CREATIVE STRATEGIES FOR PRODUCED WATER DISPOSAL IN THE ROCKY MOUNTAIN REGION

Deidre B. Boysen
John E. Boysen
Jessica A. Boysen
B.C. Technologies, Ltd.

ABSTRACT

In Wyoming, and throughout the Rocky Mountain region, produced water disposal is getting a lot of attention from the public, the government and the media. This high level of interest has resulted, in part, from concerns about the possible long-term environmental impact of producing large quantities of CBM water from underground sources and then discharging it onto the land or into surface waters. In 2000, the volume of produced water generated state-wide was about 1,904,543,316 barrels. Approximately 593 million barrels of water was produced in New Mexico and 250 million barrels of produced water was generated in Colorado. Other states in the region also reported high volumes of produced water. That water has to be disposed of or re-used beneficially in some fashion, and all methods for produced water disposal have a price tag. The problem faced by producers is how to dispose of the water in a cost-effective, environmentally-sound manner that pleases all interested parties and complies with current regulations.

This presentation will explore some of the very creative strategies that producers with leases in the Rocky Mountain Region are using for keeping produced water disposal costs low and compliant with the current regulations. It will provide a brief review of the issues surrounding produced water disposal in these states, and will relate regulations that are relevant for produced water disposal. Further, it will describe the strategies that operators are using to manage water produced on their leases. Localized disposal cost details will also be provided.

INTRODUCTION

Recent Gas Technology Institute (GTI) sponsored research on the topic of produced water management has shown that there are many factors affecting the cost of produced water disposal and they vary considerably from field to field. When realistically assessing the true costs of produced water disposal, one must consider more than just the hourly cost of the local water hauling service and the disposal fee charged by the local commercial disposal service. In a recent study sponsored by GTI, over 250 oil and gas producers were interviewed by telephone. They were asked about the produced water management strategies they used at selected oil and gas basins across the US, and to identify any operating and/or capital disposal costs in that basin with which they were familiar. This paper presents the results of that study. The oil and gas basins selected for the GTI study are illustrated in Figure 1. Basin names and abbreviations are provided in Table 1.

BACKGROUND

Public concern about the impacts of oil and gas development are affecting the costs associated with produced water. Because of the high priority currently placed on clean ground and surface water, many states are in the process of reviewing and revising environmental regulations pertaining to produced water management. Changes are occurring in many states, making standards for produced water disposal more rigorous and abandoning some disposal practices altogether. Many states have already selected deep well injection as the only strategy for produced water disposal. This is not yet the case in the Rocky Mountain States. Producers in these states still have a variety of choices for either disposing the water or re-using it. Surface discharge, for example, is currently one of several topics creating heated controversy between producers and other interested groups.

This paper examines the disposal and beneficial use options reported by producers during a series of interviews that were conducted in the Summer of 1998, and again in Fall of 2001. The research focused on the identification of producers who were experiencing high volumes of water at oil and gas fields across the United States and then continued with telephone interviews asking those producers how they managed water at the identified locations. They were also asked to identify factors associated with disposal costs and to provide any actual cost data with which they were familiar. The results from these interviews are presented in the following paper.

OVERVIEW OF WATER PRODUCTION IN THE ROCKIES

High volumes of water are associated with oil and gas production at many fields throughout the Rocky Mountain Region. Figure 2 summarizes the volumes of water reported by producers in the states of Wyoming, New Mexico, Colorado, Utah and Montana. These production volumes were determined from information provided on the regulatory and educational websites listed in the "References" section of this paper.

Within these five states, over three billion barrels of water were produced in the year 2000, with approximately 63% of this water generated in Wyoming. Partly because such high volumes of water are involved with the generation of coalbed methane in the Powder River Basin, and partly because of the drought and dry climate in this region, water availability –particularly clean water availability, has become a major source of public interest. Future clean water supplies for drinking, recreation, irrigation and livestock are issues that surround produced water disposal and beneficial use in this region and are today guiding decisions about how producers will manage water in the future.

OVERVIEW OF OPERATING AND CAPITAL COSTS ASSOCIATED WITH PRODUCED WATER DISPOSAL

During the telephone interviews, producers were asked to identify the factors they associated with produced water disposal costs. These factors included electricity to operate pumps, commercial disposal fees, fuel for company owned trucks, hourly hauling charges for commercial water trucking services, chemicals for corrosion and scale control at injection wells and weed control for pit maintenance. When asked to identify factors associated with capital costs for produced water disposal, producers most frequently mentioned the cost of drilling new disposal wells, converting abandoned, shut-in or marginal wells to injection wells, constructing pits, installing water gathering and distribution systems and purchasing other equipment such as tanks and pumps for surface facilities. In some cases producers reported that they based their per barrel disposal costs on charges for commercial handling and disposal services only. Others calculated disposal costs based the overall value of the injection well amortized over time. Some producers guessed the disposal costs while others were quite confident with their figures. The values reported in this paper encompass all responses and are intended to give a general idea of activity in each basin rather than a precise understanding of the exact cost of water disposal at each location.

OVERVIEW OF PRODUCED WATER MANAGEMENT PRACTICES PERMITTED IN THE REGION

Montana, Wyoming, Utah, New Mexico and Colorado permit a variety of produced water disposal options as well as embracing a variety of beneficial use strategies. Regulatory agencies in all of these states permit deep well injection. They also encourage and support the beneficial use of produced water for enhanced oil and/or gas recovery. Lined and unlined evaporation pits are allowed in Montana, Wyoming, Colorado and Utah, but are subject to approval by the regulatory agency and must meet specific water quantity and quality standards. Open tanks are utilized for evaporation in New Mexico and "misting towers" were reported as an evaporation strategy in Wyoming. Some producers reported the use of sprays with their evaporation pits and tanks to increase the volume of water disposed. Surface discharge is allowed in certain locations of these states, but the conditions pertaining to water quality and quantity vary considerably. Administrative discretion on the part of the regulatory agency is also an important factor.

Many beneficial uses of the produced water are permitted in the Rocky Mountain states. Producers with leases in Wyoming reported a broad variety of beneficial uses for produced water. Shallow injection for aquifer recharge, wetland development, livestock and wildlife ponds, and irrigation were some of their strategies. Dust control, drilling mix, hot oil service, and compaction during construction activities were others. One producer in the Powder River Basin planned to construct ponds that would be big enough to be used for recreation. In Utah, in the Paradox Basin, a producer said he used the produced water to flush paraffin out of his wells. Many ideas were shared on how to enhance evaporation.

In this region, produced water is generally either trucked or conveyed via pipeline to the disposal site. When pipelines can be used, they generally save the producer considerable amounts of money. When partnerships for the use of the gathering systems can be formed, more money can be saved.

PRODUCED WATER MANAGEMENT PRACTICES AND DISPOSAL COSTS IN SELECTED BASINS IN THE ROCKY MOUNTAIN REGION

Bighorn Basin

The Bighorn Basin is located in south central Montana and extends into northern Wyoming. In 2001, approximately 560,863 bbl oil; 1,297,250 mcf gas; and 2,997,926 bbl water were produced on the Montana side of the basin and 16,780,015 bbl oil; 22,370,368 mcf gas; and 814,366,576 bbl water were produced on the Wyoming side.

In Montana, this basin is largely characterized by dry gas wells – where extremely (if any) small volumes of water are associated with the gas. In fact, 90% of the water generated in this basin occurred at the Elk Basin Field, and there was only one producer with active wells at that field. That producer was contacted in 1998 regarding his leases in the Basin (Wyoming side) and he reported the use of reinjection and surface discharge. He estimated his disposal costs to be about \$.02/bbl for both strategies.

On the Wyoming side, there were approximately 3,600 actively producing wells in the year 2000 and about 1/3 of the total water generated in the basin occurred at the Oregon Basin Field. In 1998, producers with leases on the Wyoming side of the basin reported the use of reinjection, evaporation, and surface discharge to dispose the produced water. The costs ranged from \$.01/bbl to \$.10/bbl for handling and disposal. These costs were attributed to factors such as chemicals, water analyses, pit maintenance and labor. No economic information was provided during the 2001 interviews.

Central Montana Uplift

The Central Montana Uplift is located in central Montana and extends north to south across the state. According to production volumes provided on the Montana Board of Oil and Gas Commission website, approximately 554,614 bbl oil; 7,168,658 mcf gas; and 19,053,290 bbl water were generated in 2001. Producers with leases in this basin reported that they use commercial disposal facilities, company owned salt water disposal wells, evaporation pits and surface discharge. Most producers responding to the survey reported the use of field pipeline systems and/or commercial water hauling. Disposal costs in this basin ranged from \$.05/bbl to \$2.00/bbl. The high disposal cost was associated with the commercial trucking and disposal fees. Several producers reported re-using water in this basin for secondary recovery and livestock ponds.

Central Western Overthrust

The Central Western Overthrust is located in southwestern Wyoming and extends into northeastern Utah. On the Wyoming side of the basin, there were approximately 1500 actively producing wells in the year 2000. Production at these wells was reported at 5,384,834 bbl oil; 290,807,101 mcf gas; and 4,599,948 bbl water. All producers contacted in 1998 reported the use of reinjection into a disposal well and their disposal costs ranged from \$.10/bbl to \$.95/bbl. Producers contacted in 2001 did not provide any disposal cost information, although they did report the use of an injection well that serviced several producers in the basin. These producers also said they sent all their water to the well via a pipeline. Most of the producers contacted had wells on both sides of the state line.

Denver Basin

The Denver Basin is located in the northeastern corner of Colorado and extends into the southeastern corner of Wyoming. In 2000, producers reported production volumes for this basin to be about 8,795,804 bbl oil; 180,403,617 mcf gas; and 33,203,115 bbl water at approximately 11,500 wells.

In 1998, producers reported disposing their water into both owner-operated and commercial disposal wells, evaporation pits by surface discharge. The costs reported for reinjection into owner-operated wells ranged from \$.05/bbl to \$.70/bbl. Commercial disposal well fees and handling was closer to \$1.00/bbl. Producers reporting the use of evaporation pits estimated disposal costs to be very low -- from "free" to \$.05/bbl. Similar disposal strategies are still in use, as producers who were contacted in 2001 reported. The responses varied as to how the water is handled, with some producers saying they use commercial trucking, and others that they use pipeline systems. Most reported their disposal and handling costs to be about \$1.00/bbl. Other reported costs ranged up to \$1.75/bbl at some fields in the basin. Enhanced oil recovery projects were reported as a common method for beneficially using water in this basin.

Greater Green River Basin

The Greater Green River Basin is located in southwestern Wyoming. In the year 2000, producers reported generating 9,361,314 bbl oil, 738,527,478 mcf gas and 92,754,523 bbl water at approximately 4,900 wells. Some of the top oil and/or gas producing fields in this basin are the Jonah Field, Fogarty Creek, Standard Draw, Tip Top and Echo Springs.

Producers in this region were interviewed during the Summer of 1998 as well as in Fall of 2001. In 1998, producers with leases at fields in the eastern portion of the basin reported the extensive use of owner operated pits as a disposal option (almost 1/2 of the respondents). Another 25% of the respondents reported that they utilized company owned SWD wells, and the remainder reported the use of commercial disposal pits. The cost of disposal by evaporation in company-owned pits ranged from $0.50/bbl to $1.95/bbl – with most of the cost attributed to the commercial water hauling service that was utilized. Producers that used commercial water hauling services and commercial disposal pits reported paying between $1.50 - $4.00/bbl. The companies that reported using a commercial water hauling service coupled with disposal into their own injection wells reported paying $0.40/bbl to $1.50/bbl.

Producers with leases at fields in the southwestern portion of the basin consistently reported the use of commercial water hauling and disposal, and many reported paying about $3.00/bbl. One producer in this area reported the cost of disposal into a company-owned evaporation pit to be about $1.00/bbl and another producer, who disposed water into a nearby company-owned disposal well, reported paying $0.40 - $0.50/bbl. Again, transportation costs contributed significantly to the values reported.

Producers with leases in the northwestern portion of the basin often had to transport the produced water the greatest distances to reach commercial disposal sites. One producer in this area reported paying as much as $6.00/bbl for some of the water he had to dispose. Many producers reported reinjection as their management strategy for this area, but couldn't estimate the cost.

In the Fall of 2001, producers were again contacted regarding management practices in this basin. Disposal at company-owned and commercial disposal pits were the most frequently cited water management practice for this region, although some producers reported the use of company-owned salt water disposal wells. Evaporation tanks were used for disposal by one respondent and two others reported the use of a commercial injection well facility. Throughout the basin, most respondents reported the use of commercial water hauling services to handle the water, although some did report the use of field flowline systems – which helped to lower their costs.

In the southeastern portion of the basin, producers reported a range of disposal costs – from $0.50/bbl to $2.65/bbl. In the western portion of the basin, the disposal costs ranged from $1.75/bbl to $5.05/bbl. In the northern portion of the basin, disposal costs were reported between $0.80/bbl to $10.00/bbl. Again, the higher costs in this basin are attributable to the use of commercial water hauling services, that are usually paid, in this region, about $80/hour. Because many wells are at remote locations, are accessed by two-track dirt roads and are generally located at considerable distance from the disposal site, handling costs can be quite high. The weather also contributes to an elevated cost for water handling. Muddy or snow packed dirt roads cause delays, which contribute to more time spent in transporting the water.

Las Animas Arch

The Las Animas Arch is located on the eastern side of Colorado. In 2000, approximately 2,147,903 bbl oil; 12,325,800 mcf gas; and 8,961,769 bbl water were reported in this basin. Many of the producers with leases in this basin reported that they disposed their water into a "partner-owned" salt water disposal well and some said they used evaporation pits. Water is also used beneficially for secondary recovery operations in this basin. Commercial water transportation services were reported frequently, as was the use of a pipeline system. Prices for water disposal ranged from $.50/bbl to $1.50/bbl. Some producers were able to separate the costs of handling and disposal and said that the water hauler in that area charged $55/hr. Other producers said water handling cost them between $.40/bbl - $.65/bbl while the disposal fee (to use the partner-owned well) was between $.10/bbl - $.21/bbl.

Paradox Basin

The Paradox Basin is located in the southwest corner of Colorado and extends into Utah. In 2000, approximately 288,202 bbl oil; 275,312,048 mcf gas; and 1,181,047 bbl water was produced on the Colorado side of the basin and approximately 5,936,371 bbl oil; 23,554,673 mcf gas; and 47,087,973 bbl water was produced on the Utah side.

Producers with leases on the Colorado side of the basin reported using company owned saltwater disposal wells and field pipeline systems to convey the water. The cost of disposal reported in this basin was between $.06/bbl to $1.60/bbl. The respondents also reported the use of waterflood projects in the area.

On the Utah side of the basin, interview respondents reported the use of commercial and company owned saltwater disposal wells. They also reported beneficially using the water for enhanced oil recovery projects. Water handling was accomplished either through the use of commercial trucking service or by pipeline system. No disposal costs were provided during the 2001 interviews, however, when producers were contacted in 1998, they reported paying between $.04/bbl and $2.00/bbl. The highest costs for disposal were reported by producers with leases in the Papoose Canyon Field, where reinjection was the primary method for disposal. The lowest prices were paid by producers with leases at the Lisbon Field, and mid-range prices ($.08/bbl - $.20/bbl) were reported at the Greater Aneth Field.

Piceance Basin

The Piceance Basin is located in the west central part of the State of Colorado and producers in that area reported the production of 6,788,665 bbl oil; 99,186,274 mcf gas; and 96,264,958 bbl water in the year 2000. The Rangely Field produced approximately 80% of the water in this basin. Producers reported the use of both commercial and company owned evaporation pits and both commercial and company owned salt water disposal wells. They also said they used a variety of water handling strategies including commercial trucking, pipeline systems and one reported the use of a company owned water hauling truck.

Powder River Basin

The Powder River Basin extends from southcentral Montana into northeastern Wyoming. On the Montana side of the basin, there were approximately 315 actively producing wells from which 173,418 bbl oil; 8,321,028 mcf gas; and 24,455,559 bbl water was generated in 2001. Approximately 19,164,246 barrels of water (or 78% of the total water produced in the basin) was attributable to CBM activities. In Montana, coalbed methane development is occurring primarily at the CX Field in Big Horn County.

In 2001, there was only one producer at the CX field in Montana. When contacted, that producer reported that the company had obtained NPDES permits to discharge most of their water directly to the Tongue River. They also provide the highway department with water which was used for highway construction, especially for dust suppression and compaction, and some of the water from this field is pumped via pipeline to a near-by coal mine for dust suppression. When interviewed in Fall 2001, this same producer reported that the company was in the process of permitting an injection well for shallow re-injection and that they are planning to use some of their water for irrigation of native grasses in the near future. Although that respondent did not have financial figures readily available, he believed that these methods of disposal were fairly inexpensive.

In the year 2000, roughly 13,000 wells on the Wyoming side of the basin produced 18,500,982 bbl oil; 244,732,949 mcf gas; and 818,713,556 bbl water. Producers with leases in this basin reported utilizing a variety of conventional and creative handling strategies, as well as a variety of disposal methods for the produced water generated on their leases. They also identified a variety of conventional and non-conventional strategies for beneficially using the water.

Operators who were interviewed in 2001 reported the use of surface discharge as the most frequently utilized produced water disposal strategy. Handling and disposal costs ranged from \$.01/bbl to \$2.00/bbl. The low end of the range reflects the combination of utilizing a pipeline system coupled with discharge to an impoundment, while the high end of the range reflects the cost of including a commercial water hauling service to transport the water. One producer reported discharging via a direct pipe outfall into a dry drainage. Another producer who pumped his water to an injection system reported his costs to be about \$.20/bbl for disposal. Another producer estimated that the cost of electricity to operate the pumps at his CBM leases was in the range of \$.40/bbl to \$.80/bbl.

Some of the factors attributed to the disposal costs included pipeline maintenance and repair costs, electrical costs to operate pumps, virtually round-the-clock staffing to operate electrical generators (electrical infrastructure not in place at the location of some of this company's leases), life of the facility (pond and water gathering system), depth of the injection well, chemical treatments to disinfect water that is reused for livestock. One producer made an interesting point that disposal costs for her company had probably risen as a direct result of escalating costs associated with permitting a discharge. She remarked that there are more requirements now for environmental studies and that often there was a need to employee third party consultants to generate the data required by the Department of Environmental Quality prior to obtaining the NPDES Permit. She noted that "it appears that every time industry solves one problem, a new one comes up that costs money to fix or solve."

Evaporation is also used as a disposal method in this basin. About 1/3 of the respondents reported the use of misting towers. Misting towers are mobile pieces of equipment that can be conveyed from field to field behind a truck. They can be as tall as 30' and can be described as a vertical pipe with a spray head on wheels. The concept is to "mist" the water and evaporate it before it touches the ground. Operators cannot allow the water to puddle on the ground or they will be in violation of state regulations. This method works well in Wyoming during the summer because of the hot, dry climate. One producer reported that his company installed and evaluated two misting towers (Summer 2001) and were able to mist at the rate of 30 gallons per minute. Misting towers were not reported by survey respondents in any other study basin.

Several producers reported using a shallow injection system which sent the water back into the formation for aquifer recharge. One reported using shallow injection to send the water deeper into the coal seam in a non-producing area.

Almost all respondents to the interviews reported the use of water gathering and distribution systems, field pipeline systems or an on-site gravity-fed flowline system. Some reported that these systems were developed for multiple users, which helped reduce handling costs, and one producer reported that his company had been able to dig one trench only because he installed the water gathering system at the same time that the gas lines were constructed, which saved money that would otherwise would have been spent on digging an additional trench. Another producer reported that by using a gravity-fed flowline system which conveyed the water directly from the production site to a reservoir used for livestock watering, he saved money that would otherwise have been spent on electricity to operate pumps.

Many producers in this basin reported using the produced water for beneficial purposes. Several reported that water generated at their leases is discharged to a reservoir which is used by the landowner for livestock watering. Some reported similar practices of constructing reservoirs for wildlife and water fowl. Others reported that the produced water they generated is contained in large reservoirs for agricultural purposes such as irrigation. One producer reported piping his water into containment reservoirs or "cattle tanks" that are were formerly tires on coal mine equipment. A different producer said that he probably saved $.40 -$.80/bbl by using the water for livestock rather than paying for commercial disposal.

Raton Basin

The Raton Basin is located in southeastern Colorado and extends into northeastern New Mexico. On the Colorado side, gas fields are located in Huerfano and Las Animas Counties. On the New Mexico side, wells are located in Colfax County.

In 2000, producers with leases on the Colorado side of the basin reported that Spanish Peaks Field produced the highest volume of water (17,816,964 bbl) which was associated with 26,076,160 mcf gas, which came from 256 producing wells. Long Canyon, Raton and Vermejo Ranch are other fields in this basin that produced high volumes of water associated with the gas production. No disposal cost information was provided.

San Juan Basin

The San Juan Basin is located in southwestern corner of Colorado and extends into the northwestern corner of New Mexico. The basin encompasses parts of Archuleta and La Plata counties in Colorado and into parts of San Juan, Rio Arriba, Sandoval and McKinley counties in New Mexico.

On the Colorado side of the basin, the Ignacio Blanco Field is where the vast majority of wells are producing gas and water. In 2000, an estimated 1,790 wells generated conservatively 25,293,071 barrels of produced water with 403,025,158 mcf gas. On the New Mexico side, producers reported that the Basin Fruitland Coal gas pool produced the highest volume of water associated with gas in the basin, in the amount of 6,033,799 barrels of water associated with 491,374,058 mcf gas. High volumes of water (over 1 million barrels each) were also reported at the Blanco-Mesa Verde pool and the Basin Dakota Pool.

Producers with gas leases at the Ignacio Blanco Field were interviewed by telephone in 1998 and in 2001. In 1998, operators reported that they managed produced water at their leases using a variety of methods, including company-owned disposal wells, secondary recovery wells, fresh water disposal wells, commercial disposal services, and/or evaporation pits. Costs for produced water disposal (including disposal fees and/or accompanying handling fees) ranged from \$.04/bbl to \$1.88/bbl. An operator who used a company-owned fresh water disposal well reported the lowest per barrel cost (\$.04/bbl) for disposal. Economic data was not provided by the operators who reported using evaporation pits, although that cost has traditionally been very low. Midrange values reflected variations in whether or not the disposal well was company owned or commercially operated and whether a pipeline or commercial trucking service was used to transport the water. The highest values were always reported for commercial trucking coupled with a commercial disposal service.

In 2001, operators who were contacted reported the use of either company owned or commercial SWD wells coupled with either pipeline systems or commercial water hauling services – or some combination using these components. Disposal costs reported during this set of interviews ranged from \$.30/bbl - \$2.80/bbl, with the high end of the range reflecting the use of commercial water hauling and disposal services and the low end of the range reflecting a combination of pipeline system with company owned disposal well. One producer reported being permitted for surface discharge, but that the water quality at the company leases had not yet met the standards established by the state for discharge. He said they had been using reverse osmosis to treat their water prior to surface discharge but that technology did not work for their situation. One producer with leases in this basin reported beneficially using the produced water for treating oil wells.

On the New Mexico side of the basin, the story is somewhat different. In 1998, the vast majority of producers who were contacted reported that water is reinjected for disposal in this basin. Approximately 1/3 of the respondents said they utilized company-owned injection wells. Another 1/3 reported the use of commercial disposal facilities, and the remainder reported that they utilized injection wells that were "partner-owned".

In addition, one respondent reported that a "fresh water" disposal well was utilized and another reported the use of a commercial disposal pit. The cost of disposal utilizing an "owner-operated" injection well ranged from \$.025 - \$2.00/bbl, with the median value at \$1.00/bbl. That disposal cost included transportation or handling of the water as well as any disposal fees that applied. Producers who reported using commercial disposal services reported paying between \$.069 - \$2.23, with the median value at about \$1.50/bbl. Again, that range included handling as well as disposal fees. The amount reported by operators for disposal into "partner-owned" disposal wells was generally about \$1.80/bbl. No value was reported for disposal using evaporation.

The interviews were conducted again in Fall 2001, and different operators in the basin were contacted. Almost ½ of the respondents reported utilizing commercial disposal wells, while approximately the other half reported using company owned SWD wells. One respondent reported using evaporation tanks, and another stated that company owned disposal pits were used. One producer said that they used both active and passive evaporation tanks and pits. The active evaporation process utilizes a system of sprays to enhance the evaporation of water contained in reserve pits by convective heating, while the passive system relies on radiation heating from the hot, dry climate found in New Mexico to drive the evaporation process. Most operators reported the use of commercial water hauling services although many said that pipeline systems were also utilized on some of their properties. Whether or not to use a commercial service depended on the location of the well. The costs of disposal in 2001 ranged from \$0.50/bbl to \$4.20/bbl. The low end of the range reflected the cost of handling and disposal using an evaporation pit. Many of the responses fell into the range of \$1.00/bbl to \$2.50/bbl. Some producers were able to break out handling costs and those figures ranged from \$0.70 -\$3.20/bbl. Disposal fees were generally reported in the range of \$0.75 - \$1.10/bbl. Most of the operators who used commercial water hauling services and/or commercial disposal facilities were able to very quickly and accurately identify their disposal costs. Some producers in this basin reported how they were recycling the water to lower disposal costs. Two producers reported beneficially using/recycling some of the water produced on their lease for hot oil service and about 1/3 of the respondents reported recycling some of their water for drilling purposes.

One company representative said that his company had worked long and hard to transfer water rights from their oil company to a nearby coal mine so that the mine could use the water for dust control. The producer said that it was a long, painful process just to give their water away.

Sweet Grass Arch

The Sweet Grass Arch is located in northwest Montana. In 2001, producers reported that conservatively 360,159 bbl oil; 12,003,982 mcf gas; and 6,014,186 bbl water was produced in that basin. They also said that the majority of the water was reused for enhanced oil recovery projects. Several producers reported the use of evaporation pits and one producer reported using a company owned salt water disposal well. All respondents said they used field pipeline systems to handle the water. Only one respondent was able to provide a disposal cost, and he estimated it to be about \$.05/bbl. – which was essentially his cost for electricity to operate the pumps.

Uinta Basin

The Uinta Basin is located on the eastern side of the State of Utah. In 2000, approximately 3,300 wells were active and they produced about 6,754,797 bbl oil; 144,057, 164 mcf gas; and 42,535,495 bbl water. There are many fields that produce high volumes of water in this basin, and producers use a variety of strategies to dispose it. In 1998, respondents with leases at the Altamont Field reported using commercial and company owned disposal wells, and commercial and company owned evaporation pits. They reported paying in the range of $.32/bbl to $1.55/bbl for disposal. At the Blue Bell Field, they primarily reported the use of owner operated salt water disposal wells with the use of commercial facilities as needed. At this field, the range of costs for disposal were very similar to those at the Altamont Field. At Natural Buttes Field, they reported paying between $.17/bbl to $1.39/bbl into owner-operated SWD wells. At other fields in the basin, producers reported that water disposal into company owned disposal wells and evaporation pits was absolutely free.

In 2001, producers reported more frequently the use of commercial disposal wells. One respondent reported the use of a company owned SWD well and another the use of commercial disposal pits. Many reported that they reuse their water for enhanced oil recovery. Water is handled in this area using several strategies – commercial or company owned trucks, and pipelines... in effect, whatever is most cost effective for the property. Disposal costs reported for this basin ranged from $.05/bbl to about $1.00/bbl. Other beneficial uses for the produced water included use during workovers.

Williston Basin

In 2001, production in the Williston Basin was conservatively 9,213,885 bbl oil; 20,486,149 mcf gas and 47,526,911 bbl water (about 42% of the water generated in Montana). Producers with leases in the Williston Basin, which is located in the northeastern portion of the state, reported using commercial trucking services and field pipeline gathering and distribution systems, coupled with a variety of disposal strategies that included commercial disposal, company owned saltwater disposal wells, evaporation pits and surface discharge. No disposal costs were provided for this basin.

Wind River Basin

The Wind River Basin is located in the central portion of the State of Wyoming. In the year 2000, approximately 1,300 wells produced 3,282,857 bbl oil; 133,651,909 mcf gas; and 124, 300,993 bbl water. In 1998, producers who responded to the survey reported the use of surface discharge and company-owned salt water disposal wells, and estimated the cost of disposal to be between $.04/bbl to $.35/bbl. The same methods of disposal were reported in 2001, but no economic data was provided.

CONCLUSIONS

Water production is a factor that oil and gas producers in the Rocky Mountain Region must consider when evaluating a property for development. Regulatory requirements have changed significantly in many states over the past decade, and with those changes have come additional costs in the form of environmental studies, water quality analyses, and in many locations, costly agreements with the landowners. In most states, water can be recycled, and, to their credit, producers are capitalizing on that option. Not only is the water recycled for waterflood projects, drilling and construction purposes, it is also used for beneficial uses such as stock ponds, irrigation and dust control. This study has shown that oil and gas producers do try creative ways to dispose and reuse water, but as long as water quality and quantity remain a public concern, addressing the surrounding issues will continue to cost producers more money.

REFERENCES

Colorado Department of Public Health and Environment – Water Quality Control Commission; Colorado Discharge Permit System Regulations – Regulation No. 61; effective June 30, 2002. Website Address: http://www.cdphe.state.co.us/.

Colorado Oil and Gas Conservation Commission, on-line production data, Rules and Regulations, Rules of Procedure, and Oil and Gas Conservation Act, revised September 2001. Website address: http://oil-gas.state.co.us/

Montana Board of Oil and Gas Conservation, on-line production data and online version of the Administrative Rules of Montana, Title 36, containing the Rules for Oil and Gas Conservation, and links to many CBM websites including a draft copy of the MT CBM EIS, the Montana DEQ CBM website, the BLM CBM website, the EPA CBM website, the USGS CBM website, and a CBM database. Website address: http://bogc.dnrc.state.mt.us/

Montana Department of Environmental Quality, on-line version of the Administrative Rules of Montana, Title 17, containing water quality regulations. Website address: http://www.deq.state.mt.us/.

New Mexico Environment Department, on-line version of Title 20, containing New Mexico Water Quality Control Commissions Regulations, effective December 2001. Website Address: http://www.nmenv.state.nm.us/.

New Mexico Energy, Minerals and Natural Resources Department – Oil Conservation Division. On-line version of the Oil Conservation Division Rulebook (oil and gas regulations) and the Environmental Handbook (guidance for oil and gas industry). Website address: http://www.emnrd.state.nm.us/ocd/.

New Mexico Institute of Mining and Technology -- Gas and Oil Technology Center (GOTECH) , on-line production data. Website address: http://octane.nmt.edu/

Wyoming Department of Environmental Quality, information on NPDES Program, CBM surface discharge program, UIC CBM Injection Permitting and groundwater program. Website address: http://deq.state.wy.us/.

Wyoming Oil and Gas Conservation Commission, on-line production data and the on-line version of Rules and Regulations. Website address: http://wogcc.state.wy.us/.

TABLES

Table 1. Abbreviations and Locations for the Basins in Figure 1.

Basin Name	State(s) Where Basin is Located	Basin Abbreviation
Big Horn Basin	Montana & Wyoming	BHB
Central Montana Uplift	Montana	CMU
Central Western Overthrust	Utah & Wyoming	CWO
Denver Basin	Colorado & Wyoming	DEN
Greater Green River Basin	Wyoming	GRB
Las Animas Arch	Colorado	LAA
Paradox Basin	Utah & Colorado	PAR
Piceance Basin	Colorado	PIC
Powder River Basin	Montana & Wyoming	PRB
Raton Basin	Colorado & New Mexico	RAT
San Juan Basin	Colorado & New Mexico	SJB
Sand Wash Basin	Colorado	SWB
Sierra Grande Uplift	New Mexico	SGU
Sweetgrass Arch	Montana	SGA
Wind River Basin	Wyoming	WRB
Williston Basin	Montana	WIL
Uinta Basin	Utah	UIN

FIGURES

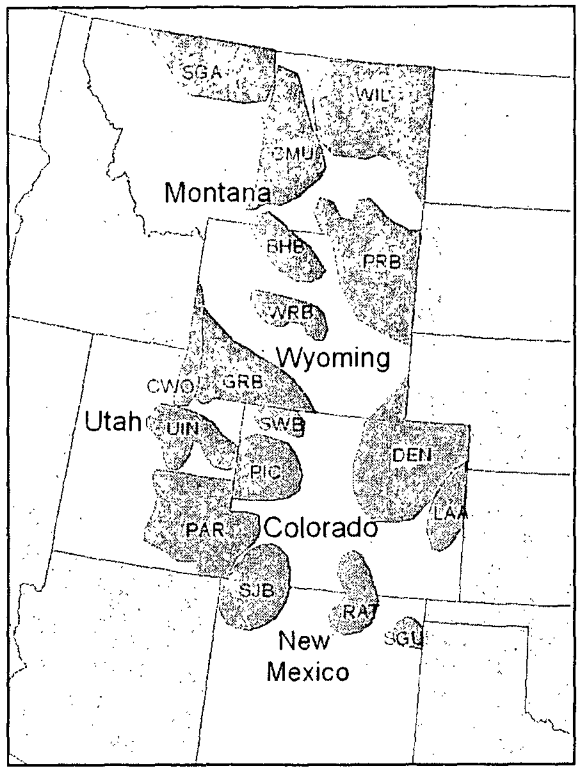

Figure 1. Selected Oil and Gas Basins in the Rocky Mountain Region

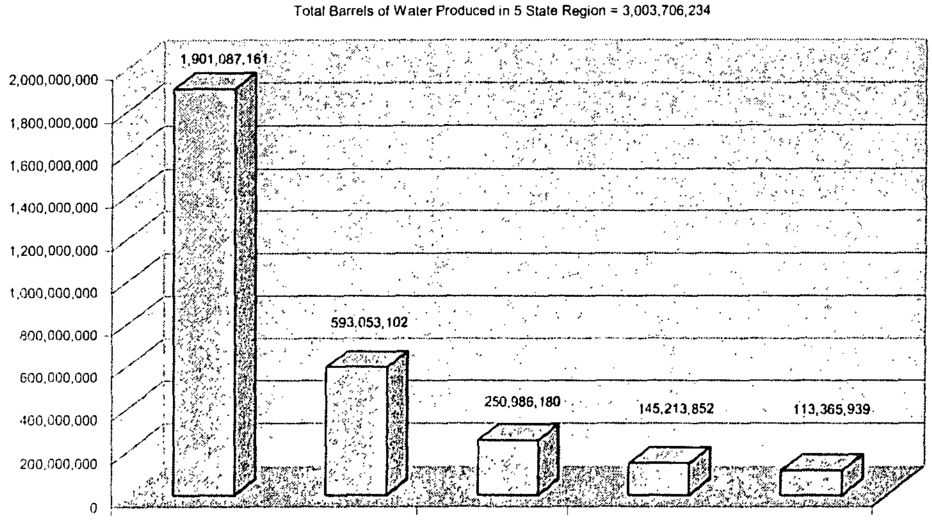

Figure 2. Produced Water Production Volumes for the Rocky Mountain States (2000 Production Data)