Subject: **Powder/Tongue River Basin Plan**
Industrial Water Needs Projections
Task 4

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INTRODUCTION

This memorandum presents projections of industrial water needs in Powder/Tongue River Basin for the period from 2000 through 2030. These projections provide a basis for gaging the adequacy of existing water resources in the Basin to meet potential future needs. Following guidelines established by the Wyoming Water Development Commission (WWDC), projections were developed for three planning scenarios:

1. Low Growth
2. Moderate growth
3. High Growth

The industrial water uses covered in this memorandum are those for which dedicated water delivery facilities are needed to provide an adequate supply. A number of small industrial firms in the planning area are located in communities and make use of municipal water supplies to meet their needs. There usage rates are typically low and for that reason they have not needed to develop dedicated water supply facilities. Projections of water needs for these small industrial users are included in projections of municipal demands for communities in the Basin.

APPROACH

The projections described in this memorandum are based upon a review of available literature and a series of personal interviews with planning and regulatory officials and representatives of large industrial water users in the Basin. A database of industrial water rights permit holders provided by the Wyoming State Engineers Office (2001) was used to develop an initial list of large industrial water users in the planning area. This initial list was refined as the interviews proceeded to insure that potential future users were identified and included in the study. Over one dozen interviews were completed with persons in the planning area that are knowledgeable about water use in the following industries:

1. Electric Power Generation
2. Coal Mining
3. Oil and Gas Production
4. Coalbed Methane Production

Information gathered during the interviews included descriptions of current water usage, plans for future expansion, and a description of factors that influence the magnitude industrial water usage. The data and information collected during these interviews, along with information gleaned from literature searches, was used to construct the following future water demand scenarios.

COAL-FIRED ELECTRIC POWER PRODUCTION

Currently there are no coal-fired electric generating facilities in the planning area. The Basin has coal and water resources to support such a facility, however, and the area has been studied in the past as a possible

as a possible site for power generation (Watts, 2001). The Lake DeSmet Energy Company is actively pursuing a developer to use its coal reserves and water rights for power production, but no firm proposals have been submitted to date. The company has vast coal reserves in the vicinity of Lake DeSmet, and has storage rights for 62,000 acre-feet in Lake DeSmet and 5,140 acre-feet of storage in Healy Reservoir that could be used for power production (Money, 2001).

One reason that generating plants have not been developed in the area in the past is that alternative sites in Wyoming and other western states have proven more desirable from a cost perspective. Another reason is the uncertainty imposed upon the electric power industry by proposals to deregulate it in various western states. Without assurances that they would be able recover costs in deregulated markets, electric power generators have been reluctant to make large capital investments in new facilities. Furthermore, transmission facilities out of the Basin to growing markets such as Colorado are nearing capacity and would have to be expanded to support significant amounts of new generation, thus adding to capital investment requirements (Parrish, 2000).

Events of the past two years, however, including power shortages in California, rapidly rising prices for electricity, and new federal incentives for plant construction, have shifted the economic climate with respect to developing new generating capacity. Several companies have announced plans to build additional generating capacity in nearby Northeast Wyoming, and those plans are in various stages of implementation as of late 2001. There is a limit, however, to the amount of additional power generation that can be developed in northeastern Wyoming due to air quality constraints (Olson, 2001). At some point over the next 30 years it is reasonable to expect power generators to revisit the Powder/Tongue River Basin as a potential site for coal fired electric generators.

There could be an air quality constraint involved in locating a generating facility in the Basin due to its proximity to wilderness areas in the Big Horn National Forest. Whether this constraint would be a fatal flaw depends upon a number of factors that are matters of speculation at this time, including the plant's design and location and the results of air quality modeling that would have to be undertaken for permitting purposes. The area does have the advantage of existing storage rights in Lake DeSmet that could be used to support wet cooling technology for power production, which is in use at other facilities in the state, including the Laramie River Station in Platte County and the Jim Bridger Power Plant in Sweetwater County. Wet-cooled plants are more efficient and less costly to run than dry-cooled plants such as the Wyodak facilities near Gillette, but their water requirements are much larger. For example, the 2000MW Jim Bridger Plant consumptively uses about 34,000 acre-feet of water annually (Watts, 2000). This figure is much larger on a per-megawatt basis than the estimated 500 acre-feet of annual consumptive use by the dry-cooled plants at the Wyodak site (Watts, 2002). The availability of storage water in Lake DeSmet makes wet cooling a viable option for power generation in the planning area.

Another potential source of water for power production is low-cost groundwater from coalbed methane (CBM) production. The process of extracting methane gas from coal seams produces large quantities of water that must be disposed of in some fashion, and use of that water for wet cooling in electric power production would be a logical way to make use of water that would otherwise be re-injected into aquifers, stored in small reservoirs, or discharged into streams. At least one power company in Northeast Wyoming has expressed an interest in utilizing CBM water for cooling purposes (Ruffato, 2001).

There are several potential problems with implementing such a proposal, however. One problem is the fact that although the production life of coalbed methane resources in the Basin is not known with certainty, resources may be depleted in a shorter time frame than the 50-plus year life expectancy of a coal-fired generating facility. Of even greater concern is the fact that water production from coal seams tends to peak when the seam is first tapped, and then drop off dramatically as methane production increases, meaning that there is a great variation in the amount of water produced at one location over time. Finally, the CBM industry is composed of a large number of players who have priorities other than insuring a reliable source of water for industrial use. Organizing those individuals and companies and providing the infrastructure needed to transport a consistent volume of water to a site for cooling purposes could prove to be a daunting challenge. Nevertheless, the potential use of CBM water for industrial purposes in the Basin remains an interesting possibility.

Projections of future water needs for electric power generation are described below for low, moderate, and high growth scenarios. These projections are based upon the assumption of wet cooling technology.

Low Growth Scenario

The low growth scenario assumes that no electric power generating facilities will be built in the Basin over the next 30 years. This scenario is equivalent to assuming that (1) the competitive advantage that other areas have held in power production in the past will continue in the future, or (2) air quality constraints will be too restrictive to site a facility in a desirable location.

Moderate Growth Scenario

The moderate growth scenario for electric power production assumes that air quality constraints on power generation can be overcome and that the availability of coal and the water resources needed for wet cooling technology will be attractive enough for a power generator to build a 1000 megawatt (MW) facility in the planning area sometime during the nest three decades. The industrial water requirements for this scenario are 17,000 acre-feet annually.[1]

High Growth Scenario

The storage rights available in Lake DeSmet should be large enough to support 2000MW of coal-fired electric power generation using wet cooling technology. The high growth scenario for electric power production thus assumes the relatively low cost water available for power production in Lake DeSmet will be used to generate 2000MW of power sometime during the next 30 years. The industrial water requirements for this scenario are 34,000 acre-feet annually.[1] Future electric power generation water use projections for all three growth scenarios are presented graphically in Figure 1.

COAL MINING

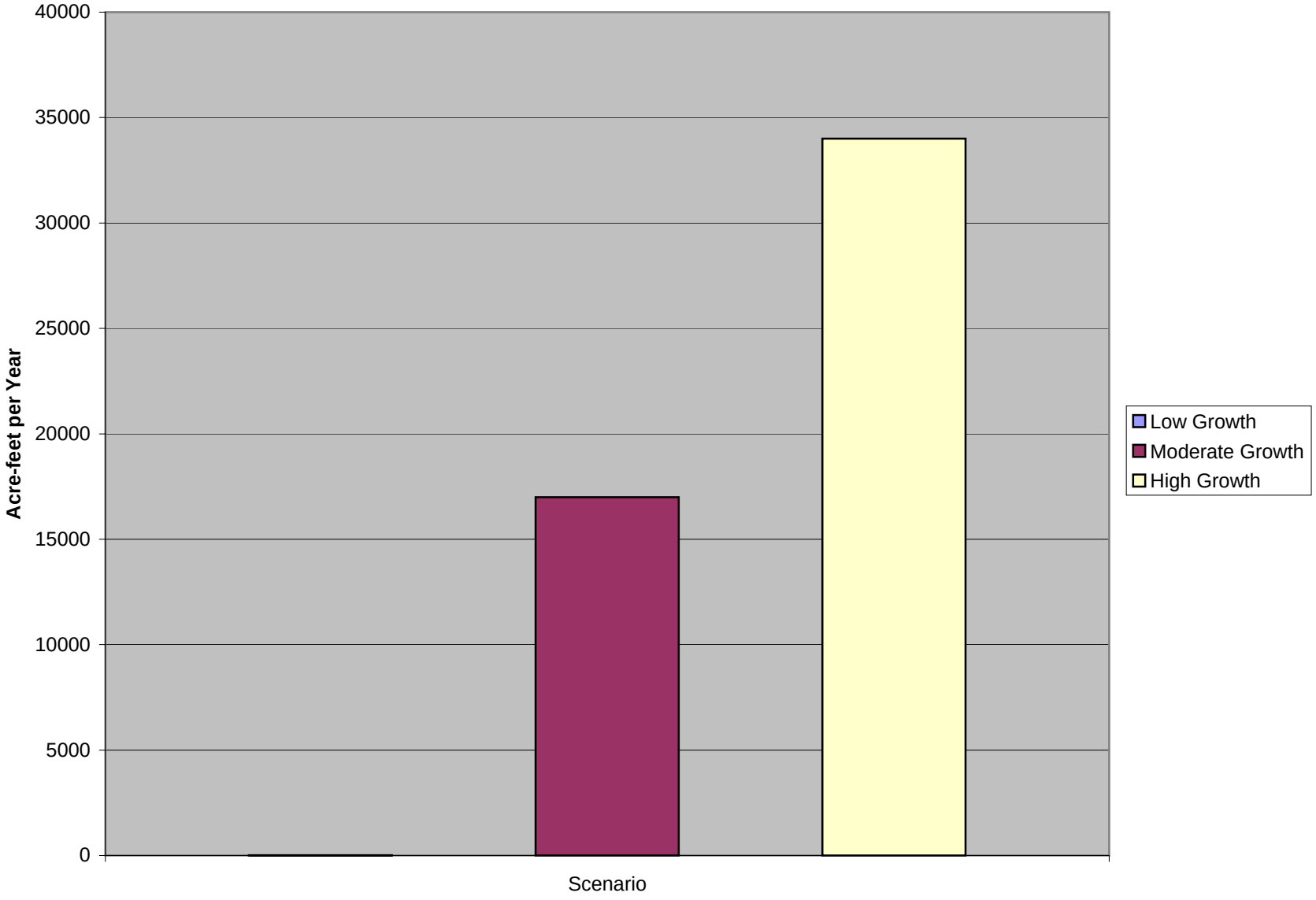
Most of the active coal mines in northeastern Wyoming are located in the Belle Fourche and Cheyenne River Basins to the west of the Powder River. The one large active surface coalmine in the planning area is the Spring Creek Mine Operated by Kennecott Energy in northern Sheridan County. This mine produces approximately 11.3 million tons of coal annually, or about three percent of the 338 million tons of coal that were mined in Wyoming in 2000 (Wyoming Coal Information Committee, 2001).

Surface coalmines use water primarily for dust abatement and reclamation, with lesser amounts used for equipment wash-down and domestic purposes. The primary sources of water for most mines are dewatering wells drilled into the coal seam ahead of advancing pit operations and sump wells to remove water from the pit. A few mines are extracting dry coal, however, and have drilled groundwater wells away from the coal seam to meet their needs. Surface runoff is also captured in some operations. Water use varies considerably among mines and by season of the year, with summer being the peak usage season. Mines in the Belle Fourche and Cheyenne River Basins typically use between 200 and 800 acre-feet of water annually. Some mines discharge a far greater amount of water than they use because their dewatering activities produce more water than they need for operational purposes. The Spring Creek Mine, however, is a “dry mine” that does not dewater the coal seam prior to mining. The mine is thus a zero discharge facility (HKM, 2002).

Future water use by the coal industry in the planning area is expected to increase slightly for two reasons. First, the Spring Creek Mine may expand production in the future if coal prices remain firm at current levels or increase. Second, some additional mines may be opened in the future to supply coal for electric generating facilities either in or out of the Basin. Nevertheless, most mines will continue to meet their relatively small operational water needs from groundwater sources on site. These activities are not

[1] This estimate is based upon water requirements for the Jim Bridger Power Plant in Sweetwater County, Wyoming (Watts, 2000).

Figure 1
Electric Power Water Demand Projections
Powder/Tongue River Basin
2030



expected to affect either surface water resources or other groundwater users in the Basin. Thus, water requirements for the mining industry have not been projected into the future.

OIL AND NATURAL GAS PRODUCTION

Traditional oil and gas production in the planning area has been declining in recent years. According to the Bureau of Land Management (2001), the number of wells plugged is expected to exceed the number of wells drilled each year for the foreseeable future. This trend will be offset by an increase in coalbed methane (CBM) production as discussed in the following section.

Very little water is consumptively used by the oil and gas industry in the planning area; only small amounts are consumed for domestic purposes and to create drilling mud. Pumping operations generally produce water as a by-product of oil and gas production. This process water is can be re-injected or discharged (with appropriate permits) depending upon circumstances. Water flooding operations are sometimes carried out on mature fields to increase production. In such cases, water wells can be drilled to provide flooding water. There are about 240 such wells in the Powder/Tongue and Northeast Wyoming River Basins combined (HKM, 2002).

Future water use by the oil and gas industry may increase if energy prices remain strong and provide an incentive for enhanced recovery in mature fields. The extent of the increase will depend upon the recovery technology adopted by producers for various fields. One process, called Alkaline Sulfacant Polymer (ASP) Enhancement, requires clean soft water for recovery process. If adopted widely, it could result in a need for new wells to produce clean water since by-product water is usually dirty (Kane, 2001). Alternatively, CBM byproduct water could be used in this process if it is available in the right quantity and quality.

Another enhanced recovery process uses CO2 to flood oil fields. Widespread adoption of this technology depends upon the construction of a CO2 pipeline into the Basin to reduce costs. If such a pipeline is built, CO2 recovery is expected to become the dominant enhanced recovery method (Kane, 2001). In that case, water use by the oil and gas industry would decrease. In any case, water use by the oil and gas industry is generally non-consumptive, is spread over a large geographic area, and does not impact either surface water resources or other groundwater users in the Basin. For these reasons, future requirements for this industry have not been quantified.

Coalbed Methane Production

Coalbed methane (CBM) production has become widespread in planning area over the past few years, and is expected to increase dramatically in the future. CBM development is not a consumptive user of water resources, but produces groundwater as a by-product of gas production. The process involves pumping water from coal seams to relieve pressure on methane gas so that it can be captured at the surface. The availability and disposal of CBM process water presents both problems and opportunities in the formulation of a water plan for the Basin.

Information obtained from the Wyoming Oil and Gas Conservation Commission indicates that as of April 2001, there were 3,141 CBM wells in the planning area, with a total water discharge of approximately 14,400 acre-feet annually (HKM, 2002). The vast majority of these wells (79 percent) are located in the Upper Powder and Little Powder sub-basins due to the proliferation of coal seams in those areas. Smaller numbers of wells are located in the Upper Tongue, Middle Power, Crazy Woman Creek, and Clear Creek sub-basins.

Projections of future CBM activity and water production in the Powder/Tongue River Basin are being prepared by the BLM for use in a forthcoming EIS, scheduled for release in late 2001 or early 2002 (Beels, 2001). The BLM has made a draft version of their projections available to the project team and the results are incorporated into this memorandum. These projections are presented with the caveat that they are preliminary and subject to revision prior to release of the draft EIS. If available, updated projections will be included in the final version of this memorandum.

The BLM's projected number of CBM production wells for the planning area is given in Figure 2. That figure shows that the number of production wells is expected to rise from about 3,200 in 2001 to a peak of almost 38,000 wells in the year 2010. There after, the number of wells is expected to decline gradually to a total of about 15,000 by the year 2019.

Projected water production for Northeastern Wyoming CBM wells is depicted in Figure 3 for the period from 2001 through 2020. That figure shows that produced water is expected to reach a peak of about 190,000 acre-feet annually by the year 2005. Production is expected to remain at that level for about five years, and then drop off to less than 25,000 acre-feet annually by the year 2019. The projected dramatic drop off in CBM production water after the year 2010 poses problems for the potential use of CBM production water for industrial purposes such as electric power generation. Most large industrial facilities have design lives of 35 to 50 years or longer, while the BLM projections show that large amounts of CBM will be available for only a relatively short period.

The rapid drop off in CBM production water over the planning horizon reflects the fact that wells typically produce large amounts of water initially to free gases from the coal seam, but that water production drops off as gas production increases. The BLM's assumptions concerning water production for a typical CBM well are that it will produce 500 barrels of water per day during the first year of operation, but that production will drop off rapidly to only nine barrels per day by year six. The BLM assumed an average 11-year production life for CBM wells, with no water production at all after year eight.

Figure 4 presents low, moderate, and high growth scenario projections for CBM water production in the planning area. These projections were generated by assuming that the level of uncertainty associated with the BLM projections can be captured by a range of plus or minus 30 percent. The results show that peak water production could fall in a range from about 140,000 to 250,000 acre-feet annually, but is expected to drop off dramatically during the period from 2010 to 2021.

COAL CONVERSION FACILITIES

Several companies have studied the possibility of building coal conversion facilities in the Campbell County over the past 20 years. There appear to be two rationales for such facilities. One rationale is the fact that coal contains a high percentage of water by weight, meaning that eliminating or reducing the water content of coal prior to shipment could mean substantial savings in transportation costs to out-of - state utilities and other users. The second rationale is that the vast coal reserves of the region could be used to produce synthetic versions of fuels such as gasoline if petroleum prices were to increase or government programs were in place to stimulate domestic energy production.

Since 1980, three such facilities have been issued construction permits by the Wyoming Industrial Siting Administration, although none have been built to date. The first facility to receive a siting permit was a coal-to-gasoline plant proposed by Hampshire Energy in the early 1980s. The facility would have utilized six million tons of coal annually to produce 1.5 million barrels of unleaded gasoline. It would have utilized approximately 5,000 acre-feet of water annually, from groundwater sources. According to the company's industrial siting application, a pipeline from Lake DeSmet was considered a source of plant water, but that the groundwater option was deemed preferable from both environmental and financial perspectives (Hampshire Energy, 1981). Project construction was deferred indefinitely when the U.S. Department of Energy abandoned a subsidy program designed to stimulate domestic energy production.

In the 1990s two companies received Industrial Siting Permits to build facilities that would convert coal to liquid and dry fuels with lower water content. One such facility would convert 12 million tons of coal annually to six million tons of briquettes for use as boiler fuel for power generation or other purposes. It would use about 1,000 acre-feet of groundwater annually (Fassett, 1997). Another facility would convert six million tons of coal annually to 1.5 million tons of coal-derived liquid (CDL) that could also be used as an industrial fuel. This facility would utilize about 1,200 acre-feet of groundwater annually (Planning

Figure 2
Projected Number of CBM Production Wells
Powder/Tongue River Basin

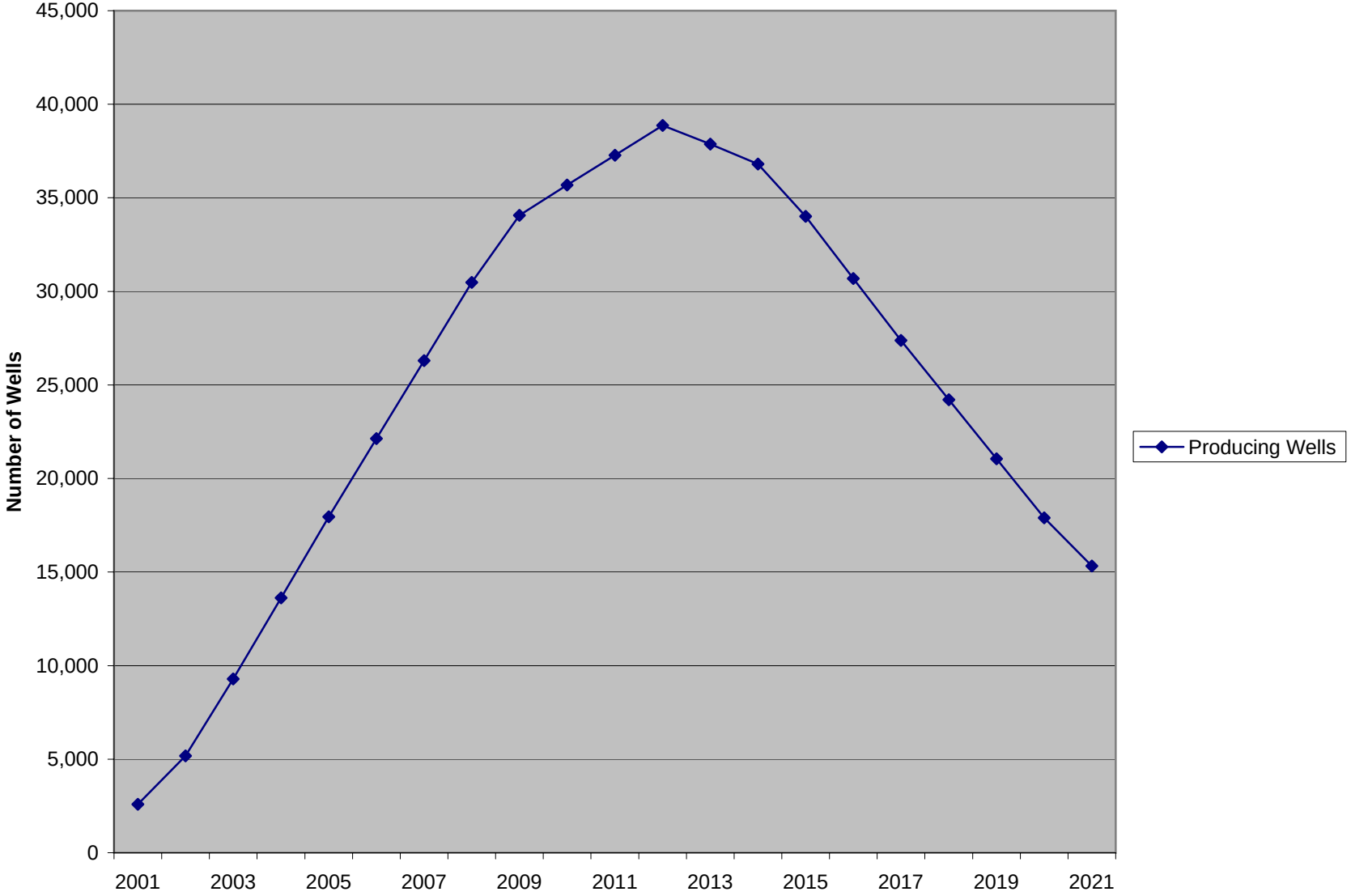


Figure 3
Projected Annual CBM Water Production
Powder/Tongue River Basin

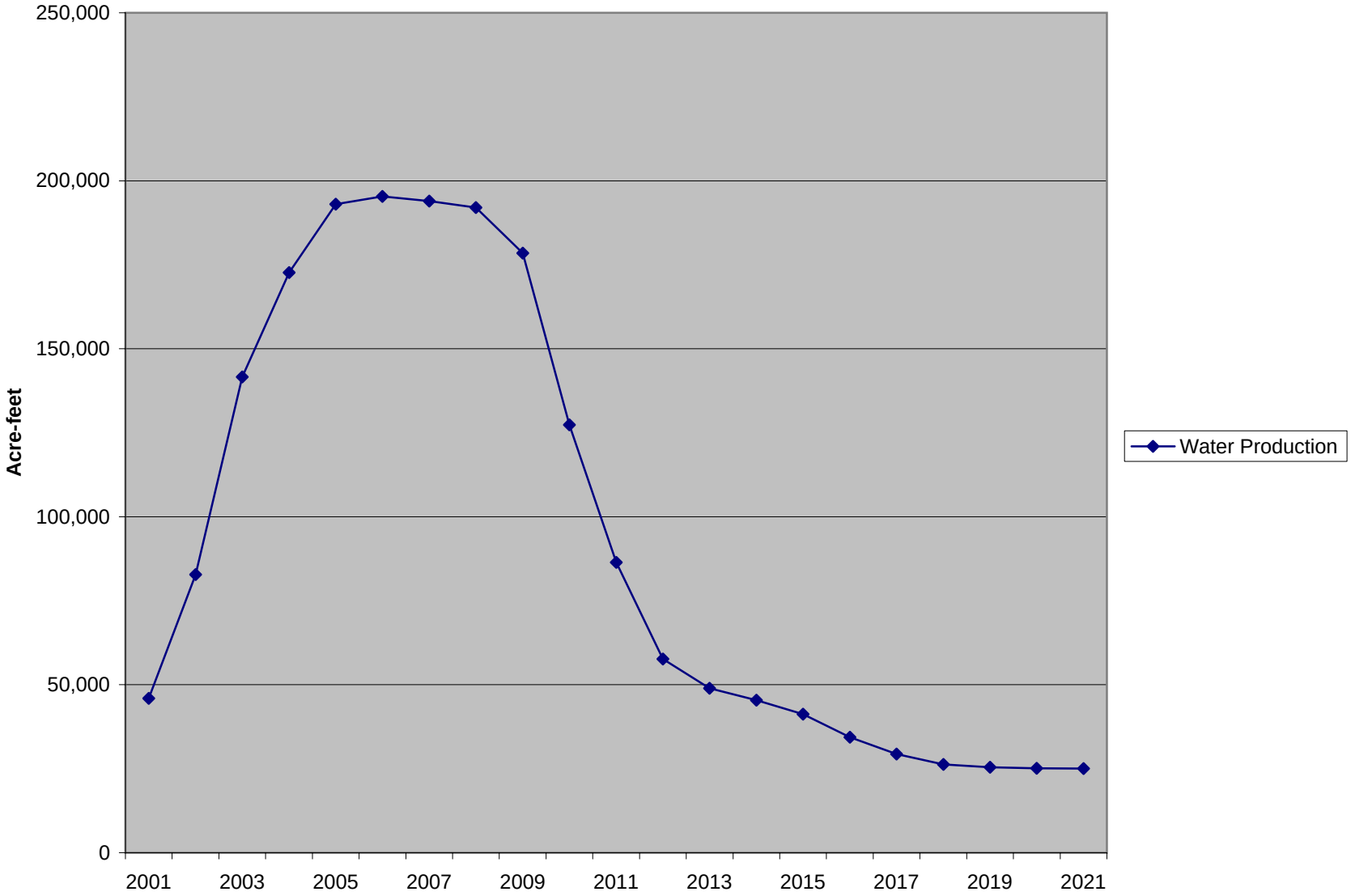
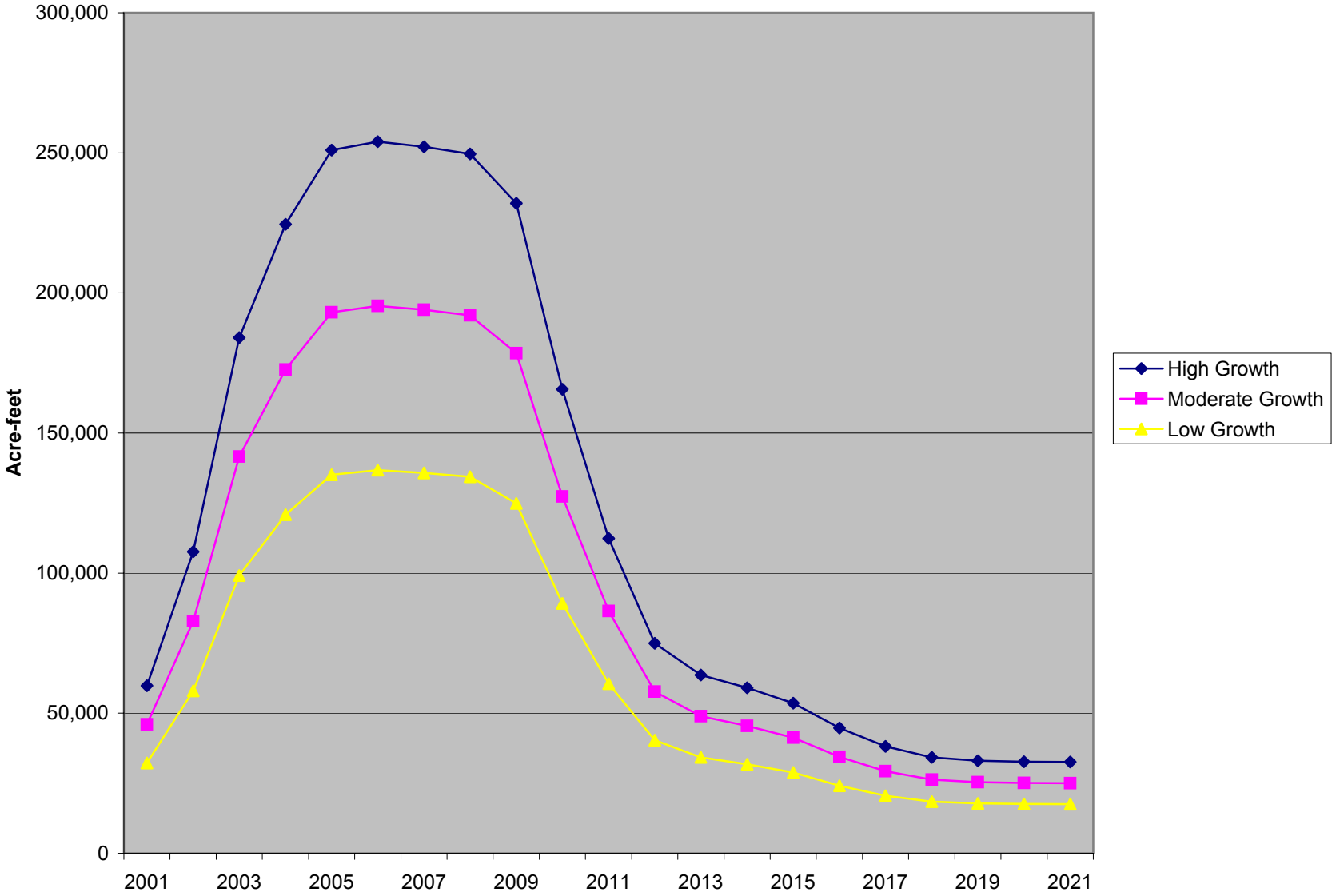


Figure 4
CBM Water Production Scenarios
Powder/Tongue River Basin



Information Corporation, 1994). Neither of these facilities has been constructed to date, possibly due to declining coal prices during much of the past decade.

If coal conversion facilities were constructed in Campbell County during the next 30 years, they would more likely be sited in the Belle Fourche River Basin than in the Powder River Basin because there are more active coalmines in the Belle Fourche Basin. Nevertheless, it is not improbable that some type of coal conversion facility might be sited in the Powder River Basin over the planning horizon of this study. One reason is that as energy related industrial activity increases in the Belle Fourche River Basin, some activity may be forced to other locations for air quality considerations. For that reason, the high growth scenario for industrial water use for the planning area assumes that one coal conversion facility designed to produce solid boiler fuel from coal will be constructed by the year 2030. The water requirements for such a facility would be approximately 1,000 acre-feet annually.

OTHER POTENTIAL FUTURE USES

The industrial water use projections described above focus on existing industrial uses or those that have been proposed but not implemented in the past. The potential for other water-intensive industries, not discussed above, to relocate to the planning area over the next 30 years also warrants discussion.

According to the U.S. Department of Commerce (1996), four industry groups in the United States account for over 95 percent of all industrial water use. Those industries are (1) electric power producers, (2) chemical and allied products manufacturers, (3) primary metals producers, and (4) paper and allied products manufacturers. Electric power producers alone account for over 80 percent of all industrial water use in this country each year. The other three industrial groups account for roughly 14 percent of all industrial water use.

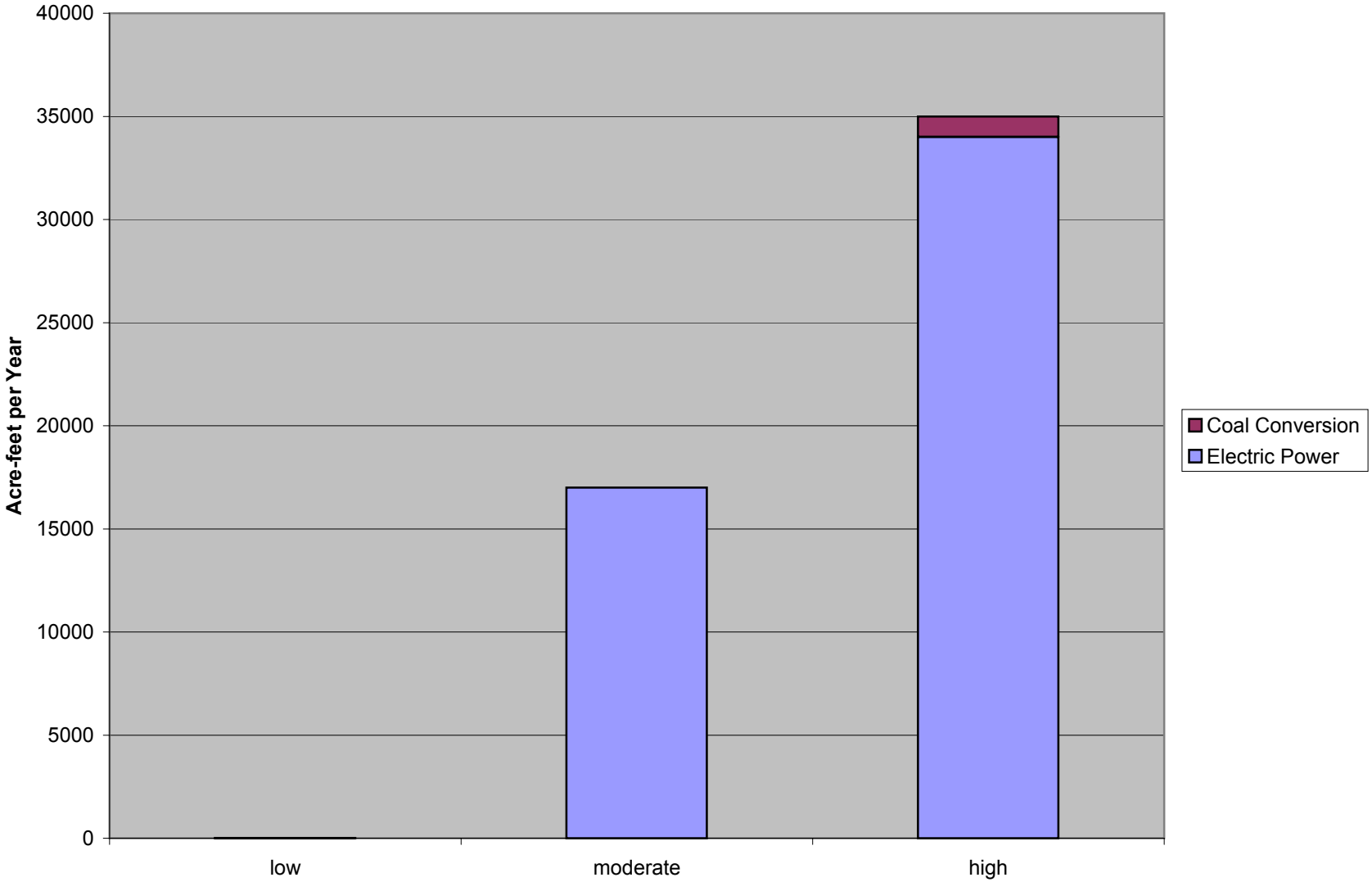
The industrial water users, electric power generators, are already represented in the Basin, and projections of their future water requirements are discussed above. The other three water intensive industries, chemicals, primary metals, and paper, tend to locate in areas close to their primary inputs. The fact that none have located in the Powder/Tongue River Basin in the past is an indication that commercially viable resources needed for their manufacturing operations are not present on a competitive basis compared to other regions of the country. Although this situation could change in the future as resources are exhausted elsewhere, such developments are not foreseeable at this time and therefore not discussed further in this memorandum.

SUMMARY OF FINDINGS

The largest demand for industrial water in the planning area over the next 30 years is expected to be associated with the construction of new coal-fired electric generating facilities. A smaller amount of water will be needed for facilities that convert coal to alternative fuels. The most likely source of water for such facilities is storage in Lake DeSmet. That storage is owned by the Lake DeSmet Energy Company and by the joint powers board that is now operating the reservoir on behalf of Campbell, Johnson, and Sheridan Counties.

Projections of total future industrial water use in the planning area are given in Figure 5. That figure shows that for the low growth scenario, no additional industrial water use is projected beyond the small (unquantified) amounts employed in coal mining and oil and gas activity. For the moderate growth scenario, a projected 17,000 acre-feet would be utilized annually for wet cooling of a 1000MW coal-fired electric generating facility. For the high growth scenario, 34,000 acre-feet annually would be used for power generation and an additional 1,000 acre-feet would be utilized in a coal conversion facility, bringing total water requirements to 35,000 acre-feet annually.

Figure 5
Total Industrial Water Demand Projections
Powder/Tongue River Basin
2030



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