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Unconventional Shale Gas Development: Conventional Risks to Surface Water from Deforestation, Erosion and Sedimentation, and Stormwater Runoff

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ABSTRACT

High-volume hydraulic fracturing ("fracking") involves blasting shale rock formations at tremendous pressure with millions of gallons water mixed with sand and chemicals to release natural gas. In the past decade, the novel combination of fracking and horizontal directional drilling has led to a shale gas rush across the United States. Although there is a debate about whether fracking itself can contaminate drinking water aquifers, there are many pathways by which shale gas development will necessarily adversely affect water resources. After a brief overview of some of these pathways, this paper examines the surface water quality impacts resulting from the land-intensive development of shale gas infrastructure, including well pads, access roads, and pipelines. Especially in the Marcellus Shale in New York and Pennsylvania, shale gas development will result in massive deforestation, increasing erosion and sedimentation and stormwater runoff. The Clean Water Act exempts gas operations as well as the construction of gas facilities under five acres from stormwater regulations. Erosion and sedimentation from shale gas infrastructure may substantially affect states' abilities to meet Total Maximum Daily Load requirements for the Chesapeake Bay and other impaired waters.

Can Hydraulic Fracturing Contaminate Drinking Water Aquifers?

Defining fracking narrowly as the act of blasting fracking fluids far underground, proponents argue that fracking itself has never been shown to contaminate drinking water through naturally occurring or manmade pathways connecting deep shale layers and shallow groundwater layers.[1] Several reports, including EPA's recently published preliminary study of a contaminated aquifer

[1] For example, Rex W. Tillerson, chief executive of ExxonMobil, testified before Congress in 2010 that "There have been over a millions wells hydraulically fractured in the history of the industry, and there is not one, not one, reported case of a freshwater aquifer having ever been contaminated from hydraulic fracturing. Not one." Quoted in Ian Urbina, "A Tainted Water Well, and Concern There May Be More," New York Times, August 3, 2011, available at http://www.nytimes.com/2011/08/04/us/04natgas.html

in Pavillion, Wyoming,[2] as well as an EPA report from 1987,[3] cast significant doubt on this assertion. The large and growing number of reported incidents of drinking water contamination potentially related to hydraulic fracturing and shale gas extraction in general only underscores the need for further investigation.[4]

In November 2011, EPA released its Final Hydraulic Fracturing Study Plan, implementing a 2010 congressional directive to study the impacts of fracking on drinking water resources.[5] Preliminary results are expected in 2012 and final results in 2014. This study, which will review scientific studies and industry reports and conduct retrospective and prospective studies of well sites within major shale plays, will focus on five major stages in the fracking process: water acquisition, chemical mixing, well injection, flowback and produced water, and water treatment and waste disposal. Although the EPA study will likely address a number of critical gaps in current knowledge, it will not capture all the routes by which shale gas extraction contaminates surface and groundwater resources. The EPA study design excludes consideration of a number of aspects of shale gas development that have water quality impacts, particularly with respect to surface water, as discussed further below.

Shale Gas Development's Myriad Water Quality Impacts

Shale gas development is an extraordinarily land- and water-intensive process that converts agricultural, forest, and range lands to industrial uses, consumes millions of gallons of water per well, and generates huge quantities of hazardous wastes.[6] Some of the major water quality impacts shale gas development causes are as follows:

Casing and Cementing Failures

Failures in the integrity of well casing and cementing occur regularly, either because of faulty construction or because of degradation over time, opening potential pathways for contaminants to

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[2] EPA, Groundwater Investigation: Pavillion, Draft Report and supporting documents, available at http://www.epa.gov/region8/superfund/wy/pavillion/ See also Chris Mooney, "The Truth About Fracking," Scientific American, November 2011, pp. 80-85, at 85.

[3] See Urbina, supra note 1, citing EPA, "Report to Congress: Management of Wastes from the Exploration, Development, and Production of Crude Oil, Natural Gas, and Geothermal Energy," December 1997, available at http://www.nytimes.com/interactive/us/drilling-down-documents-7.html#document/p1/a27935

[4] See, e.g., Amy Mall, NRDC, "Incidents where hydraulic fracturing is a suspected cause of drinking water contamination," http://switchboard.nrdc.org/blogs/amall/incidents_where_hydraulic_frac.html

[5] http://www.epa.gov/hfstudy/index.html

[6] Shale gas extraction is also a significant source of hazardous air pollution, including methane, volatile organic chemicals (VOCs), and air toxics such as benzene and ethylbenzene. In July 2011, EPA proposed a suite of draft regulations under the Clean Air Act to set new source performance standards for VOCs and sulfur dioxide, an air toxics standard for oil and natural gas production, and an air toxics standard for natural gas transmission and storage. Final regulations are due by April 3, 2012. See http://www.epa.gov/airquality/oilandgas/ The Department of Energy's advisory panel on shale gas has urged EPA to extend these rules to existing shale gas production sources and to adopt regulations addressing methane explicitly. Bridget DiCosmo, "DOE Panel Urges EPA to Strengthen Proposed Air Rules for 'Fracking,'" Nov. 10, 2010, http://insideepa.com/201111102381935/EPA-Daily-News/Daily-News/doe-panel-urges-epa-to-strengthen-proposed-air-rules-for-fracking/menu-id-95.html Methane is twenty times more potent a greenhouse gas than carbon dioxide. See http://www.climatescience.gov/infosheets/highlight1/default.htm

The oil and gas industry is the single largest source of methane emissions in the US, accounting for nearly 40% of national methane emissions. See http://epa.gov/airquality/oilandgas/pdfs/20110728factsheet.pdf reach shallow aquifers.[7] It is also plausible that fracking may create fissures that extend above the targeted horizontal shale layer and link with naturally occurring fissures or abandoned wellbores, allowing methane, fracking fluids, and produced waters to reach shallow aquifers.[8]

Hazardous Waste Disposal

Shale gas extraction uses and produces numerous toxic substances that are not governed by uniform national standards for treatment and disposal. Drilling muds and fracturing fluids contain a laundry list of toxic ingredients, while produced waters and drill cuttings bring to the surface naturally occurring hazards such as highly carcinogenic BTEX chemicals (benzene, toluene, ethylbenzene, and xylene) as well as brines, radioactive materials, arsenic, mercury, and hydrogen sulfide. Most of these wastes are exempt from regulation under Subtitle C of the Resource Conservation and Recovery Act governing the generation, transportation, treatment, storage, and disposal of hazardous wastes.[9] Similarly, under the Comprehensive Environmental Response, Compensation, and Liability Act, petroleum and natural gas (including liquefied natural gas) are excluded from regulation as hazardous substances.[10] These wastes pose water contamination and health hazard risks whether they are buried in pits, applied to land, injected into underground wells, sprayed into the air, spilled, leaked, or intentionally dumped.

Wastewater Treatment and Disposal

Flowback fluids and produced water contain all of the chemicals initially injected as part of the fracturing fluid, as well as other naturally occurring hazardous compounds released during the fracturing process. Wastewater pollutants include everything from lead, arsenic, benzene, diesel fuel[11], and high levels of total dissolved solids to naturally occurring radioactive materials such as

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[7] See, e.g., Andrew Nikiforuk, "Fracking Contamination 'Will Get Worse': Alberta Expert," The Tyee, Dec. 19, 2011, http://thetyee.ca/News/2011/12/19/Fracking-Contamination/ (quoting University of Alberta geochemist Karlis Muelenbachs); see also Runar Nygaard, Wabamun Area CO2 Sequestration Project: Well Design and Well Integrity at 6, Jan. 4, 2010, available at http://www.ucalgary.ca/wasp/Well%20Integrity%20Analysis.pdf (summarizing data on well integrity).

[8] See Mooney, "The Truth About Fracking," Scientific American, November 2011, pp. 80-85, at 83 (graphic), 84-5.

[9] U.S. Environmental Protection Agency, "Exemption of Oil and Gas Exploration and Production Wastes from Federal Hazardous Waste Regulations," pp. 10-11, available at http://www.epa.gov/osw/nonhaz/industrial/special/oil/oil-gas.pdf (listing exempt and non-exempt wastes). NRDC petitioned EPA in 2010 to regulate these wastes under RCRA. NRDC, "Petition for Rulemaking Pursuant to Section 6974(a) of the Resource Conservation and Recovery Act Concerning the Regulation of Wastes Associated with the Exploration, Development, or Production of Crude Oil or Natural Gas or Geothermal Energy," Sept. 8, 2010, available at http://docs.nrdc.org/energy/files/ene_10091301a.pdf EPA has not yet formally responded to the petition.

[10] 42 U.S.C. § 9601(14).

[11] The Energy Policy Act of 2005 exempted hydraulic fracturing from regulation under the Underground Injection Control Program of the Safe Drinking Water Act. Hydraulic fracturing utilizing a mixture containing diesel fuel represents a limited exception to this exception. Nevertheless, an investigation by the House Committee on Energy and Commerce Democrats uncovered the injection of "32.7 million gallons of diesel fuel or hydraulic fracturing fluids containing diesel fuel in wells in 20 states" between 2005 and 2009. Letter from Reps. Waxman, Markey, DeGette, House Comm. on Energy and Commerce, to Lisa Jackson, Administrator, U.S. Envtl. Prot. Agency (Oct. 25, 2011), available at http://democrats.energycommerce.house.gov/index.php?q=news/reps-waxman-markey-and-degette-report-updated-hydraulic-fracturing-statistics-to-epa . EPA is presently developing guidance on permitting the use of diesel in fracturing fluids. Underground Injection Control Guidance for Permitting Oil and Natural Gas

uranium and radium.[12] This wastewater must be treated and disposed of properly. Ground and water contamination may result from spills, leaks, or improper disposal.

Under the Safe Drinking Water Act, EPA may only regulate fracturing wastewater disposal or the use of diesel in fracturing fluid.[13] Common disposal methods include underground injection and the transport of flowback to wastewater treatment facilities. EPA's preferred method for disposing of flowback and production water is to use underground injection wells.[14] The availability of this method is reliant on regional underlying geology, however, and therefore not suitable for use in all regions undergoing shale gas development.[15] Moreover, underground injection of fracking waste has recently been associated with induced seismicity.[16] An alternate option is to transport flowback and production water to a wastewater treatment facility for treatment and disposal. However, most commercial and municipal wastewater treatment facilities are ill-equipped to handle fracking waste. Such facilities are unable to remove naturally occurring radioactive material from the waste stream and the high levels of total dissolved solids present may overwhelm a plant's treatment capacity.[17] Once released into surface waters following insufficient treatment, the wastewater may subsequently overwhelm the dilution-capacity of rivers in regions undergoing intensive shale gas development.[18]

Although EPA's ability to regulate hydraulic fracturing is limited by industry exemptions, additional regulations in the realm of fracking wastewater are proposed. Specifically, EPA's 2010 final Effluent Guidelines Program Plan indicates the agency's intent to develop pretreatment requirements for the discharge of wastewater from the shale gas extraction industry in 2014.[19] Further, EPA is presently contemplating the development of water quality criteria for bromide, a common constituent in flowback and produced water.[20] Though bromide is not itself harmful to

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Hydraulic Fracturing Activities Using Diesel Fuels, http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_hydroout.cfm

[12] See N.Y.C. Dep't of Envtl. Prot., Final Impact Assessment Report: Impact Assessment of Natural Gas Production in the New York City Water Supply Watershed 6 (2009); NRDC, Land Facts: Protecting New Yorkers' Health and the Environment by Regulating Drilling in the Marcellus Shale 3 (2009), available at http://www.nrdc.org/land/files/marcellus.pdf ; Chemicals Used by Hydraulic Fracturing Companies in Pennsylvania for Surface and Hydraulic Fracturing Activities, Pa. Dep't of Envtl. Prot., http://www.dep.state.pa.us/dep/deputate/minres/oilgas/new_forms/marcellus/Reports/Frac%20list%206-30-2010.pdf

[13] Regulation of Hydraulic Fracturing Under the Safe Drinking Water Act, U.S. Envtl. Prot. Agency, http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_hydroreg.cfm

[14] "EPA Weighs Setting Possible First-Time Water Quality Criteria for Bromide," Inside EPA, Jan. 5, 2012, http://insideepa.com/201201052386440/EPA-Daily-News/Daily-News/epa-weighs-setting-possible-first-time-water-quality-criteria-for-bromide/menu-id-95.html

[15] Id.

[16] Briana Mordick, "More Earthquakes, This Time from Oil and Gas Disposal," NRDC Switchboard (Jan. 3, 2012), http://switchboard.nrdc.org/blogs/bmordick/more_earthquakes_this_time_fro.html

[17] See, e.g., Joaquin Sapien, "What Can Be Done With Wastewater?," Pittsburgh Post-Gazette, Oct. 4, 2009, http://www.post-gazette.com/pg/09277/1002919-113.stm ; Ian Urbina, "Regulation Lax As Gas Wells' Tainted Water Hits Rivers," New York Times, Feb. 26, 2011, http://www.nytimes.com/2011/02/27/us/27gas.html?pagewanted=all

[18] Id.

[19] Notice of Final 2010 Effluent Guidelines Program Plan, 76 Fed. Reg. 207 (Oct. 26, 2011); Final 2010 Effluent Guidelines Program Plan Fact Sheet, http://water.epa.gov/lawsregs/lawsguidance/cwa/304m/factsheet2011.cfm ; Shale Gas Extraction, U.S. Envtl. Prot. Agency (Oct. 20, 2011), http://water.epa.gov/scitech/wastetech/guide/shale.cfm

[20] See supra note 14.

human health or aquatic life, it contributes to the formation of total trihalomethanes.[21] Trihalomethanes are known carcinogens and are additionally injurious to liver, kidney, and central nervous system function.[22]

Water Consumption

The proliferation of shale gas development has the potential to degrade water systems due to the massive volumes of water consumed. To the extent that fracking fluids remain underground or are disposed of in underground injection wells, much of the freshwater used for fracking is permanently removed from the hydrological cycle. While some improvements have been made in developing wastewater reuse systems, eventually the pollutants in the fracking fluid reach such extreme concentrations that the fluid becomes unusable and must disposed of.[23]

Accidents, Negligence, and Illegal Actions

Accidents resulting from negligent construction methods and operations are inevitable. In 2011 alone, the Pennsylvania Department of Environmental Protection issued more than a thousand notices of violation to natural gas operators within the Marcellus Shale region.[24] This represents a 400% increase in reported violations as compared to 2008.[25] These accidents cover a wide spectrum of violations, including surface spills, blowouts, improper casing construction, erosion and sediment control failures, faulty pollution prevention, failures in site restoration, improper waste management, and wastewater impoundment construction failures.[26] One well blowout is estimated to occur for every thousand wells drilled; however, the severe consequences of a blowout make this ostensibly small number significant.[27] Deliberate non-compliance in the form of illegal dumping also degrades water quality.[28]

Surface Water Quality Impacts of Shale Gas Infrastructure Construction and Maintenance

Shale gas development consumes not only vast quantities of water but also acres of land for well pads, pipelines, and access roads. In the forested and agricultural lands overlaying the Marcellus Shale, this massive industrialization will cause widespread impacts to surface water quality from deforestation, stormwater runoff, and erosion and sedimentation.

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[21] Id.
[22] Id.
[23] Susan Phillips, "New Technology Treats Fracking Water In Pennsylvania," Sept. 6, 2011, http://stateimpact.npr.org/pennsylvania/2011/09/06/new-technology-treats-frack-water-in-pennsylvania/
[24] Matthew Kelso, "2011 Marcellus Shale Violations in PA," http://data.fractracker.org/cbi/dataset/datasetPreviewPage?uuid=~01eff9046c035611e19931a7bb56cb4f26
[25] PADEP Oil & Gas Inspections – Violations – Enforcements: Updated 11/17/11, http://www.dep.state.pa.us/dep/deputate/minres/oilgas/OGInspectionsViolations/OGInspviol.htm (2008 total number of violations: 205; 2011 total number of violations: 1090).
[26] Id.
[27] In April 2011, for example, a natural gas well operated by Chesapeake went out of control for roughly twelve straight hours, spewing more than 10,000 gallons of chemically laced fuel into the local environment, which included a pasture and creek. Dave Fehling, "When Wells Blow Out In Pennsylvania, Texans Step In," Jan. 5, 2012, http://stateimpact.npr.org/texas/2012/01/05/when-wells-blow-out-in-pennsylvania-texans-step-in/
[28] For example, in Greene County, Pennsylvania, a waste water hauler was recently charged with illegally dumping millions of gallons of Marcellus Shale wastewater over a period of six years. "Shale Wastewater Hauler Waives Hearing in Trial," Pittsburgh Post-Gazette, Sept. 27, 2011, http://www.post-gazette.com/pg/11270/1177907-55.stm

Forests play an essential role in water purification.[29] The scientific literature clearly establishes the link between percent forest cover and water quality; for example, reductions in forest cover are directly correlated with negative changes in water chemistry, such as increased levels of nitrogen, phosphorus, sodium, chlorides, and sulfates as well as reduced levels of macroinvertebrate diversity.[30] Reducing forest cover decreases areas available for aquifer recharge, increases erosion, stormwater runoff, and flooding, and adversely affects aquatic habitats.[31] Already in Pennsylvania, researchers have correlated areas of high natural gas well density with decreased water quality, as indicated by lower macroinvertebrate density and higher levels of specific conductivity and total dissolved solids.[32]

Both deforestation and shale gas infrastructure construction and operation will, in turn, lead to greatly increased levels of erosion, sedimentation, and stormwater runoff affecting surface water quality. Excess sedimentation is associated with a number of detrimental effects on water quality, stream morphology, and aquatic life, and has been identified by the EPA as one of the primary threats to US surface waters.[33]

Shale gas well sites are like traditional construction sites in terms of stormwater runoff and sediment discharge levels.[34] A 2005 EPA study concluded that "gas well sites have the potential to negatively impact the aquatic environment due to site activities that result in increased sedimentation rates."[35] Prior to drilling, space must be cleared and graded to construct the well pad and to accommodate all necessary equipment.[36] Each well pad requires the clearing and

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[29] Robert A. Smail & David J. Lewis, Forest Service, U.S. Dep't of Agric., Forest Land Conversion, Ecosystem Services, and Economic Issues for Policy: A Review 12 (2009), available at http://www.fs.fed.us/openspace/fote/pnw-gtr797.pdf

[30] Jackson, J.K. & Sweeney, B.W., "Expert Report on the Relationship Between Land Use and Stream Condition (as Measured by Water Chemistry and Aquatic Macroinvertebrates) in the Delaware River Basin," Stroud Water Research Center, Avondale, PA, available at http://www.state.nj.us/drbc/Sweeney-Jackson.pdf

[31] State of N.J. Highlands Water Prot. and Planning Council, Ecosystem Management Technical Report 39 (2008).

[32] Academy of Natural Sciences of Drexel University, "A Preliminary Study of the Impact of Marcellus Shale Drilling on Headwater Streams," available at http://www.ansp.org/research/pcer/projects/marcellus-shale-prelim/index.php

[33] Entrekin, S. et al., "Rapid expansion of natural gas development poses a threat to surface waters," Frontiers in Ecology and Environment 2011, 9(9), 503-11 (Oct. 6, 2011), at 507, 509, available at http://www.esajournals.org/doi/abs/10.1890/110053

[34] Havens, David Loran, Assessment of sediment runoff from natural gas well development sites. M.S. thesis May 2007, available at http://digital.library.unt.edu/ark:/67531/metadc3665/m1/1/high_res_d/thesis.pdf ; see also 55 Fed. Reg. 47,990, 48,044-34 (Nov. 16, 1990) (Phase I stormwater regulation describing scope and significance of water quality impacts from sediment runoff from construction activities); 64 Fed. Reg. 68,722, 68,728-30 (Dec. 8, 1999) (Phase II stormwater regulation reiterating concerns about sediment-laded stormwater discharges and extending permitting requirements to small construction sites).

[35] Banks, Kenneth E., Ph.D., and Wachal, David J., U.S. EPA, Final Report for Catalog of Federal Domestic Assistance Grant Number 66.463 Water Quality Cooperative Agreement for Project Entitled "Demonstrating the Impacts of Oil and Gas Exploration on Water Quality and How to Minimize these Impacts Through Targeted Monitoring Activities and Local Ordinances" (Dec. 2007), available at http://www.epa.gov/npdes/pubs/oilandgas_impactgrant.pdf

[36] See, e.g., New York State Dep't of Envtl. Conservation, Revised Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas, and Solution Mining Regulatory Program: Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale

grading of, on average, 3.1 acres, while the construction of associated infrastructure (access roads, impoundments, pipelines, and compressor stations) necessary for future well site construction, drilling, and gas exportation consumes another 5.7 acres, for a total of almost 9 acres per well pad.[37]

In Pennsylvania, the Nature Conservancy has estimated that nearly two-thirds of well pads targeting the Marcellus Shale will be developed in forested areas, necessitating the clearing of 38,000 to 90,000 acres.[38] An additional 60,000 to 150,000 acres of forest area will be lost to pipeline construction and right-of-way maintenance.[39] Compressor stations along the pipelines, which occupy an average of five acres each, are likely to number in the hundreds.[40] In New York, deforestation will occur on a similar scale, with losses in forest cover of up to 16%.[41]

Well site construction and operation can have both immediate impacts and long-term impacts to surface water quality. For example, in March 2011, the Pennsylvania Department of Environmental Protection issued a stop-work order to Chesapeake Energy during its preparation of a well pad in West Branch Township, Potter County.[42] The site's discharge of sediment and silt into a tributary of a water source serving the Borough of Galeton was so significant that the Galeton Water Authority was forced to switch to another permitted drinking water source. Had the water supply operator not been on site to shut off an intake valve, the water supply for 1400 residents would have been irreparably degraded.[43]

Heavy truck traffic on rural roads, especially unpaved roads, that were not built to withstand hundreds or thousands of truck trips also leads to significant erosion and sedimentation problems.[44] Hundreds of truck trips, with each vehicle weighing up to 10 tons, may be required to construct and operate a single well. Ditches along rural roads are the primary pathways for the conveyance of polluted runoff bearing sediments and nutrients to streams, and increase runoff

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and Other Low-Permeability Gas Reservoirs 5-10 (2011), available at http://www.dec.ny.gov/data/dmn/rdsgeisfull0911.pdf

[37] The Nature Conservancy, "Pennsylvania Energy Impacts Assessment Report 1: Marcellus Shale Natural Gas and Wind," November 5, 2010, at 10, available at http://www.nature.org/media/pa/pa_energy_assessment_report.pdf . The range of numbers reflects low, medium, and high shale gas expansion scenarios over the next 30 years of 6,000, 10,000, and 15,000 new well pads.

[38] Id. at 29.

[39] The Nature Conservancy, "Natural Gas Pipelines," Excerpt from Report 2 of the Pennsylvania Energy Impacts Assessment, December 16, 2011, at 5, available at http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/pennsylvania/ng-pipelines.pdf

[40] Id. at 5-6.

[41] The Nature Conservancy, "An Assessment of the Potential Impacts of High Volume Hydraulic Fracturing (HVHF) on Forest Resources," Dec, 19, 2011, at 4, available at http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/newyork/ny-hydrofracking-impacts-20111220.pdf

[42] "DEP Shuts Down Potter County Gas Well Pre-Construction Over Violations Impacting Public Water Supply," DEP Press Release, Mar. 23, 2011, available at http://www.newsroom.dep.state.pa.us/newsroompublic/Print.aspx?id=16727&typeid=1

[43] Dunlap, Katy, "Shale Gas Production and Water Resources in the Eastern United States," Testimony before the U.S. Senate Committee on Energy and Natural Resources Subcommittee on Water and Power, Oct. 20, 2011 at 3, available at http://energy.senate.gov/public/_files/DunlapTestimony102011.pdf

[44] See C.J. Randall, Hammer Down: A Guide to Protecting Local Roads Impacted by the Marcellus Shale (Dec. 2010), available at http://www.greenchoices.cornell.edu/downloads/development/marcellus/Marcellus_Randall.pdf

volume and energy as well, contributing to flooding.[45] In addition, access roads constructed or modified to enter gas exploration or extraction facilities contribute significantly to sedimentation and surface water quality degradation.

Pipeline construction and right-of-way maintenance account for a significant proportion of shale gas extraction's land use impacts. Gathering lines connect individual well pads to the large-scale transmission infrastructure. Because each well pad must be connected to a gathering line, tens of thousands of gathering lines may be built in Pennsylvania alone. Though subject to far less regulation, the gathering lines constructed in the Marcellus region are as large in diameter and may operate at even greater pressure than interstate transmission lines.[46]

Pipelines also create significant erosion and sedimentation problems during construction as well as over the decades-long maintenance of cleared rights-of-way. In joining well pads to transmission infrastructure, a single gathering line may cross numerous streams and rivers, especially in states such as Pennsylvania with a high density of stream mileage per unit of land. Stream and wetland pipeline crossings cause erosion and sedimentation whether implemented through dry ditch or wet ditch crossings.[47] Though erosion and sediment control permits may be required for stream crossings—indeed, in Pennsylvania they are the only permits necessary for gathering line construction—in practice, permit requirements are routinely violated.[48] Both dry and wet ditch crossings necessitate the clearing of area stream banks. Because riparian vegetation functions as a natural barrier along the stream edge, both removing sediment and other pollutants from surface runoff and stabilizing stream banks,[49] its clearing necessarily increases a stream's susceptibility to erosion events. Cumulatively, the construction of numerous crossings across a single watercourse may significantly degrade the quality and flow rate of the water body.[50] Erosion and sedimentation problems are often exacerbated by the staging of construction, during which soils are exposed for long periods and over long distances by clearing, grading, and trench cutting before final pipeline installation and revegetation.[51]

Clean Water Act Issues in Stormwater Management and TMDLs

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[45] Yen Hoang & Keith Porter, Stormwater Management in the Rural New York Headwater Areas of the Chesapeake Bay Watershed, Journal of Water Law 21:6 (2010) at 8.

[46] Craig R. McCoy & Joseph Tanfani, "Similar Pipes, Different Rules," Phila. Inquirer, Dec. 12, 2011, available at http://articles.philly.com/2011-12-12/news/30507185_1_hazardous-materials-safety-administration-pipeline-safety-rules ("Also in Bradford County, another company - Chesapeake Energy - is building a pipeline the same size as the Tennessee [Interstate Transmission] line, 24 inches in diameter. And it's designed to operate at even higher pressure - up to 1,440 pounds per square inch.").

[47] The Nature Conservancy, "Natural Gas Pipelines," Excerpt from Report 2 of the Pennsylvania Energy Impacts Assessment, December 16, 2011, at 7, available at http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/pennsylvania/ng-pipelines.pdf

[48] Beth Brelje, Pike Conservation Official Fed Up With Gas Company's Violations, Pocono Record, Sept. 20, 2011, http://www.poconorecord.com/apps/pbcs.dll/article?AID=/20110920/NEWS/109200330/-1/rss01 (noting numerous violations documented on Tennessee Gas Pipeline Company project) .

[49] David J. Welsch, Forest Service, U.S. Dep't Agric., NA-PR-07-91, Riparian Forest Buffers: Function and Design for Protection and Enhancement of Water Resources (1991), available at http://na.fs.fed.us/spfo/pubs/n_resource/buffer/cover.htm

[50] Canadian Association of Petroleum Producers, Canadian Energy Pipeline Association, and Canadian Gas Association, "Pipeline Associated Watercourse Crossings," 1-4 (2005).

[51] Comments on Environmental Assessment of MARC I Hub Line Project, Exhibit G, FERC Docket No. CP10-480-000, Submittal 20110711-5189 (filed Jul. 22, 2011) (statement of Susan Beecher, Executive Director, Pike County PA Conservation District (Jul. 8, 2011)), available at http://elibrary.ferc.gov/idmws/docket_sheet.asp

The 1987 Water Quality Act amended the CWA to establish a phased and tiered set of NPDES permitting requirements for stormwater discharges,[52] but specifically excluded the discharge of uncontaminated stormwater from the operation of oil, gas, and mining facilities.[53] However, EPA's Phase I and Phase II stormwater rules covered discharges bearing uncontaminated sediment from the construction of oil and gas sites in 1990 (for activities disturbing five or more acres)[54] and 1999 (for activities disturbing one to five acres of land).[55]

In 2005, Congress amended the CWA through the Energy Policy Act specifically to exempt construction activities on oil and gas sites from coverage.[56] EPA's 2006 implementing regulations[57] exempted from stormwater permitting requirements all sediment discharges from the construction and operation of gas well sites and associated infrastructure. These regulations thus allowed unlimited discharges of sediment from oil and gas construction activities, even where such discharges otherwise violated water quality standards.[58] The Ninth Circuit overturned this regulation in Natural Resources Defense Council v. U.S. Environmental Protection Agency, 526 F.3d 591 (9th Cir. 2008).

EPA has not promulgated new regulations in response to the NRDC v. EPA decision, and the effective stormwater regulations are those that were in effect prior to the 2006 rule.[59] Currently, federal law does not require stormwater permits for the construction of a gas site under five acres. Because tens of thousands of well sites in the Marcellus Shale will occupy less than five acres, the cumulative impacts of the erosion and sedimentation from these sites will go largely unregulated.

One significant legal issue that results is whether increased nutrient and sediment runoff caused by shale gas development will impair states' abilities to comply with their obligations to meet Total Maximum Daily Loads (TMDLs) established for impaired waters under Section 303(d) of the CWA, 33 U.S.C. § 1313(d).

The TMDL program sets pollution limits for impaired waters (or "water quality limited segments" [WQLS]) that have not attained applicable water quality standards despite effluent limitations and other water pollution control regulations.[60] A TMDL for each pollutant impairing a WQLS establishes a wasteload allocation, which is allocated to existing and future point sources, and a load allocation, attributed to existing and future non-point sources, including natural background sources, plus a margin of safety.

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52 Pub. L. No. 11-4, § 405, 101 Stat. 7, 69 (Feb. 4, 1987) (codified at 33 U.S.C. § 1342(p)).

53 33 U.S.C. § 1342(*l*)(2).

54 55 Fed. Reg. 47,990 (Nov. 16, 1990).

55 64 Fed. Reg. 68,721 (Dec. 8, 1999). The implementation of these regulations was postponed and they never took effect before the 2005 Energy Policy Act was passed. See 70 Fed. Reg. 11,560 (Mar. 9, 2005) (final rulemaking to delay until June 12, 2006, the permit authorization deadline for NPDES stormwater runoff permits for small oil and gas construction activities disturbing one to five acres).

56 Pub. L. No. 109-58, § 323, 119 Stat. 594, 694 (Aug. 8, 2005) (codified as amended at 33 U.S.C. § 1362(24)).

57 71 Fed. Reg. 33,628 (June 12, 2006) (codified at 40 C.F.R. § 122.26 (2006)).

58 40 C.F.R. § 122.26(a)(2)(ii) (2006).

59 See http://cfpub.epa.gov/npdes/stormwater/oilgas.cfm

60 See generally Steven T. Miano & Kelly A. Gable, "Total Maximum Daily Loads: Section 303(d)," Ch. 11, The Clean Water Act Handbook, 3rd ed. 2011.

The Chesapeake Bay TMDL, finalized on December 29, 2010,[61] is the largest ever developed by EPA and sets watershed limits for nitrogen, phosphorus, and sediment.[62] The six states[63] and the District of Columbia that fall within the 64,000 square mile watershed of the Chesapeake Bay must implement Watershed Implementation Plans (WIPs) to meet the pollution allocations established for their respective jurisdictions.[64] A major portion of the Marcellus Shale lies within watersheds that drain to the Chesapeake Bay. Yet the potential impacts of massive shale gas extraction efforts within the Chesapeake Bay watershed were not accounted for in the modeling that led to the Chesapeake Bay TMDL.[65] In Pennsylvania, about forty-six percent of Marcellus Shale drilling occurs within the Chesapeake Bay watershed.[66] Applying loading rates for the Bay Program model to the Nature Conservancy's projections of forest loss due to gas development suggests annual increases in nitrogen runoff of between 30,000 and 80,000 pounds, increases in phosphorus runoff of between 15,000 and 40,000 pounds, and, most significantly, increases in sediment runoff of between 18 million and 45 million pounds.[67]

The Bay jurisdictions were obligated to submit draft Phase II WIPs to EPA by December 15, 2011.[68] The WIPs set out the jurisdictions' plans to implement, by 2017, measures to achieve 60% of the nitrogen, phosphorus, and sediment reductions required by the Chesapeake Bay TMDL. Yet these WIPs do not account for nor address the levels of sediment and nutrient runoff that shale gas extraction will cause. The failure of the Bay jurisdictions to account for the contributions of sediment pollution from natural gas facilities to the waters of the Chesapeake Bay watershed may lead to serious consequences for municipalities and other regulated sectors in the form of increased permitting coverage, greater oversight and enforcement and stricter compliance requirements from EPA.[69]

Conclusion

As shale gas extraction rapidly expands, the landscape level effects of deforestation and increased stormwater runoff, erosion, and sedimentation will exacerbate surface water degradation. Given the scope and scale of these adverse impacts, there is no compelling reason why shale gas production should continue to enjoy its current exemption from the Clean Water Act's stormwater permitting requirements. Intensive shale gas development will only make it more difficult and more costly for states, municipalities, and regulated sectors to fulfill their legal obligations to assure impaired waters attain water quality standards through successful TMDL implementation. The shale gas industry should no longer be allowed to externalize the costs of stormwater management, not only as a matter of fairness and equity but also to ensure better protection of public water resources.

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[61] See generally http://www.epa.gov/chesapeakebaytmdl/

[62] The Chesapeake Bay TMDL is a combination of 92 smaller TMDLs for individual tidal segments of the Bay. Executive Summary at ES-3, http://www.epa.gov/reg3wapd/pdf/pdf_chesbay/FinalBayTMDL/BayTMDLExecutiveSummaryFINAL122910_final.pdf

[63] Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia

[64] Id. at ES-7.

[65] Karl Blankenship, "Marcellus Shale drilling may take huge chunks out of PA forests: Loss could heavily impact wildlife habitat, state's ability to meet TMDL goal," Chesapeake Bay Journal, December 2011, http://www.bayjournal.com/article.cfm?article=4246

[66] Id.

[67] Id.

[68] http://www.epa.gov/reg3wapd/tmdl/ChesapeakeBay/EnsuringResults.html

[69] Chesapeake Bay TMDL Executive Summary at ES-8, ES-10-13, supra note 62.