STRATEGIC PRODUCED WATER MANAGEMENT AND DISPOSAL ECONOMICS IN THE ROCKY MOUNTAIN REGION

Deidre B. Boysen, John E. Boysen, Jessica A. Boysen

Biographical Sketch of Authors

All three authors are employed by BC Technologies, Ltd., an environmental services consulting firm in Laramie, Wyoming. Over the past four years, the authors have researched and developed a collection of produced water atlases and a produced water management handbook as part of a larger produced water study funded by the Gas Technology Institute. This project involved locating and analyzing production and injection well data, GIS mapping, gathering economic information about produced water management costs, state regulatory reviews, and information about technologies that can be utilized to manage produced water.

Abstract

The cost of produced water handling and disposal is dependent on many factors that vary on a localized level. These factors will be identified and discussed as they pertain to produced water management/disposal in the Rocky Mountain States of Wyoming, Colorado and New Mexico. Specifically, the study will focus on produced water management practices and disposal economics for the San Juan Basin (Colorado and New Mexico), the Raton Basin (Colorado and New Mexico), the Powder River Basin (Wyoming), and the Greater Green River Basin (Wyoming).

Producers who are currently operating oil and gas leases in the identified basins were contacted by telephone and interviewed about the method of disposal they are using, as well as specific costs associated with produced water handling, treatment and disposal in these basins. That information has been correlated with data gathered during previous produced water management and disposal economic studies, and trends in handling, treatment and disposal will be analyzed and presented. Details will be provided, when possible, about specific treatments that are in use. Rationale for the selection of each produced water management practice will be provided, as it was indicated by the operators. This presentation will provide useful information regarding cost-saving strategies for managing produced water at a localized level and will provide available data with respect to produced water disposal economics in the Rocky Mountain Region.

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1.0 Introduction

Recent Gas Technology Institute (GTI) sponsored research in the area 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 water 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 were using at selected oil and gas basins across the USA, 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 as they apply to the Powder River Basin, the San Juan Basin, the Raton Basin, and the Greater Green River Basin.

2.0 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. Changes are occurring in many states, making standards for produced water disposal more rigorous and abandoning some disposal practices altogether. Many states have reduced produced water disposal options to re-injection only. This is not yet the case in many of the Rocky Mountain States. Producers in these states still have a variety of options for either disposing the water or re-using it. Surface discharge, for example, is currently one of several topics creating heated controversy over whether it should be continued as a produced water disposal practice.

This paper examines the disposal and beneficial use options reported by producers during an economic study which has been on-going since 1998. This study required the identification of producers who were experiencing high volumes of water at targeted basins and fields. Many of these producers were recently interviewed by telephone and asked how they managed water at the identified leases and to identify factors associated with disposal costs and any capital costs with which they were familiar pertaining to produced water disposal or re-use in that basin. The results of this study are presented in the following paper.

3.0 Overview of Water Production in the Rockies

High volumes of water are associated with oil and gas production in many fields throughout the Rocky Mountain Region. Figure 1 summarizes the volumes of water reported by producers in the states of Wyoming, New Mexico, Colorado, Utah and Montana.[1] 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. Within Wyoming, about 43% of the water generated statewide was produced in the Powder River Basin, and much of that water came from coalbed methane production.

[1] Production volumes were originally provided on the websites of the agencies listed in the references section of this paper.

4.0 Overview of Operating Costs 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 or shut-in 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 and some calculated their costs based the overall cost of the well amortized over time. Some producers guessed the disposal costs and others were quite confident with their figures. The values reported in this paper encompass all responses.

5.0 Produced Water Management and Disposal Costs in the Powder River Basin.

The Powder River Basin extends from southcentral Montana into northeastern Wyoming and encompasses oil, gas and CBM fields located in Campbell, Crook, Sheridan, Johnson and Natrona counties in Wyoming and parts of Big Horn, Custer and Powder River Counties in Montana. In Montana, coalbed methane development is occurring primarily at the CX Field in Big Horn County, while in Wyoming, coalbed methane development and production is occurring primarily in Campbell County (see Figure 2). In 2000, conservatively 331,722,260 barrels of water were attributable to CBM development in Wyoming, and 19,164,246 barrels in Montana. Even at a conservative estimate of $.01/bbl, quite a bit of money is spent on produced water disposal in this basin.

Table 1. 2000 Oil, Gas and Water Production Volumes for the Powder River Basin

Basin Location	Number of Active Wells in Basin	Annual BBL Oil	Annual MCF Gas	Annual BBL Water
Montana	315	173,418	8,321,028	24,455,559
Wyoming	6,294	7,957,427	146,494,797	375,639,609
BASIN TOTAL	6,609	8,130,845	154,815,825	400,095,168

In 2000, 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.

Produced water generation and disposal on the Wyoming side of the Powder River Basin occurs on a much greater scale. On the Wyoming side of the basin, producers reported a variety of conventional and creative handling and disposal methods for the produced water generated on their leases, along with a variety of strategies for beneficially using the water. Most CBM producers in this basin reported the use of surface discharge as their produced water disposal strategy, with costs ranging 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 handle the water. One producer reported discharging via a direct pipe outfall into a dry drainage. Another producer who was pumping water to an injection system reported his costs to be about $.20/bbl for disposal. One 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 at one location, they 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 other wise 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 their water into containment reservoirs or "cattle tanks" that are were formerly tires on coal mine equipment. One producer said that he probably saved $.40 -$.80/bbl by using the water for livestock rather than paying for commercial disposal.

Capital costs associated with produced water disposal in this basin generally include the cost of building reservoirs, installing water gathering and distribution systems, and constructing injection wells. Costs varied considerably depending on such factors as size/capacity of the reservoir, depth of an injection well, and number of feet of pipeline required for a water gathering system. Capital costs reported ranged from $100,000 to $1,000,000 to drill a new salt water disposal well and injection system, and about $100,000 to drill and complete a new CBM well. Estimated pipeline costs ranged from $.30/ft to $6.00/ft., the latter value reflecting the installed cost. One CBM producer in the basin reported that the company's wells are on private ranch land and that his company had constructed one stock pond for every 4-6 wells they operate. This company maintains 3 – 5 ponds. He estimated the cost of pipeline to be about $1.00/foot and that they had installed between $4,000 - $5,000 worth of pipeline. He also figured that the cost of building each stock pond was between $7,000 and $8,000 and that each stock pond (reservoir) was about 4 – 7 acre feet in size.

6.0 Produced Water Management Practices and Disposal Costs in the 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 (Figure 3). Table 1 shows the volumes of oil, gas and water produced in the basin in the year 2000.

Table 2. 2000 Oil, Gas and Water Production Volumes for the San Juan Basin

Basin Location	Number of Active Wells in Basin	Annual BBL Oil	Annual MCF Gas	Annual BBL Water
Colorado	1,844	15,113	403,883,537	25,303,772
New Mexico	18,252	2,945,579	1,046,109,179	22,125,324
BASIN TOTAL	20,096	2,960,692	1,449,992,716	47,429,096

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 1790 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 the standards established by the state. He said they have 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.

Only one producer with properties in this basin was able to estimate the cost of building a new disposal well and he said his company recently paid $600,000 for their well. Other respondents did not have capital cost information available to them. However, another respondent did say that his company had invested between $2 - $3 million dollars in the basin for the purchase of tanks and pumps.

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 injected 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 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 or 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 per barrel costs pertaining to handling and that range was $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.

In the survey conducted in 2001, producers were asked to identify capital costs associated with produced water disposal. Not many of the respondents were familiar with this aspect of their operation, but one producer said that it would cost between $20,000 to $50,000 to install a pumping unit in the San Juan Basin. One producer reported that his company charges themselves about $.075/bbl over their actual disposal costs, which they use for capital recovery. Another producer reported that he determined capital costs for the development of a new injection well by using a 15% return on investment to calculate an appropriate per barrel charge for capital amortization. Capital costs vary from well to well, and well depth and location are variables that can significantly affect the cost of drilling and completing the disposal well facility. A different producer in another part of the basin reported that the cost of converting an old gas well to a disposal well was about $400,000, and yet another said the company generally pays in the range of $250,000 to $600,000 to convert a well. Converting a deep well in this basin has cost this company as much as $1.5 million.

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.

7.0 Produced Water Management Practices and Disposal Costs in the 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 (see Figure 4). Table 1 summarizes the production volumes for 2000 in the basin.

Table 3. 2000 Oil, Gas and Water Production Volumes for the Raton Basin

Basin Location	Number of Active Wells in Basin	Annual BBL Oil	Annual MCF Gas	Annual BBL Water
Colorado	613	0	85,841,189	54,551,602
New Mexico	82	162	1,021,807	2,116,464
BASIN TOTAL	695	162	86,862,996	56,668,066

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 economics were provided for the Colorado side of the basin, however, one producer with leases on this side of the basin reported that his company uses a combination of methods to dispose its produced water. Those methods include the use of injection wells, evaporation pits and surface discharge. They also have several off-site pits which are used to provide livestock water. In addition, this company uses a combination of methods to transport water from the well site to the disposal site, including pipelines and both commercial and company owned water-hauling trucks. This company also reuses some of its produced water for “frac” water and a small amount for road spray (when it is available).

One company on the New Mexico side of the basin was able to provide economic information. The respondent reported that all their wells in the basin are CBM and all their water is reinjected into company owned SWD wells. That water is conveyed from the production site to the disposal site via pipeline. The producer estimated his disposal (operating and maintenance) costs to be about $0.10/bbl. This same producer was also able to provide some capital cost data. He said it would cost about $1 million to drill a new CBM well in this basin. About ¾ of that cost would go to the disposal system which would include pumps, electrical service and tanks. He warned that it could cost considerably more if you ran into trouble. He said that some of their water is reused for well fracking, completions and workovers.

8.0 Greater Green River Basin

The Greater Green River Basin, for the purposes of the research project, encompasses the area that the Wyoming Geological Survey classifies as the Washakie Basin, the Great Divide Basin, the Green River Basin and the Hoback Basin (including the Pinedale Anticline). All of these basins are located in the south central to southwestern area of Wyoming. The Greater Green River Basin covers Carbon, Sublette, Sweetwater, Teton and the east side of Lincoln and Uinta Counties (see Figure 5). In 2000, producers reported generating 6,978,539 bbl oil, 648,225,330 mcf gas and 13,374,088 bbl water in this region. Some of the top gas producing fields in this basin are the Jonah Field, Fogarty Creek, Standard Draw, Tip Top and Echo Springs. The five fields where high volumes of water were reported are the Brady Field, LaBarge Field, Tip Top, Echo Springs and the Jonah Field. Production volumes for the year 2000 are provided in Table 4.

Table 4. 2000 Oil, Gas and Water Production Volumes for Key Fields in the Greater Green River Basin

Field Name	Wyoming County	Number of Active Wells in Basin	Annual BBL Oil	Annual MCF Gas	Annual BBL Water
Brady	Sweetwater	29	501,520	14,456,913	2,515,454
LaBarge	Sublette	413	539,598	13,819,816	2,367,817
Fogarty Creek	Sublette	16	600	99,707,070	434,898
Tip Top	Sublette	218	219,753	20,362,886	324,969
Echo Springs	Carbon & Sweetwater	162	408,202	27,072,091	318,053
Jonah	Sublette	215	1,124,289	118,674,046	305,966
Standard Draw	Carbon	169	488,233	38,038,358	217,777

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 Great Divide Basin (Carbon and eastern Sweetwater Counties) 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 – most of the cost being attributable to the commercial water hauling service that was utilized. Companies that utilized commercial water hauling 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.

At fields in Western Sweetwater County, producers 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 Sublette County or the "Pinedale Area" often had to transport their waste 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 water disposed. 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 strategy for this region, although some producers did report the use of company-owned SWD 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 convey 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 western Sweetwater County, the disposal costs ranged from $1.75/bbl to $5.05/bbl. In Sublette County, disposal costs were reported between $0.80/bbl to $10.00/bbl. Again, much of the higher cost in this basin is attributable to the use of commercial water hauling services, who 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, costs rise. 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 conveying the water.

Some producers were able to provide capital costs associated with water disposal in this basin. One respondent said it cost their company about $100,000 to excavate, line and fence an on-lease disposal pit. Two other producers said that it cost their companies between $90,000 - $100,000 to convert a formerly producing well to a

SWD well. Another reported the cost of drilling a new disposal well to be about $500,000. One had recently paid $130,000 for a new pumping unit, and other had recently paid $30,000 for a heater for their evaporation tanks.

9.0 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 and 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.

10.0 References

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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/.

FIGURES

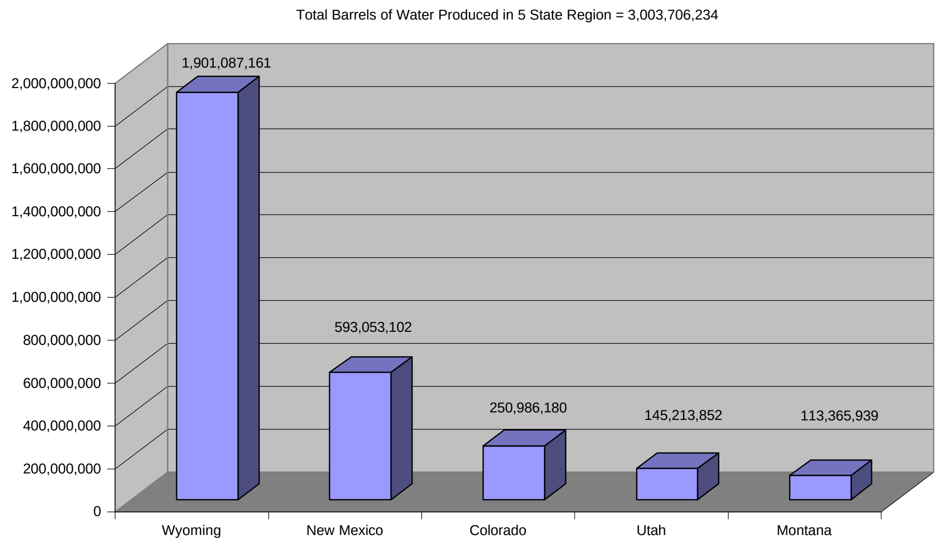

Figure 1. Produced Water Production Volumes for the Rocky Mountain States (2000 Production Data)

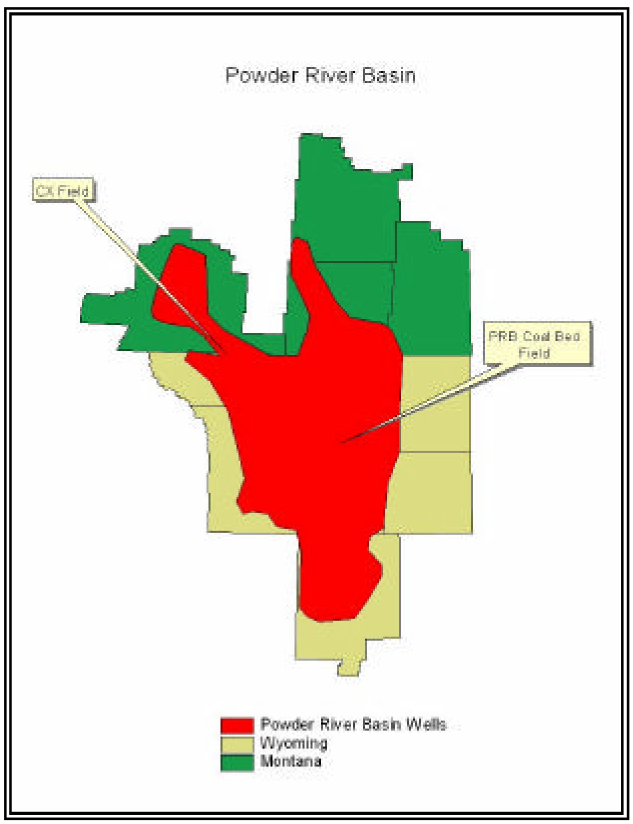

Figure 2. Map Showing Location of Powder River Basin's CX Field and PRB Coal Bed Field.

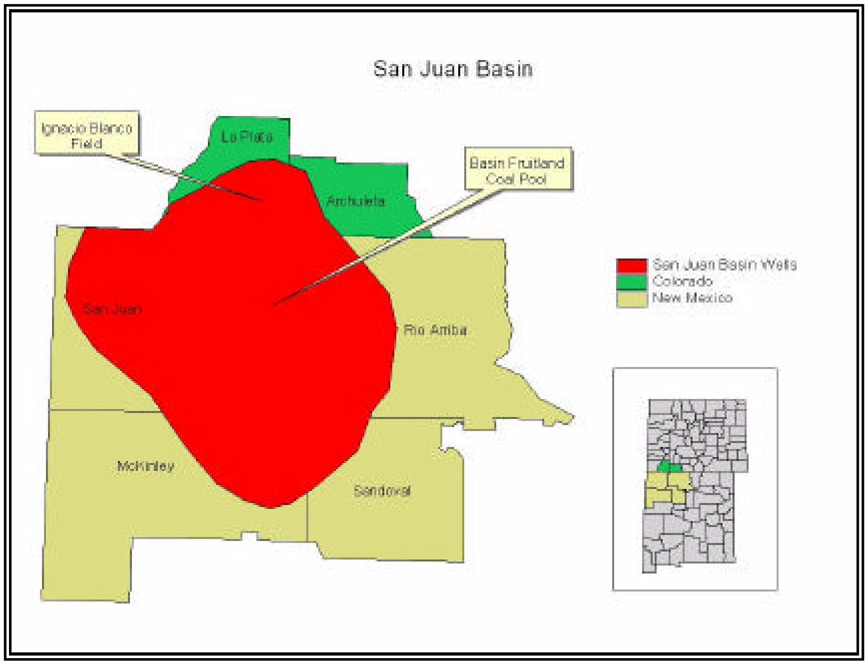

Figure 3. Production Well Locations in the San Juan Basin

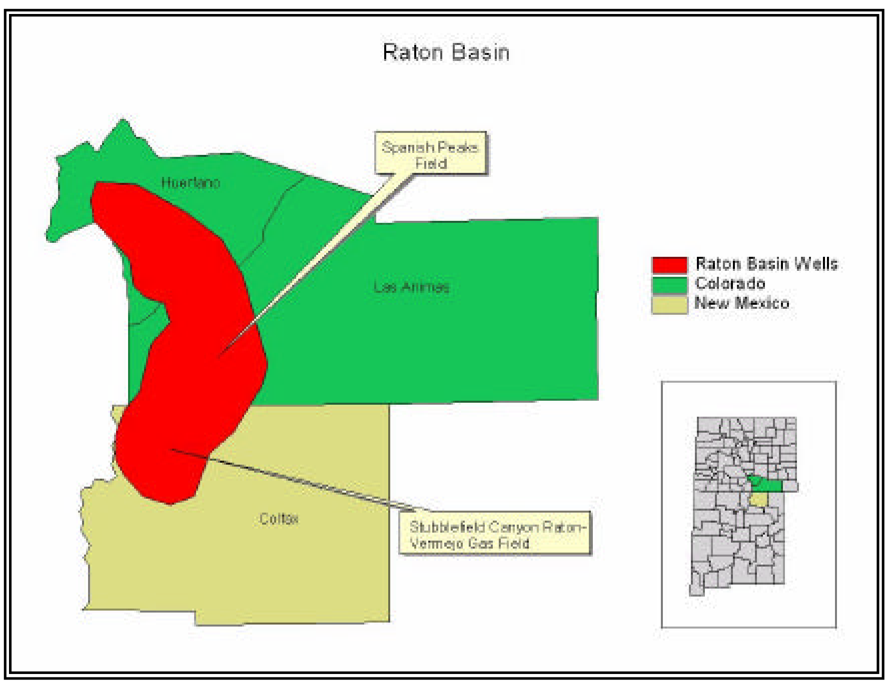

Figure 4. Fields Reporting High Volumes of Gas and Water in the Raton Basin.

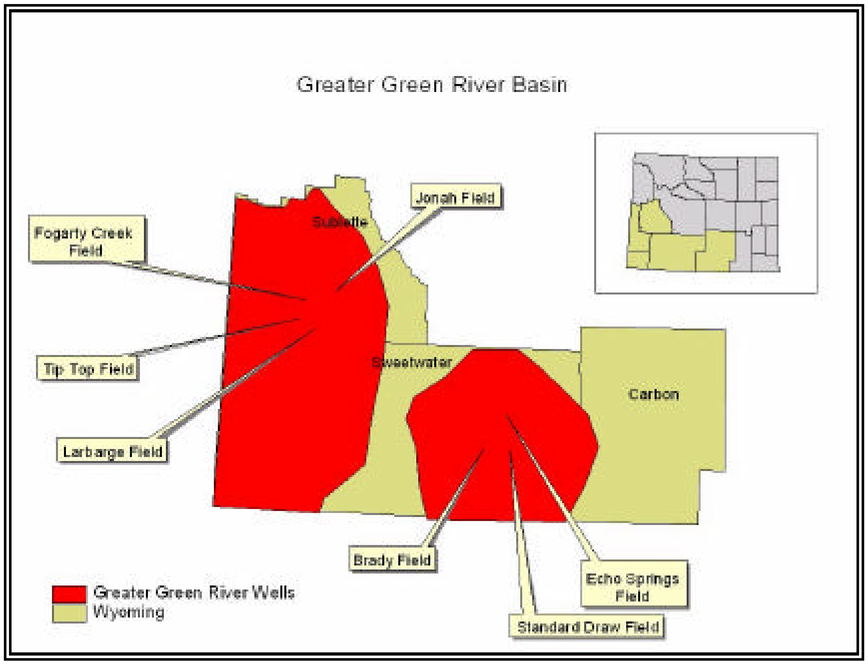

Figure 5. Fields Reporting High Volumes of Gas and Water in the Greater Green River Basin.