IN THE SUPREME COURT OF PENNSYLVANIA

No. 63 MAP 2018

ADAM BRIGGS, PAULA BRIGGS, his wife, JOSHUA BRIGGS, and SARAH H. BRIGGS,

Appellees,

vs.

SOUTHWESTERN ENERGY PRODUCTION COMPANY,

Appellant.

BRIEF OF *AMICUS CURIAE* THOMAS D. GILLESPIE, P.G.

Appeal from the April 2, 2018 Order of the Superior Court at Docket No. 1351 MDA 2017, reversing the August 8, 2017 Order of the Court of Common Pleas of Susquehanna County at Docket No. 2015-01253

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STATEMENT OF INTEREST

Amicus petitioner Thomas D. Gillespie, is a Pennsylvania-licensed professional geologist who, over a 35-year career as a practicing geologist in Pennsylvania, has been recognized at the highest levels for the thorough and rigorous application of the principles of geology over a wide spectrum of earth-resource sectors. In recognition of the ethical practice of geology and a widely-acknowledged respect for the integrity of the science of geology, Mr. Gillespie:

- was selected by the community of Pennsylvania geologists to represent the geologic community on the State Geology Registration Board;
- was vetted and confirmed by the State Senate and appointed by two successive Pennsylvania Governors to serve the Commonwealth for twelve years over two successive and distinguished terms on the Pennsylvania Registration Board for Professional Engineers, Land Surveyors and Geologists;
- served two-terms as President of the Pennsylvania Registration Board and two-terms as vice president, as well as serving on the Board's Continuing Education Committee;
- represented Pennsylvania for twelve years on the National Association of State Boards of Geology, including a term on the Executive Committee;

- was a founding member of the Pennsylvania Council of Professional Geologists and served on its Board;
- has been a professor of geology in the higher education system for 30 years;
- has taught continuing education courses to other professional geologists for 25 years;
- has provided written and oral testimony to both the Pennsylvania Senate and House on matters pertaining to earth resources, land use and geoscience education.

Having dedicated significant time and effort to the application of the principles of geology in a manner which will ensure the public weal, and having striven to ensure that public policy issues which involve geologic knowledge are accurately addressed and communicated, Amicus Petitioner was compelled to submit this amicus brief because the opinion issued by the Pennsylvania Superior Court in the matter of Briggs v. SWN (Docket No. 1351 MDA 2017) was founded on fundamental misconceptions pertaining to the mechanisms by which natural gas occurs and migrates in geologic formations and the methods by which that gas is extracted from geologic strata to provide a vital resource for the public health, welfare and benefit. That lower court opinion established precedent whereby those misconceptions will be perpetuated and will assume the force of law unless a respected representative of the community of professional geologists provides this

Court with the information by which it can correct the technical misstep made by that lower Court.

Amicus Petitioner is Principal Geologist with Gilmore & Associates, Inc., a private corporation which provides services to all industrial sectors as well as to public projects and municipal governments. Petitioner:

- is not an employee of any party to this action;
- is not retained as a consultant to, or representative of any party to this action;
- does not currently have active projects or contracts with any party to this action or with any oil and gas operator.

Petitioner was formerly employed by a Marcellus operator and, in the past, has provided consulting and expert services to oil and gas operators both within and outside of the Marcellus region.

This brief was authored solely by the petitioner and was not supported financially by any party to the action. Gilmore & Associates, Inc. has covered the expenses of petitioner's remuneration during the preparation of this brief, as well as the direct costs for printing and delivery.

ARGUMENT

INTRODUCTION

The matter this Court was petitioned to consider hinges on geologic conditions and geologic concepts. Petitioner, a licensed professional geologist, presents an unambiguous and unbiased summary of those principles of geology[1] applicable to this case, as well as conclusions relevant to the issue being considered by this Court based strictly on those principles.

The fundamental geologic principle at issue pertains to the mobility of natural gas within or through geologic rock formations[2] and whether that natural gas is mobile in all geologic formations or in only some. This seemingly straight-forward consideration has become befuddled over the course of many legal actions as a result of two fundamental misconceptions:

- **Misconception No. 1: Natural gas is mobile and migrates freely within, through and between undeveloped hydrocarbon-bearing geologic formations known as <u>conventional formations</u>;**

[1]As defined in P.L.913 No 367, CL 63, 1945; and at PA Admin code CH 37

[2] The occurrence and movement of gasses within the Earth is specifically defined as being in the purview of licensed professional geologists: P.L.913 No 367, CL 63, 1945, Sections 2(m) and 2(n)

– **Misconception No. 2: Natural gas is not mobile in geologic formations referred to as unconventional formations in the absence of the stimulation method known as hydraulic fracturing.**

Both misconceptions are based on a premise which conflates the physical properties of natural gas with the geologic formations in which the gas occurs (Briggs V SWN, Docket No. 1351 MDA 2017). The manufacture of such an impossible equivalency violates the science of geology no less than if the issue at hand were whether water in an aquifer behaves differently depending on the geologic formation in which it occurs – it is patent that water behaves as water wherever it is found. The same can be said of natural gas and it is scientifically invalid to claim that a legal stricture (e.g., the rule of capture), devised as a result of the inherent property of natural gas to flow wherever it can, applies in one geologic setting but not in another, as found by the Superior Court in Briggs v SWN[3].

The physical properties of natural gas in the context of the various geologic formations considered in the precedent cases to this matter are particularly relevant because, as this Petitioner attempts to make clear in this brief, there are no relevant

[3] The finding of the lower court is inconsistent with this Court's finding in Butler v. Charles Powers Estate, *65 A.3rd 885 (Pa. 2013)* that "Marcellus Shale natural gas is merely natural gas that has become trapped within the Marcellus shale rather than rising to the more permeable sand formations…"

differences in the behavior (e.g., fugacity) of natural gas regardless in which geologic formation it occurs.

Petitioner submits this brief in an effort to clarify the interpretations and findings presented in Briggs v. SWN by correctly stating two principles of geology which have been misinterpreted in previous actions and which are the basis of the two misconceptions, above. In terms of natural gas in the context of hydrocarbon-bearing geologic formations and structures:

1. **Natural gas does NOT migrate within, through or between undeveloped hydrocarbon-bearing formations, whether conventional or unconventional.** Prior to development, natural gas of useable volumes in all formations is trapped and does not migrate freely. It is the single goal of natural gas operations in both conventional and unconventional formations to establish the conditions, not present naturally, which provide for the migration of natural gas through the matrices of the formations[4];

[4] In the context of this brief the term 'undeveloped' refers to hydrocarbon-bearing geologic formations prior to oil or gas exploration, development or production; the term 'migration' refers to the movement within and recovery from oil or gas-bearing geologic formations at rates and volumes sufficient to be considered a benefit to human society. Specifically, it is herein recognized that oil and gas continue to move along natural migration pathways from source rocks to reservoir rocks on a geologic time scale. The distinction made herein is critical because it emphasizes that "migration" is an inherent condition of the natural gas and is not dependent on the formation in which it occurs.

2. **There are no differences in the mechanisms of natural gas migration between so-called conventional and unconventional geologic formations.**

As will be shown herein, once the conditions within which migration can occur are established via operations, the mechanisms of migration through unstimulated zones of the formation[5] are the same whether that formation is considered to be conventional or unconventional[6]. It was one of the fundamental findings of the Superior Court in the Briggs v. SWN case (Briggs Court) that the behavior of natural gas *itself* differs between conventional and unconventional formations:

"[u]nlike oil and gas originating in a common reservoir, natural gas, when trapped in a shale formation, is non-migratory in nature," (Briggs Court, pg 20).

That was concluded in contra-distinction to natural gas in a conventional formation in which setting the Briggs Court found:

"has the power and tendency to escape without the volition of the owner" (citing this Court in Westmoreland & Cambria Natural Gas v. DeWitt).

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[5] The term "stimulation" refers to secondary recovery techniques applied to formations to enhance recovery and includes hydraulic fracturing.

[6] The terms conventional and unconventional are applied in a unique manner in Pennsylvania which: 1. are not the same as applied in other states; 2. are different than the technical meanings of the words as applied by the oil and gas industry, as described later in this brief.

The Geology of Natural Gas in the Context of Pennsylvania Statutory and Regulatory Provisions

Prior to development, hydrocarbons in conventional and unconventional formations are trapped by natural geologic conditions, are immobile, and can not (and did not) migrate, else they would have bled away and dissipated long ago. In fact, the vast volumes of accumulated hydrocarbons present in the pore spaces of certain sedimentary rock formations in the Earth's upper crust have been extant for many millions, in most cases tens of millions and in some cases hundreds of millions of years, emphasizing the static condition of natural gas in the absence of recovery operations.

Conventional and unconventional formations are inextricably linked in a complex hydrocarbon geo-system which includes:

- **source rocks** – typically fine-grained sedimentary rocks (e.g., shale), in which organic matter was transformed into hydrocarbons. The hydrocarbons are under pressure and are retained in the pore spaces of the rock by capillary forces and/or structural seals. In zones of the formation adjacent to natural faults which broke the rock along discrete planes or zones of planes, a pressure gradient was established, thereby inducing the migration of natural gas. A fraction of the gas was released and transported out of the source rock via;

- **a migration pathway** – a structure or system of structures (in many instances the fault which broke the source rock) along which the hydrocarbons migrated upward from the source to;
- **reservoir rocks** – typically permeable sedimentary rocks (e.g., sandstone) in which hydrocarbons accumulated and from which traditional oil and gas recovery was conducted. Oil and gas were able to accumulate in reservoirs as a result of the presence of;
- **a trap** – a structural or stratigraphic condition at the top of the reservoir which halted the natural, generally upward movement of hydrocarbons and prevented further migration, thereby forming what would later be considered a reservoir of natural gas.

In the context of those Pennsylvania statutes and regulations governing natural gas, an unconventional formation generally corresponds to the source rock and conventional formations generally correspond to reservoir rocks[7]. The difference between conventional and unconventional oil and gas operations in Pennsylvania is that conventional operations tend to tap a reservoir rock and unconventional operations go directly to the source rock[8].

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[7] The distinction is not quite as black and white as that, but for most contexts that general correspondence holds.

[8] The technical methods used to extract natural gas are mostly the same in both formation types but the term conventional in the industry typically refers to wells

The immense volumes of oil and gas extracted from geologic formations since the beginning of the petroleum age in 1859 have been produced almost exclusively from reservoir rocks. The oil and gas were trapped in the reservoirs (conventional formations) where they remained immobile[9] until societal demand necessitated that petroleum geologists and engineers created the conditions within those geologic formations by which the natural *migration potential* of both the oil and gas could be exploited and they could be recovered.

The means by which natural gas in both conventional and unconventional formations can be recovered at beneficial rates and volumes is by the application of *"artificial means applied to stimulate such a flow."* (Briggs Decision, pg. 21) to establish two 'artificial' conditions which act in concert to provide for the migration of natural gas and for its recovery:

- **a migration path must be created** to connect the undeveloped hydrocarbon-bearing geologic formation to the Earth's surface. Whether that migration path is created via hydraulic fracturing or by the simple act of installing a well bore into the formation, the physical result is the creation of an outlet which is/was not there naturally;

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which are mostly vertical and the term unconventional generally refers to multiple horizontal well bores from a single top hole.

[9] The term 'immobile' is a relative one used herein in the context of the development of a formation. On a geologic time scale gas is never truly static.

and,

- **a gas pressure gradient must be induced** which will cause the gas to flow (migrate) through the formation to the outlet[10]. The creation of a migration pathway (above) connects the trapped, immobile, pressurized natural gas to lower pressure zones above the formation (e.g., atmospheric pressure) and thereby induces the pressure gradient.

Both conventional and unconventional formations are possessed of natural gas permeabilities[11] and the methods applied to create the outlet and pressure gradient so the gas can migrate pursuant to its inherent property of fugacity are the same for each formation type.

The question before this Court is: *Does natural gas from outside the hydro-fracturing envelope migrate through the native permeability of un-stimulated rock of the Marcellus Formation and into the hydro-fracture network.*

Migration of gas from and through unstimulated Marcellus rock is observed routinely prior to hydraulic fracturing in Marcellus well bores which produce gas

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[10] Neither gas nor oil will flow in the absence of a hydraulic or pressure gradient even if there is an outlet. Both are necessary for flow to occur.

[11] Permeability is the property of the geologic formations to transmit a fluid, in this case a gas, through the connected pore spaces of the formation. Different rock types have different permeabilities depending on the grain size, pore size and connectedness of the pores. Both reservoir and source rock have natural permeabilities but the two types of sedimentary rock which form each result in different rates of fluid conveyance through the formation.

via the formation's inherent permeability.[12] Perhaps as significant as the empirical evidence of inherent permeability of the Marcellus Formation is that the Pennsylvania General Assembly and the Pennsylvania Department of Environmental Protection (PADEP) acknowledge the permeability of all unconventional formations within the text of the often-quoted definition:

> "A geological shale formation… where natural gas generally cannot be produced at economic flow rates or in economic volumes except by vertical or horizontal well bores stimulated by hydraulic fracture treatments or …other techniques to expose more of the formation to the well bore." (emphases added)

PADEP defines a Conventional Formation as:

> "A formation that is not an unconventional formation." [13]

Based on those legal definitions:

- an unconventional formation is capable of producing hydrocarbons in the absence of hydraulic fracturing;

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[12] See, e.g., Rahimi-Aghdam, et. al., 2019, Branching of hydraulic cracks enabling permeability of gas or shale with closed natural fractures, Proceedings of the National Academy of Sciences.

[13] The confusion of terminology is highlighted in a recent decision of this Court (Snyder Brothers, Inc. v. Pennsylvania Public Utility Commission Nos. 47 & 48 WAP 2017, __ A.3d __ (Pa. Dec. 28, 2018)), in which this Court cited research by an organization, EOLSS, from which an article citation reported that both conventional and unconventional wells were drilled into a single geologic formation which is a reservoir; i.e., a formation that in Pennsylvania would be called a *conventional* formation.

- a conventional formation is not *de facto* capable of producing gas at economic flow rates or in economic volumes without hydraulic fracturing.

By both statute and regulation, Pennsylvania recognizes that unconventional formations are permeable to gas migration and the Legislature and PADEP developed regulatory mechanisms that provide for in-field methods (hydraulic fracturing, among others) whereby the natural permeability of any gas-bearing geologic formation can be enhanced (not created) so that the naturally fugacious character of the natural gas, which is the resource subject to the rule of capture,[14] will provide for recovery at rates adequate to be of societal benefit.

Acknowledging that there are geologic distinctions between the two different formation types, the salient point is that the behavior of natural gas is the same in either conventional or unconventional formations, as are the mechanisms

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[14] According to the U.S. Court of Appeals, 3d circuit, 2011 (Minard Run Oil Co. v. United States Forest Service, 670 F 3d 236, 3rd Cir, 2011) the resource which is governed by the rule of capture is the natural gas, not the formation in which that gas occurs. Moreover, by the ruling of this Court, natural gas "is a mineral with peculiar attributes" in that "unlike other minerals [oil and gas] have the power and tendency to escape without the volition of the owner." (Westmoreland & Cambria Natural Gas v. De Witt, 18A. 724 (Pa. 1889)). This Court has issued no findings that oil and gas resources which derive from any one geologic formation differ in the least in terms of their inherently fugitive nature from oil and gas resources derived from any other formation. Within the context of the various findings on this matter, this Court, as well as the 3rd Circuit Court, has determined that the rule of capture applies to the resource itself and not its point of origin or its spatial location within the overall framework of petroleum geology which, as described herein, comprises multiple components, even in the context of 'unconventional operations."

by which migration occurs in both. By way of illustration, Petitioner presents the following comparison between conventional and unconventional formations.

In a producing conventional formation, the artificially-induced pressure gradient causes gas to flow to the created migration pathway (the well) and the volume of gas in the reservoir is reduced continuously, resulting in a decline in formation pressure over time. Eventually, reservoir pressure is reduced until it is approximately equal to the capillary forces which tend to hold gas molecules in place within the natural pore spaces of the rock, at which point natural gas wells stop producing at useful rates. At that point, from both hydraulic and production perspectives, the conventional formation is similar to an unconventional formation. In most reservoirs such a point is reached when only approximately 30% of the total resource has been recovered.

Further production from such reservoirs (conventional formations) requires enhanced recovery techniques which include hydraulic fracturing. Therefore, extraction from conventional reservoirs involves hydraulic fracturing in as many instances as not. The only real difference between the two formation types is that:

- in a conventional formation, it has been gas production by humans which has reduced the gas volume and pressure to the point that natural retentive forces counteract the tendency of gas to migrate in the presence of a created

migration pathway, at which point enhanced recovery methods are employed, including hydraulic fracturing;

- in an unconventional formation, nature, in the form of faults and natural migration, reduced the pressure to a similar condition long ago.

In other words, the two regulatorily-defined formation types are simply two components of a single hydrocarbon-bearing geo-system and are not different in terms of either the occurrence of the resource, the methods of development, or the mechanisms of migration through the formations once development methods applied by operators of both conventional and unconventional formations have established the two conditions required.

The fact that techniques such as hydraulic fracturing are applied in conventional formation seems to be contrary to the finding of the Briggs Court which held that:

> *"hydraulic fracturing is distinguishable from conventional methods of oil and gas extraction."*

Such a statement is, in fact, meaningless because in Pennsylvania:

- the term conventional methods is undefined, so it is not possible to glean which specific methods of natural gas operations the Court implies;

- both statute and regulation provide for the application of hydraulic fracturing in conventional and unconventional formations so the technique itself must be considered conventional;
- the term conventional well is defined to include wells completed in conventional formations but the term conventional formation is defined to include shale formations (source rock) located stratigraphically above the Elk Formation. In other words, the regulations establish a situation in which a conventional well could be drilled into a conventional formation which, by the findings of the Briggs Court is one which requires hydraulic fracture treatment and therefore would be considered an unconventional formation;
- the term conventional well is defined as a "bore hole… to be used for the construction of a well irrespective of technology or design;" i.e., a well for which no methods are specified and, consequently, no method can be considered to be unconventional.

In the contexts of both Pennsylvania law and the practice in the field, hydraulic fracturing is routinely applied to conventional wells drilled into conventional formations. Conventional wells can include wells: completed in shale formations; wells which are hydraulically fractured; wells stratigraphically lower than the geologic stratum below which unconventional wells are defined; wells which are drilled, constructed and completed using any technique or method.

Accordingly, there are no defined conventional methods and the findings of the Briggs Court cannot be reconciled with either the principles of geology or practices of natural gas operations.

By the reasoning of the Briggs Court, the rule of capture would not apply to a gas-bearing shale formation located above the Elk Formation because hydraulic fracturing would be required to enhance production. Such a formation, however, is conventional by definition and one in which the rule of capture undeniably applies.

That such a level of confusion exists is the result of the Pennsylvania Legislature and PADEP adopting a nomenclatural scheme which imprecisely uses terms (conventional and unconventional) already in use by the oil and gas industry but with different meanings (ref: Footnote No. 13).

The Rule of Capture in Pennsylvania Unconventional Shale Gas Formations

Contrary to relevant principles of geology and with no consideration of the fact that natural gas mobility is observed in shale formations, the Briggs Court held that the rule of capture does not apply in so-called unconventional formations; i.e., that natural gas only migrates in such formations with artificial stimulation in the form of hydraulic fractures.

The very existence of hydrocarbon reservoirs provides the most compelling evidence that natural gas migrates in, through and out of so-called unconventional

formations in the absence of hydraulic stimulation. The natural gas in reservoir rocks (conventional) originally derived from migration out of source rocks (unconventional) at a magnitude of scale best comprehended by reflection on the history of petroleum use:

- the vast volumes of oil and gas consumed over the previous 150^{+} years have been extracted almost exclusively from reservoir rocks (conventional)[15];
- the faults which provided the migration pathways from source rock to reservoir rock contacted only a tiny (even fractional) percentage of the total volume of the source rock formation, leaving most of the rock mass un-fractured;
- if the source rock did not possess an inherent permeability, conventional reservoir rocks would have contained only the gas derived from rock contacted directly by the faults (as above, a tiny percentage of the mass) and would not have contained any useful volume of gas.

In other words, if gas is truly trapped in unconventional formations and is incapable of migration as the Briggs Court concluded, viable conventional gas

[15] By all estimates, the oil and gas recovered from known reservoirs amounts to approximately 30% of the known volume of the resource in place. And that estimate does not account for the vast volumes yet undiscovered, as evident by ongoing finds, as recently as the time this brief was being prepared.

reservoirs of the magnitude still being tapped today after more than a century and a half of continuous and substantial recovery, would have been impossible.

There is a corollary to the factual condition (above) which is relevant to current Marcellus production: if the gas from Marcellus wells derived solely from the rock directly fractured, the wells would produce for only a short time (days to months) and would yield only small volumes of gas (on the order of, perhaps hundreds of thousands to several millions of cubic feet). In fact, wells operating currently each yield millions of cubic feet of gas per day and many individual wells will ultimately yield billions of cubic feet[16] which, after the initial production period, flows continuously:

- via native permeability of the unfractured rock through zones outside the hydro-fracturing envelope under an induced pressure gradient;
- into the fracture network and thence;
- into the well bore and into production equipment.

Such production is wholly impossible from only the volume of rock actually fractured and derives in large part from the migration of gas from unfractured rock outside the fracture envelope. Because the Marcellus is bounded above and below

[16] Many individual wells which are still producing have already produced such volumes.

by frac barriers which are not gas-bearing rock, the gas derives from unfractured zones horizontally adjacent to, and outside of, the fracture envelope.

Therefore, the migration of gas to the hydraulic fractures through the primary porosity via inherent permeability of the source rock occurs by the same mechanism, along similar pathways and via the same driving forces by which gas within a "conventional" reservoir migrates horizontally to a well bore.

Petitioner presents one final example that natural gas migrates from areas horizontally outside the hydro-fracturing envelope. There is currently some concern among Marcellus operators about an issue known as *parent-offspring well interference*. This condition can occur in situations where one horizontal Marcellus well has been producing natural gas for some time, but planned adjacent wells have not been drilled/frac'd. After a period of production from the horizontal, or lateral, section of such an isolated (the parent well), operators must decide what distance from the parent lateral to place the lateral sections of later, adjacent wells (offspring wells) to ensure sufficient production in those offspring wells. Offspring wells can be under-producing if their laterals are too close to the parent because the parent well will have lowered pressures and drained gas in the intervening rock; i.e., from unfractured rock outside the parent well's hydro-fracturing envelope.

Therefore, ongoing practice in the field confirms that migration of gas in an unconventional formation occurs through unfractured rock *beyond the horizontal limits of the hydro-fracturing envelope.*

As to the derivative question of whether the rule of capture applies to gas from unconventional formations:

- there is no inherent difference in the occurrence of gas between conventional and unconventional formations – in both types of formations gas occurs in pore spaces and is retained by capillarity and within geologically sealed compartments. The capillarity in both formation types must be overcome by an artificially induced pressure gradient which results from the creation of an artificial migration pathway;
- there is no inherent difference in the mechanisms of migration of gas between the conventional and unconventional formations – the gas in both formations migrates along an induced pressure gradient form one connected pore space to the next (permeability) until that gas reaches the created migration pathway - a well bore or a hydraulic fracture which enhances the native permeability and which connects back to a well bore;
- gas recovered by a Marcellus well derives from zones of the formation both within and outside of the hydro-fracturing envelope;

- many if not a majority of wells in conventional formations are subject to enhanced recovery methods including hydraulic fracturing, in which case the gas recovered by an enhanced conventional well[17] derives from zones of the formation both within and from outside the hydro-fracturing envelope.

Accordingly, considering the situation put to this Court: in an unconventional formation where the hydro-fracturing halo does not cross a property boundary, it is undeniable that some unknowable and wholly unpredictable volume of the recovered gas derives from unfractured zones of the formation horizontally outside the frac'ing envelope and consequently, from the Marcellus Formation at a location below the adjacent property. That condition is exactly the case with gas derived from the reservoir in a conventional formation where the rule of capture applies uncontested.

Because the natural gas which resides in conventional formations derived originally from a source in unconventional formations, and in some cases continues to derive from unconventional formations, there is no scientific rationale for concluding that the rule of capture applies to some gas but not to all, or in one type of geologic formation and not another.

Accordingly, and contrary to the opinion of the Briggs Court, molecules of natural gas in shale formations are no less fugacious than molecules in so-called

[17] As defined by PADEP, not by EOLSS in Footnote No. 13

conventional gas-bearing formations. The differences in the rates of migration within and out of conventional and unconventional formations does not alter the fugacity of the natural gas resource itself any more than the different diameters of any two pipes could alter the inherent flowability of water.

CONCLUSION

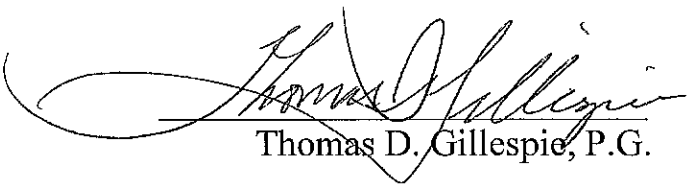
Geologically, the recovery mechanisms of gas from conventional and unconventional formations are indistinguishable as are the respective mechanisms of natural gas migration during production. The only relevant difference is the rate at which migration occurs within the unstimulated zones of the formations; a difference recognized and addressed in statute and regulation by the definition of unconventional formations and by the very considerations which led the Legislature and PADEP to differentiate the two formation types in the first instance.

Respectfully submitted to the Supreme Court of Pennsylvania on this 28th day of January, 2019, by:

Thomas D. Gillespie, P.G.
Pennsylvania Professional Geologist

CERTIFICATION OF WORD COUNT

I hereby certify that the foregoing Amicus Curiae Brief complies with Pa.R.A.P. 2135 and Pa.R.A.P. 531(b)(3). The brief, excluding cover page and supplementary matter is 4,919 words, utilizing the word count of the Microsoft Word program used to prepare the brief.



Thomas D. Gillespie, P.G.

CERTIFICATE OF COMPLIANCE

I certify that this filing complies with the provisions of the *Public Access Policy of the Unified Judicial System of Pennsylvania: Case Records of the Appellate and Trial Courts* that require filing confidential information and documents differently than non-confidential information and documents.

Thomas D. Gillespie, P.G.

CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the foregoing document was served on the following individual(s) on the date and by the method as indicated below:

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