GILLETTE AREA GROUNDWATER MONITORING ORGANIZATION: WHAT HAVE WE LEARNED IN 20+ YEARS?[1]

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Abstract. The Gillette Area Groundwater Monitoring Organization (GAGMO) was formed in 1980 to serve as a data gathering organization. Membership is limited to those companies with operating or proposed coalmines in the Powder River Basin of Wyoming and to interested State and Federal regulatory agencies. GAGMO compiles member coal mining company's annual ground-water data collected in October of each year. These ground-water data are tabulated in a regional database and published in an Annual Report with ten-year cumulative assessment reports done in 1990 and 2000.

Through the mid-1990's, the impacts to surrounding ground-water static water levels had been limited to areas immediately surrounding active mine pits. Measured drawdown in monitoring wells constructed as part of the coalmine permitting process was less than predicted by pre-mine modeling. In the mid-1990's, a method to economically dewater the Wyodak coal seam and recover methane was developed. This led to extensive coal-bed methane development in the Gillette area of the Powder River Basin. Over 8,000 wells have been constructed with an additional 39,000+ proposed within the next five years. The drawdown affect of the existing wells has been extensive and rendered a number of monitoring wells associated with coalmines "gassy" and useless. The additional proposed wells will continue to expand the impact area both horizontally and vertically. Potential concerns that will need to be addressed are the assessment of cumulative hydrologic impact associated with new coal mine permits by state agencies, the need for continuation of current ground-water monitoring programs, and bond release of reclaimed areas that continue to show water level drawdown.

Additional Key Words: Groundwater monitoring, coalmines, drawdown, coal-bed methane, cumulative hydrologic impact assessment, bond release

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[1]Paper was presented at the 2003 National Meeting of the American Society of Mining and Reclamation and The 9th Billings Land Reclamation Symposium, Billings MT, June 3-6, 2003. Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502

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Proceedings America Society of Mining and Reclamation, 2003 pp 1229-1238
DOI: 10.21000/JASMR03011229

https://doi.org/10.21000/JASMR03011229

History

The Gillette Area Groundwater Monitoring Organization (GAGMO) was formed in 1980 to serve as a data gathering organization that would facilitate regional analyses of hydrogeology in the coal mining areas of the Eastern Powder River Basin of Wyoming (Figure 1). Member mines range from Triton Coal Company's Buckskin Mine located 10 miles north of Gillette to Kennecott Energy Company's Antelope Mine located 52 miles south of Gillette, covering an area in excess of 700 square miles (Figure 2).

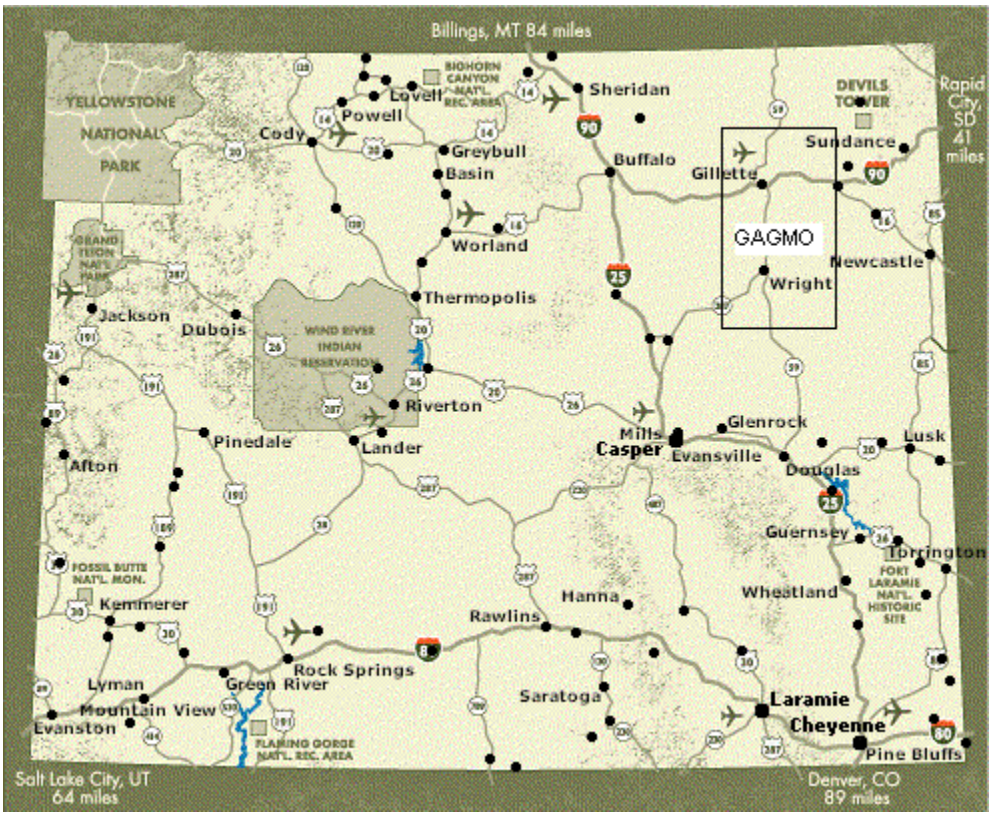

Figure 1. GAGMO Region in Northeastern Wyoming (Wyoming State Office of Tourism, 2002)

The organization assembled monitoring well data that was supplied by each GAGMO member into a regional database. Potentiometric surface contour maps were then assembled from the database to provide insight into recharge-discharge relationships, and to provide qualitative analysis of aquifer characteristics. On or around October 1 of each calendar year, GAGMO members measured water levels at the monitoring wells for which each member was responsible. This data along with well completion data were initially submitted to the GAGMO

Chairman who was responsible for publication of the annual report. A contractor was later utilized to prepare the report due to staff cuts among the member companies.

The initial (1981) GAGMO Report represented a compilation of data from 665 monitoring wells that were measured at 20 mine-sites during 1980. Initially only static water level data was included in the report. In 1994, mining had advanced sufficiently at enough operations that it was decided that backfill (spoil) water level and quality data would be added to the annual report. Five-year (1986), 10-year (1991), 15-year (1996), and 20-year (2001) reports have been published with hydrographs and trend analyses included as part of the report.

The most recent (2002) GAGMO Report represented a compilation of data from 570 monitoring wells that were measured at 16 mine-sites during 2001. One hundred thirty-one, or 23%, of the original monitoring wells for 1980 remained active. Data records for some of these wells extend back as far as 1973. The reduction in number of mine-sites from 20 to 16 was a result of combining of two or more contiguous sites into one site in a number of cases.

What the Data Show

Prior to 1995, areas of ground-water drawdown were found immediately adjacent to active pits and in areas where pre-mine dewatering operations were occurring.

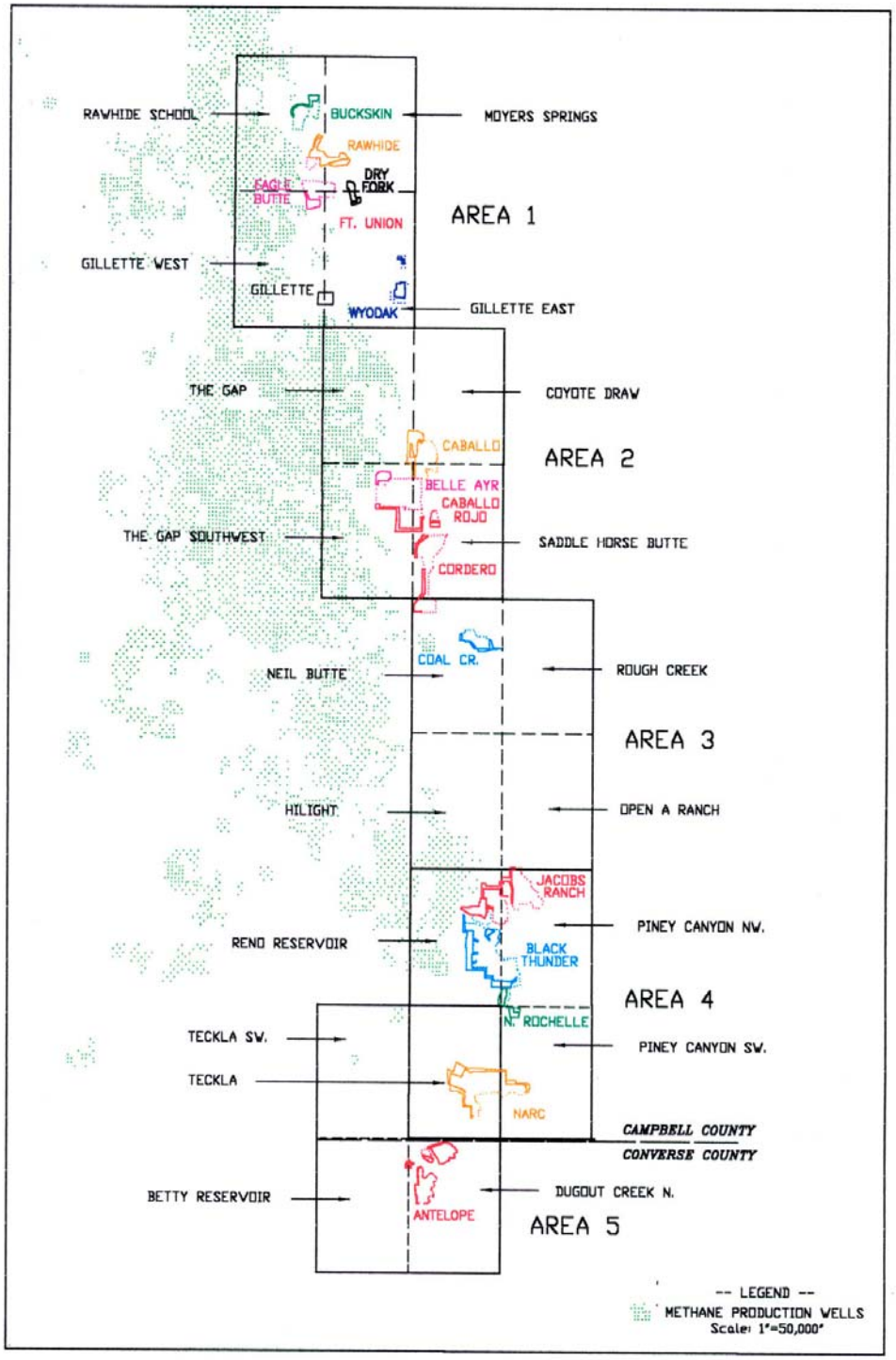

Figure 2. Location of GAGMO Member Mines with USGS Quad Coverage and Existing CBM Production Wells (GAGMO, 2002)

Drawdowns in the tens of feet were documented in the late 1980's around some mine-sites (Figure 3) while larger drawdown areas were observed near contiguous mines where the drawdown effects were superimposed. In 1995, coal bed methane development began in the eastern Powder River Basin and will be discussed below.

Backfill (spoils) aquifer water levels and water quality trends through the years have varied due to a number of reasons. In some areas backfill water levels have risen consistently over the years to levels as much as ten feet above baseline (Figure 4). Some backfill wells have shown declining water levels since construction.

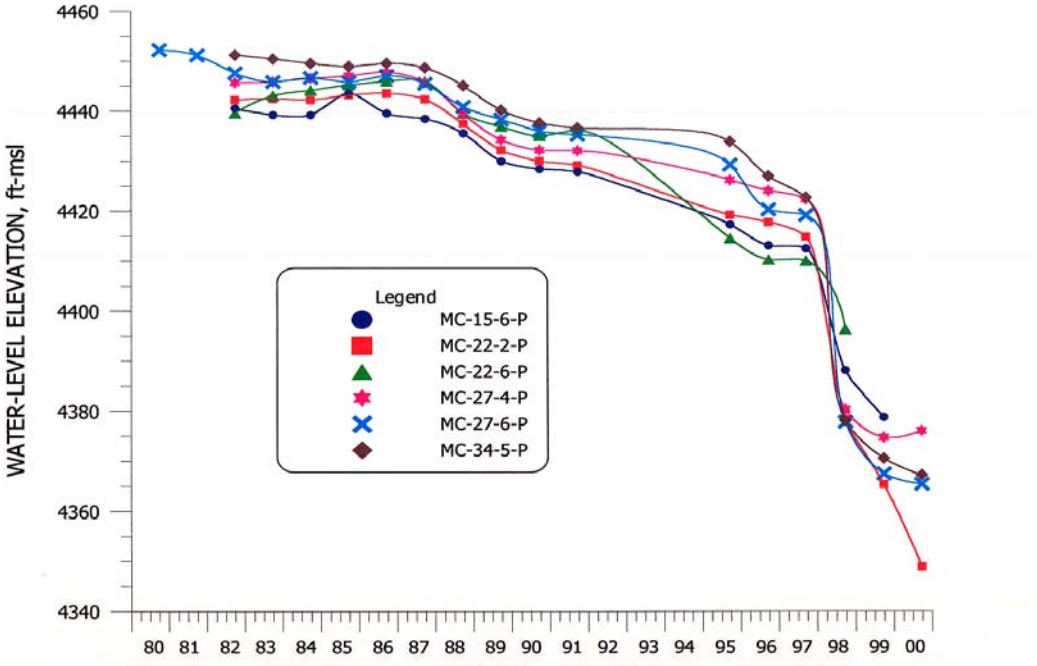

Figure 3: Representative Ground-water Drawdown (GAGMO, 2001)

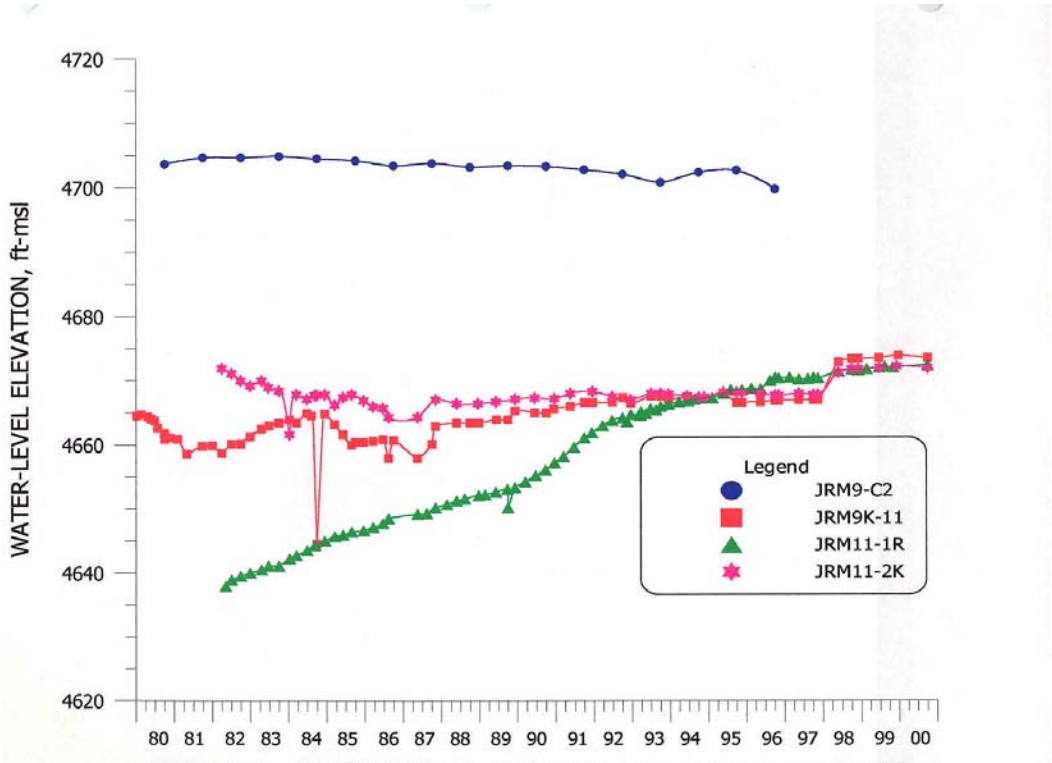

Figure 4. Representative Backfill Ground-water Recharge in JRM11-1R (GAGMO, 2001)

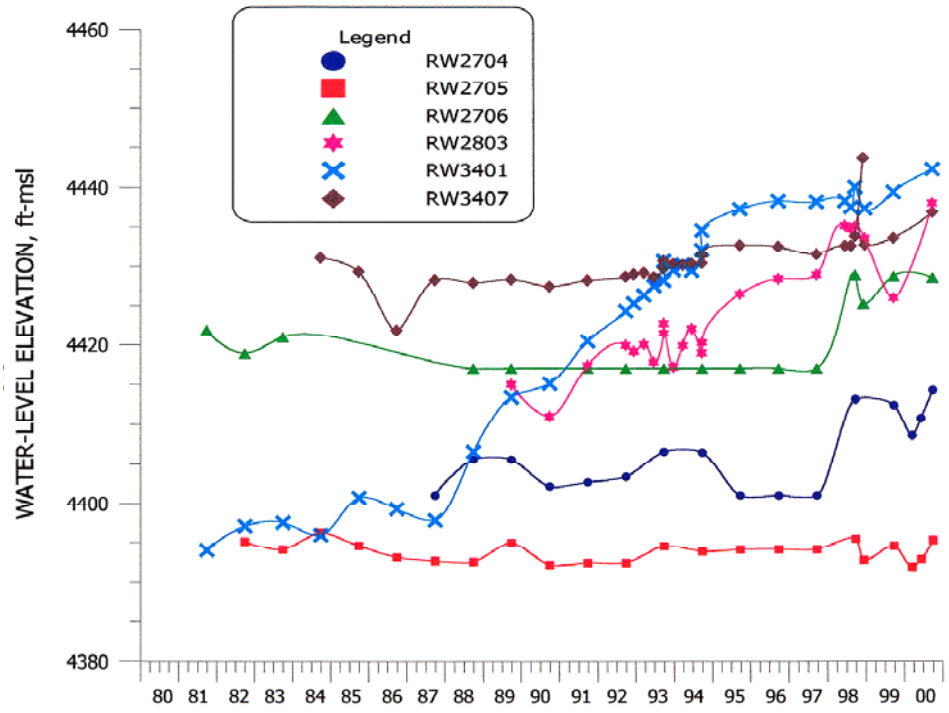

Figure 5. Representative Backfill Ground-water Recharge From Surface Water in RW3401 (GAGMO, 2001)

Backfill water level and water quality trends appear to vary depending on the physiographic location, availability of recharge sources, and the physical nature of the backfill material (Figure 5). The minimal amount of annual precipitation in the various areas (10 to 14 inches) reduces the opportunity for recharge to occur in most areas

Backfill water quality in some areas has appeared to improve with declining levels of conductivity and total dissolved solids. Other areas have exhibited stable or increasing levels of dissolved minerals.

Impacts of Coal Bed Methane Development

In 1995, a method for the extraction of coal bed methane (CBM) was developed and implemented in the eastern Powder River Basin. In this method, CBM wells are cased to the top of coal and sealed with an open hole left within the coal seam. Water is then evacuated from the well to relieve hydrostatic pressure within the coal seam, thereby releasing the methane gas. In January 1995 there were 129 producing CBM wells in Wyoming (CBMCC, 2002). By February 2002 that number had grown to 8,641 (Figure 6). Water production in conjunction with the CBM grew from 34,874 barrels per day in 1995 to 1,507,937 barrels per day in 2002 (Figure 7). CBM gas production grew from 9,009 million cubic feet per day (Mcf/day) to 826,121 Mcf/day.

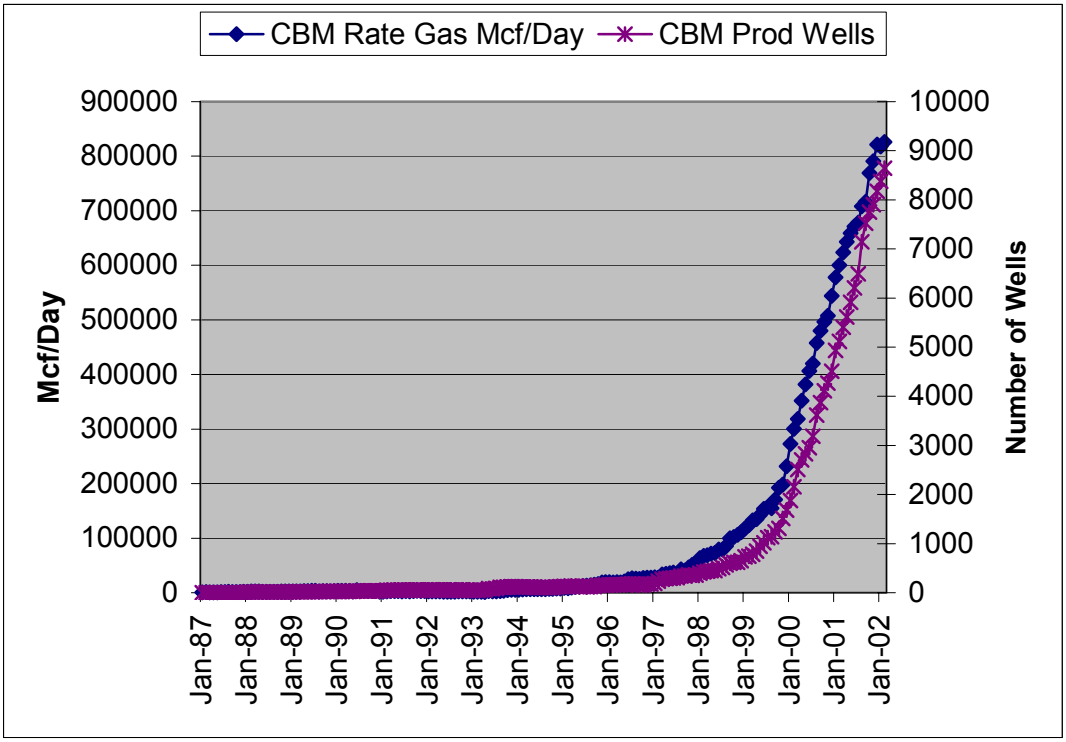

Figure 6. Comparison of Coal Bed Methane (CBM) Production with Number of Producing CBM Wells in Wyoming (Data from CBMCC, 2002)

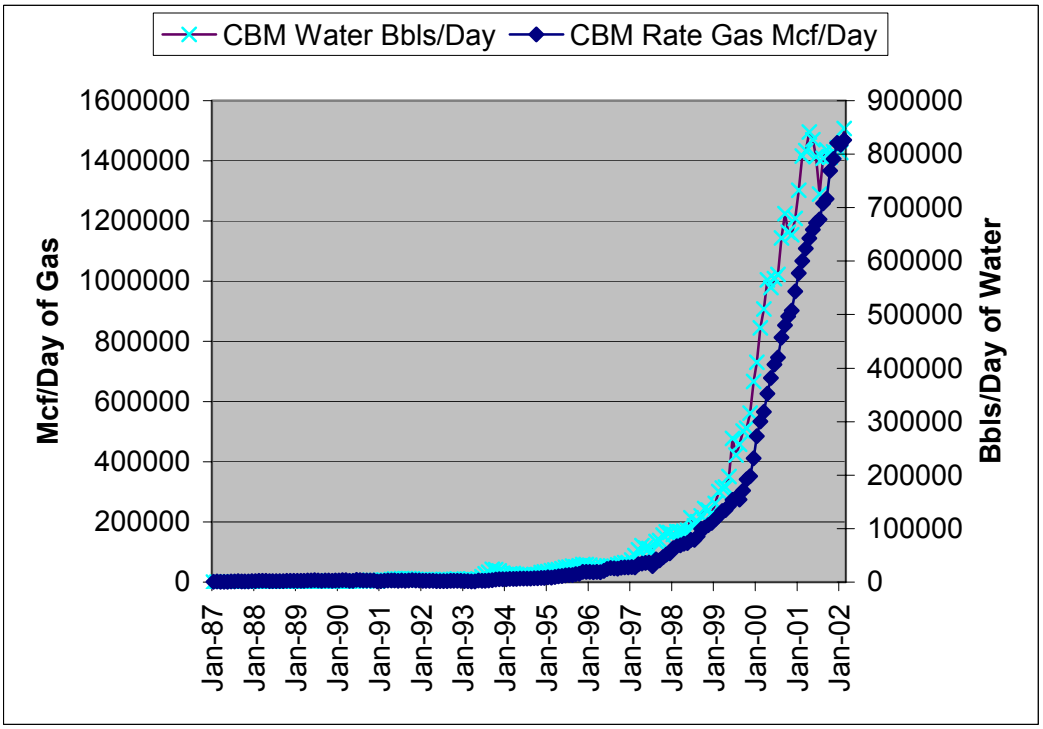

Figure 7. Comparison of Coal Bed Methane (CBM) Production with CBM Water Production in Wyoming (Data from CBMCC, 2002)

Most of the CBM wells were constructed immediately west of the existing active mines along the eastern flank of the Powder River Basin. This allowed the CBM developers to take advantage of partially dewatered coal adjacent to active mines as well as shallow depths to target coal seams. Well spacing varied from one every 40 acres to one every 80 acres. The density of well spacing is evident in Figure 2. This development resulted in water level drawdowns in excess of 200 feet within and around the well fields. The resultant drawdown cones have overshadowed the ground water hydrologic impacts associated with coal mining and in a number of cases, resulted in the loss of mine associated coal monitoring wells. The monitoring wells became "gassy" and unusable due to the volume of gas being released from the wells preventing accurate measurement of static water levels.

Where Do We Go From Here

It was anticipated by mining companies and regulatory agencies during the developmental period of coal mines in the Powder River Basin that monitoring wells would be destroyed as mine areas expanded. What was not anticipated was the development of an industry contiguous with active mine-sites of which the intent was to dewater the coal seam in order to release methane gas.

The US Department of Interior, Bureau of Land Management is anticipating release of the Final Powder River Basin Oil and Gas Project Environmental Impact Statement (FPRB OGP EIS) in January 2003 (M. Brogan, 2002). Issuance of the FPRB OGP EIS will allow for the construction of an additional 39,000+ CBM wells on federal leases in the Powder River Basin. The cumulative regional effect of almost 50,000 CBM wells will need to be evaluated as additional federal coal is proposed for leasing in the Powder River Basin. This effect will also need to be evaluated as the surface coal mines pursue final reclamation bond release from areas meeting the criteria outlined in the Surface Mining Control and Reclamation Act (SMCRA) of 1977 but still within the area of influence of CBM development.

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