CALIFORNIA
OIL AND GAS WASTE REPORT

The failure to safely manage oil and gas waste

January 2021

EARTHWORKS

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AUTHORS:

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Dedicated to protecting communities and the environment from the adverse impacts of mineral and energy development while promoting sustainable solutions.

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January 2021—Introduction

Though the Golden State is no longer a "top 5" oil and natural gas producer in the United States, it is one of the worst states when it comes to regulating the industry's waste from decades of development that continues today – from allowing crops to be irrigated with oil and gas wastewater to storing waste in unlined pits and injecting wastewater into protected water aquifers. Both good and bad changes in regulations have occurred over the past several years, and California still has major gaps that continue to put the public and environmental health at risk. Despite a short moratorium on new steam injection and fracking permits (November. 2019 - April 2020), permits for new oil and gas wells are still issued by the hundreds every month. Even companies on the verge of bankruptcy have earned permits in 2020, calling into question California's commitment to safely manage an industry in decline whose wells will produce dangerous waste and harm frontline communities for decades to come.

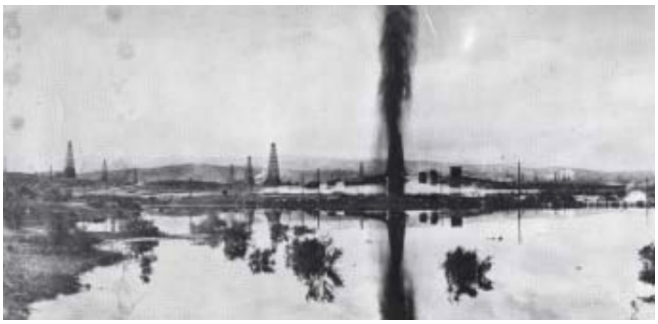
Background

California's position as a staple of the crude oil industry runs long and deep.

Since the first well was drilled in California in 1861, oil production has steadily grown in the state. In 2017, California was fourth in the nation in crude oil production. By February 2019, it dropped to seventh largest producer in terms of barrels per month, but still produced over 160 million barrels per year.[1]

When it comes to natural gas, California is not as significant a player. While natural gas was produced in the state as early as the 1880s, in February 2019 California ranked 14th in the nation in monthly natural gas production.[2]

Though the most active producing region is the Central Valley, regulation of this industry is truly a statewide concern. As of 2018, California had 52,863 active oil and gas wells throughout the state, from the southern border to the far north, and 31,132 inactive wells.[3] Though not producing oil or natural gas, inactive wells still produced waste that must be managed.



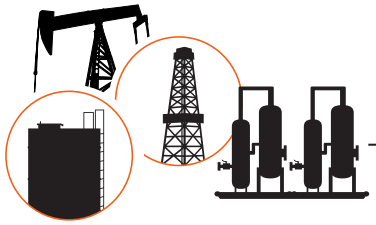
Lakeview Gusher, Kern County, California 1910.
Photo: California Department of Conservation


Photo: Joseph Sohm/stock.adobe.com

Toxic Chemicals in Oil and Gas Waste

So what is oil and gas waste, exactly?

The waste streams from the extraction and production of oil and natural gas are a combination of solid, liquid and semi-liquid materials that contain both naturally-occurring and man-made toxic chemicals.



Liquid Waste

Typically stored on site in pits or tanks; some is reused, but all is eventually disposed by injection underground, percolation through unlined pits, discharge to waterways after processing, or spread on roads or land.

Wastewater

- Flowback (includes fracking additives)
- Produced Water
- Brine
- Effluent from treatment facilities

Leachate

In Between

Drilling Muds, Sludge

Material is added to these wastes for "solidification" before being sent to landfills.

Pipe Scale

Scale can either be disposed as solid waste, or dissolved and disposed of with liquid waste.

Solid Waste

Disposed of in landfills. Drill cuttings have also been used as construction material.

- Drill cuttings (includes drilling additives)
- Fracking sand
- Fluid pit liners
- Filter socks
- Well site pad liners
- Contaminated soil
- Retired tanks and equipment

Drilling pulls earthen material and underground water sources to the surface that contain heavy metals, like arsenic and lead, as well as carcinogenic, radioactive elements like radium-226, which has a half-life of 1,600 years and accumulates on equipment and in the environment. Both drilling and fracking (hydraulic fracturing – a technical process used to extract oil and gas from deep, tight layers of the earth) also typically involve the use of chemical additives that add harmful toxics like benzene to the mix.

Some waste streams, like drill cuttings and fracking sand, are generated once or twice during the lifetime of an oil or gas well. But others, like wastewater and retired equipment, are produced throughout the lifetime of an oil or gas well.

Oil and Gas Waste Life Cycle

BURIAL ON-SITE

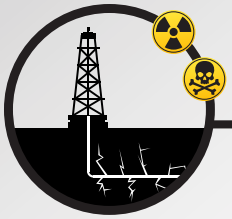
In some states, drill cuttings and the "muds" used to drill can be buried on site with little or no barrier between this waste and soil or groundwater. **Muds may contain petroleum products that can leach into groundwater and soil.**

LANDFILL DISPOSAL

Most of this (mostly) solid waste is sent to landfills for burial. **Despite the risk of radioactivity and toxicity, some states don't require radiation testing of waste or the LEACHATE that drains from landfills and can contaminate water and soil.**

BENEFICIAL WASTE "RE PURPOSING"

"Beneficial Reuse" REPURPOSING – Some states allow for the mixing of drill cuttings with other materials for use in construction, road building, and industrial development. **Somewhat experimental, there are few regulations to ensure this reuse isn't more harmful than "beneficial."**



DRILLING & FRACKING

When a well is drilled, rock and dirt that can contain naturally-occurring radioactive material (NORM) come to the surface as DRILL CUTTINGS. NORM that is "liberated" via industrial processes like drilling is sometimes called TENORM (Technically Enhanced Naturally-Occurring Radioactive Material). **When mismanaged, these radioactive materials can make their way into water, soil and air.** FRACKING FLUIDS containing trade-secret chemicals are pumped into wells and resurface as liquid waste. **These mystery toxic chemicals contaminate water and soil wherever they spill and complicate disposal.**

SOLID WASTE

LIQUID WASTE

FLOWBACK AND PRODUCED WATER

Drilling and fracking also produce liquid waste over the lifetime of a well. For the first 2-3 months, this waste is called FLOWBACK. Afterward, it's called PRODUCED WATER or BRINE, which is often saltier than seawater and contains heavy metals, hydrocarbons, fracking chemicals, and radioactive materials. Some of this wastewater can be recycled for further fracking. **Mismanaged liquid waste has contaminated drinking water supplies and rivers across the U.S.**

TREATMENT AND DISCHARGE

Wastewater can be processed to reduce, but not completely remove, pollutants and discharged to waterways. **This has led to the accumulation of toxic chemicals in rivers and threatened human and environmental health.** Toxic chemicals are concentrated into sludge left over from the treatment process which is then taken to landfills.

ROAD & LAND SPREADING

Many states allow spreading of PRODUCED WATER/BRINE from "non-fracked" wells on roads for dust suppression and deicing. **The radioactive materials, heavy metals and other toxic chemicals in this wastewater can accumulate in and pollute roadsides and nearby waterways or farm fields.** Some states also allow for the use of produced water for irrigation and livestock feeding.

INJECTION WELLS

Most wastewater from oil and gas operations ultimately ends up being injected underground for disposal. **These injection wells can leak and contaminate groundwater and cause earthquakes.**

HEALTH ALERT

At all stages of the oil and gas waste management process, toxic chemicals can enter the environment accidentally (spills, leaks, waste truck rollovers, and illegal dumping) or legally under current state and federal law (road spreading, discharge to rivers, landfill leaching). Oil and gas waste contains varying amounts of heavy metals, radioactive materials, salts, hydrocarbons, and other pollutants, some of which are carcinogenic and threaten human and environmental health. A list of oil and gas waste contamination cases can be found in our full report *Still Wasting Away* at Earthworks.org.

A Radioactive Industry

The presence of radioactive elements in oil and gas waste has been documented for decades, but both industry and government have repeatedly stated that the levels present are not of concern. However, documents unearthed in a January 2020 investigation published in Rolling Stone reveal that a) the industry has known about the real risks of radioactivity within the industry for decades, and b) there is a direct link between radioactivity on the job and cancer in workers.[4]

In fact, back in 1982, a report prepared for the American Petroleum Institute found that "[a]lmost all materials of interest and use to the petroleum industry contain measurable quantities of radionuclides that reside finally in processing equipment, product streams, or waste. In addition, groundwater used for waterflood or brine solutions from operating wells contain biologically significant quantities of Radium 226 and Radon 222."

> ***"It is concluded that the regulation of radionuclides could impose a heavy burden on API member companies, and it would be prudent to monitor [regulatory actions] closely."[5]***
>
> **— American Petroleum Institute**

A study from 1995 found concerning levels of radium 226 at oil and gas facilities in California, including levels up to 7,105 picocuries per liter in produced water. The drinking water limit for radium in water is 5 picocuries per liter.[6]

Regulatory Trends

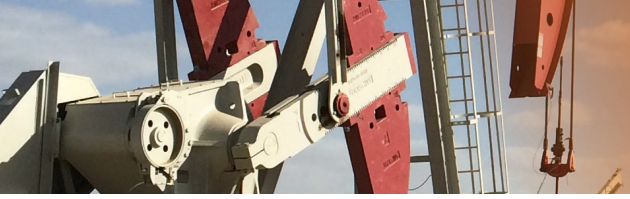
Nearly 30 years ago, the United States Environmental Protection Agency (EPA) considered whether oil and gas waste should be regulated under federal hazardous waste law, specifically the Resource Conservation and Recovery Act (RCRA).

Among the EPA's many conclusions about oil and gas waste in a 1988 report to Congress were:

- Oil and gas wastes "contain a wide variety of hazardous constituents."
- "Regulatory gaps exist."
- "[Waste management] practices vary substantially in the protection they provide to the environment."
- "For the major waste streams, EPA was unable to identify any new technologies...that offer promise for wide application in the near term." [7]

Despite these conclusions, EPA decided to exempt oil and gas development waste from the definition of "hazardous" under RCRA anyway. Many Californians believe that the state's environmental protections are stronger than federal oversight, but unfortunately that's not the case with oil production.

Photo: Goce Risteski/stock.adobe.com



California rules state that if an oil and gas waste only exhibits toxicity as defined in federal regulation, then it is exempt from regulation.

Some Oil and Gas Waste is Exempt from Hazardous Waste Rules in California

Federal rules state that, normally, waste is defined as hazardous if it exhibits one of more of the following characteristics: toxicity, ignitability, corrosivity, and/or reactivity.

California rules state that if an oil and gas waste only exhibits toxicity as defined in federal regulation, then it is exempt. However, if it meets any of the other three criteria characteristics, or if it meets a toxicity standard other than the federal standard, then it is not exempt from California hazardous waste rules.[8]

California is rare in that it does not fully adopt the federal exemption for hazardous oil and gas waste in state regulations. Other oil and gas states mirror the federal exemption completely. Under California's new fracking rules, an oil or gas operator has to determine if any well stimulation waste is considered hazardous under California law by sampling and testing the waste. If any waste is determined hazardous, it has to be managed according to the state's hazardous waste rules.[9] We were not able to find any evidence that these requirements are monitored or enforced.

California is rare in that it does not fully adopt the federal exemption for hazardous oil and gas waste in state regulations. Other oil and gas states mirror the federal exemption completely.

In recent years, public awareness has grown in California about fracking and another form of well stimulation – acidizing. The public was generally unaware that both have been taking place onshore and offshore for decades, but new information has led to growing concerns about the threats to California water, air, health, and wildlife habitat from oil and gas exploration and production around the state:

- In 2011, a report commissioned by the U.S. EPA found that California regulators were not taking all required measures to meet federal safeguards meant to protect underground sources of drinking water from the injection of oil and gas wastewater.[10]
- In 2013, the public learned that fracking had been taking place offshore, despite no previous public information about this activity, for at least 20 years.[11] A 2014 report highlighted the fact that California allows potentially toxic oil and gas waste to be stored in unlined pits. At the time, there were more than 430 active unlined pits in the Central Valley alone, some operating without permits.[12]
- In 2015, the public learned that oil and gas operators in the state were violating federal law by injecting oil and gas wastewater underground into protected drinking water aquifers through more than 2500 waste disposal or enhanced recovery wells. This wastewater can contain toxic substances that are known to cause harm to human health.[13]
- Also in 2015, a major pipeline leak led to a spill of 140,000 gallons of crude oil onto a public beach in Santa Barbara County, leading to a fine of more than $3 million.[14]

The growing trail of environmental harms caused by oil and gas exploration and production led to an increasing public outcry for protection, and state legislation enacted in 2013 led to the creation of fracking regulations for the first time in California,[15] where fracking began in 1953.[16] However, these rules did not strengthen any safeguards for oil and gas waste other than the storage of stimulation waste from fracking or acidizing. Also in 2015, the California Division of Oil, Gas and Geothermal Resources (DOGGR), issued a "Renewal Plan" that it described as a roadmap to make the agency "a modern oil and gas regulator." In April 2019, DOGGR finalized rules for underground injection control, but this is only part of the state's oil and gas waste stream.[17]

In the second quarter of 2017, oil and gas operators reported that 81 percent of produced water in California was disposed of through underground injection. See more about underground injection in the following pages.

California finally enacted fracking regulations in 2013, but the rules did not strengthen safeguards for oil and gas waste other than storage of one waste stream.

On January 1, 2020, DOGGR was replaced by the California Geologic Energy Management Division (CalGEM). According to the California Department of Conservation, the change demonstrates that "protection of public health, safety, and the environment is a heightened priority" and helps "guide the broader transition to a low-carbon future."[18]

While many oil and gas operations in California are regulated by CalGEM, other agencies, other agencies have significant responsibility for regulation of waste management and disposal. CalGEM regulates the UIC program in California while most other oil and gas waste-related operations are regulated by the California Environmental Protection Agency (CalEPA). Under CalEPA, Regional Water Quality Control Boards regulate discharges of waste to surface waters or land and CalRecycle regulates solid waste landfills. The California Department of Toxic Substances Control (DTSC) regulates any waste deemed hazardous under California rules.

Chemicals are used in all parts of the oil and natural gas extraction process. "Hazardous chemicals may be added to drilling fluids, drilling muds, and cements" used to construct wells, and "used to remove debris from wellbores prior to cementing" steel casings that are placed in the ground. Other additives are used for routine repair and maintenance, such scale and corrosion control. These chemicals include biocides, acids and corrosion inhibitors, and are brought back to the surface along with natural hazards like salts, metals, aromatic hydrocarbons, and naturally occurring radioactive materials.[19]

This cocktail of hazards in oil and gas waste means it must be tracked and managed with great care in order to protect environmental and public health.

Wastewater can contain chemical additives that industry does not have to disclose.

Wastewater

Wastewater may include produced water, fracking flowback, and used drilling fluids. These wastewaters can contain chemical additives that industry does not have to disclose. While California requires industry to report the composition of stimulation fluids, that is not the case for produced water or used drilling muds.[20]

In California, wastewater is disposed of in multiple ways, including underground injection, open pits, reuse, discharge to surface waters or the Pacific Ocean, land application such as crop irrigation or spraying, and recycling. California wells are reported to have generated over 133 billion gallons of produced water in 2017. The vast majority of that amount—84 percent, or 113.4 billion gallons, was generated onshore, with the remainder generated offshore.[21]

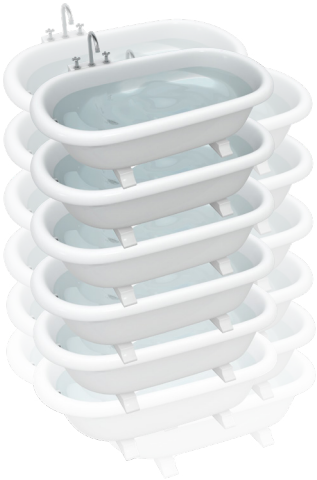
In the ten years between 2008 and 2018, oil and gas companies created a statewide total of over 1.3 trillion gallons of produced water in California.[22] That's enough wastewater to fill over 17.6 million household bathtubs.

In the second quarter of 2017, the most recent period for which data is reported on the CalGEM website, oil and gas operators reported that 81 percent of produced water in California was disposed of through underground injection. Ten percent was sold or transferred for domestic use, and three percent was sold or transferred for oil field use. Other methods of disposal reportedly used less frequently were disposal in unlined pits (1.5 percent), re-use in well stimulation (1 percent), and other methods such as surface water discharge, surface land discharge, and reuse for drilling or other well procedures.[23]

1.3 trillion gallons or

17 million BATHTUBS

wastewater in last 10 years



Solid Wastes

Solid oil and gas wastes can include drill cuttings, used drilling mud, tank sludges, used fracking proppant, spent filters, pipe scale, residual wastes from solid waste or wastewater treatment, and more. In California, these wastes seem to be mostly disposed of in pits, buried on site, landfills, or in the construction of well pads and associated roads. These solid wastes can present a host of threats to human health and the environment, particularly through the leaching of toxic chemicals out of pits and landfills into surrounding areas.

What Happens to Oil and Gas Waste?

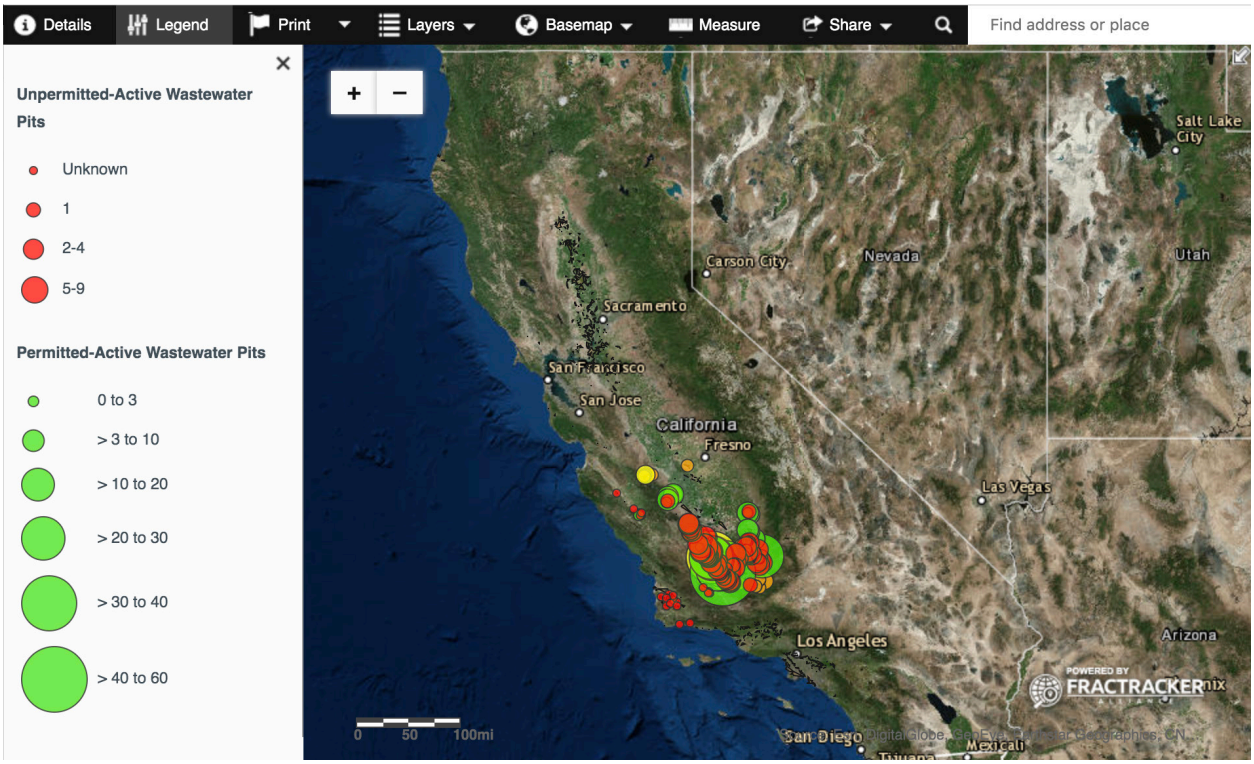
Storage Pits

California rules allow three types of pits, which are also known as "sumps" in the state: drilling sumps, evaporation sumps, or operations sumps. They are regulated by Regional Water Quality Control Boards.

There are no minimum required setbacks from homes for pits[24] and a report published by Clean Water Action found that, as of February 2016, there were 790 active pits in California, the vast majority of which are unlined. In addition, there are hundreds more that are currently inactive but may still threaten the environment. Clean Water Action also found that 60 percent of these pits either did not have a permit or were otherwise out of compliance with state water quality standards, yet they were allowed to remain in operation by state agencies.

60% of waste pits either did not have a permit or were out of compliance with state water quality standards, yet they were allowed to remain in operation in 2016.

In one location, groundwater monitoring indicated that a plume of oil and gas contaminants had migrated to an aquifer that serves drinking water wells.[25] In an earlier report, Clean Water Action found that the "vast majority" of active pits are "in close proximity to surface waterways" and some are "directly adjacent to or above high quality groundwater."[26]



The non-profit Fractracker Alliance published a map displaying active and inactive wastewater pits in California. Use the interactive California waste map here.

New state rules established in 2015 prohibit the use of open air pits for any wastewater coming out of wells that have been fracked or otherwise stimulated (such as in acidizing) from 2015 on. Wastewater coming from wells that have never been fracked or stimulated, or were fracked or stimulated before 2015, can still be disposed of in pits.[27] Drilling mud, on the other hand, can be stored in pits but can't be permanently disposed of in open pits.[28] Decisions on lining requirements are made on a case-by-base basis. State agencies may require a pit to be lined, depending on the quality of the produced water and the groundwater in the area, but most pits remain unlined. This allows wastewater to percolate into the ground for permanent disposal.

Oil and gas contaminants have migrated into underground aquifers used for drinking water in California.

In California, there are also centralized commercial facilities that accept wastewater from multiple operators in industrial-size unlined pits.[29] For example, the McKittrick 1 & 1-3 Facility, owned by Valley Water Management Company, has approximately 163 acres of 83 unlined pits. In 2018, the facility received an average of 1.8 million gallons per day. State regulators determined it is the source of an underground plume of contaminated groundwater that had migrated more than two miles, causing groundwater that supplies local agricultural irrigation wells to exceed state water quality standards for sodium, boron, electrical conductivity, and chloride. Due to an inadequate monitoring system, it's unknown how far the contaminated groundwater has traveled.[30] In 2019, the California Regional Water Quality Board's Central Valley Region issued a Cease and Desist Order that would require the operator to stop discharging any more produced water into the pits in September, 2020, unless it has come into compliance with agency requirements.[31]

In addition to wastewater, solid and semi-solid drilling mud and drill cuttings can be disposed of in a pit and buried on site in California, depending on the location and quality of local groundwater.[32]

Land Application

So-called "land application" of oil and gas waste can involve spraying or spreading wastewater or solid waste on the ground as a form of permanent disposal. This presents risks to groundwater when the waste seeps into the ground, to surface waters if it runs off into a stream or river, and to air since the waste can be blown into the air as dirt dries and becomes dust. In California, various types of land application are allowed:

- Road spreading allowed for dust suppression and crop irrigation.
- Drill cuttings may be used to build well pads or roads on oil and gas lease lands.[33]

Kern County irrigation canal and almond groves.

Crop Irrigation

Produced water has been used to irrigate crops in California for decades. There are currently three oil and gas operators whose produced water is used to irrigate food crops, and in 2017 this wastewater was used to irrigate 90,000 acres of crops in the state.[34] The Central Valley Regional Water Quality Board recently convened a Food Safety Expert Panel and oil and gas operators generating the produced water have funded third-party consultants to study the safety of using produced water to irrigate crops. In addition, the U.S. Department of Agriculture's National Institute of Food and Agriculture is funding a separate study to consider whether these crops are safe to eat.[35]

In 2017, California crops were irrigated with

90,000 Gallons

of oil and gas wastewater.

Landfills

There are more than 30 landfills in California that are permitted to accept drilling mud according to the most recent state records that are available to the public.[36] However, the state does not maintain a list of which ones are accepting oil and gas waste, so there is no way for the public to know whether this waste is being handled and disposed of in their community without doing their own research. We found approximately ten that are accepting such waste in California, but there may be more. Each landfill has an individual permit that specifies how it must handle its leachate, so again the public has no way of knowing without doing research into individual permits.

Surface Water Discharge

Discharge of oil and gas wastewater to surface waters is allowed in California, for example to Pismo Creek,[37] although it is not common onshore. Produced water is also allowed to be discharged into the state's territorial seas through individual permits. The discharged produced water must meet state water quality standards or be treated to reach those standards.[38]

Underground Injection

Oil and gas wastewater can be injected underground in three primary ways: in a UIC disposal well; in an enhanced oil recovery (EOR) well, where it is used to increase formation pressure and oil production; or in a well being fracked, where it is recycled to mix fracking fluid. The first two categories are regulated under the Safe Drinking Water Act's Underground Injection Control (UIC) program, where they are considered Class II UIC wells. As of May 2019, there are about 55,000 active Class II UIC wells in California, of which more than 95 percent are EOR wells.[39]

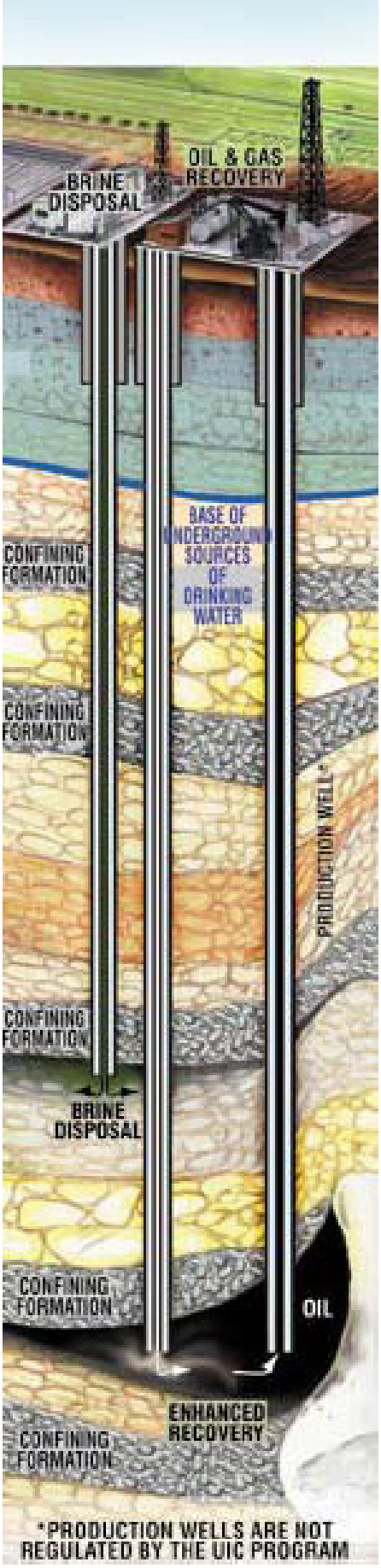
More than 5,500 underground injection control wells have been improperly permitted and are endangering clean sources of drinking water in California.

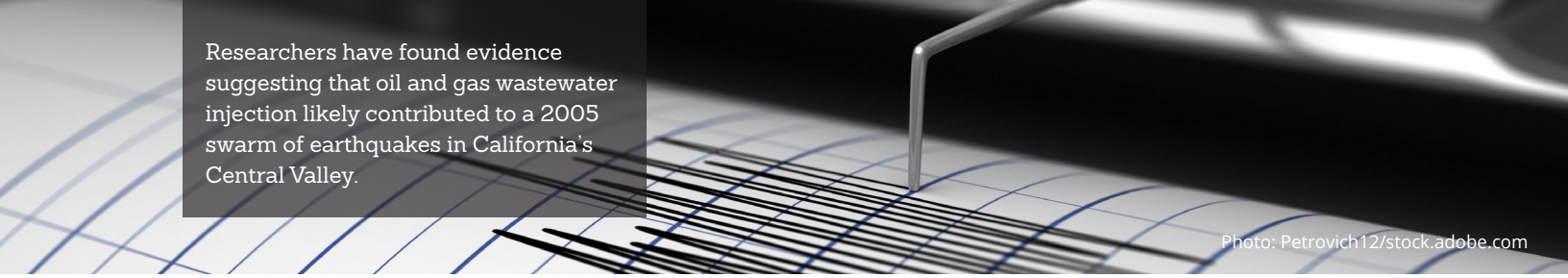
In 2011, a U.S. EPA-commissioned third party review of the California Class II UIC program found that California regulators were not meeting all federal Safe Drinking Water Act safeguards for underground injection. According to the study, CalGEM was not clearly requiring protection of underground sources of drinking water.[40] EPA asked the state for an action plan to address and resolve its deficiencies in drinking water protection.

81 percent of produced water in California was disposed of through underground injection. Above, an injection well, drawing by EPA, 2001.

Between 2017-2020, the US EPA exempt 21 water aquifers in California from federal drinking water protections to allow oil and gas companies to use those aquifers to dispose of their wastes. 18 of those exemptions are in Kern County alone.[49]

Then, in 2012, EPA reviewed aquifer exemptions in California. This review uncovered that California was permitting underground injection of oil and gas waste into freshwater aquifers that are not exempt from federal protections. More than 5,500 UIC wells were improperly permitted and endangering clean sources of drinking water in California.[41] In July 2014, EPA directed CalGEM to take action to resolve these additional issues.[42] In December of that year, dissatisfied with CalGEM's progress, EPA sent another letter with additional direction, making clear that California needed to act





promptly to maintain its primacy over the Class II UIC program in the state.[43] This was the start of continued extensive back-and-forth correspondence between US EPA and CalGEM.[44]

More than 5,500 UIC wells have been improperly permitted and are endangering clean sources of drinking water in California.

To add insult to injury, a 2015 report compiled by CalGEM itself found additional significant concerns about the California UIC program, including a lack of required tests to ensure the protection of underground sources of drinking water from waste injection. Ultimately, California developed a corrective action plan, including closing some of the wells, but it allowed illegal injection to continue for years[45] and didn't issue new UIC regulations until April 2019.

Unfortunately, the agency's poor performance continued even further. In November 2020, California's Department of Finance released an audit of CalGEM's UIC program and found "instances of non-compliance" including failures to properly review permits before approval.[46]

Seismic Activity

Researchers have found evidence suggesting that oil and gas wastewater injection likely contributed to a 2005 swarm of earthquakes in California's Central Valley.[47] The earthquake swarm occurred in Kern County, the county with the most oil production and waste injection in California. Scientists found that waste injection increased by more than 500 percent between 2001 and 2010, with the majority of wastewater being injected into three waste disposal wells that are located very close to each other. Data revealed that the start of injection corresponded with increased seismicity, and the researchers concluded that wastewater injection in the region induced earthquakes, which have occurred in other oil and gas states of Ohio, Texas and Oklahoma.

Even after waste disposal operations cease, wastewater disposal could cause earthquakes for years to come, possibly decades after, according to a study published in July 2019 in *Nature*.

Conclusion

Research has established that the harmful wastes produced from oil and natural gas extraction have several pathways by which they contaminate water, air and soil, thereby putting the health of workers, wildlife, and the public at risk.[48] Many of the pathways that lead to oil and gas waste pollution are legally permitted by the State of California, despite their effects on public health, safety, and the environment.

The only way to stop oil and gas waste contamination is to stop producing oil and gas waste. There will always be spills, equipment failures and other incidents outside of regulatory control. But California can remove many pathways for pollution by enacting stronger, necessary regulations, such as requiring full disclosure of all chemical additives used in all oil and gas operations and prohibiting the so-called "beneficial use" of waste on roads and crops. However, this does not stop waste from being produced over the next several decades.

California's laws, which currently allow dangerous waste management practices to continue, must be updated in order to protect public health and the environment.

Recommendations

- **No more "beneficial use" outside the industry** – prohibit the use of waste on roads, crops, or for discharge to waterways after processing that does not include the disclosure of all chemicals for all operations.
- **No more waste in pits** – prohibit the storage or disposal of oil and gas waste in earthen pits.
- **No more incomplete testing** – require the full disclosure of all additives used in all well operations and the full characterization of waste prior to disposal, including testing for radioactive materials.
- **No more disposal in aquifers** – stop using groundwater aquifers for the disposal of oil and gas waste.
- **No more self-policing** – require state agency or third party verification of industry compliance with chemical disclosure and hazardous waste testing policies.
- **No more guessing where waste is going** – publicly disclose and map facilities accepting, processing, and disposing of oil and gas waste, including landfills, pits, and injection wells.
- **No extraction or waste near sensitive receptors including homes, parks, community buildings, schools, medical facilities, and prisons.** Require a minimum 2,500 foot setback from all operations that produce, store, transport, process, use or dispose of oil and gas waste materials and sensitive receptors.

Endnotes

1 U.S. Energy Information Administration, Crude Oil Production, available at: https://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbl_m.htm

2 U.S. Energy Information Administration, Natural Gas Gross Withdrawals and Production, available at: https://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_FGW_mmcf_m.htm

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