



**APPENDIX AVAILABLE ON
THE HEALTH EFFECTS INSTITUTE-ENERGY WEBSITE**

Communication 1

**HUMAN EXPOSURE TO UNCONVENTIONAL OIL AND
GAS DEVELOPMENT:
A LITERATURE SURVEY FOR RESEARCH PLANNING**

HEI-Energy Research Committee

Appendix C. Glossary

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APPENDIX C

Glossary

GLOSSARY

A

Abandon – To temporarily or permanently cease production from a well or to cease further drilling operations. (Source: OSHA 2001)

Air toxics – The Clean Air Act Amendments of 1990 specify a list of 187 hazardous air pollutants that are known or suspected to cause cancer or other serious health or environmental effects. These hazardous air pollutants are referred to throughout this report as air toxics. The list includes volatile organic compounds (VOCs), such as benzene and formaldehyde, as well as other pollutants, such as diesel particulate matter (PM). (Source: U.S. Environmental Protection Agency 2016)

Annular space – The space surrounding one cylindrical object placed inside another, such as the space surrounding a tubular object placed in a wellbore. (Source: Schlumberger 2019)

Appalachian Basin – An elongate depression in the crystalline basement complex which contains a great volume of predominantly sedimentary stratified rocks. The Appalachian Basin extends from the Adirondack Mountains in New York to central Alabama, encompassing an area of about 207,000 square miles, including all of West Virginia and parts of New York, New Jersey, Pennsylvania, Ohio, Maryland, Virginia, Kentucky, Tennessee, North Carolina, Georgia, and Alabama. (Source: Colton 1961)

B

Basin – A synclinal structure in the subsurface, formerly the bed of an ancient sea. Because it is composed of sedimentary rock and its contours provide traps for petroleum, a basin is a good prospect for exploration. For example, the Permian Basin in West Texas is a major oil producer. (Source: Schlumberger 2019)

Barnett Shale – Hydrocarbon-producing geological formation consisting of sedimentary rocks and stretching from the Dallas–Fort Worth metroplex west and south, covering 5,000 square miles. (Source: Texas Commission on Environmental Quality 2018)

Blowout – An uncontrolled flow of gas, oil, or other well fluids from the well. (Source: Schlumberger 2019)

Brine – Water containing more dissolved inorganic salt than typical seawater. (Source: Schlumberger 2019)

C

Casing – Heavy steel pipe placed in an open hole and cemented into place. Casing is designed to withstand high pressures, large tensile loads, and resist chemical reaction and corrosion. A casing string refers to a series of connected segments of casing or pipe that serves to prevent the hole from caving, keep the fluids inside the casing string from migrating to porous formations, prevent unwanted fluids from entering the hole, and protect freshwater aquifers. (Source: Michigan Department of Environmental Quality 2013)

Cementing – To prepare and pump cement into place in a wellbore. Cementing operations may be undertaken to seal the annulus after a casing string has been run, to seal a lost circulation zone, to set a

plug in an existing well from which to push off with directional tools or to plug a well so that it may be abandoned. (Source: Schlumberger 2019)

Completion operations – A generic term used to describe the events and equipment necessary to bring a wellbore into production once drilling operations have been concluded, including but not limited to the assembly of downhole tubulars and equipment required to enable safe and efficient production from an oil or gas well. Completion quality can significantly affect production from shale reservoirs. (Source: Schlumberger 2019)

Compressor station – Any combination of facilities that supply the energy to move gas in transmission or distribution lines or into storage by increasing the pressure. Compressor stations might include equipment to remove liquids, particles, and other impurities from the natural gas, which are disposed of or sold as desired. (Source: U.S. Energy Information Administration 2019)

Conceptual model of exposure – Identifying sources of exposure, how the contaminant behaves in the environment, and the context in which people come into contact with the contaminant that results in an adverse health effect. (Adapted from: Boston University School of Public Health 2016)

Conventional oil and gas development – Crude oil and natural gas that is produced by a well drilled into a geologic formation in which the reservoir and fluid characteristics permit the oil and natural gas to readily flow to the wellbore. (Source: U.S. Energy Information Administration 2019)

Cuttings – *See* Drill cuttings.

D

Development phase – The phase of petroleum operations that occurs after exploration has proven successful, and before full-scale production. For the purposes of this report, development includes exploration, site preparation, vertical and horizontal drilling, hydraulic fracturing, well completion in preparation for production, and associated waste management. (Source: Schlumberger 2019)

Drilling cuttings – Fragments of rock dislodged by the drill bit and brought to the surface in the drilling mud. Washed and dried cuttings samples are analyzed by geologists to obtain information about the formations drilled. (Source: U.S. Legal 2019)

Drilling mud or drilling fluid – A circulating fluid, one function of which is to lift cuttings out of the wellbore and to the surface. It also serves to cool the bit and to counteract downhole formation pressure. (Source: OSHA 2001)

Drill rig – The machine used to drill a wellbore. In onshore operations, the rig includes virtually everything except living quarters. Major components of the rig include the mud tanks, the mud pumps, the derrick or mast, the drawworks, the rotary table or topdrive, the drillstring, the power generation equipment, and auxiliary equipment. (Source: Schlumberger 2019)

F

Field – An accumulation, pool, or group of pools of hydrocarbons or other mineral resources in the subsurface. A hydrocarbon field consists of a reservoir with trapped hydrocarbons covered by an impermeable sealing rock, or trapped by hydrostatic pressure. (Source: Schlumberger 2019)

Formation – A body of rock strata, of intermediate rank in the hierarchy of lithostratigraphic units, which is unified with respect to adjacent strata by consisting dominantly of a certain lithologic type, or by possessing other unifying lithologic features. (Adapted from: Schlumberger 2019)

Flare – A tall stack equipped with burners used as a safety device at wellheads, refining facilities, gas processing plants, and chemical plants. Flares are used for the combustion and disposal of combustible gases. The gases are piped to a remote, usually elevated, location and burned in an open flame in the open air using a specially designed burner tip, auxiliary fuel, and steam or air. Combustible gases are flared most often due to emergency relief, overpressure, process upsets, startups, shutdowns, and other operational safety reasons. Natural gas that is uneconomical for sale is also flared. Often natural gas is flared as a result of the unavailability of a method for transporting such gas to markets. (Source: U.S. Energy Information Administration 2019)

Flowback water – The mixture of drilling mud, fracturing fluids, produced water, oil, gas, salts, heavy metals, and natural gas liquids that comes out of a well after hydraulic fracturing. (Source: InsideClimate News, Center for Public Integrity, Weather Channel N.D.)

Fracturing fluid – The water and chemical additives used to hydraulically fracture the reservoir rock, and proppant (typically sand or ceramic beads) pumped into the fractures to keep them from closing once the pumping pressure is released. (Source: The Geological Society of America 2019)

Fugitive emission – Intentional or unintentional release of volatile chemicals during extraction, processing, and delivery of fossil fuels to the point of final use. (Source: Carras et al. 2006)

G

Gas – *See* Natural gas.

Gas condensate – Hydrocarbon liquid dissolved in saturated natural gas that comes out of solution when the pressure drops below the dewpoint. (Source: Schlumberger 2019)

Gas well – A well completed for the production of natural gas from one or more gas zones or reservoirs. Such wells contain no completion for the production of crude oil. (Available: U.S. Energy Information Administration 2019)

Gathering flowline – The pipes used to transport oil and gas from a field to the main pipeline in the area. (Source: Schlumberger 2019)

H

Hazardous air pollutants – *See air toxics.*

High-emitting – Facilities that have temporary abnormally high emissions that are caused by an equipment malfunction, accident, operator error, or some other unintended failure of a process to operate in a normal or usual manner. Sometimes referred to as super-emitters. (Source: Zavala-Araiza et al. 2015)

Horizontal or directional drilling – Deviation of a wellbore from vertical toward a horizontal inclination in order to intersect targeted fractures or maximize contact with a productive formation. (Source: Michigan Department of Environmental Quality 2013)

Hydraulic fracturing – A stimulation treatment routinely performed on oil and gas wells in low-permeability reservoirs. Specially engineered fluids are pumped at high pressure and rate into the reservoir interval to be treated, causing a vertical fracture to open. The wings of the fracture extend away

from the wellbore in opposing directions according to the natural stresses within the formation. Proppant, such as grains of sand of a particular size, is mixed with the treatment fluid to keep the fracture open when the treatment is complete. Hydraulic fracturing creates high-conductivity communication with a large area of formation and bypasses any damage that may exist in the near-wellbore area. (Source: Schlumberger 2019)

Hydrocarbons – Organic compounds of hydrogen and carbon, whose densities, boiling points, and freezing points increase as their molecular weights increase. Although composed of only two elements, hydrocarbons exist in a variety of compounds because of the strong affinity of the carbon atom for other atoms and for itself. The smallest molecules of hydrocarbons are gaseous; the largest are solid. (Source: OSHA 2001)

I

Impoundment – A man-made excavation or diked area for the retention of waste fluids. (Source: West Virginia Department of Environmental Protection 2012)

Induced seismicity – Earthquakes related to human activities. Events are typically small in magnitude and intensity of shaking. (Source: National Research Council 2013)

L

Liquid unloading – Removal of accumulated fluids from mature gas wells to maintain production. (Source: U.S. Environmental Protection Agency 2014)

M

Microannulus– A small gap that can form between the casing or liner and the surrounding cement sheath, most commonly formed by variations in temperature or pressure during or after the cementing process. Such variations cause small movement of the steel casing, breaking the cement bond and creating a microannulus that is typically partial. However, in severe cases the microannulus may encircle the entire casing circumference. A microannulus can jeopardize the hydraulic efficiency of a primary cementing operation, allowing communication between zones if it is severe and connected. (Source: Schlumberger 2019)

N

Natural gas – A naturally occurring mixture of hydrocarbon gases that is highly compressible and expansible. Methane is the chief constituent of most natural gas (constituting as much as 85% of some natural gases), with lesser amounts of ethane, propane, butane, and pentane. Impurities can also be present in large proportions, including carbon dioxide, helium, nitrogen and hydrogen sulfide. (Source: Schlumberger 2019)

NORM (Naturally Occurring Radioactive Materials) and TENORM (Technologically Enhanced NORM) – NORM is any terrestrial material (rock, soil, or water) that contains elements that emit radiation. TENORM is produced when activities such as OGD concentrate or expose radioactive materials that occur naturally in ores, soils, water, or other natural materials. For example, barium and strontium scales may be deposited in the wellbore or production tubulars depending on the geological formation and other factors. (Source: Babcock et al. 2015)

O

Oil – A mixture of hydrocarbons usually existing in the liquid state in natural underground pools or reservoirs. Gas is often found in association with oil. (Source: U.S. Energy Information Administration 2019)

Oil or gas field – The surface area overlying an oil or gas reservoir or reservoirs. Commonly, the term includes not only the surface area but also the reservoir, wells, and production equipment. (Source: OSHA 2001)

Oil well – A producing well with oil as its primary commercial product. Oil wells almost always produce some gas and frequently produce water. Most oil wells eventually produce mostly gas or water. (Source: Schlumberger 2019)

Orphaned well – Orphaned wells have no known or solvent owner and may or may not be capable of further production. (Source: Interstate Oil and Gas Compact Commission 2009)

P

Particulate matter (PM) – A small, discrete mass of solid or liquid matter that remains individually dispersed in gas or liquid emissions. Particulates take the form of aerosol, dust, fume, mist, smoke, or spray. Each of these forms has different properties. (Source: U.S. Energy Information Administration 2019)

Perforation – To pierce the casing wall and cement to provide holes through which formation fluids may enter or to provide holes in the casing so that material may be introduced into the annulus between the casing and the wall of the borehole. Perforating is accomplished by lowering into the well a perforating gun, or perforator, that fires bullet-shaped charges that are electrically detonated from the surface. (Source: OSHA 2001)

Permeability – A measure of the ease with which fluids can flow through a porous rock. (Source: OSHA 2001)

Play – An area in which hydrocarbon accumulations or prospects of a given type occur. The shale gas plays in North America, for example, include the Barnett, Eagle Ford, Fayetteville, Haynesville, Marcellus, and Woodford, among many others. (Source: Schlumberger 2019)

Potable water – Water suitable for drinking. (Source: Water Education Foundation 2019)

Produced water – Naturally-occurring water that comes out of the ground along with oil and gas. (Adapted from: American Geosciences Institute 2019). The characteristics of produced water vary and use of the term often implies an inexact or unknown composition. (Adapted from: Schlumberger 2019)

Production – The phase of the petroleum industry that deals with bringing the well fluids to the surface and separating them as well as with storing, gauging, and otherwise preparing the product for distribution. For the purposes of this report, production includes extraction, gathering, processing, and compression of gas; extraction and processing of oil and natural gas condensates; management of produced water and other wastes; and operation of gathering pipelines. (Source: OSHA 2001)

Production casing – The last string of casing or liner that is set in the well, inside of which is usually the primary completion components. (Adapted from: OSHA 2001 and Schlumberger 2019)

Proppant – A granular substance (silica sand, aluminum pellets, or other material) that is carried in suspension by the fracturing fluid and serves to keep the cracks open when fracturing fluid is withdrawn after a fracture treatment. (Source: International Association of Drilling Contractors 2019)

R

Reclamation – Process of restoring surface environment to acceptable pre-existing conditions. Includes surface contouring, equipment removal, well plugging, revegetation, and other processes. (Source: U.S. Energy Information Administration 2019)

Reservoir – A subsurface, porous, permeable rock body in which oil or gas or both are stored. Most reservoir rocks are limestones, dolomites, sandstones, or a combination of these. The three basic types of hydrocarbon reservoirs are oil, gas, and condensate. (Available: Aspen Environmental Group 2015)

Rig – *See* Drill rig.

S

Sediment – The unconsolidated grains of minerals, organic matter, or preexisting rocks, that can be transported by water, ice, or wind and deposited. (Source: Schlumberger 2019)

Separator – A cylindrical or spherical vessel used to separate oil, gas, and water from the total fluid stream produced by a well. Separators can be either horizontal or vertical. Separators can be classified into two-phase and three-phase separators (commonly called free-water knockout). Gravity segregation is the main force that accomplishes the separation, which means the heaviest fluid settles to the bottom and the lightest fluid rises to the top. (Source: Schlumberger 2019)

Shale – A type of sedimentary rock. Because oil and natural gas are tightly bound within the shale, operators almost always need hydraulic fracturing or another stimulation method to increase the shale's permeability so oil and natural gas can flow out of the well. (Source: InsideClimate News, Center for Public Integrity, Weather Channel N.D.)

Shale gas – Natural gas that can be generated and trapped within shale units. (Adapted from: Schlumberger 2019)

Spud – To start the well drilling process by removing rock, dirt, and other sedimentary material with the drill bit. (Source: Schlumberger 2019)

Source rock – A rock rich in organic matter which, if heated sufficiently, will generate oil or gas. Typical source rocks, usually shales or limestones, contain about 1% organic matter and at least 0.5% total organic carbon, although a rich source rock might have as much as 10% organic matter. (Source: Schlumberger 2019)

Strata – Layers of sedimentary rock. (Source: Schlumberger 2019)

Stray gas – Gas that migrates from its usual geological location into aquifers or the vadose zone (the zone between the groundwater and the surface) within the shallow subsurface. (Source: Groundwater Protection Council 2012)

Subsurface – Of, relating to, or being something located beneath a surface and especially underground. (Source: Merriam-Webster 2019)

T

TENORM – *See* NORM (Naturally Occurring Radioactive Materials) and TENORM (Technologically Enhanced NORM)

Tight gas – Gas produced from a relatively impermeable reservoir rock. Hydrocarbon production from tight reservoirs can be difficult without stimulation operations. Stimulation of tight formations can result in increased production from formations that previously might have been abandoned or been produced uneconomically. The term is generally used for reservoirs other than shales. (Source: Schlumberger 2019)

U

Unconventional oil and natural gas development –The wave of onshore development and production of oil and natural gas from shale and other unconventional, or low permeability, geologic formations as practiced starting around the beginning of the 21st century.

W

Wellbore – A borehole; the hole drilled by the bit. (Adapted from: Schlumberger 2019)

Wellhead – The system of spools, valves, and assorted adapters that provide pressure control of a production well. (Source: Schlumberger 2019)

Well integrity –Design of a wellbore which has the least potential for exposure to fluid migration, better longevity, and reliable and fit-for-purpose hydraulic and mechanical barriers (Adapted from: Kiran et al. 2017).

Well pad – A central location for the wells and equipment. A well pad may be several acres in size. Operators often place multiple wells on a single well pad. (Source: InsideClimate News, Center for Public Integrity, Weather Channel N.D.)

Well stimulation – A treatment performed to restore or enhance the productivity of a well. Stimulation treatments fall into two main groups, hydraulic fracturing treatments (*See* Hydraulic fracturing) and matrix treatments (e.g., acid or solvent and chemical treatments to improve the permeability of the near-wellbore formation). Fracturing treatments are performed above the fracture pressure of the reservoir formation and create a highly conductive flow path between the reservoir and the wellbore. Matrix treatments are performed below the reservoir fracture pressure and generally are designed to restore the natural permeability of the reservoir following damage to the near-wellbore area. Stimulation in shale gas reservoirs typically takes the form of hydraulic fracturing treatments. (Source: Schlumberger 2019)

References

- American Geosciences Institute. 2019. What is Produced Water? Available: <https://www.americangeosciences.org/critical-issues/faq/what-produced-water>. Accessed August 6, 2019.
- Aspen Environmental Group. 2015. Final Environmental Impact Report-Analysis of Oil and Gas Well Stimulation Treatments in California-Volume II of III-Appendix A. State Clearinghouse No. 2013112046. Available: <ftp://ftp.consrv.ca.gov/pub/oil/SB4EIR/EIR/Apx%20A%20Oil%20and%20Gas%20Glossary%20of%20Terms.pdf>. Accessed June 25, 2019.
- Babcock L, Butalia T, Dutta P, Frazier J, Gannon M, Hall M, et al. 2015. NORM and TENORM: Occurrence, Analysis, Methods, Monitoring, Handling and Disposal — R&D Needs. The NORM Working Group at The Ohio State University. Available: <https://certain.osu.edu/norm-and-tenorm-occurrence-characterizing-handling-and-disposal>. Accessed June 25, 2019.
- Boston University School of Public Health. 2016. Conceptual Model. Office of Teaching and Digital Learning. Available: <http://sphweb.bumc.bu.edu/otlt/mph-modules/ExposureAssessment/exposureassessment3.html>. Accessed June 25, 2019.
- Carras J, Franklin P, Hu Y, Singh AK, Tailakov OV, Picard D, Ahmed A, Gjerlad E, Nordrum S, Yesserkepova I. 2006. Chapter 4: Fugitive Emissions. 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Available: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_4_Ch4_Fugitive_Emissions.pdf. Accessed June 25, 2019.
- Centers for Disease Control and Prevention. 2013. Health-Related Quality of Life (HRQOL): Well-being Concepts. Available: <http://www.cdc.gov/hrqol/wellbeing.htm>. Accessed June 25, 2019.
- Colton GW. 1961. Geologic summary of the Appalachian Basin, with reference to the subsurface disposal of radioactive waste solutions. U.S. Geological Survey. Washington, D.C. Available: <https://pubs.er.usgs.gov/publication/ofr6228>. Accessed June 25, 2019.
- Groundwater Protection Council. 2012. A White Paper Summarizing the Stray Gas Incidence and Response Forum. Cleveland Ohio. Available: <http://www.gwpc.org/sites/default/files/files/stray%20gas%20white%20paper-final.pdf>. Accessed June 25, 2019.
- InsideClimate News, Center for Public Integrity, Weather Channel. N.D. Oil Wells in the Eagle Ford Shale: The Extraction Process (Glossary of Terms). Available: <https://insideclimatenews.org/oil-wells-eagle-ford-shale-extraction-process-glossary-terms>. Accessed June 25, 2019.
- International Association of Drilling Contractors. 2019. Drilling Glossary-Acronyms and Abbreviations. Available: <http://drillingmatters.iadc.org/drilling-glossary/>. Accessed June 25, 2019.
- Interstate Oil and Gas Compact Commission. 2009. Orphaned & Abandoned Wells: Innovative Solutions. GroundWork: The Journal of the Interstate Oil and Gas Compact Commission October 2009:2–9.
- Kiran R, Teodoriu C, Dadmohammadi Y, Nygaard R, Wood D, Mokhtari M, et al. 2017. Identification and evaluation of well integrity and causes of failure of well integrity barriers (a review). *J Nat Gas Sci Eng* 45:511–526.

Merriam-Webster. 2019. Definition: Subsurface. Available: <https://www.merriam-webster.com/dictionary/subsurface>. Accessed June 25, 2019.

Michigan Department of Environmental Quality. 2013. Hydraulic Fracturing of Oil and Gas Wells in Michigan. Available: http://www.michigan.gov/documents/deq/Hydraulic_Fracturing_In_Michigan_423431_7.pdf. Accessed June 25, 2019.

National Research Council. 2013. Induced Seismicity Potential in Energy Technologies. Washington, DC: The National Academies Press. Available: <https://www.nap.edu/catalog/13355/induced-seismicity-potential-in-energy-technologies>. Accessed June 25, 2019.

OSHA. 2001. Glossary of Terms; c2001 Petex. Available: https://www.osha.gov/SLTC/etools/oilandgas/glossary_of_terms/glossary_of_terms_a.html. Accessed June 25, 2019.

Schlumberger. 2019. Oilfield Glossary. Available: <http://www.glossary.oilfield.slb.com/>. Accessed June 25, 2019.

Texas Commission on Environmental Quality. 2018. Barnett Shale Geological Area. Available: <https://www.tceq.texas.gov/airquality/barnettshale>. Accessed June 25, 2019.

The Geological Society of America. 2019. GSA Critical Issue: Hydraulic Fracturing Glossary. Available: https://www.geosociety.org/GSA/Science_Policy/Critical_Issues/hf/GSA/Policy/issues/hf/glossary.aspx. Accessed: June 25, 2019.

U.S. Energy Information Administration. 2019. Glossary. Available from <http://www.eia.gov/tools/glossary/index.cfm?id=A>. Accessed June 25, 2019.

U.S. Environmental Protection Agency. 2016. Original list of hazardous air pollutants. Available from <http://www.epa.gov/ttn/atw/188polls.html>. Accessed June 25, 2019.

U.S. Environmental Protection Agency. 2014. White paper: Oil and Natural Gas Sector Liquids Unloading Processes. Washington, DC: U.S. EPA. Available: <https://www.ourenergypolicy.org/wp-content/uploads/2014/04/epa-liquids-unloading.pdf>. Accessed June 25, 2019.

U.S. Legal. 2019. Oil and Gas Definitions. Available: <https://oilandgas.uslegal.com/definitions/>. Accessed June 25, 2019.

Water Education Foundation. 2019. Potable Water. Available: <https://www.watereducation.org/aquapedia-background/potable-water>. Accessed June 25, 2019.

West Virginia Department of Environmental Protection. 2012. Pits and Impoundments. Office of Oil and Gas. W.Va. Code §22-6A. Available: <http://www.dep.wv.gov/oil-and-gas/impoundments/documents/pits%20and%20impoundments%20pp.5-30-2012.pdf>. Accessed June 25, 2019.

Zavala-Araiza D, Lyon D, Alvarez RA, Palacios V, Harriss R, Lan X, et al. 2015. Toward a functional definition of methane super-emitters: application to natural gas production sites. *Environ Sci Technol* 49:8167–8174.