

Light Shale (Tight) Oil Spills

Definition

Light shale oils (also called light tight oils) are very light crude oils from oil reservoirs with very low permeability that are produced by horizontal drilling and fracking methods (e.g., from Bakken and Eagle Ford formations). Often, the production sites do not have a local or central processing facility, and the crude oil that is shipped off site contains all the volatile fractions. This characteristic may create added fire risks and air quality concerns during spills because of the oil's high volatility.

Properties

- The concentration of light hydrocarbons can be as high as 7-8% dissolved gases from methane to butane: South Louisiana crude = 3%, West Texas Intermediate crude = 5.9%, and Eagle Ford crude = 8.3%.
- The Reid Vapor Pressure (volatility measure) is 8-12 pounds per square inch absolute (psia); for comparison, gasoline is 8-15 psia. Thus, light shale oils will readily ignite if there is an ignition source. See the Bakken Oil Spill Responder Guide for additional information on response options and guidelines for spills on water and land, with and without a fire.
- Light shale oils have very low viscosity. Thus, when spilled on water, they spread quickly to thin slicks and sheens and are readily dispersed into the water column when winds reach 5-7 knots or sea conditions are 2-4 feet (see ADIOS® oil weathering plots on the next page). For releases to rivers, turbulence can enhance natural dispersion.
- Light shale oils are much lighter than water (specific gravity is 0.7-0.8, compared to 1.00 for fresh water and 1.03 for seawater). These oils do not sink or accumulate on the bottom of a waterbody as free oil.

Environmental Behavior

- Once weathered, light shale oils behave like a light crude oil, though the amount of remaining oil is often a small fraction of the original spill volume.
- Light shale oils that are dispersed in the water column can adhere to fine-grained suspended sediments, which then settle out and get deposited on the bottom of a waterbody. This process is more likely to occur in streams and rivers with significant suspended sediment loads than in open marine settings. This process is not likely to result in measurable sediment contamination for small spills.
- When stranded on the shoreline or spilled on land, light shale oils tend to penetrate porous substrates quickly, which can slow evaporation. There may be secondary releases of volatiles, and concerns for ignition and worker safety, when: 1) Pooled oil on land migrates to water and quickly spreads; 2) Oil seeps into trenches dug to intercept a subsurface spill; 3) Where the oil enters storm drains, creating a hazardous confined space; and 4) When damaged rail cars are being moved.

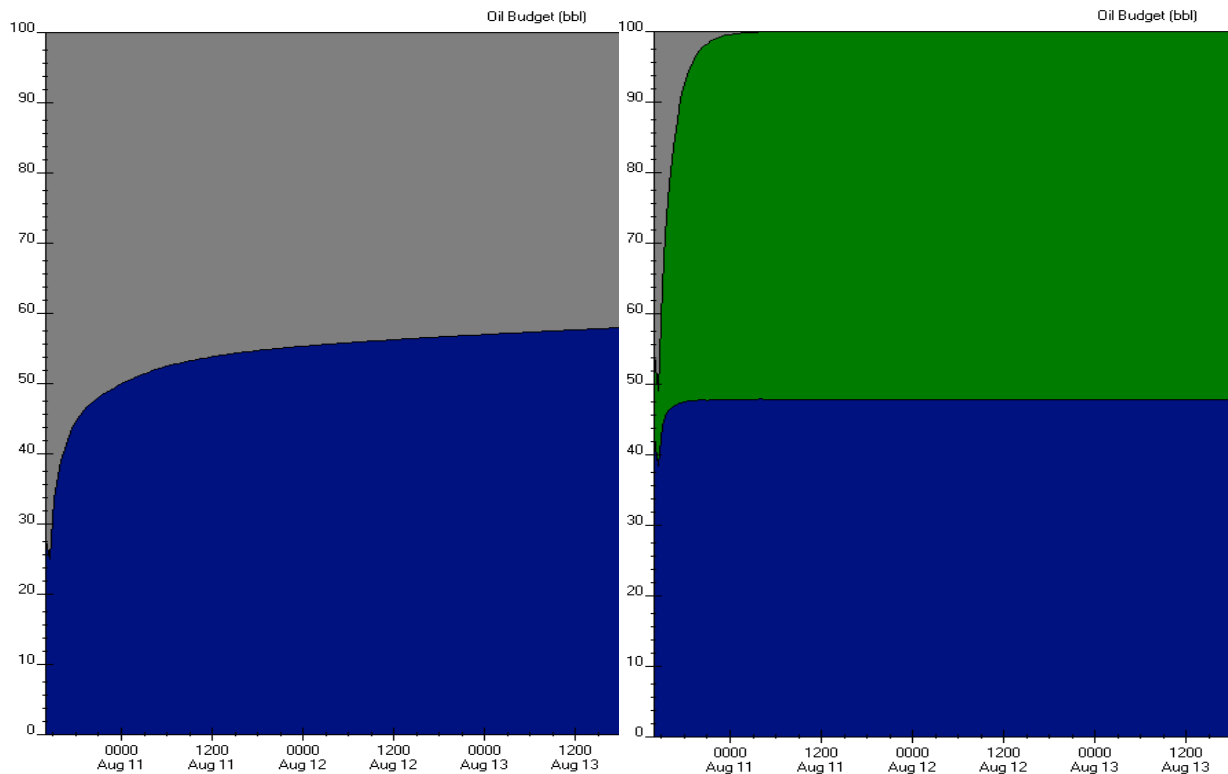
Environmental Effects

- The aquatic toxicity of light shale oils varies widely due to variations in the chemical composition of the oil source. Light shale oils containing relatively high concentrations of the more water-soluble oil components may pose greater risks of acute toxicity. These fractions are also highly volatile, thus exposures may be of short duration.

- Aquatic organisms that come in direct contact with naturally dispersed and entrained light shale oil in the water column may be killed. However, small spills in open water may not result in fish kills due to rapid dilution and evaporation. Fish kills may occur for small spills in confined, shallow water and in streams, where weathering and mixing are reduced. Fish and invertebrates in small streams can be affected for miles downstream of a light shale oil release into the water.

Special Response Considerations

- Responders may need to evacuate non-essential personnel or the public based on the area affected, and conduct air monitoring to establish hot, warm, and cold zones for operations, and use appropriate Personal Protective Equipment. They should be aware of vapor ignition hazards in areas where the oil has been contained, or in sewers or other confined spaces where the oil has spread.



ADIOS model output for a Bakken crude oil spill of 100 bbl; winds of 5 knots (left) and 20 knots (right). **Blue = evaporated**; **green = dispersed**; **grey = remaining**.

ADIOS (Automated Data Inquiry for Oil Spills) web link: <https://response.restoration.noaa.gov/adios>

Key Reference

Massachusetts Department of Environmental Protection. 2015. Bakken Crude Oil Spills – Response Options and Environmental Impacts. Available at: <https://www.mass.gov/files/2017-08/bakken-crude-oil-spills-response-options-and-environmental-impacts.pdf>

