surface area the drills can reach. *Id.*

13 John Manfreda, *The Origin of Fracking Actually Dates Back to the Civil War,* BUS. INSIDER (Apr. 14, 2015, 7:17 PM), http://www.businessinsider.com/the-history-of-fracking-2015-4.

14 *Id.*; Shale is sedimentary rock which is formed when silt and clay-sized mineral particles are compacted. Hobart M. King, *Shale*, GEOLOGY, https://geology.com/rocks/shale.shtml (last visited Mar. 26. 2018). Shale formations, formerly ocean floors, are six times saltier than ocean water and contain radioactive elements such as uranium, thorium and decay products such as radium-226 and radium-228. Jefferson Dodge & Joel Dyer, *America's Dirtiest Secret: How Billions of Barrels Of Toxic Oil and Gas Waste Are Falling Through Regulatory Cracks,* BOULDER WEEKLY (Mar. 13, 2014), http://www.boulderweekly.com/news/americarsquos-dirtiest-secret.

15 Shekar Sharma, *Evaluating Leachability of Residual Solids Generated from Unconventional Shale Gas Production Operations in Marcellus Shale,* VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY 6 (Aug. 1, 2014), https://vtechworks.lib.vt.edu/bitstream/handle/10919/50514/Sharma_S_T_2014.pdf?sequence=1.

16 *Id.*

17 King, *supra* note 12. A drill pad is a location which houses several wellbores. These drill pads increase drilling efficiency because multiple wells can be drilled. It also reduces the surface footprint of wells and the time it takes to drill the multiple wells. *Pad Drilling and Rig Mobility Lead to More Efficient Drilling*, U.S. ENERGY INFO. ADMIN., (Sept. 11, 2012), https://www.eia.gov/todayinenergy/detail.php?id=7910.

18 King, *supra* note 12.

19 *Id.*

excavation equipment.[20] As a result of this advancement, the United States now uses hydraulic fracturing in ninety percent of new oil and gas wells,[21] making it the largest producer of oil and gas in the world in 2012.[22]

Oil and gas production has three stages: well drilling and completion, well stimulation or hydraulic fracturing, and well production.[23] First, a well is drilled and a perforated steel casing is inserted down the drilled well, also known as a wellbore.[24] During the well simulation or hydraulic fracturing stage, large amounts of water mixed with chemicals and sand (or proppant—material used to prop open hydraulic fractures)[25] is injected into the well with enough pressure to create fractures in the shale rock.[26] Fracturing—or fracking—fluid (chemicals and proppant) is pumped down the wellbores to hold the fractures in place to allow the oil and gas to flow freely to the surface.[27] Once the injection stops and after the fractures have been created, fluid—known as flowback water—is pumped to the surface.[28]

Flowback water is a combination of hydraulic fracturing fluid and formation water (water containing brine from the gas-rich shale rock).[29] Flowback water may also have dissolved naturally occurring radioactive materials ("NORM") such as radium, and potassium, which have been

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20 *Id.*

21 MARY TIEMANN & ADAM VANN, CONG. RESEARCH SERV., R41760, HYDRAULIC FRACTURING AND SAFE DRINKING WATER ACT REGULATORY ISSUES 21 (July 13, 2015).

22 *U.S. Leads World in Oil and Gas Production, IEA says*, BBC (Nov. 14, 2017), http://www.bbc.com/news/business-41988095.

23 *Proper Management of Oil and Gas Exploration and Production Waste,* U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/hw/proper-management-oil-and-gas-exploration-and-production-waste (last visited Feb. 22, 2018).

24 *How Does Well Completion Work?,* RIGZONE, https://www.rigzone.com/training/insight.asp?insight_id=326&c_id= (last visited Mar. 25, 2018). A wellbore is generally a straight vertical shaft or hole that is drilled for the extraction of oil and gas. The shaft is then encased with steel pipes or cement to prevent closure or water or sand entering the well. *Wellbore*, INVESTOPEDIA, https://www.investopedia.com/terms/w/wellbore.asp (last visited July 18, 2018).

25 Jordan Hanania et al., *Proppant*, ENERGY EDUCATION, http://energyeducation.ca/encyclopedia/Proppant (last updated Feb. 18, 2016).

26 TIEMANN & VANN, *supra* note 21, at 1.

27 *Id.*

28 *Id.*

29 *Fracking Water: It's Just So Hard to Clean*, NATIONAL GEOGRAPHIC (Oct. 4 2013), http://energyblog.nationalgeographic.com/2013/10/04/fracking-water-its-just-so-hard-to-clean.

trapped in the shale.[30] At this stage, the flowback water is called "produced water" because it resembles the rock formation in its chemistry.[31] The distinction between flowback water and produced water is that flowback water is the injected fluid that is pumped or returns to the surface, while produced water is the formation water that is high in oil and gas content.[32] Produced water is what is then separated into crude oil and brine, and the brine is pulled to the surface as waste.[33] Produced water is found at all three stages of oil and gas production[34] and constitutes up to ninety-six to ninety-eight percent of all oil and gas waste, with the remaining two to four percent of waste being a combination of drilling fluid and other associated wastes.[35]

### *B. What is the Waste, How Much is It, and Where is the Waste Going?*

The oil and gas industry produces massive amounts of radioactive waste called TENORM.[36] For every barrel of oil produced, ten barrels of waste are produced—with eighteen billion barrels of fluid waste produced each year.[37] In addition to fluid waste, the industry also produces sludge, scale (radioactive chemical build up in pipes or tanks), and contaminated equipment during the entire production process.[38] This radioactive waste

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30 *How Radioactive is Fracking Flowback Water?,* REFINE 1, http://www.refine.org.uk/media/sites/researchwebsites/1refine/normrb/Norm%20RB%202.0.pdf (last visited Oct. 3, 2018); *Naturally-Occurring Radioactive Materials (NORM)*, WORLD NUCLEAR ASSOCIATION, http://www.world-nuclear.org/information-library/safety-and-security/radiation-and-health/naturally-occurring-radioactive-materials-norm.aspx (last updated May 2018).

31 *Fracking Water: It's Just So Hard to Clean*, *supra* note 29.

32 Tamzin A. Blewett et al., *The Effect of Hydraulic Flowback and Produced Water on Gill Morphology, Oxidative Stress and Antioxidant Response in Rainbow Trout (Oncorhynchus Mykiss),* SCIENTIFIC REPORTS 7 (Apr. 20, 2017), https://www.nature.com/articles/srep46582.

33 *TENORM: Oil and Gas Waste, supra* note 10.

34 *Proper Management of Oil and Gas Exploration and Production Waste*, *supra* note 23.

35 MANAGING INDUSTRIAL WASTE, *supra* note 2, at 67.

36 Jie Jenny Zou, *Fracking Produces Tons of Radioactive Waste. What Should We Do With It?,* GRIST (June 20, 2016), https://grist.org/business-technology/fracking-produces-tons-of-radioactive-waste-what-should-we-do-with-it.

37 *TENORM: Oil and Gas Waste, supra* note 10.

38 *Id.*

is called TENORM because the radioactivity of NORM[39] has been concentrated due to human activity—oil and gas production.[40] TENORM's concentration of radioactivity has a greater likelihood of exposure to humans, through work activities and the environment, because TENORM in oil and gas waste is found on equipment, is stored in open reserve pits,[41] or is injected into disposal wells that are not properly regulated.[42] The levels of radioactivity related to oil and gas exploration and production waste varies greatly depending on the salt content in the brine, the radioactivity of the rock formations, and the age of the wells.[43] The higher the salt content, the higher the radioactivity, and older wells generally have higher concentrations of TENORM.[44]

TENORM can be found during the exploration process in recycled hydraulic fracturing water or brine water, spent tank bottom, filtrate and used hydraulic fracturing sand, and in pipe scale during production.[45] This waste may include radium-228; radium-226—which emits gamma radiation and could increase the risk of cancer by penetrating the skin; and radon (decayed radium)—which could raise the risk of lung cancer when inhaled.[46] In addition, hydraulic fracturing uses toxic cocktails containing between 300 and 750 chemicals, seventy percent of which are known to

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39 *Id.*; NORM is found almost everywhere including the air, food, and in our body. RAILROAD COMMISSION OF TEXAS, *NORM (Naturally Occurring Radioactive Materials)*, http://www.rrc.state.tx.us/oil-gas/applications-and-permits/environmental-permit-types-information/norm (last updated July 18, 2017).

40 U.S. ENVTL. PROT. AGENCY, EPA 402-F-06-038, RADIOACTIVE WASTE FROM OIL AND GAS DRILLING (2006), http://large.stanford.edu/courses/2014/ph241/eller1/docs/drilling-waste.pdf; U.S. ENVTL. PROT. AGENCY, EPA 402-F-06-038, RADIOACTIVE WASTE FROM OIL AND GAS DRILLING (2006), http://large.stanford.edu/courses/2014/ph241/eller1/docs/drilling-waste.pdf; *Naturally Occurring Radioactive Materials (NORM)*, *supra* note 30.

41 Alisa L. Rich & Ernest C. Crosby, *Analysis Of Reserve Pit Sludge From Unconventional Natural Gas Hydraulic Fracturing And Drilling Operations For The Presence Of TENORM,* 23 NEW SOLUTIONS 177, 127 (2013), http://journals.sagepub.com/doi/pdf/10.2190/NS.23.1.h.

42 *Letter to EPA I*, *supra* note 4.

43 *Naturally Occurring Radioactive Materials (NORM)*, *supra* note 30.

44 *Id.*

45 OHIO DEP'T OF HEALTH, *NORM/TENORM Information Sheet* 4 (2012), https://odh.ohio.gov/wps/wcm/connect/gov/2e295499-cd71-4088-a78e-be80c5016dac/ODH-NORM-TENORM-Information-Sheet.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.Z18_M1HGGIK0N0JO00QO9DDDDM3000-2e295499-cd71-4088-a78e-be80c5016dac-mjI8lwD [https://perma.cc/UZG4-LABP].

46 *Radioactive Waste from Oil and Gas Drilling, supra* note 40.

be carcinogens or endocrine disruptors.[47] Because the fracturing cocktails are considered to be proprietary secrets, it is difficult to know the different chemicals found in the cocktails.[48] Currently, there is no federal agency fully regulating this waste, leaving regulation to states.[49] However, states have not been able to keep up with this radioactive waste, leaving the oil and gas industry to self-regulate and self-report.[50]

Produced water containing TENORM is the largest portion of hydraulic fracturing waste.[51] It is injected into disposal wells, while the sludge that accompanies produced water is dumped in landfills.[52] Old equipment that was contaminated with produced water during drilling is reused or disposed of.[53] In addition to injection in disposal wells, produced water is also treated and discharged into surface water, or recycled for other hydraulic fracturing projects.[54] A study by Duke University showed that hydraulic fracturing used nearly 250 billion gallons of water between 2005 and 2014, of which eighty-four percent or 210 billion gallons was wastewater.[55] Between 2009 and 2014, during the same time that the Duke University study was conducted, there were more than 21,000 spills from overflowing storage tanks, ruptured pipes, and other accidents or

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47 Jefferson Dodge & Joel Dyer, *America's Dirtiest Secret: How Billions of Barrels of Toxic Oil and Gas Waste Are Falling Through Regulatory Cracks,* BOULDER WEEKLY (Mar. 13, 2014), http://www.boulderweekly.com/news/americarsquos-dirtiest-secret.

48 Lisa Song, *What Chemicals are Used in Fracking? Industry Discloses Less and Less*, INSIDE CLIMATE NEWS (Nov. 25, 2015), https://insideclimatenews.org/news/24112015/fracking-natural-gas-drilling-chemicals-frac-focus-study.

49 Zou, *supra* note 36.

50 *Id.*

51 *Water Issues Dominate Oil and Gas Production*, OIL AND NAT. GAS PROGRAM NEWSL. (U.S. Dep't of Energy Nat'l Energy Tech. Lab., Albany, Or.), Fall 2013, at 1, https://www.netl.doe.gov/file%20library/research/oil-gas/epnews-2013-fall.pdf.

52 Valerie J. Brown, *Radionuclides in Fracking Wastewater: Managing a Toxic Blend,* 122(2) ENVTL. HEALTH PERSP. A50, A53 (Feb. 2014), https://www.researchgate.net/publication/260024031_Radionuclides_in_Fracking_Wastewater_Managing_a_Toxic_Blend/fulltext/549978170cf2d6581ab14807/260024031_Radionuclides_in_Fracking_Wastewater_Managing_a_Toxic_Blend.pdf?origin=publication_detail [https://perma.cc/5NRM-6FND].

53 MANAGING INDUSTRIAL SOLID WASTE, *supra* note 2, at 78.

54 Lee R. Hansen, *Transport, Storage, and Disposal of Fracking Waste, Office of Legislative Research*, CONNECTICUT GENERAL ASSEMBLY https://www.cga.ct.gov/2014/rpt/2014-R-0016.htm (last visited Mar. 6, 2018).

55 *How Much Water Does U.S. Fracking Really Use?,* DUKE TODAY (Sept. 15, 2015), https://today.duke.edu/2015/09/frackfoot.

deliberate dumping.[56] These spills released 175 million gallons of waste in the top eleven states involved in oil and gas production.[57]

Class II disposal wells, a subcategory of Class II wells, are wells designed to dispose of brine associated with oil and gas production.[58] The liquid waste from oil and gas production is pressed from the solid waste and is reinjected back into the ground in Class II disposal wells.[59] There are in excess of 150,000 Class II disposal wells in the United States, where approximately ten trillion gallons of oil and gas waste have been injected.[60] A majority of these wells are located in California, Kansas, Oklahoma, and Texas.[61] Class II disposal wells are required to be injected below drinking water, walled with several layers of steel tubing and cement, as well as have integrity tests done every five years.[62] However, tests of Class I and Class II wells showed 7,500 violations nationally, and one out of every three Class II wells tested in 2010 in Texas, had a violation.[63] Federal officials have acknowledged that the number of leaking well injection sites is unknown.[64] Between 2008 and 2011, there were at least twenty-five instances of leaks from Class II disposal wells reaching into aquifers.[65] Other tested wells were found to be designed to cheat mechanical integrity tests, leading to convictions of well operators and managers for conspiring to dump illegal waste and violate the SDWA.[66]

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56 Flesher, *supra* note 1.

57 Konkel, *supra* note 9.

58 *Class II Oil and Gas Related Injection Wells*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/uic/class-ii-oil-and-gas-related-injection-wells (last visited Mar. 6, 2018). In the U.S., it is estimated that 2 billion gallons of waste is injected to Class II wells annually.

59 *Class II Injection Wells,* FRACTRACKER ALLIANCE https://www.fractracker.org/categories/class-ii-injection-wells (last visited Aug. 31, 2018).

60 Abraham Lunstgarten, *Wastewater Injection Wells: The Trillion-Gallon Loophole*, HUFFPOST (Sept. 20, 2012, 5:26 PM), https://www.huffingtonpost.com/2012/09/20/wastewater-injection-wells_n_1901633.html [hereinafter *Trillion-Gallon Loophole*].

61 *Class II Oil and Gas Related Injection Wells, supra* note 58.

62 Abrahm Lustgarten*, Injection Wells: The Poison Beneath Us*, PROPUBLICA (June 21, 2012, 8:20 AM), https://www.propublica.org/article/injection-wells-the-poison-beneath-us.

63 *Id*.

64 *Id*.

65 *Id*. A Texas study has also found that 29 injection wells are likely to be leaking salt water into the ground without being noticed. *Id*.

66 *Trillion-Gallon Loophole*, *supra* note 60.

Some states, such as Texas, lack funding to enforce oversight regulations, and there are not enough officials to inspect the wells.[67] Texas employs just sixty-five inspectors for 428,000 wells.[68] Radioactive materials that are injected into the wells are not disclosed.[69] The EPA has known this was an issue even before the U.S. General Accounting Office released a report in 1989 highlighting that the safeguards in place were not preventing contamination from Class II wells.[70] In 2013, nearly 6,800 public water systems were estimated to have at least one hydraulic fracturing well within a one-mile radius.[71] Of the 9.4 million people living within one mile of the hydraulic fracturing wells, nearly 8.6 million people likely used water from the public water systems year-round in 2013.[72]

### C. *Exposure and Risk*

Humans are exposed to TENORM through several pathways, such as work activities, ingestion of contaminated crops and animals, and through dust particles blown on soil and crops.[73] Drilling fluids encompass drill cuttings (the shale that is removed from drilling a borehole) and mud or fluids mixed with additives that are pumped down a well to lubricate, relieve pressure, or to seal wells to prevent contamination.[74] These fluids are about two to four percent of oil and gas waste and are disposed of in reserve pits.[75] Usually, after a drilling operation is completed the pits are dried and the resulting solid waste is buried in the pits.[76] Reserve pits can expose humans to radioactive materials either through occupational exposure, direct exposure to groundwater, soil or air contamination, or through secondary sources such as ingestion of vegetable, dairy, or meat

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67 *Id.*

68 *Id.*

69 *Id.*

70 U.S. GOV'T ACCOUNTABILITY OFFICE, GAO/RCED-89-97, DRINKING WATER: SAFEGUARDS ARE NOT PREVENTING CONTAMINATION FROM INJECTED OIL AND GAS WASTES, (1989), https://www.documentcloud.org/documents/371047-gao-1989-uic-safeguards-are-not-preventing.

71 ASSESSMENT OF HYDRAULIC FRACTURING, *supra* note 5, at ES-6.

72 *Id.* at ES-5.

73 Rich & Crosby, *supra* note 41, at 119–27.

74 MANAGING INDUSTRIAL WASTE, *supra* note 2, at 67.

75 *Id.* at 67, 72. Both drilling fluids and mud are also disposed of by evaporation which is then followed by release of the waste into surface water. *Id.* at 72.

76 *See* Pedro Ramirez, Jr., *Reserve Pit Management: Risks to Migratory Birds*, U.S. FISH AND WILDLIFE SERV. 3 (Sept. 2009), https://www.fws.gov/migratorybirds/pdf/management/reservepitmanagementriskstomigbirds.pdf.

that is contaminated by radionuclides.[77] Even though guidelines are available for management of such radioactive exposure, the guidelines do not have recognized regulatory levels available. This is because radionuclides in impoundments have not been identified properly.[78]

Ingestion and inhalation of uranium and thorium decay products have documented carcinogenic effects on humans.[79] Eighty-five percent of radium that is ingested or inhaled could be concentrated in bones and stay in the body indefinitely.[80] Radon, radium's decayed by-product, could impact lungs and is the leading cause of cancer in non-smokers. Uranium has also been found to be related to chemical toxicity in the kidneys.[81]

The average exposure level in naturally occurring radiation (background radiation) in the United States is 300 millirems per year at sea level.[82] The maximum annual dose of radiation that is permitted for workers in the United States is 5,000 millirems.[83] According to the EPA, no amount of radiation is absolutely safe if above three to six

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77 Rich & Crosby, *supra* note 41, at 125–26; Radionuclides are radioactive forms of elements. *Radionuclides,* U.S. Envtl. Prot. Agency, https://www.epa.gov/radiation/radionuclides (last visited Mar. 30, 2018).

78 *Id.* at 126. "Reserve pits are commonly found in agricultural areas where the potential for crop and animal contamination is high. Animals drinking pit water, dust particles blowing onto soil and crops, and berms breaching (thus contaminating adjacent croplands) are all potential exposure pathways." *Id.* at 118–19.

79 Ass'n of State & Territorial Solid Waste Management Officials, *Incidental TENORM: A Guidance for State Solid Waste Managers*, 3 (Apr. 2011), http://astswmo.org/files/policies/Federal_Facilities/2011.04_FINAL_ASTSWMO_TENORM_Paper.pdf [hereinafter *Incidental TENORM*]

80 *Id.* at 4.

81 *Id.*

82 *Radiation, How Much is Considered Safe for Humans?,* MIT News (Jan. 5, 1994), http://news.mit.edu/1994/safe-0105. Rem is a unit that measures the biological effect of radiation dose that is absorbed. IIT KANPUR Indian Institute of Technology, Kanpur, *Radiation Units*, https://www.iitk.ac.in/ibc/RadiationUnits.pdf. Millirem is 1/1000th of a Rem. *Millirem,* https://www.merriam-webster.com/dictionary/millirem (last visited Aug. 18, 2018). Background radiation is the level of radiation that is normally present in the environment. *Background Radiation*, U.S. NRC, https://www.nrc.gov/reading-rm/basic-ref/glossary/background-radiation.html (last updated July 6, 2018).

83 *Information for Radiation Workers*, U.S. Nuclear Reg. Comm'n, https://www.nrc.gov/about-nrc/radiation/health-effects/info.html#how (last updated July 19, 2018).

millisieverts[84] or 300 to 600 millirems.[85] The oil and gas industry, as well as regulators, claim that the threat to workers and the public is considered minor enough to remain unregulated.[86] However, the Occupational Safety and Health Administration ("OSHA") has indicated that sources of exposure from TENORM may have been overlooked by federal and state agencies.[87]

## II. REGULATION (OR LACK THEREOF)

TENORM is often defined by exclusion.[88] The Nuclear Regulatory Commission ("NRC") does not consider TENORM as low-level radioactive waste under its regulatory authority nor is TENORM classified as source, special nuclear material, or by-product material under the Atomic Energy Act ("AEA").[89] Source material is related to mining radioactive ores or is produced during the mining and milling process.[90] Special nuclear material is any other material outside of source material,[91] and by-product material is any material that is incident to using or producing special nuclear material.[92]

### *A. Nuclear Regulatory Commission*

The NRC regulates radioactive waste management and classifies radioactive waste into high-level radioactive waste, low-level radioactive waste ("LLRW"), waste incident to reprocessing and uranium mill

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84 *Scientists Lack Complete Answers on Radiation Risk*, THE WASHINGTON POST (Mar. 18, 2011, 6:21 PM), http://www.washingtonpost.com/wp-dyn/content/article/2011/03/18/AR2011031804924.html?noredirect=on.

85 UNIT JUGGLER, *Convert Everything with Ease*, https://www.unitjuggler.com/convert-equivalentdose-from-mSv-to-mrem.html?val=6 (last visited Oct. 2, 2018).

86 Brown, *supra* note 52, at A51.

87 *Id.* at A53.

88 Phillip V. Egidi, *Regulatory Initiatives for Control and Release of Technologically Enhanced Naturally-Occurring Radioactive Material*, OAK RIDGE NATIONAL LABORATORY (Mar. 4, 1999), http://www.wmsym.org/archives/1999/27/27-8.pdf.

89 *Id.*

90 *Source Material*, U.S. NRC, https://www.nrc.gov/materials/srcmaterial.html (last updated June 5, 2017).

91 *Special Nuclear Material*, U.S. NRC, https://www.nrc.gov/materials/sp-nucmaterials.html (last updated Mar. 28, 2017).

92 *Byproduct Material*, U.S. NRC, https://www.nrc.gov/materials/byproduct-mat.html (last updated July 7, 2017).

tailings.[93] This Note will only consider high-level and low-level radioactive waste. High-level waste material is the by-product of nuclear fuel processing or the reactions which occur inside nuclear reactors.[94] Low-level radioactive waste is a blanket term for items that are contaminated with radioactive materials or materials that have become radioactive due to exposure to radiation.[95] These materials could have been contaminated or exposed in hospitals or nuclear fuel cycles or as waste from oil and gas production.[96]

The NRC further classifies LLRW into three different categories: Class A, Class B, and Class C.[97] Such categorization depends on the materials half-life and its radionuclide content,[98] and requires greater controls to protect public health and the environment as the categories increase from Class C to Class A.[99] The NRC only regulates materials containing radionuclides that exceed Class C; as a result, LLRW is not generally acceptable for disposal at near-surface disposal facilities regulated by the NRC.[100] Under the AEA and its amendments, unless TENORM qualifies as source material, with uranium and thorium concentrations greater than 0.05 percent by weight, the NRC does not have the authority to regulate TENORM because it is not source material waste.[101]

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93 *Radioactive Waste*, U.S. NRC, https://www.nrc.gov/waste.html (last updated Aug. 14, 2017).

94 *High-level Waste,* U.S. NRC, https://www.nrc.gov/reading-rm/basic-ref/glossary/high-level-waste.html (last visited Nov. 17, 2017).

95 *Low-level Radioactive Waste (LLW),* U.S. NRC, https://www.nrc.gov/reading-rm/basic-ref/glossary/low-level-radioactive-waste-llw.html (last updated July 6, 2018).

96 *Id.*

97 *Waste Classification (Classes of Waste)*, U.S. NRC, https://www.nrc.gov/reading-rm/basic-ref/glossary/waste-classification-classes-of-waste.html (last updated July 6, 2018).

98 *Approaches to an Integrated Framework for Management and Disposal of Low-Activity Radioactive Waste: Request for Comment,* 68 Fed. Reg. 65119 (proposed Nov. 18, 2003). https://www.federalregister.gov/documents/2003/11/18/03-28651/approaches-to-an-integrated-framework-for-management-and-disposal-of-low-activity-radioactive-waste [hereinafter *Proposed Disposal Rule*]. "[H]alf-life is defined as the time it takes for one-half of the atoms of a radioactive material to disintegrate." *Radioactive Half-Life*, NDT RESOURCE CENTER, https://www.nde-ed.org/EducationResources/HighSchool/Radiography/halflife2.htm (last visited Oct. 2, 2018).

99 *Waste Classification (Classes of Waste), supra* note 97.

100 *Proposed Disposal Rule*, *supra* note 98.

101 Rich & Crosby, *supra* note 41, at 128.

Low-Activity Radioactive Waste ("LARW") is a broad category of radioactive waste that is regulated by states.[102] It contains LLRW, Mixed Waste ("MW") and other wastes (e.g., TENORM).[103] Informally defined as radioactive waste containing very small concentrations of radionuclides, LARW does not yet require the same level of public health protection measures necessary for materials with higher activity of radioactive materials, because the concentration levels of radionuclides are deemed to be small enough that protection of public health is not yet warranted.[104] It should be noted, however, that "low-activity" is a concept rather than a statutory or regulatory definition.[105]

The National Academies Board on Radioactive Waste Management ("the Board") initiated a study to establish federal and state regulations controlling low-activity waste.[106] The Board's report defined LARW as those wastes that contain lower-levels of radioactive material less hazardous than LLRW.[107] The Conference of Radiation Control Program Directors ("CRCPD"), a non-governmental organization dedicated to radiation protection, defined TENORM as naturally occurring radioactive material with concentrated levels[108] of radioactive nuclides due to human activity such as processing—thus called Technically Enhanced Naturally Occurring Radioactive Materials ("TENORM").[109]

### *B. Atomic Energy Act*

In 2003, the EPA introduced the term "low-activity" in relation to radioactive waste, suggesting that the term would be used to encompass those wastes that can be managed in ways that protect public health and the environment without the need for regulations for high-level radioactive

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102 *Proposed Disposal Rule*, *supra* note 98.

103 *Id.*

104 *Low-Activity Radioactive Wastes*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/radiation/low-activity-radioactive-wastes (last visited Aug. 18, 2018).

105 *Id.*

106 NAT'L RESEARCH COUNCIL OF THE NAT'L ACAD., IMPROVING THE REGULATION AND MANAGEMENT OF LOW-ACTIVITY RADIOACTIVE WASTES: INTERIM REPORT ON CURRENT REGULATIONS, INVENTORIES, AND PRACTICES 7 (2003), https://www.nap.edu/download/10835 [hereinafter IMPROVING REGULATION].

107 *Id.*

108 *Incidental TENORM, supra* note 79, at 1; *About CRCPD*, CONF. OF RADIATION CONTROL PROGRAM DIRECTORS, INC., https://www.crcpd.org/page/About (last visited Aug. 21, 2018).

109 *Proposed Disposal Rule*, *supra* note 98.

waste.[110] At the time the EPA introduced the definition of "low-activity," the EPA did not have the ability to regulate LARW because, under Section 11(e) of the Atomic Energy Act of 1954, NORMs were not defined as a by-product material,[111] leaving regulation to states.[112] The Energy Policy Act of 2005 amended the AEA and added regulation of discrete sources of NORM as a category of by-product material in Section 11(e)(4) as "any discrete source of naturally occurring radioactive material, other than source material" that would pose a threat to public health and safety, similar to a discrete source of radium-226.[113]

Even if the amended AEA expanded the NRC's authority to regulate NORM, TENORM is still unregulated[114] because TENORM does not include source material or by-product materials regulated under both the NRC and the AEA.[115] Nonetheless, TENORM was defined by the CRCPD as NORM, and thus not regulated under AEA, even though it includes materials whose radionuclide content has been enhanced during oil and gas production.[116]

### C. Environmental Protection Agency Regulations

Apart from the Department of Transportation's ("DOT") regulation of TENORM transportation, TENORM is not currently regulated under federal law.[117] Even with the regulations under DOT, concentrations of

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110 *Id.*

111 U.S. NUCLEAR REG. COMM'N, NUREG-0980, NATIONAL REGULATORY LEGISLATION 109TH CONGRESS, 1ST SESSION 1–11 (2005), https://science.energy.gov/~/media/bes/pdf/nureg_0980_v1_no7_june2005.pdf. "The term 'byproduct material' means (1) any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material, and (2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content." *Id.*

112 IMPROVING REGULATION, *supra* note 106, at 3.

113 U.S. NUCLEAR REG. COMM'N, NUREG-0980, NUCLEAR REGULATORY LEGISLATION 112TH CONGRESS, 2ND SESSION 25 (2013), https://www.nrc.gov/docs/ML1327/ML13274A489.pdf.

114 *Incidental TENORM*, *supra* note 79, at 1.

115 U.S. ENVTL. PROT. AGENCY, TECHNICAL REPORT ON TECHNOLOGICALLY ENHANCED NATURALLY OCCURRING RADIOACTIVE MATERIALS FROM URANIUM MINING VOLUME 2: INVESTIGATION OF POTENTIAL HEALTH, GEOGRAPHIC, AND ENVIRONMENTAL ISSUES OF ABANDONED URANIUM MINES vi n.1 (2007), https://www.epa.gov/sites/production/files/2015-05/documents/402-r-08-005-v2.pdf.

116 *Incidental TENORM*, *supra* note 79, at 1.

117 Rich & Crosby, *supra* note 41, at 128.

radium-226 and radium-228 below 270 pCi/g each, absent any other radionuclides, are exempt from regulation.[118] Below are some of the federal regulations where the EPA has exempted regulation of oil and gas waste.

### 1. *Resource Conservation and Recovery Act*

RCRA is the principal law governing the disposal of solid and hazardous waste,[119] requiring the EPA to regulate the identification and management of hazardous waste.[120] In 1978, the EPA published the Hazardous Waste Guideline and Regulations, proposing to exempt oil and gas drilling mud and brine as "special waste" under Subtitle C of RCRA.[121] The proposal was later passed as an amendment to RCRA under the Solid Waste Disposal Act of 1980.[122] This amendment required the EPA to conduct a study and report to Congress the potential risk to humans and the environment before the end of 1982 and also determine whether regulation was required within six months of the report.[123] The Alaska Center for the Environment sued the EPA for missing the deadline and the EPA entered into a consent decree that extended the deadline to August 1987.[124] The EPA submitted a three-part report to Congress the following December.[125]

Within eight months, the EPA exempted oil and gas drilling muds and oil production brine from regulation under the RCRA Subtitle C, claiming that these wastes were lower in toxicity than those that were regulated under RCRA.[126] Instead, the EPA recommended three

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118 MONT. DEP'T OF ENVTL. QUALITY, DEVELOPMENT OF TENFORM RULES FOR THE STATE OF MONTANA 21 (2016), https://deq.mt.gov/Portals/112/Land/SolidWaste/Documents/docs/TENORMReportFinal.pdf [hereinafter MONTANA DEVELOPMENT OF TENORM RULES].

119 *History of the Resource Conservation and Recovery Act (RCRA)*, U.S. ENVTL. PROTECTION AGENCY, https://www.epa.gov/rcra/history-resource-conservation-and-recovery-act-rcra (last visited Feb. 27, 2018).

120 *Crude Oil and Natural Gas Waste*, EPA'S WEB ARCHIVE, https://archive.epa.gov/epawaste/nonhaz/industrial/special/web/html/index-16.html (last updated Apr. 19, 2016) [hereinafter *Crude Oil and Natural Gas Waste*].

121 *Id.*; Hazardous Waste Guidelines and Regulation, 43 Fed. Reg. 58946 (proposed Dec. 18, 1978).

122 *Crude Oil and Natural Gas Waste*, *supra* note 120.

123 *Id.*

124 *Id.*

125 *Id.*

126 U.S. ENVTL. PROT. AGENCY, EXEMPTION OF OIL AND GAS EXPLORATION AND PRODUCTION WASTES FROM FEDERAL HAZARDOUS WASTE REGULATIONS 5 (2002),

approaches to address the waste: (1) regulation under RCRA Subtitle D (non-hazardous solid waste), the Clean Water Act ("CWA") and Safe Water Drinking Act ("SDWA"), (2) working with states; and (3) working with Congress to regulate the waste.[127] These recommendations were based on three factors.[128]

The first factor for the recommendation relates to the diverse characteristics and waste management practices across various industries, which the EPA found to be impractical or inapplicable to individual sites.[129] Waste originating in diverse settings contains "a wide variety of *hazardous* constituents," and several of the waste management areas were in violation of federal and state requirements that resulted in damage.[130]

Second, the EPA found that, while most state and federal regulations were adequate, some gaps in regulatory oversight existed and regulatory enforcement was poor in some states.[131] It suggested that these shortcomings could be addressed under RCRA Subtitle D; the subsection regulating non-hazardous solid waste, because it gives the EPA general performance standards and the authority.[132] The remaining shortcomings would then be addressed by CWA and SDWA.[133]

Third, the EPA stated that the economic reality of "additional regulatory controls on the industry" could severely impact the industry economically.[134] It would also subject immense amounts of waste to regulation under RCRA Subtitle C, which would strain facilities under the subtitle.[135] And finally, such regulation would be inflexible to consider costs incurred by the industry.[136] As a result, the EPA concluded that it would not be able to fashion a regulatory program and the cradle-to-grave requirement under RCRA Subtitle C would not be suitable to fill the

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https://yosemite.epa.gov/oa/eab_web_docket.nsf/Attachments%20By%20ParentFilingId/945EF425FA4A9B4F85257E2800480C65/$FILE/28%20-%20RCRA%20E%26P%20Exemption.pdf [https://perma.cc/H3S8-PMHJ].

127 Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes, 53 Fed. Reg. 25447 (July 6, 1988), https://archive.epa.gov/epawaste/nonhaz/industrial/special/web/txt/ogreg88.txt [hereinafter Regulatory Determination].

128 *Id.*

129 *Id.*

130 *Id*. (emphasis added).

131 *Id.*

132 *Id.*

133 *Id.*

134 *Id.*

135 *Id.*

136 *Id.*

gaps.[137] A comprehensive waste management program, cradle-to-grave waste management requires the safe management of hazardous waste from the time it is created (cradle) to the time it is disposed of (grave), including the time in between where the waste is transported, treated and stored.[138]

The RCRA Subtitle C exemption covers only wastes uniquely related to primary field operations, including primary, secondary, and tertiary production of oil and gas.[139] To fall under the exemption, the waste must either be brought to the surface because of oil and gas drilling or it must be generated through removal of produced water and other contaminants from the production process.[140] In October 2002, the EPA issued a document which clarified the exemption and provided a non-exhaustive, but expansive, list for determining exempt or non-exempt waste in the oil and gas industry.[141]

### 2. *Safe Drinking Water Act*

The SDWA was passed in 1974 to protect public drinking water against contamination by naturally-occurring and man-made pollutants and authorizes the EPA to set the standards for regulation.[142] Not only does the SDWA ensure safe drinking water, it also sets the standards for injection of waste into waste disposal wells.[143] In the 1980's, when Congress banned injection of hazardous waste into wells, the industry successfully lobbied to have the waste classified as non-hazardous by arguing that the waste was harmless and that testing and inspecting disposal wells would cripple oil and gas production in the United States.[144] At the time, the Natural Resources Defense Council's geologist Briana

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137 *Id.*

138 *Learn the Basics of Hazardous Waste*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/hw/learn-basics-hazardous-waste#cradle (last visited Sept. 29, 2018).

139 RAILROAD COMMISSION OF TEXAS, *Interim Guidance for Statewide Rule 98: Standards for Management of Hazardous Oil and Gas Waste,* ch. 3 at 3-3, http://www.rrc.state.tx.us/media/7221/am-ch_3.pdf.

140 *Id.* at 3-4. For a detailed list of different types of waste which are exempt under RCRA, *see id*. at 3-6.

141 *Crude Oil and Natural Gas Waste*, *supra* note 120.

142 *Understanding the Safe Drinking Water Act,* U.S. ENVTL. PROT. AGENCY 1 (June 2004), https://www.epa.gov/sites/production/files/2015-04/documents/epa816f04030.pdf.

143 *Id.*

144 *Trillion-Gallon Loophole, supra* note 60 (Between 1998-2017 the oil and gas industry has spent nearly $2 billion in lobbying costs); Jake Frankenfield, *Which Industry Spends the Most on Lobbying? (ANTM, SO)*, INVESTOPEDIA (June 27, 2017, 1:15 PM), https://www.investopedia.com/investing/which-industry-spends-most-lobbying-antm-so.

Mordick stated that "[a] blanket exemption without any sense of what the actual chemistry of these wastewaters is, is very concerning."[145]

In accordance with SDWA, the EPA promulgated several Underground Injection Control ("UIC") regulations to police injection wells[146] used to store fluids, such as wastewater, brine, or other mixed chemicals, into porous deep rock formations.[147] Among the six classes of wells regulated by UIC, Class II disposal wells, a sub-category of Class II wells, are used to dispose of oil and gas brine, making up twenty percent of all Class II wells.[148] However, UIC does not regulate Class II disposal wells, which are only used for the production of oil and gas, as a result of the broad exemptions under SDWA.[149] Primacy, the primary enforcement mechanism for UIC programs, is an oversight authority granted by the EPA to states, territories, and tribes.[150] The EPA grants primacy under SDWA to states to be the primary authority for implementing SDWA.[151] In order to be granted primacy to implement SDWA, states must apply to the EPA and show that the state laws will be stricter than those required under EPA.[152]

In 1997, the Eleventh Circuit held that fracturing for coalbed methane constituted underground injection and must be regulated under the SDWA.[153] Following that decision, the EPA conducted research on the risk of hydraulic fracking on the environment and released a draft report concluding that there was only a small risk of contamination, except when diesel fuel was used during coalbed methane fracturing.[154] In 2004, based

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145 *Trillion-Gallon Loophole, supra* note 60.

146 *Region 1: EPA New England Ground Water Discharges (EPA'S Underground Injection Control Program),* U.S. ENVTL. PROT. AGENCY, https://www3.epa.gov/region1/eco/drinkwater/pc_groundwater_discharges.html (last visited Sept. 29, 2018).

147 *Underground Injection Control (UIC): General Information About Injection Wells,* U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/uic/general-information-about-injection-wells (last visited Sept. 29, 2018).

148 *Class II Oil and Gas Related Injection Wells, supra* note 58.

149 *Id.*

150 *Primary Enforcement Authority for the Underground Injection Control Program*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/uic/primary-enforcement-authority-underground-injection-control-program (last visited Sept. 29, 2018).

151 *Drinking Water Requirements for States and Public Water Systems: Primary Enforcement Responsibility for Public Water Systems*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/dwreginfo/primacy-enforcement-responsibility-public-water-systems (last visited Sept. 29, 2018).

152 *Understanding the Safe Drinking Water Act, supra* note 142.

153 Legal Envtl. Assistance Found., Inc. v. EPA, 118F.3d 1467, 1471 (11th Cir. 1997); TIEMANN & VANN, *supra* note 21.

154 TIEMANN & VANN, *supra* note 21.

on interviews and available studies, and finding no contamination cases, the EPA issued a final report stating that further study was not required and that injecting fracturing fluids into wells posed only a slight threat to drinking water.[155] However, the EPA did acknowledge that there was very little documented research on the impact of fracturing fluids injected into wells.[156]

Even though the Eleventh Circuit's decision only applied to coalbed mining, Congress amended SDWA through the Energy Policy Act of 2005 to update the definition of "underground injection," exempting fluids and proppants used in hydraulic fracturing for the extraction of oil and gas.[157] Known as the Halliburton Loophole—named after the inventor of hydraulic fracturing—this exemption stripped the EPA of its authority to regulate under SDWA.[158]

In 2015, urged by Congress, the EPA conducted a study on the relationship between hydraulic fracturing and drinking water.[159] The study was not a health risk assessment, did not summarize and evaluate current and proposed regulations, or explore the impact of hydraulic fracturing on the environment or other uses of water.[160] After reviewing every step of the hydraulic fracturing water cycle, although there were isolated cases of spills and contamination,[161] the EPA found no evidence of widespread and systemic impact on drinking water.[162]

### 3. *Clean Water Act and Other Regulations*

The Clean Water Act ("CWA") regulates the integrity of surface water in the United States and requires national permitting for facilities engaged in production, exploration, drilling, well treatment, and completion in the oil and gas industry.[163] However, in 2006 the EPA

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155 *Id.* at 20.

156 *Id.*

157 *Id.* at 21.

158 *The Halliburton Loophole*, NEW YORK TIMES (Nov. 2, 2009), http://www.nytimes.com/2009/11/03/opinion/03tue3.html (Halliburton is an oil and gas company which has been using hydraulic fracturing since the 1950's. The language of the Halliburton Loophole inserted into the Energy Policy Act of 2005 was through the efforts of former Vice President of the U.S. and Halliburton's former chairman and CEO); *Id.*

159 ASSESSMENT OF HYDRAULIC FRACTURING, *supra* note 5, at ES-1.

160 *Id.* at ES-4.

161 *Id.* at ES-3.

162 *Id.* at ES-23.

163 *Federal Water Quality Laws and Regulations*, INTERMOUNTAIN OIL & GAS BMP PROJECT, http://www.oilandgasbmps.org/laws/federal_water_quality_law.htm (last visited Mar. 2, 2018).

exempted the oil and gas industry from licensing requirements for stormwater runoff unless the runoff is contaminated with reportable quantities of oil or other hazardous materials.[164] Nonetheless, the EPA has clarified that tribes and states may regulate stormwater runoff under state and tribal authority, independent of their CWA authority.[165]

In addition, the Clean Air Act ("CAA") also exempts toxic emissions from the oil and gas industry. Generally, under the CAA, smaller emission sources are aggregated to protect public health while emissions from hydraulic fracturing wells are exempt from aggregation requirements under CAA.[166] Finally, hazardous waste cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA") also exempts the oil and gas industry from regulation because the definition of "hazardous substance" does not include waste from oil and gas production.[167] Because of the exemptions under the above-mentioned acts, federal agencies do not have authority to regulate TENORM, thus, leaving regulation to state law.[168]

### *D. Current Regulatory Scheme and State Survey*

As stated above, there is no federal regulation of TENORM under the Atomic Energy Act or the Low-level Radioactive Waste Policy Act. This is because TENORM is not classified as a source material, special nuclear material, or a by-product of nuclear production.[169] The Energy Policy Act expanded the NRC's regulatory authority to include regulation of discrete sources of naturally occurring radioactive materials; thirty-seven states signed an agreement (agreement states) with the NRC to retain the sole authority to regulate all radioactive waste, while the remaining states relinquished their authority to the NRC.[170] The agreement states are thus

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164 *Id.*

165 FRANK R. SPELLMAN, ENVIRONMENTAL IMPACTS OF HYDRAULIC FRACTURING 187 (2013).

166 *Oil and Gas Exemptions from Federal Laws The Oil and Gas Industry Enjoys Exemptions from 7 Environment Federal Laws,* FRACK FREE COLO., http://www.frackfree colorado.com/oil—gas-exemptions-from-federal-laws.html (last visited Oct. 1, 2018).

167 Tracy Hester, *CERCLA and Oil and Gas Operations*, UNIV. OF HOUS. (Oct. 18, 2017), http://www.law.uh.edu/faculty/thester/courses/Environmental%20Law%20in%20 Oil%20and%20Gas/101817%20CERCLA%20and%20E&P.pdf.

168 Zou*, supra* note 36.

169 Egidi, *supra* note 88.

170 ASS'N OF STATE & TERRITORIAL SOLID WASTE MGMT. OFFICIALS, STATE REGULATIONS AND POLICIES FOR CONTROL OF NATURALLY-OCCURRING AND ACCELERATOR PRODUCED RADIOACTIVE MATERIALS (NARM) AND TECHNOLOGICALLY ENHANCED NATURALLY OCCURRING RADIOACTIVE MATERIALS (TENORM) 2 (Dec. 2014),

granted the authority to regulate NORM, TENORM and certain by-product, special or source material.[171] For the states that have not entered into an agreement with the NRC, there is no regulation of TENORM either at the state or federal level.[172]

In a survey that was conducted by the Federal Facilities Research Center's Radiation Focus Group, in collaboration with the EPA, 37 out of 38 states had licensing mechanisms, 22 out of 40 states did not have regulations pertaining to disposal of TENORM, and only 16 out of the 44 states which had regulations responded by banning the disposal of TENORM in landfills.[173] In addition, two states regulating TENORM—Pennsylvania and Tennessee—do not explicitly set disposal limits in their guidelines, permits, regulations, or laws.[174] And, only a handful of the agreement states follow or have adopted the CRCPD guideline.[175]

Because of the complexity in quantifying the potential radiation exposure levels in TENORM, accurately assessing its impact on human health requires a thorough human health risk assessment.[176] The regulatory limits in some states are set without consultation of health officials or are not based on the impact of exposure to a combination of multiple radioactive materials, unlike those that are found in oil and gas waste.[177] Furthermore, radioactivity guideline levels have not been established for oil and gas waste because many of the radionuclides have not been identified,[178] or, for the ones which have been identified, variations in their radionuclide composition have not been properly studied.[179] Radium may not be the appropriate indicator for public

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http://astswmo.org/files/policies/Materials_Management/State_Statutes_and_Regulations_TENORM_Final_Dec2014.pdf. [hereinafter STATE REGULATIONS AND POLICIES].

171 OHIO DEP'T OF HEALTH, *Agreement State Program*, http://www.odh.ohio.gov/odhprograms/rp/nm_saf/nm_saf1.aspx (last updated May 21, 2018).

172 *See generally* MONTANA DEVELOPMENT OF TENORM RULES, *supra* note 118.

173 STATE REGULATIONS AND POLICIES, *supra* note 170, at 2–9.

174 Elizabeth Ann Geltman Glass, *Regulation of Oil & Gas Wastes Containing TENORM,* LAWATLAS 1 (Jan. 2017), http://legacy.lawatlas.org/files/upload/1_9_2017_Regulation%20of%20Wastes%20Containing%20TENORM_Essential%20Information.pdf.

175 STATE REGULATIONS AND POLICIES, *supra* note 170, at 13.

176 Rich & Crosby, *supra* note 41, at 126.

177 *Id.* at 131.

178 *Id.* at 118.

179 CONFERENCE OF RADIATION CONTROL PROGRAM DIRECTORS, INC., PUB. NO. CRCPD E-15-2, E-42 TASK FORCE REPORT: REVIEW OF TENORM IN THE OIL & GAS INDUSTRY 4 (June 2015), http://www.emlf.org/clientuploads/images/min_law_16_materials/Greenwell_task_force.pdf.

exposure as it is used as a "measure for multiple radionuclide waste streams, while a higher exemption threshold is used for an individual radionuclide"; this may lead to an underestimation of exposure levels.[180] It may also be that in areas where oil and gas waste has been dumped and humans have been exposed, health issues related to low-level radiation exposure, usually related to industry workers, may be overlooked by medical professionals because industrial-level exposures are not anticipated in these areas.[181]

The testing method currently used by the EPA may allow large quantities of radioactive materials to be dumped into landfills.[182] For example, in Texas, radioactivity in a reserve pit sludge has been found to exceed the state limits by 800 percent when tested using beta instead of alpha testing.[183] Another issue with hydraulic fracturing wastewater is that radium and uranium levels could be underestimated because the radioactivity can only be detected but not quantitatively measured.[184] Even if radioactivity could be measured, operators dumping their waste were found to be using outdated methods.[185] For example, operators in Colorado relied on a study that used a discredited testing protocol, and as a result, they undermeasured radioactivity by factors of 100 to 1,000.[186] Finally, there are no regulatory guidelines available for many radionuclides.[187] And since the radionuclides were only recently identified in some hydraulic fracturing wastes, guidelines for non-occupational exposure limits have not yet been established.[188]

*1. Pennsylvania*

The Marcellus Shale formation in Pennsylvania is known to have high uranium content.[189] Concentrations of radium-226 (decayed uranium) sometimes exceeding 10,000 picocuries per liter (pCi/l) in the concentrated brine fluids that are left from ancient seawater are

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180 Rich & Crosby, *supra* note 41, at 130–31.

181 *Id.* at 125.

182 Wendell G. Bradley, *The Dangers of Fracking Waste: Is There Any Safe Way to Dispose of It,* CTR. FOR RES. ON GLOBALIZATION, (Dec. 11, 2017), https://www.globalresearch.ca/the-dangers-of-fracking-waste/5622357.

183 *Id.*

184 *Id.*

185 *Id.*

186 *Id.*

187 Rich & Crosby, *supra* note 41, at 126.

188 *Id.*

189 Brown, *supra* note 52, at A51.

concentrated over millions of years.[190] This formation made the state the fastest-growing United States producer between 2011 and 2012.[191] In 2011, the Pennsylvania Department of Environmental Protection ("PADEP") asked all companies involved in hydraulic fracturing operations in the Marcellus Shale region to cease sending their produced water to commercial or public wastewater treatment plants, where in the past the treated water was released into rivers and streams that served as sources of drinking water.[192] This directive resulted in producers reusing their wastewater or sending it for treatment at out-of-state facilities capable of remediating produced water and reusing the water afterwards.[193] Pennsylvania is an agreement state.[194]

### 2. *Colorado*

Colorado does not permit radioactive materials in solid waste disposal facilities.[195] The Colorado Department of Public Health and Environment ("CDPHE"), which oversees oil and gas production, is statutorily prohibited from promulgating TENORM regulations.[196] As a result, until the division is able to update the Colorado Radiation Control Act and develop TENORM regulations,[197] it must use nonbinding policies and guidelines.[198] A draft of the TENORM Policy and Guidance from the CDPHE grants relief from state law prohibitions and gives special approval for certain operations.[199] The policy states that only TENORM with concentration levels less than 50 pCi/g but greater than three pCi/g are managed under the policy.[200] Because Colorado state laws conflict with federal laws promulgated by the EPA, low-level radioactive waste has been dumped illegally in facilities that are not authorized to handle the

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190 *Id.*

191 *Id.* at A52.

192 *Id.*

193 *Id.*

194 STATE REGULATIONS AND POLICIES, *supra* note 170, at 8.

195 *Hazardous Materials in Landfills*, PUEBLO CHIEFTAN, Sept. 22, 2017, http://www.chieftain.com/news/region/hazardous-materials-in-landfills/article_0aff66ad-0d36-5f1e-874f-3e1ae4013bcd.html.

196 COLO. REV. STAT. § 25-11-104 (2018); Letter from Joe Schieffelin, Manager, Solid Waste and Materials Mgmt. Program, to Solid Waste Landfill Owner or Operator (Nov. 7, 2017) [hereinafter CDPHE Letter].

197 *Id.*

198 *Id.*

199 MONTANA DEVELOPMENT OF TENORM RULES, *supra* note 118, at 11.

200 *Id.*

waste.[201] In November 2017, following news of illegal dumping in the state,[202] the CDPHE published a letter banning oil and gas waste with the potential for high concentrations of TENORM from all solid waste facilities which are not specifically authorized to accept such waste.[203] However, this prohibition only applies to solid waste such as tank bottoms, filter socks, filter press cake or sludge, discarded pipes and flow line, and residual materials, but not to produce water.[204]

The EPA granted Colorado primacy to administer Class II injection wells in 1984 and allowed for disposal of brine in Class II disposal wells.[205] Colorado has 55,000 wells generating about 500,000 tons of solid waste per year, some of which is low-level radioactive waste.[206] Between 2000 and 2010 the number of active oil and gas wells in Colorado nearly doubled, from about 22,230 to about 43,400. Approximately ninety-five percent of new wells used hydraulic fracturing.[207] The November 2017 letter requires approved facilities to reject radioactive waste that is greater than or equal to the regulated levels of TENORM.[208] All oil and gas exploration waste has the potential to exceed the regulated levels of TENORM.[209]

*3. North Dakota*

North Dakota regulates disposal of TENORM up to five pCi/g because it is similar to the pCi/g level of background radiation in soil.[210]

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201 *Hazardous Materials in Landfills, supra* note 195.

202 *Id.*

203 CDPHE Letter*, supra* note 196, at 2.

204 *Id.*

205 David Andrews, *Colorado Oil and Gas Conservation Commission Class II Underground Injection Control Rules and Regulations,* GARFIELD COUNTY ENERGY ADVISORY BOARD (Oct. 7, 2010), https://slideplayer.com/slide/5044297.

206 Bruce Finley, *Colorado Landfills are Illegally Burying Low-Level Radioactive Waste from Oil and Gas Industry, Denver Post Learns*, THE DENVER POST (updated Sept. 25, 2017, 1:54 AM), https://www.denverpost.com/2017/09/22/colorado-landfills-illegally-burying-radioactive-waste-oil-gas.

207 *COLORADO AND FRACKING*, EARTHJUSTICE, https://earthjustice.org/features/colorado-and-fracking (last updated Sept. 29, 2015).

208 *Pawnee Waste Facility Details,* PAWNEE WASTE LLC, http://www.pawneewaste.com/facility-details (last visited Oct. 2, 2018).

209 *Id.*

210 N.D. DEPT. OF HEALTH, *TENORM Information Sheet,* (2014), https://deq.nd.gov/Tenorm/InformationFactSheets/NDDoH%20TENORM%20INFORMATION%20SHEET-v.FINAL.pdf.

Otherwise, anything above five pCi/g must be shipped out of state.[211] Because acceptable limits for TENORM had not been studied, the North Dakota Department of Health ("NDDOH") commissioned a study to determine acceptable limits to protect public health and the environment.[212] The study found that the highest levels of exposure would be to landfill workers. Based on the study, NDDOH proposed robust rules which would require TENORM generators to be registered, specialized landfills to accept the waste, maximum limits to be set on the amount of waste that would be accepted at a facility, and require the waste to be buried and covered.[213] After over 150 illegal dumps were discovered in the Bakken region in 2014, North Dakota was forced to enact TENORM regulations in 2016.[214] However, because there are no landfills licensed to accept the waste in North Dakota, the waste is currently sent to Montana.[215]

## III. PROPOSED REGULATION OF TENORM

### *A. Regulation of Hazardous Waste Under RCRA*

Exemption of oil and gas waste under RCRA does not preclude the waste materials from being hazardous to public health and the environment. Under RCRA, for waste to be considered hazardous it must first be classified as solid waste.[216] Solid waste is defined by the EPA as refuse, sludge, or other materials that are disposed of including a range from solids to gaseous materials in contained form.[217] To be categorized as solid waste, the waste must also be hazardous.[218] Hazardous wastes exhibit characteristics such as ignitability, corrosivity, reactivity, and

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211 *Id.*

212 *Id.*

213 *Id.*

214 Matt Hudson, *Radioactive Bakken Waste Buried in Montana, While ND has no Licensed Dump Sites*, THE BISMARCK TRIBUNE (Jan. 5, 2018), https://bismarcktribune.com/news/state-and-regional/radioactive-bakken-waste-buried-in-montana-while-nd-has-no/article_7c2d1f04-d302-5351-a416-71cd48399708.html.

215 *Id.*

216 *What is a RCRA Hazardous Waste?,* U.S. ENVTL. PROT. AGENCY, https://waste.zendesk.com/hc/en-us/articles/211677238-What-is-a-RCRA-hazardous-waste (last visited Oct. 2, 2018).

217 *Id.*

218 CAL. DEP'T TOXIC SUBSTANCE CONTROL, DEFINING HAZARDOUS WASTE 1 (2018) https://www.dtsc.ca.gov/HazardousWaste/upload/DefiningHazardousWaste.pdf.

toxicity.[219] Hazardous waste is ignitable if the waste can cause fire in certain conditions, while corrosivity pertains to the waste material's ability to corrode metal containers.[220] The reactivity of hazardous materials relates to the chemicals ability to react or become unstable under certain conditions.[221] Finally, the toxicity of hazardous waste depends on whether the waste is harmful or fatal if ingested.[222]

The waste materials found in oil and gas waste are not included on the list of toxic elements listed under Subtitle C.[223] This is likely attributed to the waste not being accurately defined by its radioactivity,[224] and because there are no reliable tests to determine the reactivity of the radionuclides.[225] However, several studies have indicated that radioactivity of radium-226 and radium-228 in TENORM far exceed the limits set by the EPA for disposal in landfills.[226] As a result, TENORM containing radium may be categorized incorrectly and may be inadequately regulated.[227]

Under RCRA Subtitle C, an appropriate regulatory method would include classifying the waste as hazardous because constituent particles in produced water, drilling fluids, and drilling muds have been found to be toxic.[228] Produced water may contain toxic compounds that are mixed with sand and sent down boreholes. These chemicals include benzene, bromide, cadmium, lead, and mercury.[229] Testing in some states, including New Mexico, has shown that the oil and gas waste in reserve pits have failed the EPA's test for toxicity under Toxicity Characteristic Leaching

219 *Id.* at 2.

220 *Id.*

221 *Id.*

222 *Id.*

223 40 C.F.R. § 261.24 (2010).

224 Elizabeth Ann Glass Geltman & Nichole LeClair, *Variance in State Protection from Exposure to NORM and TENORM Wastes Generated During Unconventional Oil and Gas Operations: Where We Are and Where We Need to Go,* 28(2) SAGE J. 240, 244 (Feb. 6, 2018).

225 Letter from Amy Hall & Diana Donnelly, Nat. Res. Def. Council, to Lisa Jackson, Adm'r, U.S. Envtl. Prot. Agency (Sept. 8, 2010), http://www.law.uh.edu/faculty/thester/courses/Environmental%20Law%20in%20Oil%20and%20Gas/NRDC%20petition%20for%20E&P%20rulemaking.pdf [hereinafter Letter to EPA II]. For the waste to be considered reactive under 40 C.F.R. § 261.23, it needs to be shown that it has the potential to explode, release gas that is toxic, or react violently. *Id.*

226 *See* Bradley, *supra* note 182.

227 Geltman & LeClair, *supra* note 224.

228 *See generally* Sharma, *supra* note 15.

229 Konkel, *supra* note 9, at A231.

Procedures ("TCLP").[230] This test lists elements regulated for toxicity; if the leaching test shows that the presence of these chemicals exceeds the limits set by the EPA, then the waste is considered hazardous.[231] In New Mexico, tested pits contained toxic waste such as mercury, arsenic, and lead exceeding limits set under TCLP.[232]

In the Marcellus shale, leaching tests were conducted to understand leaching of heavy metals in a typical disposal site.[233] In one sample waste, barium was found to exceed TCLP limits.[234] The barium found in the samples may have been a result of barite, a barium compound, used as an agent in drilling muds.[235] The concentration of barium ions in oil and gas waste could also strongly indicate the existence of radioactivity.[236] Other elements in the waste—lead, antimony, beryllium, cadmium, and chromium—also exceeded the regulatory limits set under drinking water regulations.[237] Releasing these chemicals to surface water or groundwater could have a significant impact on human health and the environment.[238]

Oil and gas production waste meets some of the characteristics of hazardous waste. This warrants a more stringent protection under Subtitle C of RCRA. Classification of TENORM as hazardous waste under RCRA would require the waste from oil and gas production to be regulated by the EPA from cradle to grave. It would also give the industry the incentives to implement safer disposal methods.[239]

Under Subtitle C of RCRA, "any person" can petition for an amendment under Subpart G – Standards for Universal Waste Management to include additional hazardous waste materials or a category

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230 Letter to EPA II, *supra* note 225, at 40.

231 *Toxicity Characteristic Leaching Procedure*, U.S. ENVTL. PROT. AGENCY, at 1311-1, https://www.epa.gov/sites/production/files/2015-12/documents/1311.pdf. Leaching is the process by which materials in a solid phase, when coming into contact with liquids, transfer to the liquid phase. This process is dependent on many factors like biological, chemical or physical conditions of the materials. *An Introduction to U.S. EPA's Next Generation of Leaching Testing,* TRANSAMERICA, http://www.testamericainc.com/media/1606/testamerica-leaf.pdf.

232 Letter to EPA II, *supra* note 225, at 40.

233 Sharma, *supra* note 15, at 2.

234 *Id.* at 56.

235 *Id.* at 49.

236 Ebenezer T. Igunnu & George Z. Chan, *Produced Water Treatment Technologies,* 9 INT'L J. OF LOW-CARBON TECH. 157, 158–59 (2014).

237 Sharma, *supra* note 15, at 57.

238 *Id*. at 14.

239 Letter to EPA II, *supra* note 225, at 7.

of waste.[240] Such additions are approved if it is demonstrated that regulation under the subsection is warranted, and if the inclusion would improve the implementation of a hazardous waste program.[241] In addition, the waste has to meet factors for petition such as a large volume of operators (more than 1000) generating the waste, the risk associated with the waste, and whether regulation of the waste would improve compliance with hazardous waste programs.[242] The petition must also show that the waste meets the characteristics of hazardous waste.[243] Once these requirements are met, TENORM would be categorized as waste from a specific source.[244]

Categorization of the waste as hazardous would give the EPA the requisite authority to regulate the industry's waste management from cradle-to-grave because the EPA would have to approve and issue permits for treatment of waste, regulate storage and disposal, and oversee and approve States' regulation of the waste.[245] The RCRA permitting program would require facilities to provide notice of waste management for oil and gas extraction companies,[246] which would fast-track the regulation of TENORM because providing notice to the appropriate agency prohibits "any person" from operating facilities without an EPA approved permit within six months of the waste being identified and listed as hazardous waste.[247] Finally, in addition to extensive regulation by both states and the EPA, RCRA also allows for enforcement actions through civil litigation and criminal penalties for violations.[248]

Classification of TENORM as hazardous waste would also enable regulation of drilling waste in reserve pits. Drilling waste stored in reserve pits can contaminate soil and surface water if the reserve pits are not managed and closed properly[249] because several of these pits have been found to contain hazardous chemicals.[250] Reserve pits are open and may be lined to prevent leaching of chemicals; however, even if the pits are

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240 40 C.F.R. § 260.23(a) (1995); *id.* § 273 (2016).
241 *Id.* § 260.23(a); *id.* § 273.
242 *Id.* § 273.81.
243 *Id.* § 261 (1980).
244 *Id.* § 261.32.
245 *Id.* § 270.1 (2016).
246 *Id.* § 270.1(c).
247 *Id.* § 270.1(b).
248 *Id.* § 271.16 (1998).
249 Ramirez, *supra* note 76, at 4.
250 *Id.*

lined, a simple tear would make the liner ineffective.[251] After well completion, some states give reserve pit operators between thirty days and one year before the pits have to be closed.[252] The reserve pits are then dried and the remaining waste is encapsulated with liner and buried in a hole that is dug adjacent to the pit.[253]

Regulation under RCRA Subtitle C would allow the waste that is in reserve pits to be temporarily stored in surface impoundment lots.[254] Surface impoundments are required to be double lined and must have leak detection systems.[255] In addition, impoundments must be inspected regularly for deterioration, erosion, changes in content, and malfunction and operators must have an action plan in case of leakage.[256] Finally, upon decommissioning, the waste needs to be cleaned or removed. If it is not possible to clean the waste, it needs to be stabilized and the impoundment must be closed.[257]

Waste that cannot be temporarily stored in surface impoundments can be sent to Subtitle C landfills, which have more or less the same requirements as surface impoundments, but with the added benefit of stormwater runoff controls for at least twenty-five years.[258] Because these landfills are used to store waste permanently, at closure long-term liquid migration must be minimized, the landfill must be able to function with the least amount of maintenance, and the owners must monitor leaks and groundwater.[259]

Another more expansive approach would be to add a new category to the list of hazardous waste characteristics.[260] Adding TENORM to the list can be achieved by amending the hazardous waste list to include radioactivity as a new category.[261] The lack of information about the health effects of TENORM could be addressed under the Criteria for

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251 *Id.*

252 U.S. FWS, RESERVE PITS MORTALITY RISKS TO BIRDS 1 (2009) https://www.fws.gov/mountain-prairie/contaminants/documents/ReservePitsBirdMortality.pdf.

253 *Id.*

254 U.S. ENVTL. PROT. AGENCY, EPA530-K-05-014, INTRODUCTION TO LAND DISPOSAL UNITS 2 (2005), https://www.epa.gov/sites/production/files/2015-07/documents/ldu05.pdf.

255 *Id.*

256 *Id.* at 4.

257 *Id.*

258 *Id.* at 7.

259 *Id.* at 8.

260 40 C.F.R. § 261.11 (1992).

261 *Id.* § 261.

Listing Hazardous Waste, which provides that in the absence of evidence showing TENORM is fatal to humans, its toxicity can be shown through animal testing—mostly on rats and rabbits.[262] As a result, the lack of information about the health effects of TENORM could be supplemented with studies conducted on animals.[263]

### *B. Regulation of TENORM Under the SDWA*

The U.S. Geological Survey has found evidence that hydraulic fracturing waste can impact the environment after investigations discovered that a disposal site in West Virginia had contaminated a nearby creek with radioactive metals (radium) and other hormone-disrupting chemicals.[264] Even if the wastewater is treated before it is released to the environment, "[t]he treatment technologies used by wastewater treatment plants may not remove all of the pollutants contributing to radioactivity. As a result, these pollutants will be discharged to surface waters."[265] All radionuclides found in oil and gas wastewater generate radiation that is harmful to human health and the environment; and because of their higher solubility, radium-226 and radium-228 levels have been found "200 times greater than upstream and background sediment concentrations."[266]

To protect drinking water, SDWA bans underground injection of contaminants that endanger any source of drinking water.[267] Because disposal of hydraulic fracturing is not considered underground injection,[268] SDWA exempts oil and gas companies from permitting

262 *Id.* § 261.11(a)(2).

263 *Id.* § 261.11.

264 Zahira Hirji, *Dangerous Contaminants Found in Creek Near Gas Wastewater Disposal Site*, INSIDE CLIMATE NEWS (May 12, 2016), https://insideclimatenews.org/news/12052016/oil-and-gas-drilling-wastewater-injection-wells-west-virginia-water-contaminated-chemicals-fracking.

265 Memorandum from Sarah Yates, E. Research Grp., to Lisa Biddle & Karen Milam, U.S. Envtl. Prot. Agency 15 (June 6, 2016), https://www.regulations.gov/document?D=EPA-HQ-OW-2014-0598-1266.

266 *Id.* at 13–15.

267 *Regulating Oil & Gas Activities to Protect Drinking Water: The Safe Drinking Water Act's Underground Injection Control Program,* CLEAN WATER ACTION 1 (Jan. 2015), https://www.cleanwateraction.org/files/publications/UIC%20-%20Clean%20Water%20repbort%201.6.15.pdf [hereinafter *Regulating Oil & Gas*].

268 MARY TIEMANN, CONG. RESEARCH SERV., RL34201, SAFE DRINKING WATER ACT (SDWA): SELECTED REGULATORY AND LEGISLATIVE ISSUES 21 (2010).

requirements for Class II disposal wells,[269] except for those that use diesel fuel for hydraulic fracturing coalbed methane.[270]

States that apply for and are given primacy by the EPA to implement UIC for Class II disposal wells do not need to meet the same requirements set by EPA for all other waste disposal wells.[271] The states are required to show that the requirements in state regulations represent an effective program.[272] This means that, because the waste is not considered hazardous, its regulation is less stringent than other lower class wells.[273] This has led to oversight both by EPA and states in regulating and administering the UIC programs.[274]

The UIC program for Class II disposal wells exempts a section of aquifers that do not currently serve as a source of drinking water for extraction or waste disposal purposes.[275] Ninety-five percent of the aquifer exemptions are used by the oil and gas industry—a third of which are used for waste disposal.[276] Even if the aquifers are not used as a source of drinking water at the time, it still means that the exemption allows oil and gas operators to potentially contaminate groundwater.[277] Because the aquifer exemptions and the associated guidance do not require any modeling or monitoring, adjacent underground sources of drinking water which are non-exempt are at risk for contamination.[278]

If RCRA is amended to include hydraulic fracturing waste as hazardous waste, the billions of gallons of waste pumped into Class II disposal wells would be regulated under the more stringent Class I hazardous waste wells. Class I wells are typically used for industrial and

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269 *Class II Oil and Gas Related Injection Wells, supra* note 58.

270 TIEMANN & VANN, *supra* note 21, at 6.

271 *Regulating Oil & Gas*, *supra* note 267, at 3.

272 *Id.*

273 *Id.*

274 *Id.* at 4.

275 U.S. ENVTL. PROT. AGENCY, 810-S-16-009, FACT SHEET ON AQUIFER EXEMPTION DATA (2017), https://www.epa.gov/sites/production/files/2017-02/documents/ae_data_fact_sheet_508_002.pdf. Most of the nearly 3,000 aquifer exemptions in the U.S. are in Colorado, Montana, Wyoming, Utah, Texas and Indian Country. *Id.* See image on the first page showing an aquifer exemption.

276 *Id.* at 2.

277 Kyle Farrar, *What are Aquifer Exemptions? Permitted Exemptions from the Safe Drinking Water Act,* FRACTRACKER ALLIANCE (Oct. 26, 2017), https://www.fractracker.org/2017/10/aquifer-exemptions.

278 Letter to EPA I*, supra* note 4, at 41.

municipal waste disposal including petroleum refining.[279] These wells are deeper than Class II wells because the final injection site is lower than the lowest source of underground drinking water and at least a quarter mile away from the nearest drinking source.[280] Operation of a Class I well requires a permit from the EPA. To obtain the permit, geological studies need to show that: (1) the well construction area is appropriate to receive the waste; (2) the formation is large enough to handle the pressure from injection; (3) the area has low-permeability to confine the waste; (4) there are no fissures or faults; and (5) there is low probability for earthquakes and seismic activity.[281]

Class I well construction requires testing for migration of fluids and at least two layers of cement, along with packing and tubing that is approved by a UIC program.[282] Additionally, well operation requires monitoring injection pressures to avoid creating or increasing fractures, continuous monitoring and recording of activity, shutdown devices and alarms in case of emergency, and wells that can be operated only with the approval of a UIC program.[283] There are also stringent requirements for integrity tests and reporting procedures for waste analysis.[284] Finally, when the wells are closed and abandoned, operators need to conduct pressure and integrity tests and monitor groundwater for contamination.[285]

## CONCLUSION

While we wait for comprehensive, unbiased studies of the impact of hydraulic fracturing waste on human health and the environment, billions of gallons of radioactive waste continue to be injected into disposal wells that reach aquifers, and radioactive sludge is stored in open reserve pits. The oil and gas industry, and the EPA's reliance on the industry for access to information, may be the reason such studies are delayed or even

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279 *Class I Industrial and Municipal Waste Disposal Wells,* U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/uic/class-i-industrial-and-municipal-waste-disposal-wells (last visited Oct. 2, 2018).

280 *Id.*

281 *Requirements for all Class I Wells and Class I Hazardous Waste Wells*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/sites/production/files/2015-10/documents/page_uic-class1_summary_class1_reqs_508c.pdf. Well injections related to hydraulic fracturing have been known to cause earthquakes. Ellsworth, *Injection-induced earthquakes,* PUBMED (July 12, 2013), https://www.ncbi.nlm.nih.gov/pubmed/23846903.

282 *Id.*

283 *Id.*

284 *Id.*

285 *Id.*

prevented.[286] In addition, the studies we have now denying the impact of hydraulic fracturing waste on human health and the environment are not independent of the industry and have not been peer reviewed.[287]

Because the EPA categorizes hydraulic fracturing waste as non-hazardous, small exemptions have led to larger ones and a patchwork of inconsistent regulation by states, with virtually no oversight by the EPA. Existing regulations that defer to the oil and gas industry, allowing it to self-regulate and self-report, must be updated to catch up to the growing industry and the massive amount of waste it produces. The EPA should use RCRA to regulate every step of oil and gas production and protect public health and the environment by classifying hydraulic fracturing waste as hazardous waste.

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286 Justin Miller, *Why It's So Hard to Regulate Fracking*, AMERICAN PROSPECT (June 24, 2015), http://prospect.org/article/why-its-so-hard-regulate-fracking.

287 Peter Gleick, *Significant Figures: The Growing Evidence of the Threat of Fracking to the Nation's Groundwater* (June 27, 2013), http://scienceblogs.com/significantfigures/index.php/2013/06/27/the-growing-evidence-of-the-threat-of-fracking-to-the-nations-groundwater.