SUBMIT OPTION SUBMITTAL FORM BY:

1. EMAIL TO: COLORADORIVERBASINSTUDY@USBR.GOV
2. U.S. MAIL TO: BUREAU OF RECLAMATION, ATTENTION MS. PAM ADAMS, LC-2721, P.O. BOX 61470, BOULDER CITY, NV 89006-1470
3. FACSIMILE TO: 702-293-8418

Option Submittal Form

Contact Information (optional): ☐ **Keep my contact information private.**

Contact Name: ______________________ Title: ______________________

Affiliation: ______________________

Address: ______________________

Telephone: E-mail Address:

Date Option Submitted: ______________

Option Name:

CoalBed Methane Produced Water

Description of Option:

Coal Bed Methane (CBM) is natural gas associated with coal deposits. To produce gas from CBM wells, it is first necessary to reduce the hydrostatic pressure within the coal seam by pumping of some of the water from the gas-bearing coal seams. As water is pumped out of the formation and the hydrostatic pressure drops, the gas desorbs from the coal into the cleats and migrates into the well. Eventually, as pressure and water production decline, gas production increases, and a well may have a long productive period with relatively high gas production and little or no water production. Generally, as the depth of the coal deposit increases, less water is present, but the salinity/total dissolved solids (TDS) of the water is higher than for more shallow deposits.

The CBM industry has generally viewed and treated the produced water associated with gas recovery as a waste product that must be disposed at the least possible cost. In most cases, CBM produced waters are currently disposed by injection into Class II underground injection wells. This option considers treating the relatively high salinity water and using it to augment surface water supplies in the Colorado River Basin.

Location: Describe location(s) where option could be implemented and other areas that the option would affect, if applicable. Attach a map, if applicable.

CBD wells are most common along the Green River in Wyoming and Utah, along the Yampa and Colorado River in Colorado and along the San Juan in New Mexico. (CRC, 2008)

Quantity and Timing: Roughly quantify the range of the potential amount of water that the option could provide over the next 50 years and in what timeframe that amount could be available. If option could be implemented in phases, include quantity estimates associated with each phase. If known, specify any important seasonal (e.g., more water could be available in winter) and/or frequency (e.g., more water could likely be available during above-average hydrologic years) considerations. If known, describe any key assumptions made in order to quantify the potential amount.

Using the CBM reserves data and a conservative unit water production of 5 to 10 gallons per thousand cubic feet of CBM gas, total potential produced water volumes for the four major coal basins located within the Colorado River Basin can be projected. Projected values range from approximately 161,000 to 322,000 acre-feet based on “proved” reserves, and from approximately 279,000 to 558,000 acre-feet based on “total estimated” reserves. (CRC, 2008). However, this does require a significant expansion of CBM development in future years.

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Additional Information

Technical Feasibility: Describe the maturity and feasibility of the concept/technology being proposed, and what research and/or technological development might first be needed.

As described in the water quality section, desalination technology is required. Initial attempts to use RO for treatment of CBM produced waters revealed operational problems associated with rapid fouling of membrane surfaces. This suggests that substantial pre-treatment may be required for some feedwaters to control inorganic constituents that form precipitates upon concentration and to remove free and dissolved oils and soluble hydrocarbons to ensure effective long-term system operation.

Use of electrodialysis (an electrically-driven membrane separation process in which ions are transferred through ion-selective membranes upon application of direct-current voltage) is also reportedly being investigated as a potential means of treating CBM produced water to obtain finished water suitable for direct discharge. However, results of previous evaluations of electrodialysis suggest that waters with TDS concentrations exceeding approximately 2,000 mg/L may be more economically treated in most cases using RO. There are technologies available to treat CBM produced waters, but the optimum combination of treatment technologies may require some investigation.

Costs: Provide cost and funding information, if available, including capital, operations, maintenance, repair, replacement, and any other costs and sources of funds (e.g., public, private, or both public and private). Identify what is and is not included in the provided cost numbers and provide references used for cost justification. Methodologies for calculating unit costs (e.g., $/acre-foot or $/million gallons) vary widely; therefore, do not provide unit costs without also providing the assumed capital and annual costs for the option, and the methodology used to calculate unit costs.

For 500 gallons per minute of CBM produced water with TDS concentration of 1,500 mg/L, approximately $2 million in treatment facilities are estimated to be required and the operating costs for this system is estimate at between $163 and $195 per acre-foot of product water.

For 500 gallons per minute of CBM produced water with TDS concentration of 15,000 mg/L, approximately $4 million in treatment facilities are estimated to be required and the operating costs for this system is estimate at between $603 and $635 per acre-foot of product water. (CRC, 2008)

Permitting: List the permits and/or approvals required and status of any permits and/or approvals received.

Ability to readily obtain NPDES permits for direct discharge to Colorado River and/or major tributaries is unknown.

Legal / Public Policy Considerations: Describe legal/public policy considerations associated with the option. Describe any agreements necessary for implementation and any potential water rights issues, if known.

Unknown.

Implementation Risk / Uncertainty: Describe any aspects of the option that involves risk or uncertainty related to implementing the option.

There is some opposition to CBM drilling and if they development of natural gas ceases the water supply would also cease.

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Reliability: Describe the anticipated reliability of the option and any known risks to supply or demand, such as: drought risk, water contamination risk, risk of infrastructure failure, etc.

The quantity of water produced from each well is highly uncertain.

Water Quality: Identify key water quality implications (salinity and other constituents) associated with the option in all of the locations the option may affect.

In general, CBM produced water is characterized by moderate-to-high concentrations of dissolved solids, particularly high levels of sodium, bicarbonate, chloride, iron, and barium. Reported average water quality data for two of the CBM production areas closest to the Colorado River watershed (the San Juan Basin and the Piceance Basin) indicates that TDS concentrations for produced water varies from 1,000 to 15,000 mg/L for the San Juan basin, and is approximately 15,000 mg/L for produced water within the Piceance Basin (ALL, 2003). For perspective, drinking water is typically less than 500 mg/L and ocean water is typically about 33,000 mg/L. Therefore, technology similar to ocean desalination treatment would be required to address water quality issues.

Energy Needs: Describe, and quantify if known, the energy needs associated with the option. Include any energy required to obtain, treat, and deliver the water to the defined location at the defined quality.

Energy Required	Source(s) of Energy
Reverse osmosis treatment is an energy intensive process and the amount of energy required varies by the amount of dissolved solids that must be removed from the water.	Using the natural gas from the well to run a generator, the natural gas could be the energy source.

Hydroelectric Energy Generation: Describe, and quantify if known, any anticipated increases or decreases in hydroelectric energy generation as a result of the option.

Location of Generation	Impact to Generation
Colorado River Basin Generation Stations	If the water is discharged to the watershed, increased generation would be realized in locates where increase flow occurs through the hydropower facilities.

Recreation: Describe any anticipated positive or negative effects on recreation.

Location(s)	Anticipate Benefits or Impacts
Colorado River Basin	If the water is discharged to the watershed, increased flow would be realized, improving recreation.

Environment: Describe any anticipated positive or negative effects on ecosystems within or outside of the Colorado River Basin.

Location(s)	Anticipated Benefits or Impacts
Colorado River Basin	If the water is discharged to the watershed, increased flow would be realized, benefiting the ecosystem.

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Socioeconomics: Describe anticipated positive or negative socioeconomic (social and economic factors) effects.

More water in the Colorado River Basin would improve conditions for those dependent on Colorado River flows for their businesses. Reliable water supply to the Colorado Front Range would improve socioeconomic conditions in that region. However, the high cost of water, will have a negative impact.

Other Information: Provide other information as appropriate, including potential secondary benefits or considerations. Attach supporting documentation or references, if applicable.