Produced Water Beneficial Use Dialogue:

Opportunities and Challenges for Re-Use of Produced Water on Colorado's Western Slope

Prepared by: CDR Associates, for the Colorado Energy Office & Colorado Mesa University Water Center

Colorado Energy Office

Colorado Mesa University Water Center

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Introduction

On January 7, 2014 the Colorado Energy Office (CEO) and the Water Center at Colorado Mesa University (CMU) convened 65 stakeholders in Grand Junction for a dialogue about potential future re-use of produced water from oil and gas operations on Colorado's Western Slope. The first of its kind, the goal of this stakeholder dialogue was to explore whether there are potential uses of produced water on Colorado's Western Slope that could be broadly supported, factors that many consider to be standing in the way of these policy goals, and next steps that would garner enthusiasm from a large number of stakeholders.

The issue of produced water is a pressing one facing the State. Significant amounts of water are produced from oil and gas operations in Colorado, which has the third largest gas reserves in the country. In 2012, produced water amounted to over 41,000 acre-feet, with over 20,000 acre-feet from the Western Slope alone. A large amount of this water is currently injected into the ground or trucked to evaporation ponds. This re-injected or evaporated water could provide an important opportunity to supply water for use in our drought-stricken state.

There are numbers of complex legal, regulatory, geographic, technical, social, and political considerations involved in any discussion of produced water. As a result of the myriad issues involved, current drought conditions, the simultaneous surplus of produced water, and the history of collaboration around development issues on Colorado's rural Western Slope, the CEO and Water Center saw this policy issue as lending itself to proactive stakeholder dialogue and problem-solving.

To help inform, shape, and focus the dialogue, and to provide participants a common starting point for discussion, the facilitation team – Ryan Golten and Dan Birch of CDR Associates – developed a preliminary version of this white paper. The paper was initially based on interviews the CDR facilitators conducted in November-December 2013 with 28 people representing industry, state government and regulators, community and conservation organizations, local government officials, agricultural interests, produced-water treatment companies, attorneys, and researchers involved in this issue. This paper was further developed and finalized based on the January 7th dialogue for circulation to policy makers, forum participants, and other stakeholders.[1] The paper outlines potential opportunities as identified by forum participants (e.g., greater re-use of produced water for drilling operations, dust suppression, and augmentation for agricultural and municipal water supplies), existing barriers to these uses, and recommended next steps.

[1] The authors are responsible for the content of this report. Stakeholders' participation in the dialogue process does not necessarily imply agreement with or endorsement of the concepts, findings, methodologies, or recommendations of this report.

This dialogue process supplements an extensive process of stakeholder consultations conducted by the Colorado Department of Public Health & Environment (CDPHE) to better define and explain CDPHE's complex regulatory processes related to produced water. This includes a recent consultation conducted by the Solid Waste Division related to using produced water for dust suppression, and an ongoing consultation focused on Technologically-Enhanced, Naturally-Occurring Radioactive Materials (TENORM), which can occur in produced water. Appendix B provides a link to the relevant documents and website.

While key technical issues are addressed in this white paper to provide necessary context, the dialogue process was not designed or intended to address these issues in detail. A number of existing resources explain and analyze technical and specific regulatory issues related to produced water and are listed at the end of this paper. Also included at the end of this paper is a list of key issues, opportunities, constraints, and potential next steps identified by stakeholders at the January 7th forum, as well as participants' goals for the forum itself.

Summary of Findings

Perhaps the most important take-away from this process has been the level of interest among stakeholders in a robust, transparent, stakeholder-driven process to shape policy and potential models for the recycling and re-use of produced water on the Western Slope. (Produced water, generally speaking and for purposes of this paper, encompasses the water and water-based solutions produced during exploration and production operations at oil and gas wells.[2]) In the course of our interview process as well as the January 7th discussion, support for different options for re-using produced water on the Western Slope ranged from tentative to enthusiastic. While the issues surrounding the re-use of produced water are complex, nuanced and variable, a number of **take-away messages** emerged from stakeholder interviews and dialogue, in no particular order:

1. The greatest opportunity for re-use of produced water is within oil and gas operations. This is already fairly commonplace, although sharing of water and treatment options among companies could be increased.
2. There is widespread interest among key stakeholder groups in exploring the feasibility and soundness of further re-use of produced water on the Western Slope.
3. One of the chief constraints to using produced water for non-industry uses (e.g., environmental/wildlife, municipal/domestic, and irrigation/livestock) is the higher cost of treatment needed to reach quality levels for those uses, although there is a sense that technological developments are making this increasingly viable.

[2] Specific definitions of produced water vary, including those that distinguish 'flowback' water from 'formation water.' We attempt to differentiate these in this paper as applicable.

4. There are many particularly complicated logistical and technological challenges pertaining to reuse of produced water, especially with respect to non-industrial uses. Opportunities for re-use are limited by practical considerations such as geographical distances, the lifecycle of water in drilling operations (which results in highly variable supply and demand), market effects on drilling activity, challenges in both transporting and storing water, and the physical and chemical properties of produced water from different formations, stages and types of operations.
5. Reuse may be impeded by delays in permitting and what is perceived by some to be a complex, unpredictable regulatory environment, particularly with respect to the interplay between COGCC, CDPHE and county permitting processes.
6. Water rights issues under the Division of Water Resources (DWR), in light of the 2009 Vance v. Wolfe case and C.R.S § 37-90-137(7), are not a major constraint on the Western Slope, primarily because the vast majority of produced water is non-tributary, in which case its re-use for enumerated oil and gas purposes within the same geologic basin is allowed without augmentation or a well permit.
7. No matter the end use, any re-use of produced water requires adequate environmental protections, regulations, and oversight.
8. There is a widespread interest – from industry to community groups – in increased transparency, public engagement, data-sharing, and trust-building regarding produced water and its current and potential re-use.
9. Both the opportunities and challenges to additional re-use of produced water are highly site-specific, depending in part on the relative locations of where the water is produced and where the potential demand is.

Interests and Concerns

During the January dialogue and the interview process, stakeholders expressed a broad range of interests and concerns about the re-use of produced water. **Interests** include the following:

1. A widespread desire to see produced water re-used beneficially as opposed to trucking it for disposal to evaporation pits or injecting it into the ground.
2. Creating new sources of water supply in Colorado.
3. Reducing the energy required to dispose of produced water.
4. Reducing industry demands on freshwater supplies on the Western Slope (including any conversion of agricultural water rights for industry use).
5. Reducing environmental, noise and health impacts from the trucking of produced water.
6. Reducing air emissions (e.g., Volatile Organic Compounds, or VOCs) from evaporation ponds and pits.

7. Making it financially feasible for energy companies to re-use produced water.
8. Creating a sustainable plan for disposing of produced water in light of geologic and other long-term environmental concerns with deep injection wells.
9. An interest in ensuring industry continues to re-use its flowback water (the solution that flows back to the surface during the first days and weeks of a well, which includes chemical additives and total dissolved solids (TDS) but not as many dissolved salts from formation water). Flowback water tends to be less expensive to treat than formation water for industry re-use, while at the same time engendering water quality concerns due to the chemicals it can contain.
10. Energy companies' desire for flexibility in terms of options for reuse and disposal, particularly given the variability in water supply and demand over the life of a well or field.
11. Industry interests in new markets for treated produced water in times of surplus.
12. Interest from smaller companies, which lack the scale to invest in certain treatment and storage infrastructure, in using centralized or shared infrastructure for the treatment and re-use of produced water.
13. Community groups' need to see and understand data on potential hazards in an accessible form and to be consulted and involved in a meaningful way.
14. Predictability in the regulatory environment to help enable energy companies to make long-term plans for and investment in water-sharing and re-use.
15. Regulatory predictability at the state and federal levels would also help local permitting entities streamline their land-use planning and permitting processes.
16. City and county governments' interests in understanding companies' plans for treatment and re-use of produced water – for land-use planning purposes, planning and designing infrastructure such as roads and water treatment facilities, and communicating effectively with residents.
17. Making re-use of produced water viable and attractive for industry is seen by some as being consistent with agricultural interests in those communities, in light of studies showing that a strong farm economy is often directly linked to a strong overall economy.

At the same time, we heard **concerns** about the re-use of produced water, including:

1. Health concerns associated with exposing people, land, water, and wildlife to untreated produced water, due to salinity, Total Dissolved Solids (TDS), chemicals from flowback water, and other hazardous constituents that may be present in the produced water.
2. Impacts and risks from additional handling and transmission of produced water for re-use (acknowledging that re-using produced water may reduce trucking and its attendant risks overall).

3. Ensuring produced water is properly regulated and monitored, no matter its ultimate use or disposal.
4. The complex interplay of local, state and federal regulating entities, which can cause uncertainty and permitting delays –e.g., Colorado Oil and Gas Conservation Commission (COGCC), CDPHE, Bureau of Land Management (BLM), Environmental Protection Agency (EPA), Colorado Division of Water Resources/State Engineer's Office, towns and counties.
5. A sense by energy companies that some regulations, particularly county codes, are "moving targets," which is seen by some as a barrier to making creative use of treated produced water.
6. A need for responsible regulation as well as informed public understanding of the issues involved with produced water.
7. Unresolved legal questions about water rights ownership once produced water is treated and used for other beneficial uses.
8. Concerns about liability for unforeseen consequences stemming from potential re-use of produced water.
9. Local health concerns about the siting of, and environmental impacts from, waste ponds and treatment facilities.
10. Wariness about the lack of a publicly demonstrated track record for technology that adequately treats produced water to make it usable for other purposes.
11. A lack of public knowledge about the constituents of produced water and related insecurity about potential health and environmental impacts.
12. Concern among some stakeholders about any relaxation of the regulatory environment.
13. Resistance by a number of energy companies to additional regulations.

Re-use of Produced Water for Drilling Operations

As mentioned above, the greatest opportunity for re-use of produced water is currently for oil and gas operations. For example, produced water is commonly treated to remove suspended solids and hydrocarbons and re-used for drilling operations and hydraulic fracturing. A number of oil and gas companies in the Western Slope are amenable to sharing opportunities for treatment, storage, and re-use that are financially viable and mutually beneficial. To some extent this is already occurring. However, with natural gas prices and thus new production currently down, there is less demand for water than would be the case at a time of higher production and well completion.

Potential Opportunities

- Due to the geology of the Western Slope's Piceance Basin, even highly saline produced water can be used for hydraulic fracturing in this region, with only minimal treatment necessary to remove Total Suspended Solids (TSS) and hydrocarbons, in contrast to formations in the Denver Julesberg (D-J) Basin. This enables a relatively high degree of produced water re-use on the Western Slope.
- There is widespread interest in reducing the costs and energy required to dispose of produced water.
- **Water-sharing agreements** offer some companies a water source for drilling and completion, and other companies an option for disposal other than trucking. Operators involved in these arrangements have expressed frustration with long permitting delays for water-sharing agreements, particularly to make these perpetual (to be used as needed), rather than renewable on an annual basis, and would like to see this issue explored as an expanded tool for re-use.
- Many operators would like to see more **streamlined permitting** of centralized and commercial treatment facilities. This would further allow for medium and small-sized operators to collectively pool and treat produced water. (Many larger operators are able to treat and re-use their produced water internally because of the economy of scale involved in larger operations.)
- Industry representatives have suggested a need for produced water for **reclaiming and re-vegetating drill pads** in lieu of using fresh water sources.
- Industry is adept at dealing with a regulated environment, which can be quite involved and complicated. So long as regulators are prompt and regulations are reasonable, there will be at least some energy interests that will pursue creative uses of produced water, if it makes financial sense.
- In a recent case, the Colorado Supreme Court largely upheld the Division of Water Resources well permitting regulations pertaining to oil and gas. This takes away a major element of uncertainty with respect to industry's ability to re-use non-tributary produced water for drilling-related purposes in the same geologic basin without requiring a groundwater permit.[3]
- There may be opportunities to use injection wells to store treated produced water for later use.
- Parallel pipelines, where possible, may reduce surface impacts from transporting produced water.
- Profiling certain zones for possible re-use of produced water under state regulations – including field mapping and public consultation – may give communities an opportunity for public input and industry more predictability for long-term

[3] C.R.S. § 37-90-137(7).

infrastructure planning. Local communities would still be able to set their own land-use requirements.

Possible Constraints

- Natural gas drilling has stagnated in Western Colorado largely due to a reduction in demand and price, which has lowered companies' demand for re-using produced water for well completion.
- Operators report the regulatory process can be cumbersome and time-consuming, particularly with respect to obtaining permits from COGCC and CDPHE for centralized and commercial ("E&P Waste") facilities, respectively[4], and from the BLM for similar permits and long-term water-sharing agreements on federal land. (COGCC otherwise permits water-sharing agreements, to which similar concerns apply.) This is particularly problematic given the short window generally available for moving excess produced water to where it is needed for drilling.
- Smaller and mid-sized operators report these regulatory hurdles impede the pooling of produced water with larger neighboring companies that have more developed treatment systems, in order to economically treat and re-use it. The smaller operators seem to have more need for water-sharing; larger operators are often able to re-use produced water internally because of the scale of operations.
- Larger operators also report that permitting complexity and delays impede their ability to move produced water around for internal treatment and re-use, and that current regulations are an impediment to long-term storage, which is necessary to support re-use of produced water within industry.
- While there may be possibilities of better coordinating state and local permitting to promote certain types of collective treatment and water-sharing options, the BLM is bound by federal NEPA policies regarding storage or treatment facilities and pits. Particularly in light of the timeframes involved in the NEPA environmental assessment processes, these options tend to be unlikely for operations on federal lands.
- Barriers to water-sharing among operators include the geographic distances between operators producing excess water and those needing water for operations, and public concerns about the impacts and risks of trucking produced water over those distances where pipelines are not feasible.
- Despite many stakeholders' interests in seeing industry re-use produced water, there are concerns about possible impacts. There is a feeling among some operators and others that production or storage pits are not the answer to facilitating long-term re-

[4] Pits are subject to a complex regulatory regime based on whether they are considered centralized (subject to COGCC) or commercial (subject to CDPHE). This depends on factors such as whether a single or multiple companies owns and is using the pit to store produced water (and whether there is a Joint Operating Agreement among operators); how long the pit is in operation; and the amount of produced water being stored.

use of produced water, in particular because of air quality concerns from VOCs and the aeration processes used at treatment plants, truck traffic, containment system failures, and pipeline failures, and spills.

Possible Next Steps

- There is a strong interest in continuing some form of **broad stakeholder process** to study and recommend **specific types of re-use** for industry purposes, such as:
    - Facilitating long-term water-sharing agreements,
    - Increasing the ability to pool and treat produced water,
    - Use for dust suppression, and/or
    - Use for reclaiming drill pads.
- The standing or *ad hoc* working groups (see bullet above) could identify specific **impediments** and **information gaps** and make **recommendations** to facilitate these industry uses. They could propose and design small-scale **pilot projects** to study, implement, monitor, and evaluate proposals for certain types of re-use. They could also work in conjunction with educational institutions, e.g., the Water Center at Colorado Mesa University and/or the Getches-Wilkinson Center for Natural Resources, Energy and the Environment at University of Colorado Law School.
- Participants suggested establishing a process to evaluate how COGCC, CDPHE, BLM, and county **permitting processes** could be further clarified and/or streamlined to encourage greater sharing and re-use of produced water for those uses with broad public support. Possible strategies include developing inter-agency or inter-jurisdictional **guidance documents** or **memoranda of understanding** (MOUs) to coordinate permitting schemes with respect to produced water. This discussion could also be built into CDPHE's current stakeholder consultation process regarding TENORM regulations.

Re-Use of Produced Water for Dust Suppression

Industry representatives in particular described their frustration with impediments to treating and re-using produced water for dust suppression on dirt roads they use for operations. Below are some of the issues, opportunities and constraints we heard.

Potential Opportunities

- Produced water could be used for **dust suppression** on roads used by energy companies or county roads more generally.
- CDPHE has been actively consulting stakeholders to clarify and streamline the state's regulatory process with respect to this issue.

- Use for dust suppression for energy development in the same geologic basin is allowed without a State Engineer permit under CRS § 37-90-137(7) unless the produced water is tributary.
- Dust suppression is important because it decreases harmful airborne particulate matter from truck traffic on dirt roads. Use of produced water for dust suppression would displace the need for water that would otherwise be used for agricultural or other uses.
- A certain level of bonding might make the use of new technologies more acceptable for treating and re-using produced water for dust suppression, in light of the potential real and/or perceived risks to land, ground water, and surface water.
- CDPHE's Solid Waste and Radiation Divisions have been conducting two distinct stakeholder processes to clarify and streamline the existing regulatory scheme with respect to using produced water for dust suppression. The Radiation/ TENORM process is still underway, which may result in improved clarity and guidance for how CDPHE will regulate this issue. This may be an opportune time for similar clarifications of other agency rules with respect to this potential use.
- Salinity levels in produced water may be comparable to salinity levels in magnesium chloride solutions commonly used for dust suppression. Produced water's relatively high content of dissolved solids may make it compatible for use in dust suppression.
- It may be possible to provide different levels of treatment based on the sensitivity and existing baseline levels of a particular area. This could provide additional flexibility and predictability, in terms of planning for and prioritizing certain geographic areas in which to use produced water for dust suppression.

Possible Constraints

- Different agencies regulate this type of use, depending on factors including the composition of the produced water, application rate, and location. The regulatory scheme is extremely complex and includes COGCC, CDPHE, BLM, EPA, and counties.
- Operators report challenges and delays in obtaining permits from COGCC in attempting to use produced water for dust suppression on dirt roads in their areas of operation.
- It can be very difficult to obtain a BLM permit to use produced water for dust suppression on federal lands, particularly in light of the onerous time and other costs of conducting environmental assessments required by NEPA.
- Use of produced water for dust suppression may present actual and perceived land and water quality concerns because of the constituents it contains, and the fact that produced water is a regulated substance with attendant risks and liabilities.

Concerns about water quality and residual concentrations would need to be studied and addressed with local community stakeholders – starting at what is going down the well and what is coming up.

- Given the relative novelty of this issue, there is a lack of publically available data and peer-reviewed studies about treatment options and environmental risks and impacts. Associated with this is a general lack of trust and public skepticism about using treated produced water for this purpose, among others.
- Transporting produced water to county roads outside production areas could be problematic in terms of environmental impacts and public perception.

Possible Next Steps

- Based on the level of stakeholder interest in this issue, it may be worth considering a regulatory consultation process for COGCC similar to that done with CDPHE. More broadly, there is interest in developing a **state approach to clarifying its overall regulatory scheme** with respect to this issue. Included in this should be a specific discussion of whether/how the permitting process could be enhanced to encourage greater sharing and reuse of produced water for dust suppression.
- There is significant interest in pursuing development of a **pilot project** with respect to dust suppression. Ideally it would involve an academic institution to help with study, design and monitoring. Participants felt it would also be important to involve stakeholders to increase transparency, public trust, and community buy-in.
- Not all operators seeking to use produced water for dust suppression participated in the CDPHE process. There may need to be **additional outreach** conducted with energy companies and others concerned specifically about CDPHE regulations.
- Some stakeholder groups expressed interest in studying ways in which the Colorado Department of Transportation has explored and categorized use of **magnesium chloride** for dust suppression as a **potential model** for pursuing similar uses for produced water.

Re-use of Produced Water for Other Uses: Agricultural, Environmental, Compact-Related, and Municipal

There are considerable constraints to the use of produced water for beneficial uses outside of the oil and gas industry. These include issues related to the timing, reliability, limited amounts, and variable water quality of produced water, and the costs required to treat the water to levels required by the other uses. From an industry perspective, the Piceance Basin is a price sensitive basin, and stakeholders generally agree that any re-use must make economic sense, particularly in light of those high production costs. Despite these constraints, there is

also broad recognition that water supplies on the Western Slope are limited, and various interest groups have expressed openness to pursuing and incentivizing other potential uses.

Potential Opportunities

- Most produced water on the Western Slope is not subject to surface water administration since it is considered non-tributary, thus giving it a number of attractive qualities. These include being able to re-use it to extinction, which makes it more valuable, all else being equal, and being able to use it to help meet **Colorado River compact** obligations.
- Some have discussed using, and incentivizing use of, treated produced water for **in-stream flows**.
- Some industry, agricultural, and environmental groups have expressed tentative interest in exploring treatments that may bring water quality up sufficiently to use it for **wildlife and stock ponds** at drill pads.
- While industry on the Front Range is seen as driving up the cost for "spot market" water supplies at the expense of agricultural and municipal users, this same dynamic is not occurring on the Western Slope. While this suggests there may not be pressing demands for produced water beyond industry use, it may enable creative re-use of produced water without unduly influencing market dynamics.
- Treated produced water could be discharged to shallow, tributary aquifers and used as **augmentation** water for **surface water supplies**. Passage through the ground could further clean the produced water.
- Technology is rapidly advancing. **Mobile treatment plants** were discussed as a potentially promising tool that could potentially make non-industrial uses more feasible, both logistically and financially. Mobile plants would especially reduce impacts from trucking, particularly in western Colorado where haul rates are substantial. Mobile treatment plants are being used to some degree in Colorado and elsewhere, including some preliminary use on the Western Slope.
- **Bonding** may be a way to mitigate potential impacts of new technologies for treating and re-using produced water, and/or to make use of these technologies more feasible or publicly palatable.
- There may be commercial and other value in produced water **residuals**, which could reduce the cost and impacts associated with residual disposal.

Possible Constraints

- Factors such as the variability in timing, reliability, supply amounts and water quality significantly limit the ability to plan for and coordinate use of produced water for non-industry purposes.
- To be adequate for other uses, produced water must be treated to high levels, e.g., reverse osmosis. Such treatments may still be prohibitively expensive.
- To be used successfully for other uses, it is likely that produced water would need to be stored. Storage increases cost, and storage may be subject to permitting requirements of storage pits.
- Unlike elsewhere in the state, adequate fresh water supplies are generally still available on the Western Slope. However, localized seasonal shortages do exist, particularly on tributary streams without upstream reservoirs.
- Mobile treatment plants, while offering some benefits, have volume and space limitations, potentially higher costs, and possibly added permitting obstacles beyond other types of centralized and/or commercial treatment facilities.
- As with dust suppression, use of produced water for non-industrial uses may be limited because of poor water quality (when not treated to sufficient levels), adverse perceptions of its quality, and status as a regulated material.
- While landowners generally would not want liability for the produced water coming out of their land, they may want to assert an ownership interest if it is ultimately treated and marketed for other purposes.
- Surface discharge may not be a preferred option for BLM lands because of possible stream channel stability problems and possible water quality degradation.

Possible Next Steps

- There was significant interest in convening one or more longer-term **stakeholder process**(es) or **technical working group**(s) to further explore other uses, including researching best practices and models from other jurisdictions. Potential areas of further exploration for treatment and reuse, including potential **incentivizing** for such treatment and re-use (e.g., with bonding requirements), could include use for wildlife or stock ponds, or to augment freshwater supplies, e.g., for Colorado River Compact obligations
- In addition to studying new uses of produced water for dust suppression, there was interest in developing **pilot projects** regarding treatment and use of produced water to augment freshwater supplies and/or eliminate any need to convert agricultural land for industrial uses. Again, participants felt it would be important to involve stakeholders to increase transparency, public trust and community buy-in.

- A number of participants expressed interest in pursuing potential **public/private partnerships**, including partnerships between academia, industry, community stakeholders, and municipal wastewater treatment systems.
- Many suggested exploring options for **mobile treatment** and development of a **shared facility** to which producers could convey produced water for treatment. Options could include using the cleanest produced water for the cleanest end use, e.g. environmental uses, and the dirtiest water to be re-used for other industry purposes.
- In addition, participants suggested exploring options for treating and/or discharging treated produced water into **shallow aquifers** to augment freshwater supplies.
- Another potential next step would be to explore options for **storage** of treated produced water for later re-use, potentially including the use of injection wells or deep aquifers.

Next Steps and Recommendations

Participants at the January 7th dialogue identified a number of potential next steps to further the discussion and development of policy with respect to potential re-use of produced water on the Western Slope. These included the following:

Stakeholder Dialogue and Collaborative Problem-Solving

There was a high level of interest in on-going stakeholder-based dialogue and problem-solving on this issue. A number of participants felt this effort was an important first step toward setting policy around produced water in Western Colorado, and that the process should be both deepened – to identify, study, and pursue specific issues and projects within the context of a broader roadmap and defined principles – and widened, in terms of participants. Due to the nature of this preliminary process, the entities and interest groups were not necessarily represented one for one at the January dialogue. Some participants suggested identifying key constituents by basin. Many emphasized that government entities such as the CEO are well positioned to convene and provide strong facilitation for these types of process. Next steps will include identifying the proper governmental entity(ies) and funding source(s) for convening such a process.

As a number of participants noted, many of the options described below could and perhaps should be developed through such a stakeholder-based process.

Community Engagement and Transparency

Individuals from multiple sectors expressed interest in community education/engagement on the issue of re-use of produced water in order to build trust in communities and across

sectors, explore ways in which particular re-use of produced water could meet common interests, and ensure energy companies are meeting the needs of communities in which they operate. A community engagement strategy might also include joint data-collection to build transparency and local community buy-in for future reuse of produced water.

Guiding Principles or Roadmap

There was significant interest in developing a set of agreed-upon "Guiding Principles" for future discussions and next steps related to re-use of produced water. Participants noted this type of agreement or roadmap would be instrumental for fostering transparent, open and productive dialogue, by acknowledging common understandings as well as good-faith stakeholder interests. Participants suggested the following "sample" principles:

- Not all produced water is the same.
- A roadmap for re-use should be stakeholder-based, not simply data-driven.
- The value of conserving water extends to all water users, and conservation efforts should include not just industry (e.g., through E&P re-use), but also communities (e.g., through water conservation measures) and other water users through available methods.
- The re-use of produced water by industry is recognized as a valid use of water under Colorado law.
- A strong rural economy can support strong agriculture.
- Dialogue should also be based on transparent, scientifically based data and information.
- There are potentially shared economic, environmental and social benefits from the re-use of produced water.

Pilot Projects

A number of participants expressed interest in using a stakeholder process to design and develop pilot project(s) that could test the "potential opportunities" identified by stakeholders, and that pilot projects should be closely studied and monitored to help provide the transparency, learning, and public engagement that many felt are essential to any re-use of produced water in Western Colorado. Potential areas for pilot projects included studying necessary levels of treatment for use of produced water for dust suppression and/or as a potential substitute for magnesium chloride for de-icing; exploring increased sharing of E&P facilities for treating produced water for re-use; studying the treatment and use of produced water to augment freshwater supplies or alleviate any demand for agricultural water on the West Slope. There was also discussion about the role or need for educational and academic institutions to help monitor, study, provide data, and research best practices regarding this issue and any pilot projects that may arise from this effort.

Initiative to Explore and Minimize Regulatory/Jurisdictional Overlaps or Delays

Participants and regulators in the dialogue process expressed interest in a State-led effort to address jurisdictional or agency overlaps and delays in permitting, in order to advance particular uses of produced water (as established through a stakeholder process). This initiative would focus on streamlining state and county permitting processes for re-use of produced water within existing legal structures. It could also be combined with an effort by academic institutions or other technical working groups to identify models or best practices from other states to address similar issues or to implement different types of re-use within various regulatory frameworks.[5] Action may be required by state policy makers to both prioritize and make funding available for such an initiative.

Data Gathering, Monitoring, and Studying

Participants discussed the need to gather and share trusted, accessible information on this issue, including baseline data as well as rapidly evolving technologies for treating and re-using produced water. A number of participants emphasized principles of joint data-collection and monitoring, and the need to convey data to community stakeholders in accessible ways. Again, this was an area in which some participants thought educational institutions and a structure for data-sharing could play important roles.

Conclusion

This stakeholder dialogue demonstrated that overcoming barriers to making beneficial use of produced water from oil and gas development is a complex task and may not be possible in every situation. However, it is also clear that there are considerable benefits to be gained from increasing re-use above current levels, as long as care is taken to ensure this re-use does not cause harm to the environment or public health. A combination of good science and an inclusive, well-facilitated and transparent process will be required to identify tangible opportunities to promote additional beneficial re-use of produced water. Both the CEO and the Water Center at Colorado Mesa University stand ready to help facilitate these efforts.

[5] For instance, Texas recently revised its laws related to commercial and non-commercial recycling and how treated produced water is classified.

Appendix A: Goals, Issues, Constraints and Opportunities from Dialogue

The following were identified in a wrap-up discussion on January 7, 2014. These are neither exclusive nor comprehensive and should be seen as supplementing the above Report.

Goals for the Dialogue

- Listen, learn, and meaningfully discuss:
  - Environmental issues and risks
  - Economic/environmental benefits
  - Treatment technologies, e.g., for surface discharge or for irrigation
  - Value of water resources
  - Regulation issues
  - Economic feasibility of re-uses
  - Radiation and treatment thereof
  - Handling of waste and residuals
  - Handling of logistics/local impacts, e.g., infrastructure, transportation
- Find areas of common interest
- Hold respectful conversation
- Explore re-uses that are both practical and environmentally sound
- Explore ways to engage/better educate public

Goals, continued

- Find alternatives to injection/evaporation
- Ensure standards and regulations in place without being duplicative or unduly time-consuming
- Consider possibility of different tiers of treatment based on different uses
- Develop new ideas for furthering re-use
- Act as think tank – what can be done legislatively, academically, or via regulations
- Discuss role of academic/research bodies
- Protection of water resources from domestic water perspective
- Discuss ideas for pilot project to test, study. and evaluate different re-uses
- Better understand the issue
- Network and have dialogue

Opportunities for Re-Use of Produced Water

- Clean to groundwater standards
- Decrease demands on fresh water
- Augment fresh water uses (in-stream, ag.)
- Use of brine in lieu of magnesium chloride (for dust suppression)
- Large companies helping small with infrastructure
- Treat for use outside industry
- Use of disposal wells for storage
- Unlimited use of brine that meets criteria
- Current surplus because of reduced drilling
- Can lay water line in gas trench to move produced water to where there is demand

Constraints

- Disposal of residuals
- Variable volumes
- Cost of treatment for non-industry uses
- Lack of coordination, delays and overlap in regulations and permitting (challenging for water-sharing and among industry users as well as non-industry uses, including meeting requirements for surface discharge)
- Lack of public trust
- Liability pertaining to use of produced water
- Location and geography – supply/demand
- Mobile treatment – cost, volume fluctuations, permitting

Issues

- Economic viability
- CDOT use of $MgCl_2$ – study of impacts
- Maintain flexibility
- Need increased transparency of data
- Effect of local conditions on re-use possibilities
- Potential to incentivize re-use
- Truck traffic impacts
- Public perception and education
- New technologies lack long-term testing/study

Potential Next Steps

- Pilot project – involve academia
- Expanded stakeholder dialogue
- Educate and engage the public
- Process to address regulatory overlap
- Define process to explore other uses
- Involve/communicate with different interests
- Develop guiding principles and/or roadmap to govern the above next steps

Appendix B: Selected Bibliography/Resources

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