

**Unaddressed
Environmental Consequences
of Marcellus Gas Well Drilling
in the Delaware River Basin,
Wayne County, Pennsylvania**

Reply to Daniel Arthur "Report" dated 6 November 2019

Prepared for: Curtin & Heefner LLP and
The Delaware Riverkeeper Network
925 Canal Street
Bristol, Pennsylvania 19007
<http://www.delawareriverkeeper.org>

Prepared by: Schmid & Company, Inc., Consulting Ecologists
1201 Cedar Grove Road
Media, Pennsylvania 19063-1044
(610) 356-1416
www.schmidco.com

15 January 2020

This document replies to a purported “expert report” by Daniel Arthur on behalf of the Plaintiff Wayne Land and Mineral Group, LLC (WLMG) in Wayne Land and Mineral Group, LLC, vs. Delaware River Basin Commission, Defendant, and Delaware Riverkeeper Network, Maya K. Van Rossum, The Delaware Riverkeeper, Intervenor-Defendants, in Civil Action 3:16-CV-00897, United States District Court for the Middle District of Pennsylvania. The Plaintiff is challenging the authority of the Defendant to regulate its proposed unconventional gas well development project as the Defendant works to protect water resources in the Delaware River Basin. The Arthur “expert report” consists of four pages dated 6 November 2019 that fail to address issues raised in my 42-page expert report dated 8 October 2019 (Schmid & Co., Inc. 2019). This document is a brief response to Mr. Arthur’s submission.

Mr. Arthur did not attempt to rebut any of my concerns as set forth in Schmid & Co., Inc. (2019) and not repeated here. His principal, vague substantive opinion is as follows:

To the extent the authors of the documents identified above [including the Schmid & Co. 2019 report] opine that unconventional natural gas wells, including those to be developed by WLMG, cannot be developed in a manner that protects water resources, and other aspects of the environment, including the use of water as drinking water supply, such opinions have no merit.

Mr. Arthur fails to say how or why the numerous potential impacts discussed in my report are not relevant to the proposed WLMG unconventional gas wells, given the highly sensitive water and other resources of the project site and its surroundings. Minimal information has been proffered by the Plaintiff concerning its proposed construction of wells and necessary supporting facilities. Even less information has been proffered concerning resources potentially at risk, given the history of damages from recent unconventional gas development in Pennsylvania under incomplete regulations. Instead, Mr. Arthur appends outdated documents he previously prepared for the American Petroleum Institute and the Marcellus Shale Coalition commenting on certain proposed regulations of DRBC (ALL Consulting LLC 2018, 2011). Those commentaries were based on inaccurate environmental data contradicted by the sparse information actually presented by the Plaintiff regarding the WLMG site. Mr. Arthur’s appended documents do not address the WLMG proposal at all. They identify no Best Management Practices that will be used by WLMG to reduce impacts. They also fail to address many of the concerns about impacts arising in the relevant literature concerning gas development impacts published prior to their preparation.

Mr. Arthur’s 2019 “report” makes no response to the more recent and rapidly growing literature on environmental damages from unconventional gas development subsequent to his prior compilations. He does not address the WLMG project site, or how gas wells there might conform or conflict with any previously considered DRBC Article 7 regulations. That strikes me as odd, given the focus of those prior documents on the formerly proposed (but not adopted) Article 7 regulations. Mr. Arthur does not say how either those Article 7 regulations or his commentaries are relevant to the WLMG proposal. He also does not address when or how any gas actually encountered might get to market in order to provide an economic return to the Plaintiff or what the offsite impacts would be. Instead, he offers merely the conclusory statement that any work by WLMG would be undertaken in the context of

a network of well pads and related natural gas infrastructure development throughout the Delaware River Basin ... in a manner that will not have a substantial adverse effect on water resources, water supplies or the environment generally.

Mr. Arthur provides no basis for this cheerful hope, either in his 2019 “report” or in his prior commentaries on prospective DRBC regulations.

Mr. Arthur’s prior comments on DRBC regulations are based on “average anticipated environmental disturbances” from unconventional gas development (ALL Consulting LLC 2018, p. 2). Those averages are continually increasing as the length of economic lateral borings increases and volumes of both water and sand increase, as he acknowledges (p. 41).

Mr. Arthur takes note of no economic costs whatsoever for damages to human health, the environment, or recreation and tourism. Likewise, he did not mention the billions of dollars of subsidies granted to the gas industry annually (Trout and Stockman 2019). There is not much literature analyzing such costs of gas development. Mayfield et al. (2019) partially summarized the costs of Appalachian gas development 2004-2016 from air pollution alone: 1,200 to 4,600 premature deaths (more than half in urban counties downwind from the gas fields), resulting in \$23 billion loss in 2017 dollars (95% confidence interval \$2.3 to \$61 billion, depending on the value assigned to a statistical human life) and conservatively estimated long-term climate impacts of \$12 billion to \$94 billion that will persist for generations. These dollar values are not fully offset by short-term 2004-2016 employment benefits (469,000 job-years $\pm 30\%$; \$21 billion $\pm 30\%$). The gas-derived air pollution impacts on public health other than premature mortality are not included in these economic model estimates, nor are any impacts on water quality, aquatic or terrestrial wildlife, forest habitats, outdoor recreational tourism, or public infrastructure such as roads or bridges.

Mr. Arthur downplays the impacts the United States Environmental Protection Agency identified on water resources in 2016, then admits that some of them are “severe” or recurrent albeit little studied (ALL Consulting LLC 2018, p. 30). Most sensitive ecosystem components at risk from gas development are not monitored (Adams et al. 2011b), and damages unrecognized are not addressed. Curiously, Mr. Arthur nowhere acknowledges that unregulated radionuclides are generated by gasfield waste, although radionuclides are being deposited downstream from gas wells (Abualfaraj et al. 2018). Radionuclides in unmeasured quantity also are spread on roads along with gas waste brine, although Mr. Arthur believes it reasonable to spread brine on roads. He does not discuss the difficulties of chemical contaminant detection and analysis when fracking additives are not disclosed and laboratory analytical methods are unavailable.

Mr. Arthur’s prior commentaries were based on unreliable information sources. His maps of restrictions on gas drilling (ALL Consulting LLC 2018, Exhibits 6, 7) are not credible. For example, National Wetland Inventory (NWI) maps were used to identify wetlands in the Delaware River Basin, although these are known to identify less than half of the actual wetlands in Pennsylvania. Streams are identified only from National Hydrography maps, which omit thousand of miles of small streams in Pennsylvania. The closer gas production facilities are sited to sensitive resources, the more likely adverse impacts become. Runoff from the WLMG site in fact flows into High Quality Kinneyville Creek and into at least three nearby wild

trout production waters identified by the Pennsylvania Fish Commission (Tributaries 06616 and 06618 to Shehawken Creek in the Delaware Basin and Tributary 32249 of Shadigee Creek, which latter is an intact wild brook trout watershed in the Susquehanna Basin according to the Eastern Brook Trout Joint Venture), suggesting the potential impact of sediment, chemical spills and temperature changes on local fisheries. Mr. Arthur's water wells were identified from the fragmentary records in the Pennsylvania Groundwater Information System (PAGWIS; ALL Consulting LLC 2011, p. D-1), which includes only a few percent of the millions of private drinking water wells in Pennsylvania. Thus most private wells are ignored in his commentaries. Floodplains were based on Federal Emergency Management Agency (FEMA) maps, which generally ignore upper watersheds across the Commonwealth. Mr. Arthur's maps do not attempt to address local conditions such as those where the WLMG wells will be located. The Plaintiff has acknowledged the existence of wetlands near the proposed well pad (where none were shown on NWI maps), but surface water resources across the entire 182 acres of the WLMG property have not been delineated or confirmed as accurate by any agency.

Mr. Arthur does not comment on the conflicts between the assumptions in his commentaries and many inconvenient facts. His commentaries are based on the assumption of steady and continued growth of gas production in Appalachia in the short and long term (All Consulting LLC 2018, p. 10, 14), while his 2018 Exhibits 9 and 10 document a dramatic crash in drilling after 2014, based (as he acknowledged on p. 13) on a collapse in the market price of gas in Pennsylvania wellfields. He observes that an unconventional gas well pad in Pennsylvania typically seeks to drain gas from 4,880 acres, not the 182 acres controlled by WLMG. He does not say how the Plaintiff's presumed mineral rights to only 182 acres justify well pad construction; no offsite mineral rights have been acknowledged. When one of Mr. Arthur's example unconventional well pads is transposed onto the WLMG site (Figure 1) it becomes clear how much more mineral rights are needed for an economic well pad than WLMF apparently controls. The maximum lateral bore shown in Figure 1 extends about 14,000 feet from the well pad, and Mr. Arthur acknowledged current economic and technological bore lengths of 21,000 feet. As shown in the hypothetical Figure 1, several economic long borings centered on the proposed WLMG pad could cross beneath natural heritage lands of statewide significance which have been identified as close as 2,000 feet to the proposed pad (Davis et al. 1991). Even the high cost, 4,000- to 5,000-foot long laterals mentioned by the Plaintiff would extend far beyond the Plaintiff's land in any direction.

Mr. Arthur lists numerous Best Management Practices (BMPs) that could be used in efforts to reduce impacts from unconventional gas production, but he does not say which, if any, of those will be used at the WLMG site. As I noted in my 2019 report, existing BMPs have often failed to prevent environmental damage in Pennsylvania gas development projects, and there are no penalties for erosion and sedimentation that results from large thunderstorms. Some of the technical wastewater cleanup alternatives Mr. Arthur recommends in Pennsylvania are illegal (water floods by produced frackwater) or uneconomic (reverse osmosis or electrodialysis or evaporation or crystallization of contaminants in produced water). Produced wastewater is being cleaned up a bit for reuse in fracking, but even after treatment is poisonous and simply is not used here for crop irrigation or livestock watering. Gasfield wastewater is not carefully monitored in Pennsylvania. Mr. Arthur also does not discuss the

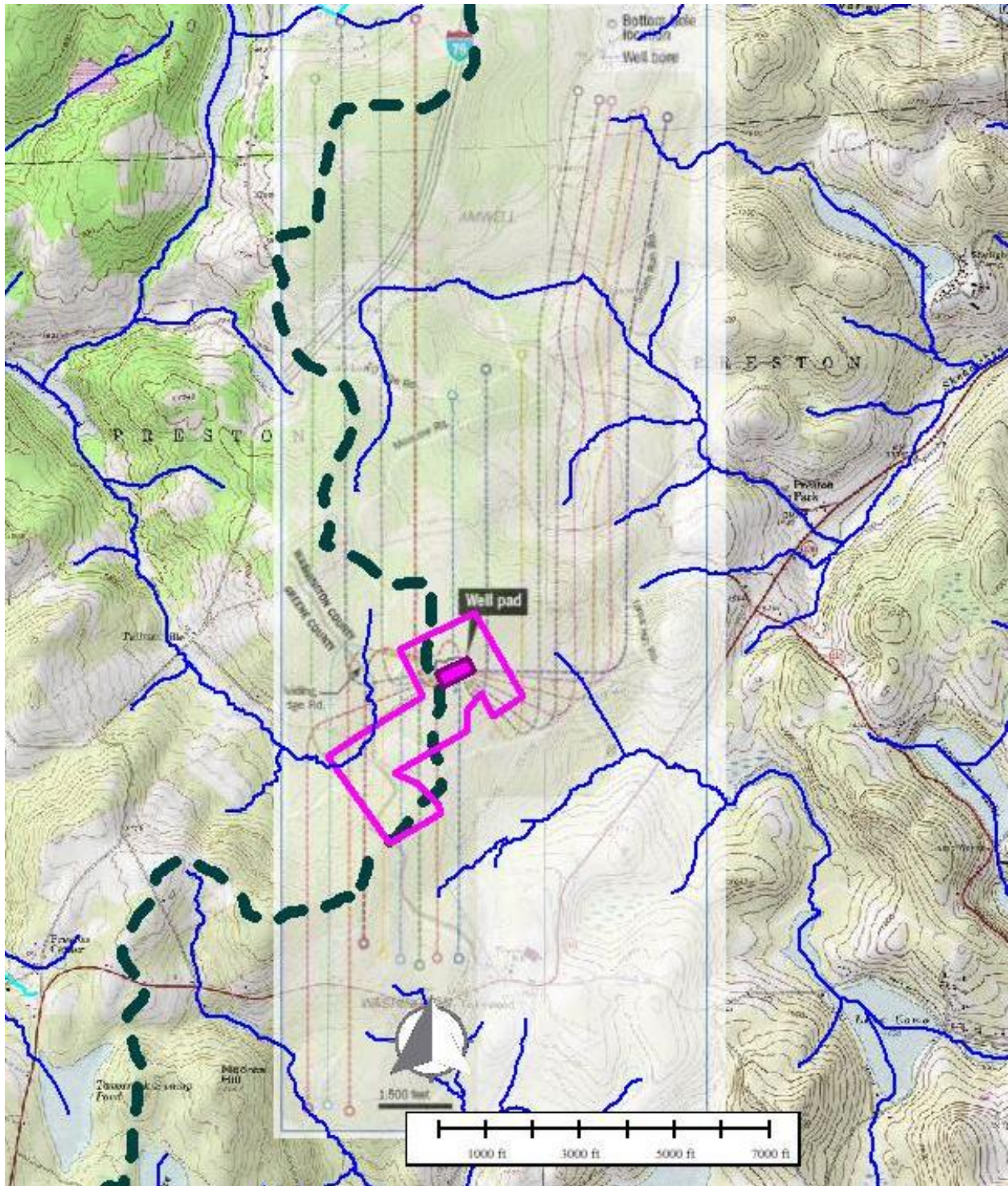


Figure 1. Example of a Pennsylvania unconventional gas well diagram transposed onto the WLMG property (pink outline). Underlying basemap is from USGS Orson and Lake Como topographic quadrangles. National Hydrography streams are highlighted in dark blue (incomplete inventory, no onsite fieldwork has been done). Drawing shows well borings in Amwell Township, Washington County (ALL Consulting LLC 2018, p. 42). Horizontal borings are dashed. Delaware River Basin boundary is dashed in prominent black.

incontrovertible adverse effects of new gas wells on the global warming crisis (Howarth 2019; Trout and Stockman 2019; Mayfield et al. 2019).

Mr. Arthur bases his general commentary regarding potential impacts on a typical well pad with access road footprint that he reports as ranging from 11.5 to 15 acres on the land surface (ALL Consulting LLC 2018, p. 42). Yet Johnson (2010) discussed at length how impacts on forests, freshwaters, and species of concern extend far offsite from roads and well pads, leading to resource damage on several times as much acreage as the clearcuts themselves. Indirect adverse impacts extend far beyond the cleared footprint of a well pad or access road and represent two-thirds of the resources impacted within a 330-foot buffer. As Kiviat (2013) has noted, adverse impacts on some interior forest-nesting breeding birds extend outwards from well pads into adjacent forests as far as 1,500 feet. Forest fragmentation is one of the major virtually unavoidable impacts of gas development in Pennsylvania, including on the WLMG property. The proposed WLMG well pad lies in a significant forest patch at the center of large areas of documented habitat for two species of declining, forest-interior breeding, migratory birds, scarlet tanager (*Piranga olivacea*) and black throated blue warbler (*Setophaga caerulescens*) based on 39,000 sites inspected 2004-2009 (Wilson et al. 2012). Even on federal forest land, unanticipated environmental damages from unconventional gas development have been significant (Adams et al. 2011a). Mr. Arthur does not address the spread of invasive, non-native weeds, which has been much exacerbated in Pennsylvania by gas development opening up forest habitat, removing native plants, disturbing soils, and transporting propagules.

Mr. Arthur discounts the number and seriousness of water quality violations in Pennsylvania. By 2013 spills had been experienced at 20% of unconventional shale gas wells (Abualfaraj 2016). Eight major spills during the 2009-2013 period ranged from 4,200 to over 57,000 gallons of polluted water. The Pennsylvania Department of Environmental Protection inspects fewer than 20% of wells each year (15% in 2008, 33% in 2013). Few violations result in fines. Frackwater spilled on land is more serious and harder to clean up than spilled oil. It is toxic to vegetation, as well as to amphibians, reptiles, and fish (Adams et al. 2011b). Forest regeneration after gas well use may require 75 to more than 100 years (Kiviat 2013).

Mr. Arthur simply has neither addressed nor rebutted the high probability of significant environmental damage to Basin waters and other resources, as well as human health, if the proposed WLMG well development were to be allowed in the Delaware River Basin.

Authorship

This report was prepared by James A. Schmid, Ph. D., with assistance from Stephen P. Kunz.

References

(Note: references cited in Schmid & Co., Inc., 2019 that support the above discussion are not repeated here.)

- Abualfaraj, Noura, P.L. Gurian, and M.S. Olson. 2014. Characterization of Marcellus shale flowback water. *Environmental Engineering Science* 31(9):514-524.
- Abualfaraj, Noura, P.L. Gurian, and M.S. Olson. 2018. Assessing residential exposure risk from spills of flowback water from Marcellus shale hydraulic fracturing activity. *International Journal of Environmental Research and Public Health* 15:727-752.
- Abualfaraj, Noura, M.S. Olson, P.L. Gurian, A.D. Roos, and C.A. Gross-Davis. 2016. Statistical analysis of compliance violations for natural gas wells in Pennsylvania. *Energy Policy* 97:421-428.
- Adams, Mary Beth; P.J. Edwards, W.M. Ford, J.B. Johnson, T.M. Schuler, M.T-V. Gundy, and F. Wood. 2011a. Effects of development of a natural gas well and associated pipeline on the natural and scientific resources of the Fernow Experimental Forest. General Technical Report NRS-76. U.S. Department of Agriculture, Forest Service, Northern Research Station. Newtown Square PA. 24 p.
- Adams, Mary Beth, W.M. Ford, T.M. Schuler, and M. T-V. Gundy. 2011b. Effects of natural gas development on forest ecosystems. P. 219-226 in Fei, Songlin, J.M. Lhotka, G.W. Stringer, J.W. Gottschalk, and G.W. Miller, eds. Proceedings, 17th Central Hardwood Forest Conference, 5-7 April 2010, Lexington KY. General Technical Report NRS-P-78. U.S. Department of Agriculture, Forest Service, Northern Research Station. Newtown Square PA.
- ALL Consulting, LLC. 2018. Response to key technical issues requested by the Delaware River Basin Commission on its proposed new 18 CFR Part 440 review. Prepared for American Petroleum Institute. Tulsa OK. 74 p.
- ALL Consulting, LLC. 2011. Analysis of Delaware River Basin Commission proposed Article 7 natural gas development regulations. Prepared for American Petroleum Institute and Marcellus Shale Coalition. Tulsa OK. 145 p.
- Davis, Anthony F., G.J. Edinger, T.L Smith, A.M. Wilkinson, and J.R. Belfonti. 1991. A natural areas inventory of Wayne County, Pennsylvania. The Nature Conservancy. Middletown PA. 138 p.
- Howarth, Robert W. 2019. Ideas and perspective: is shale gas a major driver of recent increase in global atmospheric methane? *Biogeosciences* 16:3033-3046.
- Mayfield, Erin N., J.L. Cohon, N.Z. Muller, I.M.L. Azevedo, and A.L. Robinson. 2019. Cumulative environmental and employment impacts of the shale gas boom. *Nature Sustainability*. <https://doi.org/10.1038/s41893-019-0420-1>. 10 p.

Schmid & Co., Inc. 2019. Environmental consequences of proposed unconventional gas well drilling in the Delaware River Basin, Wayne County, Pennsylvania. Prepared for Curtin & Heefner LLP. Media PA. 42 p.

Trout, Kelly, and L. Stockman. 2019. Drilling toward disaster: why U.S. oil and gas expansion is incompatible with climate limits. Oil Change International. Washington DC. 43 p.

Wilson, Andrew M., D.W. Brauning, and R.S. Mulvihill, eds. 2012. Second atlas of breeding birds in Pennsylvania. Pennsylvania State University Press. University Park PA. 612 p.