Chapter 9

Looking to the Future

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The purpose of this chapter is to discuss future water use opportunities in the Bear River Basin. This issue was examined in detail in the previous Bear River Basin Water Plans (WWC Engineering, and others, 2007; Forsgren Associates, 2001; Wyoming Water Development Office, 2012). This study provides the most current information available about the future focus and direction of Bear River Basin groundwater development projects.

The discussions of technical concepts and Thrust Belt geology previously covered in this study provide the background needed to understand the practical considerations that shape the conceptualization, design, and successful completion of a water resource development project. **Chapter 5** opened with the definition of several elementary, hydrogeologic concepts that are crucial to understanding basic groundwater science. **Section 5.1.3** introduced the dynamics of groundwater recharge, discharge, and flow and summarized the hydrogeologic settings that are characteristic of the Thrust Belt. Future groundwater development in the Bear River drainage is not only physically limited by Thrust Belt hydrogeology but is also legally bound by the provisions of the Amended Bear River Compact of 1978 (**Appendix D**). Specific groundwater development projects are discussed in **Section 9.1**, and recommendations for future updates of this Groundwater Determination Technical Memorandum are presented in **Section 9.2**.

Additional supporting information for the project assessments contained in this chapter can be found in several, previous Chapters of this study:

- Hydrogeology is discussed at length in **Chapters 5** through7 and illustrated in **Plate 5**.
- Groundwater chemical characteristics are summarized in **Chapter 7** and **Appendices E** through **H**.
- Recent and historic development patterns specified by beneficial use, obtained from the State Engineer's Office (**Chapter 8**).
- Studies published by the USGS (**Chapter 7**) and Wyoming Water Development Commission (**Appendix B**) that examine the development potential of specific aquifers.
- The 2001 Water Plan for the Bear River Basin (Forsgren Associates, 2001), the 2011 Water Plan (Wyoming Water Development Office, 2012) and associated technical memoranda, as well as the 2007 State Water Plan (WWC Engineering and others, 2007), identify potential groundwater development projects considered prior to the completion dates of those studies. Many of the opportunities examined in those publications may be under current development or will become more viable in the future as financial factors and technological improvements allow.
- The Water Resources Data System Library, specifically the WWDC Projects and Studies Web page, contains hundreds of water development reports for projects completed over the last 40 years for localities throughout Wyoming.

In this chapter, only development projects that are designed with the primary objective of producing potable groundwater are discussed. Projects that may produce groundwater as a value added byproduct of other activities, such as oil and gas production or in-situ mineral extraction, are not considered.

9.1 Issues affecting future groundwater development

- Water availability – A groundwater resource must be legally, economically, and physically available. In the Bear River Basin, groundwater availability is controlled by the hydrogeology of the Thrust Belt as well as the Amended Bear River Compact of 1978.

- Funding – Groundwater development projects are expensive and most Wyoming municipalities do not have the funds required to plan, carry out and complete development programs. Funding for these

projects, therefore, has to be obtained from governmental agencies. The primary water development funding agencies in Wyoming are the WWDO, DEQ, and the U.S. Department of Agriculture.

- Stakeholder involvement – The successful completion of any groundwater project requires the involvement of the stakeholders who have interests in the development or preservation of the water resource. Stakeholders include current and future water users; landowners; business representatives; attorneys; scientists; engineers; environmentalist groups; sportsmen; holders of competing water rights; municipal, state, and federal regulatory agencies; and others. Stakeholder support for or opposition to a water development project depends on the nature, benefits, costs, and perceived impacts of the particular project. The project will likely incur substantial cost increases and time delays if legal challenges are filed by stakeholders opposed to development.

- Interstate compacts - The Amended Bear River Compact of 1978 regulates water use in the Bear River Basin. The provisions of the compact are primarily administered by the SEO.

- Water quality – The successful completion of a groundwater development project depends on whether the quality of the water produced from the targeted resource meets the requirements of the intended beneficial use(s). State and federal laws may mandate water quality requirements for certain beneficial uses or may, alternately, be used as a reference measure for others. For example, the National Primary Drinking Water Regulations (**Table 5-2**) established by the Environmental Protection Agency (EPA) under provisions of the Safe Drinking Water Act are legally enforceable standards for public water systems (PWS) but do not regulate water quality in private groundwater wells that serve fewer than 25 people. Still, water quality in private wells is frequently evaluated in comparison to the Maximum Contaminant Levels (MCL) contained in the EPA regulations.

- Environmental regulation – Water development projects in Wyoming are subject to regulation under the provisions of state and federal environmental laws including:
  - Wyoming Environmental Quality Act – the principal state environmental law that created the Wyoming Department of Environmental Quality repealed the state's existing environmental laws (in 1973) and replaced them with the provisions of the new act.
  - Endangered Species Act – a federal environmental law designed to protect imperiled plant and animal species from extinction. The ESA is administered under the Endangered Species Program of the U.S. Fish and Wildlife Service and the National Marine Fisheries Service of the National Oceanic and Atmospheric Administration (NOAA).
  - National Environmental Policy Act (NEPA) – a main federal law that established national environmental policy. It requires federal agencies in the executive branch to write Environmental Impact Statements (EIS) and Environmental Assessments (EA) that examine anticipated impacts to the environment resulting from proposed federal agency actions.
  - Clean Water Act – the principal federal law that governs pollution in the nation's surface waters. The CWA does not regulate groundwater pollution directly. The Water Quality Division of DEQ regulates the discharge of pollutants to surface waters under the CWA.

- Safe Drinking Water Act – the primary federal law that ensures safe drinking water supplies for the public. The SDWA covers public water supplies but does not apply to private wells that serve less than 25 people. The EPA administers and enforces provisions of the SDWA.

9.1.1 Groundwater development potential in areas subject to the Amended Bear River Compact of 1978

The Amended Bear River Compact of 1978 divides water administration in the Bear River among three geographically defined divisions. The Upper Division encompasses the reach of the Bear River that extends from its headwaters in the Uinta Mountains to the Pixley diversion dam in Sec. 25, T. 23 N., R. 120 W. of the Sixth Principal Meridian in Wyoming. During a compact defined water emergency in the Upper Division, percentage allocations are made to the Utah and Wyoming sections and distribution of divertible flow is managed by diversion by the two states. The Central Division extends from below Pixley Dam to the Stewart diversion dam in Sec. 34, T. 13 S. R. 44 E. Boise Base and Meridian in Idaho; during a water emergency, divertible flow is allocated by percentage to Wyoming and Idaho. In the Lower Division, which extends from the Stewart Dam to the Great Salt Lake, divertible flows are allocated by a commission approved delivery schedule.

The portion of the Bear River drainage basin examined in this report consists of the entire Upper Division and those parts of the Central Division that are tributary to the Bear River upstream of the Idaho-Wyoming border (**Fig. 3-1**). **Appendix D** (SEO, 2006) contains a copy of the Amended Bear River Compact (1978). The compact is administered by the Bear River Commission (http://www.bearrivercommission.org/), composed of three commissioners from each signatory state. The Interstate Streams Division of the SEO, in conjunction with the Water District IV staff, administers the provisions of the compact that fall under the authority of the state of Wyoming.

Along with the distribution of water specified for each of the divisions, Article VI of the compact allocates an additional 13,000 ac-ft annual total of surface and connected groundwater each to both Wyoming and that portion of Utah above Stewart Dam for beneficial uses applied on or after January 1, 1976. Historically, Wyoming has used only a small portion of this additional allocation, so it is likely that future groundwater development in the Bear River Basin will allow Wyoming to develop and utilize its 13,000 ac-ft allocation. In Wyoming, the SEO monitors surface water and connected groundwater depletions owing to the additional allocation.

Appendix B contains a chronological summary of groundwater development related projects sponsored by the WWDC in the Bear River Basin since 1973. Information contained many of these studies was used to describe, in detail, the physical and chemical characteristics of the basin's hydrogeologic units in **Chapter 7**. **Appendix B** summarizes the following groundwater development information for WWDC projects in the Bear River Basin:

- References to the study(s) – full citations are included in the References
- Location, including as appropriate: town, county, rural area, irrigation district, well site, etc.
- Aquifers involved in the study
- Project descriptions of development potential of area(s) and aquifer(s) and development drilling project(s)
- Summary of results
- Current project status

9.1.2 Future water use opportunities

Chapter 8 of the 2011 Bear River Basin Water Plan (Wyoming Water Development Office, 2012) provides a detailed discussion of future water use opportunities with the intention that their implementation would result in expanded water supplies that could be used to meet current and future water demands. These issues were initially developed by the Bear River Basin Advisory Group (Bear River BAG) in 1998 and

updated in 2005. Their recommendations are available online at: http://waterplan.state.wy.us/BAG/bear/meetingrecords.html and identify both structural and non-structural water development opportunities. Structural opportunities are projects that involve the design and construction of new water storage and conveyance infrastructure or the modification and improvement of existing infrastructure to include new or upgraded groundwater development, enlarging reservoirs, trans-basin diversion programs, or improving existing water distribution systems. Non-structural opportunities do not require modifications to infrastructure but involve programmatic changes in water use and management such as water conservation programs, improvements in efficiency-of–use, water-banking, and improved reservoir operation.

This report briefly examines new groundwater resource development in the Bear River Basin.

9.1.3 Potential new groundwater development prospects

Article VI of the Amended Bear River Compact allocates an additional 13,000 ac-ft annual total of surface and connected groundwater to both Wyoming and that portion of Utah above Stewart Dam for beneficial uses applied on or after January 1, 1976. Historically, Wyoming has used only a small portion of this additional allocation, so it is likely that future groundwater development in the Bear River Basin will be allowed in order for Wyoming to develop and utilize its 13,000 acre-feet allocation. Unlike some Wyoming river basins such as the Platte (Taucher and others, 2013), all groundwater in the Bear River Basin is considered to be hydrologically connected to surface water flows and the compact does not consider that some bedrock aquifers may be hydraulically isolated from the river. Future groundwater development and planned depletions will have to proceed in compliance with the 13,000 ac-ft allocation.

Virtually all aquifers and some confining units in the Bear River Basin have some physical potential for development (**Pl. 2** and **Table 9-1**), depending on the requirements for quantity and quality called for by the specified beneficial use(s) and on technical limitations. The Quaternary Bear alluvial aquifer remains available for future groundwater development. Additionally, Mesozoic and Late Paleozoic bedrock aquifers are underutilized and may be prime targets for future development especially within or in close proximity to outcrop areas where recharge is actively occurring, residence times are low and water quality is good. Although well yields could be expected to range from 10 to 500 gpm in these aquifers, water quality and susceptibility to surface sources of contamination (e.g. irrigation return flows and spills from energy development activities) should be considered in evaluating development prospects. **Table 9-1** summarizes further groundwater development potential in the basin's main hydrogeologic units.

9.1.4 Recent WWDC groundwater development prospects

An examination of recent (since 2001) WWDC groundwater development projects provides, perhaps, the most realistic evaluation of future groundwater development in the Bear River Basin. The recent projects are driven by present and expected future needs of municipalities that are likely to experience population adjustments in the coming years as the economy of Wyoming becomes increasingly centered on energy production and continues to focus on the economic development of groundwater resources relative to the issues discussed in **Section 9.1**. Recent groundwater projects from the WRDS water library are presented to illustrate viable future prospects, some of which have been identified for several years, for new and additional public-support groundwater development in the Bear River Basin:

9.1.4.1 North Uinta

The North Uinta County Improvement and Service District (Town of Bear River) conducted a multi-phase, feasibility investigation (Trihydro, 2003) of the feasibility and benefits of developing a groundwater supply from the Wasatch Formation near three existing public water supply wells located near the Deer Mountain Subdivision. A

Table 9-1. Generalized groundwater development potential for major regional aquifer systems in the Bear River Basin (modified from WWC Engineering and others, 2007; Wyoming Water Development Office, 2012).

	System	Location	Well yields	Major aquifers	General potential for new development
Quaternary	Alluvial	Throughout Bear River Basin	Small to large	Unconsolidated deposits	Good to very good
	Non-alluvial	Throughout Bear River Basin	Small to moderate	Primarily unconsolidated terrace deposits	Good to very good
Tertiary	Late	Scattered small outcrops west edge of basin	Small to moderate	Salt Lake	Good - little yield data
	Early	Widespread outcrops in south and central basin	Small to large	Fowkes, Wasatch, Evanston, and equivalents	Good to very good
Mesozoic	Late Cretaceous	Scattered outcrops south and central basin	Small to moderate	Evanston, Adaville, Frontier	Fair to very good – little yield data
	Early Cretaceous	Widespread outcrops throughout basin	Small to moderate	Bear River, Thomas Fork, Gannett	Fair to good - some marginal yields
	Triassic/ Jurassic	Outcrops on uplands and flanks in central and north basin	Moderate to large	Twin Creek, Nugget, Thaynes	Good to very good
Paleozoic	Late	Exposed on uplifts in north basin	Small to large	Phosphoria, Madison, Amsden, Wells	Fair to Very good – some marginal water quality
	Early	Outcrops largely absent	Unknown	Flathead, Bighorn, Gallatin	Fair – outcrops largely absent

test well, Deer Mountain #6, was designed and completed at a depth of 544 feet in the Wasatch Formation. Aquifer testing and water quality analyses indicated that the well could serve as PWS well for the Town of Bear River. Subsequently, the Deer River #6 well was connected to the town's PWS via a new water transmission line.

9.1.4.2 Evanston/Bear River regional water system

Sunrise Engineering (2005) conducted a Level II study under contract to the WWDC to examine the feasibility of implementing a regional water system with water supplied by the City of Evanston to the Town of Bear River. The study evaluated water rights, water storage, transmission infrastructure, and water demand. Analyses of economic, environmental, engineering, and facility administration factors were also conducted. Conceptual designs and cost estimates were developed as well. The study concluded that a regional system could provide needed water supplies to the Town of Bear River. Subsequently, the regional system was constructed and is currently in operation. While the water supplied by this system comes from Bear River surface flows, this WWDC project eased groundwater demands in North Uinta County and is an example of successful regional water system development.

9.1.5 Current WWDC and SEO projects

Currently, neither WWDC nor SEO are conducting large scale groundwater development projects in the Bear River Basin. Applications submitted to the SEO largely are usually for domestic and stock well permits.

9.1.6 Groundwater interference and interconnection with surface water

Other factors that must be considered for new groundwater projects in development are the potential for interference between wells or well fields completed in the same aquifer, excessive drawdowns in over-utilized aquifers, and interconnections between groundwater and surface water. These issues have been encountered and in some cases, addressed in the Bear River Basin. The WWDC groundwater development project in North Uinta County (Trihydro, 2003) reported a case of well interference between a newly installed test well and a previously completed PWS wells. Well interference, alone, does not necessarily present significant problems to a public water system depending on several factors including, but not limited to, the physical and hydrogeologic properties of the target aquifer, construction of the production wells, and the timing and rate(s) of well production. In aquifers that possess high degrees of secondary (fracture) permeability, well interference may be unavoidable over the scale of several miles. In many cases, municipal water supply personnel, who are aware of well interference effects in their facilities, effectively manage them by adjusting well pumping times and rates, or periodically switching to other sources of municipal water.

Excessive drawdown, or groundwater depletion, in over-utilized aquifers has become a national concern (Konikow, 2013). Currently, this does not appear to be an issue of regional concern in the Bear River Basin.

Finally, the interconnection between groundwater and surface water in the Bear River Basin is addressed in the Amended Bear River Compact by treating both surface water and groundwater withdrawals as depletions of the basin's water resources.

9.2 Recommendations for future updates

The quality of the Wyoming State River Basin water plans is limited by the availability of data and the institutional resources used to develop the compiled information in a form that is readily accessible and useful to stakeholders in groundwater development. While some information (e.g., hydrogeology studies, SEO groundwater permit, data from the DEQ and other agencies) is generally available for all basins, other information (e.g. regional groundwater modeling) does not exist. The quantity, accuracy, and completeness of available groundwater information vary between and within the major drainage basins of Wyoming.

The purpose(s) of updating an Available Groundwater Determination can be to include new information generated since the previous determination, to include older information not initially provided and to utilize continuously improving technology to maximize the value of the relevant information that is presented. While information in some areas will grow slowly (e.g., mapping of geologic and hydrogeologic units), other information (e.g., SEO and other agency data) requires regular updates to maintain its utility.

9.2.1 Data challenges

Computing capabilities will continually improve but will always be limited by the availability and reliability of the input data. The quality of a compilation study such as this relies on the quality of the available data. The development of a comprehensive statewide database for water quality and aquifer physical characteristics would greatly assist Wyoming water professionals to manage and protect the state's valuable water resources.

Currently, hydrogeologic and hydrogeochemical data exist that could be integrated into a more comprehensive and evolving groundwater database for Wyoming. For example, DEQ collects copious amounts of groundwater data for site-specific investigations of contaminated sites, for issuing

industrial permits (e.g. mining, UIC, waste and wastewater management), and for monitoring for potential impacts. The SEO collects groundwater information from selected wells. The USGS, WOGCC, BLM, EPA, counties, municipalities, other agencies, and private entities all collect hydrologic information for a variety of activities and purposes. However, coordination between the various entities collecting groundwater information is generally lacking, and clearly there is abundant relevant information that was not and is not accessible for this study and groundwater determinations in other basins. While the quality of some of this information may not be consistent with the standards described in **Chapter 7**, those data could be qualified. Although, some data (e.g., on contaminated samples) would not be representative of natural groundwater, and some water quality analyses (e.g., for contaminated sites and industrial site monitoring) will be for constituents not commonly used to characterize natural groundwater quality; nevertheless, a comprehensive database would be useful.

Ongoing revision and maintenance of a comprehensive groundwater information database where data are continually being generated by numerous entities would be a substantial project, requiring a continuing commitment of resources by federal, state, and local agencies and is certainly easier described than done. As interest in groundwater resources increases, so will justification for such a program.

9.2.2 Current and future research efforts

This study is a compilation of previous investigations conducted primarily by state and federal agencies and consultants. Any significant advancement in the development of the conceptual model of the hydrogeology of the Bear River Basin or its Laramide sub-basins will require further original research, most likely conducted by academic investigators; USGS water scientists; or by consultants employed by the WWDO, SEO, or Wyoming municipalities. The recent formation of the Wyoming Center for Environmental Hydrology and Geophysics (WyCEHG) should prove to be particularly valuable to a better understanding of groundwater resources in the Bear River Basin. Funded for a five year period by the National Science Foundation, WyCEHG efforts are specifically targeted to advancing research in western hydrologic systems using advanced geophysics and remote sensing technologies. The stated goals of WyCEHG are:

- **To improve understanding of mountain front hydrology** by characterizing the processes that partition water into streams, soils, plants, rivers and aquifers in several locations throughout the state.
- **To improve understanding of how disturbances affect water flux** by studying effects on hydrological systems from climate change, bark beetle infestations, and energy extraction.
- **To improve integrated modeling of the fate and transport of water** by creating integrated computer models that will provide the scientific knowledge and tools for improved prediction of hydrological processes.
- **To provide cutting edge resources and tools** for educators and watershed managers in the state.
  Further information can be obtained from the website for WyCEHG which can be accessed at: http://www.uwyo.edu/epscor/wycehg/.

The recharge calculations based on the surface outcrop area of hydrogeologic units and the SDVC map of recharge (Hamerlinck and Arneson, 1998), contained in **Section 6.2**, went beyond summarizing existing information by using the data to estimate the groundwater resource. The recharge evaluation in this study could easily be updated and the results refined as new data is collected, with a relatively low-level commitment of resources. The estimation of recharge can be enhanced by numerical modeling in selected areas that includes additional variables that affect infiltration and recharge (**Section 5.1.3**).

Furthermore, there are several areas where additional geologic mapping would develop useful

information for future Bear River Basin Water Plan updates. More detailed geologic mapping would better define the hydrogeologic role of the basin's geologic, further identify areas where groundwater and surface water may be interconnected, and determine areas where vertical recharge may be enhanced by fracture permeability.