Feasibility Study of Potential Impacts of Select Alternative Produced Water

Produced Water Transfer Workshop

January 16, 2018, 1 p.m. – 5 p.m.

Meeting Summary

Oklahoma History Center
800 Nazih Zuhdi Dr, Oklahoma City, OK 73105
(Fischer Board Room)

ATTENDEES:

***Oil and Gas Representatives (from Sign In or Introductions)*:**

Nick Cohen, Invenergy
John Durand, WaterBridge
Mitch Elkins, Midstates Petroleum Co.
Kevin Heasley, Sandridge Energy
Robert Huizenga, Cimarex
Preston Jones, D&B Oilfield Services
Doug Kathol, WhiteStar
Jarrod Maly, D&B Oilfield Services
Mike Mathis, Continental
Thomas McCormick, Marathon Oil Corp.
Rick McCurdy, Chesapeake Energy
Naggs Nagghappan, Veolia
Stephen McNair, H2O Midstream
Ken Nichols, Devon Energy
Jesse Sandlin, Devon Energy
James Welch, Veolia

***OWRB Staff, Agencies, Study Partners, and Consultants*:**

Lindsey Atkinson, CH2M/Jacobs
Shellie Chard, ODEQ
Anna Childers, CH2M/Jacobs
Julie Cunningham, OWRB
Michael Dunkel, CH2M/Jacobs
Nathan Kuhnert, Bureau of Reclamation
Mark Layne, GWPC
Owen Mills, OWRB
Mike Moore, OCC
Dan Mueller, EDF
Nichole Saunders, EDF
Michael Teague, Secretary of Energy and Environment
Scott Thompson, ODEQ
Kevin Wagner, OK Water Resources Center (OSU)
Dan Yates, GWPC

The meeting was opened by the Oklahoma Secretary of Energy and Environment, Michael Teague. He welcomed everyone and thanked the participants for their interest in helping to advance the State's overall water conservation initiatives and particularly the industry's role in advancing the dialogue to further investigate different approaches to reducing and recycling produced water in oil and gas operations in Oklahoma. Secretary Teague emphasized the importance of the oil and gas industry's willingness to collaborate with the State's efforts to find meaningful incentives to reduce the use of fresh water in their operations. He reminded everyone that the ongoing study will not come up with a single solution to a complicated issue; however, with the support and help from the industry, the ongoing study will be able to provide different potential options to freshwater use and disposal in oil and gas operations.

Next, Mr. Owen Mills of the Oklahoma Water Resources Board (OWRB) provided background to the ongoing Bureau of Reclamation's Title XVI Water Reclamation and Reuse Program funded feasibility study lead by OWRB and conducted in collaboration with the study partners. He reviewed the final recommendations by the 2016-2017 Oklahoma Produced Water Working Group (PWWG), published in the Oklahoma Water for 2060 Produced Water Reuse and Recycling Final Report (CH2M, 2017), which are the following: 1) Reduce the challenges to re-use via targeted legislation, 2) continue to facilitate the re-use of produced water, 3) continue study of transferring the Mississippi Lime Play-produced water to the STACK and continue evaluation of evaporation, and 4) consider all negative and positive environmental and stakeholder impacts. The focus will be on investigating further the key findings and recommendations of the PWWG. To build upon the key findings of the PWWG Final Report, the ongoing feasibility study will focus on the two most viable alternatives recommended in the Final Report: 1) produced water transfer from the Mississippi Lime Play for oil extraction in the SCOOP Play, and 2) produced water evaporation. With OWRB's Study Partners (Environmental Defense Fund [EDF] and Ground Water Protection Council [GWPC]) and the University of Texas Bureau of Economic Geology, the current project aims to identify opportunities to reduce the challenges to water reuse through targeted regulations and legislation. The consultant firm hired to execute the study is CH2M/Jacobs Engineering.

Mr. Mills emphasized that it would be very helpful to understand the industry's perspectives on the two selected alternatives being looked at in the ongoing study to produced water reuse and recycling, both the opportunities and challenges. Through the facilitated group discussion as well as technical presentations by the industry representatives, everyone should have a better understanding about matching the supplies and demands for produced water and of possible impediments to the produced water transfers.

The group discussion is summarized below[1]. The presentations are posted on OWRB's website: www.owrb.ok.gov/pwwg Presentations were provided by D&B Oilfield Services, Oklahoma Department of Environmental Quality (ODEQ), Veolia, and Invenergy.

Mississippi Lime Play Group Discussion

Mr. Michael Dunkel, CH2M/Jacobs, facilitated the Mississippi Lime Play group discussion. This segment of the workshop was targeted to producers, primarily in Alfalfa and Woods Counties, and includes the companies of Sandridge, Midstates, Chesapeake, and WhiteStar.

[1] The information contained herein are discussion comments made by participants and while, for the purposes of this discussion, participant comments are very valuable, no effort has been made to verify them.

The group started by discussing the current **produced water disposal methods**. Because of the large quantities of produced water in this Play, it cannot be trucked. The producers reported between 210,000 to 450,000 barrels per day (bpd) of produced water. Approximately 95 to 98 percent of produced water is piped from tank batteries through a pipeline to salt water disposal wells (SWDs). The rest of the produced water is used for fracking and drilling fluids. The reported SWD capacities range from 10,000 to 15,000 bpd per well in the STACK Play, to an average of 100,000 bpd at the Mississippi Lime Play.

The group discussed existing **disposal pipeline infrastructure** in the area to move water from wells to SWDs. The existing pipelines are multidirectional and thus can move water across areas. In some instances, bidirectional lines connect up to five disposal wells. The importance is to correctly size the potential produced water pipeline that would connect the Mississippi Lime Play to other plays. In the PWWG Final Report, the proposed pipeline was sized at 200,000 bpd. The challenge in sizing depends on the STACK Play's needs.

The **disposal costs** in Mississippi Lime vary from 0.06 to 0.2 cents per barrel. The producers want to keep disposal costs low. Producers stated that if disposal costs exceed 0.05 cent per barrel, they are losing money.

The **freshwater demand** in Mississippi Lime for fracking wells has increased because more water has been needed for the following: the use of longer laterals (9,000 to 10,000 feet) and well completion plans. The water demands have increased from 5 million barrels to 15-20 million barrels per well. However, the higher water demand hasn't been an issue because oil prices and drilling activity have been low.

The **produced water production** decline rates are insignificant despite the performance of oil and gas production rates. These production rates decline as a function of time from the loss of reservoir pressure or changing relative volumes of the produced fluids. Produced water rates decline if no more wells are completed. But all operational wells, despite their performance rating, keep on producing water. The participants reported the rate of decline of 2 percent to 20 percent. Some producers reported an approximately 2 to 5 percent decline, and others reported 10 to 20 percent produced water decline rates (depending on stated). Yet others reported that the decline rate depends on the life cycle of the well: some reported a 10 percent decline in wells that have been in operation 3 to 4 years, whereas others reported hardly any produced water decline in wells that have been in operation for 10 years.

The produced water disposal and availability discussion yielded the following action items for the study group:

- Obtain diagrams showing existing industry pipelines (depends on the companies' ability to release these).
- Obtain map of systems and total barrels of produced water to match how much water is being produced in Mississippi Lime and how much water could be needed in STACK: get an idea of how much water being produced versus how much water is needed in STACK. May use rig counts indicative of how many wells will be drilled (frack fleet will be 0.5 of rig count).
- Use rig counts to get an approximate estimate of how many wells will be drilled and how much water is needed in STACK.
- Consider scaling 200,000 bpd pipeline up and identify the associated risks.

Next, the workshop participants discussed **opportunities** and **constraints** associated with the produced water transfer from Mississippi Lime via pipeline to STACK Play.

First, the **water quality** was discussed. The compatibility of Mississippi Lime produced water proposed for piping with STACK produced water requires closer examination. The current study is tasked with addressing water quality compatibility between the two plays. The workshop participants were encouraged to share their experiences and thoughts on the water quality in the two areas. Total dissolved solids (TDS) in Mississippi Lime are significantly different than in STACK area. There could be potential impacts on reservoirs from high TDS. The Mississippi Lime water does not contain barium or sulfate, but there are could be issues with hardness, iron, boron, and salt constituents. The participants agreed that dilution would be required for STACK fracking needs. It was suggested that under-sizing the pipeline line and diluting water would be helpful from a water quality perspective. The group discussed whether the Mississippi Lime water would be the main source of water or an alternative source of water. The pipeline would probably never be the main source of water but would be an alternative source, and the source water could be blended by an operator of the pipeline, or blended by the company taking the water. If proposing to do a blending operation, the STACK producers might have to find alternative sources of water during drought; however, the STACK producers are not overly concerned about the potential lack of water from Mississippi Lime.

Second, the **pipeline infrastructure layout** from Mississippi Lime to STACK was discussed. Logistics of the pipeline location might limit the produced water service area. It was suggested that a leg off of the trunk line be incorporated into the existing infrastructure so that the water would be handled or moved throughout area. The producers confirmed that infrastructure is being built in STACK.

Third, **produced water ownership** was discussed**.** If the produced water is reused, how would the ownership be established? The group discussed the potential parties of interest, such as surface landowners, mineral owners, industry, treatment entity, payee of the infrastructure, and others. Lack of regulation and definition on the ownership may lead to unintended consequences for the different parties of interest. Some of these consequences would result from the following questions, if unanswered: (1) Would royalty payments to mineral owners be required, even if Mississippi Lime companies would pay for the infrastructure to pipe to STACK? (2) If an entity pays for water, is that entity buying water for use, for transportation, or for disposal? (3) Who has liability when produced water leaks and spills from a combined or shared pipeline? (4) How will the custody of produced water be determined, and when does the ownership of the produced water begin? The regulations need to be formulated so that the use of produced water can be incentivized. In addition, contracts between different parties need to agree on the water ownership.

Fourth, the establishment of **rights-of-way** for the pipeline was discussed. The group considered a designation for the potential pipeline as a “common carrier” to have similar provisions as to transportation of crude petroleum by owners, operators, or managers of pipelines or any part of a pipeline in the state (for the transportation of crude petroleum). Common carrier pipelines would have a statutory right of eminent domain. The workshop participants discussed the role of a utility to have such a status. Would the pipeline operators need to obtain a common carrier status (permit), but would private companies have this capability? What if a waste hauler gets a common carrier status, would this then potentially legally classify produced water as “waste”?

Fifth, **labelling or classification of produced water** was addressed as part of the discussion of opportunities and constraints associated with produced water use and transport. The participants of the workshop brainstormed the different labels for produced water (e.g., if it is a waste, a resource, or for other purposes). If produced water replaces fresh water, could produced water be considered for beneficial use? Beneficial uses include domestic use, irrigation, stock-watering, manufacturing, mining, hydropower, municipal use, aquaculture, recreation, and fish and wildlife uses. However, under the State’s Water Quality Standards, the beneficial use classification needs to meet three requirements: (1)

designation of beneficial uses, (2) water quality criteria to protect the designated uses, and (3) antidegradation policies. The other types of classifications were discussed also. If the water is reused within a play, it is considered as waste. However, if the water is not labelled as waste, the regulatory side would be less complicated. The group concurred that carefully crafted legal text needs to written so that the produced water does not get called something that it is not. For example, by labelling produced water as a waste, it could be considered waste until it is treated. It should not be labelled as a hazardous waste but as an oilfield product. Labeling the produced water as a product could lead to ownership conflicts. The group mentioned that if all STACK wells are shut down or if the produced water transfer pipeline is at capacity, the Mississippi Lime producers would need to be able to dispose of the surplus water. Therefore, the water would need to have the deleterious classification for waste disposal purposes. The ODEQ regulatory role applies to spills or releases that would affect the public water supply. ODEQ would be involved if the entity was directly discharging produced water to a stream.

Sixth, the last main area of opportunities and constraints associated with produced water use and transfers concerned **matching water supply and demands** as well as the timing of those demands and supplies. Will an adequate amount of water be available when needed from Mississippi Lime? Although the STACK producers are not overly concerned about the potential lack of water from Mississippi Lime, if the water supplies were limited from Mississippi Lime, they would need to be augmented from other sources. Conversely, if there was too much water supply in Mississippi Lime, an outlet would be needed (e.g., ability to inject) for surplus water. The group discussed the overall uncertainty about the future needs in STACK Play.

Matching water demands and supplies would require identification of the locations of fracking and the amount of water needed daily. This would require efficient lines of communication between operators and close coordination with all the parties involved. Clear contract terms and conditions would be needed to demonstrate the commitments of all the parties. The following scenario was also discussed: if a midstream firm paid for the capital costs to put the pipeline in, what types of agreements would be required to receive water and supply water? The capital cost estimate for a gathering system in the north, storage, and a 45-mile pipeline was approximately $200 million in the PWWG Final Report.

The produced water transfer opportunities and constraints discussion yielded the following action items for the study group:

- Explore how privately-owned utilities in other states that provide drinking water, wastewater, or electric service regulate right-of-way issues and regulate produced water use.

STACK Play (Blaine, Kingfisher, Canadian) Group Discussion

Mr. Michael Dunkel, CH2M/Jacobs, led the second segment of the workshop: STACK Play group discussion. This segment of the workshop was targeted to producers, primarily in Blaine, Kingfisher, and Canadian Counties and included the companies of Cimarex, Devon, Continental, and Marathon (Newfield was invited but was unable to attend because weather delays). Julie Cunningham, Executive Director of OWRB, emphasized the need for water conservation, especially in this area, because the amount of water shipping into STACK is high and the OWRB is getting public pressure when using fresh water in the operations.

The second segment of the workshop was started with questions posed to the STACK producers on **water sourcing and produced water disposal**: What are the current sources of water for well

completions? How much is trucked to the well site versus piped? How much is piped from tank batteries to SWD? The producers provided the following information:

a) Continental. Source is mainly surface water, that is, river and creek water. Recycled produced water is used on development projects, where demand for water is high. Produced water is sent to a recycling facility for treatment prior to reuse. Development areas have infrastructure to pipe produced water; otherwise, it is trucked.
b) Devon. Mix of water sources: filling ponds, recycle approximately 10,000 bpd, and river water. Have plans to build produced water pipeline but currently all is trucked to SWD. TDS at 30,000 parts per million (ppm).
c) Cimarex. Mix of sources: rivers, farm ponds, groundwater. They don't have a recycle project currently. All water is transferred by fast line, lay-flat hose, and no trucking. Approximately 25,000 to 30,000 bpd of produced water; 75 to 80 percent of produced water is trucked to disposal. For smaller volumes, it would not be economical to construct infrastructure (pipeline). One frack spread was reported to use approximately 65,000 bpd (a frack spread is the set of pumps used during the frack job).
d) Chesapeake. 13,000 bpd produced water; 80 to 90 percent of produced water is trucked. Most infrastructure is old.

The producers did not think that disposal is a problem in STACK. Trucking of water and the source or disposal of produced water can be a problem for the public. Therefore, the landowner right-of-way issues would have to be addressed to incentivize future pipeline development.

Next, the group discussed the cost of produced water disposal and sourcing. The cost estimate provided in the 2017 PWWG Final Report was $1.09 per barrel, including sourcing and disposal costs. In general, the producers agreed on the estimate, especially if the transportation costs are excluded. Disposal costs depend heavily on whether the infrastructure is owned. If an SWD is owned by the operators, the costs are less. The average cost of sourcing fresh water is approximately $0.5 per barrel.

The participants provided estimates of the amounts of fresh water that they are currently using in completions. The **freshwater demands** would be estimated using the frack fleet counts:

- Cimarex: 50,000 bpd needed for fracking (equivalent to one frack fleet)
- Continental: four to five frack fleets
- Devon: two to three frack fleets
- Halliburton: 19 frack fleets working out of Oklahoma City

On average, 50,000 bpd per well of fresh water are used for fracking in STACK. Based on the industry folks represented at the meeting, nine frack crews were identified for a total of 450,000 bpd.

In order to move produced water around, the group discussed the **existing infrastructure** in STACK. They stated that it would be feasible to link the individual companies' systems, but the system needs to be big enough to be worth tying into. Some producers are already connected to third-party SWDs. Regardless of the type of water being transferred, the pipeline is typically constructed of polyethylene (HDPE).

The workshop participants identified the following topics for the study workgroup to explore further:

- Obtain treatment costs for planning purposes from Midstream companies
- Obtain existing infrastructure layout, size, material, etc. in STACK area
- Explore whether the existing infrastructure is worthwhile to tie into
- Use existing projects as examples: compare to other projects to develop costs and justify competitiveness

- Consider identifying existing infrastructure (pipeline) that could be repurposed
    - Pinedale Anticline used one
    - Conoco facility may have a pipeline that runs to Oklahoma City
    - Consider pipeline safety
- Determine/assume pipeline endpoint: work with STACK producers
- Make assumptions for the program timeline

The second major topic of discussion with the STACK producers included **water quality**. The group discussed mixing Mississippi Lime water in STACK operations. The group stated that water could be mixed and could be compatible, but economics needs to be factored in. Also, although Mississippi Lime produced water quality is consistent (some variation but not an issue for hydraulic fracturing operations), there is variability in water quality between SWD wells. Therefore, this should be factored in with the water quality analysis for the ongoing study because commercial SWDs get a mix of waters from different formations. If pre-treatment is needed, it would most likely be done by a third-party operator who owns the pipeline because the Mississippi Lime operators would have sufficient capacity for disposal and would be less willing to treat water prior to its going into a combined pipeline. The PWWG Final Report included minimal treatment of produced water: transfer of 200,000 ppm of TDS. The industry would need to construct a high-quality pipeline, automation, and block valves to isolate the system, and leak detection systems for shut in. High TDS water transfer is a risk, and it is costly to mitigate spills.

The group discussed the **water sampling** for the study. The producers are hesitant to provide more than TDS by county. Their standard water analysis tests for 12 constituents. A more detailed analysis would need to be conducted later and is not intended for the ongoing study. Federal/state funding would be needed to do a water quality mixing analysis (e.g., through a university).

The action items for the study group from the STACK Play water quality discussion include the following:

- Collect water samples from both plays for feasibility study: samples from commercial third-party SWDs, five sets of samples from each Play. Test for:
    - Hardness
    - TDS
    - Iron
    - Boron - relatively low, higher with active stimulation w/cross-links
- Follow up with producers to see if they could provide water quality samples (averages per county of different constitutes).
- Determine water sampling locations.
- Develop best management practices for leak detection and pipeline and storage safety.

The final group discussion segment expanded and added to the earlier group discussion on **opportunities and constraints** associated with the produced water transfer from Mississippi Lime via pipeline for use in the STACK Play.

Right-of-way: Legislative solution is needed to solve landowner right-of-way issue. **Spills**: Reporting of spills is a federal requirement (40 *Code of Federal Regulations* 122.1). The current state regulations on produced water pipelines: ODEQ does not regulate; however, if mixed with other water sources used, then ODEQ rules may apply. Oklahoma Corporation Commission (OCC) regulates water above 10,000 TDS. There is a need to develop policy to define regulatory responsibility between ODEQ and OCC. Water transfer companies are careful with spills, and improvements have been made with water transfer companies. There would be an increased liability with using lay-flat water hose to transfer

produced water. Transferring large volumes of brine in HDPE pipe is also risky because of spills and leaks. Some industry leaders have leak detection, instantaneous metering, and best practices. A wide array of water reuse options should be considered, and there is a need to develop water quality management targets. **Potential Uses of Excess Salts (Mississippi Lime)**: The use of excess sodium chloride. For example, 100,000-bpd market for salts from Antero facility was used for pool salts in Florida. Other markets are being developed. If a third party pre-treats the water, it would also handle total suspended solids or TDS removal. The disposal or reuse of large volumes of salt, the economics, the market, and the regulations need to be defined. For landfill disposal, coordination with ODEQ would be required. **Air Emissions**: Reuse reduces trucking but may cause potential volatile organic compounds (VOCs) or burning of natural gas. VOCs in the pipeline should be remedied up front. **Stakeholders:** Produced water disposal is not a problem in STACK. However, trucking water to and from operations may cause problems with the public in STACK. **Project Costing:** It is unlikely that a government entity would fund the pipeline. Different cost structures to fund the project were discussed. For example, the cost structure could be set up so that one half of the revenue to fund the project would come from operators in the STACK, and the other half of the revenue from operators would come from the Mississippi Lime. Also, disposal costs should be comparted between Mississippi Lime to source costs in STACK. The disposal costs in Mississippi Lime are 0.06 to 0.2 cent per barrel. If infrastructure costs are excluded, then the cost is less than 0.04 cent per barrell (pay nothing on royalty). Water is difficult to move, especially long distances. It is expensive and may not be instantly available at the end of the line. The design and operations and maintenance considerations need to be factored in. **Future**: State-wide drought would affect the supply and demand for water. The operators need a consistent, steady supply that is reliable.