



OIL AND GAS POLLUTION

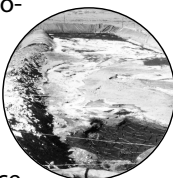


Drilling and Completion. Drilling involves boring down to rock formations that contain oil or natural gas. Fluid or “mud” is circulated down hole to keep the drill bit cool and lubricated, and it returns to the surface carrying rock debris known as “cuttings.” During completion, fluids and cuttings within the well bore are removed. Some gas usually exits as these materials come to the surface, and the gas is typically flared. **AIR:** Exhaust fumes from drilling equipment; venting and flaring of natural gas. **SOIL:** Muds and cuttings, which may contain chemical additives, salts, metals and hydrocarbons, are often stored in pits and buried on site. This may sterilize soils. **WATER:** Contaminants in pit sludge may leach out of the soil or overflow the pit and contaminate nearby soils, surface waters and groundwater.

Stimulation. Hydraulic fracturing, a common stimulation technique, involves fracturing the target formation with high-pressure injection of various substances. After fracturing, some of the injected fluids and gas from the formation flow out of the well, and sand remains behind to prop open the fractures. **AIR:** Exhaust fumes from heavy equipment; flaring or venting of gas; wastes stored in pits may contain volatile chemicals that escape into the air. **SOIL:** Many fracturing chemicals are hazardous, and may contaminate soil if spilled on site. **WATER:** Fracturing fluids may be injected into or come in contact with fresh water aquifers. Waste fluids stored in pits may contaminate surface or groundwater if pits leak or overflow.

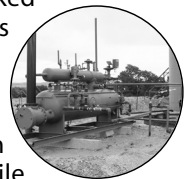


Produced Water. Typically, during coalbed methane operations water must be removed from the coals before methane will flow to the well. Over time, water production tends to decrease. In conventional natural gas and oil formations, however, water production often increases with time, as the oil and gas are depleted. Produced water is piped or trucked to disposal ponds or underground injection wells; or discharged on land or into surface

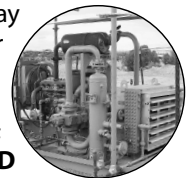


waters. **AIR:** When stored in open pits volatile hydrocarbons (e.g., benzene) escape into the air. The pumping of shallow water may result in the migration of methane and H₂S to from soil to air. Exhaust is created from water pumps powered by diesel or natural-gas-fired engines. **SOIL:** salts, metals, hydrocarbons or traces of chemical additives in produced water may contaminate soil if spilled on the surface or stored in earthen pits. **WATER:** produced water may contaminate waters through spills, pipelines breaks, leaks from storage ponds, or movement of injected water into a freshwater aquifer.

Separation and Dehydration. During separation, gas is separated from heavier hydrocarbons (e.g., oil and natural gas liquids), and water may also be “knocked out.” Dehydrators remove water from the gas stream. Separation and dehydration may occur at well sites, compressor stations, gas processing plants or oil storage sites (i.e., tank batteries). **AIR:** Dehydrators and separators often vent large volumes of methane and volatile organic compounds. Dissolved hydrocarbons in wastewater may escape into the air. **SOIL:** Pits or tanks that store wastewater may leak or overflow and contaminate soil. **WATER:** Wastewater may contain dissolved hydrocarbons, sand and metals that can contaminate surface and groundwater.



Gas Compression. Typically, diesel or natural gas-fired engines provide power to compressors that, in turn, compress the gas. Some compressors are used to pull the gas out of wells, while other compressors push the gas along a pipeline. Field compression may occur at well sites. Centralized compressor facilities are required, however, to move large volumes of gas to and through larger gas transmission pipelines. **AIR:** Engine exhaust; occasional venting of natural gas. **SOIL AND WATER:** Soil and water pollution may occur due to spills or leaks of diesel or other fuel used to power the compressors.



Natural gas is a clean fuel? THINK AGAIN

CONTAMINANTS AND THEIR SOURCES

BTEX	Benzene, toluene, ethylbenzene and xylenes.	Benzene is a known carcinogen. Toluene may affect the reproductive and central nervous systems; while ethylbenzene and xylenes may have respiratory and neurological effects.	Venting of natural gas Pits Produced water Dehydration
CH₄	Methane	Main concern is the explosive nature of this gas.	Venting of natural gas Dehydration
Diesel fuel	A complex mixture of hydrocarbons.	Both fuel and exhaust contains carcinogenic substances like benzene and PAHs.	Stimulation fluids Oil-based drilling muds Engines/heavy equipment
H₂S	Hydrogen Sulfide	Aggravates respiratory conditions, and affects neurological system, cardiovascular system and can cause central nervous system problems.	Venting and flaring of natural gas (if present in the oil and gas formations) Migration from soils
Metals	Examples: arsenic, barium, cadmium, chromium, lead, mercury, selenium, zinc and others.	There are different potential health effects associated with each metal. Possible toxic effects include skin problems, hair loss, kidney damage, high blood pressure, increased cancer, neurological damage risk and others.	Drilling muds Stimulation fluids Pits Produced water Venting and flaring Diesel exhaust
NO_x	Nitrogen oxides	React with VOCs to form ground-level ozone and smog, which can trigger respiratory problems. React with other chemicals to form particulate pollution, which can damage lungs and cause respiratory illness, heart conditions and premature death. Reacts with common organic chemicals to form toxics that may cause biological mutations.	Compressor engines Flaring Diesel and natural gas engine exhaust
PAHs	Polycyclic Aromatic Hydrocarbons	Several agencies have classified some PAHs as probable or possible carcinogens. Animal studies show reproductive effects.	Diesel exhaust Flaring Pits
Partic-ulate matter	Small particles suspended in air.	Can be inhaled and cause health effects like respiratory ailments, aggravation of asthma and allergies, painful breathing, shortness of breath, chronic bronchitis and premature death. May combine with other air pollutants to aggravate health problems. Some particulates, such as diesel exhaust are carcinogenic.	Diesel exhaust Pits (dust from) Venting and flaring
SO₂	Sulfur dioxide	Reacts with other chemicals to form particulate pollution, which can damage lungs and cause respiratory illness, heart conditions and premature death.	Diesel and natural gas engine exhaust Flaring
VOCs	Volatile Organic Compounds, include BTEX formaldehyde and others.	React with NO _x to form ground-level ozone and smog, which can trigger respiratory problems. Can cause health problems such as cancer.	Venting and flaring of natural gas Pits Oily wastes Diesel and natural gas engine exhaust Compressors