CHAPTER 7
IDENTIFIED SOURCES

7.1 INTRODUCTION

This section contains two distinct discussions regarding identified sources. The first discussion centers around short- and medium-term (hereafter referred to as "short-term") sources that will help keep Gillette in water as a long-term solution is planned, designed, constructed, and placed into operation. The second part of the discussion surrounds the sources that were evaluated as part of this study as a long–term source. In this long-term source discussion, sources that are obviously infeasible are discussed as well as sources that are feasible. These feasible long-term sources will be developed into alternatives in more detail in Chapter 8.

7.2 SHORT-TERM SOURCES

Short-term sources are the bridge that will allow Gillette to meet its rising water demands in the interim between the present and a long-term water supply. The time frame to fully implementing a long-term water supply source is dependant on a number of variables including but not limited to:

- planning/preliminary design
- funding time frames
- final design
- easement or right-of-way acquisition
- construction
- startup/commissioning.

Almost all of these tasks are dependant on one another, and all are dependent in some way on financing. Thus, it is difficult to ascertain an exact time frame for this portion of the solution. Given the size of improvements to be made, it is reasonable to assume a 5-8 year time frame until a long-term solution is in place. Since the integrity of Gillette's water system is dependent on providing a sufficient amount of water for this time period, a time horizon of 8 years will be used to plan for interim sources until the long-term water supply project is commissioned. It should be noted that delays in any of the steps above will likely delay the overall project. This is

an especially critical point given Gillette's current available source water/demand relationship. Time is of the essence in implementing a long-term source. Short-term sources are only evaluated herein as a stop-gap measure and should not be construed as a permanent solution to an issue that is worsening with time.

For the short-term alternatives, it is assumed that the populations of Crestview, Antelope Valley, and Sleepy Hollow will continue to be served off their existing systems until a long-term supply is implemented. This assumption can be applied whether these communities are served by an isolated community system or whether they are connected to the City system, but their wells are still used as a source. With these populations removed from the demand, the total design population for the short-term alternatives in 2015 is 34,915 with a peak water demand of 21.4 MGD. Given the existing system has a maximum capacity of approximately 14.5 MGD, this leaves a deficit of 6.9 MGD, or 4,791 gpm with 24 hours per day of pumping time. The maximum existing system capacity of 14.5 MGD is not firm capacity. Using firm capacity methodology, the existing firm capacity is 12.1 MGD leaving a deficit of 9.3 MGD or 6,450 gpm pumping 24 hours per day.

7.2.1 Current Source Information and Improvements

The City of Gillette currently draws water from the Fort Union, Madison, and, on a limited basis, Fox Hills sources. The details of those sources are listed in Figure 7-1. Other system infrastructure information is shown in Figure 7-2.

The City of Gillette is currently undertaking a well replacement project to replace Fort Union Wells S-12 and S-20. Well S-20 has been drilled and developed and is producing 275-325 gpm. Well S-12 is under construction and is slightly higher flow test results in the range of 325-400 gpm.

The City of Gillette is currently engaged in a pilot study to treat water from the City's existing Lance/Fox Hills formation wells. This water is high in fluoride and total dissolved solids (TDS) and is currently only useable in small quantities when large quantities of better quality water are available for blending. Burns and McDonnell has been retained to perform this study to look at possible treatment strategies to bring this water up to a quality where the full stream can be used as a water supply source without the current flow restriction due to quality.

Figure 7-1 Existing City of Gillette Water System Wells

Figure 7-2 Existing City of Gillette Water System Infrastructure

Lastly, the City of Gillette is executing a project to evaluate the condition of their existing Madison pipeline. A part of this project is evaluating the pipeline for presence of corrosion and upgrading the corrosion protection system. At the same time, the City of Gillette is installing surge controls (multiple blowoffs and a surge tank) to reduce transients in the pipeline. When these surge upgrades are complete, the existing Madison pipeline should have an ultimate capacity of 8,800 gpm. The overall condition of this pipeline is unknown due to failures in the joint bonding portion of the cathodic protection system.

7.2.2 Possible Short-Term Sources

After reviewing the existing surface water and hydrogeological conditions, it was determined that there are five (5) possible short-term water supply sources for Gillette. Those sources are:

1) Expand the Fort Union Source
2) Treat the Lance/Fox Hills Source
3) Use Coal Bed Methane Water
4) Expand the Madison Source
5) Develop the Wasatch Source

7.2.2.1 Expand Fort Union Source

This source involves expanding the City of Gillette's existing Fort Union wellfield. Well yields in the existing field range from approximately 75 gpm in the older wells to the 275-325 gpm range given for the newly constructed S-20 well. Utilizing the technology employed in the new S-20 and S-12 wells, it is assumed that any new wells drilled will produce 250-300 gpm. For the purposes of this study, an average value of 275 gpm per well will be used. As with any groundwater venture, there is no absolute guarantee that this flow rate will be achieved as an average on the whole, or at any individual well. However, a review of the new well S-20 performance as well as a literature review of Fort Union work in the area indicates this is a reasonable planning flow rate per well. As a short-term source, this option is technically feasible.

7.2.2.2 Treat the Lance/Fox Hills Source

The City of Gillette currently has three completed producing wells in the Lance/Fox Hills formation (hereafter referred to as "Fox Hills"). These well are high in fluoride and total dissolved solids. The elevated levels of these constituents prevents the City from pumping these wells at their capacity. When the Madison and Fort Union sources are producing near their maximum, City staff have indicated that in order to meet demand, they can blend in Fox Hills water at only about 1/3 of the total known Fox Hills production due to water quality nearing MCL's in the total blended stream. Table 7-1 shows the production rates from each of the three Fox Hills wells without any constraint on blending.

TABLE 7-1
Production Rate – Fox Hills Wells

Well Name	Flow Rate (gpm)
FH-3	650
FH-4	500
FH-5	500
Total Available Flow Rate = 1,650 gpm	

Treating this stream to lower fluoride and total dissolved solids levels allows full utilization of the existing well and pipe infrastructure. As a short-term source, this meets a portion of the demand needed to satisfy Gillette's short-term demand.

7.2.2.3 Utilize Coal Bed Methane Water

In the process of recovering coal bed methane (CBM) gas, the wells must be dewatered to a point where the gas is released. Under most circumstances, this involves an initial pumping to get the well to that release point and then on-going pumping to maintain that water level. Compared to potable water wells, each CBM well produces a small amount of water daily – approximately an order of magnitude less. However, there are a large number of these wells in Campbell and surrounding counties, and what they lack in flow per well, they make up for in number of wells. Discussions with CBM operators in the area indicate that they spend a significant amount of money to dispose of this water. Their current disposal methods include

treatment and surface water discharge, land application, and deep well injection. Each of these options has distinct disadvantages and costs associated with it. Discussions with CBM operators have shown some interest in a collaborative effort between the City of Gillette and the CBM operators to allow the CBM operators to get rid of their water by providing it to the City of Gillette as a drinking water source.

Water quality results from a small sampling of CBM water was provided by a local CBM operator. In many ways, the water quality of these samples is similar to that of local Fort Union wells. Three constituents that are an exception to this statement are sodium, iron, and total dissolved solids levels. The CBM water samples provided exceed the EPA secondary levels for each of these constituents.

The total amount of water being produced in the CBM in the area surrounding Gillette operations arena is far in excess of Gillette's short-term supply needs. The total quantity of this water that can be feasibly delivered to the City of Gillette on an as-needed basis is much more difficult to predict.

7.2.2.4 Expand the Madison Source

As discussed above, the Madison pipeline will be undergoing some upgrades shortly. After the surge upgrades are complete, the Madison should have a capacity of 8,800 gpm. The original design allowed for pipeline capacity up to 10,500 gpm with additional infrastructure. In order to achieve this increased flowrate, a number of substantial improvements would be required. The following items would be required to provide this upgraded capacity:

1) Drilling, developing, and putting into production at least one new Madison well.
2) Upgrading the pumping capacity or changing the station configurations at the existing Madison and Donkey Creek Pump Stations.
3) Constructing two new intermediate pumping stations – one between the existing Madison and Donkey Creek stations and one between the Donkey Creek pump station and Gillette.
4) Further upgrades to surge control equipment.

The existing Madison Pipeline has been in service in excess of 25 years. The Madison pipeline consists of cathodically-protected steel pipe. It has been discovered that the joint bonding necessary to accomplish this cathodic protection has failed on approximately 80 % of the pipeline. This failure raises concern regarding the actual condition and level of corrosion in this pipeline. A project to determine these conditions is currently underway; however, the results of that project will not be ready for approximately another year past the date of this study.

Given the failure level of the joint bonding on the existing Madison pipeline and the unknowns surrounding the condition of that pipe, undertaking a project to push more water through that element of the system may not be feasible or advisable. When the costs for this 1,700 gpm gain are coupled with the risks involved, it was determined that this is not a viable short-term supply alternative.

7.2.2.5 Develop the Wasatch Source

The Wasatch is the most shallow water-bearing aquifer formation in the Gillette area. Prior to the construction of the Madison infrastructure, the Wasatch produced some of Gillette's drinking water supply. Water quality from the Wasatch is poor, and an electro-dialysis plant was used to treat the water to then-current drinking water standards. These facilities have long been abandoned. Further, it is questionable whether the Wasatch would support a groundwater demand of the size that even the short-term scenario presents. This lack of current infrastructure and hydrogeological knowledge makes the Wasatch a questionable source which would take time to develop. Thus, this source is considered not viable and is not discussed further in this report.

7.2.3 Evaluation Approach

From the discussion above, it can be seen that not all of the sources can produce the required 8-year peak flow independent of one another. The simplest way to approach this problem is to economically evaluate the costs associated with each alternative in $/gpm and incrementally add alternatives starting with the cheapest cost per gallon then adding the next cheapest, etc. until the desired flowrate is reached. This chain of alternatives will then be evaluated to see if it efficiently fits in with the long-term water supply plans, and if not, a higher initial cost chain of alternatives may need to be selected to minimize the overall combined short- and long-term

costs to the City of Gillette. All of the details surrounding this approach including cost and order of addition of projects will be addressed in Chapter 8.

7.3 LONG-TERM SOURCES

The following sources were considered as part of this study. Those that were determined to be feasible as a reliable long-term water source for the City of Gillette were developed into alternatives, which were further evaluated and those that were feasible are discussed in detail in Chapter 8. Options found to be infeasible are discussed as to why they are infeasible, and are not considered further in this study.

The following sources were considered for a long-term water supply source:

Surface Water

1) Lake DeSmet
2) Keyhole Reservoir
3) Clear Creek
4) Wastewater Effluent Reuse

Groundwater

1) Wasatch Formation
2) Fort Union Formation (3 Members)
3) Lance/Fox Hills Formation
4) Madison Formation
5) CBM Water

7.3.1 Long-Term Sources – Surface Water

The following sources were considered as surface water candidates for a long-term water supply source for the City of Gillette.

7.3.1.1 Lake DeSmet

Lake DeSmet Reservoir is in the Powder River Drainage of Wyoming and falls within the Yellowstone River Compact of 1950. The compact is between three states: Wyoming, Montana, and North Dakota. The unused and unappropriated waters, as of January 1, 1950 were allocated as follows: Clarks Fork River – Wyoming 60%, Montana 40%; Wind/Bighorn River – Wyoming 80%, Montana 20%; Tongue River, excluding the Little Bighorn – Wyoming 40%, Montana 60%; and Powder River – Wyoming 42%, Montana 58%.

Per discussions with the Wyoming State Engineer's Office, Jason Peltier, Deputy Assistant Secretary for Water and Science, obtaining water from the LDCC would not infringe on the Yellowstone River Compact since it would involve using existing water rights and storage that has been already accounted for.[2] However, political relations between Montana and Wyoming have been recently strained. This situation could lead to objection of using Lake DeSmet as a surface water source for the City of Gillette.

In a letter dated May 18, 2004 to the State of Wyoming, the State of Montana raised issues related to satisfying their pre-compact rights and Wyoming water storage amounts. In January, 2007 the State of Montana sued the State of Wyoming in the United States Supreme Court in an effort to enforce the provisions of the Yellowstone River Compact. The complaint filed asks the court to order Wyoming to deliver more water in the Tongue and Powder Rivers according to the compact and award the State of Montana damages, costs, and other relief. It does not specify an amount. Montana interprets the compact to allocate the waters that were in actual use in each state at the time of the compact. Wyoming, meanwhile, asserts that "pre-1950" rights are excluded from the compact.

In 2004 and again in 2006, Montana experienced severe water shortages in the Tongue and Powder River Basins. Each time, Montana notified Wyoming that Montana's "pre-1950" uses were unsatisfied due to the shortages and called for Wyoming to provide the water apportioned to Montana. The complaint indicates that each time, Wyoming failed to curtail consumption for the benefit of its downstream neighbor Montana.

Another disadvantage of Lake DeSmet as a water source is that the water quality may deteriorate with time. The fact that the reservoir is off-stream and that it is filled by pumping

indicates that there is little opportunity for freshening by overflow and recharge, such as occurs in an on-stream reservoir. Evaporation exceeds rainfall in the area, which results in loss of water and a gradual buildup of mineral content in the lake. No dissolved minerals are removed by evaporation. Further study and analysis of the water quality aspect of Lake DeSmet should be completed before the City makes any arrangements for municipal water supply from Lake DeSmet.

Bob Ralston, LDCC Commissioner from Sheridan County was contacted to find out more information on what would be required to purchase storage rights for the 28,000 acre-ft that the LDCC owns. Bob Ralston indicated that Sheridan County has been evaluating using these storage rights and since it is so difficult to get water storage facilities built, the LDCC would not be interested in offering the water rights for purchase now and he indicated this would most likely hold true for the future.

Since the LDCC is not willing to offer water storage rights for Lake DeSmet, this alternative is not a viable option at this time and therefore, this alternative will not be considered any further. Even if in the future the LDCC was willing to sell long term water storage rights for the 28,000 acre-ft that the LDCC owns, this alternative is still extremely expensive for supplementing the water supply for the City of Gillette due to the 80-mile length of pipeline and required surface water treatment facility. Because this alternative requires pumping and, thus, large annual operating costs which may inflate unpredictably, as well as a long transmission line and treatment (which includes the capital costs and operating and maintenance costs for a surface water treatment plant and storage reservoir at the City), it is therefore concluded Lake DeSmet is not a viable alternative for a long term source of municipal surface water for the Gillette area.

7.3.1.2 Keyhole Reservoir

The Belle Fourche River Compact allocated the inflows and storage in Keyhole Reservoir at 90% to South Dakota users and 10% to Wyoming users. The reservoir has a conservation capacity of 193,753 acre-ft. (185,801 acre-ft. of active storage) and 140,462 acre-ft. of exclusive flood control space. Of the 90% of the conservation storage (193,753 acre-ft.) reserved for South Dakota, a portion is currently used for irrigation of approximately 57,200 acres in the vicinity of Belle Fourche and Newell, South Dakota, and a portion currently has no contract and is maintained in the U.S. (federal) account. For the portion that currently has no contract, per

the Belle Fourche River Compact, this portion for long term contracts must be sold to South Dakota users only. Short term contracts for South Dakota's portion that currently has no contract could be sold to Wyoming users on an annual basis, but only if there is water available.

Of Wyoming's portion (10 percent of active storage), the majority have been purchased by the Crook County Irrigation District per a contract, effective January 1, 1985. The contract allows the District, which consists of eighteen Wyoming irrigators, 18,080 acre-ft. The remaining 500 acre-ft. were purchased by Shattuck Hills. Therefore, there is no uncommitted portion currently available for use by the City of Gillette.

There are two major reasons why considering the Keyhole Reservoir as a source water for City of Gillette's municipal use is not a viable option. The first reason is that obtaining water storage rights isn't easy and the second and more important reason is that the inflow to the reservoir is not reliable. To obtain a long term water storage contract would require getting the Belle Fourche River Compact changed. An Act of Congress would need to be passed in order to accomplish this. Trying to change the Belle Fourche River Compact would most likely receive objection by South Dakota and not be allowed and would likely strain the relationship between South Dakota and Wyoming.

More importantly, inflow to the reservoir is not reliable since there is no consistent snowpack and precipitation is highly cyclical. As of March 29, 2007, the active storage capacity was 30.3 percent full. [4]

Due to the reasons described above, it is concluded that the Keyhole Reservoir is not a viable alternative for a long term source of municipal surface water for the Gillette area and will not be evaluated further.

7.3.1.3 Clear Creek

The City of Gillette has held rights to Clear Creek in the past, but at the current time holds no rights to this body of water. The City of Gillette can file an application with the State Engineer's Office by submitting Form SW3, to try to obtain the 8,200 acre-ft. water storage rights that were forfeited. The application would need to be reviewed and approved by the State Engineer, Patrick T. Tyrrell. It is extremely unlikely, given today's political climate, that a significantly large

quantity of water for storage, similar to the quantity the City of Gillette needs would be approved. However, maybe a smaller quantity would be approved as long as it meets the requirements of the Yellowstone River Compact. Article X of the Compact stipulates that no water shall be diverted from the Yellowstone River Basin without the unanimous consent of the three signatory states, Wyoming, Montana, and North Dakota. Clear Creek is considered part of the Powder River Basin and is a higher quality than the Powder River. For this reason, the request for water storage rights would likely receive objection from both Montana and possibly North Dakota and not be approved. Furthermore, the U.S. Army Corp. of Engineers and the U.S. Environmental Protection Agency would likely oppose construction of an on-channel reservoir when other alternatives exist.

Due to the reasons described above, it is concluded that capturing water from Clear Creek is not a viable alternative for a long term source of municipal surface water for the City of Gillette and will not be evaluated further.

7.3.1.4 City of Gillette Waste Water Treatment Plant Effluent

The Gillette WWTP operates under a NPDES Permit No. WY-0020125 issued by WDEQ. The permit addresses discharge from the WWTP to Stonepile Creek, which then flows into Donkey Creek approximately 0.7 miles downstream. A portion of the effluent discharges to the Pacific Power and Light Company's Wyodak Power Plant. The treatment effluent from the City's WWTP is not a possible source of water for irrigation or municipal use since per discussions with City Staff, as Pacific Power and Light (PP&L) has first right to the effluent.[7] For the purposes of this report, this source is considered not viable and will not be evaluated further.

7.3.2 Long-Term Sources - Groundwater

The following sources were considered as groundwater candidates for a long-term water supply source for the City of Gillette.

7.3.2.1 Wasatch Formation

The Wasatch Formation is the shallowest of the groundwater formations in the Gillette area. The City of Gillette used Wasatch water to meet part of their water needs prior to the

construction of the Madison infrastructure. Consequent to construction of the Madison system, the Wasatch wells were abandoned. The Wester-Wetstein 2004 Master Plan indicates the Wasatch water had a number of quality problems including hardness levels of 2,000 mg/l, total dissolved solids of 1,700 mg/l, and iron and manganese levels of 0.4 mg/l. All of these levels are well in excess of the maximum levels established in the EPA's Secondary Drinking Water Regulations. The yields from Gillette's Wasatch wells were low and levels were declining. Further, additional risk is injected in investigating the Wasatch as a primary water source by the fact that little hydrogeological information is known, or at least published, about the Wasatch. Water yields from the early Gillette wells were so low that a significant number of wells would be required to meet the substantial demand Due to these factors, the Wasatch is not viable as a primary long-term drinking water source for the City of Gillette.

7.3.2.2 Fort Union Formation

The hydraulic properties of the Fort Union formation are discussed at length in Chapter 5. While the Fort Union is a viable short-term alternative, it does not have sufficient capacity to support the full 30-year peak demand. The general trend for groundwater levels in monitoring wells in the Fort Union in the area surrounding Gillette is downward. This downward trend will only be exacerbated by a wellfield of the size required to support Gillette's projected 30-year demands. Further, uncertainties about the hydrogeologic properties of the aquifer add risk to pursuing this as a primary long-term source.

The Fort Union formation was the principal proposed source in the recently discontinued Southern Well Field Project. This project proposed drilling between 15 and 25 wells into the Fort Union formation in a new well field south of Gillette. The Southern Well Field project was undertaken under a different set of planning criteria with different time horizon and populations projections than this study. For comparative purposes only, the most recent cost estimate provided by the City of Gillette for the Southern Well Field has been modified in format and approach to the cost estimating template used in this report and included in Appendix A. This cost estimate should not be used for side-by-side comparisons to the other alternative cost estimates in Chapter 8 as the planning horizons and well field lives are drastically different. When the updated planning criteria of this study are coupled with the Fort Union hydrogeologic uncertainties, it becomes clear that it is not viable for the Southern Well Field to be the primary

municipal drinking water source for the 30-year planning horizon, and will not be discussed further in this report.

7.3.2.3 Lance/Fox Hills Formation

The City of Gillette currently has three wells in the Lance/Fox Hills formation that are tabulated in Section 7.2.2.2. These wells produce comparatively good yields in terms of quantity of water, but the water quality is poor. Numerous constituents in this water are above EPA SMCL's, and fluoride is well above the EPA MCL of 4.0 mg/l. A pilot study to determine treatability of the Fox Hills water for a short-term source is currently being conducted by Burns and McDonnell on the City of Gillette's Fox Hills wells. While this report is not yet final, two treatment alternatives have emerged: reverse osmosis and reverse osmosis with ion exchange. The reverse osmosis alternative has a rejection rate of approximately 25%, while the reverse osmosis plus ion exchange has a reject rate of 15%. This rejection rate means that for every gallon that comes out of the well field, only 75-85% of that gallon will make it through treatment as finished water. The details of the mechanics of these treatment strategies are discussed in detail in the short-term alternatives section of Chapter 8.

The Fox Hills has long been identified as a source for industrial users, presumably to preserve the better quality Fort Union and Madison aquifers for drinking water uses. Given the coal development east of Gillette, these industrial uses can be significant.

The Fox Hills wells are substantially deeper (~4,000 Feet) than the Fort Union wells in the Gillette area (~2,500 Feet) and the Madison wells in the City of Gillette Madison well field (~2,400 Feet). This additional depth results in increased well drilling capital costs. The water surface in the Fox Hills wells is also substantially lower, on average, than the Fort Union and Madison well fields. This leads to increased capital costs for a longer pump column and upsized pumps as well as increased operational costs to lift the water farther.

Using a reject rate of 25%, a design finished water flow rate of 12,900 gpm, and a well production rate of 550 gpm/well, the raw water flow rate required would be 17,200 gpm, which would require 32 wells. With the very limited hydrogeological data available for the Fox Hills, it is difficult to develop an accurate spacing for these wells. It is also very difficult to accurately

predict the effects that a large primary municipal water source of the size contemplated here would have long-term on the aquifer.

From a cost perspective, the Fox Hills has a number of problems associated with it. Based on proportioned depths, Fox Hills wells should be approximately 1.6 times the cost of equivalent Madison or Fort Union wells based on depth alone. Further, the capital and on-going O & M costs associated with operating the treatment required are substantial. Treatment capital costs are estimated to be approximately $30 million dollars, waste disposal capital costs are estimated to be $10 million dollars for a flow rate of 1,800 gpm of raw water. The O & M costs to run an RO plant in this situation are traditionally high due to chemical costs as well as the electrical costs needed to pressurize the water to a level where it permeates the RO membranes.

These cost issues combined with the hydrogoelogical uncertainty make the Fox Hill an unviable source for a long-term primary municipal water supply which will not be discussed further.

7.3.2.4 Madison Formation

The City of Gillette currently draws the majority of their water supply in the summer months from the Madison source. Currently, Gillette receives approximately 80-85% of their water from the Madison source during times of high demand. Since the Madison infrastructure was placed into service it has been producing generally good quality water for the City of Gillette in substantial quantities. Madison water tends to have hardness levels in the 500 mg/l (as $CaCO_3$) range, which can lead to complaints about taste and scaling issues, particularly in water heaters and other household water appliances. Hardness is not currently regulated by EPA Primary or Secondary Drinking Water Standards.

The hydrogeological properties of the Madison as a source are discussed in detail in Chapter 5. Generally, the Madison is capable of producing the quantity of water that is required to meet the 30-year projected demands for the City of Gillette. As discussed in Chapter 5, the anticipated groundwater mining effects in the Madison are projected to be much smaller percentage-wise in relation to the total water column available in the aquifer compared to similar draws from the Fort Union.

Preliminary well field siting work indicates that a new well field in the Madison could be developed reasonably close to the existing Madison well field. This siting can reduce costs by minimizing new collection pipeline and electrical infrastructure costs.

The Madison aquifer is the only source available that is projected to meet Gillette's 30-year drinking water demands. Alternatives developed around using the Madison formation as a source are developed further in the subsequent section and chapters.

7.3.2.5 Coal Bed Methane Water

CBM water was evaluated as a long-term source as well as a short-term source as discussed above. Preliminary data show more than enough water to meet the City of Gillette's demand is extracted from CBM wells. However, there are a number of complicated issues in getting that water into the City of Gillette at the quality and quantity needed. A detailed discussion of those issues is presented in discussions in Chapter 8. From a volume perspective *only*, CBM water is feasible, and is evaluated further in subsequent discussions.