UTAH LAKE BASIN
PLANNING FOR THE FUTURE

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By:

Utah Division of Water Resources

With input from the State Water Plan Coordinating Committee
(see inside-back cover for participating agencies)

U T A H S T A T E W A T E R P L A N

This document and other state water plans are available online at: www.water.utah.gov

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PREFACE

One of the major responsibilities of the Utah Division of Water Resources is comprehensive water planning. Over the past 24 years, the division has prepared a series of documents under the title "Utah State Water Plan." This includes two statewide water plans, an individual water plan for each of the state's eleven major hydrologic river basins, and five special studies on the important topics of water reuse, conjunctive management, drought, reservoir sedimentation and leak detection. The preparation of these plans involved several major data collection programs as well as extensive inter-agency and public outreach efforts. Much was learned through this process; state, local, and federal water planners and managers obtained valuable information for use in their programs and activities, and the public received the opportunity to provide meaningful input in improving the state's water resources stewardship.

This document is the latest in the "Utah State Water Plan" series and is intended to help guide and direct water-related planning and management in the Utah Lake Basin over the next couple of decades. It summarizes key data obtained through the previous water planning documents, introduces new data where available, and addresses issues of importance to all future water planning efforts. Where possible, it identifies water use trends and makes projections of water use. The document also explores various means of meeting future water demands and identifies important issues that need to be considered when making water-related decisions. Water managers and planners within the basin will find the data, insights and direction provided by this document valuable in their efforts. The general public will discover many useful facts and information helpful in understanding the basin's water resources. Both audiences should appreciate the real-life examples highlighted in the text, and photographs. Although the use of technical words is avoided wherever possible, the glossary illuminates exact usage of terminology that may be unfamiliar.

In addition to the printed form of this document, the Utah Division of Water Resources has made a "pdf" version available on the Internet. This can be accessed through the division's home page at: www.water.utah.gov. This web page allows this document and other water planning documents to be viewed by the largest audience possible, thus facilitating better planning and management at the state and local level.

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EXECUTIVE SUMMARY

The water resources of the Utah Lake Basin play an important part in the life of every basin resident. Supplying adequate water to meet the needs of the basin's growing population is a responsibility shared by the federal, state and local governments.

The purpose of this document is to describe the current status of the water resources in the Utah Lake Basin and estimate future demands that will be placed upon them. This includes quantifying the available water supply, measuring current uses, estimating future uses, discussing water quality and environmental issues, and identifying ways to manage and enhance existing supplies and develop new supplies to satisfy future needs. A main goal of this document is to help water managers and others formulate the management strategies and policies that will ensure a bright future for the basin. This document should also be a valuable resource for those who live in the basin or who are otherwise interested in contributing to water-related decisions. The following pages summarize the main points of each chapter.

CHAPTER 1 INTRODUCTION: WATERS OF THE UTAH LAKE BASIN

The Utah Lake Basin is the third most populous basin in the state of Utah and comprises most of Utah County, portions of Wasatch, Summit, Juab and Sanpete counties, and a very small piece of Carbon County. It is home to nearly 548,000 residents (2010) just over 20 percent of the state's population. In addition to the strong population and economic forces at play within the basin, the close proximity of the population to the diverse outdoor activities in the nearby mountains and surrounding areas has contributed to the basin's rapid growth. For these and other reasons, the basin is expected to experience substantial population growth into the future, nearly doubling by 2040.

The combination of relatively high precipitation, importation and water storage capacity has allowed the Utah Lake Basin to support a large human population and has also enabled local water suppliers to meet additional growth. This does not mean that the basin is without problems or that accommodating growth will come without difficulty. Current water-related infrastructure is not sufficient to meet all projected growth and not all basin streams and other water bodies meet Utah's water quality standards.

While the additional water supplies provided by the completion of the Central Utah Project and the Central Water Project will provide adequate water for projected future growth through about 2055, there will still be a need for additional local infrastructure to deliver the water to each community where it is needed. In addition to constructing adequate infrastructure for the future, water planners and managers need to continue to expand their efforts to effectively address water quality, environmental and other values. It will also be important to coordinate federal and state water resource efforts with localized needs, as a part of the ongoing efforts to better manage Utah Lake.

CHAPTER 2 WATER SUPPLY

The Utah Lake Basin receives an average 18.5 inches of precipitation annually. Precipitation in the lower elevations during the May through September growing season is only 4 to 10 inches, compared to a crop water requirement ranging between 20 to 30 inches.

Total water supply from precipitation is about 3,000,000 acre-feet per year. To this natural supply an additional 231,900 acre-feet is imported from the Uinta and Weber Basins. This provides the basin with a total annual water supply of just over 3.2 million acre-feet. It is estimated that 631,300 acre-feet of that water makes its way into the basin's groundwater aquifer systems. An estimated 505,000 acre-feet per year is diverted for irrigation, about half of which is depleted. An estimated 61,500 acre-feet per year of surface water is diverted for M&I (Municipal and Industrial) use within the basin. About 150,000 acre-feet of groundwater is withdrawn annually, primarily for M&I use. An additional 160,700 acre-feet per year is exported to Salt Lake

County for M&I use. Approximately 201,000 acre-feet per year is evaporated from Utah Lake, and 308,000 acre-feet per year flows from the basin to the Jordan River. The remaining 1,364,400 acre-feet per year is used by the basin's vegetation and natural systems.

There are five major groundwater aquifers within the basin: Utah-Goshen Valley, Heber Valley, Round Valley, Cedar Valley, and North Juab Valley. Due to over appropriation, each of these aquifers has been closed to further appropriations by the State Engineer. Groundwater models have been developed for two of these. The Cedar Valley model was created by the UGS in 2012. The Utah-Goshen Valley has two models: the Northern Utah Valley Model and the Southern Utah Valley Model.

CHAPTER 3 POPULATION AND WATER USE TRENDS AND PROJECTIONS

The 2010 U.S. Census put the population of Utah Lake Basin at just under 548,000 persons. The Governor's Office of Planning and Management estimates the basin's 2030 population will reach approximately 890,000 persons and the basin's 2060 population will reach 1,514,000. At the present time, Utah County is home to 94 percent of the basin's population, approximately 515,000 people. Wasatch County is projected to have the basin's largest percentage growth rate, almost 2.9 percent per year, increasing from a 2010 population of 23,500 residents to 44,500 by 2030, and nearly 97,000 residents by 2060.

Many small and mid-sized communities are projected to double, or nearly double their 2010 population by 2030, and then double again by 2060. This is particularly true of small communities in the western and the southern portions of Utah County (e.g. Cedar Fort, Eagle Mountain, Elk Ridge, Fairfield, Genola, Salem, Santaquin and Saratoga Springs). The small community of Vineyard situated between Orem and Utah Lake includes the reclaimed Geneva steel mill lands. This area is projected to experience tremendous growth over the next 50 years. Its prime location and a guaranteed water supply from the Central Utah Water Conservancy District make it ideal for development. Current projections are that the Vineyard area will house 90,000 residents by 2060.

The economy of the Utah Lake Basin can be characterized as a well-diversified commercial and industrial economy with agricultural influences. Approximately 44 percent of the basin's land (853,680 acres) is privately owned. Most of the privately held land is in the valleys. Although some portions in the basin's upper watersheds are privately owned, most of the lands in the upper watershed are owned and managed by federal agencies. Irrigated lands within the Utah Lake Basin have declined significantly over the past decade and a half from 163,000 acres in 1995 to 156,000 acres in 2002, a loss of about 4.3 percent over the first 7 years, and then decreasing to 127,017 acres in 2008, a loss of nearly 19 percent in the most recent 6 years.

The majority of the basin's total M&I water is supplied by public community systems and public community secondary systems.

CHAPTER 4 MEETING FUTURE WATER NEEDS

This chapter provides a detailed assessment of future water needs and presents a general strategy for how water suppliers in the basin plan to satisfy these needs. Particular emphasis is given to municipal and industrial water needs, as these will experience significant increases due to future population growth. For this document the basin was divided into seven areas based on geographical locations and drainage in order to more adequately describe the basin's water supply and demand. These divisions are as follows: Juab County; Summit and Wasatch Counties; Cedar Valley; Goshen Valley; North Utah Valley; South Utah Valley; and Mountain Homes and Resorts.

The demand in Juab County, Goshen Valley and the Cedar Valley areas is currently at or exceeding the existing reliable supply. This means that under normal conditions, and in most years, existing supplies will be adequate. But in drought years existing water supplies will be inadequate to meet peak demands. The communities in these areas will need to develop new sources of additional water not only to meet the demands of projected growth but also to address current water supply issues during drought conditions.

With water conservation the existing reliable supplies in Summit and Wasatch counties will be sufficient to meet the growing demands through about 2037. Northern Utah Valley's existing reliable supplies should be adequate through about 2040 with water conservation. Even with water conservation existing reliable supplies in South Utah Valley will only be adequate through about 2027.

A look at individual communities reveals that Eagle Mountain, Saratoga Spring, Provo and Lehi will have the largest need to develop additional water supplies over the next 50 years. These and other communities in the basin will obtain additional water supplies primarily from three sources: the Central Water Project, the Central Utah Project, and the conversion of agricultural water to M&I use.

CHAPTER 5
MUNICIPAL AND INDUSTRIAL WATER CONSERVATION

Water conservation will play an important role in satisfying future water needs in the Utah Lake Basin. Water conservation reduces future water demands and decreases the costs associated with additional water development. The state has developed a specific goal to reduce the 2000 per capita water demand from public community water systems by at least 25 percent by 2025. Consuming about 45 percent of the total public water supply, outdoor residential demand is the largest area of consumption. This outdoor usage represents the greatest potential for water conservation of all M&I water uses.

Many water suppliers within the Utah Lake Basin have set specific water conservation goals that will help them and the state reach their respective objectives. Central Utah Water Conservancy District (CUWCD) is one of Utah's leaders in water conservation and has developed a detailed plan to meet its own goal of reducing water use by 25 percent by 2025. It is required by CUWCD that any petitioners of Central Utah Project (CUP) water under the Utah Lake System (ULS) project must also reduce their per capita water use by 25 percent by the year 2025. Provo, Salem and Spanish Fork have all adopted this goal. American Fork, Pleasant Grove and Orem have gone further and set aggressive conservation goals. American Fork aims to reduce their culinary per capita use by 50 percent by 2015.

The initial survey, which established a statewide per capita water use, also determined that the total use of public water supplies was 273 gpcd in the Utah Lake Basin in 2000. In 2010, the Utah Lake Basin value dropped to 221 gpcd. This is a 19 percent reduction in only ten years.

In 1998 and 1999, the Utah Legislature passed and revised the Water Conservation Plan Act. This Act requires any water retailer with more than 500 connections and all water conservancy districts to prepare water conservation plans and submit them to the Division of Water Resources. As of June, 2014, each of the 22 water retailers and conservancy districts in the Utah Lake Basin who are required to submit a plan or update have done so.

CHAPTER 6
AGRICULTURAL CONVERSIONS AND OTHER WATER MANAGEMENT STRATEGIES

As communities in the basin grow, development will likely occur on irrigated agricultural land. This is especially true along the Wasatch Front where many cities are constrained on one or more sides by community boundaries, mountains or bodies of water. For these communities, urban development on irrigated lands will occur at a rapid pace.

When irrigated farmland changes from agricultural to urban use, many Utah communities require the agricultural water rights associated with the land be transferred to the municipality as a condition of approving the development. In most cases, the same amount of water used to irrigate an acre of agricultural land is sufficient to meet the indoor and outdoor water needs of an acre of urban development. Water transferred in this manner typically becomes part of the municipality's water supply, which can then be treated and delivered to meet growing municipal and industrial (M&I) water demands.

Current data indicate that the basin's irrigated agricultural land will be reduced by at least 50 percent over the next fifty years. The urbanization of 50,000 acres of irrigated lands over the next fifty years, in the Utah Lake Basin, would make available about

100,000 acre-feet of agricultural water for conversion to municipal and industrial use.

Because most basin communities have had abundant, inexpensive potable water supplies, the need for water reuse in the Utah Lake Basin has been limited. Intentional reuse has only recently begun to augment water supplies in communities made water-short through the expansion of their populations. Due to an ever-increasing population and limited water supplies, views towards the reuse of treated effluent (reclaimed water) are changing. Reclaimed water is becoming more appealing as an M&I water source, particularly as a replacement for the use of potable water in non-potable applications, such as landscape irrigation, cooling water, or as a supplementary supply for irrigated agriculture. The Heber Valley Special Service District and Santaquin City projects were the first direct reuse projects in the Utah Lake Basin to reuse a large portion of their effluent. Payson City's effluent is used for cooling water at a natural gas powerplant.

There is considerable potential for water reuse in the Utah Lake Basin. In order to be successful, water reuse projects will need to be price competitive with other supply options. For the near future, the feasibility of several reuse projects is being investigated in the basin as well as some that are already in the planning stage. Potential water reuse projects are explored for the following communities: Nephi, Orem, Payson, Saratoga Spring, Lehi, Springville, Eagle Mountain, and Spanish Fork.

One effective management tool that can be used to increase efficiency is the conjunctive management of surface water and groundwater. It involves using surface water when it is available so that groundwater can be left in the ground to be used during drought or high demand periods. During wet periods, when there is more surface water than is needed, it can be stored in above ground reservoirs or in the groundwater aquifer.

CHAPTER 7
WATER DEVELOPMENT

The construction of a small dam across the outlet of Utah Lake in 1872 developed 870,000 acre-feet of irrigation storage space in Utah Lake for use in Utah and Salt Lake Counties. The basin's next large irrigation storage reservoir was Mona Reservoir (21,000 acre-feet) on Current Creek in Juab County constructed in 1895. In 1910 more than a dozen small catchment basins and reservoirs (including Washington, Wall, Lost Lake and others) were built in the Provo River drainage portion of the Uinta Mountains creating about 10,000 acre-feet of irrigation water. From 1910 until the present, numerous small irrigation storage reservoirs have been built.

Three major water projects constructed by the Bureau of Reclamation have had a major impact on the basin. They are the Strawberry Valley Project, the Provo River Project and the Central Utah Project. The Strawberry Valley Project, which diverts water from the Uinta Basin to the Bonneville Basin, is one of the earliest federal reclamation developments. Construction began in 1906 and water was first used in 1915. Water was collected in a 270,000 acre-feet reservoir on the Strawberry River, a tributary of the Duchesne River and imported to the Diamond Fork drainage through the Strawberry Tunnel. Strawberry Reservoir was subsequently enlarged to 1.1 million acre-feet as part of the Central Utah Project.

Deer Creek Reservoir, the principal feature of the Provo River Project, was completed in 1941. It has an active storage capacity of 152,560 acre-feet. Approximately 120,800 acre-feet of Provo River Project water is stored in Deer Creek. Deer Creek Reservoir also stores water imported from the Weber and Duchesne Rivers.

The Central Utah Project (CUP) was authorized by the Colorado River Storage Project Act of April 11, 1956. In 1992 Congress passed, and the President signed, the Central Utah Project Completion Act. This act transferred the authority and responsibility to complete the CUP from the Bureau of Reclamation to the Central Utah Water Conservancy District, which was established on March 2, 1964. The CUP includes five units: the Vernal Unit, the Jensen Unit, the Upalco and Uintah Unit, the Ute Unit and the Bonneville Unit. The Bonneville Unit is the largest and most complex, and the only unit that brings water into the Utah Lake Basin. The Bonneville Unit was divided into six systems: (1) Starvation Collection System, (2) Strawberry Collection System, (3) Ute Indian Tribal Development, (4) Diamond Fork System, (5) Municipal and Industrial (M&I) System and (6) the Irrigation and Drainage (I&D) System, now known as the Utah Lake System. All of the Bonneville Unit systems have been completed except for the Utah Lake System.

CHAPTER 8
WATER QUALITY AND THE ENVIRONMENT

Regulation of water quality in Utah began in 1953 when the state legislature established the Water Pollution Control Committee and the Bureau of Water Pollution Control. Later, with the passage of the federal Clean Water Act in 1972 and the federal Safe Drinking Water Act in 1974, strong federal emphasis was given to preserving and improving water quality. Today, the Utah Water Quality Board and Division of Water Quality (DWQ), and the Utah Drinking Water Board and Division of Drinking Water are responsible for the regulation and management of water quality in the State of Utah.

The Clean Water Act directs each state to establish water quality standards to protect beneficial uses of surface and groundwater resources. The Act also requires states to identify impaired water bodies every two years and develop a total maximum daily load (TMDL) for each pollutant causing impairments in the various water bodies.

Deer Creek Reservoir has been identified as a priority target for the state's water quality improvement effort and has been listed on the state's 303(d) list of non-supporting waters. A TMDL was initiated and subsequently approved in March of 2002. This TMDL, designed to restore the beneficial uses of the reservoir, as assigned by the state, includes best management practices aimed at reducing pollutant loads.

The Spanish Fork River watershed was identified as one of the top natural resource concerns in Utah County. The Thistle Creek sub-watershed was also chosen as the starting point because of its high elevation headwaters. Any improvements in Thistle Creek would directly benefit the lower sub-watersheds. A TMDL for this sub-watershed was approved by the EPA in July of 2007, which addresses sediment and nutrient loads. A TMDL for Soldier Creek was also approved by the EPA in August of 2006, which addresses high sediment loads and total phosphorus through an implementation plan similar to the Thistle Creek's. The plan outlines best management practices and strategies to reduce erosion and improve fish/aquatic habitat.

The warm water fishery of Utah Lake has been identified as being impaired due to total phosphorus and high concentrations of total dissolved solids. The lake experiences extensive algal blooms in the late summer and fall and is a receiving body for treated wastewater effluent, industrial discharges, storm water discharge and nonpoint source runoff. The development of a TMDL is currently in progress.

The management and restoration of riparian corridors is becoming increasingly important. Several studies have shown that properly maintained riparian corridors and flood plains can protect and improve water quality by intercepting nonpoint source pollutants in surface and shallow subsurface flows. In 2002 DWQ estimated that resource extraction, agricultural runoff, habitat alteration and hydromodification have adversely affected the riparian corridors of about 83 stream miles in the Utah Lake Basin. One entity currently working to protect and restore riparian corridors along several river reaches in the Utah Lake Basin is the Utah Reclamation Mitigation and Conservation Commission. In 1999 the commission began the Mid-Provo River Restoration Project of about 10 miles of river between Jordanelle Dam and Deer Creek Reservoir. The project consisted of restoring the straightened river channel to its natural meandering state and removing many of the existing dikes to reestablish the river's access to its original floodplain. The Project was completed in the fall of 2009. The project area continues to be monitored to determine the effectiveness of the project and to make adjustments as needed.

As of 2010, three plant species and six animal species in the Utah Lake Basin were listed as threatened or endangered. To avoid the difficulties encountered when a species becomes federally listed as threatened or endangered, and to better protect Utah's plant and wildlife resources, the Utah Division of Wildlife Resources has developed the Utah Sensitive Species List, which identifies species most vulnerable to population or habitat loss. In addition to the nine species previously mentioned, 36 species that reside within the Utah Lake Basin are listed on Utah's Sensitive Species List.

In 1999, the U.S. Fish and Wildlife Service established the June Sucker Recovery Plan. The primary goal of the plan is to save the June sucker from extinction. The estimated cost of recovery is $50 million, and the projected recovery date is 2040. As part of the program, the Hobble Creek restoration project was constructed and the Provo River Delta Project is being planned to improve aquatic and riparian habitat. The Commission has also restored aquatic and riparian habitat along Sixth Water and Diamond Fork Creeks in Diamond Fork Canyon. While the overall objective is to aid in the recovery of the June sucker, the program also provides a mechanism to promote the recovery of other federally listed species, and prevent the need for further listings in the Utah Lake Basin.

There are a number of instream flow agreements in the Utah Lake Basin. These are all part of the CUP to help mitigate damages from the construction of new projects and various diversions. There are no wild and scenic river segments within the basin although there are quite a few waterfowl and wildlife management areas, wetlands and wilderness areas.

1

INTRODUCTION: WATERS OF THE UTAH LAKE BASIN

The Utah Lake Basin is the third most populous basin in the state of Utah and comprises most of Utah County, portions of Wasatch, Summit, Juab and Sanpete counties, and a very small piece of Carbon County. With 1,945,000 acres, the basin constitutes less than 4 percent of Utah's land area, but it is home to nearly 548,000 residents (2010) just over 20 percent of the State's population. The basin is bound on all sides by mountain ranges, including the Traverse Mountains, Wasatch Range, Uinta Mountains, Wasatch Plateau, East Tintic Mountains and Oquirrh Mountains (see Figure 1). Much of the runoff from these mountains makes its way into Utah Lake and eventually the Jordan River, which connects the Utah Lake Basin hydrologically to the Jordan River Basin.

The basin receives an average of 18.5 inches of precipitation annually and contains three large and significant water supply reservoirs: Deer Creek, Jordanelle and Utah Lake.[1] The basin also receives water imports from the Weber River and Colorado River basins. While a significant portion of the basin's water is developed for use within the basin, an annual average of 308,000 acre-feet per year flows naturally via the Jordan River from Utah Lake into the Jordan River Basin. Additionally, 161,000 acre-feet per year is diverted from the Provo River and conveyed to the Jordan River Basin through the Salt Lake Aqueduct, the Jordan Aqueduct and the Provo River Aqueduct (formerly known as the Provo Reservoir Canal a.k.a. the Murdock canal). The basin receives over 232,000 acre-feet per year in imported water from the Uinta and Weber River basins. These imports and exports are discussed in greater detail in Chapter 2 – Water Supply, and are illustrated in Figure 3 found in that chapter.

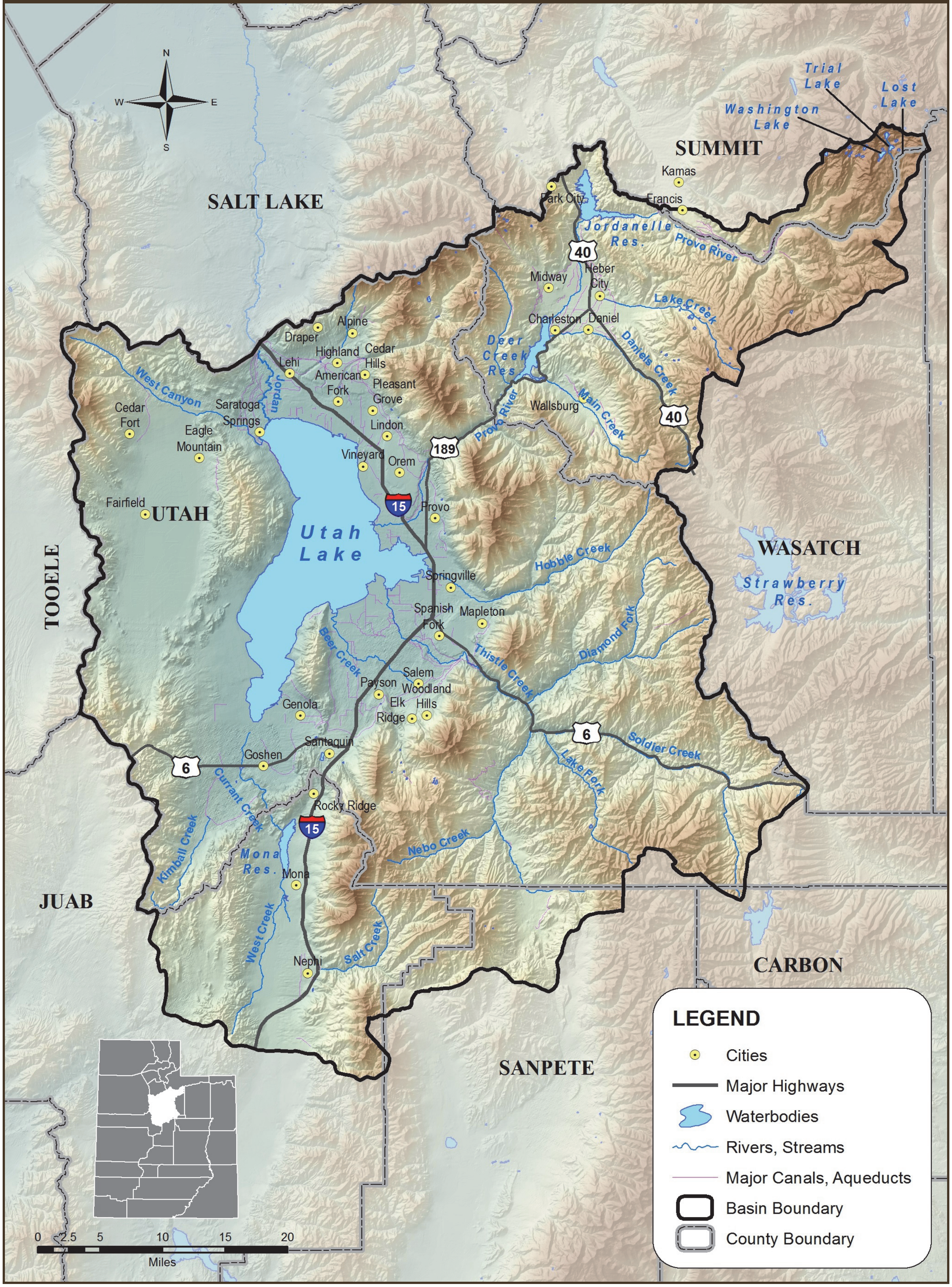
The combination of relatively high precipitation, importation and water storage capacity has allowed the Utah Lake Basin to support a large human population and has also enabled local water suppliers to meet additional growth. However, this does not mean that the basin is without problems or that accommodating growth will come without difficulty. Current water-related infrastructure is not sufficient to meet all projected growth and not all streams and other water bodies in the basin meet Utah's water quality standards. The poor water quality and ecological impairment of Utah Lake is of particular concern. In addition to these problems, other environmental and recreational demands are increasing; bringing greater competition that will require more emphasis on wise management and efficient use of all the basin's water resources.

FUTURE VISION

State and local leaders must work closely with water suppliers in the basin to continue to promote water conservation measures and other innovative water management technologies. While the additional water supplies that will be provided by the completion of the Central Utah Project and the Central Water Project will provide adequate water for projected future growth through about 2055, there will still be a need for additional local infrastructure to deliver the water to each community where it is needed.

In addition to constructing adequate infrastructure for the future, water planners and managers need to continue to expand their efforts to effectively address water quality, environmental and other values. Water agencies and institutions must integrate strategies and policies into their operations that address these issues. An important aspect of this endeavor

FIGURE 1
Utah Lake Basin Map



will be to coordinate federal and state water resource efforts with localized needs, as a part of the ongoing efforts to better manage Utah Lake. Proper coordination will allow solutions to be tailored to local conditions and help maintain a constructive and open dialog among all water resources stakeholders.

Keys to assuring a productive future for the water resources of the Utah Lake Basin include:

- Strong cooperation between all water resources stakeholders.
- Concerted effort to implement water conservation measures and practices.
- Careful application of innovative water management strategies such as water reuse, conjunctive management of surface and groundwater, increased efficiencies and cooperative agreements.
- Continued investment in water infrastructure.
- Continued investment in water quality programs.
- Conscious effort to address environmental, recreational and other needs.

PURPOSE OF THIS PLAN

The purpose of this document is to describe the current status of the water resources in the Utah Lake Basin and estimate future demands that will be placed upon them. This includes quantifying the available water supply, measuring current uses, estimating future uses, discussing water quality and environmental issues, and identifying ways to manage and enhance existing supplies and develop new supplies to satisfy future needs. A main goal of this document is to help water managers and others formulate the management strategies and policies that will ensure a bright future for the basin. In addition to presenting basic water-related data, this document should also be a valuable resource for those who live in the basin or who are otherwise interested in contributing to water-related decisions.

DESCRIPTION OF BASIN

The Utah Lake Basin, as defined by the Utah Division of Water Resources, consists of all lands draining to Utah Lake and to the Jordan River at the Salt Lake County line (see Figure 1); this includes most of Utah County and portions of Summit, Wasatch, Juab, Sanpete and Carbon counties. The Utah Lake Basin is hydrologically connected to the Jordan River Basin via the Jordan River. The Jordan River Basin includes all of Salt Lake County above the shoreline of the Great Salt Lake. While a large portion of the water supply originating in the Utah Lake Basin is exported for use in the Jordan River Basin, this report only addresses water issues specific to the Utah Lake Basin.

Drainage Area and Topography

Nearly all rivers and streams in the Utah Lake Basin terminate in Utah Lake. Significant tributaries to Utah Lake include American Fork River, Provo River, Hobble Creek, Spanish Fork River, Beer Creek and Currant Creek. The Provo River was the largest river naturally flowing into Utah Lake. Today, because of diversions for use, water exported from the Provo River to the Jordan River Basin, and water imported from the Uinta Basin to the Spanish Fork River drainage, the inflow to Utah Lake from the Provo River is less than the inflow from the Spanish Fork River (See Figure 3).

Together the Provo River and the Spanish Fork River make up approximately 70 percent of the inflow to Utah Lake.[2] In addition to their natural flow, the Provo and Spanish Fork rivers receive significant water imports from other river basins. Water is imported to the Provo River from the Weber River Basin through the Weber-Provo Diversion Canal and the Ontario Tunnel and from the Uinta Basin through the Duchesne Tunnel. Additional Uinta Basin water is imported to the Spanish Fork River drainage from Strawberry Reservoir through the Strawberry Tunnel and Syar Tunnel. Water from these tunnels enters the Diamond Fork Creek drainage, a tributary of the Spanish Fork River.

Soils and Vegetation

The basin covers approximately 1,945,000 acres. Land uses include irrigated and dryland agriculture, open water and riparian, residential, industrial, and other urban uses. The rest of the basin is forest and range lands.

Soils in Heber and Round valleys are mostly formed in alluvium from mixed sedimentary rocks on foot-

View of Utah Lake and Wasatch Mountains from a point south of Saratoga Springs near Pelican Point, Utah County. (Photo courtesy of Bill Schlotthauer.)

hills, mountain slopes and alluvial fans. Although most are well drained, some are poorly drained and are used mostly for summer pastures. Utah Valley and Goshen Valley soils range from well drained on the lake terraces to poorly drained near Utah Lake. Soil types here range from fertile loams to saline-alkali clays. Most soils at the lower elevations support agricultural crops.[3]

Soils in the Fairfield to Nephi area (west and south of Utah Lake) vary widely in their potential for major land uses. About 5 percent are used for irrigated crops, mainly alfalfa, wheat, barley, corn silage and a few small areas of orchards. This irrigated land is scattered throughout the area but is concentrated mainly around Nephi. About three percent of the land is used for dry crops, one percent for woodlands and about 85 percent is used as rangeland for foraging animals.[4]

The basin's vegetation varies markedly with elevation, which has a significant impact on temperature and precipitation. At Utah Lake elevation (approximately 4,490), annual precipitation averages about 10 inches. At the top of the mountain peaks (above 11,000 feet), precipitation is close to 60 inches. Heavy alpine forests above about 8,000 feet give way to oaks, mountain brush, and juniper trees, then to sagebrush, sparse grasses, scattered vegetation and semi-desert conditions at lower elevations. About 37 percent of the basin is forested with alpine, conifer, aspen or oaks; 35 percent of the basin is vegetated with the closely related categories of mountain-brush, juniper, sagebrush or greasewood. About 7 percent is miscellaneous native vegetation and an additional 7 percent of the basin is classified as open water, riparian, marsh-land or wetlands. The remaining 14 percent of the basin's land is classified as urban, residential or agricultural.[5]

Significance of Water Resources to the Basin

Water is a central feature of the Utah Lake Basin's landscapes. Originating primarily from high in the Wasatch and Uinta mountains, numerous rivers and streams wind their way through mountain valleys and rugged canyons on their way to the Great Basin and Utah Lake—one of the western United State's largest bodies of fresh water. Native inhabitants of the Utah Lake Basin depended upon water resources and associated habitat and wildlife to sustain their way of life. They often gathered in the low-lying areas around Utah Lake during the winter months and fish-spawning season. Some even lived for long periods near the lake. Later, with the arrival of the early pioneers, the waters of the basin were increasingly utilized.

In 1847, the Mormon pioneers arrived in the Salt Lake Valley and within the next few years several settlements sprang up in Utah Valley, Juab Valley and elsewhere near mountain streams. From the time of the first settlement in the basin until today, a significant part of the state's total population and economic activity have been located within the Utah Lake Basin. Today the basin is home to two of the six largest cities in the state: Provo (3) and Orem (6); and three of the ten fastest growing cities in the state: Mapleton (5), Lindon (7), and American Fork (9).[6]

In addition to the strong population and economic forces at play within the basin, the close proximity of the population to the diverse outdoor activities in the nearby mountains and surrounding areas has contributed to the basin's rapid growth. For these and other reasons, the basin is expected to experience substantial population growth into the future, nearly doubling by 2040. While the water resources of the basin will play an important role in facilitating this growth, additional water supplies from the Utah Lake System of the Central Utah Project (CUP) and the Central Water Project (CWP) will also play an important role in meeting the needs of the projected population.

BRIEF HISTORY OF WATER USE AND DEVELOPMENT

For thousands of years the water resources in and around Utah Lake have sustained an abundant fish and wildlife population. Native as well as more modern inhabitants of the basin have relied heavily on these resources for their sustenance. Today, the water resources of the basin are also used to sustain a large population and a productive industrial and commercial economy. Large-scale water development has played a key role in enabling these activities. While the sequence of events in the basin's water history are numerous and quite fascinating, only a brief summary is given here.

Pre Settlement (Before 1849)

According to archaeological history, human habitation of the Utah Lake Basin dates back approximately 12,000 years. From that time until about the mid-19th century, four Native American cultures made use of the abundant water and food resources in and around Utah Lake.[7] The Paleo Indians inhabited the land around Utah Lake from 12,000 to 8,500 years ago. They hunted wooly mammoths and other large animals that grazed near the lake.[8] From about 8,500 to 2,500 years ago, the Archaic Culture inhabited the region. During this period the climate became more arid and the lake shrank in size, but still supported abundant plant and animal life. From 2,500 to about 1,500 years ago, the region endured a prolonged dry period where the human population declined.[9]

In about 500 A.D., the climate became more balanced and moisture returned. This brought the Fremont Indians to the basin where they established settlements and lived until 1400 A.D. The Fremont resided near the streams entering Utah Lake. They were the basin's first farmers and grew a few crops to supplement their diet, which consisted primarily of local plants and animals.[10] Archeological evidence suggests that the Fremont were skilled fishermen and that native fish were a staple in their diet. The last Native American culture to utilize the water resources of the basin was the Ute Tribe. They too were skilled fishermen and developed advanced techniques to trap and catch fish. They built fish traps in the rivers to capture fish during spawning and used nets weighted with stone sinkers.[11]

The first known white men to explore the basin were part of the Dominguez-Escalante Expedition of 1776. Led by New Mexico-based Catholic priests, the expedition's purpose was to find a new route from Santa Fe to California. In September 1776, the group reached the present site of Strawberry Reservoir and descended into the basin by way of Sixth Water Creek, Diamond Fork Creek and the Spanish Fork River. Escalante's journal describes four rivers entering the lake (later named American Fork, Provo, Hobble Creek, Spanish Fork), excellent soil conditions for farming, plenty of timber in the nearby mountains, and abundant fish and waterfowl in and around the lake.[12] The Expedition spent several days with the Ute Indians near Utah Lake before continuing on their journey. The Spanish explorers were so impressed with Utah Valley that they planned to come back later to establish a colony.[13]

American explorers, mountain men and fur trappers also frequented the basin. Two of the more famous of these men were John C. Frement, who passed through the area taking notes as an explorer for the U.S. military, and Etienne Provost, a French-Canadian trapper who established a temporary post on the shores of Utah Lake.[14] Although a permanent settlement would not be established until the arrival of the Mormon pioneers, the archeological and early historical evidence clearly indicates that Utah Lake and its surrounding environment have long been a focal point of human activity.

Pioneer Settlement and Early Statehood (1849-1905)

Early Settlements

Although the Spanish never returned to establish a permanent settlement, Latter-day Saint (LDS) pioneers moved into the area less than 75 years after the Dominguez-Escalante Expedition. After settling the

Salt Lake Valley, LDS church leader Brigham Young sent thirty men to begin settlement of Utah Valley on March 10, 1849. These settlers immediately became acquainted with the native Ute Indians who inhabited the valley and enjoyed the bounty of the lake and its resources. On April 1, the settlers camped near the Provo River and feasted upon "sucker fish" from the river and waterfowl from the nearby marshes.[15] Soon after, they built a fort and established the community of Provo. In 1850, a flurry of settlement ensued as the communities of Alpine, American Fork, Lehi, Pleasant Grove, and Springville were founded. Salem, Santaquin, Spanish Fork and Nephi followed in 1851 and Cedar Fort and Mona were established in 1852.[16,17]

The manner in which these early settlements grew was largely influenced by the presence of the Ute Indians, who did not like the large influx of foreigners. The threat posed by the Utes forced the communities in Utah Valley to be more centralized. As a result, settlements in Utah Valley developed a significant manufacturing and commercial economy in addition to agriculture, which was the primary economic activity of most early settlements of the Utah Territory.[18] According to the 1850 Census, less than half (48 percent) those employed in Utah County worked in agriculture. In Davis and Weber counties, agricultural activities occupied 81 and 65 percent of the workforce, respectively.[19]

Diversion Dams, Canals and Ditches

In order to sustain diverse economic activities, the pioneers began to aggressively develop and use the available water resources. They built diversion dams on most major streams and constructed canals and ditches to bring the water to their farms and irrigate their crops. They also constructed mills and other appurtenances to support various other enterprises.

In the early 1860s, two diversion dams and major canals were constructed to supply water to farms north and south of the Provo River. The North Union canal diverted water near the mouth of Provo Canyon north to farms in Pleasant Grove and Lehi. The Provo Bench canal diverted water further upstream to enable irrigation of the Provo Bench area, which lay north and east of the original Provo settlement.[20] Similar diversions and canals were constructed on all the major streams entering Utah Lake, enabling large tracts of land to be irrigated and other economic activities to prosper.

Storage Reservoirs

While streamflows were sufficient to sustain the farms of some of the earliest settlers, they were not adequate to sustain all the needs without storage of spring runoff. As a result numerous small reservoirs were constructed. The story of the Salem Pond Irrigation Company is representative of the early dam building activities of many communities throughout the basin. In 1851, the settlers of Salem banded together to form the Salem Pond Irrigation Company, one of Utah's earliest irrigation companies. The company built a small dam near the outlet of a wide hollow area and created Salem Pond, which stores approximately 440 acre-feet of water.[21] The pond is fed by several springs, which were sufficient to irrigate only a few farms. However, with the storage capacity of the new pond, the water needs of the entire community were satisfied.

As the communities in the basin continued to grow, larger dams and reservoirs were constructed. In 1872, a low dam was placed across Utah Lake's outlet to the Jordan River, creating a storage volume in the lake of 710,000 acre-feet. Although the water stored was for use in the Salt Lake Valley, Utah Lake became the first large storage reservoir in the basin and the entire state.[22] In 1880, Elberta Dam was built in Juab County, creating Mona Reservoir.[23] In 1895, the reservoir was enlarged to a capacity of 21,100 acre-feet. In 1903, Wasatch County farmers also made additional water available (3,735 acre-feet) for their use by building dams at the outlet of five lakes at the headwaters of the Provo River and developing them into regulated reservoirs.[24]

Importation Projects

Despite these gains in water storage, irrigators in parts of the basin still needed additional water. In the 1880s, Wasatch County farmers constructed several canals and a 1,000-foot long tunnel to import water from the Strawberry River, a Uinta Basin stream that is part of the Colorado River drainage, to the Daniel's Creek drainage in Heber Valley.[25] Seeing the success of Wasatch County's importation projects, several in Utah Valley devised their own plan to import water from the Uinta Basin for the benefit of residents in southern Utah Valley. A few were so convinced that this plan would work that they began construction of the original Strawberry Dam in 1902 on their own, long before they received financial backing to complete the project.[26] This support eventually came from the federal government under the Newfoundland Act of 1902, which provided money and technical support for water development projects throughout the western United States.

Utah Lake – Fishery and Recreation Destination

In 1855, drought and grasshoppers decimated crops throughout the Utah Territory. To fight-off malnourishment and starvation, settlers from all along the Wasatch Front came to Utah Lake to take advantage of its abundant fishery. Records in Salt Lake City and Provo indicate that at least 8,000 pounds of fish were donated as tithing from 1855-1856, which suggests that at least 80,000 pounds or 40 tons of fish were harvested from the lake during this period.[27] Commercial fishermen were among the first to harvest Utah Lake's bounty. In 1856, at least six companies fished the lake. Although thirteen species of fish were native to the lake, only the Utah sucker and the endangered June sucker remain.[28] As native fish populations declined, more hearty and aggressive fish were introduced into the lake, including the common carp in the 1890s.[29]

Construction of Strawberry Dam approximately one-half completed. Concrete core wall can be seen in the middle of the fill area. (Photo courtesy of U.S. Bureau of Reclamation.)

Utah Lake also became a commercial recreation destination during the 1880s. Numerous resorts sprang up around the lake, including Saratoga, Geneva, Garden City and Provo Lake resorts. These and other destinations soon attracted thousands of local and non-local visitors to the lake. In addition to freshwater bathing and other common activities, these resorts hosted numerous lake tours, boat races and water shows.[30]

Federal Water Projects and Industrial Expansion (1906-Present)

During the twentieth century, three major water projects were constructed by the U.S. Bureau of Reclamation (USBR) that have had a major impact on the Utah Lake Basin. They are the Strawberry Valley Project, the Provo River Project and the Bonneville Unit of the Central Utah Project.

Strawberry Valley Project

The Strawberry Valley Project (SVP), which diverts water from the Uinta Basin to the Bonneville Basin, was only the second federal reclamation project ever built. Continuing the work that was begun by Utah Valley farmers, the USBR began construction in 1906. Within a few years, Strawberry Dam was completed and water began to fill the reservoir, which had an active capacity of 270,000 acre-feet. Other major features of the project included Indian Creek Dike, Currant Creek Feeder Canal, Strawberry Tunnel and the High Line Canal. In 1915, the High Line canal was completed and water was delivered to farmers in southern Utah County, from Spanish Fork south to Spring Lake and westward to the Goshen Valley. In 1918 the Mapleton-Springville lateral was constructed to deliver SVP water north of the Spanish Fork River to farmers in the Mapleton and Springville While farming had been possible in these areas ever since pioneer days, the SVP brought needed security and reliability to the region's agricultural economy. The project also brought needed electrical power to sustain the growth of local communities and related industry.

Provo River Project

Deer Creek Reservoir, the principal feature of the Provo River Project, was completed in 1941. It has an active storage capacity of 152,560 acre-feet. Approximately 120,800 acre-feet of Provo River water is stored in Deer Creek Reservoir which includes 17,400 acre-feet by exchange of return flows to Utah Lake from imported water. The remaining normal flows and flood flows are required to satisfy prior rights on the Provo River and in Utah Lake. Deer Creek Reservoir also stores water imported from the Weber and Duchesne rivers.[31]

The Provo River Project also enlarged the Weber-Provo Diversion Canal from 200 to 1,000 cfs. This canal conveys surplus high flows and some exchange waters from the Weber River to the Provo River near Francis. The Provo River Project also imports water from the Uinta Basin through the Duchesne Tunnel for storage in Deer Creek Reservoir. This tunnel, completed in 1953, diverts water from the North Fork of the Duchesne River, a tributary of the Green River which is tributary to the Colorado River. The tunnel is six miles long and is under a spur of the Uinta Mountains. It discharges into the main stem of the Provo River upstream from Woodland. Its capacity is 600 cfs.[32]

The Provo River Project also enlarged the Provo Reservoir Canal to 550 cfs at its diversion in Provo Canyon and 350 cfs at its terminus near the Point of the Mountain. This canal, which was recently piped and renamed the Provo River Aqueduct, is used to convey agricultural water and municipal and Industrial (M&I) water to northern Utah County and to Salt Lake County. The Salt Lake Aqueduct was also constructed as part of the Provo River Project and transports water from the Provo River all the way to 3300 South in Salt Lake City. It went into operation in 1952 and is used to convey water stored in Deer Creek Reservoir to North Utah County users, the Metropolitan Water District of Salt Lake City and Sandy, and the Jordan Valley Water Conservancy District, for M&I use.[33]

Central Utah Project

The Bonneville Unit of the Central Utah Project is located in central and northeastern Utah and is the largest federal reclamation project in the State of Utah. Construction of the Bonneville Unit's six major components began in 1967. These components are: (1) Starvation Collection System, (2) Strawberry Collection System, (3) Ute Indian Tribal Development, (4) Diamond Fork System, (5) Municipal and Industrial (M&I) System, and (6) Utah Lake System. All components of the Bonneville Unit have been completed, except for the Utah Lake System.

The Utah Lake System took the place of an earlier project component that would have delivered water as far south as Yuba Lake, primarily for irrigation purposes in the Delta area, in Millard County and exchanged water upstream as far south as Panguitch in Garfield County. However, due to environmental opposition, greater need for M&I water in northern Utah County and Salt Lake County, cost and legal complications, this component was abandoned and much of the water allocated to water petitioners to the north. The Bonneville Unit already provides increased flood control, recreation, fish and wildlife measures and, potentially, power generation. Major features of the project include Jordanelle Reservoir (capacity 310,980 acre-feet), Jordan Aqueduct, Starvation and Strawberry collections systems, and the Diamond Fork Tunnel and Pipeline. The project also includes Soldier Creek Dam, which replaced Strawberry Dam and enlarged Strawberry Reservoir from 270,000 acre-feet to 1.1 million acre-feet, making it the largest storage reservoir located entirely in Utah.

Industrial Developments

Following the arrival of the railroad in 1881, many industrial developments sprang up throughout the basin. These included the Lehi Sugar Factory, and sugar beet processing plants in Payson, Pleasant Grove, Provo, Spanish Fork and Springville.[34]

The first significant industrial plant in the county operated as a purely commercial enterprise was Columbia Steel Corporation's Ironton plant completed near Springville in 1926.[35] Numerous other industries followed Ironton to the basin, the most significant being Geneva Steel. As part of the war effort, the U.S. Government constructed the Geneva Steel Works on the shores of Utah Lake near Orem in 1944.[36] Although only owned and operated by the government for two years, Geneva Steel has had a profound impact on the growth of the Utah Lake Basin. From 1940 to 1950, Utah County's population grew 43 percent, a growth spurt that was atypical for 17 other counties in the state that recorded a net decline in population over the same period.[37]

Industry has always played an important role in the economy of Utah County. (Photo of the Lehi Sugar Factory, 1905. Used by permission, Utah State Historical Society, all rights reserved.)

Geneva Steel remained an important part of the local economy until it filed for bankruptcy in the late 1990s and eventually closed in 2001.

The Impacts of Settlement, Industry and Water Development on the Utah Lake Ecosystem

Throughout its history, Utah Lake and its surrounding environment has provided an abundance of plant and animal life for the human inhabitants of the basin. It has been a gathering place for hunters, a resting place for travelers, a home for settlers and a playground for recreationists. Unfortunately, the human population has been less than kind to the lake and its ecosystem. For decades, raw sewage flowed unabated into the lake.[38] Pesticides and nutrients from farms have run off into the lake and accumulated there. Oils and other toxic substances have also run off streets and roads into the lake. Stream channels have been dredged and channelized; flood plains developed; and tributary streams damned and diverted.[39] Non-native fish species have also been introduced, altering critical habitat and pushing out native species.

As a result of this abuse and exploitation, Utah Lake, was viewed by many during the last half of the 20th century as a place too filthy, smelly and unsafe to visit and its waters too polluted to use for most purposes. In recent years, efforts by local, state and federal agencies have helped to clean up the lake, reducing pollutants and restoring the lake to some of its former splendor. Further efforts are needed to restore the lake and its valuable ecosystem

State Water Planning: Fulfilling a Stewardship

One of the main responsibilities of the Division of Water Resources is to conduct comprehensive water planning in Utah. Over the past several decades, the division has conducted several studies and prepared many reports for the Utah Lake Basin. A document resulting from these studies was the *Utah State Water Plan: Utah Lake Basin*, published in 1997.

1997 Utah Lake Basin Plan

Although this document, *Utah Lake Basin—Planning for the Future*, touches upon many of the same topics presented in the 1997 Utah Lake Basin Plan, there is a valuable collection of pertinent data and useful information contained in the original plan that will not be revisited here. Some of the topics that will not be repeated, but may be valuable to the reader, are listed below:

- *Section 7 – Regulation/Institutional Considerations:* A discussion of water-related laws and regulations and the responsibilities of various state and federal agencies with regard to carrying-out these laws.
- *Section 8 – Water Funding Programs*: A description of significant state and federal water funding programs.
- *Section 11.3 – Organizations and Regulations:* A discussion of local, state and federal agencies as well as the various laws that regulate drinking water.
- *Section 13 – Disaster and Emergency Response:* A description of the various types of disasters and emergencies that could disrupt the supply of water and the organizations and regulations that deal with them.
- *Section 16 – Federal Water Planning and Development:* A list of all the federal agencies involved directly or indirectly with water planning and development within the ba-

sin and description of their respective responsibilities.

A copy of the 1997 Utah Lake Basin Plan can be obtained by contacting the Division of Water Resources, or online at the division's web site: www.water.utah.gov.

The 2001 Utah State Water Plan

In May of 2001, the Division of Water Resources updated the Utah State Water Plan with the publication of *Utah's Water Resources—Planning for the Future*. This plan addressed a host of issues important to Utah's future (see sidebar) and is a valuable guide to water planners, managers and others interested in contributing to water-related decisions throughout the state. It is also available online at: www.water.utah.gov/WaterPlan/SWP_pff.pdf.

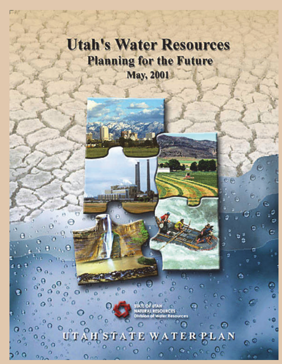
The Current Plan

This document, *Utah Lake Basin—Planning for the Future,* is modeled in large part after the 2001 State Water Plan and provides the reader with more detail and perspective concerning issues of importance to the Utah Lake Basin. It takes a fresh new look at the water resources of the basin. With increasing water demands caused by rapid population growth, water is becoming a more precious resource. The waters of the basin have and will continue to play an important role in meeting some of Utah's most critical future needs, and protecting the quality of this water and its ability to sustain the increased population is of utmost concern. The Division of Water Resources hopes this plan establishes a strong framework that will help guide and influence water-related decisions within the basin.

2001 Utah State Water Plan:
Utah's Water Resources—
Planning for the Future

Managing water resources in Utah is not an easy task. Supply is limited and competition between various uses continues to intensify. Add to that the unpredictable nature of wet vs. dry periods, and one gets an inkling of the complex challenges facing Utah's water planners and managers.

Utah's Water Resources—Planning for the Future attempts to bring all the issues to light and to put the many pieces together that are required to obtain balanced and efficient water management. It discusses the major issues facing Utah's water resources and provides valuable data and guidance that will help in the important effort to efficiently manage one of the state's most precious resources.



NOTES

[1] A dam at the outlet of Utah Lake to enhance the natural storage was first constructed in 1872.

[2] Utah Division of Water Resources, *Utah State Water Plan: Utah Lake Basin Plan,* (Salt Lake City: Dept. of Natural Resources, 1997), page 5-3.

[3] Ibid, page 3-8.

[4] Ibid, page 3-11.

[5] Ibid.

[6] Utah State Data Center, *Utah Data Guide: A Newsletter for Data Users,* Summer/Fall 2010 (Salt Lake City: Governor's Office of Planning and Budget, 2010), 1.

[7] Carter, D. Robert, *Utah Lake: Legacy,* edited by Betsy Stevenson, (Vanguard Media Group, 2003), 20.

[8] Ibid.

[9] Ibid.

[10] Janetski, Joel C., "Utah Lake: Its Role in the Prehistory of Utah Valley," Utah Historical Quarterly, vol. 58, no.1 (Salt Lake City: Utah State Historical Society, 1990), 16.

[11] Carter, 2003, 20.

[12] Utah Division of Water Resources, 1997, page 3-11 & page 3-12.

[13] Carter, 2003, 23.

[14] Holzapfel, Richard Neitzel, *A History of Utah County,* Utah Centennial County History Series, (Salt Lake City: Utah State Historical Society, 1999), 18 & 36.

[15] Ibid, 53-54.

[16] Ibid, 54-55.

[17] Wilson, Pearl D. et. al., *A History of Juab County,* Utah Centennial County History Series, (Salt Lake City: Utah State Historical Society, 1999), 44 & 48.

[18] Holzapfel, 1999, 57.

[19] Ibid.

[20] Provo Bench Canal and Irrigation Company Records, 1862-1976. From the "Background Note" retrieved from the Utah State Historical Society's Internet web page: http://history.utah.gov/FindAids/B00209, January 2006.

[21] Salem Pond Irrigation Company Records, 1851-1979. From the "Background Note" retrieved from the Utah State Historical Society's Internet web page: http://history.utah.gov/FindAids/B00208, January 2006.

[22] Utah Division of Water Resources, 1997, page 3-13. A pumping plant was installed at the dam in 1902 so that the lake water could be lowered below the outlet elevation; this and subsequent modifications to the pumping plant and outlet works increased Utah Lake's storage capacity to 870,000 acre-feet.

[23] Wilson, 1999, 64.

[24] Embry, Jessie L., *A History of Wasatch County,* Utah Centennial County History Series, (Salt Lake City: Utah State Historical Society, 1996), 85-86.

[25] Ibid, 51 & 84.

[26] From an interview with Wallace Gardner conducted by Jay Haymond, August 7, 1972 as part of the Utah State Historical Society's Oral History Program.

[27] Carter, 1999, 44-47.

[28] From the Wikipedia web page: http://en.wikipedia.org/wiki/Utah_Lake. Retrieved February 2014.

[29] Carter, 1999, 44-47.

[30] Ibid, 84-97.

[31] Utah Division of Water Resources, 1997, page 3-14.

[32] Ibid.

[33] Ibid.

[34] Holzapfel, 1999, 159.

[35] Ibid, 202.

[36] Ibid, 246.

[37] Ibid, 270.

[38] Carter, 2003, 37.

[39] Ibid, 37 & 53.

2

WATER SUPPLY

This chapter provides an overview of the water supply available in the Utah Lake Basin. It begins with a discussion of climatological data that influences the water supply, including precipitation and temperature. Surface and groundwater supplies are then discussed, followed by a water budget for the basin and a section on developed water supplies. The chapter's final section discusses water rights, since it plays a key role in water supply and development.

CLIMATOLOGICAL INFLUENCES

Climate in the Utah Lake Basin is typical of mountainous areas in the western United States, with wide ranges in temperature between summer and winter, and between day and night. The high mountain regions experience long, cold winters and short, cool summers. The lower valleys are more moderate with less variance between maximum and minimum temperatures. As part of the Great Basin Region lowlands, the Utah Lake Basin is classified as semi-arid.

The basin experiences four distinct seasons with a major portion of the precipitation occurring as snow in the mountain regions during the winter months, producing high runoff during the spring snowmelt periods. The Utah Lake Basin receives an average 18.5 inches of precipitation annually. This precipitation is distributed as shown in Figure 2 and ranges from a low of 9 inches in the western portion of the basin to nearly 60 inches in the Mountain peaks of the Wasatch Mountains northeast of Alpine and American Fork.

The Utah Lake Basin, as defined by the Utah Division of Water Resources, consists of all lands draining to Utah Lake and to the Jordan River at the Salt Lake County line (see Figure 1); this includes most of Utah County and portions of Summit, Wasatch, Juab, Sanpete and Carbon counties. The Utah Lake Basin is hydrologically connected to the Jordan River Basin via the Jordan River. The Jordan River Basin includes all of Salt Lake County above the shoreline of the Great Salt Lake. Almost 60 percent of the surface water inflow to Utah Lake flows out of the lake and into the Jordan River Basin. This report addresses water issues specific to the Utah Lake Basin.

Precipitation in the lower elevations during the May through September growing season is only 4 to 10 inches, compared to a crop water requirement ranging between 20 to 30 inches. A portion of the precipitation on both mountain ranges is absorbed into the soil and underlying bedrock during the runoff periods, providing recharge to the valley groundwater aquifers.

Table 1 contains climatological data for the weather stations within the basin. Mean temperatures for January range from 20°F at Birdseye station to 31°F at the Provo, BYU station and the Olmstead Powerhouse station. Average minimum temperatures for January range from 5°F at the Birdseye station to 23°F at the Provo, BYU station, with average maximum temperatures ranging from 33°F at Deer Creek Dam to 42°F at the Spanish Fork 1st South Station. July's mean temperatures range from 66°F at the Birdseye and Snake Creek stations to 77°F at several stations. Average minimum temperatures for July range from 43°F at Birdseye to 60°F at multiple stations, while average maximum temperatures varied from 85°F at Snake Creek to 94°F at the Provo, BYU station.

FIGURE 2
Average Annual Precipitation

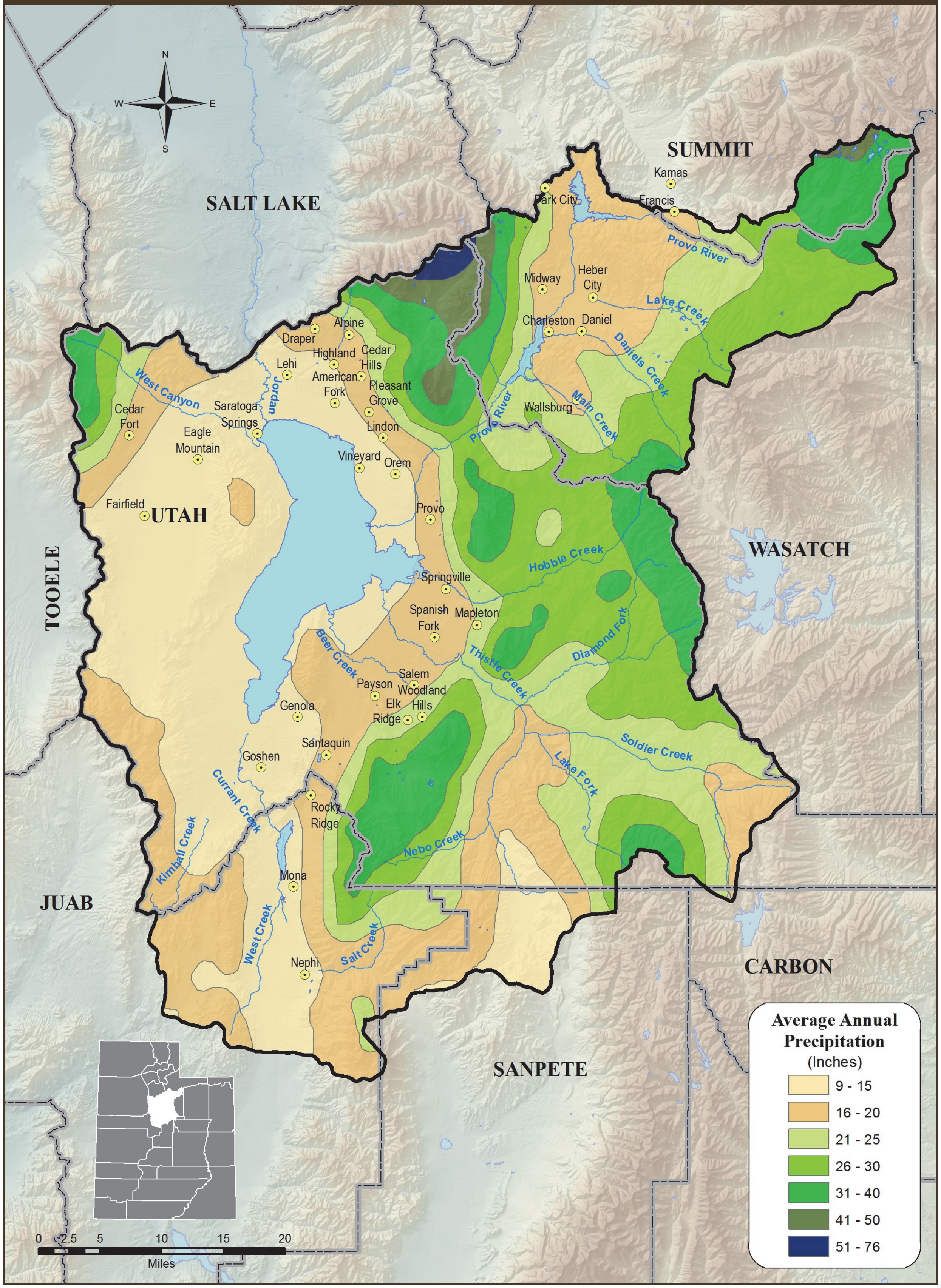


TABLE 1
Climatological Data

Weather Station	Temperature (Average Max. Min. and Mean in °F)								Precipitation	
	January			July			Record		Snow (in.)	Avg. Ann. (in.)
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.		
Alpine	39	20	29	90	57	73	105	-20	51.0	16.9
Birdseye	36	5	20	88	43	66	101	-37	66.2	13.5
Deer Creek Dam	33	8	21	87	57	77	100	-39	79.5	22.1
Elberta	37	16	27	92	58	75	10.7	-29	25.7	10.7
Geneva Steel	38	22	30	91	63	77	103	-10	11.4	9.0
Heber	35	9	22	88	47	67	105	-38	70.0	15.9
Olmsted Powerhouse	40	21	31	92	59	75	108	-16	33.7	20.3
Pleasant Grove	39	20	29	91	59	75	104	-19	43.0	16.7
Provo Airport	35	15	25	89	58	73	99	-25	58.6	13.2
Provo BYU	40	23	31	94	60	77	108	-20	56.0	20.2
Provo Radio KAYK	38	16	28	92	53	73	106	-20	14.3	11.9
Santaquin Chlorinator	39	17	28	90	60	75	108	-22	65.8	18.7
Snake Creek	34	10	22	85	47	66	102	-34	121.9	22.3
Spanish Fork 1S	42	19	30	93	58	76	106	-12	35.6	13.2
Spanish Fork Powerhouse	38	20	29	93	60	76	108	-20	53.9	19.2
Timpanogos Cave	34	20	27	90	58	74	112	-14	86.0	24.0
Utah Lake Lehi	36	15	26	90	55	73	106	-28	27.8	11.4

Note: The period of record varies for each station and goes through 2010.

Available Water Supply

The Utah Lake Basin's present water supplies come from three sources: groundwater, local surface water and imported surface water. Local surface water sources include the Provo River, Spanish Fork River, American Fork River, Hobble Creek and other small streams tributary to the Utah Lake.

Surface Water

The portion of precipitation not initially evaporated or transpired by vegetation, eventually makes its way into streams and other surface water-bodies, or percolates into the ground. Surface water can be quantified at gaging stations on streams segments. The U.S. Geological Survey, in cooperation with other federal and state entities, monitors an extensive network of gaging stations throughout Utah. Table 2 shows the average annual flow for active gaged streams and rivers in the Utah Lake Basin. Table 3 shows the average annual flow for stream gages that have been discontinued.

Figure 3 shows a graphic estimation of the present average annual streamflow of Utah Lake's primary contributors: the Provo River (141,000 acre-feet per year), the Spanish Fork River (256,000 acre-feet per year), the American Fork River (76,000 acre-feet per year), as well as several minor tributary inflows: Hobble Creek, Current Creek, Cedar Valley and groundwater. The band widths represent the flows and are proportional to the average annual flow in acre-feet. Gaging stations are not shown. There is a

TABLE 2
Active Streamflow Gaging Stations

Number	Location	Years of Record	Average Annual Flow (acre-feet)
Gaging Stations on Current Creek and Tributary Streams			
10145400[1]	Salt Creek Below Nephi Powerplant[2]	1993-present	10,180
10146000[1]	Salt Creek at Nephi[3]	1950-present*	17,780
10146400	Current Creek Near Mona	1978-present	20,870
Gaging Stations on Spanish Fork and Tributary Streams			
10149400	Diamond Fork Above Red Hollow[4]	2001-present	104,000
10150500	Spanish Fork at Castilla	1903-present*	170,200
Gaging Stations on Provo River and Tributary Streams			
10154200	Provo River Near Woodland	1963-present	157,200
10155000	Provo River Near Hailstone	1949-present	199,400
10155200	Provo River at River Road Bridge near Heber	2001-present	111,420
10155300	Provo River near Midway	1995-present	149,200
10155400	Spring Creek near Heber City	1993-present	17,370
10155500	Provo River near Charleston	1991-present	172,000
10156000	Snake Creek near Charleston	1938-present*	32,790
10157500	Daniels Creek at Charleston	1993-present	7,290
10163000	Provo River at Provo	1903-present*	146,100
10164500	American Fork above Upper Powerplant	1927-present	25,000
10166430	West Canyon Creek near Cedar Fort	1965-present*	2,590

* Data collection at these sites was not continuous, and may include many years of little or no data .
1: These two gaging stations measure instream flow compliance in the generator penstock bypass reach and are not a measurement of total flow.
2: Flow in the bypass reach below the powerplant diversion.
3: This station is located upstream of the Nephi powerplant tailrace discharge and does not represent the total flow in the creek. Records are missing for the extremely wet period in the mid-1980s and the powerplant return flow is not included in this number after 1985.
4: Includes releases from Strawberry Reservoir.

considerable difference between the estimated current average annual flows shown in Figure 3 and the historic gaged flows. This is largely due to the recent changes in the amount of water imported to, and exported from the basin. Gaged stream flows with records dating back to the 1920's and 1930's more closely reflect the natural system. Recent increased imports from the Uinta Basin particularly through the Strawberry Collection System, and increased exports to the Jordan River Basin via the Jordan Aqueduct and the Salt Lake Aqueduct have significantly altered the flows in the Spanish Fork and Provo Rivers from their historic norm. Furthermore, while the import amounts shown for the Ontario Tunnel, Weber/Provo Diversion Canal and the Duchesne Tunnel are average annual flows, those shown for the Syar Tunnel, Strawberry Tunnel, Jordan Aqueduct, and Salt Lake Aqueduct are maximum flows. Consequently, Figure 3- Estimated Annual stream Flow and Diversions may not match up precisely with existing stream flow records, nor reflect current gaged stream data for any given year. The figure does, however, present a balanced estimate of the basin-wide water budget, given the known historic diversions, the known imports and exports from the basin along with the estimated groundwater recharge to the Lake, estimated evaporation from the Lake, and the gaged outflow of the Jordan River to Salt Lake County.

Collectively, the average annual surface water inflow to Utah Lake is 590,000 acre-feet per year. An

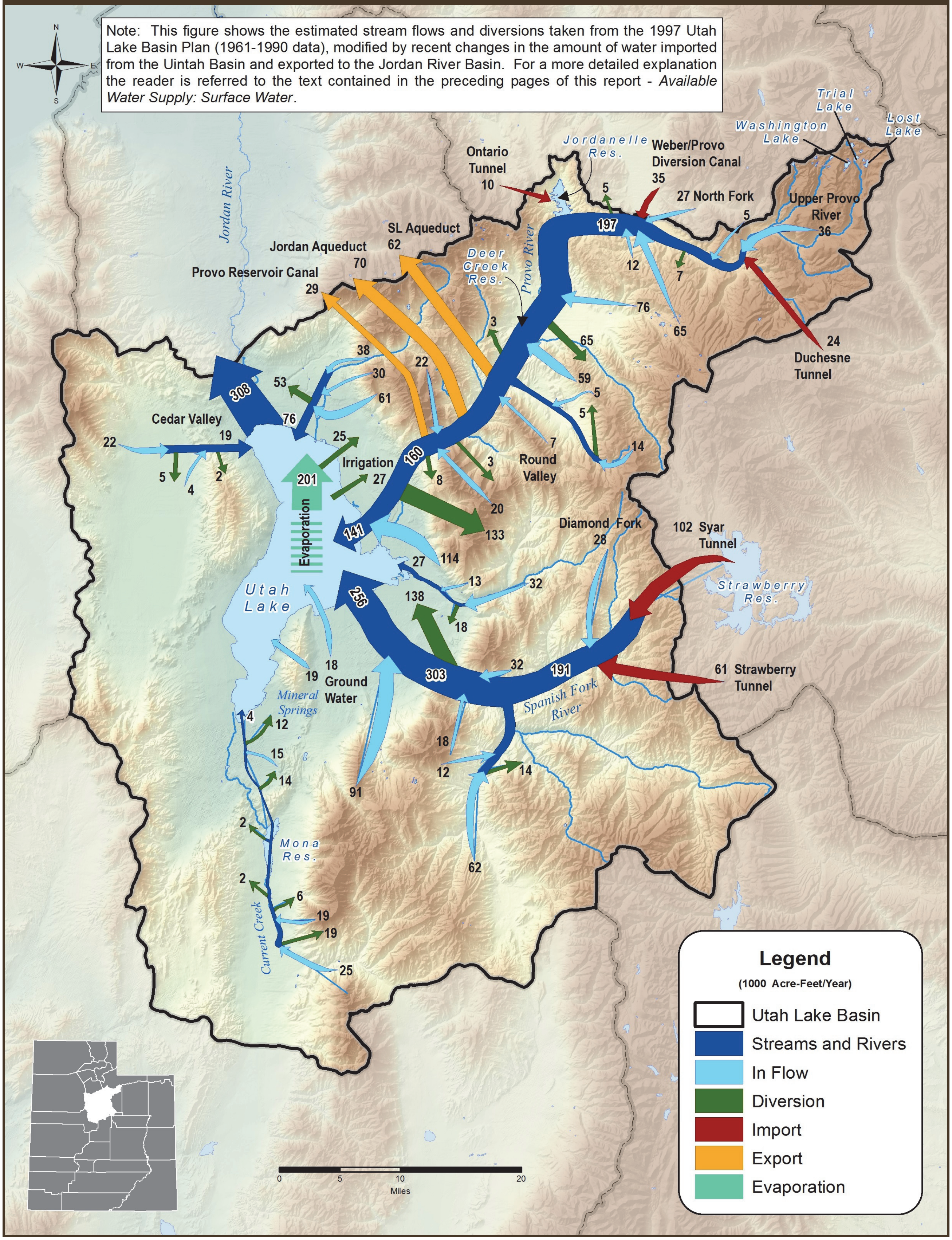
TABLE 3
Discontinued Streamflow Gaging Stations

Number	Location	Years of Record	Average Annual Flow (acre-feet)
09272500	Duchesne Tunnel near Kamas	1953-1969	31,123
09282000	Strawberry Tunnel near Thistle	1922-1968	61,523
10147000	Summit Creek Near Santaquin	1911-1966	9,003
10147500	Peteetneet Creek Near Payson	1948-1962	9,167
10148400	Nebo Creek Near Thistle	1964-1974	10,091
10149000	Sixth Water Creek above Syar Tunnel	1998-2003	17,140
10149500	Diamond Fork Near Thistle	1954-1993	76,954
10152500	Hobble Creek Near Springville	1909-1974	31,244
10153800	North Fork Provo River near Kamas	1963-1973	9,620
10152900	Maple Creek near Mapleton	1965-1973	1,510
10154000	Shingle Creek near Kamas	1963-1993	26,641
10154500	Weber-Provo Canal near Woodland	1943-1993	37,100
10155100	Provo River Below Jordanelle	1992-1993	60,726
10158500	Main Creek near Wallsburg	1939-1950	9,615
10159500	Provo River below Deer Creek	1953-2003	254,600
10160000	Deer Creek near Wildwood	1939-1950	26,641
10161500	South Fork Provo River at Vivian Park	1912-1962	9,620
10164500	American Fork River above Powerplant	1928-1989	40,863
10165500	Dry Creek near Alpine	1948-1955	5,426
10166000	Fort Creek near Alpine	1948-1955	5,426
10166430	West Canyon near Cedar Fort	1965-1993	2,204
10167000	Jordan River at Narrows	1936-1991	310,000
10145500	Salt Creek near Nephi	1951-1981	18,756

estimated 37,000 acre-feet per year enters the lake from groundwater sources. Approximately 52,000 acre-feet per year is withdrawn from the lake for irrigation and M&I uses within the basin. Because Utah Lake is so shallow it is estimated that more than 40 percent of its inflow (230,000 acre-feet per year) is lost to evaporation. An average 308,000 acre-feet leaves the lake annually flowing north in the Jordan River to Salt Lake County.

Utah Lake became a storage reservoir in 1872 when a low dam was placed across the lake's outlet to the Jordan River. Traditionally, much of the water released from Utah Lake to the Jordan River has been diverted for irrigation and other uses in northern Utah County and Salt Lake County. At compromise level (4,489.045 feet), Utah Lake can store approximately 870,000 acre-feet of water. Compromise level is the lake surface elevation at which the gates releasing water to the Jordan River must be fully opened. The first 12 feet of storage below the compromise level is considered active storage (710,000 acre-feet). The next 160,000 acre-feet of storage is considered inactive. The first 125,000 acre-feet of active storage is called primary storage, while the balance is called system storage.

FIGURE 3
Estimated Annual Stream Flows and Diversions



Fifteen lakes clustered at the headwaters of the Provo River near the crest of the Uinta Mountains were fitted with dams and outlet works around 1910 and have for many years provided reservoir storage capacity for irrigators in Utah Valley. With the construction of Jordanelle Reservoir, 12 of these lakes were stabilized (fixed surface elevation) and their storage capacity was moved into Jordanelle Reservoir. Three lakes: Trial, Washington, and Lost continue to function as reservoirs collectively providing 3,433 acre-feet of storage for irrigators in and around the towns of Woodland, Francis and Kamas.

Groundwater

Although groundwater recharge within the basin is estimated to be 631,000 acre-feet/year, groundwater modeling and historical data indicate that any additional groundwater withdrawals will produce a significant impact upon surface water flows. This fact, coupled with the fact that each of the basin's aquifers has a significant number of approved, yet unperfected water rights, has prompted the State Engineer to close the basin's aquifers to further appropriation, and establish a "safe yield" groundwater withdrawal limit of 165,000 acre-feet per year.

The Utah Lake Basin consists of five groundwater aquifers (See Figure 4). These are the Utah-Goshen Valley Aquifer and the Cedar Valley Aquifer in Utah County, the Heber Valley Aquifer and the Round Valley Aquifer in Wasatch County, and the Northern Juab Valley Aquifer in Juab County. All five of these aquifers are valley fill type, consisting of alternating granular alluvial fan deposits, creating a number of confined, unconfined and perched aquifers as illustrated in Figure 5. Data for the five groundwater aquifers are summarized in Table 4, and a description of each is provided below.

<u>Utah – Goshen Valley aquifer</u>

Geologically, the Utah – Goshen Valley aquifer is a string of coalescing alluvial fans and river deltas on the hanging wall of the Wasatch Front. The alluvium is composed of multiple layers of sand and gravel deposited at the mouths of canyons, becoming finer westward toward Utah Lake. This is interlayered with clay deposited on the beds of ancient lakes. Gravity and drill-hole data shows up to 1,000 feet of depth of unconsolidated alluvium.

The State Engineer (the Director of the Division of Water Rights) adopted the Utah - Goshen Valley Groundwater Management plan for the valley on November 15, 1995. The purpose of the management plan is to establish guidelines for the future administration and management of the groundwater resources in Utah and Goshen valleys.[1] The plan is intended to encourage the efficient transfer of water, especially from irrigation to municipal and domestic uses, while protecting prior water rights.[2]

In the past the aquifer has been managed as if it were several distinct aquifers. Surface water rights and groundwater rights have also been appropriated independently of each other. However, recent studies, by the USGS have shown that the valley's fill is more accurately described as "one aquifer comprised of many discontinuous layers of permeable and less permeable material."[3] Furthermore, modeling of the valley's groundwater has shown that "every acre-foot of well water consumed in Utah - Goshen Valley causes the loss of an acre-foot of water discharging to Utah Lake."[4] Consequently, the Utah - Goshen Valley aquifer is managed jointly with surface water. Both surface and groundwater are closed to new appropriations at this time, since it has been determined that the basin's water supply has been fully appropriated.

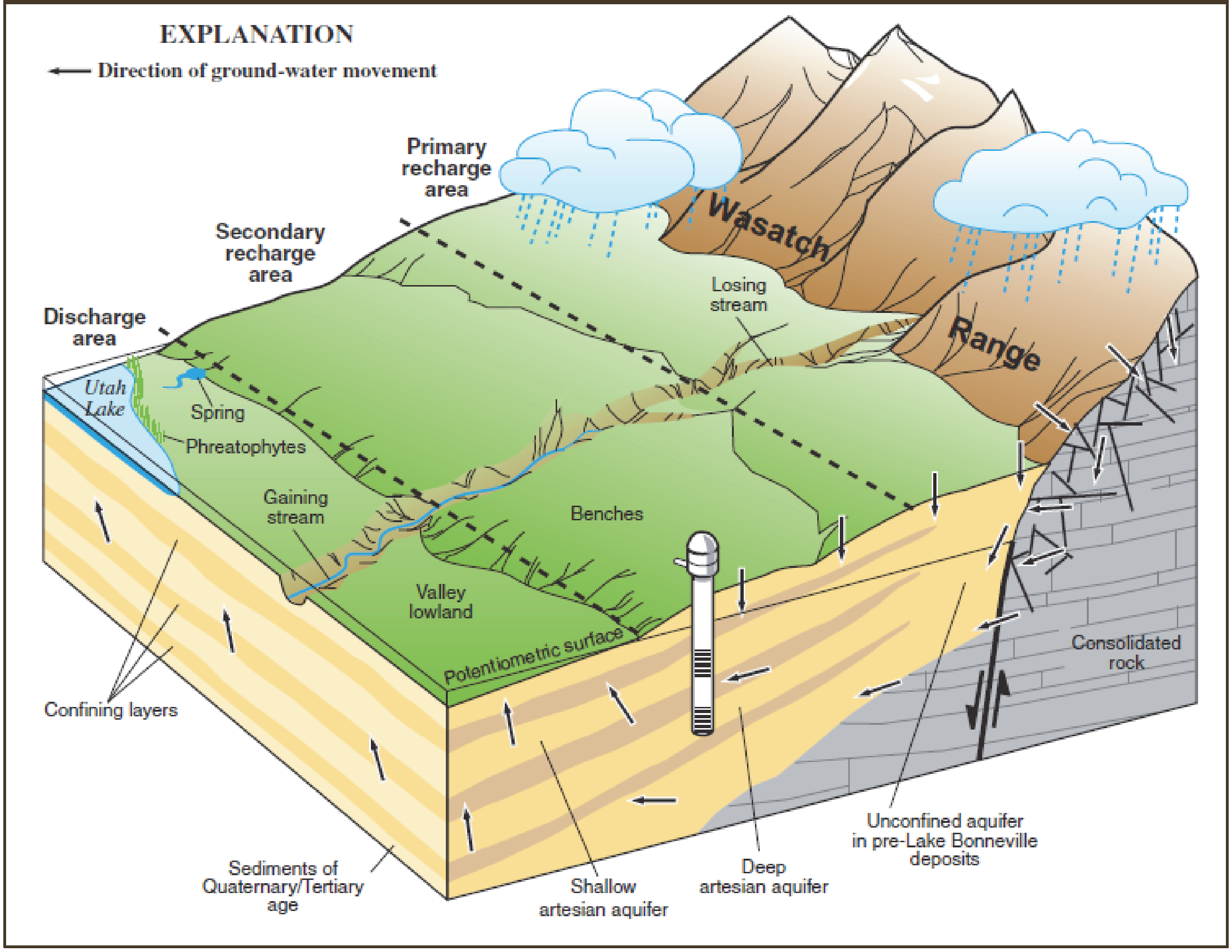
Recharge to the aquifer is estimated to average 344,000 acre-feet per year. At the present time, production wells withdraw an average of 106,000 acre-feet per year. Based upon existing water rights, however, the valley's wells have the potential to withdraw 239,700 acre-feet per year. Additionally, there is the potential for an estimated 77,000 acre-feet per year to be taken from seeps and springs.[5]

<u>Heber Valley Aquifer</u>

The Heber Valley Aquifer is characterized by alluvial fan materials that are coarse around the valley margins and become finer toward the valley bottom. The other component of valley fill comes from the Provo River, which in meandering back and forth across the valley has deposited fluvial sands and gravels up to 375 feet thick. The groundwater recharge for the basin is estimated to be 111,300 acre-

FIGURE 4
Groundwater Withdrawal Regions

FIGURE 5
Groundwater Cross-Sectional Schematic



feet. Groundwater withdrawals from the basin, however, are merely 870 acre-feet per year. The bulk of the aquifer's discharge flows to Deer Creek reservoir, the Provo River and through subsurface outflow into the Utah-Goshen Valley aquifer.

Both the Heber Valley Aquifer and the Round Valley Aquifer are managed under the Upper Provo River Groundwater Policy.[6] Due to the strong interrelationship between groundwater and surface flows, the groundwater rights are managed jointly with surface water rights. This portion of the basin currently allows the appropriation of water for single family residential use where no other source of water is available. The policy does cite the currently changing land use practices from largely agricultural use to primarily residential use.

Round Valley Aquifer

The Round Valley Aquifer is a valley fill of alluvial fan deposits consisting of poorly sorted gravel, sand, silt and clay. The thickest section of unconsolidated valley fill drilled thus far is about 100 feet. Total annual groundwater recharge is about 8,000 acre-feet. Production from more than 115 small domestic and stock watering wells amounts to about 140 acre-feet per year (about 2 % of the average annual recharge). Along with the Heber Valley Aquifer, the Round Valley Aquifer is managed by the State Engineer's Upper Provo River Ground-water Policy, established in November, 1995. The policy states that the further development of surface and groundwater is closed except for the appropriation of water for single family residential use where no other source of water is available.

TABLE 4
Summary of Groundwater Recharge and Withdrawals

Name	Aquifer	Groundwater Model	Recharge (acre-feet)	Withdrawals (acre-feet)	Water Quality	Water Rights Status
Cedar Valley	Valley Fill	Yes	22,000	6,750	Good to Marginal	Closed
Heber Valley	Valley Fill	Yes	111,300	870	Good to Marginal	Closed
Round Valley	Valley Fill	Yes	8,000	140	Good to Marginal	Closed
Utah and Goshen Valleys	Valley Fill	Yes	344,000	106,000	Good to Marginal	Closed
Northern Juab Valley	Valley Fill	Yes	40,000	20,500	Good to Marginal	Closed
Basin Total			**631,300**	**149,260**		

Groundwater withdrawals reported in the Utah/Goshen Valley Ground-water Management Plan and the Upper Provo Ground-water policy.

Cedar Valley Aquifer

Geologically the Cedar Valley Aquifer is a down-dropped graben filled with alluvium, eroded from the surrounding mountains and deposited as coalescing alluvial fans. Associated with the fan deposits are sediments laid down as ancient lake beds. The valley fill materials are coarse-grained nearer the mountains, becoming finer-grained toward the center of the valley.

It is estimated that the aquifer receives an average annual recharge of 22,000 acre-feet per year, with the majority (an estimated 15,000 acre-feet per year) leaving the basin as subsurface outflow to Utah Valley. Groundwater production is from both springs and wells. Three springs west of Cedar Fort produce a combined flow of approximately 800 acre-feet annually. Fairfield spring discharges between 3 and 5 cfs, resulting in an annual average of approximately 3,000 acre-feet per year. Average annual discharge from wells within the sub-basin accounts for 2,950 acre-feet per year.

The current Cedar Valley Ground-water Policy was set forth by the State Engineer and became effective on November 15, 1995. The Cedar Valley area is closed to new appropriations of groundwater, since studies have shown that Cedar Valley groundwater is tributary to Utah Lake and the Jordan River.

Northern Juab Valley Aquifer

The northern Juab Valley is a down dropped valley against the Wasatch Fault. Valley fill consists of a series of alluvial fans and inter-bedded lake bottom deposits. The alluvium is coarse and granular adjacent the mountain front and becomes fine toward Mona Reservoir and the middle of the valley. Recharge to the groundwater aquifer is estimated to average 40,000 acre-feet per year. Annually, approximately 20,500 acre-feet is withdrawn from the aquifer through pumped and flowing wells, springs and seeps. The balance of the groundwater recharge outflows through subsurface movement primarily north into the Utah-Goshen Valley Aquifer.

Imported and Exported Water

Water is imported to the Utah Lake Basin from both the Weber and Uinta basins. Water is exported from the Utah Lake Basin to the Jordan River Basin (Salt Lake County).

Weber-Provo Diversion Canal

The initial Weber-Provo Diversion canal, with a capacity of 210 cfs, was constructed between 1928 and 1931 as a feature of the Weber River Project. The canal diverts water from the Weber River near Oakley, and transports it nine miles southward through the Kamas Valley and delivers it into the Provo River near Francis, upstream of the Jordanelle Reservoir. Annual water diversions between 1932 and 1942 ranged from a low of 2,500 acre-feet per year to a high of 17,300 acre-feet per year with an average of 9,900 acre-feet per year. In 1942 the Weber-Provo Diversion Canal was enlarged to 1,000 cfs as part of the Provo River Project.

Currently water is diverted under an existing water right appropriated by the Provo River Water Users Association. This water right allows a maximum annual diversion from the Weber River and Beaver Creek of 136,500 acre-feet per year. An additional water right allows for the diversion of up to 37,200 acre-feet per year. These water rights are, however, junior to earlier downstream water rights in the Weber River Basin. Consequently, the actual amount of water diverted from the Weber River Basin is considerably less than the water right, and fluctuates significantly from year to year. Between 1943 and 1993, (a 51 year period) the amount of Weber River water diverted to the Utah Lake Basin ranged from a low of 5,294 acre-feet to a high of 88,440 acre-feet averaging 35,000 acre-feet per year.

The Duchesne Tunnel

The Duchesne Tunnel, also part of the Provo River Project, diverts water from the North Fork of the Duchesne River, a tributary of the Green and Colorado rivers. The tunnel intake is 21 miles east of Woodland. This tunnel, located under the spur of the Uinta Mountains, has a capacity of 600 cfs, is six miles long and discharged into the main stem of the Provo River upstream of Woodland. Completed in 1953, the tunnel began delivering water for the 1954 irrigation season. Flow is dependent upon the availability of surplus water for its diversions, because it has a 1936 water right and there are many prior rights on the Duchesne River. More than 70 percent of average annual flow diverted through the Duchesne Tunnel occurs during May and June. Water diversions have ranged from 0 to 57,750 acre-feet per year, averaging 24,000 acre/feet per year.

The Ontario Tunnel

In the upper Provo drainage, the Ontario Tunnel was constructed in 1891 to drain the lower levels of the Ontario, Daly, West and Silver King mines. These mines, near Park City are in the Weber River Drainage. The tunnel drains water across the divide and discharges into the Provo River Basin. Throughout the length of four miles this tunnel receives water from underground sources. The average annual flow from this tunnel is about 10,000 acre-feet.

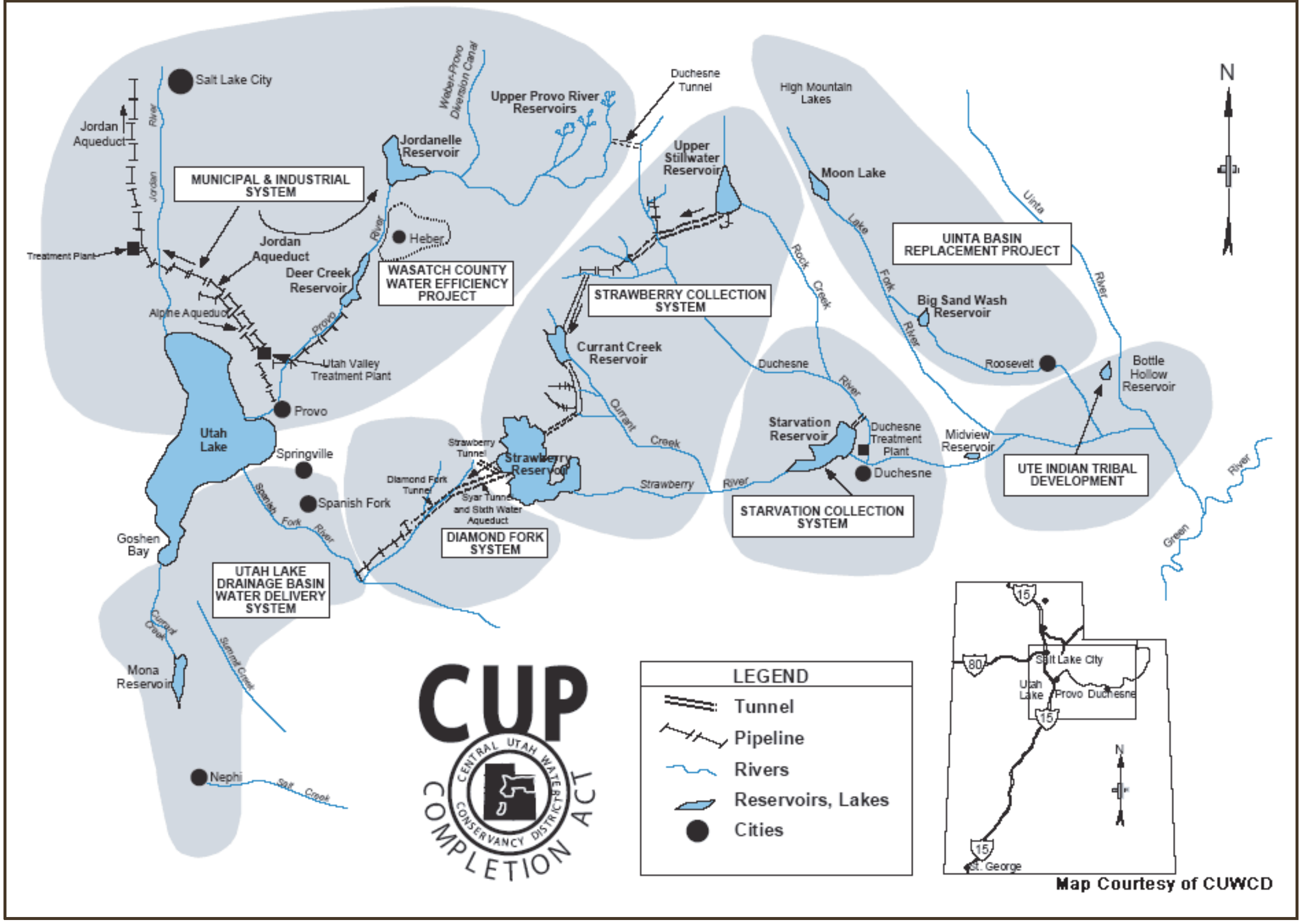
The Strawberry Valley Project, operated by the Strawberry Water Users Association was the first Bureau of Reclamation project in Utah. The construction of the Strawberry Dam and reservoir commenced on March 6, 1906 and was completed in1913. The initial project included the diversion of water from Strawberry Reservoir to the Spanish Fork River and the Utah Lake Basin. The project did not include the diversion of water from the Duchesne River or Currant Creek to Strawberry Reservoir, although such strategies had been considered at the time. The Strawberry Valley Project imports an average annual 61,000 acre-feet of water into the Utah Lake Basin from the Uinta Basin. The CUP imports 101,900 acre-feet of water from the Strawberry Collection System (See Figure 6).

The Metropolitan Water District of Salt Lake and Sandy (MWDSLS) can export as much as 61,700 acre-feet per year of Provo River Project water. This water can be conveyed to Salt Lake County via the Salt Lake Aqueduct, the Jordan Aqueduct, the Provo Reservoir Canal, or by surface flow through Utah Lake. The Welby-Jacob Exchange provides the Jordan Valley Water Conservancy District with the right to export an average annual 29,000 acre-feet of water from the basin. As part of the Central Utah Project (CUP) an annual average annual 70,000 acre-feet of water is exported from the Utah Lake basin to Salt Lake County for municipal and industrial use in the Jordan River Basin.

Total Available Supply

The total precipitation within the Utah Lake Basin is about 3,000,000 acre-feet per year (See Table 6). This figure was arrived at by performing a mass-balance evaluation of the data presented in Figure 2 – Average Annual Precipitation, and represents approximately 18.5 inches of precipitation over the basin's 1,945,000 acres. To this natural supply an additional 231,900 acre-feet is imported from the Uinta and Weber Basins (See Table 5 – Interbasin Diversions), providing the basin with a total annual water supply of just over 3.2 million acre-feet. It is

Figure 6
Central Utah Project



estimated that 631,300 acre-feet of that water, referred to as groundwater recharge, makes its way into the basin's groundwater aquifer systems and deep percolation. An estimated 505,000 acre-feet per year is diverted for irrigation, (see figure 3) and 61,500 acre-feet per year is diverted for M&I (Municipal and Industrial use) within the basin (See Table 8). An additional 160,700 acre-feet per year is exported to Salt Lake County for M&I use. Evaporation from Utah Lake is estimated to be approximately 201,000 acre-feet per year and average annual flow of the Jordan River leaving the basin is 308,000 acre-feet per year. This means that 1,364,400 acre-feet or 45% of the basin's naturally occurring precipitation is used by the vegetation and natural system's including evaporation.

The most recent land use survey identified 127,000 acres of irrigated land in the basin. With the basin's irrigation duty set at 4 acre-feet per acre, this equates to a potential for 508,000 acre-feet of water to be diverted from surface and groundwater sources for irrigation. This is very close to the current estimate of irrigation diversions from surface runoff and Utah Lake of 505,000 acre-feet per year. It is estimated that about half of the water diverted for irrigation (252,000 acre-feet) is depleted from the basin, through evapo-transpiration. Estimated M&I depletions are estimated to be 73,300 acre-feet per year.[7]

VARIABILITY OF SUPPLY

For the sake of convenience, the discussion to this point has focused on the basin's average annual water supply. Actual water supply conditions rarely match these averages. In fact, it is not unusual to experience water supply conditions that are extremely drier or wetter than average. Figure 7 illustrates this point with a comparison of a dry, an average and a wet year. The blue bars show monthly precipita-

TABLE 5
Interbasin Diversions

Basin	Source	Receiving Conveyance	Receiving Stream	Owner	Developed Supply (acre-feet/year)
Imports					
Weber	Weber River	Weber Provo Diversion Canal	Provo River	Provo River Water Users	35,000
Weber	Ontario Tunnel	Ontario Tunnel	Provo River		10,000
Uinta	Duchesne River	Duchesne Tunnel	Provo River	Provo River Water Users	24,000
Uinta	Strawberry River	Strawberry Tunnel	Sixth Water	Stawberry Water Users	61,000
Uinta	Duchesne Tributaries	Syar Tunnel	Diamond Fork	CUWCD	101,900
Total					**231,900**
Exports					
Jordan	Deer Creek Reservoir	Salt Lake Aqueduct	MWDSL	MWDSL	61,700
Jordan	Welby-Jacob Exchange	Provo Reservoir Canal	Jordan Treatment Plant	Jordan Valley WCD / MWDSLS	29,000
Jordan	Central Utah Project	Jordan Aqueduct	Jordan Treatment Plant	Jordan Valley WCD / MWDSLS	70,000
Total					**160,700**

tion in inches received at the basin's Snotel sites, while the red line shows monthly streamflow of the Provo River in acre-feet.

Figure 7 shows that the actual water supply can vary substantially from the average amounts. On average (1971-2000), the Provo River delivered 144,120 acre-feet to Utah Lake. During the drought year of 2003, the total flow of the Provo River (at gage 10163000) was 62,298 acre-feet, less than half of the thirty-year average. In the wet year of 1986, 400,956 acre-feet flowed from the Provo River to Utah Lake, nearly 3 times the annual average. This variability illustrates the need for water storage, either surface or subsurface and the possible scenarios that may come to fruition during any given water year that water suppliers must take into account in their planning activities. Without the benefits of storage, and imported water, the effects of poor water years, such as prolonged drought, would be severely felt, as would the effects of flooding during wet periods. Instead, surface and subsurface storage allows much of the excess flows available during wet years to be captured and held for use in drier years.

Drought

For planning purposes, it would be useful to be able to predict periods of drought; their duration and intensity. Meteorologists have attempted to make such predictions and are continually fine tuning their models as their understanding of climate-influencing factors expands. There has been limited success to date. Drought prediction or other "early warning" systems could provide the needed stimulus during wet periods for implementing conservation measures and for investing in infrastructures such as reservoirs, aquifer storage and recovery projects, and water reuse; helping to foster a more proactive approach to managing drought. Currently, officials use one or more of several indices to measure the relative severity of droughts. The State of Utah uses both the Palmer Drought Severity Index (PDSI), based upon precipitation and temperature, and the Surface Water Supply Index (SWSI) based upon precipitation, stream flow, snowpack and reservoir storage, when declaring drought status. Figure 8 shows the PDSI record (over 100 years of drought record) for Utah's climatic divisions 3 and 5, which are presented here because they either included the mountainous regions where the majority of the area's moisture is derived or contain part of the Utah Lake Basin. Positive PDSI values are indicative of wet conditions whereas negative values represent dry or drought conditions.

TABLE 6
Estimated Water Budget

Category	Water Supply (acre-feet/year)
Supply	
Total Precipitation[1]	3,000,000
Imported Water[2]	231,900
Total Water Supply	**3,231,900**
Uses	
Groundwater Recharge[3]	631,300
Surface Water Diversions for Irrigation[4]	505,000
Surface Water Diversion for M&I (including Secondary)[5]	61,500
Exported to Salt Lake County	160,700
Lake Evaporation	201,000
Surface Water Flow to Jordan River Basin	308,000
Water Used by Vegetation and Natural Systems[7]	1,364,400
Utah Lake Water Budget[8]	
Surface and Groundwater Inflow to Utah Lake	561,000
Evaporation from the Lake	201,000
Withdrawals from the Lake (Irrigation and M&I)	52,000
Outflow to Salt Lake County	308,000
Allowable Groundwater Withdrawals[9]	165,000
Current Groundwater Withdrawals	149,260
Current Depletions	
Agricultural Depletions[10]	252,000
M&I Depletions[11]	73,300
Total Depletions	**325,300**

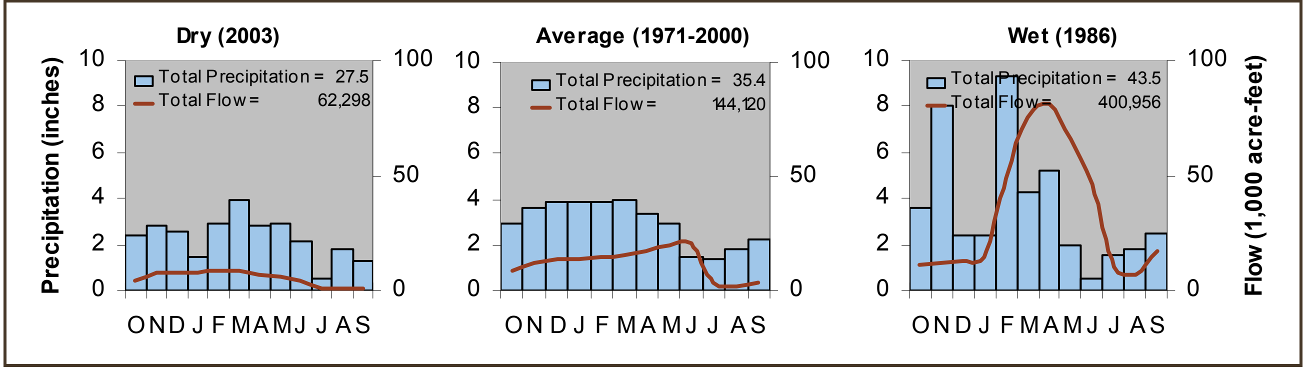
1. Mass balance evaluation of data in Figure 2 (roughly 18.5 inches over 1,945,000 acres).
2. See Table 5 Interbasin Diversions.
3. See Table 4 Summary of Groundwater Recharge.
4. Summary of Diversion shown in Figure 3 (excluding diversions M&I).
5. From DWRe 2010 M&I Water Supply and Uses in Utah Lake Basin (See Table 8).
6. See Figure 3 Estimated Annual Stream Flows and Diversions.
7. Total Supply minus groundwater recharge, surface water flows, diversions, & exported water.
8. See Figure 3 Estimated Average Basin-wide Water Budget.
9. See Table 4 A summary of the State Engineer's groundwater management plans.
10. Estimated to be 50% of the estimated irrigation diversion within the basin.
11. State of Utah Municipal and Industrial Water Supply and Use Study, Summary 2010

Six droughts have been identified using the PDSI and developed drought criteria (see Figure 8 for drought criteria). Each drought is distinctly colored to allow comparison between the climatic regions. For example, the Dust Bowl Years, the drought which started in the early 1930s in these regions, is identified by the yellow shading on the figure. The width correlates with the duration and the gray shading (or negative PDSI values contained within the yellow shading) can be used to determine the drought's severity (see Table 7 for drought severity—average PDSI over the duration of the drought in each region).

Looking at Figure 8, it can be noted that droughts, longer and with similar or greater severity than the statewide drought of 1999, have occurred several times in the last 110 years. As can be seen each drought varied between the two regions shown in Figure 7, with some similarities in intensity and duration.

Impacts of each of these droughts are also varied due to the development of water supplies, economic conditions, population growth, water demand and other regional and local characteristics. The impacts of the most recent drought (2000-2004) were amplified by large population increases that have occurred over the past fifty years. In 2002, groundwater lev-

FIGURE 7
Water Year Scenarios



Note: Precipitation at basin Snotel sites and flow at gage 10163000 (Provo River).

els in the majority of the water supplier's wells steadily declined throughout this most recent drought and some suppliers purchased "extra" water to meet demands and contracts, such as Provo City, which purchased "spot market" water to ensure peak summer demands would be met. Some cities instituted outdoor watering ordinances, such as time of day restrictions, to lessen the strain on the water supply. Water suppliers in the basin were able to meet demand largely due to the "Slow the Flow" campaign (an aggressive water conservation and education program), which was instituted statewide. Several water suppliers reported a 10-15 percent decrease compared to the previous year and this decrease in water use was continued throughout the drought, despite an increase in population.

Due to high population growth, future drought events will likely have an even greater impact than the droughts of the past. Many of the basin's communities rely heavily upon groundwater sources to meet their culinary needs. Drought conditions often result in an increased reliance upon groundwater sources to compensate for deficiencies in surface water supplies. These demands can put the basin's aquifers at risk from the problems associated with groundwater declines and need to be managed appropriately. Steps can be taken now to mitigate future drought impacts. To further investigate drought and possible mitigation strategies, refer to the Utah Division of Water Resources' report on drought titled, *Drought in Utah: Learning from the Past—Preparing for the Future*, accessible online at: http://www.water.utah.gov/.

DEVELOPED SUPPLY

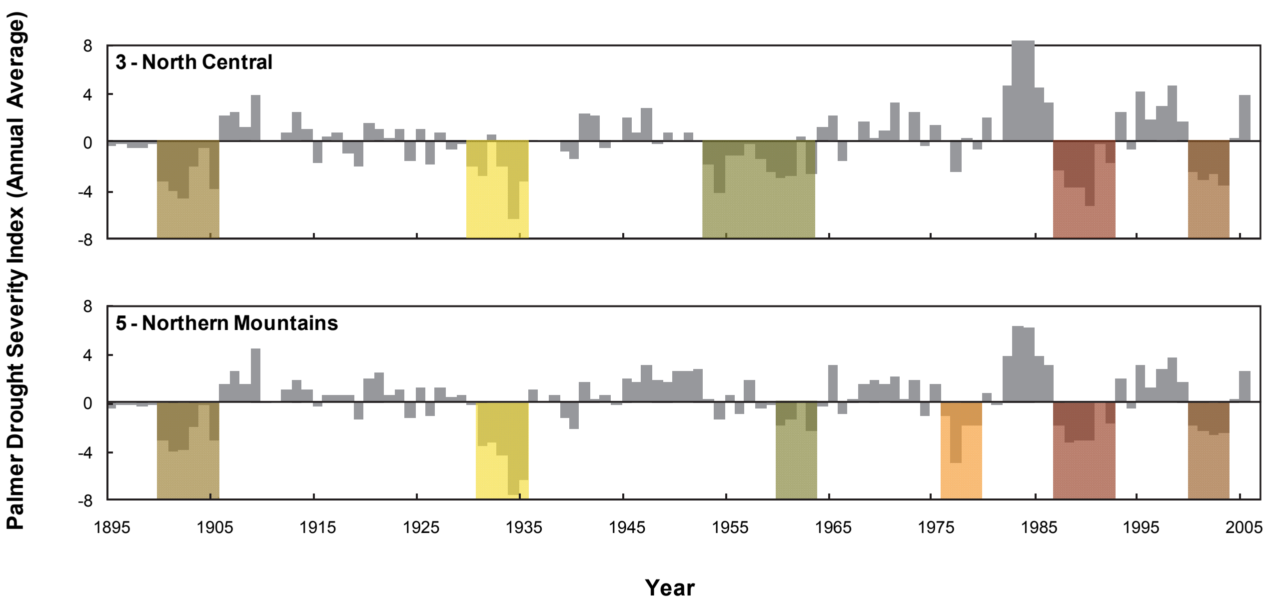
Historically, surface water sources were first developed for irrigation, while groundwater was used for domestic and culinary needs. With increasing population, a series of exchanges were employed to convert the highest quality surface water to municipal and industrial use. Consequently, surface water sources currently provide the Utah Lake Basin with

TABLE 7
Drought Duration and Severity

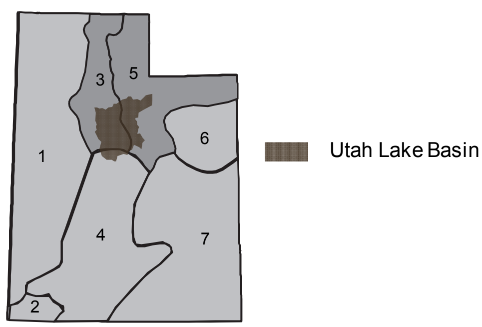
Climatic Regions	Drought	Duration (years)	PDSI Average
3	1900-1905	6	-3.11
	1930-1935	6	-2.74
	1953-1963	11	-1.96
	1987-1992	6	-2.89
	2000-2003	4	-3.03
5	1900-1905	6	-2.77
	1930-1935	5	-5.08
	1960-1963	4	-1.45
	1976-1979	4	-2.53
	1987-1992	6	-2.24
	2000-2003	4	-2.37

Source: Utah Division of Water Resources Analysis, 2007
Note: The range of years shown for each drought includes the ending year, for example in climatic region 3, the 1900-1905 drought includes the year 1900 in its entirety and is through 1905, resulting in a total of 6 years

FIGURE 8
Palmer Drought Severity for Utah's Climate Regions 3 and 5



Climatic Regions



Palmer Drought Severity Index Climatic Regions which influence and/or are within the Utah Lake Basin are highlighted in dark gray.

Droughts:

Six significant droughts (colored areas on graphs) were identified using the PDSI and developed drought criteria. The drought of the 1970s was not significant in climatic region 3 and therefore does not appear.

Drought Criteria:

A drought was considered to have started with two consecutive years of annual average PDSI values less than or equal to –1.0.

A drought was terminated when there were two consecutive years of near normal or above normal conditions (annual average PDSI above –0.5).

61,500 acre-feet of M&I water: 31,000 acre-feet for drinking water and 30,500 acre-feet of secondary water (See Table 8). Despite a decline in the basin's irrigated acreage over the past decade, irrigated agriculture currently diverts about half a million acre-feet of surface water annually to irrigate 127,000 acres. All together, developed surface water in the basin is estimated to be 566,500 acre-feet per year.

Public supply wells and springs withdraw 132,800 acre-feet of groundwater for municipal and industrial uses. Private domestic wells pull 5,700 acre-feet of groundwater annually and it is estimated that self-supplied industrial use withdraws 10,000 acre-feet annually. Altogether basin-wide groundwater withdrawals are estimated to be 149,260 acre-feet annually.

WATER RIGHTS

Under Utah water law, the distribution and use of water is based upon the doctrine of prior appropriation. The Division of Water Rights, under the direction of the State Engineer, regulates water allocation and distribution according to state water law. To facilitate the administration and management of water rights, the Utah Lake Basin has been divided into five management areas (See Figure 9): The northeastern portion of Utah Valley, along with that portion of the basin drained by the Provo River is designated as Area 55. The southeastern portion of Utah Valley, along with that portion of the valley drained by the Spanish Fork River is designated Area 51. Cedar Valley is Area 54. The Goshen Valley, south and west of Utah Lake along with most of the Juab County portion of the basin including the town of Nephi, is Area 53. There is a small portion of Juab County in the extreme southwest corner of the basin that is designated as Area 66.

Although the Utah Lake Basin has not yet been fully adjudicated, Proposed Determination Books have been prepared for Round Valley, Pleasant Grove, and American Fork in the Provo River drainage (Area 55), Hobble Creek/Springville, Spanish Fork Canyon, Birdseye, and Palmyra/Lake Shore in the

TABLE 8
Presently Developed Water Supplies

Source/Description	Average Annual (acre-feet/year)
Surface Water	
Irrigation[1]	505,000
Public Supply (Drinking Water)[2]	31,000
Public Supply Secondary Water[2]	30,500
Subtotal	**566,500**
Groundwater*	
Public Supply Wells and Springs[2]	132,800
Private Domestic[2]	5,700
Self Spplied Industrial[2]	10,000
Irrigation Wells[3]	760
Subtotal	149,260
Total Developed Supply	**715,760**

1. Division of Water Resources Water Budget, (See Figure 3)
2. Utah Division of Water Resources, Municipal and Industrial Water Supply Studies, 2007
3. Estimated to balance groundwater withdrawal shown here with reported withdrawals shown in Table 4.

TABLE 9
General Status of Water Rights

Area	County	Subarea	General Policy
51	Utah	Spanish Fork Creek & Hobble Creek	All supplies of water are fully appropriated. Non-consumptive use applications, such as hydroelectric power generation, will be considered on their individual merits. Changes from surface to underground sources, and vice versa, are considered on their individual merits with emphasis on their potential to interfere with existing rights and to ensure that there is no enlargement of the underlying rights. Fixed-time and temporary projects, especially those involving surface waters, must be handled by temporary change applications.
53	Juab Utah	Current Creek	
54	Utah	Cedar Valley	
55	Utah Wasatch	Provo River	In addition to the General Policy listed for area 51, 53 and 54, the General Policy for area 55 includes the following: Changes based on shares of stock in irrigation companies and exchanges based upon contracts with the Central Utah Water Conservancy District have been approved to authorize development in this closed area.
66	Juab	West Desert	All surface and groundwater is closed to new appropriations. All new development of surface and groundwater for consumptive purposes is by acquisition and changing of existing valid surface water rights. Applications for non-consumptive use can be considered on an individual basis. Fixed-period and transient projects must be handled by temporary change application.

FIGURE 9
Water Rights Areas

Spanish Fork River Drainage (Area 51), Cedar Valley (Area 54) and Goshen Valley (Area 53). See Figure 9 for the location of Water Rights Areas and the boundaries of the Proposed Determination Books. The State Engineer has established water rights policy for each of these areas, including groundwater management plans which were discussed earlier in this chapter. These policies have a profound impact on the availability and management of water resources, and are summarized in Table 9.

NOTES

[1] Utah Division of Water Rights, *Utah/Goshen Valley Ground-Water Management Plan*, (Salt Lake City: Department of Natural Resources, November 15, 1995), 1.

[2] Ibid, 4.

[3] Ibid, 1.

[4] Ibid, 3.

[5] Ibid, 2.

[6] Utah Division of Water Rights, *Upper Provo River Ground-Water Policy*, (Salt Lake City: Department of Natural Resources, November 15, 1995).

[7] Utah Division of Water Resources, *State of Utah Municipal and Industrial Water Supply and Use Study, Summary 2010*, Department of Natural Resources, December, 2013

3

POPULATION AND WATER USE TRENDS AND PROJECTIONS

A PROMISING ERA OF GROWTH AND PROSPERITY

The 21st century holds bright prospects for the people living within the Utah Lake Basin. Desirable communities, education and employment opportunities, a pleasant climate, beautiful mountains, and a broad range of recreational opportunities will encourage current residents and their children to stay and will attract nonresidents to move into the region. As a result, the population of the Utah Lake Basin is expected to continue to grow well into the foreseeable future.

With such growth comes an abundance of issues and challenges for water providers in the area. How to plan infrastructure and manage resources are some of the important issues that will need to be resolved effectively. One certainty is that additional water will be needed to meet the demands of municipal and industrial (M&I) growth. This chapter looks at some of these issues and attempts to quantify the amount of water that will be needed. Chapters 4, 5, 6, and 7 address different ways these needs will likely be met.

As the Basin's economy grows with time, planning at all levels of government will depend on reliable and consistent data detailing the demand for water. This section presents data to help local leaders anticipate the need for timely water resources development. This data along with the latest technology for delivery, use and conservation of water should provide planners and managers with tools that will help them coordinate and manage the water resources under their control.

POPULATION TRENDS AND PROJECTIONS

The 2010 U.S. Census put the population of Utah Lake Basin at just under 548,000 persons. The Governor's Office of Planning and Budget estimates the basin's 2030 population will reach approximately 890,000 persons and the basin's 2060 population will reach 1,514,000. This is a projected average annual growth of 2.5 percent per year through 2030 and then a 1.8 percent average annual growth between 2030 and 2060. Table 10 shows population projections for each of the basin's communities.

At the present time Utah County is home to 94 percent of the basin's population, approximately 515,000 people. Utah County's 2010 population is projected to increase by approximately 2.4 percent per year to 830,000 persons by 2030, and then to almost 1.4 million inhabitants by 2060. That is a projected growth of 170 percent over the next 50 years.

Wasatch County is projected to have the basin's largest percentage growth rate, almost 2.9 percent per year, increasing from a 2010 population of 23,500 residents to 44,500 by 2030, and nearly 97,000 residents by 2060. That is an increase of 311 percent over the next fifty years, essentially quadrupling the counties 2010 population.

Juab County is projected to increase 174 percent from 8,400 people in 2010 to just over 23,000 residents by 2060. Summit County is projected to increase 151 percent over the next fifty years, from a the 2010 population of just over 1,190 residents to nearly 3,000 residents by 2060. See Figure 10 for a graphic representation of the 2010 population and projections for the Utah Lake Basin and Utah County. Figure 11 shows the 2010 population and projections for Wasatch, Summit and Juab Counties.

TABLE 10
Basin Population Projections

City/Community	2000	2010	2030	2060
Utah County				
Alpine	7,146	9,560	11,673	13,707
American Fork	21,941	26,270	39,646	58,916
Cedar Fort	341	370	2,772	9,049
Cedar Hills	3,094	9,800	10,888	11,905
Eagle Mountain	2,157	21,420	54,108	152,536
Elk Ridge	1,838	2,440	4,704	8,514
Fairfield	139	120	963	5,345
Genola	965	1,370	4,370	10,800
Goshen	874	920	1,219	1,798
Highland	8,172	15,520	20,708	29,494
Lehi	19,028	47,700	83,099	134,627
Lindon	8,363	10,070	12,459	15,900
Mapleton	5,809	8,160	14,064	21,783
Orem	84,324	88,400	103,406	123,701
Payson	12,716	18,300	41,157	67,222
Pleasant Grove	23,468	33,510	42,063	54,502
Provo	105,166	112,490	131,070	189,404
Salem	4,372	6,420	27,089	45,179
Santaquin	4,834	9,130	32,082	52,912
Saratoga Springs	1,003	17,780	58,492	133,992
Spanish Fork	20,246	34,690	54,142	78,298
Springville	20,424	29,470	45,084	61,608
Woodland Hills	150	1,340	2,992	5,284
Vineyard	0	10	19,880	90,244
Balance of County	11,025	9,550	11,643	15,107
Total	**368,536**	**514,810**	**829,773**	**1,391,827**

Sources: 2000 & 2010 U.S. Census & Governor's Office of Planning and Budget 2013 projections

An investigation of individual communities throughout the basin reveals that many small and mid-sized communities are projected to double, or nearly double their 2010 population by 2030, and then double again by 2060. This is particularly true of small communities in the western and the southern portions of Utah County (i.e. Cedar Fort, Eagle Mountain, Elk Ridge, Fairfield, Genola, Salem, Santaquin and Saratoga Springs). Obvious exceptions are the basin's two largest communities: Orem and Provo. Figure 12 shows the 2010 population and projected growth for Orem, Provo and Vineyard. Orem is projected to increase from a 2010 population of just over 88,000 residents to 123,000 residents by 2060. Provo is projected to increase from a 2010 population of 112,000 residents to 189,000 by 2060. Although these two communities are the basin's largest cities, both are projected to grow at rates less than one half of the projected growth rate for the basin as a whole. This reflects the fact that both Provo and Orem are bounded to the east by mountains, to the west by Utah Lake, and to the North and South by neighboring communities. Being so bounded, Provo and Orem will not face the same kind of dramatic growth and related development issues that will impact many other basin communities.

Included in Figure 12 with Orem and Provo cities is the community of Vineyard. This small community situated between Orem and Utah Lake includes the reclaimed Geneva steel mill lands. This area is projected to experience tremendous growth over the next 50 years. Its prime location and a guaranteed water supply from Central Utah Water Conservancy District make it ideal for development. Current projections are that the Vineyard area will house 90,000 residents by 2060.

Figure 13 shows the 2010 population and projections for the Northern Utah County communities. Lehi is projected to experience tremendous growth over the next fifty years, increasing from a 2010 population of 47,700 residents in 2010 to nearly 135,000 by 2060. American Fork and Pleasant Grove are slated to experience growth rates somewhat less dramatic than Lehi. American Fork is projected to increase

TABLE 10 (continued)
Basin Population Projections

City/Community	2000	2010	2030	2060
Juab County				
Mona	850	1,550	2,602	4,160
Nephi	4,733	5,390	9,756	16,225
Rocky Ridge	403	750	1,259	2,013
Balance of County[1]	540	730	730	730
Total	**6,526**	**8,420**	**14,347**	**23,128**
Summit County				
Francis	698	900	1,436	2,370
Balance of County[1]	69	290	409	617
Total	**767**	**1,190**	**1,845**	**2,987**
Wasatch County				
Charleston	378	700	1,589	9,432
Heber City	7,291	11,360	19,240	25,670
Midway	2,121	3,850	8,770	18,505
Wallsburg	274	500	630	1,983
Balance of County[1]	5,151	7,110	14,311	41,106
Total	**15,215**	**23,520**	**44,540**	**96,696**
Basin TOTAL	**390,894**	**547,940**	**890,505**	**1,514,638**

Sources: 2000 & 2010 U.S. Census & Governor's Office of Planning and Budget 2013 projections.
1: Within the Utah Lake Basin.

from a 2010 population just over 26,000 to about 59,000 by 2060. Pleasant Grove is projected to increase from 33,500 to 54,500 by 2060. Alpine, Lindon and Highland are all projected to experience similar growth rates. Again, these projections are a function of the availability of developable ground within the current city limits, and the ability of each community to expand boundaries and annex new ground. Other factors may arise that may alter the relative rates at which these communities expand.

Figure 14 depicts growth in the western portion of Utah County. Eagle Mountain and Saratoga Springs are expected to continue to experience the rapid growth that is taking place there. Eagle Mountain is projected to increase from the 2010 population of just over 21,000 residents to 152,000 residents by 2060. Saratoga Springs is projected to have similarly growth increasing from a 2010 population of about 18,000 to 134,000 residents by 2060. Cedar Fort and Fairfield, although much smaller, will post even larger percentage gains. Cedar Fort is projected to grow from a 2010 population of 370 residents to more than 9,000 by 2060, while Fairfield is projected to reach 5,000 from a 2010 population of 120.

The communities in south Utah Valley are also predicted to have tremendous growth. Projected growth in these communities are depicted in Figure 15. Payson is projected to increase from a 2010 population of 18,000 residents to over 67,000 by 2060. Santaquin is projected to increase from 9,100 residents to nearly 53,000. Salem is also expected to flourish, increasing from a 2010 population of 6,400 to more than 45,000 by 2060. Spanish Fork is predicted to increase from 34,700 residents to over 78,000. Springville's growth is expected to taper off slightly after 2030, taking its population from just over 29,000 to 61,600 by 2060. Mapleton is projected to have a flatter growth rate than the other southern Utah County communities increasing from the 2010 population of 8,000 to almost 22,000 residents by 2060.

Figure 16 shows the current population and projections for Wasatch County. Heber City is projected to increase from a 2010 population of about 11,400 residents to more than 25,000 by 2060. Similarly, Midway is projected to increase from a 2010 population of 3,800 to nearly 19,000 residents. Interestingly, 42 percent of Wasatch County's projected growth is included in the balance of county category which increases from a 2010 population of 7,100 to more than 41,000 residents by 2060. This indicates some uncertainty about where exactly the county's projected growth will take place. Clearly, there is the potential for Heber, Midway and other Wasatch County communities to experience growth rates significantly greater than the high rates shown here.

ECONOMIC TRENDS AND PROJECTIONS

The economy of the Utah Lake Basin can be characterized as a well-diversified commercial and industrial economy with agricultural influences, particu-

FIGURE 10
Current Population and Projections: (Utah Lake Basin and Utah County)

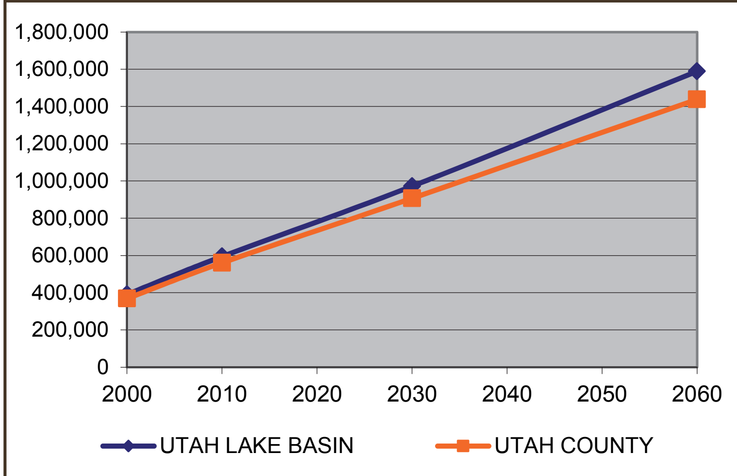


FIGURE 11
Current Population and Projections: (Wasatch, Summit and Juab Counties)

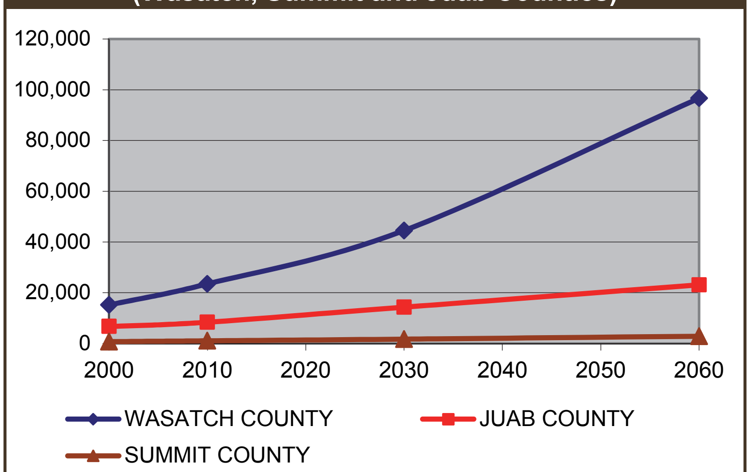
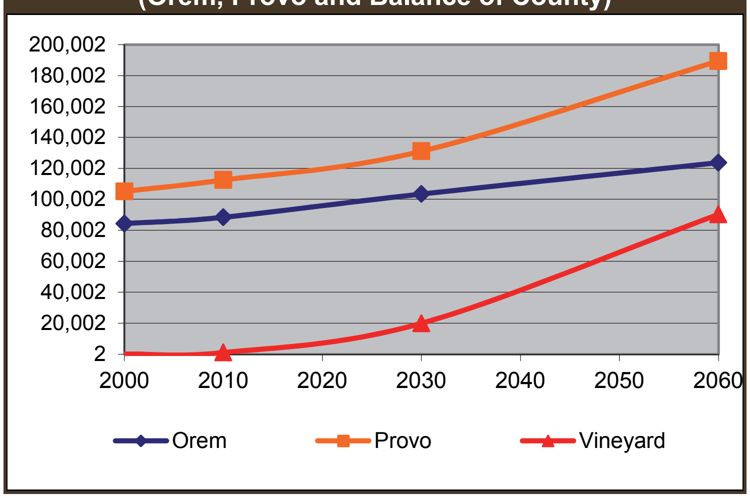


FIGURE 12
Current Population and Projections: (Orem, Provo and Balance of County)



Sources: 2000 & 2010 U.S. Census & Governor's Office of Management and Budget 2013 projections.

larly in the smaller rural communities. Just as is true throughout most of the state, the basin's communities were all established, primarily as agricultural communities. Over the past century most of the basin's communities have expanded dramatically and come to rely increasingly on commercial and industrial enterprises for economic growth. The basin's two largest cities, Provo and Orem are home to two universities, one public and one private. These two universities provide a strong education related economic base for the Utah Valley portion of the basin. But many other commercial and industrial enterprises are evident throughout the basin, creating a diversified and stable economic situation. Within the Utah Valley portion of the basin, a significant portion of the agricultural ground and surface water supply has been and continues to be converted to commercial and industrial uses. This process of urbanization and the conversion of agricultural water to municipal and industrial use will be discussed in more detail in Chapter 6. Despite the tremendous growth in Utah Valley and the transition from agriculture to a commercial and industrial based economy agriculture is still an important part of the economy for many of the basin's smaller communities, particularly in Juab County, Wasatch County, and the southern portion of Utah County.

Employment opportunities directly influence population growth. Utah's population and economic growth rates are projected to continue to outpace the nation through the year 2020. Utah experienced a population increase of 29.6 percent between 1990 and 2000. This increase was more than twice the U.S. national average of 13.3 percent over the same period of time. Utah's population growth rate over the last decade was fourth highest in the nation, exceeded only by Nevada (66%), Arizona (40%) and Colorado (30%). The population growth rate for the Utah Lake Basin, of 24 percent, was slightly lower than that of the state. According to Bureau of Economic Analysis data, Utah experienced a growth in total employment of 47 percent during the same period, with only two states posting better figures namely, Nevada (65%) and Arizona (48%). Both Nevada's and Arizona's increase in total jobs were close to their population increase. Utah's increase in total jobs, however, exceeded its population growth by nearly 20 percent. This is a strong indication that the state's economic growth is more than keeping pace with the state's population growth, particularly along the Wasatch Front and in the Utah Lake Basin.

Land Use Patterns

Approximately 44 percent of the basin's land (853,680 acres) is privately owned. Most of the privately held land is in the valleys. Although some portions in the basin's upper watersheds are privately owned, most of the lands in the upper watershed are owned and managed by federal agencies. The Forest Service administers 36 percent of the basin (698,050 acres) as national forest; including 57,570 acres of wilderness area. The next largest federal land managing agency is the Bureau of Land Management (BLM), which controls approximately 132,500 acres, primarily in western Utah and Juab Counties. The U.S. Army and Corps of Engineers manage 15,900 acres of land in the Camp Williams area of northwestern Utah County. The National Park Service manages 250 acres at the Timpanogos Cave National Monument. The State owns 148,220 acres in the basin, the majority of which is the bed of Utah Lake. Included in the State lands are five State Parks: Jordanelle, Wasatch Mountain, Deer Creek, Utah Lake and Camp Floyd/Stagecoach Inn. Various local, city, county and state agencies collectively hold an additional 97,500 acres of lands that are managed for wildlife, and outdoor recreational uses (See Figure 17).

The general pattern of land use, as shown in Figure 18, reveal that residential, commercial, industrial, and agricultural uses are confined almost exclusively to the valley. One detail not apparent from the land use map is that recreational use is prevalent in each of the basin's canyons and throughout the

FIGURE 13
Current Population and Projections: (Northern Utah County Communities)

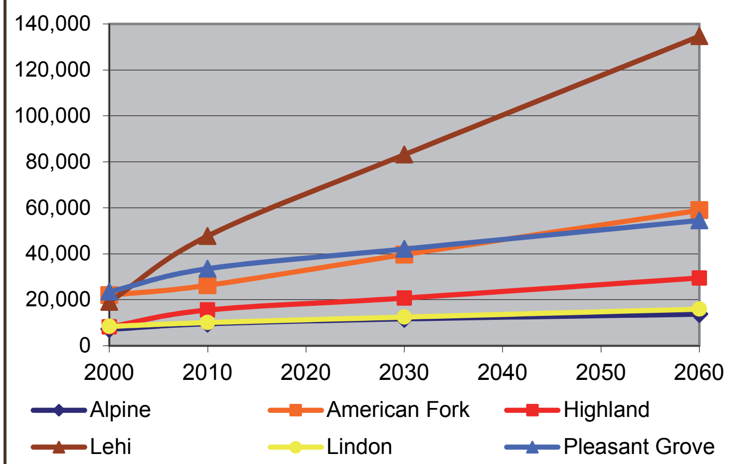


FIGURE 14
Current Population and Projections: (Western Utah County Communities)

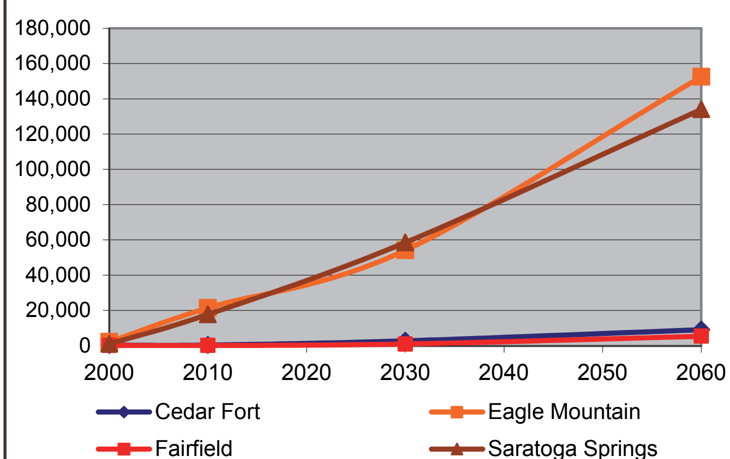
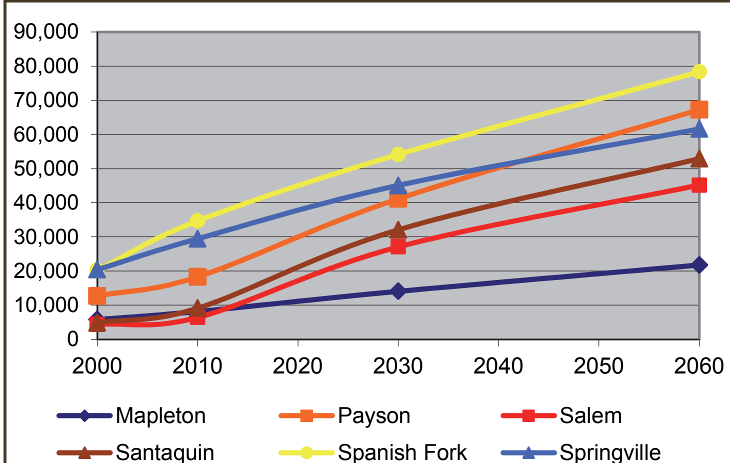


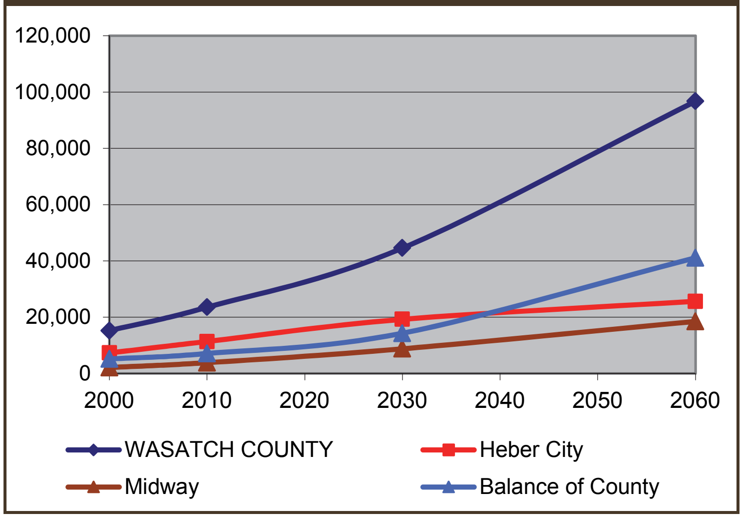
FIGURE 15
Current Population and Projections: (Southern Utah County Communities)



Sources: 2000 & 2010 U.S. Census & Governor's Office of Management and Budget 2013 projections.

mountainous areas on the eastern portion of the basin. Most heavily used are Provo Canyon, American Fork Canyon and the eastern slope of Mount Timpanogos.

FIGURE 16
Current Population and Projections: (Wasatch County)



Sources: 2000 & 2010 U.S. Census & Governor's Office of Management and Budget 2013 projections

Water Use Trends and Projections

Agriculture

In recent decades, Utah Valley has experienced widespread residential growth. More recently Heber Valley has also experienced tremendous residential expansion. In both of these valleys the urbanization of agricultural ground has resulted in the retirement of many acres of agricultural lands. The Division of Water Resources conducted water-related land use surveys in the Utah Lake Basin in 1988, 1995, 2002 and 2008. The data (see Table 11) show that the irrigated lands within the Utah Lake Basin have declined significantly over the past decade and a half from 163,000 acres in 1995 to 156,000 acres in 2002, a loss of about 4.3 percent over the first 7 years, and then decreasing to 127,017 acres in 2008, a loss of nearly 19 percent in the most recent 6 years. The decrease of irrigated acres between 2002 and 2008 was greater than the decline of previous years and appreciably larger than the Division had anticipated given the population projections for the basin and the anticipated urbanization. The topic of urbanization is covered in more detail in Chapter 6.

Figure 19 shows the irrigated lands that have been lost since 1995. The lands depicted by all three colors (yellow, orange, and green) were irrigated in 1995. Lands shown in green were still being irrigated in the most recent land-use survey (2008). Lands depicted in yellow were irrigated in 1995, but were no longer being irrigated in 2002. Lands shown in orange were irrigated in 2002 but no longer irrigated in 2008. Not all of the irrigated acres lost during this time period are the result of urban expansion. It is likely that the a significant portion of the irrigated lands lost between 1995 and 2008 are a direct result of the reduced water supply due the drought years of 1999 through 2005. One example of this can be seen in the Mona Valley area east and northeast of Nephi. The lands depicted in yellow and orange, at that location, were irrigated pastures during the wet year of 1995, but are currently idle and fallow. Despite the fact that urbanization is not the sole cause of all lost irrigated lands a clear pattern emerges, indicating the impact of urbanization in the central portion of Utah Valley throughout the Orem, Provo and Springville area and also in the northern portion of the Utah Valley in and around Alpine, Lehi, American Fork and Pleasant Grove areas.

TABLE 11
Irrigated Land by Year

Year	Irrigated Acres
1988	166,394
1995	163,000
2002	156,000
2008	127,017

Municipal and Industrial Water Use

The Division of Water Resources recently completed an intensive study of M&I water supply and use in the Utah Lake Basin. Table 12 shows a summary of the basin's M&I water use as estimated by this study. As shown, potable water (treated to drinking water standards) use amounted to just under 117,000 acre-feet per year, or roughly 72 percent of total M&I use, in 2010.

Also evident from Table 12 is that the majority of the basin's total M&I water is supplied by public community systems and public community secondary systems. In 2010 water supplied through these

FIGURE 17
Land Ownership

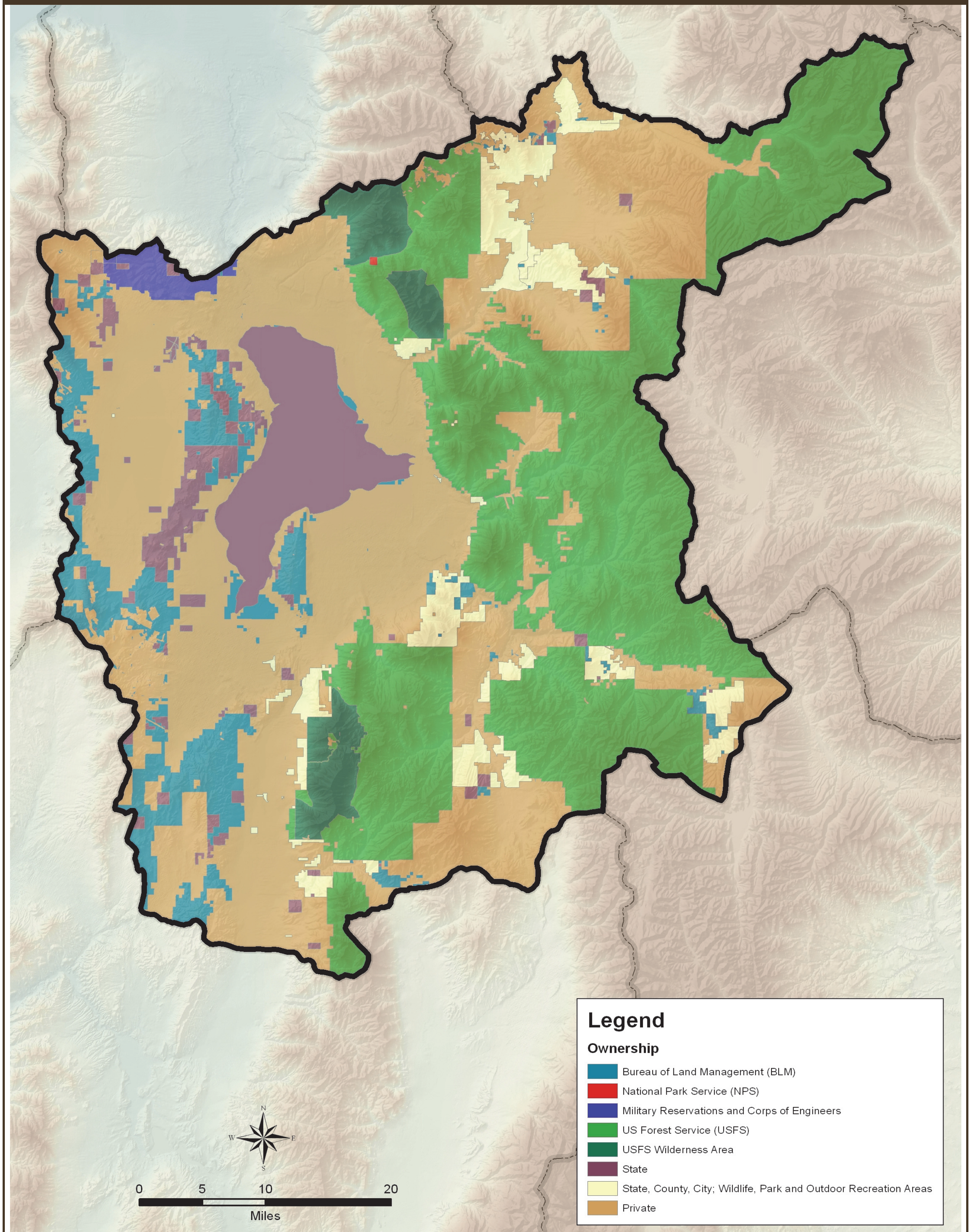


FIGURE 18
Land Use

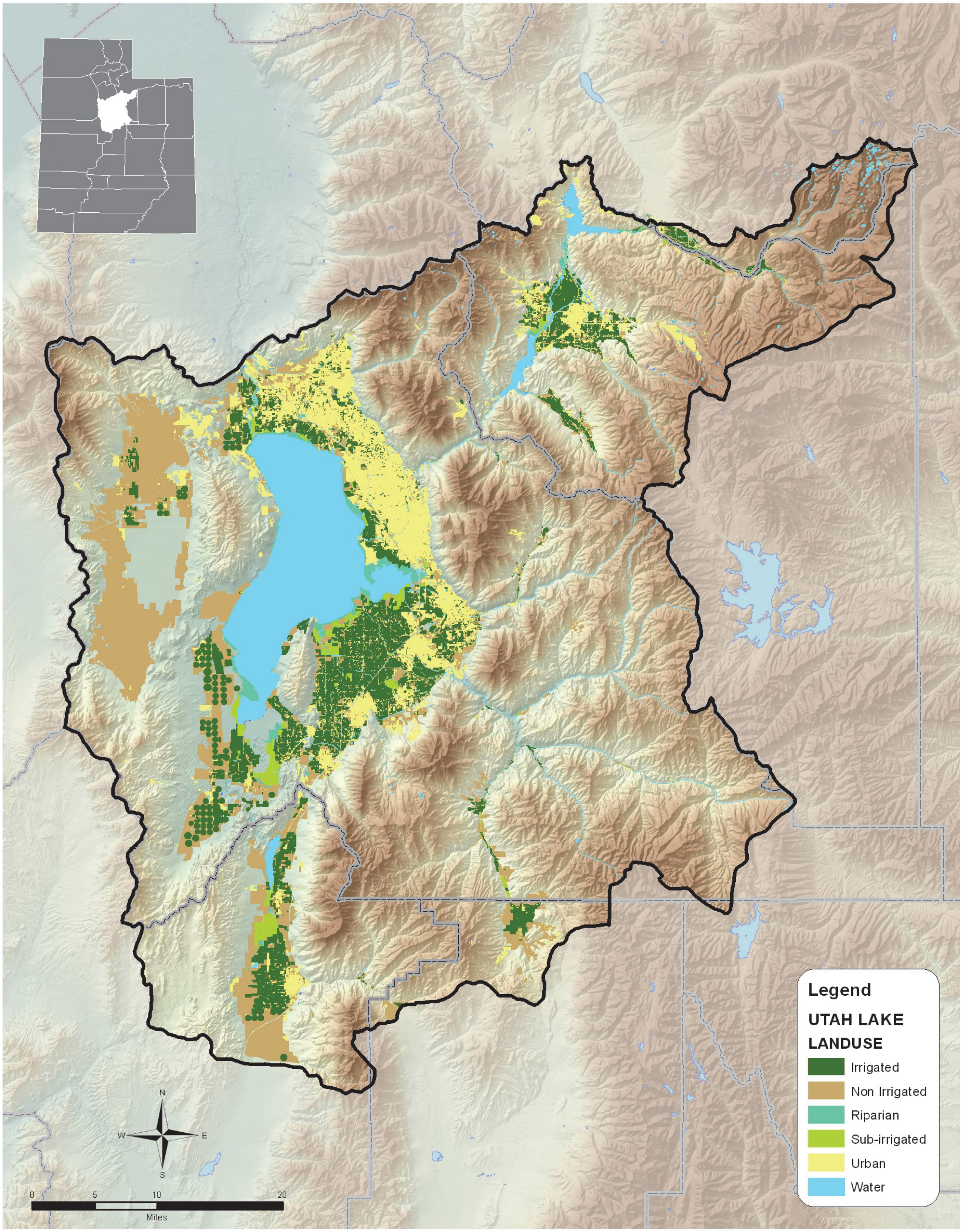


FIGURE 19
Irrigated Land Losses

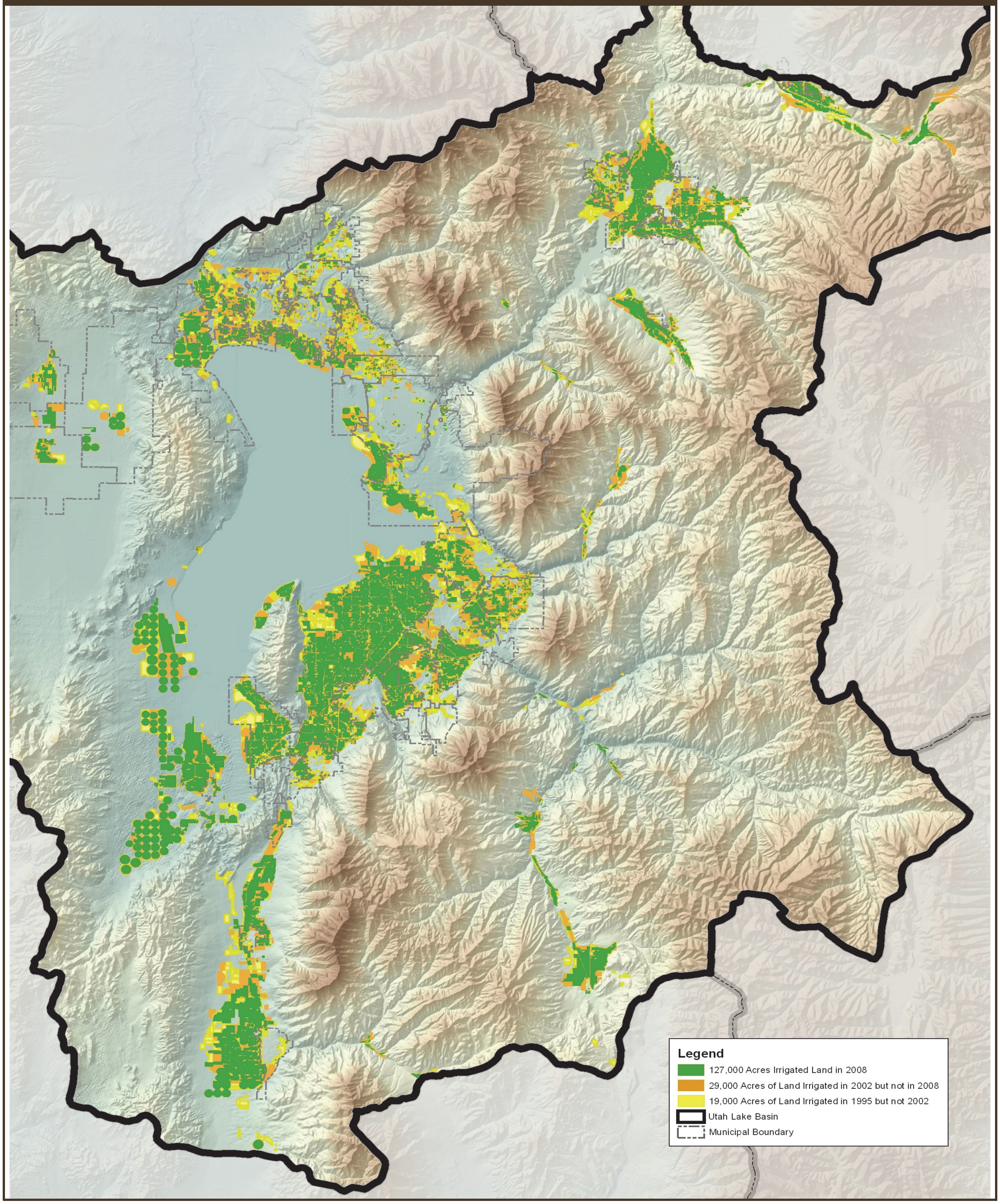


TABLE 12
Total M&I Water Use (2010)

Use Category	Water Use (acre-ft)				
	Juab	Summit	Utah	Wasatch	Total
Potable Suppliers					
Public Community Systems	2,732	241	83,690	3,938	90,601
Public Non-Community Systems	2	5	906	117	1,031
Self-Supplied Industries	83	0	24,571	0	24,653
Private Domestic	150	10	270	150	580
Potable Total	**2,967**	**256**	**109,437**	**4,205**	**116,865**
Non-Potable Suppliers					
Public Community Systems Secondary	550	65	42,030	1,724	44,369
Non-Community Systems	0	0	0	250	250
Self-Supplied Industries	0	0	0	0	0
Private Domestic	0	0	0	0	0
Non Potable Total	**550**	**65**	**42,030**	**1,974**	**44,619**
TOTAL	**3,517**	**321**	**151,467**	**6,179**	**161,484**

Source: Utah Division of Water Resources, *State of Utah Municipal and Industrial Water Supply and Use Study Summary* 2010, (Salt Lake City: Department of Natural Resources 2013).

systems amounted to just over 134,900 acre-feet (90,601 plus 44,369), or 84 percent of the basin's total M&I use. Non-community systems, self-supplied industries and private domestic users account for roughly 16 percent of the basin's total M&I water use.

Table 13 lists the basin's public community water systems and shows how much potable and non-potable water each system delivered in 2010.

Figure 20 shows the average per capita use rate of all the public community and secondary water systems in the basin as observed in the division's 2010 study. As indicated, residential water use was 166 gallons per capita per day (gpcd), or 72 percent of the total public supply (230 gpcd). Institutional water use represents 21 gpcd (9 percent), commercial 39 gpcd (17 percent), and industrial 4 gpcd (2 percent). The portion of residential water use that is applied to outdoor landscapes was 110 gpcd or 66 percent of the total residential water use.

Table 14 shows the 2010 total M&I water use for the basin's public community water systems and the projected demand for public community system water for 2030 and 2060. The 2010 data was derived from the U.S. 2010 Census data and the division's State of Utah Municipal and Industrial Water Supply and Use Study. The projected demands for 2030 and 2060 were based upon the 2013 population projections from the Governor's Office of Management and Budget. The numbers shown in Table 14 are current and projected demands for the basin's Public Community Water Systems only and do not include non-community systems, self-supplied industry or Private Domestic supplies.

Environment

More concern is being expressed about the environment than ever before and with it an awareness of society's effects on ecosystems. Utah Lake and its tributaries are an important part of the environment within both the Utah Lake and Jordan River basins. Stream flows of Utah Lake's tributaries, especially the Provo River and Spanish Fork River sustain valuable habitat for wildlife, as do the wetlands surrounding Utah Lake. Properly balancing these environmental needs with other important water management objectives will allow future M&I demands to be met without compromising the quality of life that comes with healthy ecosystems.

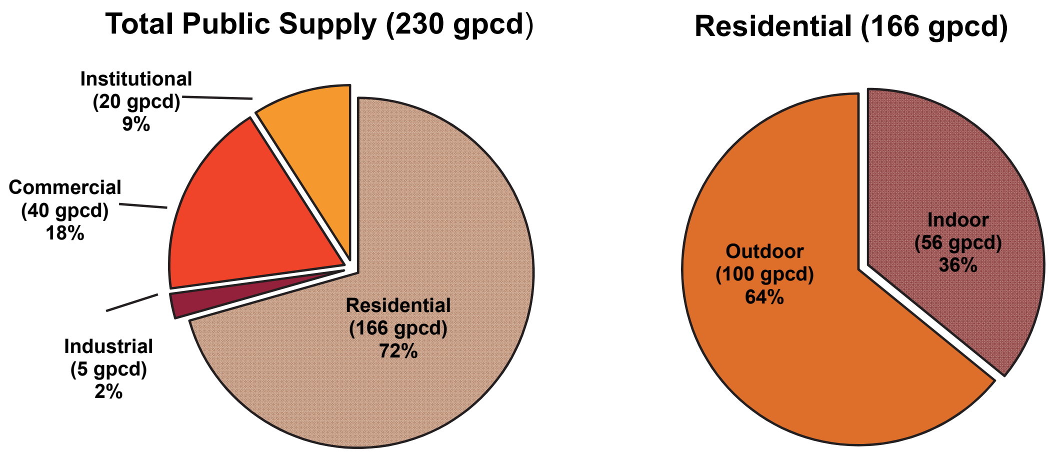
Minimum flow requirements have been established for a number of tributary streams in the Utah Lake Basin. These are discussed in Chapter 8, Water Quality and the Environment: Critical Components of Water Management. In general the outflow from Utah Lake into the Jordan River has been maintained

TABLE 13
Potable and Non-Potable (Secondary) Water Use in Public Community Water Systems (2010)

Public Community System	Water Use (acre-feet/year) Potable	Non-Potable	Total	Public Community System	Water Use (acre-feet/year) Potable	Non-Potable	Total
Utah County				**Utah County (continued)**			
Alpine	740	2,020	2,760	Utah State Hospital	61	75	136
Alpine cove Water SSD	87	0	87	White Hills Subdivision	101	0	101
American Fork	3,732	577	4,309	Woodland Hills	282	0	282
Bradford Acres Water Assoc.	4	15	19	**Utah County Total**	**83,690**	**42,030**	**125,721**
Cedar Fort	158	20	178	**Juab County**			
Cedar Hills	507	1,791	2,298	Mona	302	175	477
Covered Bridge Canyon	63	300	363	Nephi	2,360	375	2,735
Eagle Mountain	4,028	25	4,053	Rocky Ridge	69	-	69
Elberta	38	0	38	**Juab County Total**	**2,731**	**550**	**3,281**
Elk Ridge	486	28	514	**Summit County**			
Fairfield Irrigation Company	11	380	391	Francis	162	60	222
Genola	235	0	235	Woodland Mutual Water Co.	80	5	85
Goosenest Water Company	28	125	153	**Summit County Total**	**242**	**65**	**307**
Goshen	255	0	255	**Wasatch County**			
Hidden Creek Water Company	9	6,000	6,009	Canyon Meadows	15	0	15
Highland City	1,441	10,249	11,690	Center Creek Culinary Water	28	60	88
Lehi	3,531	3,621	7,152	Charleston WCD	150	66	216
Lindon	1,140	0	1,140	County Estates Mobile Homes	13	3	16
Manila Culinary Water Company	1,324	800	2,124	Daniel Domestic Water Co.	161	180	341
Mapleton	1,653	0	1,653	Heber City Water System	2,220	420	2,640
North Fork SSD	290	0	290	Interlaken Mutual Water Co.	71	0	71
Orem	20,058	292	20,350	Jordanelle SSD	244	0	244
Payson	2,601	2,550	5,151	Midway City Water System	718	650	1,368
Pleasant Grove	2,508	3,000	5,508	Storm Haven	15	20	35
Provo	24,081	1,200	25,281	Swiss Alpine Water Company	30	0	30
Salem	528	1,060	1,588	Timber Lakes Water SSD	132	0	132
Santaquin	2,602	964	3,566	Twin Creeks SSD	80	225	305
Saratoga Spring Municipal	1,280	2,659	3,939	Wallsburg Town Water System	49	79	128
Spanish Fork	2,625	3,650	6,275	Woodland Hills Irrigation	10	21	31
Spring Lake	78	30	108	**Wasatch County Total**	**3,938**	**1,724**	**5,662**
Springdell Plat A & B	18	0	18				
Springville	7,107	600	7,707	**Basin Total**	**90,601**	**44,369**	**134,970**

Source: Utah Division of Water Resources, *State of Utah Municipal and Industrial Water Supply and Use Study Summary* 2010, (Salt Lake City: Department of Natural Resources 2013).

FIGURE 20
Breakdown of Public Community Water Use Including Secondary Water Use (2010)



in large part because of water rights held by public and private water fowl management areas in the Jordan River Delta, but also because of irrigation return flows, and natural reach gains.

Some of the valley wetlands and riparian areas have been lost or impacted due to development over the past century and a half. Wetlands and riparian areas are important wildlife habitats for many species. Such areas generally offer all four major habitat components: food, water, cover, and living space. Only an estimated 1,200 acres of wetlands remain along the undeveloped reaches of the Jordan River between Utah Lake and the Salt Lake County line. There is an estimated 14,000 acres of wetlands surrounding Utah Lake. The sensitivity and scarcity of wetlands reflect the need for increased protection, conservation, management and restoration efforts by local, state and federal agencies. Improper development around the perimeter of Utah Lake or along the Jordan River corridor could result in a net wetlands loss, increased nutrient and pollutant loading, loss of fish and wildlife habitat, and loss of recreational opportunities. These issues are discussed in more detail in Chapter 8.

Recreation

The Utah Lake Basin offers some of the most diverse and highest quality recreational opportunities in the State. In addition to a National Monument (Timpanogos Cave), state parks, numerous campgrounds, golf courses, alpine hiking trails, ski resorts, and off-road trails (hiking, jogging, biking and OHV) the basin has many water-based recreational facilities and opportunities. Fishing is very popular on both streams and reservoirs throughout the basin. Boating is extremely popular through the spring, summer and into the fall on many of the basin's reservoirs and lakes, particularly Deer Creek Reservoir, Jordanelle, and Utah Lake. Wind surfing is popular on these reservoirs as well as Mona Reservoir. State parks adjacent several reservoirs offer

TABLE 14
Present and Projected M&I Water Demands for Public Community Systems (acre-feet)

Location	2010	2030	2060
Juab County	3,282	5,650	9,803
Summit County	306	459	793
Utah County	125,720	172,411	287,918
Wasatch County	5,662	9,746	22,156
Total	**134,970**	**188,266**	**320,670**

These figures are for Public Community Systems and do not include the Non-Community Systems, Self-supplied Industry, or Private Domestic deliveries included in Table 12.
Source: Utah Division of Water Resources, *State of Utah Municipal and Industrial Water Supply and Use Study Summary* 2010, (Salt Lake City: Department of Natural Resources 2013). Totals may differ slightly due to rounding.

camping as well as a host of water related recreational opportunities. Many federal, state and local agencies are involved in managing water-based as well as non water-related recreational sites throughout the basin.

The Utah Division of Parks and Recreation has responsibility for conserving Utah's rich natural resource heritage while making recreational opportunities available to the resident and non-resident user. The division's mission is to "enhance the quality of life in Utah through parks, people and programs." The division manages five state parks in the Utah Lake Basin (Utah Lake, Deer Creek, Jordanelle, Camp Floyd/Stagecoach Inn, and Wasatch Mountain State Park), coordinates four funding programs, manages OHV (off-highway vehicles), boating and trails programs and prepares the Statewide Comprehensive Recreational Plan (SCORP).

The Division of Wildlife Resources stocks millions of fish in streams and reservoirs, and is heavily involved in hatchery and research efforts on Utah Lake, Jordanelle, Deer Creek reservoirs and the Uinta mountain lakes. The division also performs law enforcement and big game management functions throughout the basin.

City and county recreational facilities range from golf courses, to camping and day-use facilities. The basin's many golf courses use millions of gallons of water annually for maintenance and aesthetics. Ski areas, while primarily reliant upon natural snowfall, also use water in snow-making activities. Provo city and Utah County manage 14 miles of Provo River Parkway from Utah Lake to Vivian Park. The county is planning an access trail around Utah Lake, with several staging areas. The county has also developed 12 miles of trail from Utah Lake, north to the Salt Lake County line as part of the Jordan River Parkway. As part of the Central Utah Project, public access will be developed at specific sites along the 10 miles from Jordanelle State Park to Deer Creek Reservoir. Also, a trail has been constructed as part of the Provo Reservoir Canal Enclosure Project.

4

MEETING FUTURE WATER NEEDS

Chapter 2 discussed the water supply available within the Utah Lake Basin. Chapter 3 described the basin's current population and water use and made some general estimates of future water needs based on population projections made by the Governor's Office of Management and Budget (GOMB). This chapter provides a more detailed assessment of future water needs and presents a general strategy for how water suppliers in the basin plan to satisfy these needs. Particular emphasis is given to municipal and industrial water needs, as these will experience significant increases due to future population growth.

MUNICIPAL AND INDUSTRIAL WATER NEEDS

As discussed in Chapter 3, water use in public community systems and secondary water systems makes up about 84 percent of the total M&I water demand in the Utah Lake Basin and is the main component of M&I demand that is projected to increase significantly in the future. As a result, the discussion of M&I water needs in this chapter is limited to water needs in public community systems.

The basin was divided into seven areas based on geographical locations and drainage in order to more adequately describe the basin's water supply and demand. These divisions are as follows: Juab County; Summit and Wasatch Counties; Cedar Valley; Goshen Valley; North Utah Valley; South Utah Valley; and Mountain Homes and Resorts. Table 15 summarizes the Utah Division of Water Resources' estimates of current reliable water supply and demand for public community systems for each of the seven divisions within the Utah Lake Basin. The table also shows estimates of the water demand with water conservation for 2030 and 2060.

Figure 21 shows the data graphically to help visualize approximately when existing basin-wide reliable water supplies will become insufficient to satisfy future demands. The figure shows the basin's projected future water demand both with and without the State's water conservation goal of 25 percent reduction in per capita water use by 2025.

As shown, the division estimates the basin's total water demand for public community water systems was approximately 125,000 acre-feet per year in 2000, and 135,000 acre-feet per year in 2010. Shown in dark blue, the basin's current reliable supply is about 216,000 acre-feet per year. If the basin's (2000) per capita water use rate remained unchanged, the demand would increase to approximately 428,000 acre-feet per year by 2060.

That water use rate is depicted by the dashed red line in Figure 21. The solid red line shows that future demand would be about 321,000 acre-feet per year in 2060 if water conservation efforts reduce per capita water consumption 25 percent by 2025. The figure's left vertical dashed white line illustrates that without water conservation the basin's existing reliable supply would be insufficient to satisfy the growing demand sometime around 2024. The right vertical dashed white line indicates that with water conservation existing reliable supplies will be sufficient to meet demand through 2036. However, several points should be clarified. First, the actual water conservation efforts within the basin have thus far exceeded the projected goal. Consequently, preliminary data indicates that the actual current demand is slightly less than what is shown by the solid red line shown in Figure 21. More on this topic will be presented in Chapter 5-Municipal and Industrial Water Conservation. Secondly, there are projects currently underway that will increase the basin's existing reliable water supply and address the immediate concerns for additional water. These will be discussed later in this chapter. Thirdly, additional

TABLE 15
Current Public Community System Water Supplies vs. Future Demands

Water System	2010 Demand (ac-ft/yr)	2010 Reliable Supply (ac-ft/yr)	Water Use Projections w/ Water Conservation† (acre-feet/year)		Water Supply Deficits/Surpluses‡ (acre-feet/year)	
			2030	2060	2030	2060
Juab County						
Mona Town	477	713	686	1,147	27	(434)
Nephi City	2,735	2,495	4,842	8,451	(2,347)	(5,956)
Rocky Ridge Town	69	121	122	205	(1)	(84)
Juab County Total	**3,282**	**3,329**	**5,650**	**9,803**	**(2,321)**	**(6,474)**
Summit County						
Francis Town	222	409	321	554	88	(145)
Woodland Mutual Water company	85	58	138	239	(80)	(181)
Summit County Total	**306**	**467**	**459**	**793**	**8**	**(326)**
Wasatch County						
Canyon Meadows	15	186	16	17	170	169
Center Creek Culinary Water Co.	88	154	136	479	18	(325)
Charleston WCD	216	207	436	2,712	(229)	(2,505)
Country Estates Mobile Homes	16	3	16	16	(13)	(13)
Daniel Domestic Water Company	341	321	585	2,068	(264)	(1,747)
Heber City Water System	2,640	3,282	4,322	6,049	(1040)	(2,767)
Interlaken Mutual Water Company	71	182	166	592	16	(410)
Jordanelle Special Service District	244	4,150	569	2,032	3,581	2,118
Midway City Water System	1,368	2,492	2,494	5,488	(2)	(2,996)
Storm Haven	35	64	26	28	38	36
Swiss Alpine Water Co.	30	31	72	160	(41)	(129)
Timber Lakes Water SSD	132	192	309	1,103	(117)	(911)
Twin Creeks SSD	305	725	461	1,007	264	(282)
Wallsburg Town Water System	128	198	117	383	81	(185)
Woodland Hills Irrigation Co.	31	40	21	22	19	18
Wasatch County Total	**5,662**	**12,227**	**9,746**	**22,156**	**2,481**	**(9,929)**
Utah County						
Cedar Valley						
Cedar Fort	178	250	1,325	4,540	(1,075)	(4,290)
Eagle Mountain Town	4,328	4,181	11,081	32,814	(6,900)	(28,633)
Fairfield Irrigation Company	39	125	214	1,229	(89)	(1,104)
White Hills Subdivision	101	1,120	106	112	1,014	1,008
Cedar Valley Total	**4,646**	**5,676**	**12,726**	**38,695**	**(7,050)**	**(33,019)**
Goshen Valley						
Elberta	63	76	167	432	(91)	(356)
Goshen	380	385	441	680	(56)	(295)
Genola	615	948	1,424	3,655	(476)	(2,707)
Goshen Valley Total	**1,058**	**1,409**	**2,032**	**4,767**	**(623)**	**(3,358)**
North Utah Valley						
Alpine	2,760	5,821	2,241	2,725	3,580	3,096
Alpine City Water SSD	87	99	111	137	(12)	(38)

American Fork City	4,309	14,377	6,370	9,935	8,007	4,442
Cedar Hills	2,298	3,009	1,634	1,847	1,375	1,162
Highland Water Co.	7,441	7,688	6,214	9,138	1,474	(1,450)
Lehi	13,780	13,933	15,816	26,515	(1,883)	(12,582)
Lindon	4,761	6,850	3,828	5,053	3,022	1,797
Manila Culinary Water Co.	1,324	2,501	1,745	2,378	756	123
Orem City	20,350	26,359*	24,817	31,210	1,542	(4,851)
Pleasant Grove City	5,508	11,000	5,280	7,121	5,720	3,879
Provo City	25,281	31,550**	30,197	45,853	1,353	(14,303)
Saratoga Springs Mutual	3,938	3,564	9,004	21,392	(5,440)	(17,828)
Utah State Hospital	136	588	104	108	484	480
Total	**91,973**	**127,339**	**107,361**	**163,412**	**19,978**	**(36,073)**
South Utah Valley						
Bradford Acres Water Assoc.	19	99	12	12	87	87
Elk Ridge	486	1,424	983	1,871	441	(447)
Mapleton	2,453	4,301	3,715	6,019	586	(1,718)
Payson	5,151	6,350	9,149	15,574	(2,799)	(9,224)
Salem	1,588	4,900	4,682	8,100	218	(3,200)
Santaquin City	3,566	3,964	11,378	19,649	(7,414)	(15,685)
Spanish Fork	6,275	10,922	7,287	10,959	3,639	7
Spring Lake	108	317	98	103	219	214
Springville	7,707	11,674	11,898	17,078	(224)	(5,404)
Woodland Hills	282	190	662	1,229	(472)	(1,039)
Total	**27,635**	**44,185**	**49,864**	**80,594**	**(5,679)**	**(36,409)**
Mountain Homes and Resorts***	**408**	**1,318**	**428**	**450**	**890**	**868**
Central Utah Water Cons. District	**0**	**20,476**	**0**	**0**	**20,476**	**20,476**
Utah County Total	**125,720**	**200,403**	**172,411**	**287,918**	**27,992**	**(87,515)**
BASIN TOTAL	**134,970**	**216,424**	**188,267**	**320,667**	**28,157**	**(104,243)**

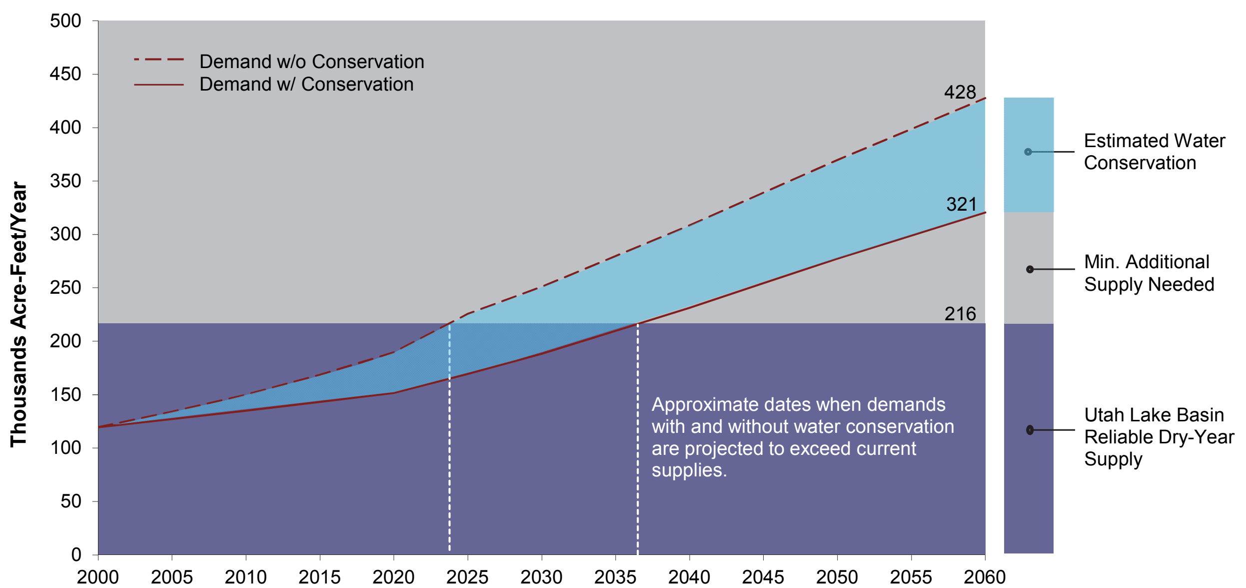
† All water use projections come from the Utah Water Demand/Supply Model and include incremental estimates of water conservation, with a total of 25% by 2025.
‡ Positive number indicates surpluses; numbers in parentheses (red text) are deficits.
*Includes Metropolitan District of Orem wholesale supply (8,675 acre-ft).
**Includes Metropolitan District of Provo wholesale supply (4,600 acre-ft).
***Mountain Homes and Resorts include: Covered Bridge Canyon, Goosenest Water Company, Hidden Creek Water Company, North fork SSD, and Springdell Plat A&B.
Note: Values have been rounded to the nearest whole number.

water management and development strategies will be discussed in Chapters 6 - Agricultural Conversion and Other Management Strategies and Chapter 7 - Water Development. And finally, the reader should understand what is, and what is not, being shown in Figure 21 and the reliable water supply figures that follow. The reliable supply is the amount of water that can be delivered even in the driest of water years. It is less than the amount of water that would be available during an average water year or wet water year conditions. Consequently, even when the demand (red line) exceeds the reliable supply (blue shaded area) water deliveries would not be affected most years. Only during droughts and only then during peak demand times (typically late summer) would water shortages occur; and then only to outside watering and landscape uses.

Juab County

Figure 22 shows the reliable supply and demand for the Juab County portion of the basin. Data for public community systems within the county was listed previously in Table 15. As shown, the Utah Division of Water Resources estimates the public community system water demand within Juab County

FIGURE 21
Reliable Water Supply vs. Demand for the Utah Lake Basin



Source: Utah Division of Water Resources, *Utah Water Demand/Supply Model* and M&I water supply and use data collection program, 2010. Projected demands are based upon the Governor's Office of Management and Budget's 2013 population projections.
Note: CUWCD, Metropolitan of Orem and Metropolitan of Provo supplies are included in the "Utah Lake Basin Reliable Total Water Supply."

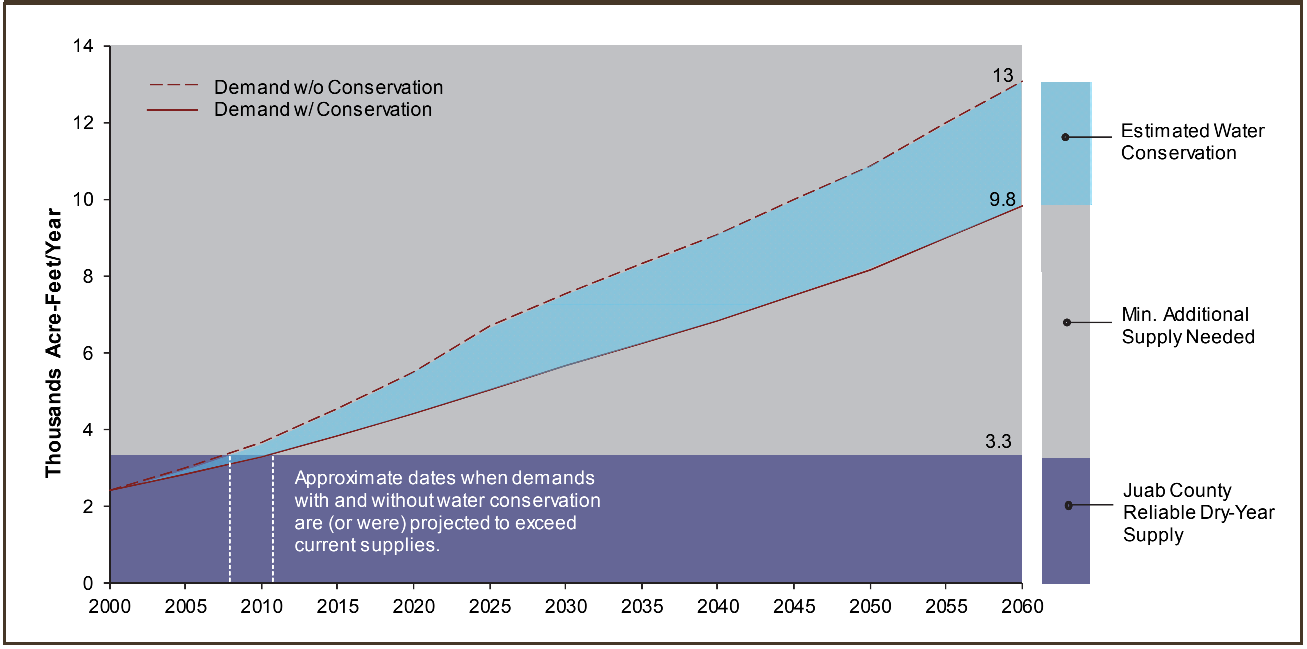
was approximately 3,300 acre-feet per year in 2010. With the considerable growth expected for Juab County, demand is projected to increase to approximately 9,800 acre-feet per year by 2060 (an increase of 253 percent) with water conservation. If the per capita use within Juab County is not reduced through water conservation, the demand is projected to increase to 13,000 acre-feet per year by 2060.

As can be seen in Figure 22, current demand within the Juab county portion of the Utah Lake Basin already exceeds these existing reliable supplies. As explained earlier, under normal conditions, and in most years, existing supplies will be adequate. But in drought years existing water supplies will be inadequate to meet peak demands. This means that the communities of Mona, Nephi and Rocky Ridge will need to develop new sources of additional water not only to meet the demands of projected growth but also to address current water supply issues during drought conditions.

Summit and Wasatch Counties

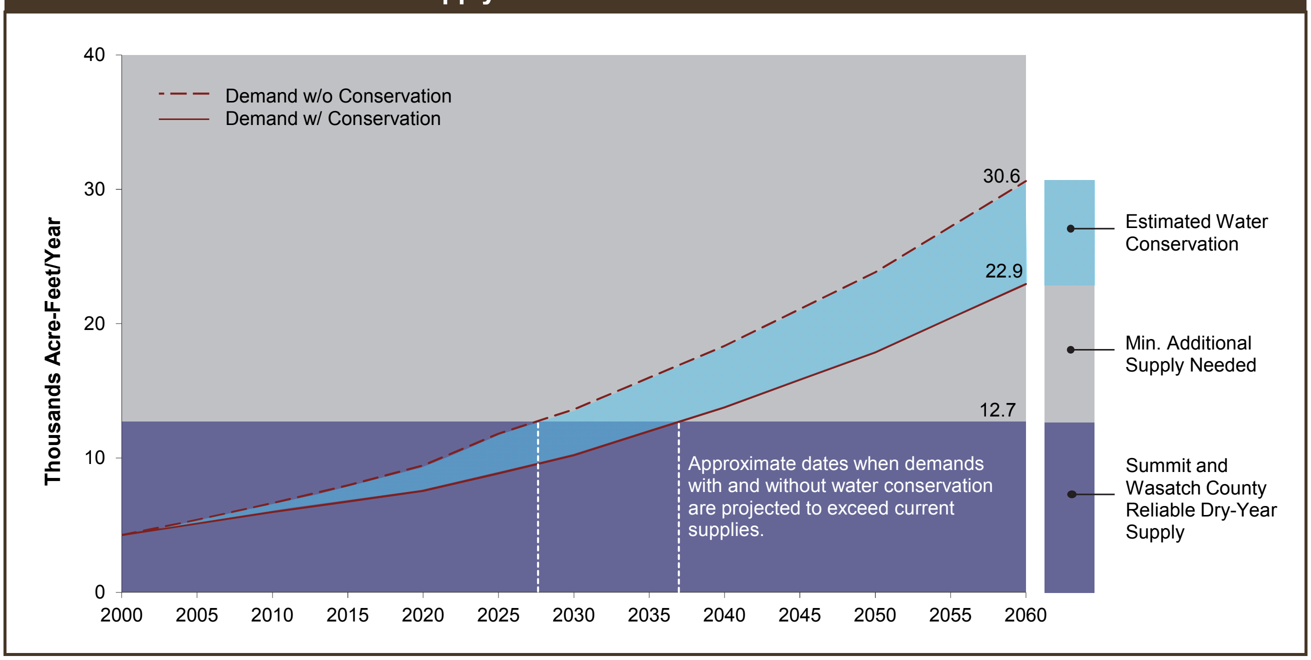
Figure 23 shows the reliable supply and demands for the Summit and Wasatch county portions of the basin. Refer to Table 15 for public community systems data within the two counties. The division estimates the demand for public community system water within these two counties was approximately 5,967 acre-feet per year in 2010. With water conservation this demand is projected to increase by 285 percent, to approximately 22,900 acre-feet per year by 2060. Without water conservation the per capita usage rate for the year 2000 would result in a demand of 30,600 acre-feet per year in 2060. The division estimates that the county currently has a total reliable supply of about 12,700 acre-feet per year. Figure 23 shows that without conservation the current reliable supply will be adequate to meet the two counties' water demands through about 2030. With water conservation efforts the existing reliable supplies would prove sufficient to meet the counties' growing demands through about 2037.

FIGURE 22
Reliable Water Supply vs. Demand for Juab County



Source: Utah Division of Water Resources, *Utah Water Demand/Supply Model* and M&I water supply and use data collection program, 2010. Projected demands are based upon the Governor's Office of Management and Budget's 2013 population projections.

FIGURE 23
Reliable Water Supply vs. Demand for Summit and Wasatch Counties



Source: Utah Division of Water Resources, *Utah Water Demand/Supply Model* and M&I water supply and use data collection program, 2010. Projected demands are based upon the Governor's Office of Management and Budget's 2013 population projections.

Cedar Valley

Figure 24 shows the reliable supply and projected demand for the Cedar Valley area (see Table 15 for public community systems data). As shown, the division estimates the public community system water demand within the Cedar Valley area to be 4,646 acre-feet per year in 2010. With the tremendous growth that is expected to continue in Cedar Valley, this demand, without conservation, would increase dramatically to 51,600 acre-feet per year (more than a 1000 percent increase) by 2060. With water conservation, that demand could be reduced to 38,700 acre-feet per year (still an increase of 730 percent) by 2060. The estimated reliable supply of community system water in the Cedar Valley area is only 5,700 acre-feet per year. As can be seen from Figure 24 the demand for M&I water in the Cedar Valley area already exceeds the existing reliable supply. This information portrays an urgent need to develop additional supplies within the Cedar Valley area. The Central Utah Water Conservancy District plans is already addressing this pressing need with water from the Central Water Project over the next few years. The Central Water Project is discussed later in this Chapter.

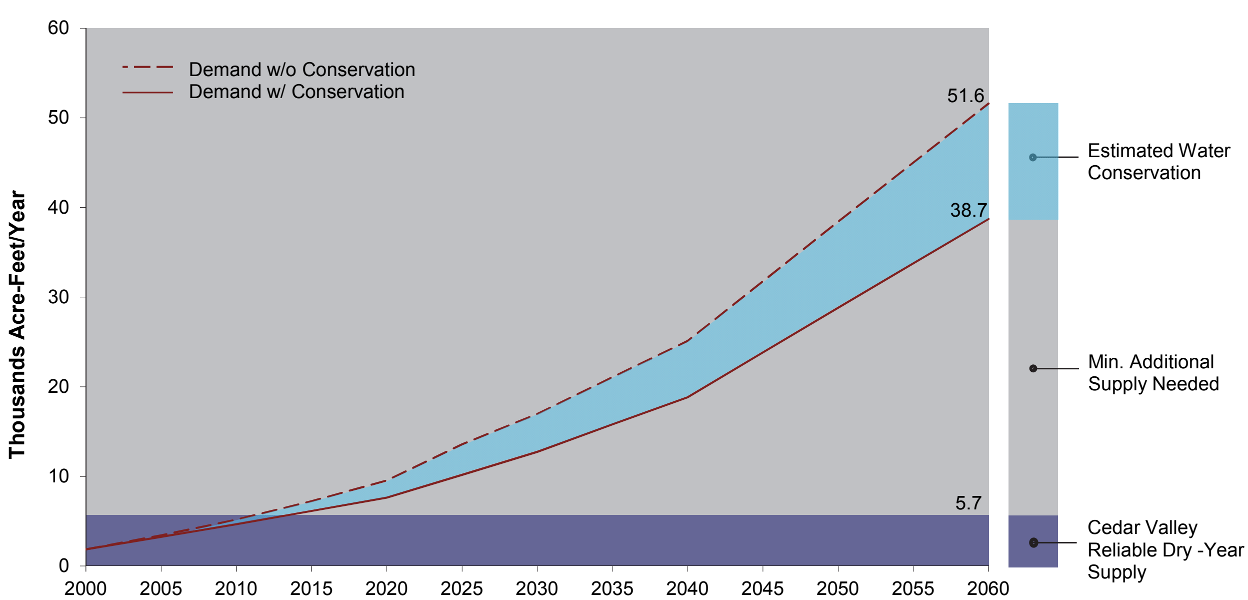
Goshen Valley

Figure 25 shows the reliable supply and demands for the Goshen Valley area. Data for public community systems within this area is included in Table 15. As shown, the division estimates the public community system water demand within the area was approximately 1,060 acre-feet per year in 2010. At the 2000 per capita water use rate, demand in the Goshen Valley area is projected to increase to 6,400 acre-feet per year by 2060. With water conservation the valley's projected growth will increase demand to 4,800 acre-feet per year by 2060. The division estimates that the area currently has a total reliable water supply of about 1,400 acre-feet per year. This means that the current demand in the Goshen Valley already exceed the current reliable supply and indicates a need to develop additional water supplies for the Goshen Valley area as soon as possible.

North Utah Valley

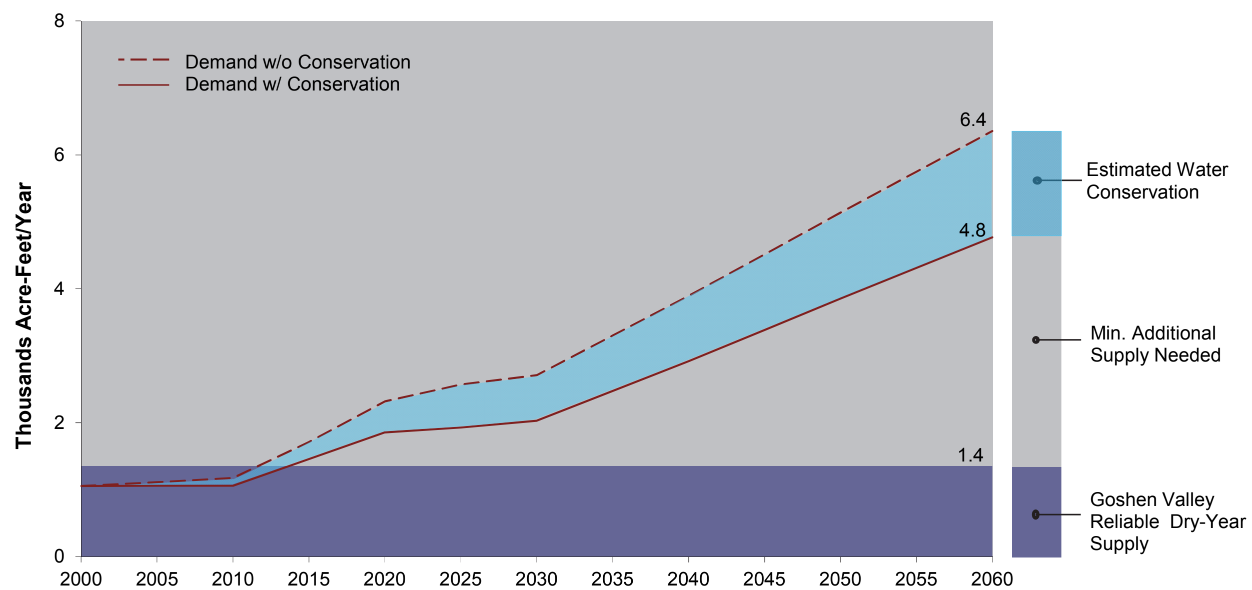
Figure 26 shows the reliable supply and demands for the Northern portion of Utah Valley. See Table 15 for specific reliable supply and demand data. The division estimates the public community system water demand for North Utah Valley was approximate-

FIGURE 24
Reliable Water Supply vs. Demand for Cedar Valley



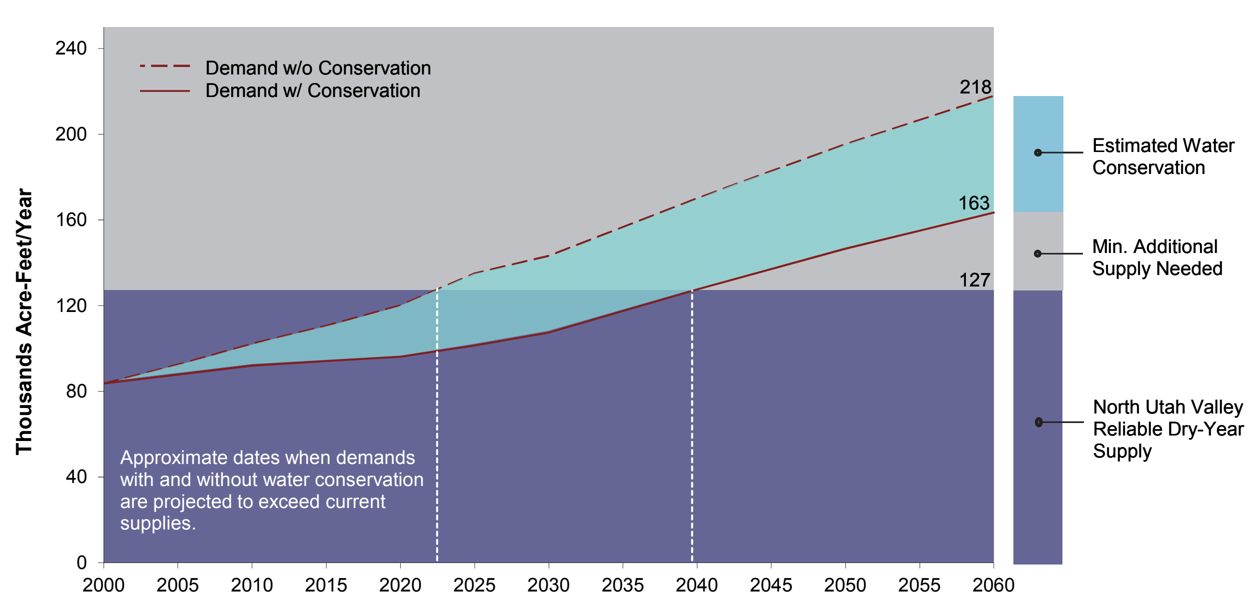
Source: Utah Division of Water Resources, *Utah Water Demand/Supply Model* and M&I water supply and use data collection program, 2010. Projected demands are based upon the Governor's Office of Management and Budget's 2013 population projections.

FIGURE 25
Reliable Water Supply vs. Demand for Goshen Valley



Source: Utah Division of Water Resources, *Utah Water Demand/Supply Model* and M&I water supply and use data collection program, 2010. Projected demands are based upon the Governor's Office of Management and Budget's 2013 population projections.

FIGURE 26
Reliable Water Supply vs. Demand for North Utah Valley



Source: Utah Division of Water Resources, *Utah Water Demand/Supply Model* and M&I water supply and use data collection program, 2010. Projected demands are based upon the Governor's Office of Management and Budget's 2013 population projections.

ly 92,000 acre-feet per year, in 2010. Without conservation this demand would increase to 218,000 acre-feet per year by 2060. Meeting the State's conservation goal of 25 percent reduction in per capita use by 2025 would reduce this future demand to 163,000 acre-feet per year in 2060. The Division estimates that the North Utah Valley area currently has a total reliable water supply of about 127,000 acre-feet per year. Without conservation this reliable supply would satisfy the North Utah County demand through about 2023. With water conservation this existing reliable supply will be adequate through about 2040. These numbers indicate that North Utah County is in relatively good shape with respect to meeting future water demands.

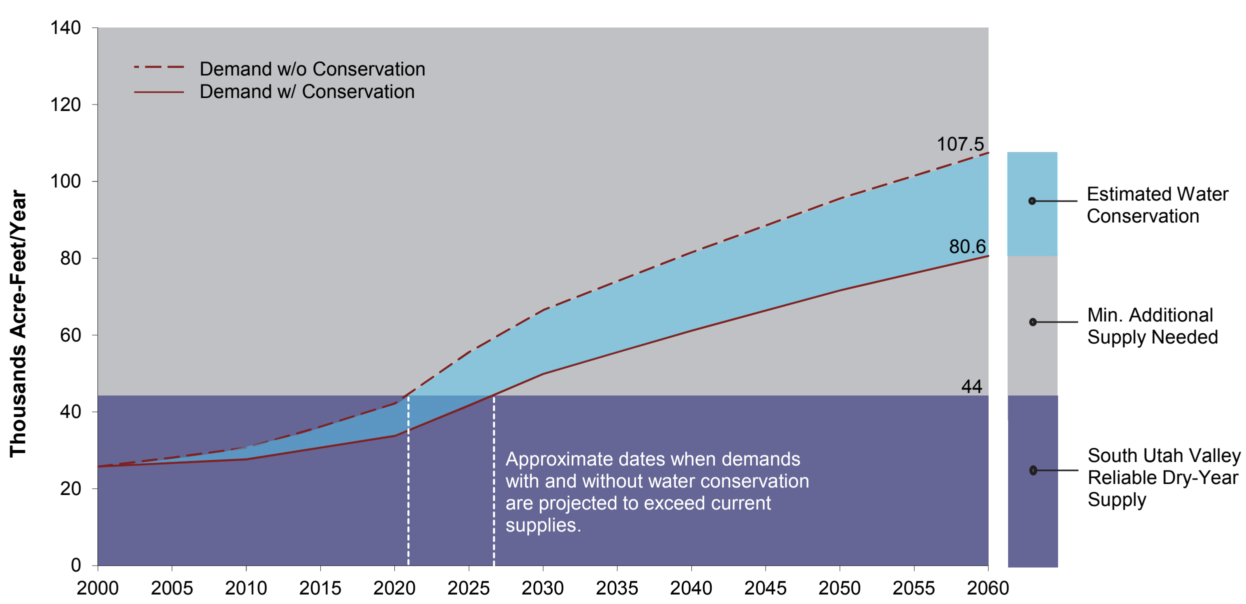
South Utah Valley

Figure 27 shows the reliable supply and demands for the Southern portion of Utah Valley. See Table 15 for specific reliable supply and demand data. The Utah Division of Water Resources estimates the public community system water demand in South Utah Valley was approximately 27,600 acre-feet per year, in 2010. Without water conservation this demand is projected to increase by more than 289 percent to about 107,500 acre-feet per year by 2060. With water conservation the 2060 demand would be reduced to 80,600 acre-feet per year. The Division estimates that the South Utah Valley area currently has a total reliable water supply of about 44,000 acre-feet per year. Figure 27 illustrates that without conservation existing supplies would be adequate through about 2021. With water conservation existing supplies would be adequate through about 2027.

Mountain Homes and Resorts

Data for public community systems within the Mountain Homes and Resorts portion of the basin are provided in Table 15. The Division estimates the public community system water demand within these areas was approximately 408 acre-feet per year in 2010. There are a number of factors that will limit growth in the Mountain Homes and Resorts portion of the basin, including available water supply. Consequently, the Utah Water Demand and Supply Model projects little growth and estimates the 2060 demand (with conservation) at 450 acre-feet per year. This number is well within the existing reliable supply of 1,318 acre-feet per year. Even if other factors do not limit growth in the Mountain Homes and Resort areas it is likely that existing reliable water supplies will.

FIGURE 27
Reliable Water Supply vs. Demand for South Utah Valley



Source: Utah Division of Water Resources, *Utah Water Demand/Supply Model* and M&I water supply and use data collection program, 2010. Projected demands are based upon the Governor's Office of Management and Budget's 2013 population projections.

Selected Individual Water Systems

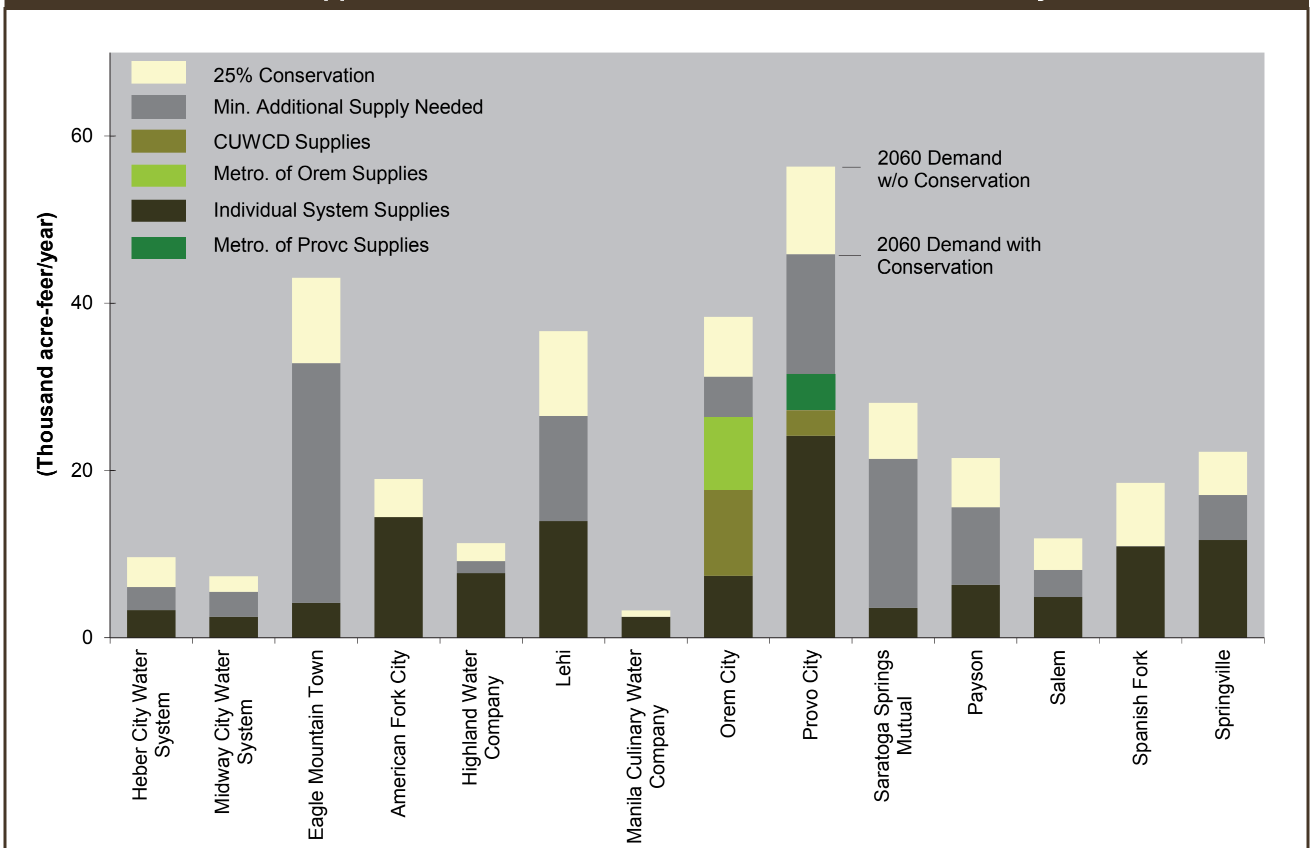
Figure 28 compares the estimated reliable supplies currently available to 14 of the largest individual water systems in the basin to their respective 2060 water demand projections. Provo and Orem cities are the only entities which are shown to currently receive CUWCD water. They also receive water from the Metropolitan Water District of Provo and Orem respectively, as indicated in Table 15.

As shown, all but American Fork, Spanish Fork and Manila Culinary Water Company are projected to need additional water supplies to meet the projected 2060 demands with water conservation. Eagle Mountain's need for additional water is the most significant, followed closely by Saratoga Springs, Provo, Lehi, and Payson. The need for additional water in Heber, Midway Salem and Springville is noteworthy because in each case the amount of new water needed is significant in comparison to the community's existing supplies. It is important to reiterate that reliable supply is a calculation of the amount of water available in drought conditions. Several areas and communities within the Utah Lake Basin are shown, in this section, to have reliable supplies that are deficient when compared to existing demand. Each of these communities will most likely continue to deliver water during wet or average year conditions without any real problems. The supply deficit issues will only become apparent during periods of peak demand during dry (drought) years.

PROPOSED WATER MANAGEMENT STRATEGIES AND DEVELOPMENT PROJECTS

Many of the water systems within the Utah Lake Basin have plans to implement various water management strategies as well as traditional water de-

FIGURE 28
Current Supplies vs. 2060 Demands for Selected Individual Water Systems



Source: Utah Division of Water Resources, *Utah Water Demand/Supply Model* and M&I water supply and use data collection program, 2010. Projected demands are based upon the Governor's Office of Management and Budget's 2013 population projections.
Note: The top of the ivory colored box in each column denotes the 2060 demand without water conservation; the bottom denotes the 2060 demand with water conservation (as labeled for Provo City).

velopment projects to meet their respective future water needs. Details are provided below for the most significant strategies and projects.

Central Water Project

In addition to the existing 2010 water supply shown in Table 15 and depicted in blue in Figures 21 through 27 the Central Utah Water Conservancy District (CUWCD) has purchased 53,300 acre-feet per year of existing water rights from various sources. The largest block of this water comes from the purchase of 42,000 acre-feet per year of water from the Geneva Steel Corporation. This was the industrial water supply used at the Geneva Steel plant, formerly located adjacent the shoreline of Utah Lake west of Orem and Lindon. An additional 11,300 acre-feet per year has been purchased from various agricultural water users in the same area. This 53,300 acre-feet per year of project water is referred to by the CUWCD as the Central Water Project (CWP) water. The first 15 acre-feet per year of this water was put to use in 2011 in the Vineyard area. The balance of the Central Water Project supply will be used to meet the water demands imposed by future growth in the Northwestern portion of the Utah County, primarily in and around Saratoga Springs and Eagle Mountain. Plans are in place to begin the delivery of CWP water to Eagle Mountain by 2014 and Saratoga Springs by 2019.

Central Utah Project

The CUWCD will receive a significant amount of water from the Central Utah Project (CUP) that will be used in the Utah Lake Basin. Once the final stages of this project are complete, the basin will receive additional supply to help meet future water demands (see Table 18). The portion of the CUP that will benefit the basin the most is the Utah Lake System (ULS), which is a component of the Bonneville Unit. The ULS is scheduled to provide the South Utah Valley Municipal Water Association with 22,500 acre-feet of water for M&I use. For further details regarding state and local efforts to develop additional water supplies within the basin, see Chapter 7 – Water Development.

Water Conservation

The state of Utah has adopted a statewide goal to reduce per capita demand of public community system water supplies 25 percent by 2025. The majority of the individual community water systems fully support this goal, with some on track to achieve a greater reduction in per capita use. As shown previously in Figures 21 through 28, water conservation will play a significant role in reducing future M&I water demands and thereby helping the basin's water suppliers meet growing water needs. Table 16 shows estimates of how much 25 percent conservation will reduce future demands for each of the basin's seven areal divisions (values for each division is an aggregate amount of water "saved" by each water supplier through conservation). As shown, basin-wide demands in 2060 will be reduced by 101,400 acre-feet.

TABLE 16
Estimated M&I Water Conservation (2060)

Water Supplier	Water Conservation (acre-ft)
Juab County	2,400
Summit and Wasatch Counties	5,800
Cedar Valley	9,700
Goshen Valley	1,600
North Utah Valley	55,000
South Utah Valley	26,900
Mountain Homes and Resorts	0
TOTAL	**101,400**

Source: Utah Division of Water Resources, *Utah Water Demand/Supply Model,* 2010.

Achieving the water conservation goal will require a concerted effort by the state and all the water suppliers in the basin. Fortunately, the state and local water suppliers have already established a strong water conservation program and framework upon which to build. For further details regarding efforts to conserve water within the basin as well as estimates of conservation that have already been realized, see Chapter 5 – Municipal and Industrial Water Conservation.

TABLE 17
Estimated Agricultural Conversions (2060)

County	Agricultural Conversion (acre-feet)
Juab County	4,000
Summit and Wasatch Counties	16,000
Utah County	80,000
TOTAL	**100,000**

Agricultural Conversions

Table 17 contains estimates of agricultural water that will likely be made available for conversion to municipal and industrial uses by 2060. These estimates are based upon the inevitable urbanization of irrigated agricultural lands that currently exist within and immediately adjacent to the cities and towns that will shoulder the impact of the basin's projected population growth. The natural transition of agricultural water to M&I use as agricultural ground is converted to urban uses is already occurring throughout the basin. One example of this is 10,200 acre-feet per year of Strawberry Valley project water which SUVMWA (South Utah Valley Municipal Water Association) has contracted with the Central Utah Water Conservancy District to deliver through CUP facilities, secondary water use primarily in the communities of Spanish Fork and Payson.

Although it is impossible to predict exactly how this water will be put to use, it is likely that much of it will be placed in secondary irrigation systems. For further details on the conversion of agricultural water to meet growing urban water demands within the basin, see Chapter 6 – Agricultural Conversions and Other Management Strategies.

Other Water Management Strategies

In addition to water conservation and agricultural water conversions, there are many ways that water suppliers in the Utah Lake Basin can more fully utilize the water supplies that are already developed to help meet future water needs. Some of the strategies that have proved successful elsewhere include water reuse, conjunctive management of surface and groundwater, water banking and cooperative agreements, and pressurized secondary water systems. A combination of these methods will be used to help satisfy future demands in the basin.

Summary

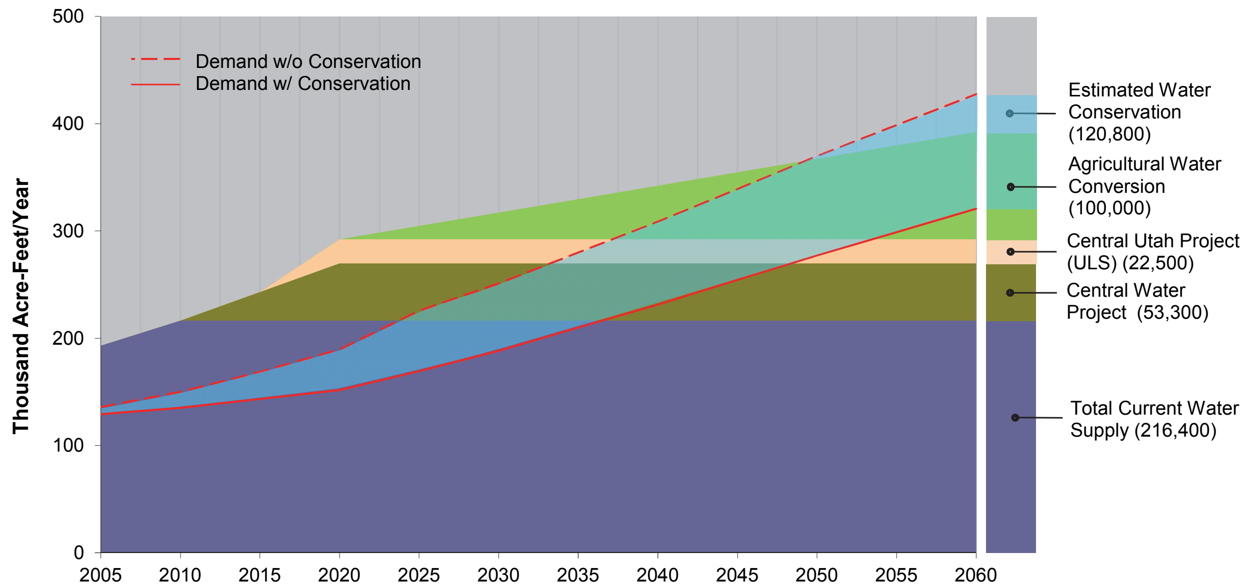
As estimated previously in Table 15 and Figure 21, the basin's current reliable supplies are generally sufficient to match growing demands until about 2036 with water conservation. By 2060, the net reduction in water demands due to water conservation is estimated to be about 100,000 acre-feet per year (See Table 16). Even with water conservation, demands will outstrip the currently available reliable supply by about 105,000 acre-feet per year by 2060. This "deficit" will be satisfied by a combination of traditional water development projects (i.e. Central Water Project and Central Utah Project), agricultural water conversions, and other water management strategies. Figure 29 shows how the projected future water supplies in the basin will provide a significant cushion above the future projected demands with water conservation. Over the next decade the CUWCD's Central Water Project will provide an additional 53,300 acre-feet per year to the basin's existing supply. Beginning around 2015 the Utah Lake System portion of the Central Utah Water project will begin providing an additional 22,500 acre-feet per year of water for M&I use. Agricultural water conversions are projected to add about 20,000 acre-feet per year, every decade. As shown in Figure 29 the Central Water Project coupled with the ULS portion of the Central Utah Project and converted agricultural water should provide the basin with an adequate reliable supply through the planning horizon of 2060. If water con-

TABLE 18
Planned Water Developments

Water Development	Approximate Year(s)	CUWCD (acre-feet)
Central Water Project	2011-2020	53,300
Central Utah Project, Utah Lake System†	2015-2020	22,500 (M&I)
TOTAL	**-**	**75,800**

† Planned deliveries from the portion of the CUP that has not yet been constructed.

FIGURE 29
Projected Future Water Supply vs. Demand for the Utah Lake Basin



servation efforts and agricultural water conversion do not prove to be as beneficial as currently projected, there are a number of additional management strategies and development options that could be employed to further increase the basin's reliable supply. These are discussed in Chapter 6 - Agricultural Conversion and other Water Management Strategies, and Chapter 7 – Water Development.

It is important to point out several issues here. The rosy portrayal of the basin as a whole, as depicted in Figure 29, does not tell the complete story. The down turned economy of the past ten years has greatly reduced projected population growth within the basin. Current population projections for 2030 are about 10 percent lower than projections made just 10 years earlier. In addition, successful water conservation efforts have motivated Governor Herbert to alter the state's water conservation goal from a 25percent reduction in 50 years to a 25percent reduction in 25 years. These two factors have resulted in a significant reduction in the future demand figures found in Table 15 and the demand curves shown in Figures 21 through 29. Prior to these changes the basin's total current water supply appeared adequate only through about year 2020. Additionally, the basin's total current water supply reflects the adequate water supply situation that exists for many of the large communities in the Northern and Central portions of Utah County as well as Summit and Wasatch Counties. The Juab County portion of the basin along with Goshen Valley, Cedar Valley and Southern end of the Utah Valley all have projected demands that will exceed existing supplies well before the year 2035 indicated by Figure 29(See figures 22, 24, 25 and 27). It is for these communities that the Central Utah Project water and the Central Water Project are currently being brought on line.

Agricultural, Environmental and Recreational Water Needs

As stated previously, agricultural water demands in the Utah Lake Basin continue to decline and will be significantly reduced by the year 2060. Any agricultural water needs remaining in 2050 should be easily met using existing water rights.

As the basin's population nearly triples over the course of the next half century, the water needs of the environment will become more critical. However, as new water is imported into the basin to satisfy growing M&I demands, return flows from these imports will tend to offset some of the negative environmental impacts. In addition to this, as projects are completed, water will also be utilized to supplement stream flows and help sustain environmental and aquatic quality. In the future, water quality concerns within the basin will likely be the most critical environmental issues. More stringent monitoring and water quality regulations may be necessary to preserve and sustain the delicate ecological functions unique to the basin. Water planners and managers should continue to work closely with the environmental and water quality communities to identify issues and craft appropriate solutions. For more detail on what needs to be done to preserve the environment and improve water quality in the basin, see Chapter 8 – Water Quality, the Environment and Other Considerations.

Recreational water needs within the basin will increase as the population increases. In order to satisfy these needs, additional facilities at the basin's various water bodies may be required. Water planners and managers should work with interested parties to incorporate their needs into policies and long-term water management strategies.

5

MUNICIPAL AND INDUSTRIAL WATER CONSERVATION

Water conservation will play an important role in satisfying future water needs in the Utah Lake Basin. Water conservation reduces future water demands and decreases the costs associated with additional water development. If water providers implement water conservation programs and measures now, they will be better able to meet short-term and long-term demands. Since the bulk of new water demands will be in the municipal and industrial (M&I) sector, the focus of this chapter is M&I water conservation.

UTAH'S MUNICIPAL AND INDUSTRIAL (M&I) WATER CONSERVATION GOAL

The state has developed a specific goal to conserve municipal and industrial (M&I) water supplies. This goal is to reduce the 2000 per capita water demand from public community water systems[1] by at least 25 percent by 2025. Specifically, statewide per capita demand will need to decline from 293 gallons per person per day (gpcd) to a sustained 220 gpcd or less. This goal is based on modeling and research indicating that indoor and outdoor water use can be reduced by at least 25 percent without a significant change in lifestyle. Indoor reductions will be realized through the installation of more efficient fixtures and appliances as well as public education to change people's water wasting habits. Outdoor reductions will be realized through public education, emphasizing more efficient application of water on landscapes, and proper maintenance of those landscapes. Consuming about 45 percent of the total public water supply, outdoor residential demand is the largest area of consumption.[2] This outdoor usage represents the greatest potential for water conservation of all M&I water uses.

The per capita water consumption in Utah is sometimes compared to other states and to the national average of 179 gpcd. Such comparisons are problematic since they are often made without consideration of several important factors. Residents of states receiving high amounts of precipitation typically do not use public water supplies to water lawns and landscaping. The residents of the more arid states, however, must use public water supplies to water lawns and gardens. Another important factor is that the northern states have shorter growing seasons and water for lawns and landscaping require less water than do the southern states. Also, heavily industrialized states have a higher gpcd since the industries often use public water supplies for their processes. The cost of water can vary widely depending on distance from its supply source to its end-use, its need for pumping, treatment and other factors.

Similarly, it is not valid to make direct comparisons of total gpcd use between cities within a given state. Some cities are "bedroom communities" with little or no industry. Some cities have large industrial areas, which drive up the per capita water use. Other cities have a large daily influx of commuters who use water in the course of their jobs and then leave at the end of the day. This affects the water use in both the city they live in and the one to which they commute. Finally, residential lot sizes, types of landscaping, and other water uses vary among communities. Given all these variables, per capita comparisons between states and between cities are meaningful only when relevant factors are considered. It is more beneficial for individual water suppliers and consumers to track their own usage and focus on conserving water in the ways that make the most sense for their respective circumstances.

Reducing outdoor water waste will play an important role in meeting future water needs.

Probably the most equitable way to compare water use between communities is to consider only the indoor residential water use. The American Water Works Association has found that such indoor use is consistent throughout the United States at about 69 gpcd.[3] The Utah Division of Water Resources conducted an independent assessment that indicated that Utahns use, on average, about 61 gpcd for indoor residential use.[4]

Water suppliers within the Utah Lake Basin have set specific water conservation goals that will help them and the state reach their respective objectives. Central Utah Water Conservancy District (CUWCD) is one of Utah's leaders in water conservation and has developed a detailed plan to meet its own goal of reducing water use by 25 percent by 2025. It is required by CUWCD that any petitioners of Central Utah Project (CUP) water under the Utah Lake System (ULS) project must also reduce their per capita water use by 25 percent by the year 2025. Provo, Salem and Spanish Fork have all adopted this goal. American Fork, Pleasant Grove and Orem have gone further and set aggressive conservation goals. American Fork aims to reduce their culinary per capita use by 50 percent by 2015. Orem's goal is to see a reduction of 20 percent in 10 years while Pleasant Grove's goal is 15 percent reduction in five years. Many other communities in the basin have goals of 5-7 percent reduction in water use within five years. It is encouraging that local communities are taking water conservation seriously and setting aggressive goals for per capita water use reduction. Achievement of these goals will allow these cities to delay or reduce the costs associated with new water supply infrastructure construction and ensure a reliable water supply for their growing populations for many years. It would be wise for other water suppliers in the basin to follow their example and set specific water conservation goals and develop plans and policies to meet them.

Establishment of Baseline Water Use

In order to monitor the success of water conservation measures, water providers must accurately determine baseline water use. This typically includes all public M&I uses but does not include self-supplied industries, private domestic and other non-community systems. Establishing the specific local baseline water use enables water suppliers to track the success of their own conservation efforts. This baseline use is usually expressed as gallons per capita per day (gpcd). Although statewide and basin values provide useful information for comparison purposes, individual communities should establish their own baseline use rates. This will assist them in setting appropriate goals and monitoring progress toward reaching those goals through the various conservation measures and programs they implement.

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Statewide Summary

The Division of Water Resources recently completed a statewide summary of M&I water use. According to data in the summary, the statewide 2010 per capita use of publicly supplied water has declined from the 2000 level of 293 gpcd to 242 gpcd, a reduction of 18 percent in ten years. While the overall goal of 25 percent reduction has not yet been met, it is clear that the State is making excellent progress (See Figure 30).

Utah Lake Basin

The initial survey, which established a statewide per capita water use, also determined that the total use of public water supplies was 273 gpcd in the Utah Lake Basin in 2000. In 2010, the Utah Lake Basin value dropped to 221 gpcd. This is a 19 percent reduction in only ten years and represents and overall reduction of 1.9 percent per year. Clearly, water suppliers and their customers in the Utah Lake Basin have responded to the call for water conservation and have achieved significant results.

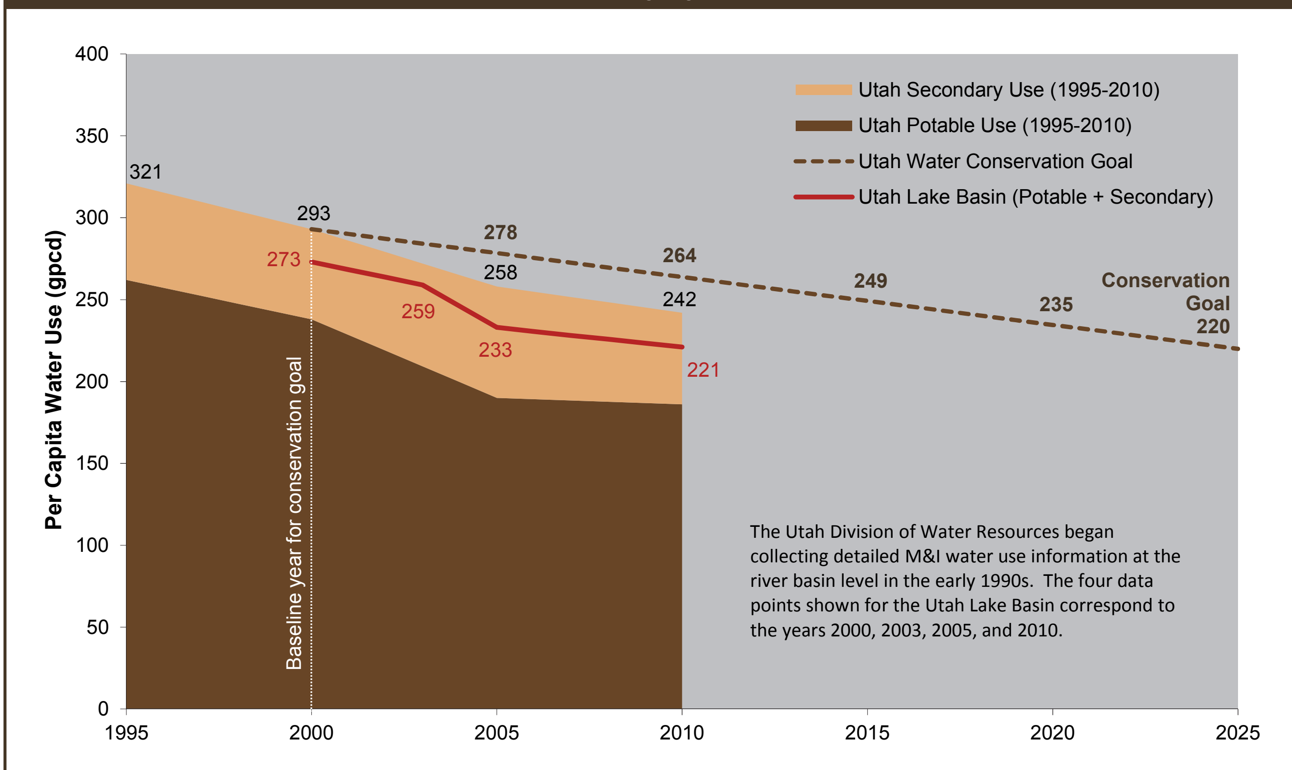
The Division, on behalf of the Governor's Water Conservation Team, has collected total M&I water use data from eighteen communities around the state. Two of these communities, Provo and Orem, are located in the Utah Lake Basin. According to these data, water use within these two communities has decreased steadily. From 2000 to 2010 the per capita water use for the combined communities went from 295 gpcd to 205 gpcd. A decrease of 31 percent. As a whole, the eighteen participating communities have decreased their per capita water use by 25 percent since 2000.

The reduction in per capita water use observed in two major cities in the Utah Lake Basin seems to indicate that the water conservation message is being heard, and that basin residents are modifying their habits to become more efficient in their water use. This is very encouraging. However, it remains to be seen how much of this reduction is due to the severity of the 1999-2004 drought and how much is the result of permanently-changed habits.

WATER CONSERVATION'S ROLE IN MEETING FUTURE NEEDS

If Utah successfully achieves its M&I water conservation goal of at least 25 percent per capita reduction by 2025, the total statewide demand in the year 2060 will be reduced by approximately 561,000 acre-feet per year by the year 2060. This represents the most significant component in meeting Utah's future wa-

FIGURE 30
Per Capita Water Use of Public Community Systems in Utah and the Utah Lake Basin



Source: Utah Division of Water Resources, M&I Data Collection Program.

ter needs. Approximately 25 percent of this amount, or 141,000 acre-feet per year, will occur within the Utah Lake Basin. Without water conservation, it is estimated that by the year 2060 the Utah Lake Basin would experience a water demand of about 483,600 acre-feet per year. With conservation, this demand can be reduced to approximately 321,000 acre-feet per year. The next section details specific activities water suppliers can employ to achieve further water conservation.

WATER PROVIDER ACTIVITIES TO MEET WATER CONSERVATION GOALS

In 2014, the Division of Water Resources updated the M&I water conservation plan for the State of Utah.[5] This plan outlines the state's strategy to meet its water conservation goal and contains specific programs and other activities to help water providers meet their goals. A few of these are provided below. The division is responsible for administering these strategies and will help water providers achieve their goals.

- Prepare Water Conservation Plans
- Support the Public Information Program of the Governor's Water Conservation Team
- Implement Best Management Practices
- Set an Example at Publicly-Owned Facilities

Prepare Water Conservation Plans

In 1998 and 1999, the Utah Legislature passed and revised the Water Conservation Plan Act. This Act requires any water retailer with more than 500 connections and all water conservancy districts to prepare water conservation plans and submit them to the Division of Water Resources by April 1999. Those required to submit water conservation plans must update and resubmit them every five years from the date of the original plan.

In 2004, the Legislature revised the Act, making some significant changes to enhance the quality of water conservation plans and increase the likelihood of compliance. The changes made in the 2004 Amendment to the Act are summarized below:[6]

- ➢ Water conservation plans shall include an overall water use reduction goal, implementation plan, and a timeline for action and measuring progress.
- ➢ Water conservancy districts and water providers shall devote a part of at least one regular governing body meeting every five years to discuss and formally adopt the water conservation plan and allow public comment.
- ➢ Water conservancy districts and water providers shall deliver a copy of the plan to the local media and the governing body of each municipality and county to whom they provide water.
- ➢ The Division of Water Resources shall publish an annual report in a newspaper of statewide distribution a list of water conservancy districts and water providers that have not submitted a plan or five-year update.
- ➢ No entity shall be eligible for state water development funding without satisfying the water conservation plan requirements.

In addition to these legislative requirements, the Board of Water Resources also requires that petitioners for its funds implement a progressive water rate structure and a time-of-day watering ordinance. These requirements are explained later in this chapter.

As of June, 2014, each of the 22 water retailers and conservancy districts in the Utah Lake Basin who are required to submit a plan or update have done so. In addition, nine communities that were not required to submit a conservation plan have also done so.

Water providers within the basin clearly recognize the importance of water conservation plans and have set a good example for other water providers throughout the state. Their success in achieving a 19 percent reduction of water use in ten years indicates that these plans are working. The majority of these water providers outlined overarching water conservation goals, such as reducing per capita or outdoor water use by 5 to 25 percent by 2025 or during the five years until the next plan update is required. In order to accomplish this and other goals, water providers and community systems have identified conservation measures that are applicable for their region.

At the crux of many of these plans, is a well thought out and implemented public education and outreach program. Many conservation actions, if not all, require public participation to some degree. Education and outreach programs are an integral aspect in increasing public awareness regarding wise water use and ultimately fostering action taken by the public to conserve water. Most water communities presented within their conservation plans the need for continuous and bolstered public education and outreach programs. These programs range in simplicity from water conservation-oriented websites and bill stuffers to active and more complex programs involving elementary school youth, all in effort to instill a long-term water conservation ethic. Orem has a very active school program in which they incorporate a hands on water system model for children to learn from. They have also produced an animated video for the children. CUWCD has constructed an education garden that allows visitors to learn of water conserving practices and see them in action. They offer a variety of free classes to the public. Provo is currently in the process of acquiring their "Conservation House." It is a 50 year old house that will be retrofitted with energy and water conserving devices. Provo plans to do an audit before and after renovation to determine the savings. It will be a fantastic educational tool for the public. Public education and outreach is an important strategy to be implemented by water providers in order for these providers to meet their specific water conservation goals and increase public involvement.

Some water providers mentioned promote the Slow the Flow campaign. A large component of this effort is to decrease outdoor water use through efficient landscaping techniques and irrigation practices. Many communities in the Utah Lake Basin such as Saratoga Springs, Eagle Mountain, and Highland are establishing watering ordinances and landscape ordinances. Others are displaying water efficient landscaping at their city buildings. Within the last couple of years, Lehi has Xeriscaped many of their public buildings. Most cities mentioned that they have a program for meter replacement and leak detection and repair. Provo has installed new meters on all city parks and cemeteries with some parks having rain sensors as well. They also use secondary water on five of their parks and all of the Brigham Young University campus. Salem installed a metered secondary water system that serves 95 percent of all residences and commercial customers. Other communities in the basin, such as Highland, Alpine, and American Fork also use a pressurized irrigation system for secondary water. Orem has leak detection equipment and trained personnel to locate problems. This system allows the city to be within 5 percent of the water produced and the water billed, which is well below the industry standard. Lehi replaced all of their old meters with an automatic reading system within a five year period. They can now read their meters on a monthly basis and detect high water usage and possible leaks and have them repaired in a timely manner.

These are a few examples of measures detailed within community system water conservation plans. These plans are meant to be modified as local circumstances change and be utilized in such a manner to ensure effective conservation measures are identified and implemented following a timeline deemed appropriate by community leaders, water managers and suppliers. The Division of Water Resources encourages each community to implement and/or assess measures stated within their respective conservation plans.

Support the Public Information Program of the Governor's Water Conservation Team

All local water providers have the opportunity to choose between creating their own Public Information Program (PIP) or simply providing support for the public information program created by the Governor's Water Conservation Team. These programs are designed to educate the public by providing water conservation information and education. The Division of Water Resources supports these programs by providing information through a water conservation web page, a water-wise plant tagging program and web page, and water conservation workshops, all of which are available to water providers for use in their own PIP campaigns.

Governor's Water Conservation Team

In 2000 the Governor created the Governor's Water Conservation Team to coordinate a statewide water conservation media campaign. The team is chaired by the Director of the Utah Division of Water Resources and is made up of key water officials from the State's five largest water conservancy districts and metropolitan water districts (including Central Utah Water Conservancy District), and representatives from the Governor's Office of Planning and Budget, the Rural Water Association of Utah, the Utah Water Users Association, the landscape industry, and others.

The mission of the Team is to develop a statewide water conservation ethic that results in a reduction in M&I water use of at least 25 percent by the year 2025. Building upon the successes and name recognition the "Slow the Flow" campaign, the team is working together to educate Utahns about water conservation. The intent is for state and local entities to better communicate a consistent water conservation message to their constituents.

Media Campaign

The media campaign consists of a variety of radio, television and print ads disseminated as broadly as possible to Utah residents. These ads continue to be produced and disseminated to remind Utahns of the need to develop a long term conservation ethic. All ads are available online at: www.conservewater.utah.gov and www.slowtheflow.org.

Water Conservation Web Page – www.conservewater.utah.gov

Over the past few years of drought, public interest in water conservation has grown tremendously. With it has come a demand to communicate a consistent and effective water conservation message. Recognizing this need, the Division of Water Resources created a water conservation web page to promote effective water conservation habits in Utah. This web page has been online since the spring of 2002 and contains valuable materials for individuals, educators and water supply agencies.

Water-Wise Plant Tagging Program and Web Page – www.waterwiseplants.utah.gov

The Division of Water Resources, in cooperation with Utah State University Extension, has developed a water-wise plant tagging program to promote the use of native and other drought-tolerant plants in Utah landscapes. This program distributes promotional posters and plant tags to participating nurseries and garden centers. Tags attached to the plants help customers find and identify water-wise landscaping species. Information to identify and select plants for landscapes, including nearly 300 plant species with pictures and descriptions of water needs, hardiness, and other characteristics, is available on the above-mentioned website. To date, the program has provided well over 500,000 tags, which are displayed in nearly 80 nurseries and garden centers throughout the state.

Implement Best Management Practices

The Division of Water Resources recommends that the basin's water providers consider using the following list of Best Management Practices (BMPs) in their water conservation planning efforts. Water providers should implement the mixture of these practices that best fits their own unique needs. Broad implementation of these BMPs will help the individual water suppliers and the state achieve water conservation goals.

Table 19 shows the status of the required conservation plans within the basin and the best management practices (BMP's) that have been implemented or partially implemented for each community as stated in their conservation plans.

BMP 1 - Comprehensive Water Conservation Plans

- Develop a water management and conservation plan as required by law. Plans are to be adopted by the water agency authority (for example, city council, water district board of trustees) and updated no less than every five years.

Currently, all of the Utah Lake Basin's water suppliers have water conservation plans in place.

BMP 2 - Universal Metering

- Install meters on all residential, commercial, institutional, and industrial water connections. Meters should be read on a regular basis.
- Establish a maintenance and replacement program for existing meters.

Table 19
Status of Water Conservation Plans and BMP's

Community System	Update Required	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5	BMP 6	BMP 7	BMP 8	BMP 9	BMP 10	BMP 11	BMP 12	BMP 13	BMP 14
Alpine	2014	X		X			X	X							
American Fork	2014	X		X	X		X								
Cedar Hills	2017	X	X	X			X								
CUWCD	2016	X				X	X		X	X	X	X			X
Eagle Mountain	2015	X	X	X	X	X	X	X	X						
Elk Ridge	2016	X	X	X			X				X				
Highland City	2016	X		X	X	X		X							
Lehi	2014	X	X	X	X		X	X	X			X		X	X
Lindon	2014	X	X		X		X	X							
Manila	2018	X					X					X			
Mapleton	2014	X		X											
Orem City	2017	X	X				X	X				X			
Payson	2014	X	X				X	X	X						
Pleasant Grove City	2014	X	X	X			X	X				X			
Provo	2014	X	X			X	X		X					X	X
Salem	2014	X	X	X		X	X	X							X
Santaquin	2018	X	X	X	X		X	X			X		X		
Saratoga Springs	2015	X	X	X	X	X	X		X		X				X
Spanish Fork	2015	X	X	X			X		X				X		
Springville	2016	X		X			X	X			X			X	
Heber	2016	X		X	X		X	X				X		X	
Midway	2018	X	X	X	X		X	X							

Note: An "X" indicates the community partially or fully implemented the BMP as stated in their water conservation plan.

- Meter secondary water at the most specific level possible, somewhere below source water metering. Individual secondary connection metering should be done as soon as technology permits.

In order to effectively bill customers according to the amount of water they use, the connection must be metered and these meters must be read frequently. The metering of potable (drinking) water connections is a high priority for most public community water systems within the Utah Lake Basin. As indicated in the water conservation plans submitted to the Division of Water Resources, not only do these systems meter their connections but most of them actively read and replace meters to assure they are functioning properly.

While potable water lines are metered, individual secondary water connections are rarely monitored. Meters on secondary water lines typically clog and otherwise malfunction because secondary water is rarely treated to remove sediment and debris that is removed in drinking water treatment. These problems are not easy to overcome and may require expensive retrofits that are not currently feasible. Eventually, however, a better accounting of secondary water use by the end user will be required. This may make it necessary for secondary water providers to apply some degree of treatment for the water or use a meter that will operate satisfactorily with untreated water. This being said, Spanish Fork and Salem are unique in that they do meter their secondary water systems.

BMP 3 - Incentive Water Conservation Pricing

- Implement a water pricing policy that promotes water conservation.
- Charge for secondary water based on individual use levels as soon as technology perpermits.

TABLE 20
Potable Water Prices of Various Communities in the Utah Lake Basin[1,2,3]

Community System	Number of Accounts	Estimated Cost per 1,000 gallons	Average Monthly Bill
Alpine	2,340	$1.66	$16.74
American Fork	7,410	$2.70	$29.24
Elk Ridge	585	$3.95	$61.85
Lindon	2,643	$3.01	$41.89
Manila	1,227	$1.26	$5.58
Orem	21,807	$1.01	$33.55
Payson	5,485	$0.83	$19.06
Pleasant Grove City	6,790	$2.58	$35.54
Provo	18,573	$0.48	$29.26
Salem	1,871	$1.21	$29.43
Santaquin	2,345	$1.03	$26.36
Spanish Fork	8,899	$1.29	$20.54
Springville City	8,016	$1.04	$31.81
Woodland Hills	348	$3.05	$70.16
Midway	1,989	$0.26	$15.07
Utah Lake Average	--	$1.36	$32.42
Utah State Average	--	$1.62	$43.14
National Average	--	$2.50	$25.70

1. Except for the Utah Lake average cost per 1,000 gallons, all averages are weighted averages.
2. Does not include non-potable water, which is generally cheaper, that may be delivered within the listed community.
3. Unless otherwise noted, data from: *Utah Division of Drinking Water, Survey of Community Drinking Water Systems, 2010.*

Table 20 lists average water prices for potable water of several cities in the Utah Lake Basin. As shown, the cost per 1,000 gallons in the Basin is slightly higher than the Utah average but is still well below the national average. Some reasons that may explain why these costs are lower than the national average include the following:

- Much of the basin's population is located near mountain watersheds which have been easily developed to gravity feed a significant portion of the water needs;
- Water derived from the mountains is of high quality, without pollutants, and needs less treatment.
- Property taxes are used to pay a portion of the water costs.
- Some communities have secondary water systems which provide less expensive, untreated water for outdoor irrigation; and
- Federally and state subsidized water projects provide inexpensive water to a significant portion of the population.

Simply raising water rates may not be the best solution to conserving water. Water pricing strategies that provide an incentive to customers to became more efficient and use less water should be implemented. Rate structures should also be designed to provide sufficient income to finance system maintenance and improvements and avoid capital shortfalls, as successful conservation generally reduces revenue. Some of the more effective rate structures are discussed briefly below. See Figure 31 for a visual representation and example bill summary for each rate structure.

<u>*Uniform Rates*</u>

In this rate structure the unit price for water is constant or flat, regardless of the amount of water consumed. It provides no price incentive for water conservation.[7] Eight of the 21 major water suppliers in the Utah Lake Basin (38%) have a uniform rate structure. The unit price varies from a minimum of $0.55 per 1,000 gallons to a maximum of

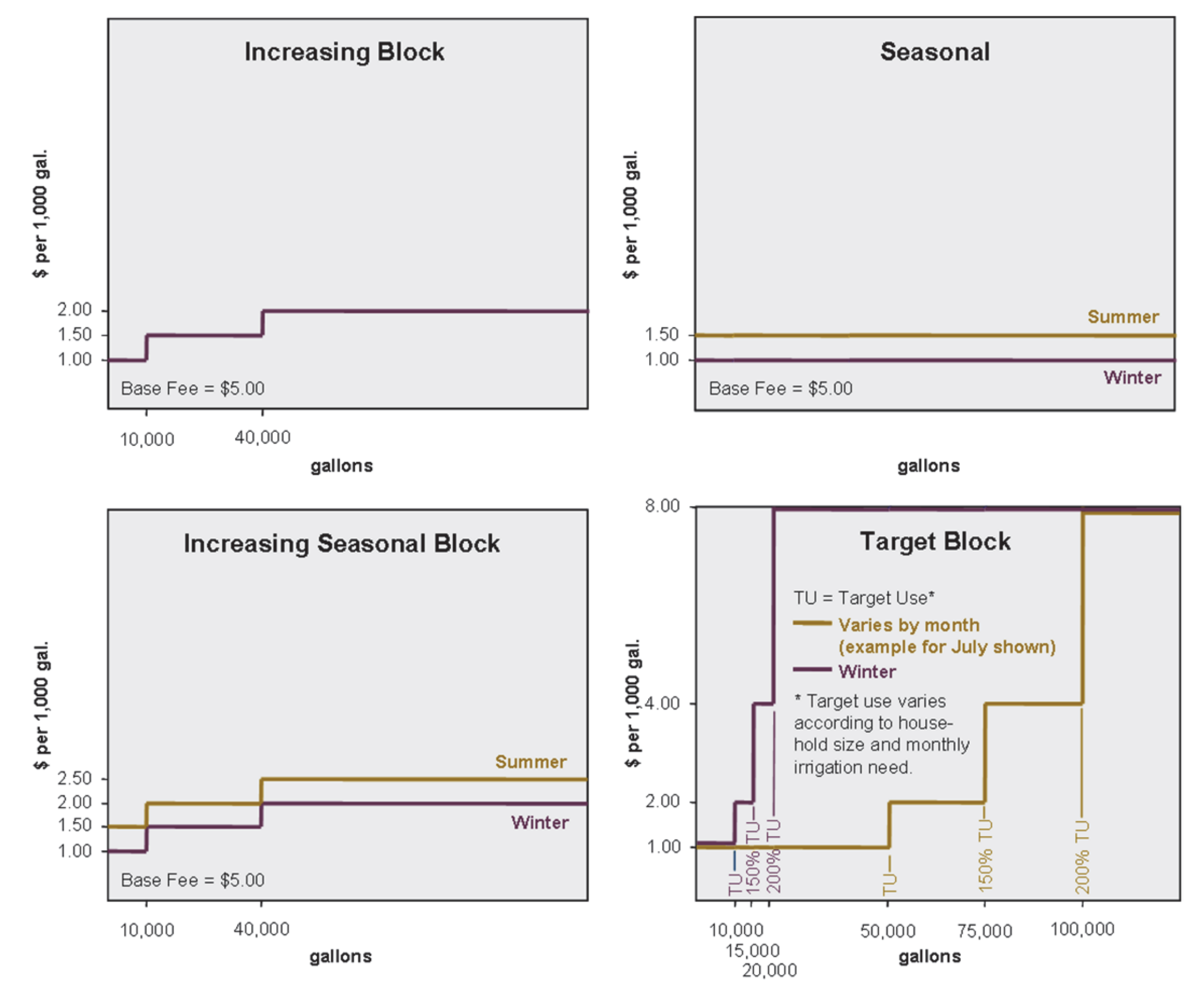
$1.49 per 1,000 gallons with an average of $1.01 per 1,000 gallons.

All of the major suppliers charge a base fee. The lowest base fee is $7.50 per month, the highest is $40.00 per month. In some cases this base fee provides a minimum amount of water, while in other cases it does not. The amount of water provided for the base fee ranges from zero up to 13,000 gallons per month. Ideally, base rates should include only operating costs and not provide any water associated with it.

Increasing Block Rates

Increasing block rate pricing structures typically have a base fee, which must be paid whether or not any water is used. Sometimes a fixed amount of water is made available at no additional cost. The price of subsequent increments of water supplied then increases in a step-wise fashion. This rate structure encourages efficiency only if the steps in the incremental price are sufficient to discourage excessive use.

FIGURE 31
Examples of Rate Structures and Bill Comparison



The increasing block rate (sometimes called progressive rate structures) is currently used by about 42 percent of Utah's drinking water systems. [8] In the Utah Lake Basin, 57 percent (12 of 22) of the major suppliers employ this type of rate structure. Base fees in systems with increasing block rate structures range from a low of $7.50 to a high of $40.00, with an average of about $16.50. The amount of water included in the base rate ranges from a low of zero gallons to a high of 13,000 gallons, with an average of about 7,780 gallons. The price of the first additional increment of water (not supplied as part of the base charge) ranges from a low of $0.75 per 1,000 gallons to a high of $2.00 per 1,000 gallons, with an average of about $1.43 per 1,000 gallons. Up to four blocks are used by the basin's water suppliers. The price of each of the three additional increments, above the first block, range from a low of $1.00 to a high of $2.75 per 1,000 gallons.

Seasonal Rates

This rate structure has a base charge just like other rate structures. The main difference is that instead of rate increases based upon the volume of water used, rates are set according to seasons. The price for each unit of water delivered in winter is lower than for water delivered in the summer. The summer price is set strategically to encourage consumers to be more conscious of irrigation habits during the months when peak demands often strain the delivery system. If desired, a spring and fall use rate can also be applied to help reflect the rising and falling costs associated with typical use patterns within the water system. It also provides water suppliers with an opportunity to remind consumers that irrigation needs are typically less during the spring and fall months and, therefore, sprinkler timers should be adjusted accordingly. One of the 22 major suppliers in the Utah Lake Basin employs a seasonal rate structure. None currently adjust rates in both the spring and the fall.

Increasing Seasonal Block Rates

This rate structure is a combination of the increasing block and seasonal rates. Like the seasonal rate, it has a price for each unit of water delivered in winter that is lower than for water delivered in the summer. However, instead of a flat rate for a given season, the increasing seasonal block rate has an increasing block rate for each season (see Figure 31). If desired, an increasing rate for the spring and fall seasons can also be applied. This type of rate structure is new to Utah. None of the water suppliers in the Utah Lake Basin are using this water rate structure.

Target Block Rates

This rate structure requires that a target use be established for each customer. This target is based on the water needs of the landscape and the number of people in the home or business. Landscape water need is determined by using evapotranspiration rates for turf grass from local weather stations and landscape size. Then, each unit of water is priced in such a way so as to reward the consumer for using no more than the target use for their individual property or penalize the consumer for using amounts that exceed the target use (see Figure 31). Water providers can assess penalties by using a sequentially higher rate. Because of the effort required to obtain and maintain accurate data on each customer, the target block rate requires more capital resources and staff attention than other rate structures, especially when first implemented.

BMP 4 - Water Conservation Ordinances

- Adopt an incentive water rate structure.
- Adopt a time-of-day watering ordinance.
- Adopt an ordinance requiring water-efficient landscaping in all new commercial development. This should include irrigation system efficiency standards and an acceptable plant materials list.
- Adopt an ordinance prohibiting the general waste of water.

For sample ordinances, go to www.conservewater.utah.gov and click on "Agency Resources."

Outdoor Watering Guidelines and Ordinances

If residential outdoor conservation were practiced, the potential water savings would be significant since it makes up the biggest part of public water use in the Utah Lake Basin and incurs the greatest amount of waste or excessive use. The Division of Water Resources estimates that the water needed to produce a healthy lawn on a typical residential landscape could be reduced at least 25 percent by following two simple steps. These are: (1) watering to meet the turf water requirement -- the amount of water needed by turf to produce full growth; and, (2) maintaining a sprinkler distribution uniformity (how evenly the sprinkler system spreads the water) of at least 60 percent.

Table 21 contains a general recommended irrigation schedule for Utah County. These recommendations should only be used as a starting point from which to establish an optimum watering schedule for each individual lawn. Residents should consult their community water supplier to see if they have site-specific recommendations. Finally, each irrigation system delivers different amounts of water per unit time depending on water pressure, sprinkler type and other variables. Watering to only meet and not exceed the turf water requirement also produces a healthier and better-adapted turf. Average residential sprinkler uniformities in Utah have been found to be about 51 percent.[9] Increasing these to 60 percent or more can easily be achieved by properly designing sprinkler systems and by regularly inspecting and maintaining their performance.

If a homeowner were to implement additional outdoor watering guidelines, overall residential water consumption could be reduced beyond 25 percent.[10] Other conservation measures include setting watering durations to suit different soil types and microclimates, using several short durations (cycling) to water deeply while avoiding runoff, and watering flower and shrub areas less than turf areas.

Time-of-Day Watering Ordinance

Another method that has proved effective in reducing water consumption is simply confining watering to times during the day that minimize evaporation, between 6 p.m. and 10 a.m., and then reducing the watering duration to reduce evaporation losses. These recommendations should be made to the public during both wet and dry climatic conditions. Saratoga Springs has adopted a time-of-day watering ordinance and many other communities recommend this practice on voluntary basis.

TABLE 21
Recommended Irrigation Schedule for Utah County*

Irrigation Period	Watering Interval (days between watering sessions)
Startup until April 30	6
May	4
June	3
July	3
August	3
September	6
October 1 until shutdown	10

* This schedule assumes an application of ½ inch of water per watering session and is based on historical turf water requirements from Hill, Robert, *Consumptive Use of Irrigated Crops in Utah,* (Logan: Utah Agricultural Experiment Station, 1994).

Water Efficient Landscape Guidelines

The types of plants that make up a landscape and the total area that requires irrigation can have a significant impact on overall water consumption. Irrigation methods and human behavior play a large role in water use and water waste. One way to help change behavior includes changing the style of landscaping. The replacement of typical turf grass and other water-intensive vegetation with native or adapted low water-use plants, in lower no-use areas, significantly reduces outdoor water needs. Hardscaping a portion of the landscape eliminates the need to water that area. If the low water-use vegetation is irrigated using efficient irrigation practices, outdoor water use can be reduced more than the 25 percent goal currently set by the State. Not only do water-wise landscapes conserve water, they require lesser amounts of chemicals (herbicides, pesticides and fertilizer), require less maintenance than typical turf, and add variety, interest, and color to the ordinary landscape.

Changing the way people landscape to more closely match the conditions of Utah's semiarid climate is an important aspect of long-term water conservation. Demonstration gardens and public education programs that communicate efficient landscaping techniques, as well as ordinances that promote more "natural" landscaping practices, are important components of an outdoor water conservation program.

While parks and green spaces make significant contributions to city life, ordinances that require unnecessary lawn space or other water intensive planting and encourage excessive water use should be eliminated.

BMP 5 - Water Conservation Coordinator

- Designate a water conservation coordinator to facilitate water conservation programs. This could be a new person or an existing staff member.

The Division of Water Resources recommends that the individual appointed to the position of Water Conservation Coordinator have knowledge or training in as many of the following areas as possible:

- principles and practices of water conservation, including residential and commercial water audits;
- techniques and equipment used in landscape design and installation;
- Utah native and adapted plants, and turf grasses;
- laws and regulations applicable to water management;
- make presentations to community, technical or professional groups;
- maintain computer records and customer databases;
- research and implement State and local water conservation requirements;
- review architectural and landscape plans for water efficiency requirements;
- design simple informational publications; and
- education equivalent to completion of college level course work in landscape architecture, horticulture, public relations, architecture or a closely related field.

BMP 6 - Public Information Programs

- Implement a public information program consistent with the recommendations of the Governor's Water Conservation Team. Such programs can be adapted to meet the specific needs of the local area and may use the "Slow the Flow" logo with approval of the Division of Water Resources.

Local water providers need to bring water conservation to the attention of individual families and businesses. The intent is to make conservation a permanent part of everyday life. One suggestion is to permanently add water conservation-related website addresses, to on all water bills (see Table 22). Another suggestion would be to add flyers promoting water conservation in the envelope with water bills every three or four months. Internet sites with representative flyers are shown in Table 22. Almost eve-

TABLE 22
Water Conservation Internet Websites

1	**Site: www.conservewater.utah.gov** **Sponsor:** Utah Division of Water Resources **Features:** Water Wise Plants for Utah, Water Conservation Case Studies (includes flyers for water bills), Lawn Maintenance Tips, Reasons to Conserve, Utah's M & I Water Conservation Plan, Water Conservation Plans and Pricing Database, Slow The Flow "Infomercial".
2	**Site: www.centralutahgardens.org** **Sponsor:** Central Utah Water Conservancy District **Features:** Garden tutorial videos, Seven steps for the design and execution of water conservation, List of classes, Calendar of events, and concerts, Map of the demonstration garden, Photo gallery, Sample designs, What's Blooming, Plant of the week, and Water data
3	**Site: www.slowtheflow.org** **Sponsor:** Jordan Valley Water Conservancy District (JVWCD) **Features:** 12 different Water Wise Landscaping Classes, Suppliers of Water-Wise Plants, Model Landscape Ordinances for Cities, Description of JVWCD 2-acre Demonstration Garden (examples for homes & businesses), Landscaping Workshops, Ultra Low-Flush Toilet Replacement Program, Landscaping Information Pamphlets for Many Different Plants, and many other useful features.

ry community in the Utah Lake Basin includes water conservation flyers in their bills regularly or seasonally and that they have water conservation tips on their websites.

BMP 7 - System Water Audits, Leak Detection and Repair

- Set specific goals to reduce unaccounted for water to a specific, acceptable level.
- Set standards for annual water system accounting that will quantify system losses and trigger repair and replacement programs, using methods consistent with American Water Works Association's Water Audit and Leak Detection Guidebook.

In some water systems, the best way to conserve water may be to discover and repair leaks within the distribution system. Leak detection and repair programs often receive substantial capital investment because the results of such efforts are quantified. However, if a thorough investigation determines that leaks are not a significant problem, such programs may not yield savings as significant as other conservation measures.

Many water providers in the Utah Lake Basin who submitted water conservation plans to the Division of Water Resources indicated the importance of leak detection and repair programs to their operations. Water utilities should carefully weigh the costs of infrastructure repair and replacement against all possible conservation measures in order to determine which will most economically attain the desired objective of water conservation.

BMP 8 - Large Landscape Conservation Programs and Incentives

- Promote a specialized large landscape water conservation program for schools, parks, and businesses.
- Encourage all large landscape facility managers and workers to attend specialized training in water conservation.
- Provide outdoor water audits to customers with large landscape areas.

The basin's water distributors and user can qualify for financial assistance to implement water conservation measures through the CUPCA. The Central Utah Project Completion Act, enacted by the U.S. Congress in October 1992, provided major water distributors and users an opportunity to conserve and save significant amounts of water. The CUPCA legislation only applies to areas within the Central Utah Water Conservancy District (CUWCD), which includes all or parts of Salt Lake, Utah, Wasatch, Duchesne, Uintah, East Juab, Sanpete, Piute, Summit and Garfield counties. The Act provides an incentive by authorizing federal funds to finance up to 65 percent of the cost of the water conservation measures.

To date, the CUPCA water conservation program has resulted in the implementation of 51 projects which conserved almost 134,300 acre-feet of water during the 2013 water year. These water conservation projects have also provided nearly 15,000 acre-feet of water for instream flow to enhance environmental purposes during that same period.

CUWCD has three financial assistance programs that address water conservation by encouraging participation from those that will benefit from such projects. The following sections detail these plans.

<u>Water Conservation Credit Program</u>

As required by the CUPCA, federal money is provided on a cost-share basis to public and private entities that demonstrate need and appropriate planning for larger water-saving projects. Projects submitted for consideration undergo rigorous examination by committee members from CUWCD, the Department of Interior and private citizen groups. Through the summer of 2013, the Program is credited by the Department of Interior with conserving over 134,000 acre-feet of water per year. For additional information on the Credit Program and active projects, see www.cuwcd.com/cupca/wccp.htm.

<u>Water Conservation - General Administration Fund</u>

The CUWCD encourages the continued development of technology that will increase water use efficiency. This is accomplished by offering cost-share assistance to organizations interested in pursuing irrigation improvements on a smaller scale than is usually attempted by the Water Conservation Credit Program. The District also provides funding for statewide water conservation education through the State Office of Education, the Living Planet Aquarium, and, in the Uinta Basin, the PAWS-On program of the Dinosaurland RC&D.

<u>Water Conservation Technology Grants</u>

Challenges associated with drought, as well as concern for long-term water supplies for our growing population, have prompted CUWCD to encourage a variety of innovative responses to water conservation. The district makes cost-share grants to smaller-scale enterprises such as schools, municipalities, housing developments, condominium homeowners associations, and individual property owners that demonstrate need and initiative in water management.

Termed "Water Conservation Technology Grants," funds are distributed on a 50 percent (or less) cost-share basis up to $5,000. Grants exceeding $5,000 and up to a 50 percent cost-share may be considered on a case by case basis for projects of unusually large scope and for projects that demonstrate exceptional water conservation savings. Recipients of Water Conservation Technology Grants to date include Utah Valley University and the American Fork Cemetery for the installation of soil moisture sensors. A parking strip sprinkler and planting display and a small demonstration garden are among pending projects.

BMP 9 - Water Survey Programs for Residential Customers

- Implement residential indoor and outdoor water audits to educate residents on how to save water.

Water audits are becoming a commonly used tool to help consumers reduce their water use. A complete water audit consists of both an indoor and an outdoor component. A typical indoor audit involves checking the flow rates of appliances and identifying leaks, and if necessary, replacing basic fixtures with low-flow devices and making other necessary adjustments or repairs. A typical outdoor audit measures the uniformity and application rate of an irrigation system, identifies problems, and suggests how to improve system efficiency and how to water according to actual plant requirements.

Beginning in 1999, the Jordan Valley Water Conservancy District, in cooperation with its member agencies and Utah State University Extension Service, initiated a free "water check" program in Salt Lake County. A water check is basically a simplified outdoor water audit for residents. Since December 2005, the program has been adopted and implemented by other agencies and is operational throughout Cache, Salt Lake, Utah, Juab, Duchesne and Uintah counties. CUWCD coordinates and funds a water check program as well as for the Slow-the-Flow campaign. A flyer describing the water check program could be included with water bills and can be found at: www.slowtheflow.org/programs/H2Oprogram.asp.

BMP 10 - Plumbing Standards

- Review existing plumbing codes and revise them as necessary to ensure water-conserving measures in all new construction.
- Identify homes, office building and other

Homeowners may receive a free outdoor "Water Check" by calling 1-877-SAVE-H20.

structures built prior to 1992 and develop a strategy to distribute or install high-efficiency plumbing fixtures such as ultra low-flow toilets, showerheads, faucet aerators, hot water recirculators and similar technologies.

Retrofit, Rebate, and Incentive Programs

It has long been known that the largest indoor consumption of water occurs by flushing the toilet. This fact prompted legislation to phase out the manufacture of old-style toilets, which typically consumed 3.5 to 7.5 gallons per flush, and replace them with newer, low-flow devices that consume 1.6 gallons or less. Since 1992, Utah law requires the installation of low-flow toilets in new construction. Federal law has prohibited the manufacture of higher-flow toilets since 1994. This change has reduced indoor residential water consumption in new construction by an estimated 5 gpcd or 9 percent.[11]

BMP 11 - School Education Programs

- Support state and local water education programs for the elementary school system.

In a cooperative effort between CUWCD, The Living Planet Aquarium and the Division of Water Resources, the Utah Waters Van will visit all of the fourth grade classes in the ten counties served by the CUWCD. The Utah Waters Van works within the State Science Core Curriculum for fourth grade and teaches students about the water cycle, weather, and the plants and animals in Utah's wetlands.

For more information, go to: www.wateredducation.utah.gov.

BMP 12 - Conservation Programs for Commercial, Industrial and Institutional Customers

- Change business license requirements to require water reuse and recycling in new commercial and industrial facilities where feasible.
- Provide comprehensive site water audits to those customers known to be large water users.
- Identify obstacles and benefits of installing separate meters for landscapes.

BMP 13 –Reclaimed Water Use

- Use reclaimed or recycled water where feasible.

BMP 14 – "Smart Controller" Technology

- Install "smart controller technology to irrigate public open spaces where feasible.
- Encourage customers to utilize "smart controller" technology by offering rebates for these products.
- (Salem City is currently installing "smart controllers" in new homes and subdivisions.)

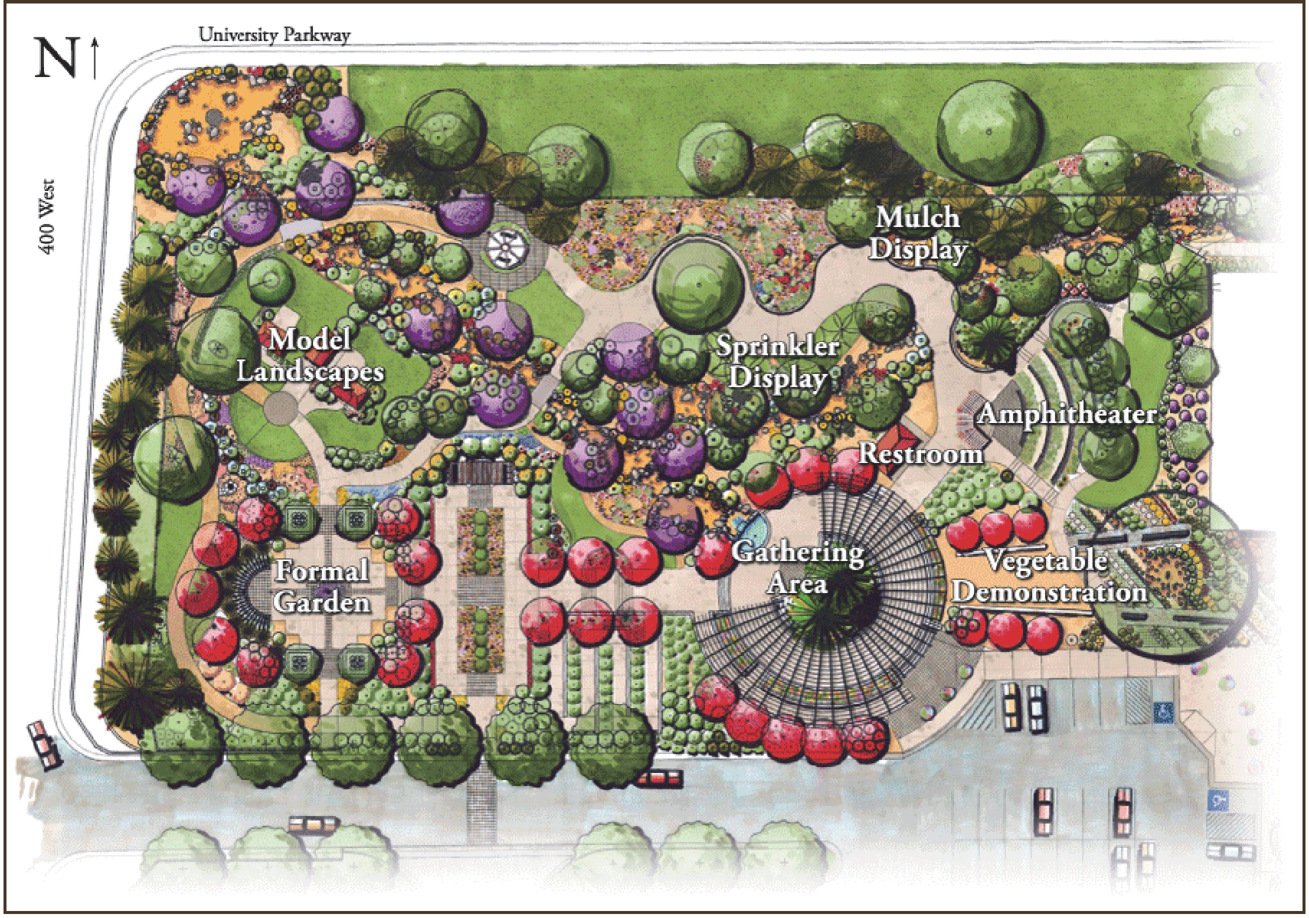
Central Utah Water Conservancy District offers rebates and small grants to homeowners and larger water users within the district who will take the necessary steps to purchase and use equipment that has been shown to reduce water use. Link to www.cuwcd.com/rebates for downloadable forms and additional links to product information.

Set Example at Publicly Owned Facilities

It is important that government entities within the basin be good examples of water conservation for the citizens they serve. To help accomplish this at state facilities, the state recently revised its building guidelines and policies to incorporate water-wise landscapes and more water-efficient appliances (faucets, showerheads, toilets) at new facilities. In addition, by Executive Order, Governor Leavitt mandated that all State facilities avoid watering between 10 a.m. and 6 p.m. Local governments should consider making similar adjustments to their building guidelines. This will help ensure that water use at public facilities does not deter citizens from conserving water on their own landscapes.

The Division of Water Resources has a large collection of materials that can help local governments strengthen their water conservation ethic. Various guidelines and recommendations, including sample ordinances, water-wise landscaping manuals and other resources are all available through the division.

FIGURE 32
Central Utah Water Conservancy District's Garden



Source: Central Utah Water Conservancy District's Central Utah Gardens website.

Many of these materials are also available online at the state's water conservation web page: www.conservewater.utah.gov. Finally, the Division recommends the three texts listed in the last endnote of this chapter.[12]

The CUWCD headquarters seven-acre property, at 355 West University in Orem, has been upgraded to more wisely use water. The original landscaping and irrigation system were designed with the best technology available 35 years ago. Since that time, major improvements have been made in both the landscaping and watering strategies. Approximately one quarter of the CUWCD site was landscaped specifically to showcase low-water use plants and advanced irrigation system layout and equipment. Older sections of the CUWCD landscape are being replaced and renovated as opportunities and needs arise. Significant water savings are being realized at the headquarters site.

The Central Utah Gardens at CUWCD is a valuable resource for those interested in water-wise landscaping as well as water education. Central Utah Water Conservancy District has created the Gardens to support its commitment to conservation, and to encourage an ethic that promotes responsible management of water resources within the community. CUWCD offers classes, concerts, and other events at their garden throughout the season. The website for the Central Utah Gardens is: www.centralutahgardens.org.

NOTES

[1] A privately or publicly owned community water system which provides service to at least 15 connections or 25 individuals, year-round.

[2] Utah Division of Water Resources, *Utah's M&I Water Conservation Plan,* (Utah Division of Water Resources, July 2003), 3. This plan is available through the Division's web page at: www.water.utah.gov.

[3] Mayer, Peter W., William B. DeOreo, Eva M. Opitz, Jack C. Kiefer, William Y. Davis, Benedykt Dziegielewski, and John Olaf Nelson, *Residential End Uses of Water,* (Denver, CO: AWWA Research Foundation and American Water Works Association, 1999), 86 & 87.

[4] Utah Division of Water Resources, *2009 Residential Water Use: Survey Results and Analysis of Residential Water Use for Seventeen Communities in Utah,* (Salt Lake City: Utah Dept. of Natural Resources, 2010), 29.

[5] Utah Division of Water Resources, 2003.

[6] *Utah Administrative Code, Title 73-10-32,* (2004).

[7] Western Resource Advocates & Utah Rivers Council, *Water Rate Structure in Utah: How Cities Compare Using This Important Water Use Efficiency Tool,* (January 2005), 4 & 6.

[8] Utah Division of Drinking Water, *2001 Survey of Community Drinking Water Systems,* (Salt Lake City: Dept. of Environmental Quality, 2002). A total of 28 systems within the Jordan River Basin responded with information about their water rate structures. 12 of these employed a uniform rate structure; 16 employed an increasing block rate structure. Conclusions cited in the text are based upon the data provided by these systems only and may not be representative of all systems within the Basin.

[9] Jackson, Earl, *Results and Impacts Report: Water Check 2001, Salt Lake County,* (Salt Lake City: USU Extension, 2002), Table 6.

[10] A possible reduction in outdoor water use of 50 percent is cited in numerous documents, among which the following is an excellent source of Utah specific information: Keane, Terry, *Water-wise Landscaping: guide for water management planning*, (Logan: Utah State University Extension Services, 1995), 1. This document is available on the Internet at the USU Extension Service web page: www.ext.usu.edu/publica/natrpubs.htm.

[11] Utah Division of Water Resources, *2009,* 29.

[12] Mee, Wendy, Jared Barnes, Roger Kjelgren, Richard Sutton, Teresa Cerny, & Craig Johnson, *Water Wise Native Plants for Intermountain Landscapes,* (Logan, UT: Utah State University, State University Press, 2003).

Denver Water & American Water Works Association, *Xeriscape Plant Guide, 100 Water-Wise Plants for Gardens and Landscapes*, (Golden, CO: Fulcrum Publishing, 1998).

Busco, Janice & Nancy R. Morin, *Native Plants for High-Elevation Western Gardens*, (Golden, CO: Fulcrum Publishing, in partnership with The Arboretum at Flagstaff, 2003).

6

AGRICULTURAL CONVERSIONS AND OTHER WATER MANAGEMENT STRATEGIES

Using existing developed water supplies efficiently is an important element in successfully addressing the future water needs of the Utah Lake Basin. Increased competition for the basin's water supplies will boost the value of those supplies and will allow creative and new water management strategies to be implemented. In some instances, the economic incentive created by increased competition may also lead to the transfer of water from one use to another, thereby maximizing the beneficial use of existing water supplies. This chapter discusses the nature of some of these water transfers and highlights other management strategies, including: conjunctive use of surface and groundwater, secondary water systems, cooperative water operating agreements and water reuse.

AGRICULTURAL TO MUNICIPAL & INDUSTRIAL CONVERSIONS

As communities in the basin grow, development will likely occur on irrigated agricultural land. This is especially true along the Wasatch Front where many cities are constrained on one or more sides by community boundaries, mountainous regions or bodies of water. For these communities the urban development on irrigated lands will occur at a rapid pace.

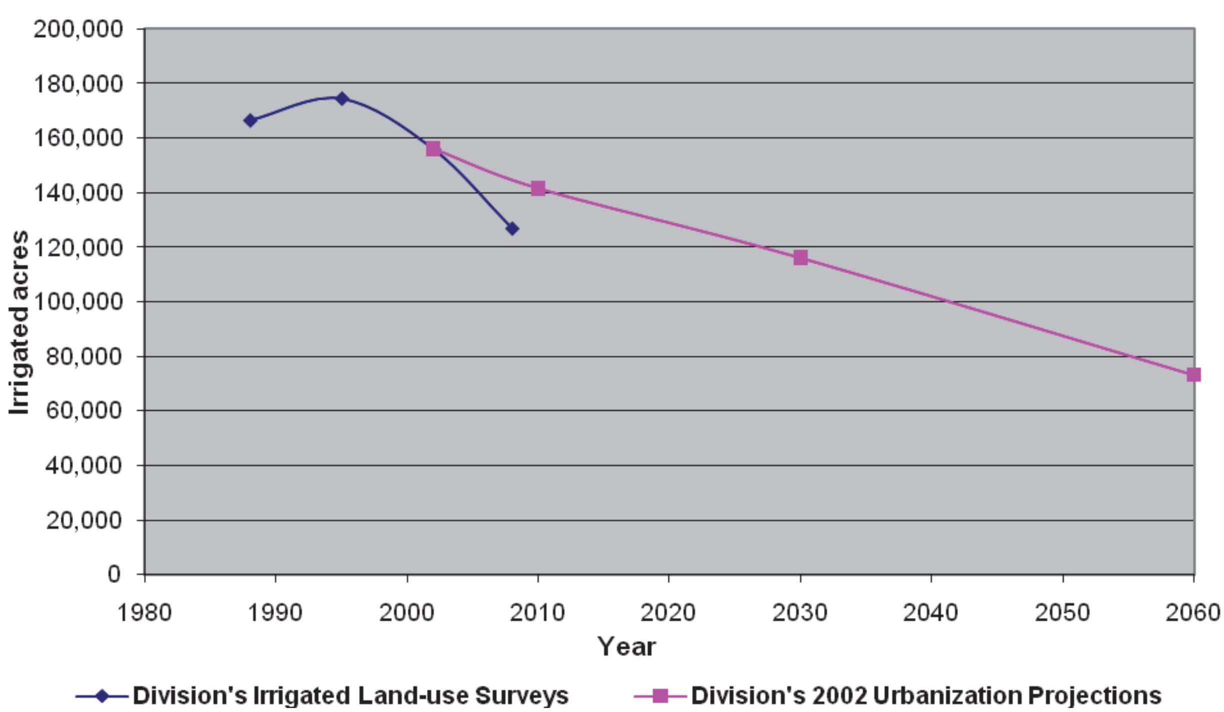
When irrigated farmland changes from agricultural to urban use, many Utah communities require the agricultural water rights associated with the land be transferred to the municipality as a condition of approving the development. In most cases, the same amount of water used to irrigate an acre of agricultural land is sufficient to meet the indoor and outdoor water needs of an acre of urban development. Water transferred in this manner typically becomes part of the municipality's water supply, which can then be treated and delivered to meet growing municipal and industrial (M&I) water demands.

The Division of Water Resources has conducted land use surveys in the Utah Lake Basin in 1988, 1995, 2002 and 2008. The basin's 166,000 acres of irrigated land in 1988 has decreased by about 23 percent in twenty years to 127,000 acres in 2008. (See Table 11 "Irrigated Land by Year" in Chapter 3)

In 2002 the Division investigated the impacts of urbanization in the Utah Lake Basin. That investigation used population projections provided by the Governor's Office of Planning and Budget along with existing land-use patterns and existing population densities. The Division's 2002 land-use data was used to determine the percentage of undeveloped land within each community's boundaries that was irrigated. In Utah County the figures ranged from 14 percent in Provo, to 60 percent in Pleasant Grove. In Wasatch County 83 percent of undeveloped ground within Heber City's boundaries was irrigated. In Juab County 43 percent of the undeveloped land with the Nephi City boundaries was irrigated. These numbers coupled with the population densities and projected population growth from the GOPB's 2002 population projections, were used to estimate how much irrigated land will be lost to urbanization in 2010, 2030 and 2060.

Figure 33 shows the basin's irrigated lands, as determined by the Division's four land-use surveys, along with the 2002 projected urbanization impacts. The recent 2008 land-use survey has revealed a reduction of irrigated land that is significantly greater than was predicted by the 2002 urbanization evaluation. There are a couple of possible reasons for this.

FIGURE 33
Utah Lake Basin's Irrigated Acreage vs Time



The first is that the recent drought years (1999-2004) coupled with the subsequent economic downturn has resulted in a temporary reduction in irrigated acres. The second is that since many Utah communities require developers to provide a water supply to accompany the newly developed ground, irrigated lands are being developed at a faster rate than the ground within the city boundaries that does not have a water right associated with it. At any rate the current data indicates that the basin's irrigated agricultural land will be reduced by at least 50 percent over the next fifty years. The urbanization of 50,000 acres of irrigated lands over the next fifty years, in the Utah Lake Basin, would make available about 100,000 acre-feet of agricultural water for conversion to municipal and industrial use.

WATER REUSE

Only about 5 percent of a community's indoor water use is consumed and unavailable for further use. The remaining 95 percent, returns to the hydrologic system as municipal wastewater. In the past, this wastewater was often viewed as a nuisance to be disposed of. However, due to an ever-increasing population and limited water supplies, views towards treated effluent (reclaimed water) are changing. Reclaimed water is becoming more appealing as an M&I water source, particularly as a replacement for the use of potable water in non-potable applications, such as landscape irrigation, cooling water, or as a supplementary supply for irrigated agriculture.

Water has always been used and reused by humans as a natural part of the hydrologic cycle. The return of wastewater effluent to streams and rivers and the reuse of these waters by downstream users is not new. However, in this document, "water reuse" refers to the deliberate reuse of treated wastewater.

Reuse Options

Water reuse typically requires varying degrees of additional treatment and disinfection that make the effluent more suitable for use in close proximity to human populations. In Utah municipal wastewater treatment plants (WWTP) must treat their effluents to secondary effluent standards[1] or better if they are to be discharged into waters of the state. And because of Utah's anti-degradation policy,[2] some effluents must meet higher standards before discharge or in some cases discharges are not allowed. As a result of this, treatment facilities located along high quality rivers and streams (such as the Heber Valley Special Service District's plant located near the Provo River) have to totally contain their effluent. Non-discharging treatment plants typically treat their effluent by evaporation and sometimes land application. Most wastewater treatment plants in the Utah Valley discharge their effluent into Utah Lake after treating it to secondary effluent standards. In order to directly reuse these effluents, further treatment is required.[3] Utah *Administrative Code*, *Title R317-1-4*, provides regulations that must be followed for reuse of treated wastewater. These regulations describe the water quality standards that must be met for two distinct categories of reuse—Type II reuse, where human contact is unlikely, and Type I reuse, where human contact is likely. Type II water quality standards require secondary level treatment and would have to meet Type II quality standards. Type I water quality requires filtration and more stringent quality standards. The allowable applications for Type II and Type I reuse categories are listed in Table 23.

TABLE 23
Acceptable Uses for Reclaimed Water in Utah

Type II – Human Contact Unlikely
1. Irrigation of sod farms, siliviculture (tree farming), limited access highway rights-of-way, and other areas where human access is restricted or unlikely to occur.
2. Irrigation of food crops where the applied reclaimed water is not likely to have direct contact with the edible part, whether the food will be processed or not (spray irrigation not allowed).
3. Irrigation of animal feed crops other than pasture used for milking animals.
4. Impoundments of wastewater where direct human contact is not allowed or is unlikely to occur.
5. Cooling water. Use for cooling towers that produce aerosols in populated areas may have special restrictions imposed.
6. Soil compaction or dust control in construction areas.
Type I – Human Contact Likely
1. All Type II uses listed above.
2. Residential irrigation, including landscape irrigation at individual houses.
3. Urban uses, which includes non-residential landscape irrigation, golf course irrigation, toilet flushing, fire protection, and other uses with similar potential for human exposure.
4. Irrigation of food crops where the applied reclaimed water is likely to have direct contact with the edible part. Type I water is required for all spray irrigation of food crops.
5. Irrigation of pasture for milking cows.
6. Impoundments of treated effluent where direct human contact is likely to occur.

Source: *Utah Administrative Code, R317-1-4.*

Existing Water Reuse in the Utah Lake Basin

Because most basin communities have had abundant, inexpensive potable water supplies, the need for water reuse in the Utah Lake Basin has been limited. Intentional reuse has only recently begun to augment water supplies in communities made water-short through the expansion of their populations. The Heber Valley Special Service District and Santaquin City projects were the first direct reuse projects in the Utah Lake Basin to reuse a large portion of their effluent. Payson City's effluent is used for cooling water at a natural gas powerplant.

Heber Valley Special Service District

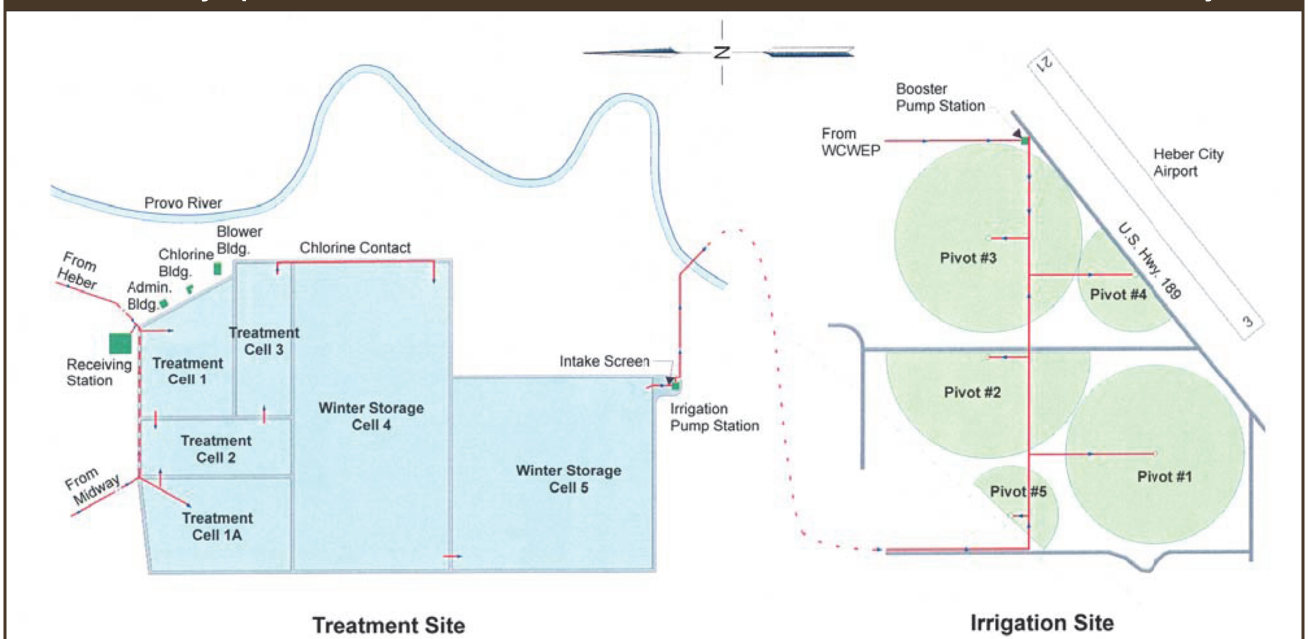
The Heber Valley Special Service District's (HVSSD) water reuse project is one of the best examples in the state of agricultural reuse of wastewater effluent. Because the district's treatment facility is located next to the Provo River, (just upstream of Deer Creek Reservoir), and is a source of drinking water for many Wasatch Front residents the facility is not allowed to discharge its effluent into the river without advanced treatment. Therefore, the primary function of the agricultural reuse project is the complete disposal of effluent resulting in zero-discharge. HVSSD treats wastewater from the entire

Heber Valley to Type II reuse standards and uses the effluent to grow alfalfa. The district treats approximately 1.4 million gallons per day (mgd) — approximately 1,500 acre-feet per year. The aerated lagoon facility is located in the central portion of the valley between Heber City and Midway. Treated effluent is pumped approximately three miles southeast to irrigate 400 acres located southwest of Heber and directly across U.S. Highway 89 from the Heber airport. The water is applied by the use of five center-pivot sprinkler lines equipped with drop-sprinkler heads. The district has an additional 80 acres of land for the future expansion of its treatment facilities as the valley population grows. To regulate the supply proportionate to the irrigation demand and to provide containment during the winter months, the district has a 1,100 acre-foot containment lagoon located on 75 acres adjacent to the treatment lagoons. A schematic of the Heber Valley wastewater treatment facility and irrigated ground is shown in Figure 34. The lagoons are lined to limit seepage to acceptable levels. The facility went on line in 1981 and irrigation with the treated effluent began the following year. Initially some expressed concerns regarding seepage of the effluent into the groundwater. But reportedly, the only recent complaints concern odor problems, which develop periodically when the water level in the storage lagoons is low or when the ice melts off the lagoons in the spring.

Due to the relatively high growth rate in Heber Valley, the population was projected to exceed the capacity of the existing facilities by about 2013. In order to meet future demands, the district is considering three expansion options:

- Construct new storage cells and additional land application sites. Under this option, the district would continue to operate as it does today. The projected cost estimate for this alternative is $13,968,000.
- Construct a discharging mechanical treatment facility to treat excess quantities of effluent while continuing wastewater reuse on the current project. Under this option, the district would treat the excess wastewater to Type I standards as well as remove phosphorus from the effluent (very expensive), which would allow it to be discharged into the Provo River. The cost estimate for this alternative is $29,500,000.
- Construct a non-discharging mechanical treatment facility. This alternative is a hy-

FIGURE 34
Heber Valley Special Service District Wastewater Treatment Facilities and Water Reuse Project



Source: Horrocks Engineers, *Heber Valley Special Service District 2003 Facility Plan – Executive Summary,* June 2004.

brid of the other two in that the treated effluent would not be discharged into the Provo River (phosphorus removal not required) but would be treated for Type I irrigation (or other uses) for other nearby entities. The estimated cost for this option is $10,800,000.

It is interesting to note that the most economical of the three options being investigated involves expanding the reuse project to include other higher-valued irrigation purposes.

Santaquin

Santaquin City has a new membrane bioreactor (MBR) system for wastewater treatment and water reclamation. This system produces high quality effluent which can be reused in the city's existing pressure irrigation system. The facility has the capability of treating 1.5 MGD. The city also has two winter storage reservoirs with a total capacity of about 550 acre-feet. Santaquin periodically diverts some of the treated effluent from the storage reservoirs onto 32 acres of alfalfa owned by the city. Harvesting of the crops is then contracted out to local farmers who keep a portion of the crop as payment. Due to the 2001-2005 drought, which reduced the amount of effluent available for reuse, the city did not irrigate the fields for several years. With the return of near-average precipitation, the city returned to land application of their effluent.

Payson

The Nebo Generating Facility (NGF), located adjacent to Payson city's treatment facility, began reusing some of the reclaimed water in October 2004. The natural gas-fired generating facility was completed in June 2004 by the Utah Association of Municipal Power Systems and was specifically constructed next to the wastewater treatment facility with the intent to receive some of the reclaimed water for its cooling towers. NGF operates only during peak demand hours and can pump up to 1,100 gallons per minute depending upon the demand. The water is circulated through the cooling towers four or more times before it evaporates or is removed from the system. The NGF purchases the reclaimed water from the treatment facility for approximately $0.40 per 1,000 gallons ($130 per acre-foot) and draws the necessary water from storage tanks having a capacity of about 150,000 gallons.

Potential for Reuse

There is considerable potential for water reuse in the Utah Lake Basin. As seen in Table 24, the current annual volume of effluent discharged from wastewater treatment plants in the basin is 45,550 ac-ft. In reality, only a portion of this effluent would be available for reuse due to water rights and environmental issues, seasonal requirements, and limited storage for the treated effluent.

TABLE 24
Wastewater Treatment Facilities in the Utah Lake Basin

Facility	Average Flow (mgd)	Average Annual Flow (acre-feet/year)	Potential Reuse (acre-feet/year)*
Heber Valley [1]	1.40	1,568	784
Orem [4]	8.95	10,024	4,010
Payson [4]	1.03	1,154	461
Provo [4]	15.23	17,058	6,823
Salem [3]	0.66	739	370
Santaquin [2]	0.37	414	207
Spanish Fork [4]	3.06	3,427	1,371
Springville [4]	3.50	3,920	1,568
Timpanogos [4]	6.47	7,246	2,898
Total	**40.67**	**45,550**	**18,492**

1 Lagoon-Land Application, 2 Membrane Bioreactor system, 3 Lagoon-Discharging, 4 Mechanical-Discharging.
* Based on 50% of non-discharging lagoon system flows and 40% of discharging system flows.

The Nebo Generating Facility is located adjacent to Payson City's Wastewater Treatment Facility to take advantage of the available reclaimed water for cooling tower purposes. (Photo courtesy of Utah Association of Municipal Power Systems.)

Because irrigation requirements vary throughout the growing season, reaching a peak in mid-summer, without storage facilities the division estimates that only 40 percent of the annual effluent volume from discharging facilities could reasonably be utilized. Treatment facilities with total containment lagoons would be able to provide a slightly larger portion of their effluent for irrigation due to the winter storage capacity built into them, with an estimated 50 percent reduction due to seepage and evaporation.[4] Quantities shown in Table 24 include estimates of the volume of effluent that could potentially be developed in the basin based on irrigation usage, and have been reduced to reflect the estimated losses at each facility.

In order to be successful, water reuse projects will have to be price competitive with other supply options. Larger reuse projects generally benefit from "economies of scale" where fixed costs such as development, maintenance and operational costs are spread over a larger amount of product and a greater number of customers, thus reducing the unit cost of reuse water. Two facilities listed in Table 24, currently discharge more than 10 million gallons per day (mgd) and could implement large-scale reuse projects. In order to economically use treated effluent, wastewater treatment facilities need to be nearby their intended customers, such as the service population, irrigated lands, power generation facilities etc. A relatively new trend in water reuse is the employment of "scalping plants," small wastewater treatment plants that remove and treat only a portion of a community's effluent for reuse locally. These plants can be located nearer to the point of reuse thus minimizing the distance to and from the WWTP, which in turn, reduces the associated piping and pumping costs.

For the near future, the feasibility of several reuse projects is being investigated in the basin as well as some that are already in the planning stage. These are described as follows:

Nephi

The city of Nephi has been delivering up to 1.2 cfs of effluent from a nearby rubber molding plant to farmers for irrigation and stock watering since the early 1950s. More recently, the city's lagoon system has been nearing capacity. The recent drought has reduced the inflow to the lagoon system, temporarily postponing needed upgrades. The city is now deciding whether to enlarge the systems pond area to provide additional capacity or add disinfection that will allow Type II reuse. Nephi City owns a large amount of land nearby the treatment lagoons that is currently leased to local farmers where Type II reuse water could be applied.

Orem

Although the city of Orem has been approved by the State Engineer to reuse over 9,500 acre-feet per year of reclaimed water from the Orem City Water Reclamation Plant, it currently only has plans to reuse between 1.3 to 2 million gallons per day (728 to 1120 acre-feet per year based on a 180-day irrigation season). A new golf course and driving range adjacent to the treatment plant was completed by spring of 2005 and will eventually use some of the treated effluent for water features and irrigation. The golf course and driving range have a dual irrigation system that allows them to be irrigated with potable water for the first two to three years. The city will then irrigate the facility with reuse water. At that time, the city will also provide reuse water for irrigation of the 40-acre City of Orem Lakeside Sports

Park located a few city blocks from the reclamation plant. A supply line will be hooked into the existing irrigation system for the sports park, and purple sprinkler heads will be installed to indicate the presence of reclaimed water. In addition to Orem's own reuse of its effluent, the newly developing city of Vineyard may utilize some of the water. Vineyard (2005 population approximately 200) could potentially reach a population greater than 90,000 as it builds out into land formerly occupied by Geneva Steel. This area is located north of the treatment plant at approximately the same elevation.

Payson

Payson City Corporation proposes to ultimately reuse 4,532 acre-feet per year of treated effluent from its WWTP when its current water rights are fully utilized. Currently the city's treatment plant discharges its treated effluent into a ditch that empties into Beer Creek, a tributary to Utah Lake. The project will supply non-contact cooling water and water for a retrofitted secondary irrigation system for Payson City. Due to water quality rule changes made during construction of its WWTP, the facility added a sand filter before its final disinfection step and has already been meeting the necessary standards for municipal irrigation (Type I reuse). Thus, reuse has proven to be a particularly economical option for Payson. The required upgrades necessary for municipal reuse have included the addition of a pump station to provide the reclaimed water to where it is needed, the installation of purple-painted hose-bibs with removable handles and signage indicating reuse water. Nearly 100 percent of the city is serviced by the secondary system. The newer sections of the secondary system have been connected directly to residential sprinkler sections in accordance with previous reuse requirements. Payson will mix Type I reuse water with other surface water for use in the secondary system.

Saratoga Springs and Lehi City

Sewage from the Saratoga Springs and Lehi City systems is currently treated at the Timpanogos Special Service District (TSSD) facility adjacent to Utah Lake. The two cities are investigating a proposed "satellite" or scalping plant to provide Type I water for irrigation. A satellite plant is a small treatment facility located near the desired area of reuse that removes and treats a portion of the wastewater from a main sewage collection line. Solids removed during treatment are discharged back into the collection system for further treatment at the main treatment plant. The proposed satellite plant will have a capacity of 1.0 million gallons per day (mgd) that could be expanded into 2.0 mgd as needed. The plant would provide reclaimed water for residential irrigation systems (and possibly a golf course) in both cities. The satellite plant would be the first of three possible plants to provide reclaimed water for cities served by the district. Other potential cities served include American Fork, Pleasant Grove, Alpine, Highland, Cedar Hills and Eagle Mountain. The two additional plants will be investigated only if the initial project proves economically viable.

Springville

Springville has a large amount of clean potable (drinking) water from the three main springs that supply the city. City officials estimate that at build-out (about 60,000 people) the portion of the city to the east of 400 West will use culinary water for all indoor and outdoor uses, as it does now. The portion of the city to the west of 400 West will have secondary irrigation systems installed to utilize the city's existing surface water supplies. The city's potable water is fairly inexpensive, making it difficult to justify the expense of treating effluent for municipal uses, especially since secondary surface water supplies are also adequate through build-out. Springville's effluent is however, currently treated to Type II reuse standards. With the addition of sand filters, the city could meet Type I reuse standards for a modest increase in cost. The city is considering the addition of Type I treatment as a supplemental source of water for the future. Currently the city's effluent flows into Little Spring Creek near to where Provo City's effluent enters the creek as well.

Eagle Mountain

Wastewater flows from the city of Eagle Mountain are treated by two systems. One third of the city's effluent (the southern area of the development) is treated in a non-discharging lagoon system. Two-thirds of the city's effluent (the northern end nearer to Saratoga Springs) flows into the TSSD system. City officials are considering reuse of the effluent from the lagoon system for large city owned landscapes. The city may also allow Saratoga Springs to reuse some of Eagle Mountain's effluent after treatment in that city's new scalping plant, which is currently being designed. Eagle Mountain's lagoon system would be upgraded mainly to solve the effluent disposal problem of a growing population, but would also help the city extend potable supplies to more customers.

The Timpanogos Special Service District currently services several cities in north Utah County. A proposed satellite plant near Saratoga Springs would reclaim a portion of the city's wastewater for reuse and send the removed solids on to the main wastewater treatment facility show. (Photo courtesy of Timpanogos Special Service District.)

Spanish Fork

In addition to serving Spanish Fork, the city's WWTP treats effluent from the city of Mapleton, five miles to the northeast. Spanish Fork City has a secondary system in place and with minor modifications could reuse their effluent. The city currently treats its effluent to Type II reuse standards before it is released into Beer Creek. City engineers estimate that after the installation of a $600,000 filter, Type I reuse requirements could be met, allowing the effluent to be used in the secondary system. The effluent would mostly be used in the industrial area northwest of the city for landscape irrigation and other large area turfs. The city's secondary system is one of the few in the state that is metered. Current costs for the city's secondary water (above the monthly service fee) are $1.00 per 1000 gallons.

Reuse Risks

Water reuse poses risks to the environment and human populations. Although pathogens and organic matter have been destroyed and removed through treatment and filtration, treated effluent typically retains high concentrations of salts and other chemicals that, when used for irrigation, can build up and render some soils saline. Fine-grained clayey soils can be especially problematic in that they can quickly plug. Sandy soils perform better in this regard and in some cases only require a periodic over-application of water to reduce salt build up in the upper few inches of soil.[5] Chemicals and pharmaceutical drugs are not readily removed by biological treatments or sand filtration. Endocrine blockers that can disrupt the production of natural hormones can make their way into underground aquifers from the surface application of reuse water. Shallower groundwater is more at risk of contamination initially, but harmful constituents may eventually reach the deeper drinking water aquifers in the valley. Many of the chemical constituents left in reuse water can be substantially reduced by reverse osmosis filtration, however, this is a very expensive option that could make reuse impractical. Alternatively, thoughtful matching of reuse water to individual project requirements and applications can minimize risks associated with reuse water. For a more detailed description of water reuse options for Utah, see "Water Reuse in Utah,[6]" online at: www.water.utah.gov/WaterReuse/WaterReuseAA.pdf.

Conjunctive Management of Surface and Groundwater

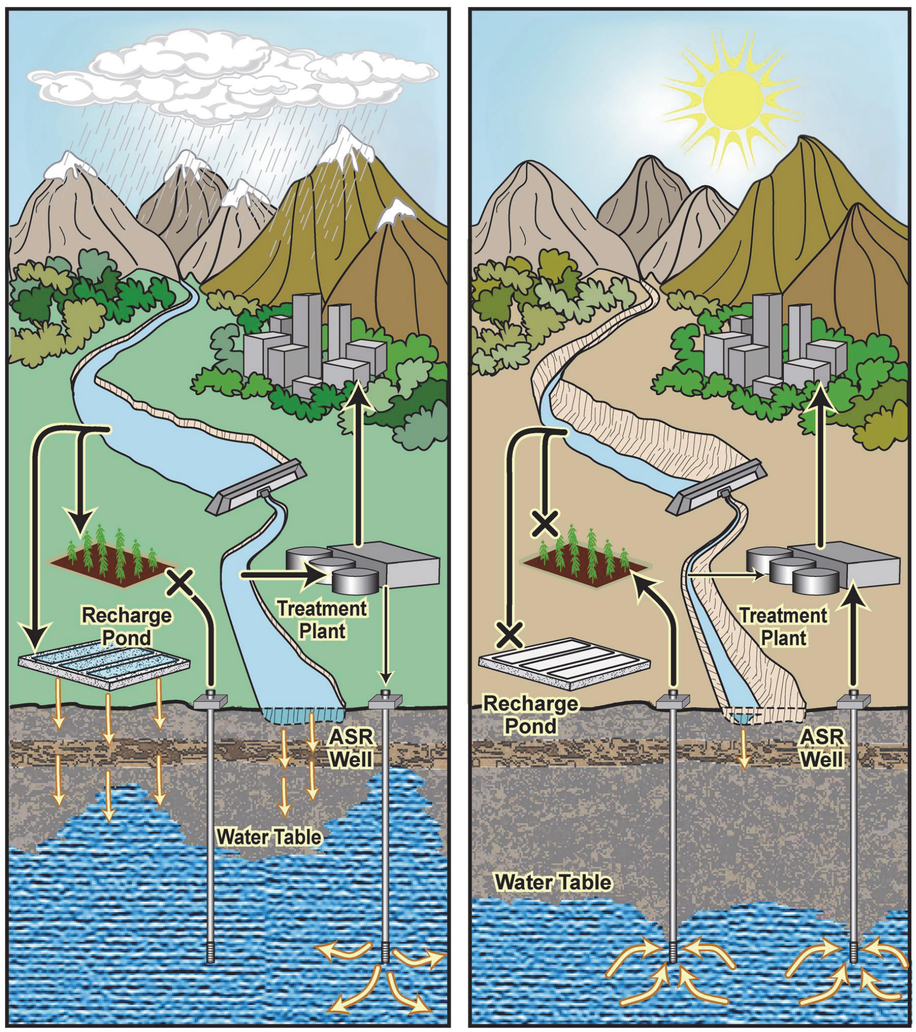
Definition of Conjunctive Management[7]

In its broadest definition, conjunctive management is the coordinated and combined use of surface water and groundwater. It involves using surface water when it is available so that groundwater can be left in the ground to be used during drought or high demand periods. During wet periods, when there is more surface water than is needed, it can be stored above ground reservoirs or in the groundwater aquifer. Wet periods include the annual spring season snowmelt and consecutive years of above-normal precipitation. Conversely, less surface water and more groundwater is used during dry periods when surface water supplies are reduced. Water previously stored, above ground and underground, is taken out of storage during dry periods. Dry periods include the annual summer months and consecutive years of below-normal precipitation. The key point is that unused surface water is intentionally stored above ground and underground in order to have it available when it is needed. This can be accomplished on an annual basis by storing water in the spring and withdrawing it in the summer. It can also be accomplished on a longer-term basis by storing water during a wet year (or consecutive wet years) and withdrawing it during a dry year (or consecutive dry years). Such coordinated management can change the timing and location of water use to result in greater efficiency. It transfers water from the high supply season to the high demand season. See Figure 35 for a graphical illustration of conjunctive management.

Conjunctive management of surface and groundwater can be a very effective tool to improve the efficiency of water use, increase the amount of water available, and enhance the reliability of the supply. Moreover, it helps solve the problem of inadequate water supplies during drought times. These important benefits to water suppliers can be achieved thru application of this technology. While this section provides a brief overview of the topic, a complete discussion of the subject can be found in *Conjunctive Management of Surface and Groundwater in Utah*, a July 2005 publication of the Utah Division of Water Resources. This report can be viewed online at: www.water.utah.gov/Planning/OtherReports.asp.

There are two basic conjunctive management strategies that can be employed. The first is conjunctive use—the deliberate, planned and coordinated use of surface and groundwater resources with the intent of fully utilizing those resources. This strategy involves planned timing of surface and groundwater use, and significant cooperation among water suppliers to best utilize both resources for mutual ad-

FIGURE 35
Schematic Representation of Conjunctive Management



Source: Utah Division of Water Resources, *Conjunctive Management of Surface and Groundwater in Utah,* (Salt Lake City: Dept. of Natural Resources, 2005), cover page.

vantage. During drought years, water can be shared to allow suppliers with water to transfer it to those without water. The second strategy is conjunctive use, as just explained, coupled with aquifer storage and recovery (ASR). This involves intentionally storing excess surface water in underground aquifers in order to withdraw it later when needed. Most conjunctive management projects include ASR. The aquifer is viewed and managed much the same as a surface reservoir. Water can be stored in the aquifer using surface recharge basins or ASR wells.

Conjunctive Management Opportunities without ASR

Opportunities for conjunctive management without ASR exist throughout the basin. Perhaps the most simple and inexpensive strategy is to maximize deliveries of treated surface water and reduce or eliminate groundwater pumping when surface flows are available. This strategy involves the maximum utilization of surface storage reservoirs, in accordance with the respective reservoir administration plan. Fully utilizing surface water sources in this manner allows the groundwater aquifer to "rest" and naturally recharge its capacity. This results in water storage with no added construction cost. In order for this strategy to work, water suppliers providing the treated surface water might need to lower prices as an incentive for local communities to buy more surface water and reduce their groundwater pumping.

Collaborative actions among water providers can promote conjunctive management on a local or even a regional basis. Such cooperation can result in a win-win situation for all parties, including the overall benefits described earlier. Providers could work together to reallocate their "water rights portfolios" to optimize their use of both surface and groundwater. There would be challenges to such an agreement. These include working out the value of the several water rights that may need to be exchanged. Depending on physical locations, additional pipelines might need to be constructed to transfer water from one supplier to another. The needed infrastructure might be less costly than building new surface reservoirs or adding more wells. Another advantage could be to postpone the construction of new facilities by either or both providers. It would be worth considering such arrangements. Such exchanges could include raw water as well as treated water.

Conjunctive Management Opportunities with ASR

Opportunities for aquifer storage and recovery in the Utah Lake Basin exist primarily in the valley west of the Wasatch Mountains and surrounding Utah Lake. The geology of this part of the Basin and Range Province is conducive to such projects due to the deep unconsolidated basin fill aquifers found there. Water can be stored in the aquifers using surface recharge methods in the areas of natural recharge found primarily along the east side of the basin at the mouths of canyons and along the base of the mountains. There may also be opportunities for surface recharge on the west side of the basin in the Cedar Valley area. ASR wells can be used almost anywhere in the valley surrounding Utah Lake. While there may be exceptions, shallow unconsolidated valley-fill aquifers in the rest of the basin do not suggest opportunities for aquifer storage and recovery projects. Water suppliers are encouraged to obtain the publication Conjunctive Management of Surface and Groundwater in Utah and determine whether this technology is suitable for their area. Chapter 5 of that document identifies about 12 potential ASR sites in Utah County.

The mouth of American Fork Canyon is a potentially good surface recharge location since it is above the unconfined aquifer. There are gravel pits in the area that may facilitate recharge. Similarly, gravel pits along the benches north and south of the American Fork River are candidates for recharge sites. Considerations for recharge water include spring season runoff from the river and the Central Utah Water Conservancy District raw water aqueduct which is located nearby. If ASR wells are used, treated water from the Utah Valley Treatment Plant in Orem may be available. Water from this source could be used at several locations throughout the distribution system. Unused capacity of the plant, particularly in the winter time, could supply considerable water volumes.

Every one of the water treatment plants, and the associated distribution systems, in the Utah Lake Basin could potentially supply water for an ASR project. Underground aquifers can and should be viewed as a potential water storage reservoir; they would be managed much the same as any surface reservoir. Local geology would determine suitability for such a project and water suppliers are encouraged to investigate the possibility.

In late 2005 the Bureau of Reclamation began studying the feasibility of conjunctive management of water at the mouth of Salt Creek, in Nephi. There are flood retention basins in the area that do not retain water, suggesting their possible use for surface recharge. While downstream water users must always be considered, the possibility exists that in some years excess water might be available during the spring runoff.

There are several areas along the bench from the Spanish Fork River southward, including the area southeast of Salem, that could be studied for conjunctive management opportunities. Gravel pits in these areas may provide suitable surface recharge sites.

SECONDARY WATER SYSTEMS

A secondary (or dual) water system supplies non-potable water for uses that do not have high water treatment requirements, such as residential landscape irrigation. A secondary system's major purpose is to reduce the overall cost of providing water by using cheaper, untreated water for irrigation while preserving higher-quality, treated water for drinking water uses. Secondary systems are also an efficient way to transfer agricultural water to M&I uses. As farm lands are sold and converted to urban lands, many of the same facilities and right-of-ways that were used to deliver water to farms can be used to deliver secondary water to homes.

Secondary System Water Use in the Utah Lake Basin

In 2010, over 44,000 acre-feet of secondary water was delivered to residents of the Utah Lake Basin (see Table 25). This represents over 33 percent of the total M&I water demand and about 66 percent of the total outdoor water demand in the basin.[8] As shown in Table 25, most of this use (42,030 acre-feet or 96 %) occurred in Utah County. Public community systems that had more than 1,000 acre-feet of secondary water delivered within their boundaries included Alpine, Highland, Lehi, Provo, Pleasant Grove and Saratoga Springs in north Utah Valley and Payson, Salem, and Spanish Fork in

TABLE 25
Secondary (Non-potable) Water Use in Public Community Systems (2010) (acre-feet)

Water Supplier	Use
Juab County	
Mona	175
Nephi	375
JUAB COUNTY TOTAL	**550**
Summit County	
Francis Town Water System	60
Woodland Mutual Water Co.	5
SUMMIT COUNTY TOTAL	**65**
Utah County	
Alpine	2,020
American Fork	577
Bradford Acres Water Assoc.	15
Cedar Fort	20
Cedar Hills	1,791
Covered Bridge	300
Eagle Mountain	25
Elk Ridge	28
Fairfield Irrigation Company	380
Goosenest Water Company	125
Hidden Creek Water Company	6,000
Highland City	10,248
Lehi	3,621
Manilla Culinary Water Company	800
Orem City	292
Payson	2,550
Pleasant Grove City	3,000
Provo City	1,200
Salem	1,060
Santaquin City	964
Saratoga Spring Municipal	2,659
Spanish Fork	3,650
Spring Lake	30
Springville City	600
Utah State Hospital	75
UTAH COUNTY TOTAL	**42,030**
Wasatch County	
Center Creek Water System	60
Charleston WCD	66
Country Estates Mobile Homes	3
Daniel Domestic Water Company	180
Heber City Water System	420
Midway City Water System	650
Storm Haven	20
Twin Creeks SSD	225
Wallsburg Town Water System	79
Woodland South Hills Irrigation	21
WASATCH COUNTY TOTAL	**1,724**
UTAH LAKE BASIN TOTAL	**44,369**

Source: Utah Division of Water Resources, *Municipal and Industrial Water Supply and Uses in the Utah Lake Basin,(Salt Lake City: Department of Natural Resources, 2010).*

south Utah Valley. These communities have experienced rapid growth over the past few decades and have clearly relied on secondary water systems to help ease the burden that this growth has placed upon drinking water sources. Some of the land in these areas was previously devoted to agricultural activities, and as the lands were converted to residential developments, water that was used to irrigate crops was placed in a secondary system to irrigate yards and gardens. As the communities served by these water systems continue to grow, it is likely that expanding existing secondary water systems and constructing new ones will meet more outdoor water demands.

High Water Use in Secondary Systems

Although secondary systems do free up treated water supplies for drinking water purposes, it is important to recognize that they usually result in higher overall water use than a typical potable (drinking water) system that provides water for both indoor and outdoor uses. This is because most secondary connections are not metered and users pay a flat rate for all the water they use. To address the problem of high water use in secondary systems, the Utah Division of Water Resources has been investigating ways to reduce water use in these systems. One way to deal with over-watering is to meter the water and bill using an incentive pricing rate structure. However, because conventional meters plug up and wear out quickly on secondary systems, filtering the water to a level where conventional meters will function properly or using a meter that can function in such conditions is usually required and is almost always an economic impediment to metering. Another option that would help reduce the amount of water used by secondary water customers would be to install some type of "smart" timer that automatically applies water according to the needs identified by a local weather station. The division has been studying the use of two such timers in recent years. Results from these studies show that water use can be decreased approximately 20 percent. These studies also demonstrate that targeting the highest water users with a "smart" timer is extremely effective, with an average savings of 50 percent. Whatever the solution, making water use in secondary systems more efficient is an important component of future water management within the basin.

Health Issues

Because secondary water is untreated, care must be taken to protect the public from inadvertently drinking from a secondary system and possibly becoming ill. Codes preventing cross-connections and providing adequate backflow prevention devices need to be enforced and secondary lines and connections need to be clearly labeled. In public areas, signs need to be installed to warn individuals to not drink from the irrigation system.

NOTES

[1] The minimum standard for discharging sanitary effluent into the State of Utah's waters is secondary treatment. Typical secondary treatment entails coarse screening to remove large particles, settlement and floatation to remove smaller non-floating particles and oils and grease, and biological treatment with microbes to digest ammonia and break down nitrates to safer concentrations and forms. Further treatment to Type I and Type II reuse standards are quality performance based, limiting Biochemical Oxygen Demand (BOD), E. coli bacteria and turbidity. Type I effluents require filtering in addition to secondary treatment.

[2] Utah Administrative Code R317-2 Standards of Quality for Waters of the State.

[3] Secondary effluents are not suitable for direct use in secondary water systems. Effluents directly used in secondary systems must meet Type I standards if it has not first been discharged into waters of the state. Secondary effluent, once it has been discharged into a receiving body of water (such as Utah Lake) can be indirectly used in secondary systems.

[4] Personal communication with Ed Macauley, Manager of the Construction Assistance Section for the Utah Division of Water Quality, January 27, 2005.

[5] Presentation given by Dan Olson, Tooele Reclamation Plant Superintendant, to the Water Environment Coalition, November 2003.

[6] Utah Division of Water Resources, *Water Reuse in Utah,* (Salt Lake City, Utah: Utah Department of Natural Resources, April 2005).

[7] The following paragraph is modified from the California Department of Water Resources, *California's Groundwater, Bulletin 118, Update 2003,*page 100, (Sacramento: 2003) to fit this publication.

[8] Utah Division of Water Resources, "2003 Public Community System Water Use," March 4, 2005. This data comes from an unpublished, statewide summary of potable and nonpotable water supply and use data collected as part of the division's Municipal and Industrial Water Supply Studies program.

7

WATER DEVELOPMENT

Water development was an essential element of early settlements and continues to play a major role today. The availability of water resources is critical to survival in Utah's semi-arid environment. Early Mormon church leaders stressed community development over individual ownership, especially with regards to natural resources. The early pioneer's approach was to develop cooperative water distribution systems. Those early ideals laid the foundation for many of the principles embodied in Utah's water law, and the methods now employed to administer and manage the state's water resources. Community rights led to a standard of "beneficial use" as the basis for the establishment of an individual water right. The overriding principle of Utah's water law is that all water belongs to the citizens of the state collectively, not individually. An individual citizen may own a water right entitling them to put the water to beneficial use, but the actual ownership of the water continues to rest, collectively, with the citizens of the state. Throughout the years, water planning and development has been founded upon this principle.

WATER DEVELOPMENT PROJECTS

Water Development History

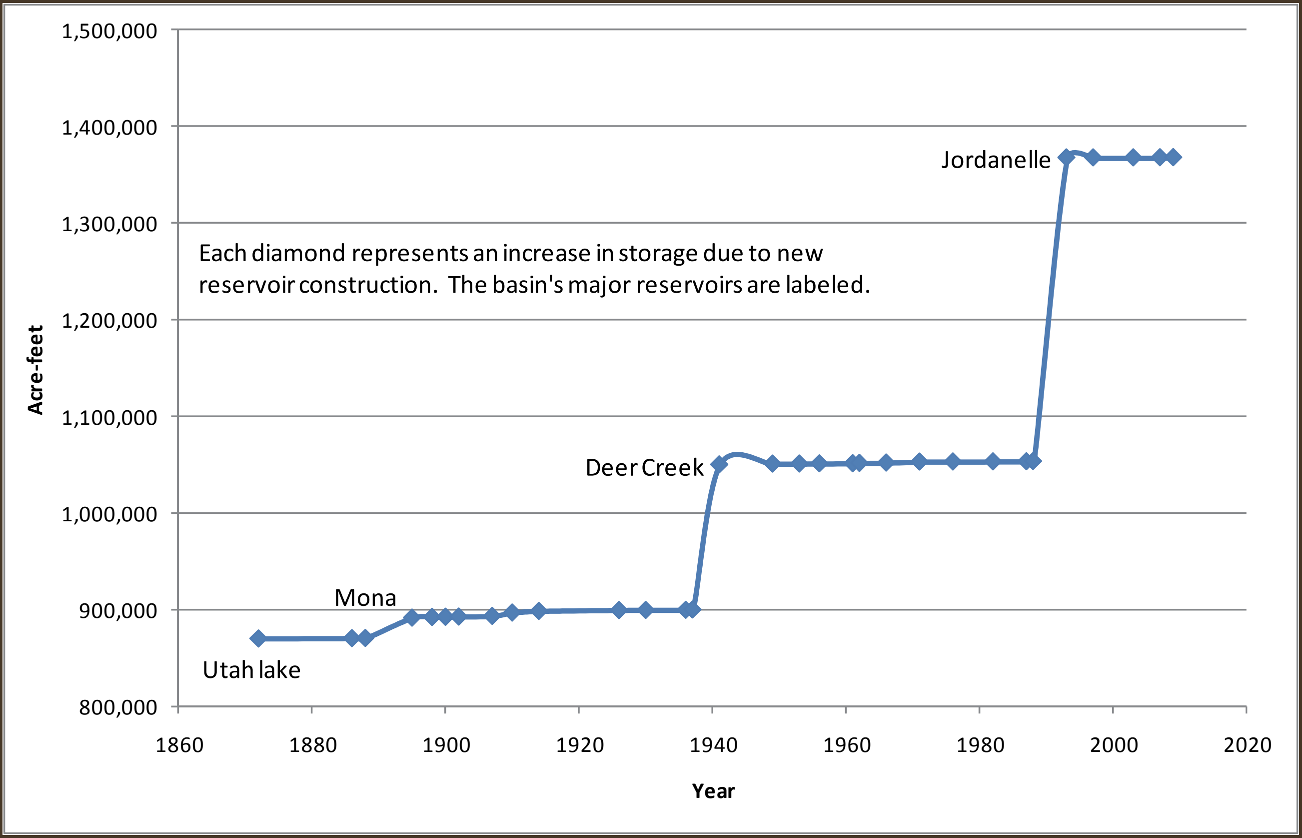
On March 10, 1849 Brigham Young sent 30 men from Salt Lake Valley to begin settlement of Utah Valley. They named the county after the Ute Indians who lived there at the time. A low dam was placed across Utah Lake's outlet to the Jordan River in 1872, creating the basin's first storage reservoir and one of the first and most cost-effective reservoirs in the entire state. A pumping plant was built in 1902 so that lake water could be lowered below the outlet elevation. The pumping plant has been modified and enlarged several times. Its present capacity is about 1,050 cfs, and it can lower the lake level eight to ten feet below the compromise elevation (4,489.045 feet).

Figure 36 shows the development of reservoir storage in the Utah Lake Basin. The construction of a small dam across the outlet of Utah Lake in 1872 developed 870,000 acre-feet of irrigation storage space in Utah Lake for use in Utah and Salt Lake Counties. The basin's next large irrigation storage reservoir was Mona Reservoir on Current Creek in Juab County constructed in 1895. Mona Reservoir provided 21,000 acre-feet of irrigation water for use in northern Juab county and southern Utah county. In 1910 more than a dozen small catchment basins and reservoirs (including Washington, Wall, Lost Lake and others) were built in the Provo River drainage portion of the Uinta Mountains creating about 10,000 acre-feet of irrigation water. From 1910 until the present numerous small irrigation storage reservoirs have been built bringing the basin's total irrigation water storage to 747,480 acre-feet.

Three major water projects constructed by the Bureau of Reclamation have had a major impact on this basin. They are the Strawberry Valley Project, the Provo River Project and the Central Utah Project.

The Strawberry Valley Project, which diverts water from the Uinta Basin to the Bonneville Basin, is one of the earliest federal reclamation developments. Construction began in 1906 and water was first used in 1915. Water was collected in a 270,000 acre-feet reservoir on the Strawberry River, a tributary of the Duchesne River and imported to the Diamond Fork drainage through the Strawberry Tunnel. Strawberry

FIGURE 36
Reservoir Storage vs Time in the Utah Lake Basin



Reservoir was subsequently enlarged to 1.1 million acre-feet as part of the Central Utah Project.

Deer Creek Reservoir, the principal feature of the Provo River Project, was completed in 1941. It has an active storage capacity of 152,560 acre-feet. Approximately 120,800 acre-feet of Provo River Project water is stored in Deer Creek. Deer Creek Reservoir also stores water imported from the Weber and Duchesne Rivers.

The 9-mile long Weber-Provo Diversion canal was originally constructed in 1928 to a capacity of 210 cubic feet per second (cfs). It was enlarged to 1,000 cfs as part of the Provo River Project in 1941. It conveys surplus high flows and some exchange waters from the Weber River nine miles south through Kamas Valley, delivering it to the Provo River near Francis. Provo River Project water is also imported to the Provo River from the Uinta Basin through the Duchesne Tunnel for storage in Deer Creek Reservoir. This tunnel, completed in 1953, diverts water from the North Fork of the Duchesne River. The tunnel is six miles long and is under a spur of the Uinta Mountains. It discharges into the main stem of the Provo River upstream from Woodland, with a capacity of 600 cfs.

The Provo Reservoir Canal was enlarged as part of the Provo River Project to 550 cfs at the diversion and 350 cfs at the point of the mountain. This canal is used to convey agricultural and municipal water to northern Utah County and to Salt Lake County. In 2010 the canal was converted to a pipe system with assistance from the Board of Water Resources.

The Provo River Project transports water from the Utah Lake Basin to the Salt Lake Valley. It went into operation in 1952 and is used to convey water stored in Deer Creek Reservoir for Municipal uses to Utah County users, the Metropolitan Water District of Salt Lake City and Sandy, and the Jordan Valley Water Conservancy District. See Table 26 for a complete list of the major existing lakes and reservoirs in the basin.

Central Utah Project

The development of a project that could deliver water from the Colorado River Basin to the Utah Lake and Jordan River Basins was considered as early as 1902 by farmers and civic leaders. Investigations by the U. S. Bureau of Reclamation (USBR) from 1945 to 1951 resulted in a feasibility report in 1951. Based on those early investigations and the USBR's report, the Central Utah Project (CUP) was authorized by the Colorado River Storage Project Act of April 11, 1956.

TABLE 26
Existing Reservoirs

Name	Owner	Storage (acre-feet)	Year Built	Use
Juab County				
Mona	Current Creek Irrigation Company	21,078	1895	IR
Summit County				
Lost Lake	Central Utah Water Consv. Dist.	1,080	1910	IR
Trial Lake	Central Utah Water Consv. Dist.	1,660	1914	IR
Washington Lake	Central Utah Water Consv. Dist.	2,355	1910	IR
Utah County				
American Learning Park Dam	Highland City Corp	48	1976	M&I
American Fork Lower Reservoir	American Fork City	27	2009	IR
Berrypoint	Hobble Creek Ranch	33	1976	IR
Big East	Payson City	670	1898	IR
Big Hollow #1	Calvin Crandell	38		IR
Big Hollow #2	Calvin Crandell	36		IR
Box Lake	Payson City	328	1962	IR
Deseret Regulation Pond	LDS Church	31		IR
Ewell Ponds	Strawberry Hi-line canal Co.	71	1953	IR
Goshen Reservoir	Goshen Irrigation Company	125	1982	IR
Highland City NW Pressure Irr.	Highland City Corp.	19		IR
Highland City Pressure Pond	Highland City Corp.	29		IR
Maple Lake	Payson City	130	1936	FC
McClellan Lake	Payson City	20	1907	IR
Santaquin Pressure Irrigation	Santaquin City	43	2009	IR
Saratoga Springs	City of Saratoga Springs	38	2007	M&I
Silver Lake	Pleasant Grove Ranger District	200	2007	M&I
Silver Lake Flat	N. Utah County Water Cons. Dist.	1040	1971	M&I
Smith's	Lake Fork Cattle Company	400	1907	IR
Spanish Fk. Pressure Irr. Ponds	Spanish Fork	68	2003	IR
Summit Creek	Summit Creek Irrigation Company	841	1945	IR
Tibble Fork	N. Utah County Water Consv. Dist	259	1966	IR RE
Utah Lake	State of Utah	870,000	1872	IR RE
Winward	Payson City	73	1907	IR

TABLE 26
Existing Reservoirs
(Continued)

Name	Owner	Storage	Built	Use
Wasatch County				
Anderson	Lindsey Family Trust	132	1900	IR
Atkinson #1	Dan Matthews	20	1900	IR
Barnes	Center Creek Irrigation Co.	50	1900	IR
Bloods Lake	United Park City Mining Co.	23		M&I
Center Creek #1	Center Creek Irrigation Company	400	1886	IR
Center Creek #2	Center Creek Irrigation Company	150	1886	IR
Center Creek #3	Center Creek Irrigation Company	86	1886	IR
Center Creek #5	Center Creek Irrigation Company	130	1886	IR
Christensen	Heber Power and Light	80	1988	IR
Clegg (aka Clyde Lake)	Twin Creeks Special Service Dist.	75	1930	
Deer Creek	USBR	150,000	1941	M&I
Deer Valley	Lake Creek Irrigation Company	172	1888	IR
Dutch Canyon	Midway Irrigation Company	47	2007	IR
Glennwood Village	Holly Ernest	30		
Jones	Russ Wall, Dee Mills, et. al.	176	1956	IR
Jordanelle	USBR	310,980	1994	M&I
Lake Brimhall	United Park City Mining Co.	54		M&I
Lindsay	Twin Creeks Special Service Dist.	179	1902	IR
Mill Hollow	Division of Wildlife Resources	328		RE
Riverview Ranch	W.C. Holdings	56		M&I
Silver Lake	United Park City Mining Co.	78		M&I
Three Lakes	Prestige Pictures Ind.	24	1961	IR
Witt Lake	Lake Creek Irrigation Company	853	1926	IR
Total Storage		1,367,711		

IR – Irrigation, M&I – Municipal and Industrial, RE – Recreation,

In 1992 Congress passed, and the President signed, the Central Utah Project Completion Act (CUPCA). This act transferred the authority and responsibility to complete the CUP from the USBR to the Central Utah Water Conservancy District (CUWCD), which was established on March 2, 1964. The original counties included in the CUWCD were Salt Lake, Utah, Wasatch, Duchesne, and Uintah, and portions of Juab and Summit counties. In 1967 the District was expanded to include the Sevier River Basin counties of Sanpete, Sevier, Millard, Piute and a portion of Garfield. Sevier and Millard Counties withdrew from the CUWCD in 1994. Piute and Garfield counties withdrew from the CUWCD in 2013.

The Central Utah Project includes five units: the Vernal Unit, the Jensen Unit, the Upalco and Uintah Unit, the Ute Unit and the Bonneville Unit. The Bonneville Unit is the largest and most complex of the CUP, and the only unit that brings water into the Utah Lake Basin. The USBR prepared a definite plan report (DPR) for the Bonneville Unit, which was approved on November 5, 1965 and construction started in 1966. It has been under construction since that time but the scope of the project has changed several times. The USBR updated the DPR in 1983 (as revised in 1984) and again in 1988. Section 205 of CUPCA required the CUWCD to update the 1988 DPR and prepare an environmental impact statement before constructing what is now known as the Utah Lake System of the Bonneville Unit. A draft supplement to the1988 DPR was completed in March 2004 and the final supplement to the 1988 DPR was completed in October 2004. An environmental impact statement was completed in September 2004 with a Record of Decision issued on December 22, 2004. All required funding, implementation and water service contracts were finalized and signed on March 15, 2005 allowing the design and construction of the final features to proceed.

The Bonneville Unit includes facilities to develop and more fully utilize waters tributary the Duchesne River and to facilitate a transbasin diversion from the Colorado River Basin to the Bonneville Basin, and to develop and distribute project water in the Bonneville Basin. For planning and coordination purposes, the Bonneville Unit was divided into six systems: (1) Starvation Collection System, (2) Strawberry Collection System, (3) Ute Indian Tribal Development, (4) Diamond Fork System, (5) Municipal and Industrial (M&I) System and (6) the Irrigation and Drainage (I&D) System, now known as the Utah Lake System. All of the Bonneville Unit Systems have been completed except for the Utah Lake System.

The Starvation System, completed in 1970 delivers water for irrigation and M&I use in the Duchesne area. The Strawberry System completed in 1980 diverts part of the flow of Rock Creek and other tributaries of the Duchesne River and conveys the diverted water through the Strawberry Aqueduct to Strawberry Reservoir. The primary purpose of the Ute Indian Tribal Development is to mitigate stream-related fish and wildlife losses on Indian lands. The Diamond Fork System was completed in 2004 and conveys water stored in Strawberry Reservoir to the Utah Lake Basin.

The M&I System provides M&I water to Salt Lake County, North Utah County, Wasatch County and a portion of Summit County. It also provides supplemental irrigation water to Wasatch and Summit Counties. The Jordanelle Dam on the Provo River is the main feature of this system. It was completed in 1994 and has an active capacity of 310,980 acre-feet. The supply water for this system are surplus flows of the Provo River and by exchange, water rights owned by the Department of the Interior in Utah Lake and water from Strawberry Reservoir released to Utah Lake. The Salt Lake Aqueduct, the Provo River Aqueduct and the Jordan Aqueduct convey water to Salt Lake County. North Utah County receives water from the Alpine Aqueduct. The water for Wasatch County is delivered from Jordanelle Reservoir.

The Irrigation and Drainage System would have provided irrigation water to south Utah County, eastern Juab County, and the Sevier River Drainage. The name was changed to the Spanish Fork-Canyon Nephi Irrigation System (SFN) when Millard and Sevier Counties withdrew from the CUWCD in 1994 and the scope of the project was changed. Because of issues raised by the Draft Environmental Impact Statement released in 1998, the scope of the project was again changed from an irrigation project to an M&I project and the name was changed again to the Utah Lake Drainage Basin Water Delivery System or the Utah Lake System (ULS).

Board of Water Resources Funding

The Utah Water and Power Board was created in 1947 and given direction to provide state funding (low interest loan money) for water development projects. The Utah Legislature replaced this Board with the Board of Water Resources and Division of Water Resources in 1967 to continue providing state support and funding of water development projects. Table 27 gives a summary of projects funded by the Board of Water Resources in the Utah Lake Basin.

State funding has been significant in the basin, providing 128 million dollars for water development. As shown in Table 27, Utah County received over $101 million in board loan funds for the development of 120 projects. Thirty-six projects in Wasatch County have benefited from board’s loan assistance of nearly $17.9 million. Juab County has had 22 water development projects, which have received a total of just over $7.5 million in state loan funds, with Summit County funding 5 projects with nearly $2 million in state loan funds.

Provo Reservoir Canal Enclosure

The Provo Reservoir Canal Enclosure Project entails the encasing of approximately 21 miles of existing canal, from the mouth of Provo Canyon to the Point of the Mountain, with 126-inch diameter lined steel pipe. Construction on the $150 million project was begun in the fall of 2010 and was completed in 2013.

The canal was originally constructed by the Provo Reservoir Water Users Company and enlarged as part of the Provo River Project. Its original capacity was 550 cfs at the head, decreasing to about 350 cfs at the Point of the Mountain. The enclosure project will increase the capacity to 628 cfs throughout the alignment.

The project is estimated to conserve at least 8,000 acre-feet of water annually, currently lost to seepage. This water will be exchanged for other water supplies to be used by the CUWCD (which is paying half the project cost) for use to fulfill part of its instream flow requirements in the Provo River as part of the June Sucker Recovery Program.

The Board of Water Resources is provided $26.7 million to Provo River Water Users Association which is the official sponsor of the project. The board also provided $25.1 million to Provo Reservoir Water Users Company which is a major shareholder in the canal. The CUPCA Section 207 provided $39 million and CUWCD provided $36 million. Central Utah Water Conservancy District, Jordan Valley Water Conservancy District, and the Metropolitan Water District of Salt Lake and Sandy are also stakeholders in the project and all five entities have executed a “Master Agreement” governing the ownership and operation of the project. Currently the USBR holds title to the project but it will be transferred to the Provo River Water Users Association upon completion of construction.

TABLE 27
Board of Water Resources Projects

County	Number of Projects	Total Cost of Projects	Board Funding
Juab	22	$17,760,402	$7,514,919
Summit	5	$1,904,584	$1,380,081
Utah	120	$342,763,557	$101,424,366
Wasatch	36	$22,647,596	$17,870,536
Total	183	$385,076,139	$128,189,902

Period of record 1947- June 2014

Hydro Power Development

Since the original Utah Lake Plan was written the United States Department of Interior (DOI) entered into a long-term agreement with CUWCD and Heber Light & Power to develop a power facility below Jordanelle Dam under a lease arrangement with the DOI. The potential to produce hydroelectric power was incorporated into the original construction of Jordanelle Dam; however, DOI made a decision to delay power development as part of the construction of the dam until a non-federal entity could determine if power production was economically feasible and marketable. In July 2005 an environmental assessment for the project was completed. The construction of a 13 megawatt power plant at the base of the Jordanelle dam commenced in 2006 and was completed in 2008. Today the Jordanelle hydropower plant produces about 39,000 megawatt-hours of energy annually, providing for the needs of approximately 9,000 homes. Under the Utah Lake System, additional hydropower plants were authorized in the EIS within the previously constructed Diamond Fork System that would add another 50 megawatts of generating capacity. CUWCD is working with interested parties and the federal government to remove the remaining obstacles that inhibit development of these power plants.

8

WATER QUALITY AND THE ENVIRONMENT

If water planners and managers in the Utah Lake Basin are to meet future water needs, they will need to do more than simply provide adequate water supplies and delivery systems and encourage conservation. The water supply decisions they make can greatly impact water quality, the environment and recreation. For the most part, water planners and managers are aware of these impacts and are working to develop plans and strategies that will protect these important values; however, there is still much that needs to be done. This chapter discusses in detail the importance of water quality and the environment to the management of the Utah Lake Basin's water resources, and describes some of the things being done to safeguard these important values.

WATER QUALITY

Regulation of water quality in Utah began in 1953 when the state legislature established the Water Pollution Control Committee and the Bureau of Water Pollution Control. Later, with the passage of the federal Clean Water Act in 1972 and the federal Safe Drinking Water Act in 1974, strong federal emphasis was given to preserving and improving water quality. Today, the Utah Water Quality Board and Division of Water Quality, and the Utah Drinking Water Board and Division of Drinking Water are responsible for the regulation and management of water quality in the State of Utah.

As a result of these agencies and regulations, residents of the Utah Lake Basin enjoy safer water systems than the basin's early settlers. However, due to the magnitude of growth and development that is projected to occur and the increased pollution loads that growth will bring, the Utah Lake Basin will continue to face some serious water quality challenges. Water resource planners and managers within the basin need to be increasingly aware of these issues and work closely together to satisfy future water quality needs.

The State Water Plan identified several water quality programs or concerns that are of particular importance to the future of the state's water resources. These are also of concern to the Utah Lake Basin and are as follows:

- Total Maximum Daily Load program
- Preservation and restoration of riparian and flood plain corridors
- Storm water discharge permitting
- Nutrient loading
- Concentrated animal feedlot operations
- Septic tank densities

Each of these topics is discussed below with emphasis given to how they affect the water resources of the Utah Lake Basin.

Total Maximum Daily Load Program

Section 303 of the Federal Clean Water Act directs each state to establish water quality standards to protect beneficial uses of surface and groundwater resources. The Act also requires states to identify impaired water bodies every two years and develop a total maximum daily load (TMDL)[1] for each pollutant causing impairments in the various water bodies.

The Division of Water Quality (DWQ) has identified stream segments that are fully supporting, partially supporting or not supporting their beneficial uses that are in the Utah Lake Basin (see Figure 37). Table 28 lists the impaired water bodies for which TMDLs are required, the pollutant or nature of impairment, and the status of the TMDL.

Utah Lake near Saratoga Springs. (Photo courtesy of Jim Mullhaupt.)

In cooperation with state, federal and local stakeholders, DWQ organizes and facilitates locally-led watershed groups for each of the impaired water bodies under consideration for a TMDL. Below is a brief description of some of the TMDLs currently under investigation and/or completed in the Utah Lake Basin.

Deer Creek Reservoir

Past water quality monitoring by the Division of Water Quality has shown that Deer Creek Reservoir regularly exceeds state standards for total phosphorus, dissolved oxygen and temperature. The reservoir has been identified as a priority target for the state's water quality improvement effort and has been listed on the state's 303(d) list of non-supporting waters. A TMDL was initiated and subsequently approved in March of 2002. In 2003, the reservoir was de-listed for temperature as standards were met for that pollutant/stressor. This TMDL, designed to restore the beneficial uses of the reservoir, as assigned by the state, includes best management practices aimed at reducing pollutant loads. These practices include the following:

- Provo River Restoration Project
- Conversion to Sprinkler Irrigation Systems
- Heber Valley Water Quality Basins
- Cleanup of Potential CAFOs
- Integrated Watershed Information System
- Main Creek Stream Bank Restoration
- Agricultural BMP Projects
- Midway Fish Hatchery

Some of these projects have been completed and others are being implemented.

Spanish Fork Watershed

In 1997, the Timp-Nebo Soil Conservation District and Natural Resources Conservation Service organized a local work group that pinpointed the Spanish Fork River Watershed as one of the top natural resource concerns in Utah County. Within months the group began working on the Spanish Fork watershed Coordinated Resource Management Plan, but soon realized that the size and diversity of the watershed made the task overwhelming. As a result, the watershed was broken into six sub-watersheds.[2]

Thistle Creek sub-watershed was chosen as the starting point because of its high elevation headwaters. Thus, any improvements in this area would directly benefit the lower sub-watersheds. A TMDL for this sub-watershed was approved by the EPA in July of 2007, which addresses sediment and nutrient loads. Several endpoints and management strategies are identified within the TMDL. These strategies include, but are not limited to:

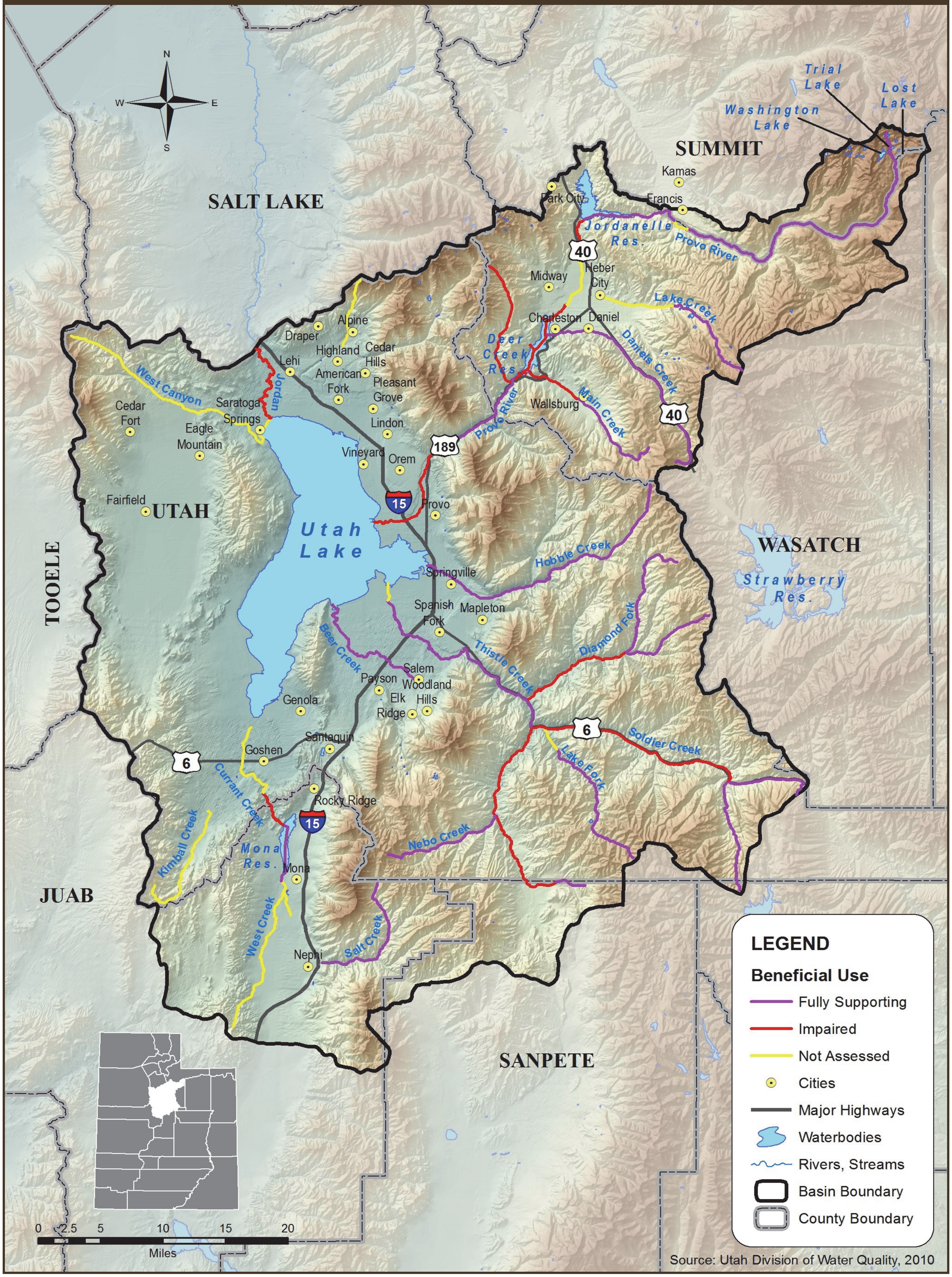
- Improve grazing practices
- Implement noxious weed treatment program
- Improve stream bank stability
- Establish and improve riparian buffer areas

A TMDL for *Soldier Creek* was also approved by the EPA in August of 2006, which addresses high sediment loads and total phosphorus through an implementation plan similar to the Thistle Creek's. The plan outlines best management practices and strategies to reduce erosion and improve fish/aquatic habitat.

Utah Lake

The warm water fishery of Utah Lake has been identified as being impaired due to total phosphorus and agriculture is impacted by the high concentrations of

FIGURE 37
Water Quality Impairments and Beneficial Use Support Assessment



total dissolved solids. The lake experiences extensive algal blooms in the late summer and fall and is a receiving body for treated wastewater effluent, industrial discharges, storm water discharge and nonpoint source runoff. Because of these factors, Utah Lake is listed on Utah's 303(d) list for exceeding state criteria for total phosphorus and total dissolved solids. A TMDL is currently in progress. A data assessment and evaluation report and pollutant loading assessment have been completed for the identified constituents (pollutants) and other relevant parameters.

Preservation and Restoration of Riparian and Flood Plain Corridors

Riparian corridors can best be defined as the transitional areas between a stream channel and the upland terrestrial habitats. The landscape typically possesses unique soil and vegetation characteristics that are dependent upon the presence of water. While riparian corridors cover a small percentage of the landscape, these habitats harbor a large number of wildlife, provide flood protection and perform many different ecological functions that maintain the integrity of the stream channel and the quality of the water passing through them.

Many riparian zones in the Utah Lake Basin have already been severely impacted by flood plain development and channelization. As the basin's human population increases, additional riparian and flood plain corridors are in jeopardy. In 2002 DWQ estimated that resource extraction, agricultural runoff, habitat alteration and hydro-modification affected about 83 stream miles in the Utah Lake Basin.[3]

The management and restoration of riparian corridors is becoming increasingly important. Several studies have shown that properly maintained riparian corridors and flood plains can protect and improve water quality by intercepting nonpoint source pollutants in surface and shallow subsurface flows. The ability of the riparian strip to provide various functions depends upon its width, soil type, the density and type of vegetation, and other factors.[4]

One entity currently working to protect and restore riparian corridors along several river reaches in the Utah Lake Basin is the Utah Reclamation Mitigation and Conservation Commission. This commission is

TABLE 28
TMDLs in the Utah Lake Basin

Water Body	Pollutant(s) or Stressor(s)	TMDL Status
American Fork River	pH	De-listed
Currant Creek	pH, Temperature	Identified
Deer Creek Reservoir	Total Phosphorus, Dissolved Oxygen, Temperature	De-listed for Temperature, Approved 2002
Big East Lake	Dissolved Oxygen	Targeted
Mill Hollow Reservoir	pH, Total Phosphorus	Targeted
Jordan River	Total Dissolved Solids	Identified
Soldier Creek	Sediment, Total Phosphorus	Approved 2006
Spring Creek	pH, Temperature	Identified, De-listed for pH
Snake Creek	Arsenic	Identified
Thistle Creek	Sediment and Nutrient Loads	Approved 2007
Utah Lake	Total Phosphorus, Total Dissolved Solids	Targeted and In Progress

Source: Utah's 2004 303(d) List of Impaired Waters, June 15, 2006. This list is available at www.waterquality.utah.gov.

a branch of the federal government that is responsible for the funding, design, and implementation of projects to offset the impacts to fish, wildlife and other resources caused by the Central Utah Project and other federal projects in Utah. The commission's recently completed projects in the Utah Lake Basin include the Mid-Provo River Restoration Project, the Hobble Creek Restoration Project, and the Diamond Fork Mitigation Project. The Provo River Delta Project is in the early planning stages and may be similar in nature to the Hobble Creek Project when completed.

Mid-Provo River Restoration Project

Following a 10 year planning process, the Commission began the Mid-Provo River Restoration Project of about 10 miles of river between Jordanelle Dam and Deer Creek Reservoir in 1999. The project consisted of restoring the straightened river channel to its natural meandering state and removing many of the existing dikes to reestablish the river's access to its original floodplain. This helped to re-create important aquatic features.

The project also established an 800 to 2,200 foot-wide corridor along the entire length of the restored middle reach of the Provo River. Planted vegetation and established side channels helped to create healthy fisheries, provide habitat for wetland dependent wildlife and assist the commission in its purpose to partially offset the losses to the general public from construction of the Central Utah Project and other federal reclamation projects in Utah.[5] Construction of the 10 mile project was completed in the fall of 2009 with the addition of the last of seven public access points. The project area continues to be monitored to determine the effectiveness of the project and to make adjustments as needed. The estimated project cost is about $30 million with $20 million of the total allocated for land acquisition and the remainder for construction costs.[6]

The Hobble Creek Restoration Project

The June sucker Recovery Program recognized that more habitat would be needed to be recovered in addition to that being restored on the lower Provo River. After surveying all the tributaries to Utah Lake, it was decided that Hobble Creek offered the next best alternative for restoration based on benefit to the June sucker, available water, and budget. A 21 acre site was purchased just west of I-15 on the historic channel of Hobble Creek near to where it had entered Provo Bay in Utah Lake. After straightening in the 1950s to accommodate agriculture, the deepened channel no longer supported June sucker spawning activity. Rehabilitation involved relocating approximately 3,000 linear feet of the stream bed and excavating more than three feet of earth from 14 acres of the property to create a floodplain and wetland habitat adjacent to the new stream channel. The recovery program commission had purchased the 21 acre project property for the project at a cost of just over $1 million and had little money left for the rehabilitation project. The Utah Transit Authority (UTA) was concurrently building the Front Runner South Project and was required to replace wetlands that the project had disturbed. Consequently UTA funded the design and construction of the wetlands at a cost of $1.6 million. Water for the project will come from the CUP with up to 8,500 acre-feet designated on an annual basis for Hobble Creek and up to 6,000 acre-feet available on an intermittent basis when the CUP's Utah Lake System is complete. The Hobble Creek Restoration project was completed in November of 2008. It is not yet known how successful the project is in helping the June sucker recover. Lake levels and stream flows during the spring of 2011 were too high to examine the wetlands for larval suckers, though the fish were seen to spawn there the previous summer. Future plans for this project include expansion to the east of I-15 on Hobble Creek, as June suckers have been found spawning there as well.

Sixth Water and Diamond Fork Creeks

The Commission has also restored aquatic and riparian habitat along Sixth Water and Diamond Fork Creeks in Diamond Fork Canyon. Both creeks had been severely damaged as a result of excessively high flows in summer months from the transbasin diversion of water from Strawberry Reservoir. Since completion of the Central Utah Project's Diamond Fork System in 2004, these high flows have been diverted through a tunnel and pipeline to allow the river to return to a more naturally functioning system. Restoration of riparian and wetland areas on the lower 9,000 feet of Diamond Fork Creek was undertaken as mitigation for CUP construction projects. On the upper part of the reach, structures made of logs and boulders were placed in the creek to help the river more quickly return to its meandering state by deflecting the river laterally. Since completion of these structures, gravel bars have reappeared and natural riparian vegetation has reestablished and continues to grow. Subsequent monitoring of the reach has revealed that significant bed loads and fine sediment continue to be transported from the previous upstream construction activities and a recent landslide. In order to limit the negative effects of these sediments, the commission is experimenting with differing flow volumes. Other projects on the reach included excavating depressions for deep pools and side channels, a series of small ponds, and rehabilitating a ditch system and a diversion structure.[7]

Provo River Delta Project

The lower Provo River has historically been a spawning area for the June sucker. Recovery efforts have long been anticipated to restore the now channelized lower Provo River to a more natural delta. June sucker fry need warm protected waters with adequate food to grow large enough (about 8 inches) to survive predation in Utah Lake. Similar in nature to the Hobble Creek restoration, the Provo River Delta Project is currently in its preliminary stages (NEPA compliance study) with the target area likely to be north of Utah Lake State Park in an area known as "Skipper Bay." The river would have to be diverted and wetland areas similar to those on Hobble Creek, constructed. Project implementation would most likely start by 2015. Scoping meetings for public comments began in early 2011.

County and city planners need to work together with the Utah Reclamation Mitigation and Conservation Commission, U.S. Army Corps of Engineers and other agencies to preserve the riparian zones and flood plains from unwise development. Zoning laws and master plans need to consider the ability of these lands to improve water quality and buffer the population from the impacts of flooding. If development is not kept a safe distance from the river, hard structures such as bridges, roads, houses and businesses will replace the important buffer zones that help to protect water quality, further depredating area rivers.

Nutrient Loading

As mentioned in previous sections, urban and agricultural runoff is a contributor to the pollution of the Utah Lake Basin's water resources. The main problems that come from runoff are sediment and nutrients. Although nutrients (nitrogen and phosphorus) are essential to the health of aquatic ecosystems, excessive nutrient loads have resulted in the undesirable growth of aquatic vegetation and algae, resulting in oxygen depletion in several of the basin's water bodies.

Nutrients enter the basin's waterways primarily through urban and agricultural storm water runoff and agricultural irrigation return flows. In between storms, nutrients, pesticides, volatile organic compounds and other contaminants accumulate on impervious surfaces and are later washed into waterways during storms. On agricultural and urban landscapes, the careful management of salts and other chemicals for deicing and other purposes, proper application of fertilizer, and efficient irrigation could help reduce the amount of these substances entering waterways.

Other sources of nutrients include wastewater treatment plant effluent and septic tank systems. Although it is a relatively easy process to remove nutrients from wastewater (a point source), it is not inexpensive, and controlling nutrient loads from the other non-point sources is a bigger challenge. In the few areas of high septic tank densities in the basin, sewer systems may eventually need to be installed and nutrients removed at a wastewater treatment plant.

Storm Water Discharge Permitting

Pollution from storm water discharge is a result of precipitation and runoff flowing over land, pavement, building rooftops and other impervious surfaces where it accumulates pesticides, fertilizers, oils, salt, sediment and other debris.[8]

To minimize the amount of pollutants that enter the nation's water bodies through storm water runoff, the U.S. Environmental Protection Agency (EPA) initiated a two-phase process for implementation of storm water regulations. Implementation of Phase I began in 1990, and affected certain types of industry, construction sites larger than five acres, and cities or counties with a population larger than 100,000. Nearly all the cities on the east side of Utah Lake along the I-15 corridor are required to comply with Phase I regulations.

Phase II of EPA's storm water regulations, which began implementation in 2003, affects smaller construction sites and any area designated as an "Urbanized Area" by the U.S. Census Bureau.[9] Phase II rules also apply to any community outside an Urbanized Area that has a population greater than 10,000 and a population density higher than 1,000 people per square mile.

The phase II storm water program requires that municipal segregate sewer systems (MS4s) reduce the discharge of storm water pollutants to the "maximum extent practicable," protect water quality, and satisfy the appropriate water quality requirements of the Clean Water Act. Small MS4 programs must be comprised of a minimum of six elements; (1) Public Education and Outreach, (2) Public Participation/Involvement, (3) Illicit Discharge Detection and Elimination, (4) Construction Site Runoff Control, (5) Post-Construction Runoff Control, and (6) Pollution Prevention/Good Housekeeping.

To achieve each of these measures the EPA provides guidance from their web site in selecting the best management practices (BMPs) most applicable to each MS4 based on their configuration. The Utah Department of Environmental Quality is the permitting authority for the program and can also provide guidance. Further information is available online from the EPA's web site at http://www.epa.gov/ npeds/stormwater or by contacting the Utah Department of Environmental Quality at http://www. waterquality.utah.gov/UPDES/stormwatercon.htm.

John Beck, located south of Spanish Fork, is one of many animal feedlot operators that have successfully reduced his operation's nutrient loading through the help of USDA's funding program. (Photo courtesy of Utah Farm Bureau.)

Concentrated Animal Feeding Operations

Another water quality concern within the Utah Lake Basin is the impact animal feeding operations (AFO) and concentrated animal feeding operations (CAFO) have on water quality. These operations, where large numbers of animals are grown for meat, milk or egg production, can increase the biological waste loads introduced into rivers, lakes, and surface or groundwater reservoirs. Animal manure contains nutrients, pathogens, pharmaceuticals and salts.

The Utah Department of Environmental Quality has prepared a Utah AFO and CAFO strategy.[10] This strategy has three primary goals: (1) to restore and protect the quality of water for beneficial uses, (2) to maintain a viable and sustainable agricultural industry, and (3) to keep the decision-making process on these issues at the state and local level. The strategy provided a five-year window for facilities of particular concern to make voluntary improvements. Subsequently, the focus of more stringent regulatory action has been directed toward those facilities located within priority watersheds with identified water quality problems.

The first step in implementing this strategy—completing a statewide inventory of AFO and CAFO—is complete. The inventory has identified 2,056 AFOs and 454 CAFOs or potential CAFOs. Seven of the state's AFOs are located within the Utah Lake Basin; nine percent of the state's CAFOs or potential CAFOs (41) are located in the basin.[11] Of the seven AFOs, five are located in the Utah Lake watershed and two are located in the Spanish Fork watershed. Of the 41 CAFOs or potential CAFOs, three are located in Alberta, one in Spanish Fork, and one in Mosida.

In only a few years of operation, this program has enjoyed full cooperation from all AFO and CAFO operators. The program has been extremely successful in the Utah Lake Basin with all of the 48 AFOs and CAFOs in full compliance. A Utah Animal Feedlot Runoff Risk Index Model was run on 20 of those in full compliance that has estimated a significant reduction in pollutants. The results are shown in Table 29.

Septic Tank Densities

In some of the rural areas of the basin, advanced wastewater treatment systems have not been constructed and individual septic tank systems are used to dispose of domestic wastes. While septic tanks are designed to partially treat domestic waste and disperse the remaining pollutants into the natural environment in quantities that are not particularly

TABLE 29
Utah Lake Basin Feedlot Nutrient Load Reduction Summary*

Hydrologic Area	Number of Animal Operations	Total Number of Animals	Nitrogen Load Before	Nitrogen Load After	Phosphorus Load Before	Phosphorus Load After	BOD_5 Load Before	BOD_5 Load After
Spanish Fork	14	2,046	10,744	331	2,660	102	40,660	1,330
Provo	3	41	865	28	282	7	3,505	120
TOTAL	**17**	**2,087**	**11,609**	**359**	**2,942**	**109**	**44,165**	**1,450**

* These load reductions are estimates from the Utah Animal Feedlot Runoff Risk Index Model and do not necessarily reflect actual results.
Source: Mark Peterson, 2006 *Annual Progress Report--AFO/CAFO Inventory and Assessment Project,* an unpublished report by the Utah Farm Bureau, December 31, 2005.

harmful, when the number of systems in a localized area becomes too high, concentrations of certain pollutants (nitrogen, for example) can begin to cause problems.

Although there are currently no problems associated with high densities of septic tank systems in the basin, one development in the South Fork of Provo Canyon could present a problem to the Provo River. Vivian Park is an old summer home development that consists of about 25 homes on very small lots. Because of the combination of unknowns about the types of septic systems installed, high concentration of homes in a small area, high groundwater and the proximity to a tributary to the Provo River, the failure of one or multiple systems could easily contaminate the river.[12]

Groundwater Contamination

Because much of Utah Lake Basin's population receives groundwater for household purposes, the quality of this source is crucial to the continued health and growth of the population. And because the shallow aquifer is unconfined and not far from the surface, it is more easily affected by overlying human activities than are the deeper confined and unconfined aquifers. Utah Valley residents do not currently use shallow groundwater for drinking. However, the deeper aquifers are used extensively as a drinking water supply. These may be susceptible to contamination through secondary recharge from the shallow unconfined aquifer as higher pumping rates draw water from the shallow aquifer into the deeper aquifer.

The principal aquifer in Utah and Goshen Valleys consists of multiple confined aquifers with groundwater flowing generally toward Utah Lake. The primary recharge areas are around the perimeter of the valleys at the base of the mountains. The overall quality of the groundwater appears to be acceptable from the limited number of studies that have been completed in the basin. Although these studies have not been comprehensive, preliminary results have not warranted further studies, as have those in the Salt Lake Valley. The dissolved-solids concentrations range from about 500 mg/L to greater than 1,000 mg/L.

There are a few cases of groundwater contamination identified in the Utah Lake Basin. Only one of these instances has had an in-depth investigation, while the others are in the early investigative stages. Two of these, Ensign-Bickford (Trojan Plant) and Geneva Steel contamination sites, are discussed below. Other sites that have recently begun investigation include an old Reilly Industries site in Ironton, and a wood-treating site that is being cleaned up for the building of a department store near Lehi. Reilly distilled creosote oil and electrode binder pitch from coal tar[13] and stored and treated process wastewater onsite until 2001 when operations were discontinued.

<u>Ensign-Bickford Company's Trojan Plant</u>

The Ensign-Bickford Company (EBCo) manufactured explosives at the old Trojan plant in Utah County near Mapleton and Spanish Fork. Past manufacturing operations have resulted in the contamination of soil and groundwater. In 1999, EBCo and the Utah Division of Solid and Hazardous Waste agreed upon a plan to investigate the contamination at the facility. Forty-four areas were tested through comprehensive soil and groundwater sampling. Following the sampling, EBCo submitted an Interim Measures Work Plan and a Corrective Action Order was issued in 2005.[14]

An agreement was also established for EBCo to pump and treat the groundwater to "restore, replace, or acquire the equivalent" of the contaminated groundwater for the use of the public in the impacted area. Five extraction wells in the area pull groundwater to be treated at one of three treatment plants to provide drinking-quality water to Mapleton and Spanish Fork. The quality of the process is assured by frequent sampling and analysis and will continue for an estimated 20 years.[15] While the explosives manufacturing plant is no longer in operation, the parent company in Connecticut is still in business and is obligated to continue treating the drinking water. Further, the Utah Division of Water Quality is pursuing settlement for damages to the groundwater to assure funds are available to continue long-term monitoring and water treatment.

Geneva Steel Plant

From 1941 to 1944, more than 10,000 workers participated in the construction of the Geneva Steel Plant near Orem. The site for this plant was chosen because of its proximity to many of Utah's raw materials and its relative safety from coastal attacks during the war. Geneva Steel was operated by the U.S. Government for only two years after which U.S. Steel purchased the plant following the end of World War II. During its operation it has provided Utah County with thousands of well-paying jobs and attracted numerous ancillary industries. In 1987 the plant was closed and later opened under a new owner, Basic Manufacturing and Technology of Utah, Inc.[16] Basic Manufacturing later filed for bankruptcy and eventually ceased operations in 2002.

As with nearly all major industries, Geneva Steel has not been able to carry out its operations without leaving an impact on the surrounding environment. The Utah Department of Environmental Quality is overseeing recently begun investigations into the contamination of the unconfined aquifer beneath the site. The main areas of concern are benzene plumes along the west side and in the middle of the production site as a result of coal and coke production. The plumes are thought to only be on-site and a series of perimeter wells are being established to maintain surveillance of the plume and to confirm the actual boundaries of the contamination.[17] In addition to benzene, arsenic, lead, polycyclic aromatic hydrocarbons, cadmium, chromium, petroleum hydrocarbons, naphthalene and cyanide have been detected onsite and exceed respective action levels.

Water Quality Protection and Improvement Efforts

Many state and federal programs are in place to improve Utah's water quality. The Utah Pollutant Discharge Elimination System closely regulates point sources of pollution. DWQ is also working hard to eliminate nonpoint source pollution and will do so through its TMDL planning process, which is coordinated through local watershed groups. By organizing and fostering local watershed groups, DWQ seeks the critical participation and involvement of local stakeholders.

There are several local groups working to help protect the environment of the Utah Lake Basin. These groups include the Jordanelle Technical Advisory Committee and the Lower Provo River Technical Advisory Committee. The primary goal of these entities is to manage and protect the watershed through coordinated efforts that will protect the ecology of the area, water quality, instream flows, and recreational and other land uses.

THE ENVIRONMENT

During the settlement of the Utah Lake Basin, there was little understanding of the health of the ecosystems surrounding Utah Lake and its tributaries. When settlers first entered the area, the Provo River was a highly braided stream with low reedy banks as it entered Utah Lake, and the bays and banks of the lake were lined with bulrush, sage and other native plants aiding the clarity and quality of the water. Fish were so bounteous that the Provo River would be full from bank to bank, thick with suckers and others as the fish would swim upstream to spawn.[18] Soon after the arrival of the settlers, however, much of this changed.

As fields were planted with crops, reservoirs were built, rivers were dredged, and countless fish were caught for food and fertilization, the growing human population began taking a toll on the environment. Through these activities as well as the discharge of wastewater and production byproducts from various mills, the settlers nearly annihilated the fish that had saved them when their crops failed from drought or were devoured by pests. In an effort to restore the fish population, the problem was only exacerbated by the addition of non-native species that further altered the Utah Lake ecosystem.

At the time these activities were carried out, many environmental functions were not well understood. Since then, however, the arena in which water managers and planners operate has undergone enormous change. Environmental values are now better understood and there is an effort within the Utah Lake Basin to protect the environment from further degradation and mitigate problems caused by past actions. Water planners and managers within the basin are and will continue to integrate environmental policies and strategies into their operations to provide balanced and comprehensive solutions to water supply problems. This will be important to the success of every future water development project or management measure.

Some of the environmental values that affect the water resources of the Utah Lake Basin, or have the potential to do so, include: threatened, endangered and sensitive species, wetlands, instream flow maintenance, Wild and Scenic River designations, and Wilderness Areas. Each is discussed briefly below.

Threatened, Endangered and Sensitive Species

In 1973, the federal Endangered Species Act (ESA) was passed by Congress to prevent plant and animal species from becoming extinct. Although the ESA has had some success, it has been widely criticized because of its negative impacts on the communities located near threatened and endangered species. Once a species is federally listed as either threatened or endangered, the ESA restricts development, certain land uses and other activities that may impair recovery of the species.[19]

TABLE 30
Utah Lake Basin
Threatened and Endangered Species

Species Name	State Status
Plant	
Clay Phacelia	Endangered
Deseret Milkvitch	Threatened
Ute Lady Tresses	Threatened
Animal	
Brown Grizzly Bear	Threatened
Canada Lynx	Threatened
Greater Sage-Grouse	Threatened
June sucker	Endangered
Utah Valvata Snail	Endangered
Yellow-Billed cuckoo	Threatened

Source: Utah Division of Wildlife Resources, "Utah's Sensitive Species List,"

As of the year 2010, three plant species and six animal species in the Utah Lake Basin were listed as threatened or endangered (see Table 30).[20] Two of the animal species are thought to no longer exist in Utah, including the Brown Grizzly Bear and the Utah Valvata Snail. Two endangered species located in the basin include the June sucker (a fish native only to Utah Lake) and the Clay Phacelia, a plant species that occurs only in Spanish Fork Canyon. The other five species found within the basin, which are threatened, are the Ute Ladies-tresses (a plant species associated with wetland vegetation), the Deseret Milkvitch (a plant species that grows exclusively on sandy-gravelly soils weathered from conglomerate outcrops of the Moroni Formation), the greater Sage-Grouse and the Yellow-billed Cuckoo.

To avoid the difficulties encountered when a species becomes federally listed as threatened or endangered, and to better protect Utah's plant and wildlife resources, the Utah Division of Wildlife Resources (DWR) has developed the Utah Sensitive Species List, which identifies species most vulnerable to population or habitat loss. In addition to the nine species previously mentioned, 36 species that reside within the Utah Lake Basin are listed on Utah's Sensitive Species List. Of these, 12 are bird species, eight are mammals, two are amphibians, six are invertebrates, seven are fish species, and one is a reptile.[21] Table 31 lists these species and the counties in which they are found. The Division of Wildlife Resource's goal is to develop and implement appropriate conservation strategies for these species that will preclude their being listed as threatened or endangered.[22]

In 1998, the Utah Legislature created the Endangered Species Mitigation Fund (ESMF) to help protect essential habitat for Utah's threatened, endangered and sensitive species. The fund makes it possible for Utah land and water developers to continue responsible economic growth and development throughout the state while providing for the needs of various wildlife species. Through innovative, cooperative partnerships funded by the ESMF, state wildlife managers are working hard to create conservation and habitat agreements aimed at down-listing existing threatened and endangered species and avoiding the listing of other sensitive species. The ESMF provides a stable, non-lapsing revenue base which addresses the needs of Utah communities, local government and citizens who have struggled financially to comply with the requirements of federal law.[23]

In 2001, the State Wildlife Grants (SWG) program was established to increase funds necessary for the conservation of fish and wildlife species. SWG is now the nation's core program to help keep fish and wildlife from becoming federally threatened and endangered. Efforts are underway in Utah to restore habitat, enhance or reintroduce native species, and improve the stewardship of public and private lands using State Wildlife Grants. In order to receive these grants from the federal government, states are required to submit a Comprehensive Wildlife Conservation Strategy outlining conservation priorities for up to 10 years to:

- identify priority fish and wildlife species and their habitats,
- assess threats to their survival, and
- identify actions that may be taken to conserve them over the long term.

Utah's strategy was accepted and approved by the U.S. Fish and Wildlife on September 9, 2005, and will help sustain and enhance the ecological, social and economic viability of communities to ensure a better quality of life for all. Any funds obtained through this program must be matched with state or private money.[24]

<u>*June sucker Recovery Program*</u>

Of the 13 fish originally inhabiting Utah Lake, only the June sucker and Utah sucker can still be found. In the early 1900s, the June sucker was so bountiful that many anglers could "catch" the fish by merely dragging a line with hooks through the water often snagging more than one at a time.[25] Human activities altered critical habitat by dredging, irrigating, discharging pollutants into the waterways and introducing more than 20 non-native fish species into the lake. By 1979, the June sucker population was in peril. Conditions continued to worsen and by 1986, the population has diminished from millions to a mere estimated 311 to 515 individuals.[26]

In 1999, the U.S. Fish and Wildlife Service established the June Sucker Recovery Plan. The primary goal of the plan is to save the June sucker from extinction. The plan identifies the fish as a species with a high degree of threat of extinction, a low recovery potential and the presence of conflict. Priority was thus given to:[27]

- "Preserving the genetic integrity of the species and developing brood stock and refugia populations;
- Monitoring the spawning runs;
- Designing, constructing and managing a weir in the Provo River to facilitate capture of spawning suckers for monitoring and taking of eggs and to restrict nonnative fishes from entering;
- Establishing a permanent warm water native fish hatchery to propagate June sucker;
- Determining and enhancing Provo River instream flows necessary for successful spawning and recruitment of June sucker;
- Restoring habitat in the Provo River and Utah Lake for all life stages of the species;
- Protecting from non-native species impacts; and
- Establishing a self-sustaining spawning run of June sucker."

The estimated cost of recovery is $50 million, and the projected recovery date is 2040.

In 2002, numerous agencies and groups joined together to create a Recovery Implementation Program for June sucker that established a "multi-agency co-

TABLE 31
Utah Lake Basin Sensitive Species

Species Name	County	State Status
Birds		
American White Pelican	Juab, Utah	SPC
Bald Eagle	Juab, Summit, Utah, Wasatch	SPC
Black Swift	Juab, Summit	SPC
Bobolink	Juab, Utah	SPC
Burrowing Owl	Juab, Utah	SPC
Ferruginous Hawk	Juab, Summit, Utah, Wasatch	SPC
Grasshopper Sparrow	Juab, Summit, Utah, Wasatch	SPC
Lewis's Woodpecker	Juab, Summit, Utah, Wasatch	SPC
Long-Billed Curlew	Juab, Summit, Utah, Wasatch	SPC
Northern Goshawk	Juab, Summit, Utah, Wasatch	CS
Short-Eared Owl	Juab, Summit, Utah, Wasatch	SPC
Three-Toed Woodpecker	Juab, Summit, Utah, Wasatch	SPC
Mammals		
Dark Kangaroo Mouse	Juab	SPC
Fringed Myotis	Juab, Utah, Wasatch	SPC
Kit Fox	Juab, Utah	SPC
Pygmy Rabbit	Juab, Utah	SPC
Spotted Bat	Utah	SPC
Townsend’s Big-Eared Bat	Juab, Utah, Wasatch	SPC
Western Red Bat	Utah	SPC
White-Tailed Prairie-Dog	Summit, Utah	SPC
Amphibians		
Columbia Spotted Frog	Juab, Summit, Utah, Wasatch	CS
Western Toad	Juab, Summit, Utah, Wasatch	SPC
Reptiles		
Smooth Greensnake	Summit, Utah, Wasatch	SPC
Invertebrates		
California Floater	Juab, Utah	SPC
Deseret Mountainsnail	Summit	SPC
Eureka Mountainsnail	Juab, Utah	SPC
Southern Bonneville Springsnail	Utah	SPC
Utah Physa	Juab, Utah	SPC
Western Pearlshell	Summit	SPC
Fishes		
Bluehead sucker	Summit, Utah, Wasatch	CS
Bonneville Cutthroat Trout	Juab, Summit, Utah, Wasatch	CS
Least Chub	Juab, Utah	CS
Northern Leatherside Chub	Summit	SPC
Roundtail Chub	Utah, Wasatch	SPC
Southern Leatherside Chub	Juab, Utah, Wasatch	SPC

SPC: Wildlife species of concern.
CS: Species receiving special management under a Conservation Agreement in order to preclude the need for Federal listing.
Source: Utah Division of Wildlife Resources, "Utah's Sensitive Species List," (Salt Lake City: Dept. of Natural Resources, June 24, 2010).

cooperative effort to implement the June sucker Recovery Plan by funding, coordinating and facilitating June sucker recovery, while balancing and accommodating water resource needs."[28] While the overall objective is to aid in the recovery of the June sucker, the program also provides a mechanism to promote the recovery of other federally listed species, and prevent the need for further listings in the Utah Lake Basin.[29] The Program is made up of the following organizations:

- U.S. Fish and Wildlife Service
- Utah Department of Natural Resources
- Central Utah Water Conservancy District
- U.S. Bureau of Reclamation
- U.S. Department of Interior
- Utah Reclamation Mitigation and Conservation Commission
- Provo River Water Users Association
- Provo Reservoir Water Users Company
- Outdoor and environmental interest groups

Through the efforts of this program it is now estimated that there are over a quarter of million adult June suckers currently inhabit the Lake. Unfortunately, this is primarily due to stocking from the hatchery and refuge. Few of the naturally spawned suckers survive to maturity.[30] Habitat recovery efforts as noted previously on Hobble Creek have shown promise in the recovery effort by providing spawning habitat for the June suckers. More habitat will be developed in the next few years both through expansion of the Hobble Creek site to the east of I-15 and by diversion and creation of habitat on the lower Provo River.

In addition to habitat re-creation, the removal of up to 60 million lbs of carp between 2009 and 2014 from Utah Lake will aid the June sucker. It is hoped that the carp population will crash and remain at a more manageable level, allowing plant life to recover and reduce predation on sucker fry. The carp are being removed by netting in areas where they are known to congregate. Some of the carp are being used for feed at mink farms with the remainder currently going to a landfill. Recovery managers are looking for a permanent self-sustaining use (such as for fish meal) for the harvested carp that can perpetuate their removal. More information about the program as well as the participating members can be found at www.junesuckerrecovery.org.

Utah Lake Wetlands and the Greater Great Salt Lake Ecosystem

The Greater Great Salt Lake Ecosystem encompasses the area from Cache Valley down the Bear River to the Great Salt Lake, up the Jordan River through Utah Lake, and up the Provo River to Jordanelle Reservoir. This ecosystem plays a large role in Utah's beauty and diversity of plant and animal life as well as recreational opportunities. The Utah Lake wetlands are a crucial part of this habitat. They are used by approximately 226 species of birds, 49 mammalian species, 16 species of amphibians and reptiles and 18 species of fish, and have long been recognized nationally for their importance to fish and wildlife resources.[31]

In order to help mitigate past and likely future effects from Central Utah Project water development, the Utah Reclamation Mitigation and Conservation Commission is working to establish the Utah Lake Wetland Preserve at the southern end of the lake. In 1996, the commission entered into an agreement with The Nature Conservancy, Utah Division of Wildlife Resources, U.S. Department of the Interior, Bureau of Reclamation, Bureau of Land Management, and U.S. Fish and Wildlife Service for acquisition and management with the management ultimately falling to the Utah Division of Wildlife Resources. The Preserve consists of two units: Goshen Bay and Benjamin Slough, consisting of about 21,750 acres.[32] These efforts play an important role in preserving sensitive lands as sanctuaries for wildlife and the enjoyment of future generations.

Instream Flow Maintenance

An instream flow is often defined as "free flowing water left in a stream in quantity and quality appropriate to provide for a specific purpose."[33] In general, the purpose of an instream flow is to provide habitat for fish and other aquatic wildlife; however, an instream flow may also provide water for terrestrial wildlife and livestock watering, maintain critical riparian vegetation, accommodate certain recreational purposes, or simply enhance the aesthetics of the natural environment. The quantity and timing of instream flows vary with each purpose and are not necessarily the same as a minimum flow.

In Utah, there are several ways to obtain instream flows; these are listed below:

- Instream Flow Agreements – When water storage and diversion facilities are constructed, minimum instream flows are often negotiated among the various water users as a means of mitigating negative impacts of the project to fish and wildlife values. These agreements often describe conditions where the minimum flows may be compromised and have no legal mechanism of enforcement. Instream flow agreements are the most common form of stream flow maintenance in Utah.
- Conditions on New Water Rights Appropriations – Since 1971, the State Engineer has had the authority to place a condition on the approval of a water right application if, in his judgment, approval of the full requested right would "unreasonably affect public recreation or the natural stream environment." In other words, the State Engineer can reject (or reduce the amount of) a new appropriation or reject a change application in order to reserve sufficient flow for recreation or the environment.
- Conditions of Permits or Licenses – Hydroelectric facilities must receive a license from the Federal Energy Regulatory Commission to operate. Alterations to streams must receive a permit from the Utah Division of Water Rights. Before a license or permit is issued or renewed, the public is given the opportunity to comment. If this process identifies instream flows as critical to other uses of the water, such as wildlife habitat, these flows may become part of the permit or license conditions.
- Instream Flow Water Rights – In 1986 the Utah Legislature amended the water rights law of the state to allow the Utah Division of Wildlife Resources to file for changes of a perfected water right that would provide sufficient instream flow for fish propagation. These water rights may be obtained through purchase, lease, agreement, gift, exchange or contribution. Acquisition of such flows must be approved by the legislature before the State Engineer can make a determination. Later, the Utah Division of State Parks and Recreation was given the same authority. In 2008 the Legislature passed a law authorizing the filing of a change application for a fixed period of time, not exceeding ten years, for an instream flow to protect or restore habitat for native trout.

Instream Flow Agreements in the Utah Lake Basin

Table 32 lists the known minimum instream flow agreements within the Utah Lake Basin. These flows are all part of the Central Utah Project to help mitigate damages from the construction of new projects and various diversions. Most of the minimum flows are already set, however two of the segments shown are in progress of acquiring and establishing

TABLE 32
Minimum Instream Flow Agreements in the Utah Lake Basin

Reservoir or Diversion Dam	River	Min. Instream Flow (cfs)
Jordanelle	Provo (Jordanelle to Deer Creek)	125
Deer Creek	Provo (Deer Creek to Olmstead Diversion)	100
Olmstead Diversion	Provo (Olmstead Diversion to Utah Lake)	25-75*
Strawberry	Sixth Water Creek	32/25**
Strawberry	Diamond Fork	80/60†
Jordanelle	Spring Creek	23-39
Jordanelle	Creamery Ditch	6
Jordanelle	London Ditch	4
Jordanelle	Lower Lake Creek	6
Jordanelle	Snake Creek	20
Strawberry	Hobble Creek	4,000 acre-feet‡

* The current minimum flow is 25 cfs, with an objective of 75 cfs contingent upon funding and willing sellers of water rights.
** 32 cfs from May to October and 25 cfs from November to April.
† 80 cfs from May to September and 60 cfs from October to April.
‡ 4,000 acre-feet of conserved Utah Lake System water would be made available to the Department of the Interior for instream flow purposes to assist in the recovery of the June sucker. It would be released during April, May and early June.
(Sources: Central Utah Water Conservancy District, *Supplement to the Bonneville Unit Definite Plan Report*, Draft 1996, 3-12 through 3-14 & *Utah Lake Drainage Basin Water Delivery System Final Environmental Impact Statement*, September 2004, 1-33 & 4-149.)

the specified amount. The lower portion of the Provo River from the Olmstead Diversion to Utah Lake currently has a winter minimum flow of 25 cfs, but an objective of 75 cfs has been established to increase the flow as close to this amount as possible dependent upon availability of funding and willing sellers of water rights. The second minimum flow is an augmentation for Hobble Creek during April, May and early June. Utah Lake System water that would be conserved under the Section 207 Program (part of the Central Utah Project's Water Management Improvement Plan) would be conveyed through the Mapleton-Springville Lateral Pipeline in the amount of 4,000 acre-feet to assist in the recovery of the endangered June sucker.[34]

Wild and Scenic River Designation

The Wild and Scenic Rivers Act (WSRA) of 1968 states that, "certain selected rivers of the nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations."[35] Only Congress has the authority to designate a stream or river segment as "Wild and Scenic." In most cases, such designation would prevent construction of flow-modifying structures or other facilities on designated river segments. The area for which development is limited along a wild and scenic river varies, but includes at least the area within one-quarter mile of the ordinary high water mark on either side of the river.

Currently there are no rivers in Utah that have been designated as Wild and Scenic. In recent years, however, national forests and other federal agencies have made inventories of streams for consideration as wild and scenic rivers and found numerous stretches to be eligible. For instance, a 1997 inventory for the Uinta National Forest found four river segments in the Utah Lake Basin to possess at least one outstandingly remarkable value. These segments are now eligible for the Wild and Scenic River designation and include: the upper mile of the South Fork of American Fork River, the upper 1.1 miles of the North Fork of Provo River, 2.6 miles of Little Provo Deer Creek including and directly downstream of Cascade Springs, and the entire 7.8 miles of Fifth Water Creek located in the Spanish Fork River drainage.[36] As of 2014, Congress has not made a decision concerning the official designation of these streams. Until Congress does make a decision, the areas are managed as Wild and Scenic Rivers.

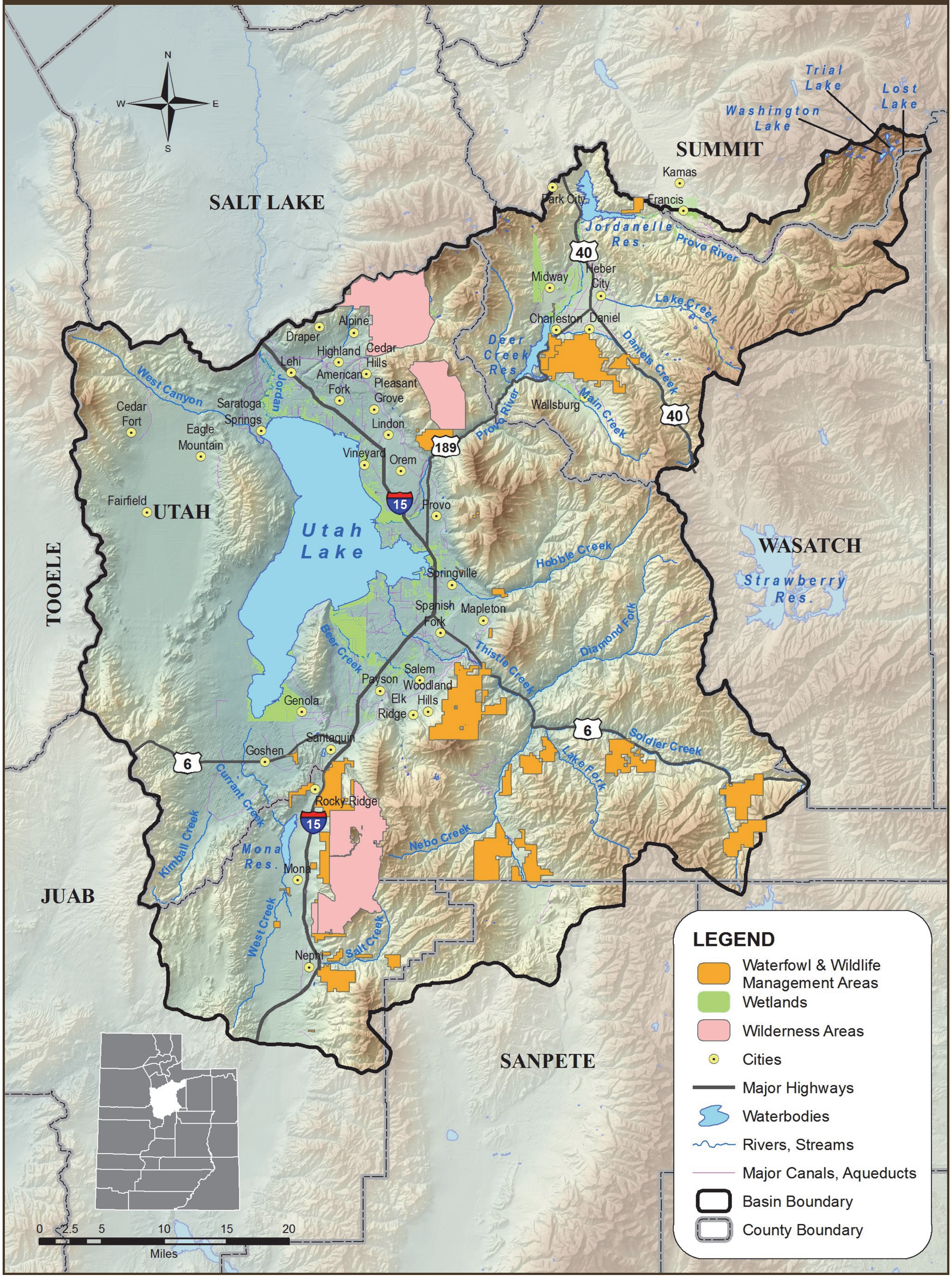
Wilderness Areas

In 1976, the President of the United States signed the Federal Land Policy and Management Act of 1976. This act directed the Bureau of Land Management (BLM) to conduct a study of its remaining roadless areas and make recommendations as to whether or not each area should become a congressionally designated Wilderness Area. In 1980, BLM completed an inventory of the roadless areas in Utah and identified 95 Wilderness Study Areas totaling around 3.3 million acres. In order to be considered a Wilderness Study Area (WSA), an area must possess the following characteristics as identified in the Wilderness Act:[37]

- "Size - roadless areas of at least 5,000 acres or of a manageable size, and roadless islands;
- Naturalness - generally appears to have been affected primarily by the forces of nature;
- Opportunities - provides outstanding opportunities for solitude or primitive and unconfined types of recreation.
- WSAs may also possess special qualities such as ecological, geological, educational, historical, scientific and scenic values."

Once an area is designated as a WSA, BLM manages the area as a wilderness area until Congress determines if an area should indeed be classified as wilderness by law. In managing a WSA, the BLM must provide opportunities for the public to use wilderness for recreational, scenic, scientific, educational, conservation, and historical purposes in a manner that will leave the area unimpaired for future use and enjoyment as wilderness.[38] There are three areas in the Utah Lake Basin that have already been designated by Congress as a Wilderness Area; these include Mount Nebo, Timpanogos and Lone Peak Wilderness Areas. There are currently no WSAs in the Utah Lake Basin.

FIGURE 38
Wetlands, Wildlife Management Areas and Wildlife Preserves



Obtaining Balance Between Competing Values

In recent decades, water quality and environmental values have emerged as important factors in the water resources arena. Taking their place alongside the traditional role of supplying the public with adequate water supply, these important values have changed the landscape within which water planners and managers operate. Water resources are now subject to numerous federal and state laws, which are intended to help keep water clean, protect the environment and preserve natural areas for the future.

Water quality and environmental laws help sustain the beneficial use of water and bring valuable balance to the water resources arena, where growing needs are causing increased competition and are often conflicting in nature. While this balancing act is not easy, if properly orchestrated, it will lead to better water planning and management, higher quality water, and a healthier and more enjoyable environment.

Water planners and managers, local leaders, and interested individuals within the Utah Lake Basin all play important roles in the management of the basin's water resources. By working closely together, they can help meet future water resources challenges. Following the spirit of the pioneers who first settled the basin, they too can assure a promising future for subsequent generations.

Notes

[1] A TMDL sets limits on pollution sources and outlines how these limits will be met through implementation of best available technologies for point sources and best management practices for nonpoint sources. For more information, see U.S. Environmental Protection Agency, "Total Maximum Daily Load (TMDL) Program." Retrieved from EPA's Internet web page: www.epa.gov/owow/tmdl/intro.html, December 2005.

[2] "Jordan River/Utah Lake Basin TMDLs." Retrieved from the Utah Division of Water Quality's Internet web page: http://www.waterquality.utah.gov/watersheds/jordan/tmdl_reports.htm, February 2006.

[3] Utah Division of Water Quality, *Utah Lake – Jordan River Watershed Management Unit Stream Assessment,* (Salt Lake City: Dept. of Environmental Quality, 2002), 14-15 & 18-19. This report is also available online at the Division of Water Quality's web page: www.waterquality.utah.gov.

[4] Fischer, Richard A. and J. Craig Fischenich, "Design Recommendations for Riparian Corridors and Vegetated Buffer Strips," (April 2000), 2 & 13. This publication was developed under the U.S. Army Corps of Engineers Ecosystem Management and Restoration Research Program and was taken from Wisconsin's Department of Wildlife Resources Internet webpage: http://www.dnr.state.wi.us/org/water/wm/dsfm/shore/documents/sr24.pdf.

[5] "Provo River Restoration Project." Retrieved from the Utah Reclamation Mitigation and Conservation Commission's Internet web page: www.mitigationcommission.gov/prrp/prrp.html, February 2006.

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GLOSSARY

Acre-Foot (ac-ft) - The volume of water it takes to cover one acre of land (a football field is about 1.3 acres) with one foot of water; 43,560 cubic feet or 325,850 gallons. One acre-foot is approximately the amount of water needed to supply a family of four with enough water for one year (assuming a residential use rate of 225 gpcd).

Animal Feedlot Operations (AFO) - A lot or facility where animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period; and where crops, vegetation, forage growth, or post-harvest residues are not sustained over any portion of the lot or facility in the normal growing season.

Aquifer - A geologic formation that stores and/or transmits water. A confined aquifer is bounded above and below by formations of impermeable or relatively impermeable material. An unconfined aquifer is made up of loose material, such as sand or gravel, that has not undergone settling, and is not confined on top by an impermeable layer.

Beneficial Use - Use of water for one or more of the following purposes including but not limited to, domestic, municipal, irrigation, hydro power generation, industrial, commercial, recreation, fish propagation, and stock watering; the basis, measure and limit of a water right.

Commercial Use - Water uses normally associated with small business operations which may include drinking water, food preparation, personal sanitation, facility cleaning and maintenance, and irrigation of landscapes.

Concentrated Animal Feedlot Operations (CAFO) - An animal feedlot operation (see above) where more than 1,000 animal units are confined, or 301 - 1,000 animal units are confined and waters of the United States pass through the facility or the operation discharges via a man-made device into waters of the United States. Also, AFOs can be designated as CAFOs on a case-by-case basis if the NPDES permitting authority determines that it is a significant contributor of pollution to waters of the U.S.

Conjunctive Use - Combined use of surface and ground water systems to optimize resource use and minimize adverse effects of using a single source.

Conservation - According to Webster's Dictionary, conservation is the act or process of conserving, where conserve is defined as follows: (1) To protect from loss or depletion, or (2) to use carefully, avoiding waste. In this document, the second definition is used exclusively. However, in the water resources field the first definition is also used. Using the first definition, constructing a reservoir to capture excess runoff in order to more fully utilize the water is also considered conservation.

Consumptive Use - Consumption of water for residential, commercial, institutional, industrial, agricultural, power generation and recreational purposes. Naturally occurring vegetation and wildlife also consumptively use water.

Culinary Water - See "Potable Water."

Depletion - The net loss of water through consumption, export and other uses from a given area, river system or basin. The terms consumptive use and depletion, often used interchangeably, are not the same.

Developable - That portion of the available water supply that has not yet been developed but has the potential to be developed. In this document, developable refers to the amount of water that the Division of Water Resources estimates can be developed based on *current* legal, political, economic and environmental constraints.

Diversion - Water diverted from supply sources such as streams, lakes, reservoirs, springs or wells for a variety of uses including cropland irrigation and residential, commercial, institutional, and industrial purposes. This is often referred to as withdrawal.

Drinking Water - See "Potable Water."

Dual Water System - See "Secondary Water System."

Efficiency - The ratio of the effective or useful output to the total input in a system. In agriculture, the overall water-use efficiency can be defined as the ratio of crop water need (minus natural precipitation) to the amount of water diverted to satisfy that need.

Eutrophication - The process of increasing the mineral and organic nutrients which reduces the dissolved oxygen available within a water body. This condition is not desirable because it encourages the growth of aquatic plants and weeds, is detrimental to animal life, and requires further treatment to meet drinking water standards.

Evapotranspiration - The scientific term which collectively describes the natural processes of evaporation and transpiration. Evaporation is the process of releasing vapor into the atmosphere through the soil or from an open water body. Transpiration is the process of releasing vapor into the atmosphere through the pores of the skin of the stomata of plant tissue.

Export - Water diverted from a river system or basin other than by the natural outflow of streams, rivers and ground water, into another hydrologic basin. The means by which it is exported is sometimes called a transbasin diversion.

Gallons per Capita per Day (gpcd) - The average number of gallons used per person each day of the year for a given purpose within a given population.

Ground Water - Water which is contained in the saturated portions of soil or rock beneath the land surface. It excludes soil moisture which refers to water held by capillary action in the upper unsaturated zones of soil or rock.

Hydrology - The study of the properties, distribution, and effects of water in the atmosphere, on the earth's surface and in soil and rocks.

Incentive Pricing - Pricing water in a way that provides an incentive to use water more efficiently. Incentive pricing rate structures include a base fee covering the system's fixed costs and a commodity charge set to cover the variable costs of operating the water system.

Industrial Use - Use associated with the manufacturing or assembly of products which may include the same basic uses as a commercial business. The volume of water used by industrial businesses, however, can be considerably greater than water use by commercial businesses.

Institutional Use - Uses normally associated with operation of various public agencies and institutions including drinking water; personal sanitation; facility cleaning and maintenance; and irrigation of parks, cemeteries, playgrounds, recreational areas and other facilities.

Instream Flow - Water maintained in a stream for the preservation and propagation of wildlife or aquatic habitat and for aesthetic values.

Mining - Long-term ground water withdrawal in excess of natural recharge. (See "Recharge," below.) Mining is usually characterized by sustained (consistent, not fluctuating) decline in the water table.

Municipal Use - This term is commonly used to include residential, commercial and institutional water use. It is sometimes used interchangeably with the term "public water use," and excludes uses by large industrial operations.

Municipal and Industrial (M&I) Use - This term is used to include residential, commercial, institutional and industrial uses.

Nonpoint Source Pollution (NPS) - Pollution discharged over a wide land area, not from one specific location. These are forms of diffuse pollution caused by sediment, nutrients, etc., carried to lakes and streams by surface runoff.

Nutrient Loading - The amount of nutrients (nitrogen and phosphorus) entering a waterway from either point or nonpoint sources of pollution. Nutrients are a byproduct of domestic and animal waste, and are present in runoff from fertilized agricultural and urban lands. Nutrients are not typically removed from wastewater effluent, and if present in excessive amounts result in growth of aquatic weeds and algae.

Phreatophyte - A plant species which extends its roots to the saturated zone under shallow water table conditions and transpires ground water. These plants are high water users and include such species as tamarisk, greasewood, willows and cattails.

Point Source Pollution - Pollutants discharged from any identifiable point, including pipes, ditches, channels and containers.

Potable Water - Water meeting all applicable safe drinking water requirements for residential, commercial and institutional uses. This is also known as culinary or drinking water.

Private-Domestic Use - Includes water from private wells or springs for use in individual homes, usually in rural areas not accessible to public water supply systems.

Public Water Supply - Water supplied to a group through a public or private water system. This includes residential, commercial, institutional, and industrial purposes, including irrigation of publicly and privately owned open areas. As defined by the State of Utah, this supply includes potable water supplied by either privately or publicly owned community systems which serve at least 15 connections or 25 individuals at least 60 days per year.

Recycling - See "Reuse."

Recharge - Water added to an aquifer or the process of adding water to an aquifer. Ground water recharge occurs either naturally as the net gain from precipitation, or artificially as the result of human nfluence. Artificial recharge can occur by diverting water into percolation basins or by direct injection into the aquifer with the use of a pump.

Residential Use - Water used for residential cooking; drinking; washing clothes; miscellaneous cleaning; personal grooming and sanitation; irrigation of residential lawns, gardens, and landscapes; and washing automobiles, driveways, etc.

Reuse - The reclamation of water from a municipal or industrial wastewater conveyance system. This is also known as recycling.

Riparian Areas - Land areas adjacent to rivers, streams, springs, bogs, lakes and ponds. They are ecosystems composed of plant and animal species highly dependent on water.

Safe Yield - The amount of water which can be withdrawn from an aquifer on a long-term basis without serious water quality, net storage, environmental or social consequences.

Secondary Water System - Pressurized or open ditch water delivery system of untreated water for irrigation of privately or publicly owned lawns, gardens, parks, cemeteries, golf courses and other open areas. These are sometimes called "dual" water systems.

Self-supplied Industry - A privately owned industry that provides its own water supply.

Stakeholders - Any individual or organization that has an interest in water management activities. In the broadest sense, everyone is a stakeholder, because water sustains life. Water resources stakeholders are typically those involved in protecting, supplying, or using water for any purpose, including environmental uses, who have a vested interest in a water-related decision.

Total Maximum Daily Load (TMDL) - As defined by the EPA, a TMDL "is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. [Its] calculation must include a margin of safety to ensure that the water body can be used for the purposes the State has designated. The calculation must also account for seasonal variation in water quality." The TMDL must also provide some "reasonable assurance" that the water quality problem will be resolved. The states are responsible to implement TMDLs on impaired water bodies. Failure to do so will require the EPA to intervene.

Water Audit - A detailed analysis and accounting of water use at a given site. A complete audit consists of an indoor and outdoor component and emphasizes areas where water could be used more efficiently and waste reduced.

Water Yield - The runoff from precipitation thatreaches water courses and therefore may be available for human use.

Watershed - The land above a given point on a waterway that contributes runoff water to the flow at that point; a drainage basin or a major subdivision of a drainage basin.

Wetlands - Areas where vegetation is associated with open water and wet and/or high water table conditions.

Withdrawal - See "Diversion."

UTAH STATE WATER PLAN
Utah Lake Basin—Planning for the Future

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