Water Injection

February 2017

Los Cerritos Wetlands Oil Consolidation and Restoration Project

Water Injection White Paper
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Introduction

The Los Cerritos Wetlands Oil Consolidation and Restoration Project (Project) includes the drilling and operation of up to 120 oil production, water injection and water source wells from two sites in Long Beach, California. This paper provides a broad overview of the water injection practices the Project proposes, and also attempts to address common misconceptions associated with water injection.

What does the Project propose?

During the oil extraction process, oil, water, and gas are brought to the surface from the production formation. Once these components reach the surface, they are separated and processed.[1] The produced water must be disposed. Commonly, it is injected back in to the formation from which it came. This process is known as water injection. The purpose of water injection is to inject sufficient quantities of water back in to the production formation to replace the volume of fluids extracted. The injected water is a mixture of water derived during the oil extraction process, and also water obtained from the source wells. Additional water from source wells is needed to augment the volume previously occupied by the oil and gas.

The **production formation** is an underground rock formation from which oil, gas or water is produced.

Source wells are wells used to pump salt water from a deep reservoir. This water (also called make-up water) is combined with the produced water and injected back into the production formation.

Why inject?

Throughout the United States in states such as California, Texas, and Alaska, and abroad in places such as the North Sea, water injection is, and has been, used for over 60 years to prevent subsidence. The extraction of large volumes of fluid from the production formation causes the pressure within that formation to decrease. As pressure decreases, the rock-matrix skeletal structure of the formation carries a greater share of the force to support the overlaying rock. If the structural integrity is low, it can cause the underground formation to compact and correspondingly, the surface to subside. Water injection serves to maintain pressure within the formation, as the water injected replaces the volume of fluids extracted. This is also known as “voidage replacement.” In California oil fields, there is about 15 times more water than oil produced and approximately 52,000 injection wells used in oil and gas operations (Class II Injection Wells) throughout the state.[2]

Subsidence is the sinking or gradual lowering of the earth's surface, and has both natural and man-made causes.

Locally, Long Beach was once known as the "Sinking City," with subsidence up to 29 feet deep in and around the Port of Long Beach and along the coast. Early 1940s groundwater pumping contributed to

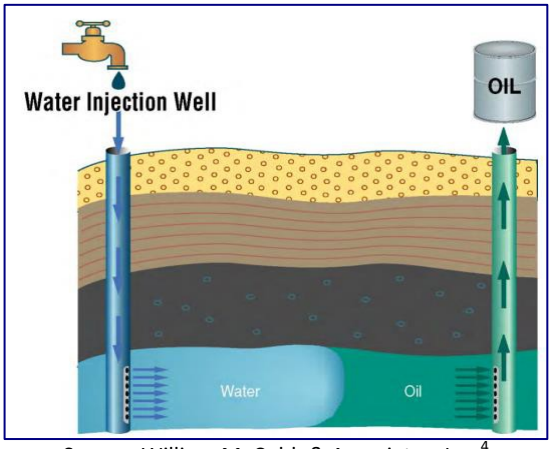
[1] See Oil Drilling and Production Overview White Paper
[2] California Division of Oil, Gas and Geothermal Resources (CDOGGR). Oil, Gas and Geothermal – Injection Wells. http://www.conservation.ca.gov/dog/general_information/Pages/class_injection_wells.aspx

the land sinking, but the majority of the subsidence resulted from oil and gas extraction, primarily from the Wilmington Oil Field, due in large part to the soft sandstone reservoir makeup of the field. In the late 1950s, when it was shown that water injection would reduce underground compaction and surface subsidence, the practice was employed and subsidence has since been arrested.[3]

Also, preventing subsidence via water injection reduces the likelihood of inducing seismic activity. Failing to replenish the fluids extracted can result in subsidence and/or slippage along planes of weakness in the Earth.

In addition to protecting against subsidence and preventing earthquakes, water injection also serves to increase oil production. As the injected water displaces the oil, it "pushes" it toward production wells (see Figure 1). This type of water injection activity is also often called "water flooding."

Figure 1: Injected Water Replaces the Space of Produced Fluids



Source: William M. Cobb & Associates, Inc.[4]

Water Injection Misconceptions

There are several misconceptions about water injection, generally discussed below:

A common misconception is that water injection induces seismicity. As explained in the Induced Seismicity White Paper[5] and generally summarized here, under specific geologic conditions "water disposal" practices can trigger seismicity. "Water disposal" is different from "water injection" and "water flooding."

In the central United States, particularly in Oklahoma, induced seismicity has been triggered when water produced during oil extraction is disposed of ***below*** the production formation in particular areas where this injection creates a pressure imbalance and an increase in sheer stress resulting in earthquakes. This Project will inject water back into the production formation; underground pressures will be maintained,

[3] Long Beach Oil and Gas Department, Subsidence Information. November 2016. Accessed: http://www.longbeach.gov/lbgo/about-us/oil/subsidence/
[4] http://www.arcanres.com/operations/waterflood-operations/
[5] See Induced Seismicity White Paper

neither increased nor decreased. The Project's water injection practices are dissimilar to the problematic water disposal techniques utilized in Oklahoma. Also, with few exceptions, California has not historically experienced induced seismicity related to prolonged water injection associated with oil production. Because of the differences between the ***water disposal*** practices seen in Oklahoma as compared to the ***water injection*** conducted in California oil fields over the past 60 plus years, the proposed Project is not likely to induce seismicity.

Another common misconception is that because water injection (or "water flooding") can increase oil production, it is similar to fracking[6] which also serves to increase oil production. Water injection improves production by pushing the oil toward the production well (see Figure 1 above). The practice of water injection does not change the structural integrity of the underground formation; new fractures are not created, nor are existing fractures expanded. This is in contrast to fracking whose purpose is to inject water, sand and chemicals into the formation to either create new fractures or expand existing ones, therein creating a new pathway for the "trapped" oil to flow to the well. The Project's proposed water injection techniques are unlike fracking techniques, though both serve to increase production.

Another common misconception is that the process of water injection will result in contamination of underground freshwater aquifers. The Project's target formation is more than 5,000 feet deeper than the fresh water aquifer. As explained in the Oil Overview White Paper,[7] wells are designed and constructed with multiple barriers of steel casing and are cemented in place. Casing restricts the inward and outward migration of fluids and serves as a barrier to prevent the transfer of fluids between underground layers. Also, well injection pressures are closely monitored and any pressure drop (signaling a potential leak) will result in immediate shutdown of the well. The Project's water injection practices are not expected to contaminate underground aquifers.

Conclusion

In conclusion, the Project's oil production activities will include water injection and water flooding, which are processes to inject water into the production formation. Water injection – which has been part of California oil operations for more than 60 years, including in the Long Beach area -- serves to prevent subsidence and also increases oil production. Water injection is neither expected to induce seismicity nor is it expected to contaminate underground aquifers. Though water flooding increases oil production, it is very different than fracking, and has historically not produced the same geologic problems being attributed to fracking.

[6] See Well Stimulation Treatments White Paper
[7] See Oil Drilling and Production Overview White Paper