

## Technical Memorandum 4.2

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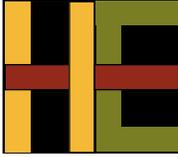
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## **MEMORANDUM**

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FROM: ED HARVEY, HARVEY ECONOMICS

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DATE: JUNE 10, 2005

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RE: PLATTE RIVER BASIN WATER PLAN  
TECHNICAL MEMORANDUM 4.2. PLATTE RIVER BASIN WATER DEMAND PROJECTIONS – FUTURE ECONOMIC AND DEMOGRAPHIC SCENARIOS

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PURPOSE: THE PLATTE RIVER BASIN PLAN IS A PLANNING TOOL DEVELOPED FOR THE WYOMING WATER DEVELOPMENT OFFICE. IT PRESENTS ESTIMATED CURRENT AND ESTIMATED FUTURE USES OF WATER IN WYOMING'S PLATTE RIVER BASIN. THE PLAN IS NOT USED TO DETERMINE COMPLIANCE WITH OR ADMINISTRATION OF STATE LAW, FEDERAL LAW, COURT DECREES, INTERSTATE COMPACTS, OR INTERSTATE AGREEMENTS.

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This memorandum describes economic and demographic projections for the Platte River Basin (Basin) under three alternative scenarios. The study team's economic and demographic projections for the Basin are addressed as follows:

- a description of the forecasting approach employed in this study, including a review of existing forecasts
- alternative scenario projections for each of the key economic sectors within the Basin, such as agriculture
- aggregate economic and demographic projections under each scenario incorporating the individual sector projections

Information summarized in this memorandum was gathered from publicly available secondary sources and from personal and telephone interviews conducted by Harvey Economics (HE) from November 2003 through March 2005. References are listed at the end of this memorandum.

This memorandum is one of three that comprise the water demand projections for the Basin. An overview of economic and demographic conditions in the Basin, and more specific description of current conditions in key economic and water use sectors, was provided in Memo 1. The third memorandum describes the future water demand projections, based upon the economic and demographic projections detailed in this memorandum.

## Approach

There are numerous approaches to developing economic and demographic projections for a regional economy, ranging from simple statistical extrapolation to sophisticated econometric modeling. The projection approaches vary in terms of complexity, the amount of information they convey, and the amount of data they require. The following paragraphs provide a description of existing economic and demographic projections for the Platte River Basin area and HE's assessment of the appropriateness of those projections for the purposes of this study.

Review of existing projections. HE reviewed a number of existing economic and demographic projections for potential suitable use in this study. These projections came from various sources, including:

- the Federal government – US Census Bureau
- Wyoming state government – Department of Administration and Information, Economic Analysis Division (WYEAD) projections
- local governments within the study area – county and municipal planning projections; and
- the private sector – Woods & Poole

Necessary characteristics for purposes of projecting Platte River Basin water demands include: a time horizon similar to (or longer than) the 30-year planning horizon for this study, recognition of basin-specific economic and demographic characteristics, and sufficiently detailed results to allow projection of specific types of water demand (such as agricultural use). The study team found that although each of the previously developed projections has merit for its intended uses, none was ideally suited in isolation to the purposes of this study.

Exhibit 1, below, provides a summary of the review of each economic and demographic projection found by HE to include the Platte River Basin.

Exhibit 1.  
Alternative Economic and Demographic Forecasting Techniques Potentially  
Applicable to the Platte River Basin

Source of Projection	Geographic Detail	Future Period	Variables Projected	Means of Application	Issues
US Census Bureau	State	2025	Population	Trend applied to state, adjusted to reach national total	Not sufficiently Basin specific
Wyoming EAD	State, counties	2020	Population, employment by sector	National model, step down to state and counties	Forecast period not long enough
City of Laramie/Albany County - The Laramie Plan	Albany County	2010	Population, employment by sector	State forecast adopted to county/city	Not full basin
Carbon County Land Use Plan	Carbon County	2015	Population	Detailed local trend analysis	Not full basin
Plan Cheyenne	Cheyenne Area	2030	Population	Percentage growth	Not full basin
Cheyenne Water Master Plan	Cheyenne Area	2052	Population	Percentage growth	Not full basin
Laramie County Comprehensive Plan	Laramie County	2020	Population	Percentage growth	Not full basin
Woods and Poole (private firm)	Counties	2020	Many economic/ demographic variables	National model step down to economic areas and counties	Not sufficiently basin specific

Source: Harvey Economics, 2005.

Economic base methodology. The economic and demographic projection approach adopted by the HE team for this effort employs an established technique in regional economics known as “economic base analysis.” The economic base approach is a "bottom-up" method that has the advantages of focusing directly on specific activities that are likely to drive economic and demographic changes in the future, while at the same time being less data intensive than econometric modeling approaches. Essentially, this approach involved the following five steps:

- 1) *Identify the existing and potential basic economic activities in the region through analysis of economic statistics and local interviews.* Basic activities are defined as businesses or governmental organizations that bring money into the region from sales of goods or services to outside areas or through transfers of public funds.
- 2) *Identify the current statistical relationships: a) between total employment in economic base activities and other employment in the economy (termed "local service employment"); and b) between total employment and population.* The latter relationship reflects the proportion of the population that is of working age, the labor force participation rate amongst the working age population and the unemployment rate plus in-commuting or out-commuting from the area.
- 3) *Conduct industry studies for each of the basic economic sectors to identify trends in employment and production and factors affecting potential future growth of those sectors.*

These studies entailed research and analysis of available industry data and local interviews. HE also assessed the likelihood of emergence of new basic economic activities in the region in this step.

- 4) *Develop specific projections of future basic economic activity levels.* These were based upon the results of step 3 and clearly defined scenario assumptions.
- 5) *Develop overall employment and population projections built upon the basic activity projections developed in step 4 and the statistical relationships developed in step 2.* HE also considers potential changes in these statistical relationships in the future in this step.

Overview of planning scenarios. HE developed three alternative planning scenarios for this study, employing a modified version of the economic base forecasting approach just described that incorporated insights on overall regional growth patterns from local planning officials and industry representatives from across the Basin. An overview of each of these scenarios is provided below. More specific details about the assumptions for the key economic sectors in the Basin and the local insights on regional growth are provided following this overview.

**High scenario.** In the simplest terms, the High Scenario incorporates HE's views of the most growth in each of the key sectors and in the region that could potentially occur over the forecast horizon. It is possible that one or more of the key sectors could grow even more than we have assumed under this case, or an unforeseen, new basic economic activity could establish itself and flourish in the region. However, it is also possible that other sectors will not develop to the maximum and so the growth in aggregate employment and population that drives future water demand will be somewhat moderated if one sector expands beyond the bounds we foresee. Therefore, the study team felt that the underlying aggressive assumption that each of the key sectors will achieve its highest reasonably likely growth at the same time makes this scenario a useful upper bound for subsequent water planning purposes.

**Low scenario.** The Low Scenario embodies the study team's views of the lowest simultaneous growth (or largest contraction) reasonably likely to occur in each of the key sectors and in the region over the planning horizon. While even lower economic activity levels in one or more sectors are not impossible, again, the study team felt that the assumption of simultaneous low activity levels in each of the key sectors, though somewhat artificial, made this scenario a supportable lower bound for planning purposes. While the Low Scenario obviously will not impose pressure on regional water resources, this scenario is sometimes used for purposes of determining the financial risk involved with potential water resource enhancements.

**Mid scenario.** The Mid Scenario represents the study team's views of the most realistic level of growth likely to occur in each of the key sectors and in the region over the planning horizon. As in the other two scenarios, the potential interaction between the economic sectors and the wider economy is acknowledged. Although the actual economic growth experienced in the Basin may vary somewhat from this projection, the assumed activity levels represent, in the study team's best judgment, the rate of growth most likely to be experienced in the Basin. As such, this scenario is perhaps the most useful for water planning purposes.

## Economic Base Scenario Assumptions for Key Sectors – Agriculture

Local interviews and research into both historic agricultural practices and competing environmental and recreational interests provide insight into potential factors that may influence the future of agriculture in the Platte River Basin. The factor that will most likely have the largest potential impact on the economic prospects for Basin agriculture is the demand for and price of beef. Other potential factors that may significantly impact agriculture within the Basin include changes in public land grazing policies, second home and subdivision development, the aging of the ranching population, and management of cattle range with stockwater supplies. The following are summary observations about prospects for Platte River Basin agriculture over the next thirty years.

History and potential future constraints. The agricultural sector historically has been an important component of the economy in the Basin; however, its relative share of the local economy in terms of employment, sales and income is and will continue to be small. Agricultural operators within the Basin constantly face difficult margins on production, vulnerability to natural cycles such as drought and the pressures of urbanizing areas around the larger cities of Cheyenne, Laramie and Casper. While such pressures are likely to prevent the Basin's agricultural sector from expanding significantly in the near future, the sector is also unlikely to disappear. The continued existence of agricultural enterprises within the Basin is vital to maintaining the rural character of the region and to underpinning the Basin as a productive place in which to live and work.

Local Insights. Interviews with local agricultural representatives indicate that while little has changed in the Basin's agricultural practices over the past 30 years, some ranchers have pursued and continue to pursue more efficient livestock, range and irrigation management techniques. While range and irrigated acreage and numbers of cattle have remained fairly constant within a fluctuating range over the years, calf weaning weights have increased as cow weights have generally decreased, through hybrid breeding, indicating that ranchers today can produce more beef on the same amount of range and irrigated cropland than they could 30 years ago (Mount, 2005). It is possible that this phenomenon, over time, might cause a small but steady decline in irrigated acreage and cattle numbers into the future (Stumbough, 2005).

As discussed in detail in Memo 1, livestock across the basin comprises primarily cattle; in 2004, there were roughly six times as many cattle as sheep, and horses' numbers were marginal (Wyoming Agricultural Statistics Service). Sheep numbers have steadily declined from the 1970s with falling wool prices, while cattle numbers dropped in the early 1980s but rebounded to higher 1970s levels in the late 1990s. Cattle numbers over the longrun in the Basin have remained steady, after oscillations, at about 650,000 head, though they are down to 575,000 in 2005 with the persistent drought.

The relationship between cattle and irrigated acres is complex. The growing of feed (grass, hay and corn) for local livestock is still the primary driving force behind irrigated agriculture within the Basin. Numbers of livestock and irrigated acres are not closely correlated, however. Irrigated acreage has remained fairly steady from the late 1970s through 2002; the

only significant drop was into 2002 as the drought worsened (TriHydro Corporation, 2005). Further, local sources in the Basin indicate that almost all irrigable land in the Basin is currently being irrigated, though with adequate water, up to 5 or 10 percent more land could potentially be productively irrigated, at maximum. The statistics indicate that cattle production follows more closely beef prices and demand, and irrigated acreage seems to hold steady regardless of cattle numbers, except in severe drought when both fall. In normal years, the Basin fully consumes the hay and crops it produces, except barley that it exports to outside markets (Stumbough, 2005). Cattle from other areas, like Texas, consume some of these crops when they graze in the Basin during the summer (Moline, Henderson, 2005).

According to local agricultural sources, public lands grazing does not play as large a role in this basin as it does in other parts of Wyoming. Public lands contribute significantly to cattle production in the upper reaches of the basin in Carbon, Natrona, Albany and Converse counties, but they play almost no role in the downstream counties of Platte, Goshen and Laramie. Public lands grazing policies in this basin have not changed dramatically over the years, and no major changes are anticipated for the foreseeable future.

Local sources in most of the Basin counties commented on the aging of ranchers and the selling of ranches to corporations or to smaller landowners for subdivision or hobby ranching. This change, which is most pronounced near the urban areas of Laramie, Cheyenne and Casper, can often mean lower productivity, as small landowners run fewer animals with less land, and corporations run fewer animals to ease environmental concerns and because profit maximization is not vital, as it is to the traditional rancher. Conversely, the transfer of ranches into new hands can mean more water use as new landowners more intensively manage their smaller plots.

Scenario approach. HE projected a high, low and mid scenario for livestock, irrigated acreage and crop mix in the Platte River Basin based on historic trends and assumptions about public lands grazing policies, beef productivity and prices and demand, wool and lamb prices, and subdivision and consolidation of ranches. HE's analysis of agricultural sector water use is based on Wyoming agricultural statistics and information from interviews with local agricultural experts in each Basin county. To standardize the analysis in terms of livestock forage levels, county level livestock inventories were converted to "animal units" by dividing estimated cattle inventories by two and sheep inventories by five for water use purposes.

HE performed basic trend and cycle analysis on total irrigated acreage and head of cattle and sheep as a test of sorts against input from local agricultural experts. Using trend analysis on various historical data series stretching as far back as 1975, and based on input from local sources, HE then projected total head of cattle and sheep from 2005 to the end of the planning horizon (2035). This analysis revealed that if trends and cycles in irrigated acreage from 1975 through 2002 continued through 2035, irrigated acreage might increase by as much as 50 percent. Similarly, if trends in the numbers of head of cattle in the Basin from 1975 through 2004 continued through 2035, analysis suggested that cattle numbers might increase by as much as 25 percent. If trends in the numbers of head of sheep in the Basin from 1975 through 2004 continued through 2035, however, analysis suggested that sheep

numbers might continue to decrease by as much as 95 percent. This analysis challenges the insights of local agricultural experts to a great extent, and HE deferred to local expertise over historical trend and cycle analysis in the scenarios.

Interviews with local agricultural personnel indicated only a loose correlation between stocking levels and irrigated pasture, hay and crop acreage. Basin counties are near their maximum level of productive irrigated acreages, and the economics of agriculture in the basin would have to change significantly at this point to justify the large investment required to irrigate additional acres. If prices justify raising more cattle in the Basin, the practice has been to maximize irrigated agricultural production and use of range and then to limit additional cattle from outside the Basin allowed to graze local lands. Two key assumptions for HE's analysis are: 1) irrigated land in the Basin will remain roughly constant unless local agricultural experts thought otherwise given different scenarios; and 2) producers in the Basin likely would not be able to meet the feed and forage needs of more than historically high numbers of cattle in the Basin, roughly 650,000 head, without limiting outside cattle from grazing in the Basin. The resulting trends are then applied to GIS-estimated 2002 irrigated acreage levels for the Basin (TriHydro Corporation) to project changes in irrigated acreage over the planning horizon under each planning scenario.

Data collected by the study team indicate that ranchers across the Basin grow crops other than hay, primarily corn, sugarbeets, dry beans, barley and winter wheat, but primarily in the counties further downstream and lower in elevation (TriHydro Corporation). Crop acreage other than hay is minimal in the Above Pathfinder Dam and Upper Laramie subbasins. Based on interviews with local agricultural experts, HE assumed these crops are consumed within the Basin for livestock feed or for the ethanol and sugar processing facilities in Torrington, with the exception of barley sent to the Coors beer production facility in northern Colorado (Tatman, 2005). Alfalfa and grass hay do move around the Basin between counties, but that movement does not affect overall Basin analysis.

High scenario. The High Scenario for livestock production reflects what the study team feels are the most optimistic stocking assumptions given production of feed from irrigated lands and arid rangelands and strong demand and prices for beef, wool and lamb. Other positive influences on agriculture in the High Scenario might be slower urban development and subdivision or consolidation of ranches; investment in stockwater developments to increase range productivity; steady prices for inputs like fertilizer; and fewer cattle from outside areas grazing in the Basin as Basin cattle inventories rise. Local agricultural representatives generally indicated that in the High Scenario, sheep inventories would remain constant across the basin while cattle inventories would remain steady or rise, potentially to historic highs. HE assumed that historic highs in cattle inventories in each county represented the highest case realistic scenario for livestock production in the Basin by 2035. By the end of the planning horizon, HE projects roughly 710,000 head of cattle and 106,900 head of sheep within the Platte River Basin, up from 587,000 and 106,000 head of cattle and sheep, respectively, in 2005.

Under the High Scenario, irrigated acreage in the Basin will increase from current levels by roughly 6 percent, from 613,000 acres to 649,000 acres, and the crop mix is projected to

remain similar to current conditions, with roughly 80 percent of irrigated acreage planted in alfalfa, other hays and pasture. Under this scenario, ranchers bring into irrigated production some marginal lands that under normal economic conditions may not be economically viable to cultivate, given low returns on investment. HE assumed that the investment in irrigation techniques already in place indicates that the use of flood versus pivot irrigation and surface versus groundwater will remain consistent under all scenarios.

Low scenario. The Low Scenario for livestock production reflects what the study team feels are the most pessimistic stocking assumptions for the Basin, given production of feed from irrigated lands and arid rangelands and weak demand and prices for beef, wool and lamb. Other negative influences on agriculture assumed under the Low Scenario are faster urban development and subdivision or consolidation of ranches; no investments in stockwater developments to increase range productivity; rising prices for inputs like fertilizer; and larger numbers of outside cattle grazing local lands as ranchers seek additional income. Local agricultural representatives generally indicated that in the Low Scenario, sheep inventories would continue to fall at historic rates across the basin while cattle inventories would remain steady or fall, potentially to historic lows. HE generally assumed that historic lows in cattle inventories in each county represented the lowest case realistic scenario for livestock production in the Basin by 2035. By the end of this planning horizon, HE projects roughly 514,000 head of cattle and 40,000 head of sheep within the Platte River Basin, down from 575,000 and 106,000 head of cattle and sheep, respectively, in 2005.

Under the Low Scenario, irrigated acreage will decrease by just 2 percent from current levels, from 613,000 acres to 602,000 acres. The statistics on livestock and irrigated acreage suggest that when economic conditions deteriorate in the Basin, ranchers respond with changes in livestock herds and not as much with changes in irrigated acreage patterns. Regardless of how many cattle ranchers run, those animals need feed, which justifies keeping most irrigated acreage under irrigation even in poor economic conditions. HE assumed that under all scenarios, levels of irrigated acreage do not change much into the future. Under this Low Scenario, the crop mix is anticipated to remain unchanged with roughly 80 percent of irrigated acreage planted in alfalfa, other hays and pasture.

Mid scenario. The Mid Scenario for livestock production reflects what the study team feels are the most realistic stocking assumptions for lands in the Basin, given production of feed from irrigated lands and arid rangelands and steady demand and prices for beef, wool and lamb. Other Mid Scenario assumptions for agriculture in the Basin are moderate urban development and subdivision or consolidation of ranches; steady investment in stockwater developments to increase range productivity; and stable prices for inputs like fertilizer. Local agricultural representatives generally indicated that in the Mid Scenario, sheep inventories would hold steady across the basin while cattle inventories would remain steady or increase slowly to more average inventories, up from the drought lows of 2004. HE generally assumed that roughly average cattle inventories in each county represented the most likely scenario for livestock production in the Basin by 2035. By the end of the planning horizon, HE projects roughly 620,000 head of cattle and 106,900 head of sheep within the Platte River Basin, up from the drought depressed figures of 579,000 head and 107,000 head of cattle and sheep, respectively, in 2005.

Under the Mid Scenario, irrigated acreage will decline by just 1,000 acres by 2035, from 613,000 acres to 612,000 acres. This decline reflects local agricultural experts' beliefs that under normal conditions, most irrigated acreage will remain in production, but some acreage will be lost to ranch sales to large corporations or to developers in the more urban areas around Cheyenne, Laramie and Casper. Ranchers will makeup some of those losses by bringing additional acreage under irrigation, resulting in a net loss of only 1,000 acres of irrigated land over the next 30 years. Crop mix is expected to remain unchanged with most irrigated acreage planted in alfalfa, other hays and pasture.

Exhibit 2 presents HE's projections for cattle and sheep numbers and irrigated acreage by crop type in the Basin for 2035 under the High, Low and Mid Scenarios.

Exhibit 2.

Current and Projected Cattle, Sheep and Irrigated Acres by Crop Type, Platte River Basin, by Scenario

	Current (2005)	Projected (2035)		
		Low	Mid	High
<b>Crops - Acres</b>				
Alfalfa	137,000	133,000	136,000	143,000
Other hay	203,000	201,000	203,000	216,000
Irrigated pasture	164,000	162,000	164,000	176,000
Corn	43,000	42,000	43,000	45,000
Sugar beets	21,000	20,000	21,000	22,000
Dry beans	19,000	19,000	19,000	20,000
Oats	7,000	7,000	7,000	8,000
Barley	10,000	10,000	10,000	10,000
Winter wheat	8,000	7,000	8,000	8,000
Spring wheat	1,000	1,000	1,000	1,000
<b>Total Crops - Acres</b>	<b>613,000</b>	<b>602,000</b>	<b>612,000</b>	<b>649,000</b>
<b>Livestock - Head</b>				
Cattle	579,000	514,000	620,000	710,000
Sheep	106,900	40,000	106,900	106,900
<b>Total Livestock - Head</b>	<b>685,900</b>	<b>554,000</b>	<b>726,900</b>	<b>816,900</b>

Source: Current irrigated acreage levels from TriHydro Corporation. Projections made by Harvey Economics based on historic trends and interviews with local agricultural representatives (Heald, Henderson, Moline, Mount, Ryan, Stumbough, Tatman), 2005.

These same data in a more summary form by subbasin are presented in Exhibits 3 and 4.

Exhibit 3.

Current and Projected Irrigated Acres by Subbasin, by Scenario

Subbasin	Current (2005)	Projected (2035)		
		Low	Mid	High
Above Pathfinder	150,000	150,000	150,000	152,000
Pathfinder to Guernsey	90,000	86,000	89,000	94,000
Guernsey to State Line	85,000	84,000	85,000	94,000
Upper Laramie	92,000	92,000	92,000	110,000
Lower Laramie	92,000	90,000	92,000	95,000
Horse Creek	58,000	56,000	58,000	58,000
South Platte	46,000	45,000	46,000	46,000
<b>Total Basin Irrigated Acreage</b>	<b>613,000</b>	<b>603,000</b>	<b>612,000</b>	<b>649,000</b>

Source: Current irrigated acreage levels from TriHydro Corporation. Projections made by Harvey Economics based on historic trends and interviews with local agricultural representatives (Heald, Henderson, Moline, Mount, Ryan, Stumbough, Tatman), 2005.

Exhibit 4.

Current and Projected Livestock by Subbasin, by Scenario

Subbasin	Current (2005)	Projected (2035)		
		Low	Mid	High
Above Pathfinder	117,000	91,000	134,000	151,000
Pathfinder to Guernsey	215,000	153,000	225,000	246,000
Guernsey to State Line	77,000	72,000	77,000	91,000
Upper Laramie	53,000	43,000	62,000	70,000
Lower Laramie	111,000	101,000	114,000	122,000
Horse Creek	57,000	50,000	57,000	68,000
South Platte	56,000	44,000	58,000	69,000
<b>Total Basin Irrigated Acreage</b>	<b>686,000</b>	<b>554,000</b>	<b>727,000</b>	<b>817,000</b>

Source: Projections made by Harvey Economics based on historic trends and interviews with local agricultural representatives (Heald, Henderson, Moline, Mount, Ryan, Stumbough, Tatman), 2005.

Future agricultural employment. Future agricultural employment is projected using the key assumption that agricultural employment will change in proportion to the projected change in irrigated acreage within the Basin. Under the High Scenario, the number of farm jobs within the Basin would increase moderately, by about 6 percent. Under the Low Scenario, there would be a decline in total agricultural employment proportional to the projected 2 percent decline in irrigated acreage within the basin by 2035. Similarly, under the

Mid Scenario, total agricultural employment would decrease marginally, by less than 1 percent, by the end of the planning horizon.

## Economic Base Scenario Assumptions for Key Sectors – Tourism and Recreation

The tourism and recreation sector does not play a large role within the economy of the Platte River Basin, but it is important to note the extent to which it contributes to sales, income and employment in the Basin's two largest sectors – retail trade and services. As tourism and recreation contribute to providing jobs and income for the region, the effects on economic and population projections are captured in the municipal and rural domestic projections discussed later in this memo and in Memo 3. More importantly, tourism and recreation create notable consumptive and nonconsumptive demands on water in the basin for golfing, alpine skiing, angling, boating, swimming, waterskiing and enjoyment of water amenities such as creeks, rivers, reservoirs and the scenery and habitats that accompany them.

Based on extensive interviews with government officials, HE assumes that local, state and Federal agencies will continue to develop and maintain recreational amenities across the Basin to take advantage of water resources. No new reservoirs or other large water-based recreational facilities are on the planning horizon at this time (Lawson and Myler, Thibodeau, 2005). However, water-based recreation activities do appear to be on the rise in some sectors, including guided angling (Van Rensselear, 2005).

HE specifically projected growth in two recreational sectors, alpine skiing and golfing. These two sectors consumptively use water across the subbasins, and growth assumptions are important for water demand projections.

Golf. TriHydro inventoried 19 golf courses currently operating in the Platte River Basin. These courses comprise more than 260 holes over 1,850 irrigated acres. HE projected high, low and mid scenarios for golf development based on interviews with local planners and other representatives.

In the High Scenario, HE assumed that all courses newly developed in 2005 and any planned or proposed courses or expansions in each subbasin will be built and irrigated at similar acreage rates as other courses in that subbasin. In the Above Pathfinder Dam subbasin, a new 18-hole course will begin operation in Rawlins in summer 2005 with 95 irrigated acres using surface water from a raw water pipeline (Florquist, 2005). In the Pathfinder to Guernsey subbasin, a new 18-hole course will begin operation in Casper in summer 2005 with 175 irrigated acres using surface water (Kraft, 2005). HE also projects in the High Scenario in the Pathfinder to Guernsey subbasin that the Trail Ruts golf course in Guernsey will expand from 9 to 18 holes over the next thirty years, adding 30 new irrigated acres on groundwater. No new courses or expansions are anticipated in the Guernsey to State Line or Upper Laramie subbasins. In the Lower Laramie subbasin, HE projects in the High Scenario that the Wheatland Golf Club will expand from 9 to 18 holes, adding 95 irrigated acres on surface water. There are no courses in the Horse Creek subbasin. In the South Platte subbasin, HE projects that the Prairie View Golf Course will expand from 9 to 18 holes, adding 70 new irrigated acres on surface water. HE also projects that the Cheyenne area will add two new

golf course communities with 36 total holes of golf and 300 new irrigated acres on surface water (Ashby, Matsen and Mason, 2005).

In the Low Scenario, HE projected that no new courses or expansions are built in any of the subbasins and that all current operations continue.

In the Mid Scenario, HE forecasted that the two new courses scheduled for operation in 2005 will begin using water and that no other courses or expansions will be built in the next thirty years.

Skiing. There are two alpine ski areas that consumptively use water to make snow in the Platte River Basin. Hogadon Basin near Casper in the Pathfinder to Guernsey subbasin has surface water rights to make snow and has no plans for expanding its snowmaking capabilities into the future. The volume of water that it diverts and uses consumptively for snowmaking depends mostly on the amount of natural precipitate snow received each winter (Wenger, 2005). HE projects that this ski area will have a constant demand for water under all scenarios, as the area's customer base is local and is not predicted to vary much under different economic conditions.

HE was unable to contact the Snowy Range ski area near Laramie in the Upper Laramie subbasin. HE assumed that this ski area's situation is similar to that of Hogadon in that its water use will be fairly constant into the future due to a very local visitor base that should not vary much under different economic conditions. Water demands will be driven by precipitation received each year.

## Economic Base Scenario Assumptions for Key Sectors – Power Generation

Electric power generation, whether hydropower or fossil fuel driven, is a large consumer of water. Hydropower uses water nonconsumptively, whereas fossil fuel powerplants that are water cooled tend to consumptively use a large amount of water and an even larger amount of diverted water. The Platte River Basin is home to several wind turbines, six hydropower facilities operated by the US Bureau of Reclamation (USBR) and two coal-fired generating plants operated by private companies.

HE developed its High, Low and Mid Scenarios for power generation through interviews with the operating entities of existing plants and through interviews with local planning and economic development representatives. Interviews with Pacificorp that runs the Dave Johnston coal fired powerplant in the Pathfinder to Guernsey subbasin and with the Basin Electric Cooperative that runs the coal fired Laramie River Station in the Lower Laramie subbasin revealed no expansion plans in the foreseeable future at either plant (Dugan, Woolsey, 2005). HE held production and water use at these plants constant in all scenarios.

Discussions with USBR revealed no plans in the foreseeable future for expanded or new hydropower facilities in the basin. Since hydropower generation schedules are subordinate to agricultural and other uses, public sector hydropower production is not a driving factor of

water use patterns (Lawson and Myler, 2005). No private sector hydrogeneration is anticipated at this time.

Finally, interviews with local planning officials indicated that two new fossil fuel powerplants are in the planning stages. One will be a natural gas fired plant between Glenrock and Douglas in the Pathfinder to Guernsey subbasin, sized for a capacity of 1,000 megawatts (MW) of power (Schroeder, 2005). This plant will require about 10,000 acre-feet of water consumptively each year. The second plant will be a coal conversion facility producing 300 to 500 megawatts of electricity and more than 9 million barrels of diesel fuel per day. The plant will consume up to 10 million tons of coal each year and will consumptively use roughly 15,000 acre-feet of water each year (Werner, Loomis, Grabow and Kilgore, 2005). Each plant will employ roughly 300 individuals. HE's High Scenario assumes the construction of both of these new plants, providing 600 new jobs. The Low Scenario assumes neither plant is constructed, and the Mid Scenario assumes that the natural gas fired powerplant in the Pathfinder to Guernsey subbasin is built, providing 300 new jobs.

### Economic Base Scenario Assumptions for Key Sectors – Mining and Mine Reclamation

One uranium company with two mines continues to operate in the Pathfinder to Guernsey subbasin. One coal mine in the Above Pathfinder Dam still operates in the Platte River Basin but will soon close. All other mining activity is in reclamation as of 2005 (TriHydro).

In the High Scenario, HE projects that the Jackpot Mines will reopen in the Above Pathfinder Dam subbasin due to high uranium prices and will produce at the same level as the combined production of the two existing mines, employing 50 people. In the High Scenario, HE forecasts one new surface coal mine in the Above Pathfinder Dam subbasin near the town of Hanna, mainly to serve the production needs of the new coal gasification plant. To meet the plant's needs, this mine must produce 6 million tons or more of coal each year, which is twice what the two mines in the Hanna area produced in earlier years. Under the high scenario, the sole existing coal mine will close in 2005.

In the Low Scenario, the uranium operation in the Pathfinder to Guernsey subbasin will continue to operate with no additional activity in the Basin. The same situation is projected for the Mid Scenario for uranium mining. In the Low Scenario, all coal production ceases in 2005, and no new mines are opened. In the Mid Scenario, coal production ceases by 2006, and reclamation of mines is the only activity in the sector. No new mines are opened, and employment remains flat through 2035. Reclamation water use is minimal.

### Economic Base Scenario Assumptions for Key Sectors – Oil Refining, Exploration, Production and Reclamation

HE consulted with the companies that operate the three oil refineries in the Platte River Basin, one in Sinclair in the Above Pathfinder Dam subbasin, one in Casper in the Pathfinder to Guernsey subbasin and one in Cheyenne in the South Platte subbasin. Interviews with company representatives and industry experts indicated that refining will not expand in the basin because of government regulation, and production should remain fairly constant given current and expected oil prices (Likwartz, Robitaille, Fritz, Wohgnant, 2005). HE assumed

under all scenarios that production in oil refining in the Platte River Basin will remain constant over the planning horizon; water use will remain constant, as well, commensurate with production. Employment in refining is forecasted to remain steady.

As for exploration, production and reclamation of oil in the basin, the trends have been downward for 19 years, and there is little reason to expect a change in that trend. Much of oil production in the basin is in the secondary production phase using hot water injection to extract more oil, but production and water use should continue to decline. Production may flatten for several years with extensive tertiary production using carbon dioxide injection, but no water use is involved in that process, so water use for oil production should decline steadily under all scenarios (Likwartz, Robitaille, DeBruin, 2005).

Under the High Scenario, HE assumed that oil production steadies in the basin for five years followed by declines consistent with historic rates, but water use declines steadily at historic rates of production. Under the Low Scenario, oil production and water use decline at twice the historic rate across the basin. Under the Mid Scenario, oil production and water use decline at historic rates with no steadying for tertiary production.

### Economic Base Scenario Assumptions for Key Sectors – Natural Gas and Coalbed Methane Exploration and Production

Natural gas and coalbed methane development use little water in exploration and production, and coalbed methane, which usually produces water in other areas, may not produce any releasable water in the Platte River Basin, as it would come from so deep as to be of questionable quality. Reinjection may be required. There is also great uncertainty whether coalbed methane development is possible at all within the actual borders of the Platte River Basin (Robitaille, Likwartz, DeBruin, 2005). Located just outside the Platte River Basin, the potential for additional natural gas and coalbed methane development in the Powder River Basin just north of Casper and in the Great Divide Basin southwest of Rawlins could be a potentially powerful economic driver within the Platte River Basin, however, and warrants further discussion.

The US Bureau of Land Management estimates that coalbed methane development in the Great Divide Basin could generate up to 3,300 jobs across a wide area. HE adopted an optimistic assumption of 1,000 of those jobs captured in the Rawlins area over the next thirty years under the High Scenario. Under the Low Scenario, none of those jobs would be captured in the basin as coalbed methane development fails to meet expectations. Under the Mid Scenario, HE assumed that half, or 500, of those new jobs will be captured in the Rawlins area within the basin. No significant employment is expected to be captured by coalbed methane development in the Powder River Basin, as most employment locates in Gillette.

Experts anticipate that natural gas production across the basin and state will continue to increase, as it has for 19 years. Declines in oil and gas production are anticipated in Albany, Converse, Goshen, Laramie and Platte Counties, however. In sum, the Platte River Basin is simply not as rich in minerals as other river basins in Wyoming.

## Economic Base Scenario Assumptions for Key Sectors – Aggregates, Cement, Gravel and Road Construction

The Basin's largest water users in the aggregates, cement and gravel sectors are the JTL Group in the Pathfinder to Guernsey subbasin, the Mountain Cement Company and LaFarge Group in the Upper Laramie subbasin, Platte County Concrete and Stone in the Lower Laramie subbasin, and Martin Marietta Materials, EG Sanders and Read Ready Mix in the South Platte subbasin. In the road construction sector, the only large water user is the Board of Albany County Commissioners that uses water in several different subbasins (TriHydro).

HE interviewed the JTL Group and Platte County Concrete and Stone (Aldrich, Hollingsworth, 2005). These two interviews suggested that no new production or water use is expected, even under favorable conditions in a High Scenario. HE projects that production and water use in the aggregates, cement, gravel and road construction sectors would remain constant across all scenarios.

## Economic Base Scenario Assumptions for Key Sectors – Miscellaneous Industry

Miscellaneous industrial water use was generally unverifiable in the Platte River Basin, and TriHydro relied upon State Engineer records of water rights appropriated for industrial uses. In these unverifiable cases, HE projected constant production, employment and water use across all scenarios. Three industrial water users in the miscellaneous category had verifiable water use, and HE contacted all three to discuss future production and water use.

The Western Sugar Cooperative in Torrington in the Guernsey to State Line subbasin produces refined sugar from sugar beets and uses water from an artesian well and two pumps from the North Platte River. An interview with the company revealed that in a High Scenario, production at the plant would increase slowly with increased sugar beet harvests and high demand for sugar; water use would commensurately increase slowly over time. HE assumed a 10 percent increase in production and water use. Under a Low Scenario, the company expected production might slowly decline with decreased beet harvests, and water use would also slowly decline (Boll and Cummings, 2005); HE assumed a 10 percent decline in production and water use. In the Mid Scenario, the company expects production and water use to remain fairly constant over the planning horizon; HE assumed steady production and water use.

Wyoming Ethanol in Torrington within the Guernsey to State Line subbasin produces ethanol from corn, and water use at the plant is fairly independent of production levels. As of 2005, the company is exploring the possibility of doubling production capacity, but water usage would not increase with such an expansion. The company predicted steady water use patterns across all scenarios, and HE adopted those assumptions. In the High Scenario, production will double while water use remains constant. Under the Low Scenario, production decreases 10 percent, but water use remains steady. Under the Mid Scenario, production and water use hold constant (Newman, 2005).

Finally, Dyno Nobel operates an ammonium nitrate plant in Cheyenne in the South Platte subbasin to produce chemicals primarily for explosives. The plant's production and water use

are currently down from 2003 levels due to a partial plant closing that will not be reopened. To increase production or water use, the company would have to add a new production unit, which may happen in 2010 or later (Cabot, 2005). In the High Scenario, HE assumed an expansion of production and water use of 10 percent from current levels, while under the Low Scenario, production and water use are expected to hold steady, as they are expected to do in the Mid Scenario.

## Summary of Economic and Demographic Projections

The preceding evaluations and assumptions and interviews with local planning officials were incorporated into a model of Platte River Basin employment and population to develop aggregate estimates of total residents and total jobs in 2035 under each of the three planning scenarios (Stamp, 2004; DuBord, 2004; Grabow and Kilgore, 2005; Florquist, 2005; Werner, 2005; Reid, 2005; Ashby, Matsen and Mason, 2005; Winer and Hough, 2005; Fabian, 2005; Johnson, 2005).

Overview of projection technique. HE projected jobs and population in the Platte River Basin with a base year of 2005 and a projection period of 30 years through 2035. Employment projections begin with forecasts based on the assumptions outlined above plus input from local planning officials for regional economic growth and for the Basin's basic economic sectors, those sectors that drive the economy, including:

- ⇒ Natural resources and mining
- ⇒ Manufacturing
- ⇒ Tourism portion of retail trade
- ⇒ Agriculture
- ⇒ Portions of other sectors that generate economic resources from outside the Basin

HE then estimated a basic employment multiplier for the Basin of 1.4, meaning that each basic job creates roughly .4 local service jobs, such as additional retail and other services. Higher multipliers imply relatively larger levels of supporting local service employment that are characteristic of larger economies. HE based its estimate on the multiplier generated by the IMPLAN macroeconomic model for Wyoming in 2000 (Minnesota IMPLAN Group, Inc., 2004).

The sum of projected basic jobs plus forecasted secondary local service jobs in the Basin equals the total number of jobs available to people working in the region. From this projected number of total jobs in the Basin, HE proceeded through the following five steps to generation forecasted population in the Basin:

- Net in-commuters were accounted for. This step is necessary because, on net, a sizable number of workers commute into the Basin from other locations. These in-commuters' jobs do not actually contribute to population levels inside the Basin itself and must be removed from the total to forecast population. HE assumed that the number of net in-commuters would remain constant over the projection period.

- Total jobs were relied upon to estimate the number of employed persons, which is less than the total number of jobs. This step is necessary because the employment estimates used in this study follow the convention of counting part-time jobs and self-employment; consequently there are numerous instances of multiple jobs holding by individuals.
- Based upon the number of employed persons and assumed unemployment rates, an estimate of the total labor force was derived. HE forecasts that the Basin's unemployment rate will be about 4 percent over time.
- Based upon assumed labor force participation rates, an estimate of the total population over the age of 16 was projected. In projecting future labor force participation rates, HE assumed average participation rates would decrease by 5 percent over the projection period, reflecting the aging of basin population.
- The population of persons aged 16 and older was utilized to project future population of all ages. The study team assumed that the Platte River Basin population proportion age 16 and older would remain constant over the projection period.

The final product of this analysis is projections of population in the Basin in 2005 and 2035.

HE began employment and population projections for each scenario with estimates for 2005. To estimate employment and population for the Basin in 2005, HE applied the State of Wyoming's own estimates of employment in 2005 and then proceeded through the steps described above to estimate 2005 total employment and population in the Basin (WYEAD, 2004). These 2005 estimates of basic and total employment and population for the Basin served as the starting point for each of the scenarios.

High scenario. HE independently projected changes in employment in the Basin through 2035, based on the information described for each sector in this memo as summarized in Exhibit 5 below, and based on input about regional economic growth from interviews with local planning and industry officials from across the Basin.

Exhibit 5.  
Projected Economic Sector Changes, Platte River Basin, High Scenario

Economic Sector	Sector Prospects	Quantitative Changes
Agriculture	Growth in irrigated acres, livestock with high demand	Irrigated acres up 36,000 Livestock up 131,000
Recreation	New and expanded golf courses	765 new irrigated acres
Power generation	2 new plants, one natural gas, one coal-fired	1,500 MW, 600 jobs
Mining	1 new uranium mine, 1 new coalmine, 1 closed coalmine	Additional employment and production
Oil refining and production	Refining flat, production steady 5 years, then declining at historic rates	Employment flat to declining
Natural gas production	Production flat to declining, coalbed methane development surrounding Basin	New employment spillover from outside Basin
Other industries	Production generally increasing	Employment flat to increasing

Source: Harvey Economics, 2005.

With these inputs and assumptions, HE began with 2005 employment numbers and projected basic employment through 2035 and then proceeded through the steps outlined above to derive population forecasts for the Basin. The results of this analysis for the High Scenario are presented in Exhibit 6 below.

Exhibit 6.  
Current and Projected Basic Employment, Total Employment and Population by Subbasin, 2005 and 2035, High Scenario

Subbasin	Basic Employment		Total Employment		Population	
	2005	2035	2005	2035	2005	2035
Above Pathfinder	7,400	12,500	10,400	17,500	15,000	29,000
Pathfinder to Guernsey	37,300	62,600	52,200	87,700	79,000	145,000
Guernsey to State Line	3,500	5,800	4,900	8,100	7,000	13,000
Upper Laramie	16,200	29,600	22,600	41,400	34,000	68,000
Lower Laramie	3,200	4,700	4,500	6,600	6,000	11,000
Horse Creek	1,000	1,300	1,300	1,800	2,000	2,000
South Platte	37,500	57,800	52,500	81,000	79,000	134,000
<b>Total Basin</b>	<b>106,100</b>	<b>174,300</b>	<b>148,400</b>	<b>244,100</b>	<b>222,000</b>	<b>402,000</b>

Source: Harvey Economics, 2005.

HE projects that Platte River Basin employment under the High Scenario will increase by roughly 65 percent, from 148,000 jobs at present to 244,000 by 2035. This increase would be primarily driven by growth in the minerals and energy sector, which would create support service and related employment, and by growth in services to accommodate an aging

population, including healthcare and social services. This forecast also aligns closely with local planning officials' expected growth patterns across the Basin. Under the High Scenario, the Basin's population is projected to increase by more than 80 percent, topping 400,000 residents by 2035. These forecasts are aggressive but reflect an assumption supported by statewide population projections from the US Census Bureau that Wyoming will increasingly attract – with its low cost of living and quality of life amenities – a significant retirement age in-migration that will become an increasingly large portion of the population (US Census Bureau, 2005).

Low scenario. For the Low Scenario, HE adopted the State's employment projections through 2020 and extrapolated them through 2035 (WYEAD, 2004). The State's forecasts were comparable to HE's low threshold forecasts of growth in the Basin based on interviews with local planning officials and industry representatives. These low scenario assumptions were outlined in the earlier sections of this memo for each economic sector, as summarized in Exhibit 7 below. Thus, these projections represent a reliable lower bound for planning purposes in this study.

Exhibit 7.  
Projected Economic Sector Changes, Platte River Basin, Low Scenario

<b>Economic Sector</b>	<b>Sector Prospects</b>	<b>Quantitative Changes</b>
Agriculture	Decline in irrigated acres and livestock with weak demand, urban development, aging ranchers	Irrigated acres down 10,000, livestock down 132,000
Recreation	No new golf courses or expansions	Steady irrigated acres
Power generation	No new plants or expansions	Steady employment
Mining	One coalmine closed, uranium continues	Coal employment down
Oil refining and production	Refining flat, production down at 2x historic rate	Employment flat to declining
Natural gas production	Production flat to declining, coalbed methane development surrounding Basin	No new employment spillover from outside Basin
Other industries	Production generally decreasing	Employment flat to decreasing

Source: Harvey Economics, 2005.

HE proceeded through the same steps of forecasting from WYEAD's employment projections, from the assumptions outlined in Exhibit 7, and from input from planning personnel, through total employment to population for the Basin under the Low Scenario. The results of this analysis are presented in Exhibit 8.

Exhibit 8.

Current and Projected Basic Employment, Total Employment and Population by Subbasin, 2005 and 2035, Low Scenario

	Basic Employment		Total Employment		Population	
	2005	2035	2005	2035	2005	2035
<b>Subbasin</b>						
Above Pathfinder	7,400	8,700	10,400	12,200	15,000	20,000
Pathfinder to Guernsey	37,300	53,300	52,200	74,600	79,000	123,000
Guernsey to State Line	3,500	4,300	4,900	6,000	7,000	10,000
Upper Laramie	16,200	21,800	22,600	30,500	34,000	50,000
Lower Laramie	3,200	4,300	4,500	6,000	6,000	9,000
Horse Creek	1,000	1,200	1,300	1,700	2,000	2,000
South Platte	37,500	46,900	52,500	65,600	79,000	108,000
<b>Total Basin</b>	<b>106,100</b>	<b>140,500</b>	<b>148,400</b>	<b>196,600</b>	<b>222,000</b>	<b>322,000</b>

Source: Harvey Economics, 2005.

Under the Low Scenario, Basinwide jobs are projected to increase at less than 1 percent per year, rising by about 48,000 jobs over the 30-year projection period. Under the Low Scenario, population within the Basin is projected to experience mild growth over the next 30 years, reaching 322,000 residents. These forecasts are somewhat aggressive but also reflect an assumption supported by statewide population projections from the US Census Bureau that Wyoming will increasingly attract – with its low cost of living and quality of life amenities – a significant retirement age in-migration that will become an increasingly large portion of the population (US Census Bureau, 2005).

Mid scenario. For the Mid Scenario's employment and population projections, HE started with the Basin's 2005 basic and total employment and population and applied the assumptions discussed earlier in this memo for each economic sector, summarized in Exhibit 9 below, plus growth estimates generated from interviews with local planning officials and industry representatives.

Exhibit 9.  
 Projected Economic Sector Changes, Platte River Basin, Mid Scenario

Economic Sector	Sector Prospects	Quantitative Changes
Agriculture	Slight decline in irrigated acres, moderate increase in livestock with steady demand	Irrigated acres down 1,000, livestock up 41,000 head
Recreation	2 new golf courses, no expansions	270 new irrigated acres
Power generation	1 new natural gas plant	1000 new MW, 300 jobs
Mining	Uranium mine continues, coalmine closes	Coal employment down
Oil refining and production	Refining flat, production down at historic rate	Employment flat to declining
Natural gas production	Production flat to declining, coalbed methane development surrounding Basin	New employment spillover from outside Basin
Other industries	Production generally steady	Employment flat to increasing

Source: Harvey Economics, 2005.

HE proceeded through the same steps of forecasting from basic employment through total employment to population for the Basin under the Mid Scenario. The results of this analysis are presented in Exhibit 10 below.

Exhibit 10.  
 Current and Projected Basic Employment, Total Employment and Population by Subbasin, 2005 and 2035, Mid Scenario

Subbasin	Basic Employment		Total Employment		Population	
	2005	2035	2005	2035	2005	2035
Above Pathfinder	7,400	10,500	10,400	14,700	15,000	24,000
Pathfinder to Guernsey	37,300	52,700	52,200	73,800	79,000	122,000
Guernsey to State Line	3,500	4,700	4,900	6,600	7,000	10,000
Upper Laramie	16,200	22,900	22,600	32,000	34,000	53,000
Lower Laramie	3,200	4,100	4,500	5,800	6,000	9,000
Horse Creek	1,000	1,100	1,300	1,600	2,000	2,000
South Platte	37,500	53,100	52,500	74,300	79,000	123,000
<b>Total Basin</b>	<b>106,100</b>	<b>149,100</b>	<b>148,400</b>	<b>208,800</b>	<b>222,000</b>	<b>343,000</b>

Source: Harvey Economics, 2005.

Under the Mid Scenario, aggregate jobs are projected to increase by roughly 60,000 over the course of the projection period. Under the Mid Scenario, population within the Basin would experience steady growth of about 1.5 percent each year over the next 30 years, gaining more than 120,000 additional people to reach a total of 343,000 residents. Again, these forecasts are somewhat aggressive but also reflect an assumption supported by statewide population

projections from the US Census Bureau that Wyoming will increasingly attract – with its low cost of living and quality of life amenities – a significant retirement age in-migration that will become an increasingly large portion of the population (US Census Bureau, 2005).

## Summary

HE projected three future scenarios for economic and demographic growth in the Platte River Basin through the year 2035. All three scenarios employed an economic base modeling approach, combined with input from local planning officials, in which prospects for key economic sectors that either bring money into the region and/or are the source of substantial water use were analyzed in detail along with prospects for regional growth. Based upon these analyses, high, low, and middle case alternative scenarios were developed for the Basin that led to total employment and population projections. The high and low projections presented in the memo are intended to bracket optimistic and pessimistic assumptions about the future, but they represent useful bounds for water planners. It is HE's judgment that the Mid Scenario is the most realistic and is the most likely scenario to occur.

The three scenarios presented in the memo portray markedly different potential futures for the region. Under the High Scenario, both the number of irrigated acres and commercial livestock within the Basin would increase modestly, and communities would make investments in new infrastructure and natural resources projects. Under the Low Scenario, both livestock numbers and irrigated acreage would decline due to worsening economic viability of ranching, and investments in new and existing industries would be minimal. The Mid Scenario projects livestock and irrigated acreage within the Basin to decline very slightly, and investments in new and existing industries would be moderate.

Projected Platte River Basin population in 2035 under the High Scenario would reach 400,000 residents, compared with 322,000 residents under the Low Scenario and 343,000 residents under the Mid Scenario.

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