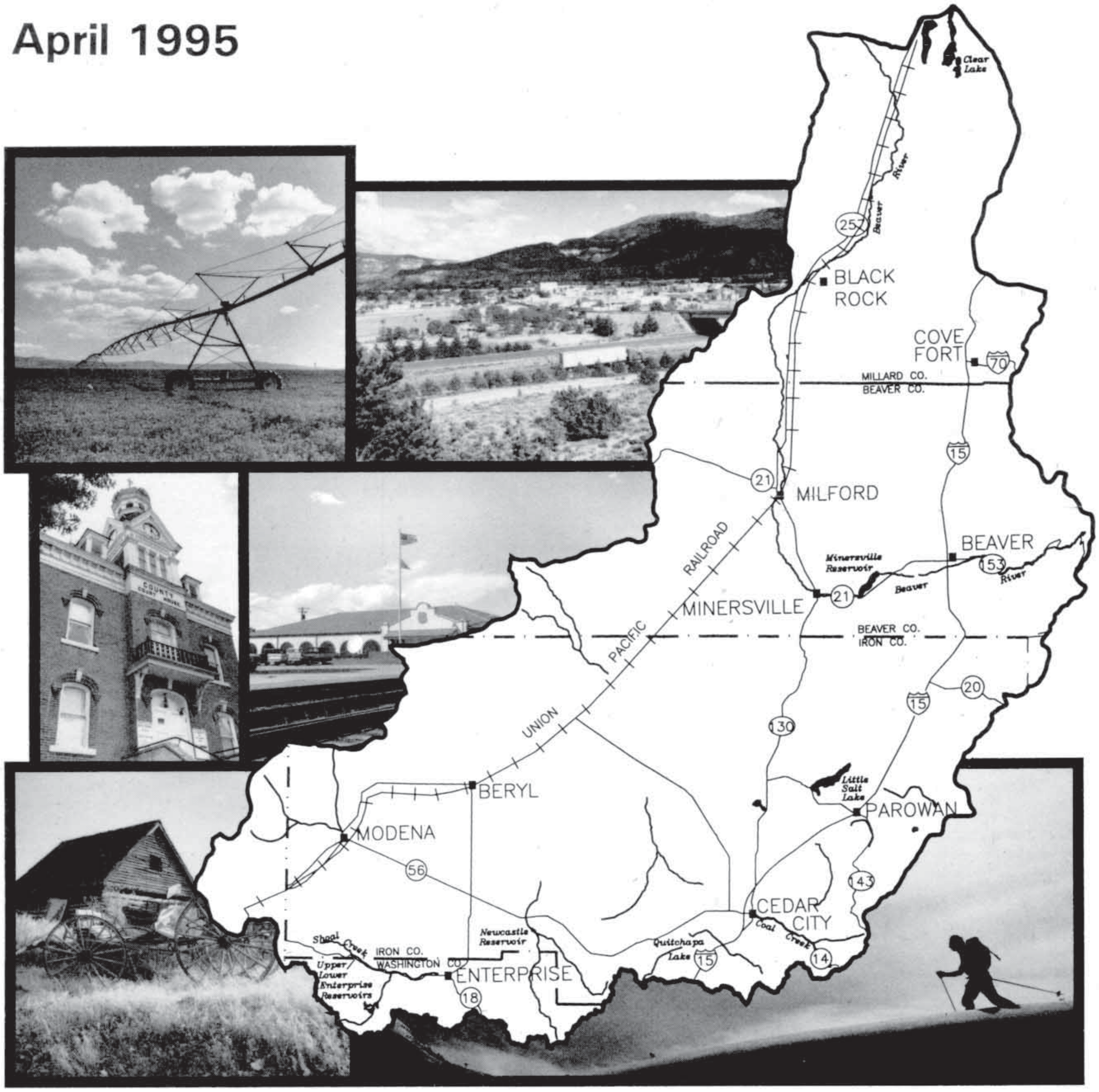
Utah
State Water Plan
Cedar/Beaver Basin

April 1995



Utah Division of Water Resources
Utah Department of Natural Resources

■ **State Water Plan** - Cedar/Beaver Basin

Section

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UTAH CENTENNIAL 1896-1996

State Water Plan
Cedar/Beaver Basin

Utah Board of Water Resources
1636 West North Temple, Suite 316
Salt Lake City, UT 84116

April 1995

Foreword

A *State Water Plan* was distributed in early 1990 to provide the foundation for establishment of state water policy. Within the framework of water policy planning, the state meets its obligation to plan and implement programs to best serve the needs of the people.

In addition to the *State Water Plan*, more detailed plans are being prepared for each of the 11 river basins. The Cedar/Beaver Basin is one of these. This plan discusses water and water-related problems, needs, demands and alternatives for potential conservation and development measures. Final selection of alternatives will rest with local decision makers.

Like the *State Water Plan*, this basin plan is designed to be flexible. There is always a need for continuous re-evaluation so adjustments can be made to reflect changing situations. Planning needs the active participation of all concerned entities and individuals and their responses to issues. The success of this planning process is enhanced through public involvement, resulting in broader support to implement recommendations. In addition, there is a greater need for coordination at all levels of government. Progress is more difficult when some are trying to go their separate way. This basin plan is intended to help bring about greater coordination between those involved to assure the needs and demands of the local people are met.

Acknowledgement

The Board of Water Resources gratefully acknowledges the dedicated efforts of the State Water Plan Steering Committee and Coordinating Committee in preparing the *Cedar/Beaver Basin Plan*. This work was spearheaded by the planning staff of the Division of Water Resources. Valuable assistance was provided by individual coordinating committee members and their associates representing state agencies with water related missions. Their high standards of professionalism and dedication to improving Utah's natural resources are essential to this basin plan. Representatives of state and federal cooperating entities, the statewide local advisory group and the basin planning advisory group brought expertise from a broad spectrum of Utah's population. Representatives of many local entities and groups provided much needed assistance at the "grass-roots" level. We appreciate their input and assistance.

In endorsing this plan, as was the case with the *January 1990 State Water Plan*, we reserve the right to consider individual water projects on their own merits. This basin plan is an important guide for water development in the Cedar/Beaver Basin.

Larry S. Ross, Chair

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Section 2 Contents

Section 2 State Water Plan - Cedar/Beaver Basin

Executive Summary

This section summarizes the *Cedar/Beaver Basin Plan*. Like the *State Water Plan*, this document contains 19 sections. Also, Section A, Acronyms, Abbreviations and Definitions, and Section B, Bibliographies, have been added.

Besides the 19 sections, the *State Water Plan* contains Section 20, "River Basin Summaries", and Section 21, "Annual Status Reports." The following headings are titles of each of the sections summarized. These sections should be studied for more detailed information.

Union Pacific Railroad Office in Milford

2.1 Foreword

Within the broad responsibility to enhance the quality of life and general welfare of its citizens, the state of Utah has the specific obligation to plan for and encourage the best use of its resources. The *State Water Plan* (1990) provides the statewide foundation and direction. More detailed plans are and will be prepared for the 11 hydrologic basins. The *Bear River Basin Plan* was published in January 1992, and the *Kanab Creek/Virgin River Basin Plan* was published in August 1993. This plan for the Cedar/Beaver Basin is the third report to be completed.

The purpose of this plan is to identify potential conservation and development projects and describe alternatives to satisfy the problems, needs and demands. The final selection of alternatives will be made at the local level.

2.3 Introduction

Section 3 contains the general planning guidelines used to insure continuity during plan preparation. The guidelines consist of guiding principles, purpose, organizational structure and review process. The organizational arrangements provide contribution and review opportunities for state and federal agencies, special interest groups and, especially, local entities, organizations and individuals. The planning process allows for review and approval at various stages of completion. This section also discusses the settlement, climate, general characteristics and land status of the Cedar/Beaver Basin.

The Cedar/Beaver Basin is part of the Sevier Lake Region, which is part of the larger Great Basin Region which is a closed basin. The Cedar/Beaver Basin drains into the Sevier River which terminates in the normally dry Sevier Lake Playa. There are 3.6 million acres in the basin.

Mean annual valley temperatures vary from 48° to 51° F. Summer temperatures often reach 100° F. Precipitation ranges from eight inches in the west desert areas to 40 inches in the high mountains. Elevations range from 4,600 feet to 12,173 feet above sea level.

The lofty Tushar Mountains and colorful Markagunt Plateau on the east are in marked contrast to the rugged mountain ranges and environment of the western part of the basin. The federal government administers nearly two-thirds of the total area and the state administers about 8 percent. About 26 percent of the land is in private ownership. Tribal lands. amount to about 1 percent.

2.4 Demographics and Economic Future

Population, employment and the economy are discussed in this section. Cedar City is the most rapidly growing area in the basin. The 1990 and projected populations follow with the latter in parentheses. The basin population is 26,485 (56,576); 4,765 (10,331) in Beaver County, 20,561 (43,648) in Iron County, and 1,159 (2,597) in Washington County. At present, the largest city populations are: Cedar City, 13,443; Beaver, 1,998; Enoch, 1,947; Parowan, 1,873; and Milford, 1,107. The estimated growth rate is 3.7 percent for Beaver County and 3.7 percent for Iron County.

Major growth is in the trade and service sector. Agriculture employment has been down, but it is expected to rebound. Cedar City is expected to continue its aggressive strategy for recruiting new business, resulting in a growth of light industry and commercial firms. The entrance of pork production and processing in the Milford area will significantly strengthen agricultural employment and income.

2.5 Water Supply and Use

Section 5 discusses the historical water supplies and present uses. The surface water supplies are estimated primarily from two stream gages. They indicate the long-term annual flows are 38,116 acre-feet for the Beaver River near Beaver and 24,637 acre-feet for Coal Creek near Cedar City. The highest flows in the Beaver River were about 88,000 acre-feet and about 62,000 acre-feet for Coal Creek, both in 1983. The average annual groundwater discharge from wells is about 188,700 acre-feet.

Total water diversions are: irrigation, 318,790 acre-feet; culinary, 8,810 acre-feet; and secondary, 3,330 acre-feet. Total depletions are 185,320 acre-feet. Wetland and riparian vegetation uses are not included.

2.6 Management

The water supply is generally well-managed to serve the various uses. About 65 percent of the total water supply is managed by a combination of 77 irrigation companies. The 19 existing lakes and reservoirs are used to help manage the surface water resources. The culinary water supply comes from groundwater. The major present concern is deteriorating water quality.

2.7 Regulation/Institutional Considerations

Responsibility for water regulation rests primarily with two state agencies. These are the Division of Water Rights and the Department of Environmental Quality.

Proposed determinations of water rights have been made for all areas of the basin. Groundwater is the major supply to satisfy the needs of the basin. This has resulted in the need for groundwater management strategies.

In addition, water quality is always a concern. Constant vigilance is needed to maintain the quality of surface water and groundwater.

There are 13 high hazard dams in the basin. The state engineer is currently assessing the condition of these dams.

2.8 Water Funding Programs

This section discusses the funding programs available. Funding can be either grants or loans at various interest rates. These funding resources are available for all kinds of water-related proposals.

The time periods reported by the agencies vary but the total funds expended are impressive. The state and federal grants are nearly $14 million and loans are over $45 million for a total of $59 million. Strikingly, the amount of loans is three times the amount of grants. Data from local sponsor funding, including private financial institutions, are not available.

2.9 Water Planning and Development

Section 9 discusses the water resources problems and needs. Development and management alternatives are described for surface water and groundwater.

The only issue discussed concerns long-range planning. Long-range planning is important because of the many state, federal and local agencies and entities involved. The extensive use of groundwater in this basin, more so than in any other basin in the state, also presents opportunities for long-range planning.

Irrigation water shortages can be critical, especially for users with only direct flow rights. Some irrigators supplement their supplies with groundwater, especially in the drier years. Where there is reservoir storage, supplies last longer into the late part of the irrigation season. Surface water supplies most of the irrigation water in Beaver Valley, the Minersville area and Parowan Valley. The Milford area, Cedar Valley and the Beryl-Enterprise area depend more on groundwater. Culinary water demands are expected to increase by 72 percent or about 6,160 acre-feet by the year 2020. All of the supplies come from springs or the groundwater reservoirs. Secondary systems can save culinary water for this higher use. The demand for secondary water by the year 2020 will increase by about 800 acre-feet. This does not consider addition of more systems. Current depletions for wetlands is about 25,410 acre-feet. There is a need for improvement of habitat of fish and wildlife. Some of the waterfowl areas have dried up over the years. The Cedar/Beaver Basin is becoming more popular for people seeking recreational experiences. This is going to increase the demand on the natural resources as well as on man-made water-based facilities. Making more efficient use of existing water supplies increases the availability for future demands. This can be accomplished by increasing use efficiency, water conservation and protection of existing supplies. There is the possibility of surface water storage. There are 10 potential reservoir sites that may be utilized in the future if conditions change to make them feasible. Management of the groundwater reservoirs is one of the most important ways to maintain the existing supply from this source. Transbasin diversions are a possibility, but not likely, in the foreseeable future.

Depletions for all uses will increase by about 4,000 acre-feet by the year 2020. Culinary water uses will account for 3,200 acre-feet of this increase, but needed supplies will likely be converted from agricultural uses. Agricultural uses will stay about the same or decrease slightly.

2.10 Agricultural Water

This section discusses the agricultural aspects of the basin. Agricultural activities are an important part of the economy. Water shortages are a problem.

There are 110,810 acres of irrigated cropland which depletes about 178,740 acre-feet of water, mostly for the production of alfalfa. The cropland irrigation water deficit on currently cropped land is only about four percent of the consumptive use. If all of the existing irrigated cropland (including idle land) with a valid water right were to receive a full water supply, an additional 44,000 acre-feet of water would be depleted. Cropland is only 3 percent of the total basin area, although much of the basin contains arable soils. They cannot be cropped because they lack irrigation water or sufficient precipitation. The number of farms has decreased over the years, but the average farm size has doubled, containing about 1,000 acres.

Over 90 percent of the basin area is used for grazing purposes producing about 325,000 AUMs annually. Wildlife utilizes about 11,000 AUMs and 8,000 AUMs are allocated for wild horses on land administered by the Bureau of Land Management. The Forest Service estimates about 10 percent of the total AUMs are used by wildlife.

There are critical (accelerated) erosion areas throughout the basin. These areas are eroding at over three times the background geologic rate.

There are various alternatives for solving problems including canal lining and pipelines, reservoir storage and rangeland improvement measures. Increasing resource use efficiencies is a viable option.

Shakespeare Theater in Cedar City

2.11 Drinking Water

Section 11 discusses the drinking water systems, their problems and the future needs. The systems are publicly or privately owned. Groundwater is the only current culinary water supply, either from springs or underground reservoirs. The basin-wide use is 272 gallons per capita per day (GPCD). This is higher than the state average of 265 GPCD. The GPCD use in the cities and towns ranges from 143 in Parowan to 464 in Minersville. The use rate for other public community systems ranges from 107 at Rainbow Ranches to 518 at New Castle (this was before New Castle installed a secondary system). Most of the communities have adequate culinary water sources to meet future needs. Some communities will have to enlarge their system delivery capacity to meet projected needs.

There are 21 public community water systems in the basin and 22 public non-community systems. Nineteen of the public community systems have an approved rating, one is pending corrective action and one is not approved. Most public water suppliers expect an increased demand in the next 20 to 30 years. Cedar City increased its delivery by 47 percent from 1981 to 1991 and expects this to double by the year 2020. It is expected all future needs will be satisfied from groundwater sources. This will come from transfers of water from irrigation to culinary uses.

2.12 Water Quality

Section 12 discusses the water quality of the basin along with the problems and needs. Most of the water in the basin is of good quality. The quality of some surface water streams carries high sediment loads during periods of high spring snow-melt runoff and when high intensity summer convection storms occur. Three reservoirs have been classified as eutrophic. In general, the quality of the surface water has stayed about the same over the last number of years while the groundwater quality has deteriorated.

Funds have been received for a Non-point Source Demonstration Project on the Beaver River between Beaver City and Minersville Reservoir. This will complement a Clean Lake Project underway on Minersville Reservoir.

Coal Creek yields more sediment than any other stream in the basin. Low flows only carry 200 to 500 mg/l, but one flood flow of 1,200 cfs yielded sediment at a rate of 2.3 million tons per day or a total dissolved solids concentration of nearly 700,000 mg/l. In comparison, Beaver River yields concentrations of about 1,200 mg/l. Groundwater quality is good in the Beaver Valley with the highest values reaching 1,000 mg/l. Concentrations in the Milford area are up to 4,600 mg/l in the north end of the groundwater reservoir. There was a peak of 875 mg/l in Parowan Valley in 1973, but it is usually about half that amount. Some of the wells in Cedar Valley reached up to 2,100 mg/l, but those supplying culinary water are below the recommended limits. A few wells in the Beryl-Enterprise area reached 1,000 mg/l, but most are below 500 mg/l. A monitoring program is needed to obtain data to help manage the groundwater reservoirs.

2.13 Disaster and Emergency Response

Flood hazard mitigation and disaster response are discussed in Section 13. It also discusses the problems and needs. Flooding and drought are the major water-related emergencies.

Some of the local entities have hazard mitigation and disaster response plans. All local governments need these type plans with staff ready in order to reduce damages and save lives. It is much easier to be ready for an event than to try and correct the problems after the fact.

Floodplain management can help alleviate problems in the future. All of the counties in the basin participate in the National Flood Insurance Program and all cities should. The counties also have disaster response plans in place. Cities and towns without these plans should prepare them to be ready for future emergencies. Floods of various sizes have occurred in all parts of the basin, the most recent occurring in Fiddlers Canyon north of Cedar City producing a peak flow of 4,080 cfs.

Droughts are always a recurring problem, aggravating most of the basin, particularly on the south and west where at low elevations the winter snow packs are small.

2.14 Fisheries and Water-Related Wildlife

Section 14 discusses the fish and wildlife resources of the basin along with the problems, needs and some alternative solutions. The range in the environment varies from areas above the timber line and alpine to the semi-desert of the western part of the basin. Species of wildlife are varied according to their environments. There are 22,000 acres of wetlands/open water and riparian areas. The only wetland managed specifically for waterfowl is the Clear Lake Waterfowl Refuge in the northern part of the basin. The Cedar City Upland State Game Sanctuary is in the northern part of Cedar Valley.

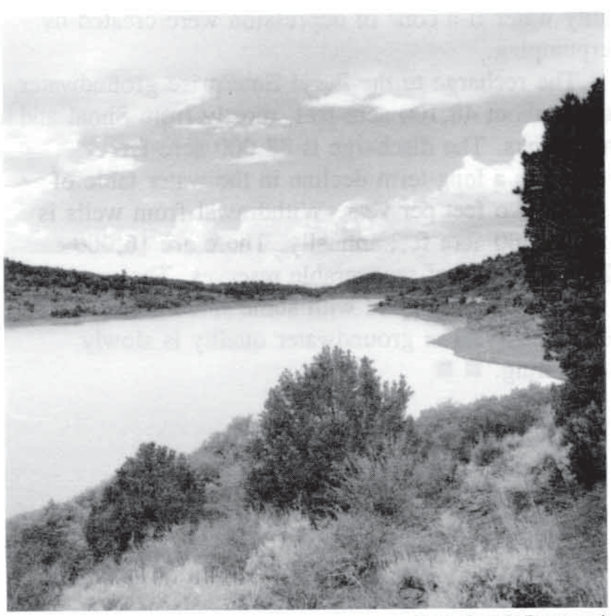
Many people are attracted to live and play in the area because of the unique year-round attractions. Summer homes are being constructed in the upper watershed areas. This is creating problems and conflicts in use of the resources. With a growing population, problems will increase in the future. There are areas where damage is caused by ATV travel, other recreational uses and dewatering of streams.

Water-related mitigation alternatives include maintenance of native fish communities and habitat or replacement of these values with similar facilities. One way to protect riparian areas from livestock and wildlife is to provide watering facilities upland from streams. Riparian area re-growth can be accelerated by construction of low head dams, rock weirs, streambank protection, sediment traps and vegetative plantings.

2.15 Water-Related Recreation

The importance of recreation and related facilities is presented in Section 15 along with problems and needs. Recreation is becoming a larger part of the basin's lifestyle. The area offers a diversity of outdoor recreational opportunities. There are two state parks, one national monument, two national forests, one wilderness area, four byways, two backways and many camping areas, RV sites and trails in the basin. Other points of interest include Old Cove Fort, Old Irontown and the Jefferson Hunt Historical Site. There are two ski resorts along with golf courses and swimming pools around the basin. Nine projects have been assisted through the federal Land and Water Conservation Fund program, three in Beaver County and six in Iron County. Total grant funds amounted to $224,800 and $321,000, respectively, in these two counties.

Surveys have been conducted to determine the recreational and environmental issues. It was noted that over 50 percent of all tourists visiting Utah pass by Cedar City and Beaver on I-15. More of them need to be made aware of local attractions. Many of the most requested facilities were water-related.



Red Creek Reservoir

2.16 Federal Water Planning and Development

Section 16 describes the federal involvement in basin planning and development. The federal role is changing. Many of the past activities concerned development of the resources. Concerns now are more oriented around conservation and protection.

The main concern is the part federal agencies should play compared to state and local involvement. Coordinated planning and use is definitely needed. With the large amount of land area administered by the federal government, local needs and desires become even more important.

The largest construction projects by federal agencies was the Minersville and Green's Lake Watershed projects carried out by the Natural Resources Conservation Service (Soil Conservation Service). The Corps of Engineers completed project work on Big Wash near Milford and on Shoal Creek near Enterprise. The corps completed flood control studies on Coal Creek near Cedar City and another study covering most of the basin. Other federal activities are the many and varied programs carried out to assist the local people. These include technical assistance as well as financial grants and loans.

2.17 Water Conservation/Education

The importance of water conservation along with the need for and ways of conserving this resource are discussed in Section 17. Water conservation can alleviate the effects of drought by stretching available supplies. A system-wide long-term conservation program can extend the need for developing additional water supplies. Conservation can also carry communities through short-term emergencies. Installing secondary systems for outside uses can reduce the need for increased high quality water supplies. In the long term, water education is the key to conservation through more efficient use.

The basin population is expected to increase from about 26,500 in 1990 to 56,600 in 2020, an increase of nearly 115 percent. Without conservation, this growth will require an additional 9,170 acre-feet of culinary water. There is a need for agricultural water throughout the basin. However, it will be difficult to develop additional supplies.

Water conservation will require the input and support of the public. If everyone believes in water conservation, it will happen.

2.18 Industrial Water

Section 18 discusses the industrial water use in the basin. There is relatively little water used for industrial purposes other than light industrial operations. Most of these industries are supplied from existing municipal and industrial water supplies delivered through systems now in place.

There are six hydroelectric power plants now in operation; four on the Beaver River and one each on Center Creek and Red Creek. Two geothermal plants produce power in the basin; one at Roosevelt Springs near Milford and one at Sulfurdale.

A large greenhouse near New Castle uses geothermal and cold groundwater. Other industrial users include Cache Valley Cheese in Beaver and Circle Four Hog Farms and Continental Lime Company near Milford.

Heavy industry is not expected to increase. Light industry is being attracted to the area in increasing numbers. There are potential hydroelectric sites, but it is unlikely these will be developed in the near future.

2.19 Groundwater

Groundwater supplies and use and related problems are discussed in Section 19. Groundwater supplies about one-half of the agricultural needs and all of the municipal and industrial water. This includes springs used for culinary water supplies. The groundwater in the Cedar/Beaver Basin is more fully developed than in any other area in Utah. One of the concerns is protection of recharge areas, primarily the alluvial fans of tributary streams.

The Cedar/Beaver Basin consists of six structural basins containing unconsolidated deposits which form the primary aquifers. These are Upper Beaver Valley, Milford Valley of the Escalante Desert, Lower Beaver Valley, Parowan Valley, Cedar Valley and the Beryl-Enterprise area of the Escalante Desert. The alluvial fill in each of these forms an essentially isolated groundwater reservoir.

In the Beaver Valley, there is 55,600 acre-feet of recharge to the groundwater reservoir. About half the total discharge of 56,200 acre-feet comes from springs. The balance is from wells. There are about 4 million acre-feet of recoverable reserves. The water quality is generally good, although there are areas of poorer quality water in the basins.

Milford Valley receives most of its recharge from infiltration from irrigation, although some of the 58,000 acre-feet comes from the Beaver River. The total discharge is 81,000 acre-feet, mostly from wells. There are about 10 million acre-feet of recoverable reserves. There has been some long-term decline in the water table which has caused land subsidence locally. The quality of the water is generally good, but there are areas of poorer quality. Many wells show a long-term downward trend in water quality.

The recharge in Parowan Valley is about 40,000 acre-feet, mostly from Parowan, Red and Summit creeks. The discharge is 43,000 acre-feet; about half which is from wells. There are about 4 million acre-feet of recoverable reserves. The water quality is generally good.

Cedar Valley is similar to Parowan Valley. Coal Creek is the primary contributor to the groundwater recharge of 40,000 acre-feet. The discharge is about 44,000 acre-feet with a little over half of this from wells. The water table decline was decreased when most of the basin was closed for further drilling of wells in 1940. There are about 4 million acre-feet of recoverable reserves. The groundwater is hard but satisfactory for most uses. The water in the southwest and northeast parts of the basin is better quality than most of the rest. This is where Cedar City obtains a large share of its culinary water supply. There is danger of poorer quality water infiltrating the better quality water if a cone of depression were created by overpumping.

The recharge to the Beryl-Enterprise groundwater basin is about 48,100 acre-feet, mostly from Shoal and Pinto creeks. The discharge is 88,000 acre-feet resulting in a long-term decline in the water table of less than two feet per year. Withdrawal from wells is about 76,300 acre-feet annually. There are 16,000 million acre-feet of recoverable reserves. The water quality is generally good with some small areas of poorer quality. The groundwater quality is slowly deteriorating. ■ ■

Section 3 Contents

Section 3 State Water Plan - Cedar/Beaver Basin

Introduction

3.1 Background

The people of Utah have always planned for the protection and use of the water resources through cooperative efforts. State directed water planning was formalized by specific legislation in 1963. This plan for the Cedar/Beaver Basin is another step in that process.

3.2 Planning Guidelines

The *State Water Plan* describes the basic premises and lays the foundation for all state water planning. This insures continuity so individual basin plans will be consistent with the statewide plan and with each other.

3.2.1 Principles

There are many values, uses and interests involved in preparing a basin plan. There are also certain guiding principles to be considered. These are listed below.

- All waters, whether surface or subsurface, are held in trust by the state as public property and their use is subject to rights administered by the state engineer. The doctrine of prior appropriation has governed Utah water law since statehood.
- Water is essential to life. It is our responsibility to leave good quality water to meet the needs of the generations to follow.
- The diverse present and future interests of Utah's residents should be protected through a balance of economic, social, aesthetic and ecological values.
- Water uses that are difficult to identify beneficiaries for, such as recreation and aesthetics, should be included in program evaluation.
- Public input is vital to water resources planning.
- All residents of the state are encouraged to exercise water conservation and implement wise use practices.
- Water rights owners are entitled to transfer their rights under free market conditions. The state engineer should be informed of any ownership transfers in order to keep records current and avoid interference with other rights.

■ The *State Water Plan*[21] describes a process for planning, conserving and developing the water resources. It covers all aspects of Utah's water resources and has the flexibility to be changed as future conditions require.

Relics in Cedar City

◦ Water resources projects should be technically, economically and environmentally sound.

◦ Water planning and management activities of local, state and federal agencies should be coordinated.

◦ Local governments, with state assistance as appropriate, are responsible for protecting against emergency events such as floods and droughts.

◦ Designated water uses and quality should be improved or maintained unless there is evidence the loss is outweighed by other benefits.

◦ Educating Utahns about water is essential. Effective planning and management requires a broad-based citizen understanding of water's physical characteristics, potential uses and scarcity values.

3.2.2 Purpose

One main purpose of this basin plan is to identify issues and describe future alternatives and possible development to provide for the water needs of future generations. Irreversible commitments could be very costly and prevent the fulfillment of future needs. Coordinated planning between all state and federal agencies and local entities can be the vehicle to involve concerned parties.

3.2.3 Organization

State water planning is the responsibility of the Division of Water Resources under the auspices of the Board of Water Resources. Several other state agencies with major water-related missions are involved in the water planning process.

With this in mind, a state water plan coordinating committee representing 12 state agencies facilitated preparation of the *Cedar/Beaver Basin Plan*. There is a steering committee consisting of the chair and vice chair of the Board of Water Resources, executive director of the Department of Natural Resources, and director and assistant director of the Division of Water Resources. This committee provided policy guidance, resolved issues and approved this plan prior to acceptance by the Board of Water Resources.

In addition, 19 federal and other state agencies participated as cooperating entities. These agencies have particular expertise in various fields to assist with plan development. Also, a statewide local advisory group representing 17 organizations and special interest groups have assisted with input and plan review. This group represents a spectrum of various interests and geographical locations. The original memberships of these committees and groups are listed in Section 3.4, Introduction, of the *State Water Plan*.[21]

Also, the local Basin Planning Advisory Group for the Cedar/Beaver Basin provided input by way of advice, review and decision making. Most of the members of this group reside within or are directly involved in basin affairs. They represent various local interests and provide geographical representation within the basin.

3.2.4 Process

During the review and approval process, four drafts of the *Cedar/Beaver Basin Plan* were prepared. These were: (1) In-House Review Draft, (2) Committee Review Draft, (3) Advisory Review Draft, and (4) Public Review Draft. Revised drafts occurred where warranted. After this process, the final basin plan is distributed to the public for their information and use. It is provided to give guidance for water use, conservation, preservation, and development; primarily for local entities but also for state and federal agencies.

3.3 Basin Description

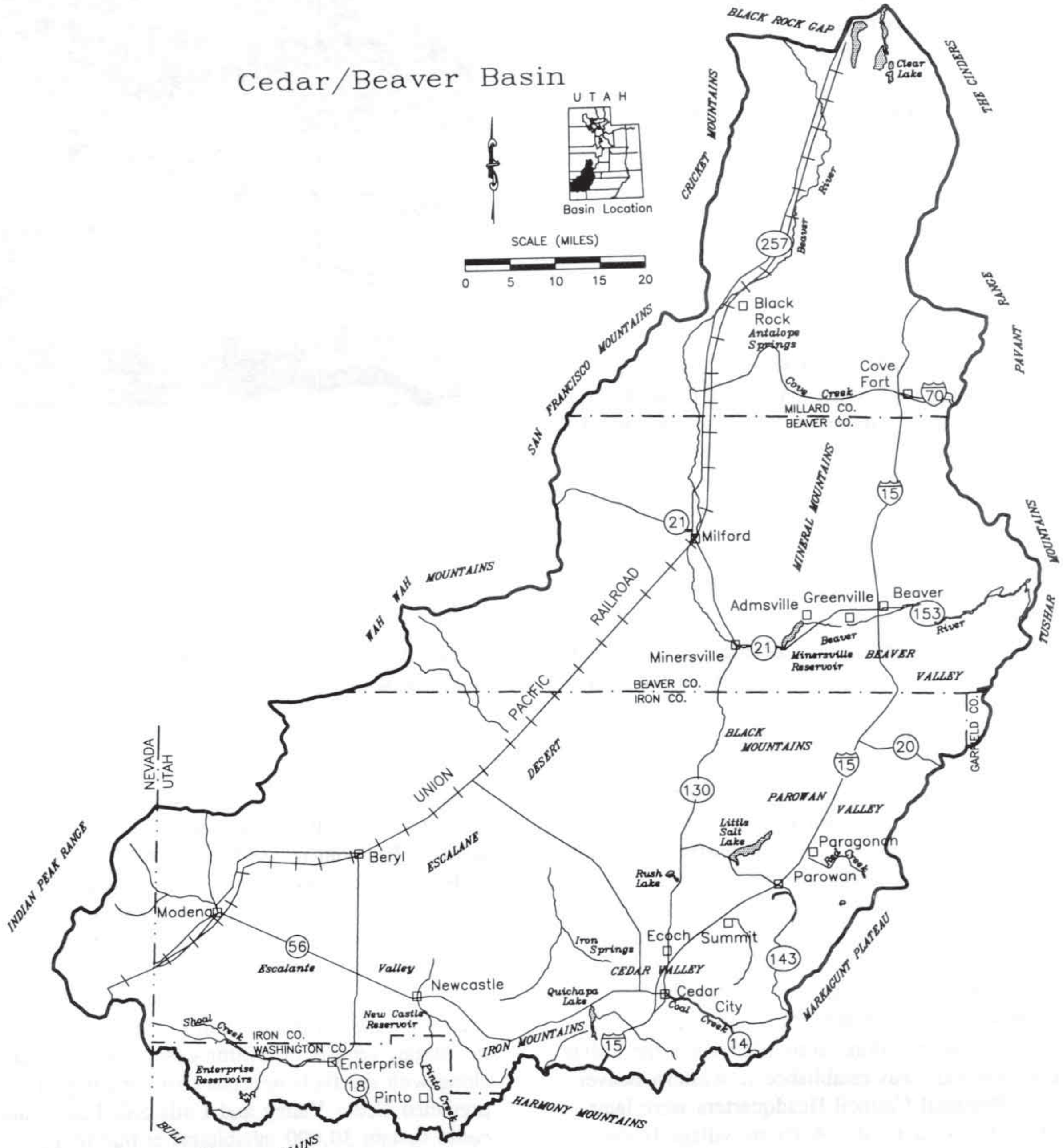
The Cedar/Beaver Basin, located in southwestern Utah, is shown on Figure 3-1. The Cedar/Beaver Basin includes the Beaver River drainage and Parowan and Cedar valleys and the Beryl-Enterprise area. These are all part of the Sevier Lake Basin which is part of the landlocked Great Basin. A small part of the hydrologic boundary of Shoal Creek extends into Nevada.

The Beaver River once terminated in prehistoric Lake Bonneville and in more recent history, before white men arrived, joined the Sevier River and discharged perennially into Sevier Lake, normally a dry playa. At its highest level, Lake Bonneville shores extended into the Escalante Desert. Although not a part of the Beaver River mainstem, Parowan Valley, Cedar Valley and the Escalante Desert would drain into the Beaver River if there were sufficient runoff.

The upper part of the Shoal Creek and Gold Springs Wash drainages within the hydrologic boundary of the Cedar/Beaver Basin are located in Lincoln County, Nevada. The Nevada portion of these drainages has no perennial streams.

The eastern boundary of the Cedar/Beaver Basin is formed by the Tushar Mountains and the Markagunt Plateau. The southern boundary is formed by the Harmony Mountains on the east and the Bull Valley mountains on the west, both foothill extensions of the Pine Valley Mountains. The western boundary consists of a series of mountain ranges. These include the Indian Peak Range, Wah Wah Mountains and Cricket Mountains. The northern boundary crosses to the east

Figure 3-1
LOCATION MAP



south of Black Rock Gap and north of Clear Lake, goes down the Cinders to Cove Creek, and along the transition from the Pavant Range to the Tushar Mountains.

The basin contains 3.6 million acres and includes parts of Beaver, Garfield, Iron, Millard and Washington counties. In addition, there are 38,500 acres in Lincoln County, Nevada, not included in this study. This area includes the upper drainage of Shoal Creek, 2,180 acres, and Gold Springs Wash, 36,320 acres.

Elevations range from 12,173 feet at Delano Peak in the Tushar Mountains on the east and 9,660 feet at Frisco Peak in the San Francisco Mountains on the west to 5,600 feet in Cedar Valley, 5,200 feet in Escalante Valley and 4,600 near Clear Lake.

3.3.1 History and Settlement

The history and settlement of the Cedar/Beaver Basin is varied and interesting. The eastern part of the area was settled when the Mormon Church began expanding throughout Utah and into present day southern California. Discovery of precious metals and ore bodies sparked settlement in the western part of the basin and helped bring in the railroad.

Prehistory - Some researchers believe the first inhabitants in the area existed about 10,000 to 12,000 years ago, having crossed the Bering Sea from Siberia long before.[41] They are classed as part of the Archaic culture.

Beginning about 1,000 years ago, a new culture moved into the region. In the northern part of the Cedar/Beaver Basin, there were three different tribes at one time or another calling the area their homeland. The Western Shoshoni were to the north and northwest. To the east were the Utes. To the southwest, south and southeast were the Southern Paiutes. The Southern Paiutes were the predominant tribe in the area and remnants are still found in the basin.

There was consideration of establishing reservations as early as the 1860s and again in the 1880s. Nothing was done until 1915 when the Indian Peak Reservation was established in western Beaver County. Regional Council Headquarters were later established in Cedar City. A Paiute village is also currently located there.

History - The Spaniards came into southern Utah in the late 1540s, but the extent of their travels is not well known.[3,41,53] In October, 1776, the Dominguez and Escalante party passed through the area in search of a route from Santa Fe, New Mexico, to Monterey, California. Their route entered the basin just west of Clear Lake and went south through the Escalante Desert to near Blue Knoll, about halfway between Milford and Cedar City. After casting lots on whether to go on to California or return to New Mexico, they crossed over to Cedar City and then south to the Virgin River. They gave Coal Creek its first European name, "Señor San Jose", and described Cedar Valley as very beautiful with a great abundance of pasturage.

Petroglyphs west of Parowan

The Old Spanish Trail crossed Fremont Pass from the Sevier River into the Little Salt Lake and Cedar valleys and then westward through Iron Springs to Mountain Meadows and on to the Santa Clara River. This trail was followed by trappers and by Captain John C. Fremont in 1844 on his return from California. Jefferson Hunt was the first of those known as "Mormonee" by the natives to cross through the area. He traveled to California in 1847 to get seed for the settlers in Salt Lake Valley.

In 1849, Parley P. Pratt led a party of 52 men to explore south beyond the rim of the Great Basin and to investigate reports of an immensely rich iron ore body along with the fuels necessary for smelting. Pratt predicted Cedar Valley and Little Salt Lake Valley could sustain 30,000 inhabitants at that time, and 100,000 eventually. As a result, it was decided to settle the area and take advantage of these deposits.

Settlement - Parowan, an Indian word meaning evil water (not bad or stagnant water), was settled in January 1851 by a company of 167 people.[12] They located on Center Creek. Cedar City was established in November 1851 on the Little Muddy, now called Coal

Creek.[39] Cedar City was so named because of the abundance of cedar (juniper) trees in the area. The first iron was manufactured here in 1852. The first culinary water system south of Provo was constructed in Cedar City in 1903. After a typhoid fever epidemic, the system was extended beyond diverting water directly from Coal Creek to piping water from springs higher up in the canyon. The next year, Cedar City voted prohibition in an attempt to substitute water for liquor as the main liquid for drinking.

Shortly after in 1852, Enoch was settled. It was originally called Johnson's Springs, later changed to Johnson's Fort. Paragonah, meaning "many springs or marshes", was permanently settled in 1853. At that time, Iron County covered an area from the Sevier River on the east into Arizona and Nevada on the south and west.

In 1856, a group of men left Parowan to settle the area on the Beaver River. This was thought to be a good place to pasture cattle. It was also known there were large quantities of good timber in the canyons. Water was first diverted in the spring of 1856 to irrigate valley lands.

The Post of Beaver was established in 1873. It was named Fort Cameron and maintained until its closure in 1883. In addition, a timber reserve was declared in 1879 covering a large expanse of the area. In 1898, the Beaver Branch of Brigham Young University, later called Murdock Academy, was established at the fort. The many black rock houses built by the soldiers housed students. The school was closed in 1922.

Greenville was established in 1860 by a group of people from Parowan and Cedar City. They had been coming to the area for several years to cut the grass and haul it home for winter feed. Nearby Adamsville was settled in 1862 by several families to take advantage of the pasture lands for farming and raising livestock. The population was bolstered by people escaping from Indian troubles in Sevier, Garfield and Iron counties.

The discovery of the Rollins Mine (Lincoln Mine) in the Mineral Range resulted in the establishment of Minersville northeast of where it now stands. The ore was used to make bullets. Because of the high silver content (19-30 ounces per ton), reports carried to the east said the Mormons used silver bullets.

The Minersville Reservoir and Irrigation Company built a reservoir dam in the early 1890s, but it washed out soon after construction. This dam was rebuilt in 1894. In 1913, the Delta Land and Water Company purchased the interests and built the present Minersville Reservoir. Prior to construction of Minersville Reservoir, water flowed north of Milford toward Black Rock. After the reservoir was constructed, there was no perennial flow in the Beaver River beyond Milford, causing an area near the Beaver-Millard County line to turn from a marsh/swamp area to one of sand dunes and blowing dust, threatening the highway and the railroad.

A mill was established near present day Milford to process ore from the Mineral Range. Two fords across the Beaver River were used. The ore freighters used one of these two "mill fords" and hence the name Milford. The first family established themselves in 1880. With the coming of the railroad, Milford became a shipping terminal for all of southern Utah.

A southern extension of the railroad, begun from Salt Lake City in 1871, was extended to Clear Lake in 1880.[41] This was a part of the extension of the Utah Central Railway which became the Utah Southern Railroad. The Utah Southern Extension was completed to Frisco during the summer of 1880. These were later all combined under one name, the Utah Central Railway, which ran from Ogden to Frisco. By 1899, the railroad had been extended to Uvada on the Utah-Nevada border. Eventually, it all became a part of the Union Pacific Railroad Company with service from Salt Lake City to Los Angeles.

The original settlers on Shoal Creek located in Hebron. In May 1882, Orson W. Huntsman cleared 320 acres where Enterprise now stands. Five families located there in 1896, officially establishing Enterprise.

New Castle was established in 1908. They diverted part of their water from the Santa Clara River drainage, making this the first and still only transbasin diversion in the Cedar/Beaver Basin.

3.3.2 Climate[2]

Precipitation in the area is influenced by two major storm patterns: one, frontal systems from the Pacific Northwest during winter and spring; the other, late summer and early fall thunderstorms from the south and southwest. The Southern Utah Low, a high altitude low pressure system often covering parts of several states, causes wide-spread precipitation between the winter frontal systems and summer thunderstorms.

There are 11 climatological stations within the basin where daily temperatures and precipitation are measured and 17 snow courses in and near the basin where the winter snowpack is measured. Telemetry systems have been installed on 11 of these to make data available on a continuing basis. The 1961-1990 base period is used in this report. The climatological and snow course stations are shown on Figure 3-2.

Temperature - Temperatures fluctuate nearly every year from a maximum of about 100° F. to a minimum of below zero with daily variations as much as 40° F. The mean annual temperature in the valleys varies from 48°F in the Beaver and Enterprise-Beryl Junction area to 51°F at the Cedar City Airport. The average frost-free periods range from 135 days at Cedar City to 98 days in the Escalante Valley. Temperature data is given in Table 3-1 for some of the key valley stations.

Precipitation - The precipitation ranges from over 40 inches in the Tushar Mountains and Markagunt Plateau to about eight inches in the desert areas of the northwest part of the basin. Climate in the valley areas is arid to semi-arid with an average precipitation of about 11 inches. Precipitation can be highly variable, some wet years receiving three times that in the drier years. The annual precipitation is shown on Figure 3-3. The annual precipitation and reference evapotranspiration at five valley stations are shown in Table 3-2. The reference evapotranspiration is calculated from the Hargreaves equation for alfalfa. Snow course records show accumulated water content collected during the winter months.[66,77] Most stations can be accessed to determine monthly, daily, or even single storm accumulations. The April 1st forecast is the water supply indicator for the coming season. This is based on the snow course soil moisture levels, snow pack water content and other factors. Snow course locations are shown on Figure 3-2.

Annual water surface evaporation varies from about 41 inches at Beaver to 44 inches at Milford and Black Rock. Possible sunshine varies from 82 percent during September to 47 percent during December. Prevailing winds are from the southwest at 7 to 12 miles per hour. Maximum wind movement generally occurs during May. The velocity increases to the west in the open desert areas.

3.3.3 Physiography and Geology

Physiography - The Cedar/Beaver Basin as discussed in this report is located entirely within Utah. The only exception is the upper drainage areas of Shoal Creek and Gold Springs Wash which extend into Lincoln County, Nevada. These areas are briefly described in Section 5. The basin area is varied, distinguished by plateaus, escarpments, rugged peaks, and mountain ranges and basins. They are all a reflection of the geology.

The topography is such that there is only surface water outflow from the basin during very wet periods of precipitation. This outflow would be in the Beaver River, through Black Rock Gap and downstream until it joins the Sevier River.

Table 3-1
MEAN TEMPERATURES

Station	Monthly January Max. (F°)	Monthly January Min. (F°)	Monthly July Max. (F°)	Monthly July Min. (F°)	Mean Annual (F°)	Frost-free Days
Beaver	42	14	88	51	48	104
Cedar City Airport	42	17	90	58	51	135
Enterprise-Beryl Junction	41	11	90	51	48	98
Milford	39	13	92	55	49	120
Parowan	42	14	87	55	49	129

Note: All temperatures are 1961-90 normal values.
Frost-free days are from average last spring to first fall freezes (32 F°).

Source: Utah Climate.

Table 3-2 PRECIPITATION AND EVAPOTRANSPIRATION		
Station	Annual Precipitation	Seasonal Evapotranspiration
	(inches)	
Beaver	11.7	28.4
Cedar City Airport	11.5	34.4
Enterprise-Beryl Junction	10.2	34.8
Milford	9.4	34.1
Parowan	13.1	35.0

Note: All precipitation values are 1961-90 normals.

Source: Utah Climate

In effect, the Cedar/Beaver Basin is made up of six groundwater reservoirs. These are the upper Beaver River, Milford area, lower Beaver River, Parowan Valley, Cedar Valley and the Beryl-Enterprise area. The lower Beaver River groundwater basin, which includes the area below Black Rock and Sulphurdale, is not discussed in detail as there are no data available.

The east boundary of the basin is formed by the Markagunt Plateau and the Tushar Mountains. From this high rim on the western boundary of the basin and Range-Colorado Plateau transition, there is a sharp drop to the valley floor, exposing some spectacular scenic views. Cedar Breaks National Monument is a colorful amphitheater eroded into the Claron (Wasatch) formation. To the north are the lofty, snow-capped Tushar Mountains. This is the highest point in the basin. From this high vantage point, one can look westerly over a broad panorama of distant ranks of mountain ranges, characteristic of the Basin and Range Province.

In direct contrast to the cool, forested topography on the east, the western desert areas swelter in the intense desert heat, dissipating any water they receive into the atmosphere. This topography produces an environment from conifer-aspen forests and cool mountain streams to scantily vegetated, dry desert lands.

General Geology - The Cedar/Beaver Basin lies at the eastern edge of the Basin and Range Province, characterized by small fault-block mountains interspersed among alluvial basins. Most of the Cedar/Beaver Basin is relatively low in elevation and arid. However, its eastern rim rises to 12,000 feet in the Tushar Mountain, and 11,000 feet in the Markagunt Plateau. The perennial streams draining westward from these high elevations provide most of the surface water in the basin, and most of the recharge to the groundwater basins.

The bedrock uplifts are composed of a variety of rock types. Hard and dense metamorphic, volcanic, and sedimentary rocks of all ages may or may not yield water to wells or springs depending upon their fracture permeability. Softer volcanic and sedimentary deposits of primarily Mesozoic and Tertiary age (M and Tv in Figure 3-4) generally have low permeability, but there are some exceptions. The rock formations in the Cedar/Beaver Basin have received little exploration, and as a rule "water is where you find it."

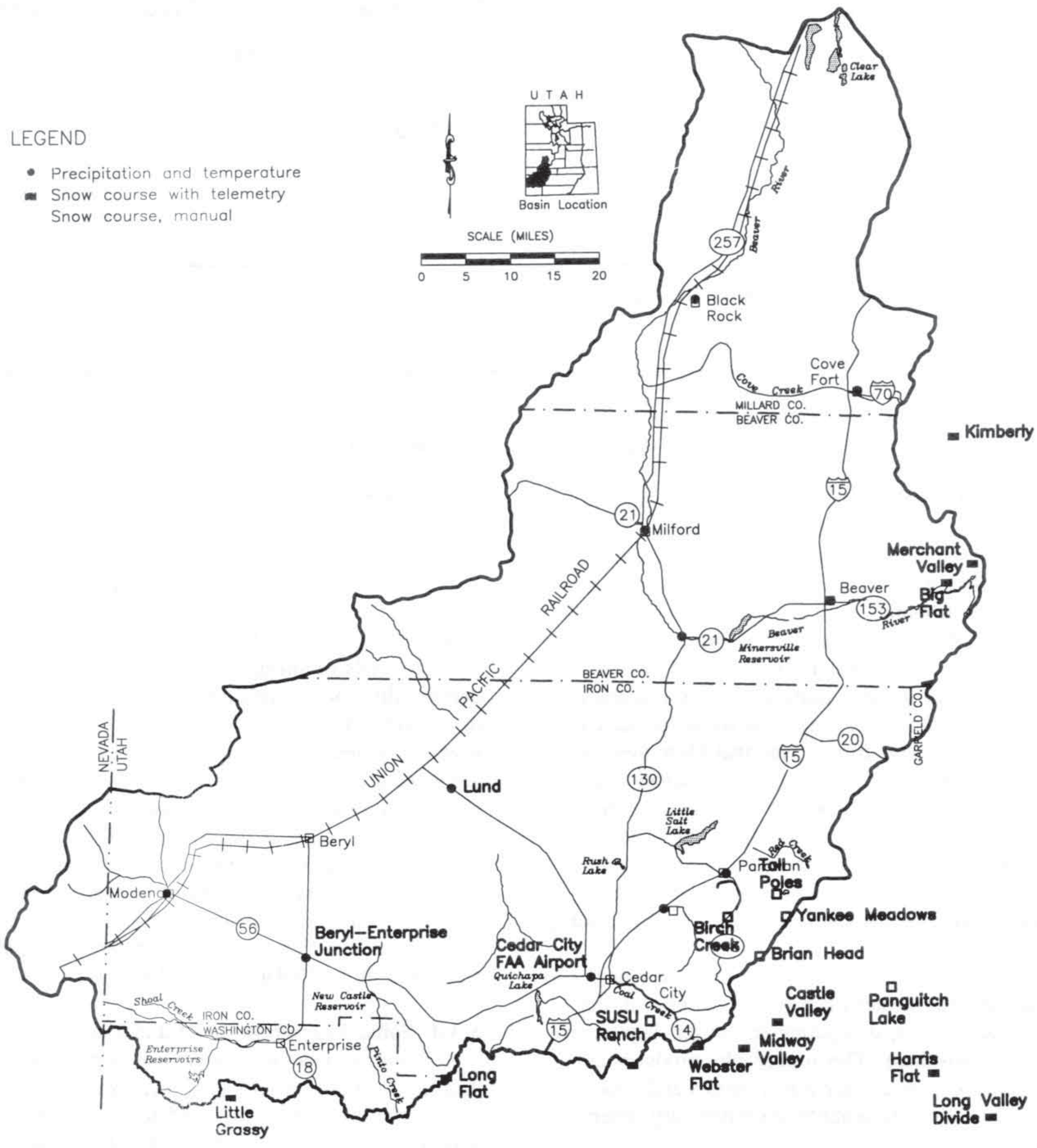
The alluvial basins (Qa and Ql in Figure 3-4) contain as much as 5,000 feet of unconsolidated gravel, sand, silt, clay, and interbedded lava flows. It is these alluvial basins which provide the primary groundwater reservoirs in the Cedar/Beaver Basin.

3.3.4 Soils, Vegetation and Land Use

Resource data on the soils and vegetation varies in detail, particularly across land ownership and administration boundaries. Land use data vary depending on the purpose for collecting the data and on the methodology used.

Soils - Interagency coordination has made these soil surveys exceptionally useful. See Figure 3-5 for survey orders and areas. Soil Survey information is

Figure 3-2
CLIMATOLOGICAL REPORTING STATIONS
Cedar/Beaver Basin



SOURCE: UTAH CLIMATE AND NATURAL RESOURCES CONSERVATION SERVICE.

Figure 3-3
ANNUAL PRECIPITATION
Cedar/Beaver Basin

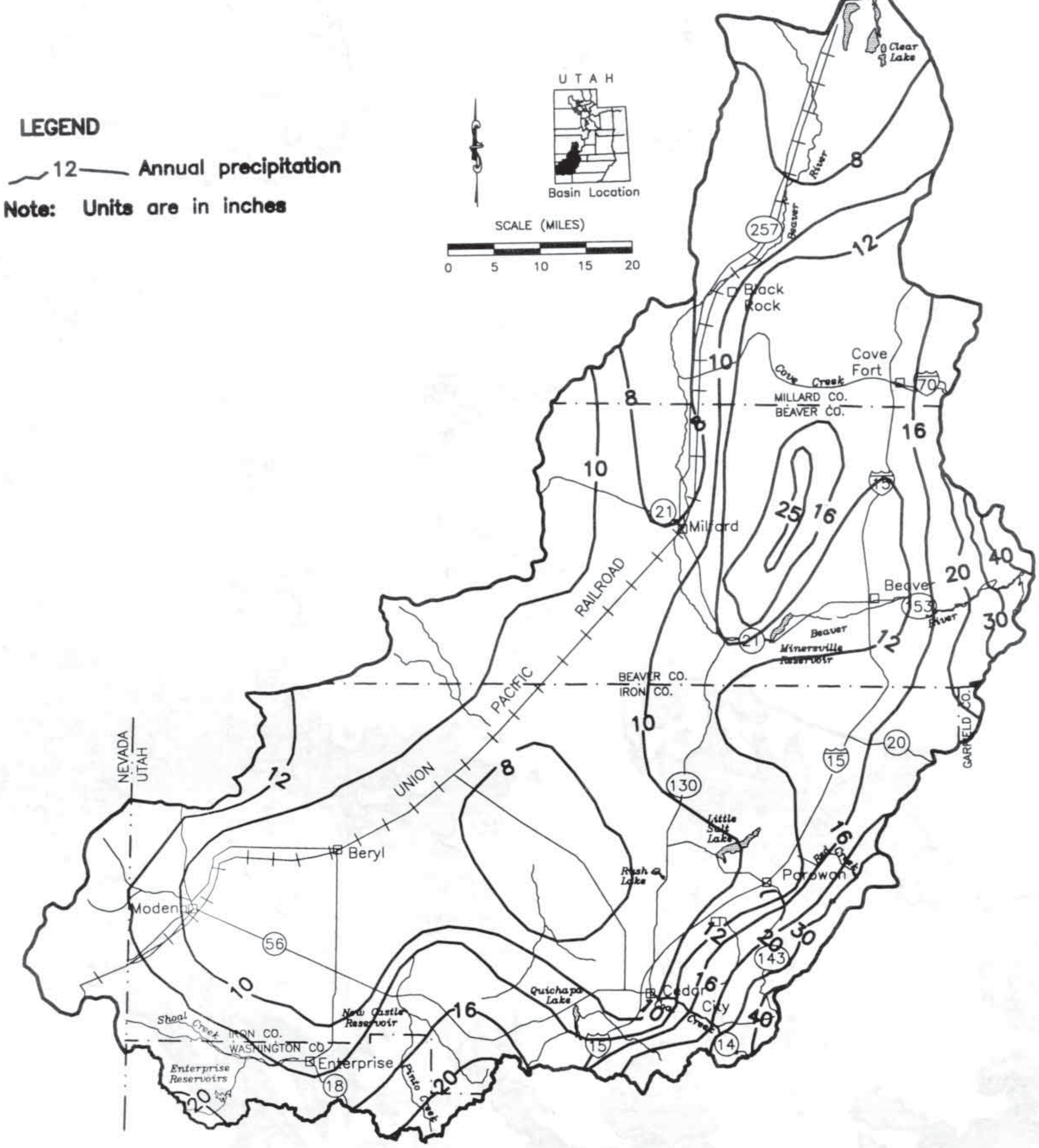


Figure 3-4
GENERAL GEOLOGY
Cedar/Beaver Basin

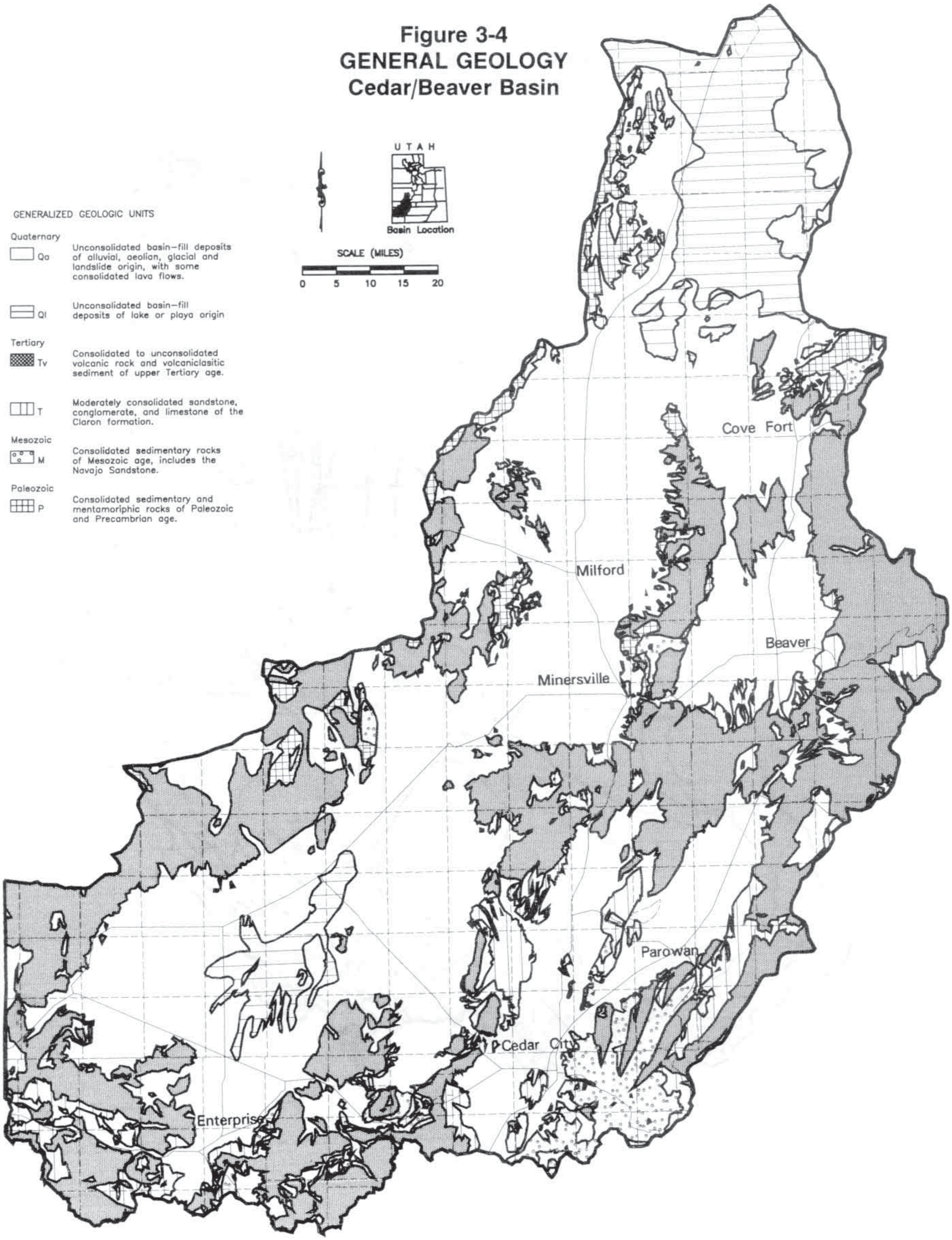
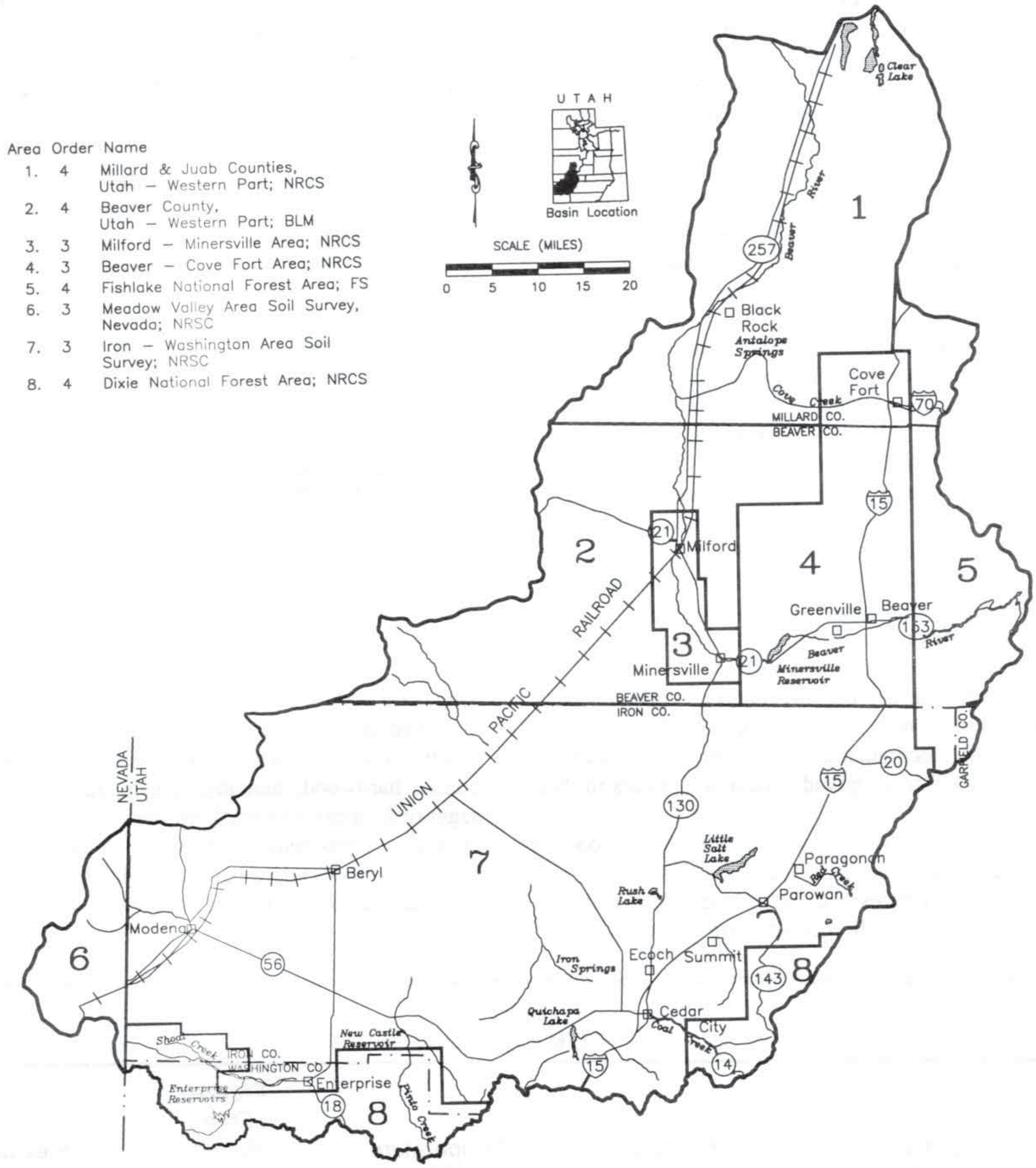


Figure 3-5
SOIL SURVEY AREAS
Cedar/Beaver Basin



SOURCE: NATURAL RESOURCES CONSERVATION SERVICE found in reports available from the Natural Resources Conservation Service, Forest Service and Bureau of Land Management. Soil surveys were conducted at different levels of detail to accommodate the land uses. In general, the information was collected at three levels: 2nd, 3rd and 4th order mapping described as follows.

The 2nd order surveys are made for intensive land uses requiring detailed information for making predictions of suitability for use and treatment needs. This type survey is conducted on all cropland areas.

The 3rd order surveys are made for land uses not requiring precise knowledge of small areas or detailed soil information. This type survey is conducted on all national forest lands and the majority of private and public rangelands.

The 4th order surveys are made for extensive land uses requiring general soil information for broad statements concerning land use potential and general land management. This type survey was conducted in western Beaver and Millard counties.

There are four climatic zones in the Cedar/Beaver Basin. The zones are summarized in Table 3-3. Generalized soils descriptions follow.

SEMIDESERT CLIMATIC ZONE soils generally have very little development and are usually found in alluvial deposits and lake sediments. These soils include the ochric and calcic horizon, a pH of more than 8.0 and very deep soil depths. The surface ochric horizons are light in color with little development. Calcic horizons show accumulations of calcium carbonates. The majority of the cropland production occurs in this zone.

UPLAND CLIMATIC ZONE soils have moderate development and are usually found on alluvial fans and hills. The soil features usually include mollic and argillic horizons. Mollic horizons are organically enriched surface layers showing dark colors. Usually this horizon is minimally expressed. The argillic horizon is expressed by textural clay accumulation in the subsoil, which helps contain water in the upper subsoil. These soils have a pH from about 7.5 to 8.0 due to the higher precipitation which leaches the calcium carbonate. The majority of this zone is used for rangeland with only a small amount of cropland.

MOUNTAIN CLIMATIC ZONE soils have high development and are usually found on mountain slopes. The soil features include mollic and argillic horizons. Mollic horizons are organically enriched surface layers displaying dark colors. The argillic horizon is expressed by textural clay accumulation in the subsoil, which helps contain water in the upper subsoil. These soils have a pH of about 7.0 to 8.0 due to the higher precipitation. The majority of this zone is used for rangeland with some timber production.

HIGH MOUNTAIN CLIMATIC ZONE soils have high development and are usually found on mountain slopes and in mountain valleys. The soil features include thick mollic and argillic horizons. Mollic horizons are organically enriched surface layers, well expressed with dark colors. The argillic horizon is expressed by textural clay accumulation in the subsoil which helps contain water in the upper subsoil. These soils have a pH of about 6.0 to 7.5 due to the higher precipitation. The majority of this zone is used for rangeland and timber production.

Vegetation - There are six vegetative types identified in the Cedar/Beaver Basin. These are conifer-hardwood, mountain brush, pinion-juniper, sagebrush, grass and northern desert shrub. These vegetative types roughly follow the higher elevations to the valley floors and areas with annual precipitation of 35 inches to lower areas of 8 inches.

Table 3-3
CLIMATIC ZONES

Climatic Zone	Precipitation (inches)	Temperature (°F)	Freeze Free Period (days)	Elevation (feet)
High Mountain	22-40	34-45	40-90	8,000-10,000
Mountain	16-22	42-50	70-170	6,000-8,200
Upland	12-16	45-59	120-170	4,500-6,900
Semidesert	8-12	52-59	120-190	4,500-6,300

The conifer-hardwood forest type lies above the 8,000-foot elevation. It consists mostly of white fir, Douglas fir, spruce and quaking aspen. The mountain brush type lies predominantly between 7,500 and 8,500 feet elevation. It consists mainly of gambel oak, serviceberry and curlleaf mountain mahogany. The pinion-juniper forest type is predominantly pinion, Utah juniper and singleleaf pinion. It occurs between 5,800 and 7,500 feet elevation. The sagebrush type ranges from the semidesert valley floors of 5,000 feet to mountain valleys and mountain slopes at about 8,000 feet. Soils dictate this vegetative type more than the elevation. The predominant vegetative community is big sagebrush, black sagebrush, low sagebrush, wheatgrasses, tall native bluegrasses and Indian ricegrass. The grass vegetative type is found in the semidesert zone at about 5,000 feet. This type occurs on sandy loams and sands. Important plants include Indian ricegrass, needleandthread, bottlebrush, squirreltail, galleta, along with winterfat. The northern desert shrubs include mainly black greasewood and shadscale. These plants occur in the bottomlands of the basin on soils affected by salts.

Cropland and barren areas are not included. The barren lands include desert playas, recent extrusions of volcanic basalt and areas covered predominantly with annual weeds. On the higher flanks of the Tushar Mountains, an area of rock was also included as barren. Table 3-4 shows the vegetative types and areas.

Land Use - The Natural Resources Conservation Service capability groupings show, in a general way, the suitability of the soil for most field crops. Soils are grouped according to their limitations and the way they respond to treatment.

Capability classes, the broadest group, run from one to eight. The numbers indicate progressively greater limitations and narrower choices for practical uses of agricultural cultivation. Other uses, such as for grazing or wildlife, may not be as restrictive. The lower numbers are the more choice lands suitable for growing irrigated crops. As the numbers increase, the land becomes more suitable for permanent pasture and progressively to grasslands, forested areas and rocklands. Most of the cropland is found in the first four classes.

Lands used for farming can also be defined according to their agricultural production ability and potential. There are two categories describing the better croplands: prime farmlands and farmland of statewide importance. Only about 3 percent of the basin area is used for irrigated agriculture while about 3 million acres are used primarily for grazing.

Table 3-4
VEGETATIVE TYPES

Vegetative Type	Beaver/ Milford	Cedar/ Parowan (Acres)	Escalante Desert	Total
Conifer-hardwood	77,400	62,100	2,200	141,700
Mountain-brush	92,500	68,800	47,100	208,400
Pinion-juniper	272,600	195,600	502,600	970,800
Sagebrush	443,600	190,600	438,800	1,073,000
Northern desert shrub	453,300	92,800	356,300	902,400
Grassland	57,200	31,100	61,600	149,900
Subtotal	1,396,600	641,000	1,408,600	3,446,200
Other land	57,100	53,900	48,300	159,300
Total	1,453,700	694,900	1,456,900	3,605,500

Note: Some other miscellaneous areas are not listed.

Table 3-5
LAND AREAS

SUB-BASIN	Beaver	Garfield	COUNTY Iron (Acres)	Millard	Washington	Total
Beaver	502,240	-0-	12,840	684,270	-0-	1,199,350
Milford	292,990	-0-	42,320	-0-	-0-	335,310
Parowan	10,580	7,220	315,480	-0-	-0-	333,280
Cedar	-0-	-0-	330,440	-0-	-0-	330,440
Escalante	168,590	-0-	1,096,750	-0-	153,050	1,418,390
Total	974,400	7,220	1,797,830	684,270	153,050	3,616,770

Forest resources found in many areas provide opportunities for commodity production in addition to the utilization of the grazing resource. There are six different forest types: fir/spruce, pine, aspen, gambeloak, mountain mahogany and pinion-juniper. The only intensive management of commercial timber stands are the fir/spruce, pine and aspen in the Beaver River drainage on the Tushar Mountains and in the Parowan Creek and Coal Creek drainages. It is not emphasized in other parts of the basin where there are some commercial stands of ponderosa pine and aspen along with minor amounts of fir and spruce. There is a commercial logging and processing operation located in Beaver. The logs harvested in a commercial operation near Cedar City are shipped to Panguitch for processing.

Pinion-juniper stands are the major forest type. Christmas trees are an important product, primarily in the Beaver area. There is some commercial harvesting of fire wood, fence posts and pinenuts. There has been some interest in harvesting sap from pinion and using juniper for fire starter, perfume and deodorizing bases.

3.3.5 Land Status

The total area of the Cedar/Beaver Basin is about 3.6 million acres. The areas by sub-basin are shown in Table 3-5. The federal government has the responsibility to administer about 66 percent of the lands in the basin. The state administers about 8 percent and 26 percent is privately owned lands. The Forest Service lands include 7,150 acres in the Ashdown Gorge Wilderness Area. There are also 3,670 acres of Indian lands included in the federal lands covering 0.1 percent of the basin. The breakdown of land ownership and administration is shown in Table 3-6.

The federally administered land is under the jurisdiction of three agencies; the Forest Service, Bureau of Land Management and the National Park Service. Table 3-7 shows the areas under each of these jurisdictions. ■ ■

Table 3-6
LAND OWNERSHIP AND ADMINISTRATION

STATUS	Beaver	Garfield	COUNTY Iron (Acres)	Millard	Washington	Total
Private	180,330	2,060	668,770	78,250	21,160	950,570
State	84,150	-0-	126,820	70,170	1,690	282,830
Federal	709,920	5,160	1,002,240[a]	535,850	130,200	2,383,370
Total	974,400	7,220	1,797,830	684,270	153,050	3,616,770

[a] Includes 7,150 acres of wilderness area.

Table 3-7
FEDERAL LAND ADMINISTRATION

AGENCY	COUNTY					
	Beaver	Garfield	Iron (Acres)	Millard	Washington	Total
Forest Service	136,600	580	135,150[a]	34,390	125,330	432,050
Bureau of Land Management	573,320	4,580	859,110	500,290	4,870	1,942,170
National Park Service	-0-	-0-	5,480	-0-	-0-	5,480
Indian Reservation	-0-	-0-	2,500	1,170	-0-	3,670
Total	709,920	5,160	1,002,240	535,850	130,200	2,383,370

[a] Includes 7,150 acres of Ashdown Gorge Wilderness Area

Section 4 Contents

Tables

Figures

Demographics and Economic Future

4.1 Introduction

Although the trade and government sectors each exceed agriculture in employment, the economy of the Cedar/Beaver Basin is characterized by agricultural commodity production, mostly beef, dairy and irrigated crops. Alfalfa, produced on 60 percent of the irrigated land, grass hay (11 percent), pasture (10 percent), grain (8 percent), and corn (2 percent) are grown mainly for livestock feed. Potatoes are produced on 3 percent of the irrigated land. Approximately 2 percent is in fallow. A major addition to agricultural production and income is taking shape. A large hog production and processing enterprise is located near Milford. Projections of population and employment presented here account for this potential change.

As growth occurs, proper planning at all levels of government will depend on reliable and consistent data. This section will present the data to help local leaders anticipate the need for timely water resources development. Combining these data with the latest technology for delivering, using and conserving available water should result in coordinated planning and manageable economic growth.

4.2 Demographics

For the 30-year projection period of 1990 to 2020, Beaver County's population is projected to grow at an average annual rate of 2.6 percent. This is higher than the expected growth of the state, which is 2 percent. The community of Beaver will experience the greatest growth as shown in Table 4-1 and Figure 4-1. Minersville shows a similar growth pattern from 1990 to 2020, while Milford is projected to experience a lower growth pattern. Current unincorporated areas will grow at a faster rate

Iron County's population will grow by 2.5 percent annually during the projection period. Figure 4-2 shows that

■ **The Cedar/Beaver Basin consists of stable farm and ranch enterprises and rural communities. Provo, the nearest major commercial center to the basin, is 150 miles from Beaver. Cedar City is the major commercial center in the basin.**

Southern Utah University - Cedar City

Cedar City will continue to lead the Iron County municipalities in absolute population growth. The current unincoporated area shows the strongest growth with an average of 3.7 percent per year for the projection period.

The Governor's Office of Planning and Budget has developed the procedures and criteria for making population projections. The Utah Process Economic and Demographic (UPED) model is part of this. This projection model takes into account many variables regarding the demographics and industrial mix of an area. This model incorporates historical employment growth rates into the future growth patterns. Assumptions regarding labor force participation rates, non-employment related migration rates, and constant age-specific fertility and survival rates are also incorporated. The transient population occupying the large number of seasonal hotel rooms at Brian Head are not counted.

Because of the dramatic growth, an Iron County Population Work Group is being formed to address new projections in the future. This is in conjunction with the Five County Association of Governments. Projections for Beaver County will also be addressed as the need arises.

Table 4-1
BASIN POPULATION AND PROJECTIONS

County/City	1970	1980	1990	2000	2010	2020
BEAVER						
Beaver	1,453	1,792	1,998	3,496	4,086	4,325
Milford	1,304	1,293	1,107	1,728	1,827	1,846
Minersville	448	552	608	1,060	1,236	1,319
Unincorporated	595	741	1,052	1,966	2,446	2,841
Subtotal	3,800	4,378	4,765	8,250	9,615	10,331
IRON						
Brian Head	NA	77	109	150	199	242
Cedar City	8,946	10,972	13,443	17,352	22,275	26,194
Enoch	120	1,669	1,947	2,900	3,633	4,177
Paragonah	275	310	307	382	460	513
Parowan	1,423	1,836	1,873	2,800	3,492	4,002
Unincorporated	1,209	2,230	2,882	4,233	6,249	8,520
Subtotal	11,973	17,094	20,561	27,817	36,308	43,648
WASHINGTON						
Enterprise	844	905	936	1,229	1,550	1,838
Unincorporated	104	77	223	343	562	759
Subtotal	948	982	1,159	1,572	2,112	2,597
Basin Total	16,721	22,454	26,485	37,639	48,035	56,576

4.3 Employment

In 1980, agriculture and government provided the most employment in Beaver County, totalling 43 percent or 700 jobs. In 1990, government and trade were the two largest sectors, accounting for 45 percent of the jobs in Beaver County. Government and trade led employment in 1980 in Iron County, combining for 50 percent or 3,400 jobs. In 1990 government and trade still accounted for 50 percent or 4,400 jobs. Future employment gains in the basin are expected to be most rapid in the trade and service sectors. Agricultural employment in Beaver County was 316 in 1990, but it is expected to increase to 807 due to the hog production operation. Mining lost 40 jobs in Beaver County in the last decade and is not expected to provide additional employment in the future. Iron County can be expected to experience a loss of mining employment. Other sectors are expected to show steady growth with the services sector leading the increase with an average of 3.5 percent per year.

Trade and service employment is projected to concentrate in Beaver and Cedar City. Government will lead the employment field in Beaver and Iron counties as shown in Table 4-2 and Figures 4-3 and 4-4. Agricultural employment in Beaver County will outpace all sectors during the 1990s, leveling out at just over 800 jobs. This will be primarily because of the hog production facility. Services is the third largest employment sector in Iron County with manufacturing, agriculture and construction showing the least in numbers employed and rate of growth.

4.4 Economic Future

Cedar City and Beaver will experience strong population growth through the planning period. Small towns will have slow but steady growth. Household size in Iron County is slowly decreasing and is expected be below 3.0 by 2005. In Beaver County, the average household size currently estimated at 3.0 is expected to slowly decrease to 2.76 at period's end. Cedar City in Iron County is expected to continue its aggressive strategy for recruiting new businesses, resulting in a growth of light industrial and commercial firms.

As with the state, the overall pattern in Iron County shows a significant shift away from dependence on traditional goods-producing economic activities. The trend is toward service-producing industries as the driving sectors in the private economy. Government employment, which includes personnel and faculty at Southern Utah University, will continue to be a significant force in the basin economy.

Circle Four Farms hog facility near Milford

The entrance of pork production and processing to the Milford area will strengthen agricultural employment and income significantly. As farmers expand their operations to meet the new demand, opportunities will be created for additional employment and use of area resources. ■ ■

Table 4-2
BASIN EMPLOYMENT PROJECTIONS

INDUSTRY	1980	1990	2000	2010	2020
BEAVER COUNTY					
Agriculture[a]	340	330	807	807	806
Mining	40	0	0	0	0
Construction	50	30	58	68	76
Manufacturing	30	82	114	131	146
TCPU[b]	130	149	170	181	189
Trade	280	370	621	756	862
FIRE[c]	30	35	65	76	82
Services[d]	120	141	363	444	512
Government	360	478	692	835	908
Non-Farm Proprietors[e]	240	125	233	289	323
Total Employment	1,620	1,740	3,123	3,587	3,904
Non-Agriculture W&S Employment[a]	1,050	1,285	2,087	2,495	2,778
IRON COUNTY					
Agriculture[a]	560	584	567	589	604
Mining	160	156	31	31	31
Construction	290	215	479	578	705
Manufacturing	450	723	952	1,093	1,275
TCPU[b]	410	412	355	440	540
Trade	1,510	2,065	2,799	3,600	4,362
FIRE[C]	300	209	294	375	439
Services[d]	640	1,509	2,413	3,303	4,233
Government	1,890	2,342	3,384	4,491	5,505
Non-Farm Proprietors[e]	600	553	761	1,016	1,227
Total Employment	6,810	8,768	12,035	15,516	18,921
Non-Agriculture W&S Employment[a]	5,660	7,687	10,784	14,009	17,205

[a]Agriculture and non-agriculture wage and salary employment includes specific agriculture support services.
[b]Transportation, communications and public utilities.
[c]Finance, insurance and real estate.
[d]Includes private household employment; excludes agricultural employment.
[e]Utah Department of Employment Security definition.

Figure 4-1
BEAVER COUNTY POPULATION AND PROJECTIONS

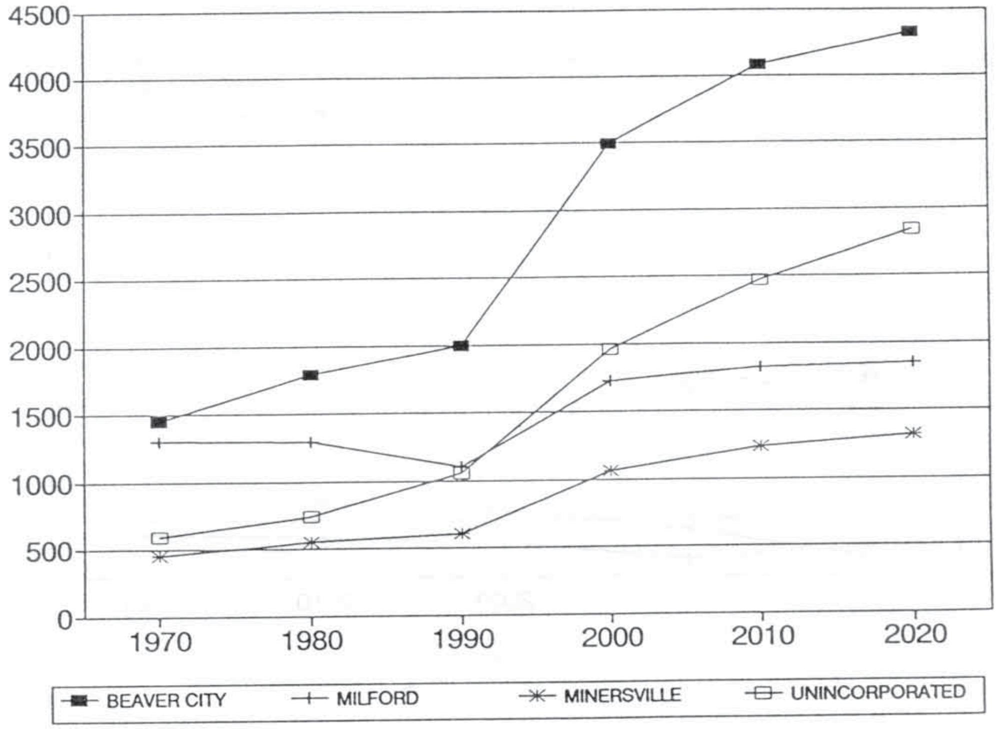


Figure 4-2
IRON COUNTY POPULATION AND PROJECTIONS

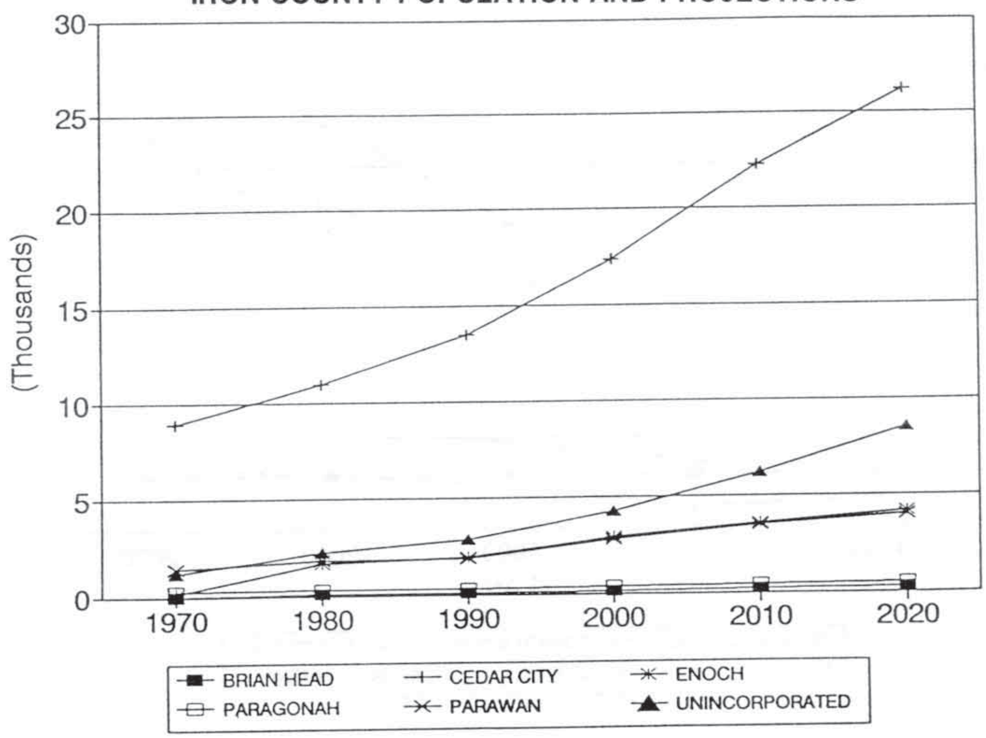


Figure 4-3
BEAVER COUNTY EMPLOYMENT PROJECTIONS

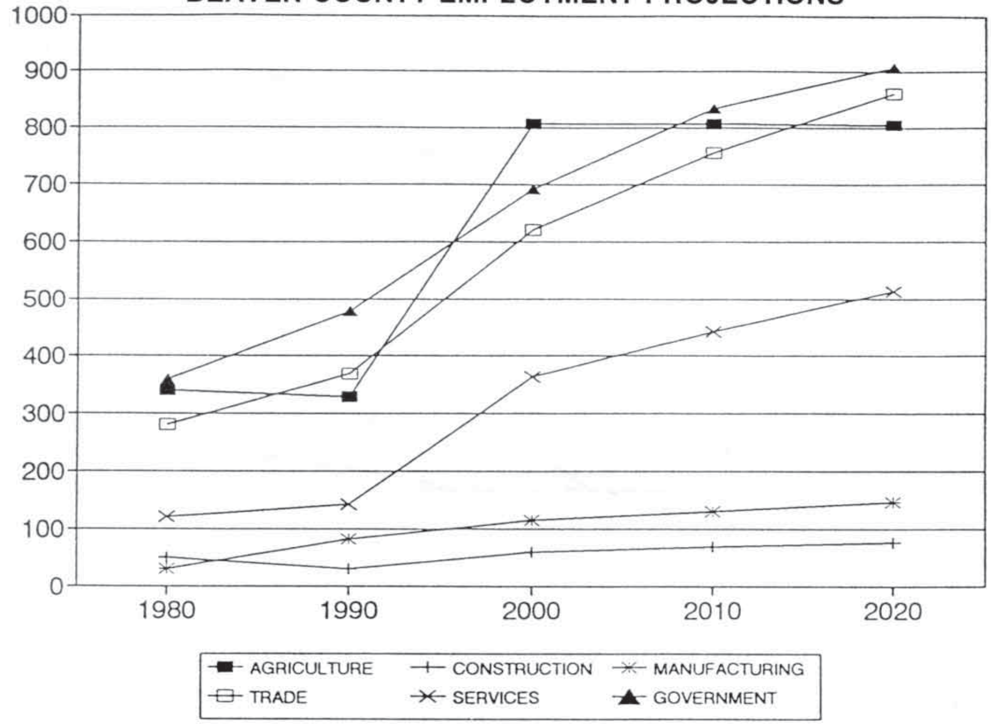
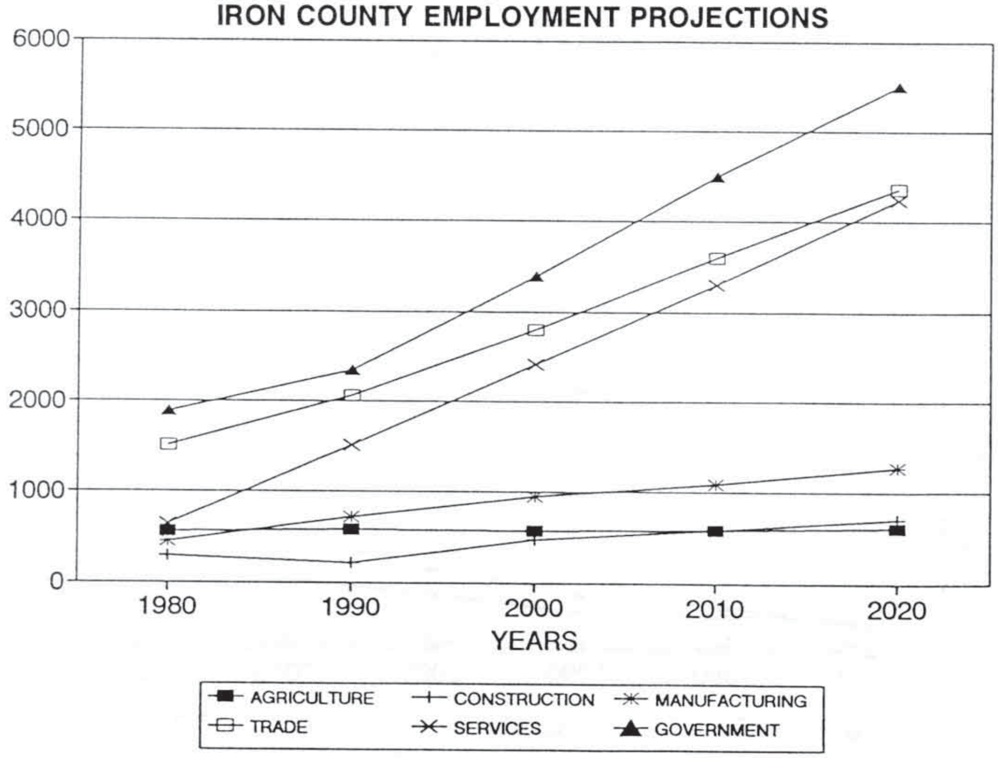


Figure 4-4
IRON COUNTY EMPLOYMENT PROJECTIONS



Section 5 Contents

Water Supply and Use

5.1 Introduction

This section discusses the present water supply and use from surface water tributary inflows as well as the groundwater reservoirs. There is a surface water transbasin diversion from the Santa Clara River into Pinto Creek. There is a natural groundwater inflow from the Sevier River drainage on the Markagunt Plateau into the Cedar City-Paragonah area.

5.2 Background

The base period for determining the surface water supply is water years 1941 through 1990. Some of the groundwater recharge and discharge data are discussed for different time periods. These will vary depending on the reports used. These reports were published by the U.S. Geological Survey, the Division of Water Resources or Division of Water Rights covering the various studies where this information was determined.

The Beaver River and its tributaries, with headwaters in the Tushar Mountains, produces the largest volume of water in the basin. Hydrologically, the surface water flows of the Beaver River system are separate from the balance of the Cedar/Beaver Basin. Parowan Creek and Coal Creek produce moderate amounts of water, primarily because their drainage areas are smaller. Pinto Creek and Shoal Creek are the principal sources of surface water along the southern boundaries of the basin.

Many normally dry drainages experience high volume-short duration flood flows produced by high intensity cloudburst storms. These can occur at any location within the basin and cause considerable damage in the more populated areas.

The primary use of water is for irrigation. When the first settlers arrived, diversion of water for irrigation was one of the first activities undertaken.

Culinary water supplies originally came from individual wells or nearby springs, although surface streams were often used. As populations grew, community systems were installed to pipe water from wells and springs.

5.3 Water Supply

The Cedar/Beaver Basin does not have an abundant water supply. The erratic nature of heavy winter snows can easily double the annual snowpack or cut it drastically during mild winters with a resulting increase or decrease in the surface water runoff. The groundwater supply is similarly affected over a delayed period of time.

There is a direct relationship between surface water and groundwater. Surface water inflow is the major supply for groundwater reservoirs. Other sources include canal seepage and precipitation. Any change in the surface

■ The water supply comes primarily from precipitation, mostly in the form of snow during the winter months and summer-fall thunderstorms. A small amount comes from a surface water transbasin diversion and from groundwater transbasin inflow.

water runoff that discharges into a groundwater basin area will result in a change in the volume of groundwater recharge. If the groundwater reservoir is full, there will be groundwater outflow. There are situations where only part of the surface water will percolate downward while some of the balance will flow over the groundwater reservoir area and on downstream. This is the case in the upper Beaver River area.

The water requirements of upper watershed vegetation is a fairly constant demand that must be satisfied before there is surface water runoff or infiltration to the groundwater network. Any water not consumed produces surface water runoff or contributes to groundwater. The groundwater becomes the supply to seeps and springs on downstream. Warm season precipitation helps supply upper watershed vegetation demand, thus helping to augment late season downstream flows.

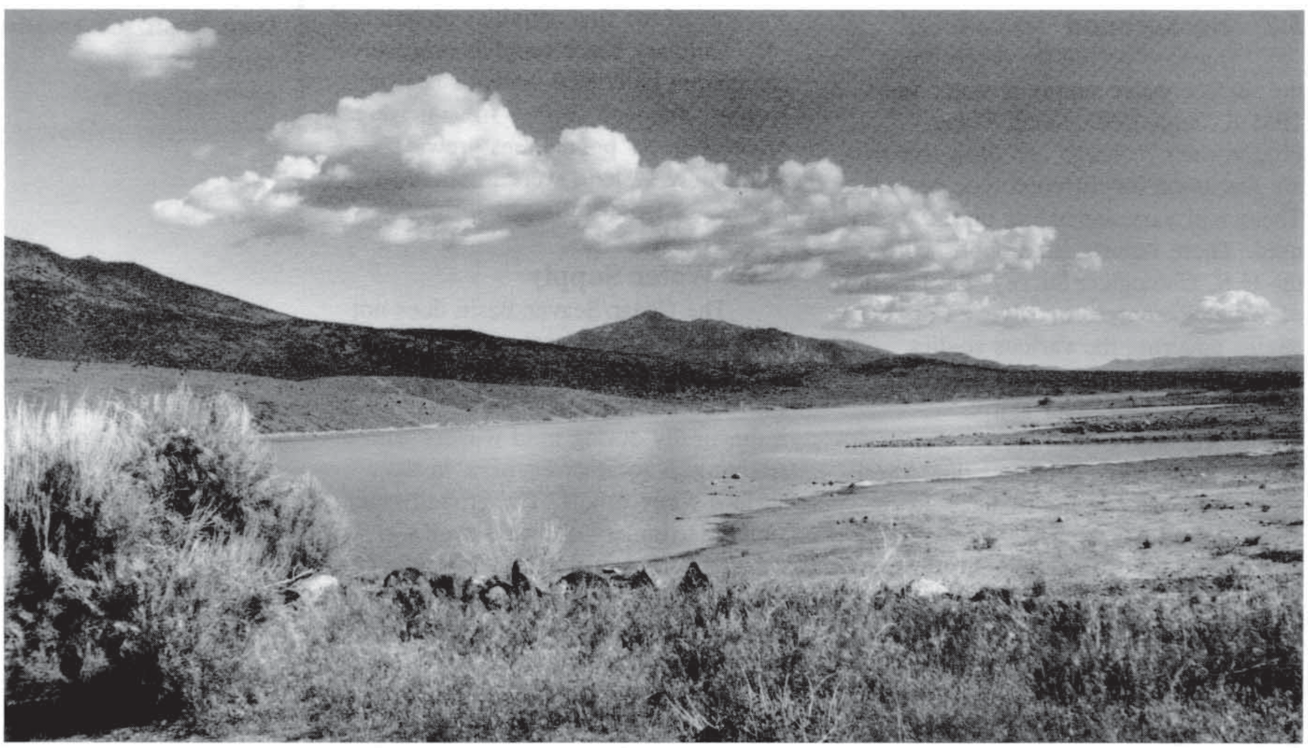
5.3.1 Surface Water supply

Most of the surface water runoff comes from snow-melt during the months of April, May and June although streams in the basin peak at different times depending on the watershed aspect, elevation and configuration. Where there are surface water storage reservoirs, some modification of the streamflow can be expected.

Part of the hydrologic drainage of the Cedar/Beaver Basin, 38,500 acres, is in Lincoln County, Nevada. A small part of this or about 2,180 acres, is in the Shoal Creek drainage. The balance of the area is in Gold Springs Wash, draining into the Modena area. There are no perennial streams in the Nevada portion of these drainages. The only water flowing into the downstream areas are snow-melt flows in the early spring and flood flows produced by summer thunderstorms or long duration rainstorms.

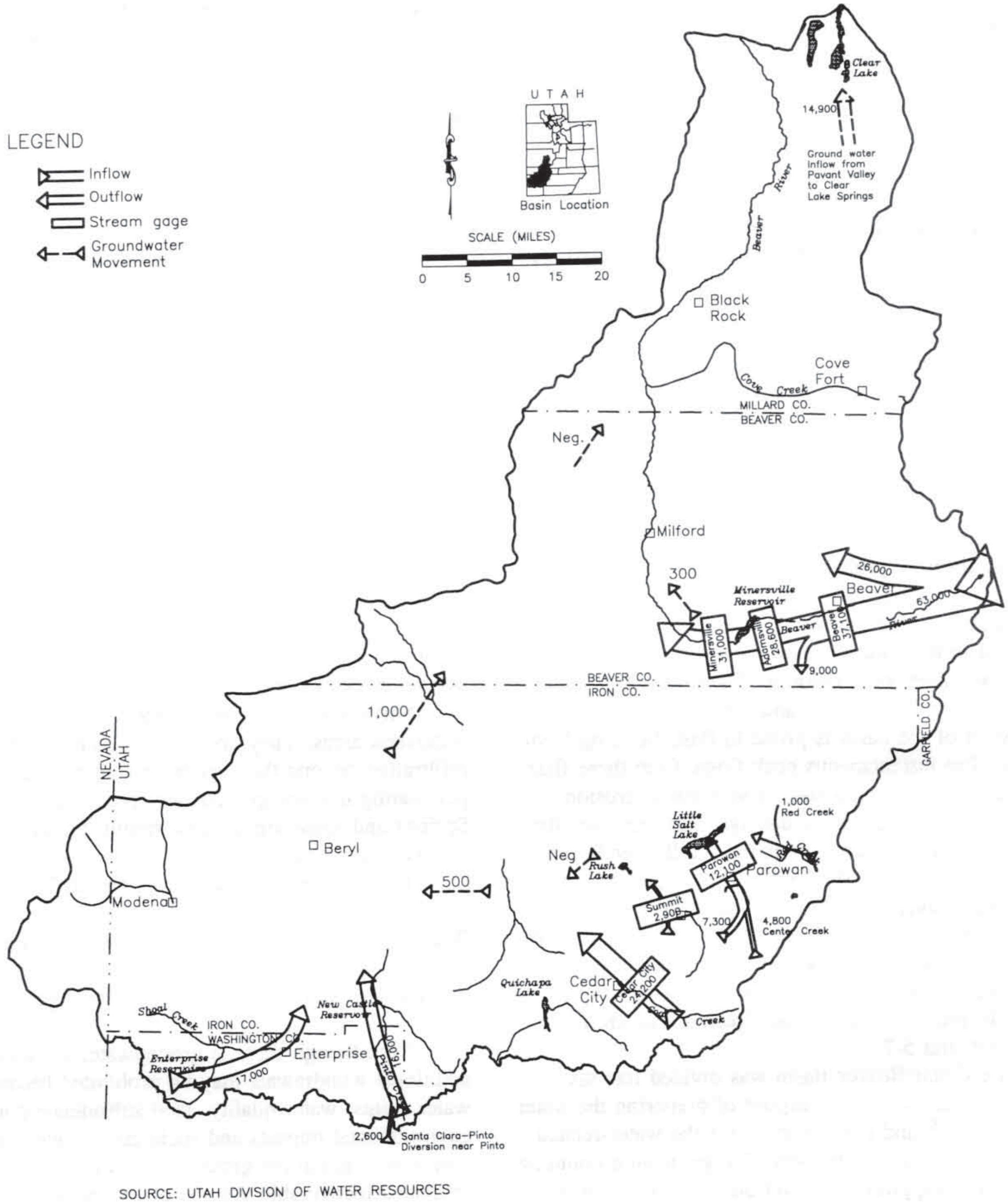
Figure 5-1 is a graphical representation of the average annual streamflows and stream depletions for the period 1941-1990 for the Cedar/Beaver Basin. The width of the arrows indicates the average annual flow volume. The volumes are derived or estimated from stream gage or other records by correlation. All of the stream gages are maintained and read by the U.S. Geological Survey.

The longest continuous stream gage record is on the Beaver River at Beaver. It is important because of the long uninterrupted record, from 1914 to the present time, and can be used to estimate and correlate other streamflow records where data is missing or non-existent. The record on Coal Creek runs from 1916 to



Minersville Reservoir

Figure 5-1
FLOW CHART
Cedar/Beaver Basin
1941-1990 Base Period (Acre-feet)



1919 and from 1936 to the present. All of the annual and monthly mean flows for gaged streams are given in Table 5-1. The annual flows for the Beaver River at Beaver and Rocky Ford Dam (Minersville Reservoir) are shown on Figures 5-2 and 5-3. The annual flow of Coal Creek near Cedar City is shown on Figure 5-4. The monthly mean flows for the Beaver River at Beaver and Coal Creek near Cedar City are shown on Figures 5-5 and 5-6.

As can be seen on Figure 5-2, the flow of the Beaver River at Beaver does not change much from using the long-term historical average or the 1941-1990 base period. The dampening effect of Minersville Reservoir is particularly noticeable with the wet extremes of the early 1920s and 1980s being the only exceptions. The variations in the annual flows between the Beaver River and Coal Creek reflect the differences in aspect, gradient and vegetation between the two watersheds. The extremes are greater in Coal Creek, indicating a steeper watershed with less vegetative cover to retard flows. Watersheds like the Beaver River with flatter drainages and denser vegetation allow the water to infiltrate into the soil mantle, percolating down to become groundwater.

The flows at the Beaver River and Coal Creek gages at different probability levels are shown in Table 5-2 and 5-3, respectively. A probability level of 90 percent means nine times in 10 the flows will be greater than the values shown. A level of 50 percent means near average conditions. These are shown graphically on Figures 5-7 and 5-8.

Most of the basin is prone to flash flooding from rainfall. The instantaneous peak flows from these flash floods can be very high and cause extreme erosion, sedimentation and property damage. For example, the highest peak flow ever recorded at the Beaver River gage at Beaver was 1,080 cubic feet per second (cfs) occurring on July 22, 1936. The peak flow recorded on Coal Creek was 4,620 cfs on July 23, 1969. The peak flows for the top ten years recorded at these two gages are shown in Tables 5-4 and 5-5. The flood frequencies for the Beaver River and Coal Creek are given in Tables 5-6 and 5-7.

The Cedar/Beaver Basin was divided into six subareas or units for the purpose of preparing the water budget report[22] and five subareas for the water-related land use inventory[17]. The water budget is an accounting of the water supplies, uses and outflows for a given subarea. The land use inventories cover the lower valley areas where agricultural croplands and most of the cities and towns are located. The water budget base period is 1961-1990, although in some cases a different period is used because of data availability.

Water budget area inflow was determined from gage records along with various published reports and records compiled by water users. Missing streamflow data were estimated by statistical correlation methods. Ungaged surface and subsurface inflow, was estimated by water budget procedures. Inflow includes surface water tributary inflow, groundwater tributary inflow and deep percolation from irrigation. This does not include groundwater movement between basins. The average annual inflow for the six water budget areas is shown in Table 5-8.

5.3.2 Groundwater Supply

There are five major groundwater reservoirs throughout the basin.[7,31,44,45,46,47] In addition, there is a smaller groundwater reservoir in the Sulfurdale area but lack of data prohibits a detailed discussion in this report. The groundwater reservoirs are shown in Figure 5-9. They are used to supply water for municipal and industrial, irrigation, stock and other minor miscellaneous uses. Groundwater reservoirs function in a way similar to surface water storage reservoirs. The volume of water in storage is determined by the recharge and discharge. When groundwater levels decline, well water levels drop and seep and spring discharges on the valley floors may be reduced. The opposite is also true when groundwater levels raise. If the groundwater discharge exceeds the recharge over several decades, then mining occurs.

Springs are more often found in the higher watershed areas. They are fed by precipitation infiltrating beyond the vegetation root zone and percolating into the groundwater recharge zones. Springs and seeps are a major supply for the base flows of creeks and streams.

The volume of groundwater physically recoverable from storage varies from 60 percent in the Beaver groundwater basin to less than 10 percent in Cedar Valley and Parowan Valley. The data given for groundwater storage should be used as a general guide only.

Even though there is groundwater in storage, any additional withdrawals may be prohibited because of water rights, water quality, land subsidence potential, environmental impacts and socio-economics. Utah's policy is to not allow groundwater mining. The estimated recoverable volume of groundwater in each of the reservoirs is shown in Table 19-1. These values were estimated by the U.S. Geological Survey from studies conducted during the 1970s.

Table 5-1
MEAN MONTHLY AND ANNUAL STREAMFLOWS
(Acre-feet)

Number	Description	Years	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
09408500	Santa Clara-Pinto Diversion near Pinto	1954-1990	32	59	12	6	16	151	824	1101	381	11	23	0	2616
10234000	Three Creeks near Beaver	1947-1961	304	250	221	189	168	206	438	1,241	1,921	1,133	614	343	6,697
10234500	Beaver River near Beaver	1914-1993	1,449	1,285	1,197	1,119	1,054	1,381	3,274	10,698	9,112	3,846	2,266	1,530	38,116
10236000	North Fork North Creek near Beaver	1965-1976	104	101	100	85	89	212	517	1,336	951	241	120	87	3,631
10236500	South Fork North Creek near Beaver	1965-1976	284	230	227	181	197	436	1,180	4,402	3,835	1,307	519	292	12,068
10237000	Beaver River at Adamsville	1914-1993	1,198	2,465	2,571	2,428	2,440	2,693	1,960	5,040	4,767	976	978	670	28,109
10237500	Indian Creek near Beaver	1947-1949, 1965-1976	145	122	117	105	102	166	585	1,730	841	500	253	149	3,803
10238000	Indian Creek near Adamsville	1914-1916	145	78	25	30	397	214	337	399	131	377	280	291	2,407
10239000	Beaver River at Rocky Ford Dam Near Minersville	1914-1993	766	620	695	748	686	989	1,748	6,056	6,410	5,058	3,993	2,071	29,736
10239500	Minersville Canal at Minersville	1951-1955	117	121	96	91	109	103	214	2,408	2,040	1,718	1,642	731	8,329
10240000	Beaver River at Minersville, Utah	1910-1955	546	1,326	1,686	2,166	1,388	1,716	1,116	2,794	2,499	930	735	476	14,473
10241000	Beaver River near Milford	1952-1955	0	0	7	24	218	438	57	1,108	1,103	28	24	19	3,026
10241400	Little Creek near Paragonah	1960-1981	49	46	48	51	56	97	198	354	240	119	72	48	1,316
10241430	Red Creek near Paragonah	1965-1975	71	69	70	64	58	81	153	292	148	91	80	66	1,048
10241470	Center Creek above Parowan Creek near Parowan	1965-1986	316	280	282	280	248	290	376	569	670	675	432	330	4,750
10241500	Center Creek near Parowan	1943-1950	732	599	600	577	541	639	1,068	2,142	1,822	1,490	1,121	787	12,117
10241600	Summit Creek near Summit	1965-1986	119	108	103	94	89	125	309	1,345	628	223	151	113	3,405
10241800	Ashdown Creek near Cedar City	1958-1961	332	325	244	253	271	492	1,325	2,063	976	363	387	316	7,346
10242000	Coal Creek near Cedar City	1916-1919, 1936-1993	754	664	613	596	645	1,094	3,579	9,290	4,096	1,397	1,074	836	24,637
10242430	Grassy Creek near Enterprise	1965-1968	0	13	103	11	47	43	79	4	1	0	0	0	299

Figure 5-2
ANNUAL FLOWS
Beaver River at Beaver

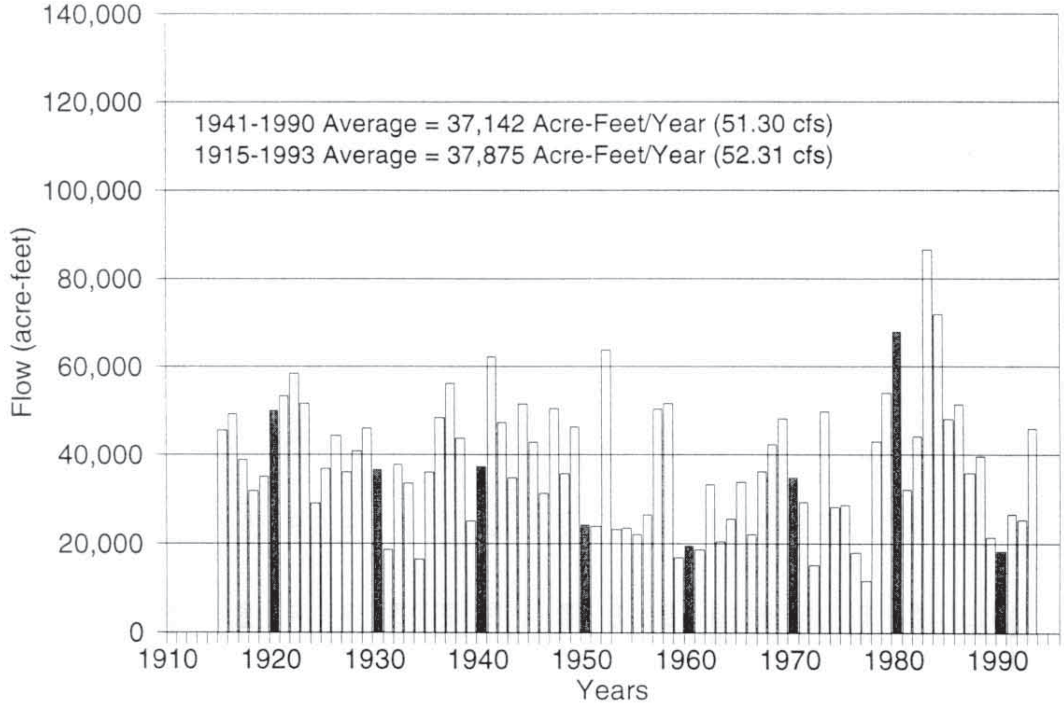


Figure 5-3
ANNUAL FLOWS
Beaver River at Rocky Ford Dam

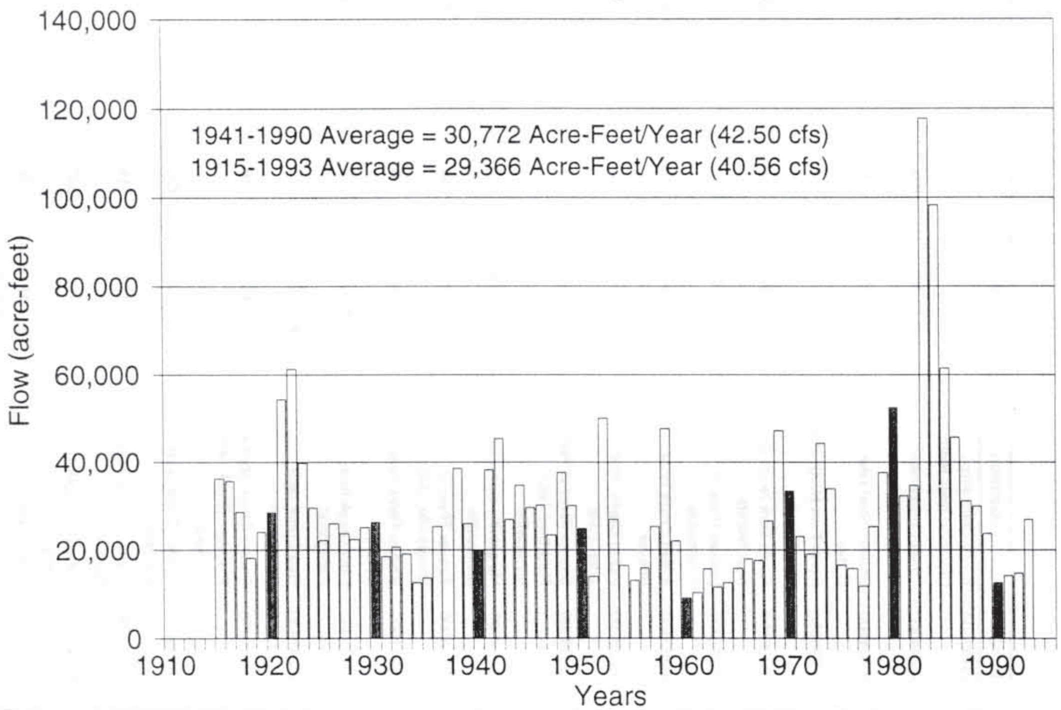


Figure 5-4
ANNUAL FLOWS
Coal Creek Near Cedar City

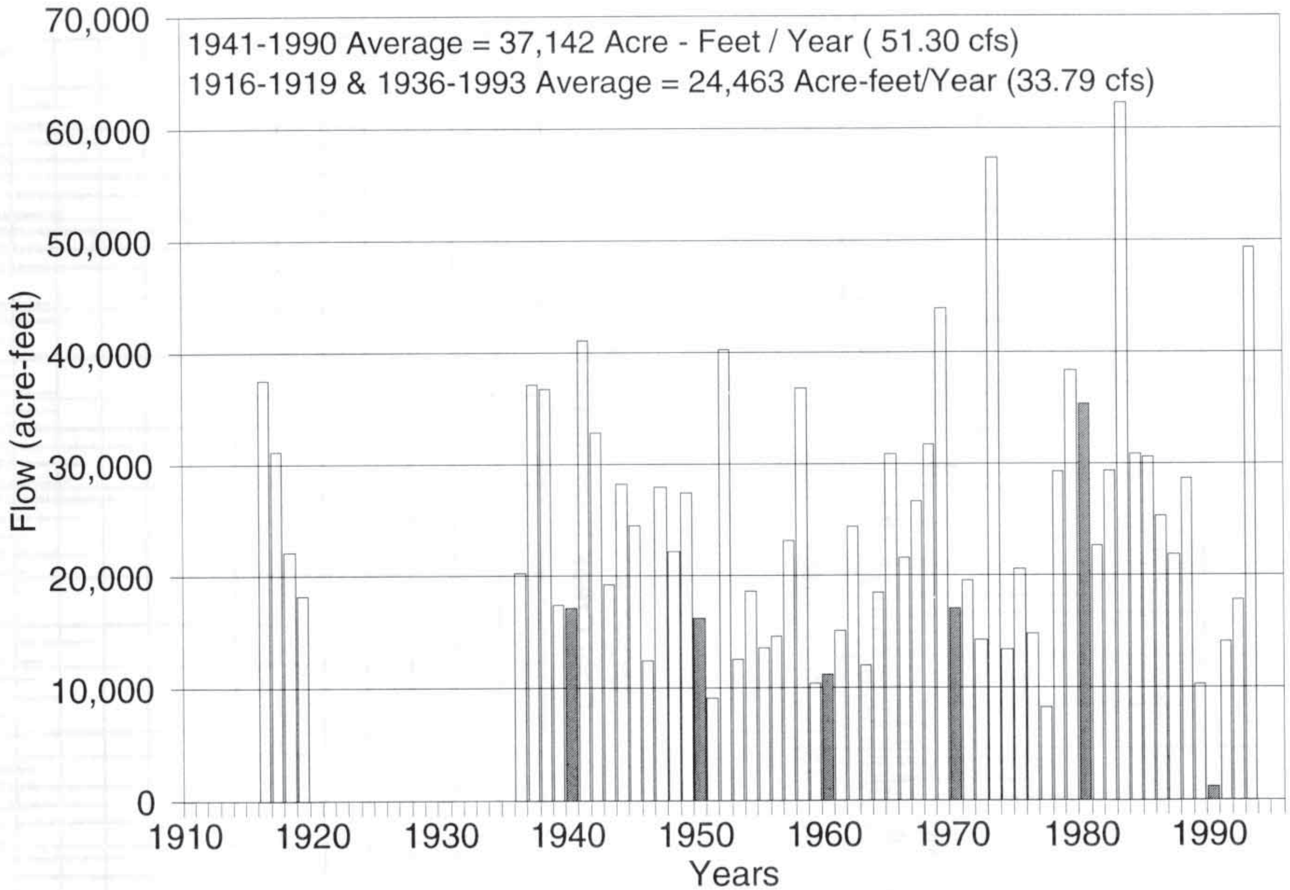


Figure 5-5
MONTHLY MEAN FLOWS
Beaver River at Beaver

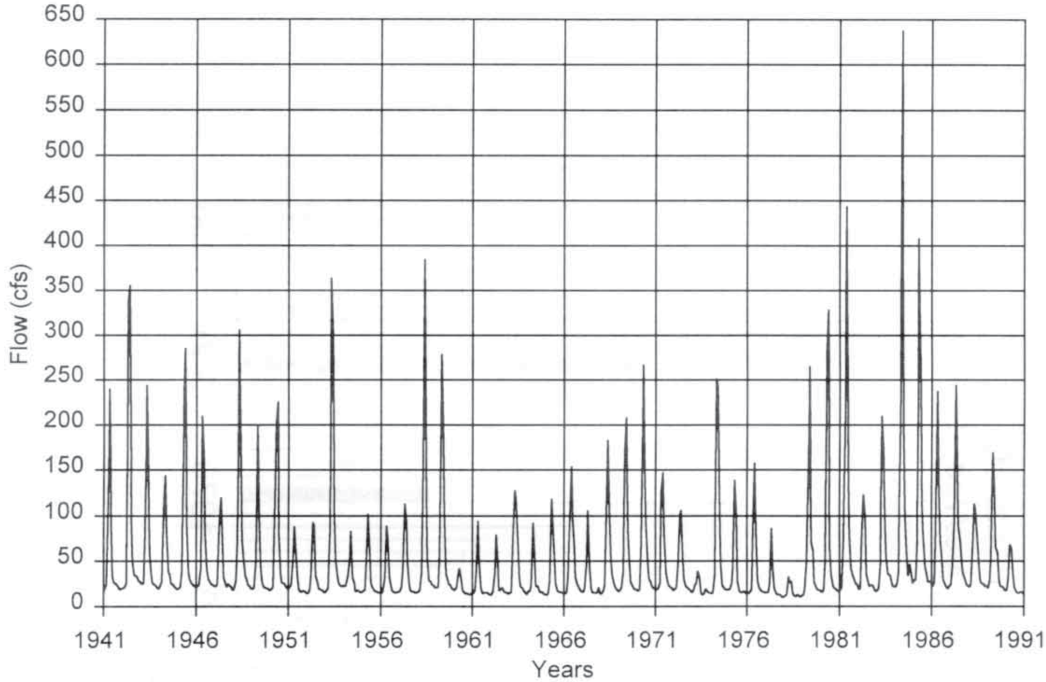


Figure 5-6
MONTHLY MEAN FLOWS
Coal Creek Near Cedar City

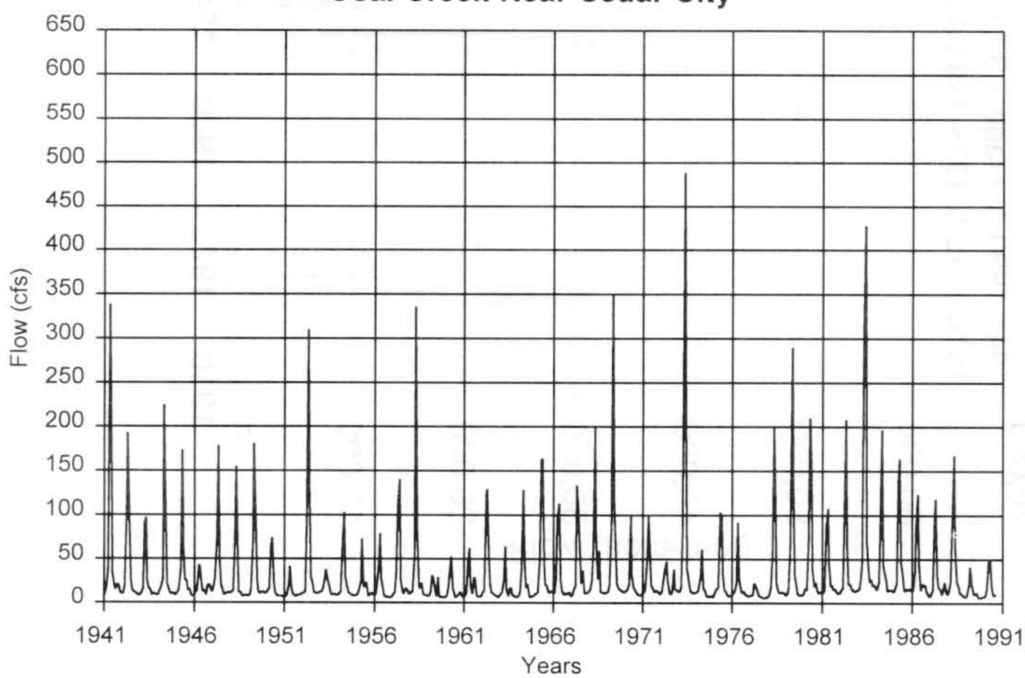


Figure 5-7
MONTHLY STREAMFLOW PROBABILITIES
Beaver River at Beaver

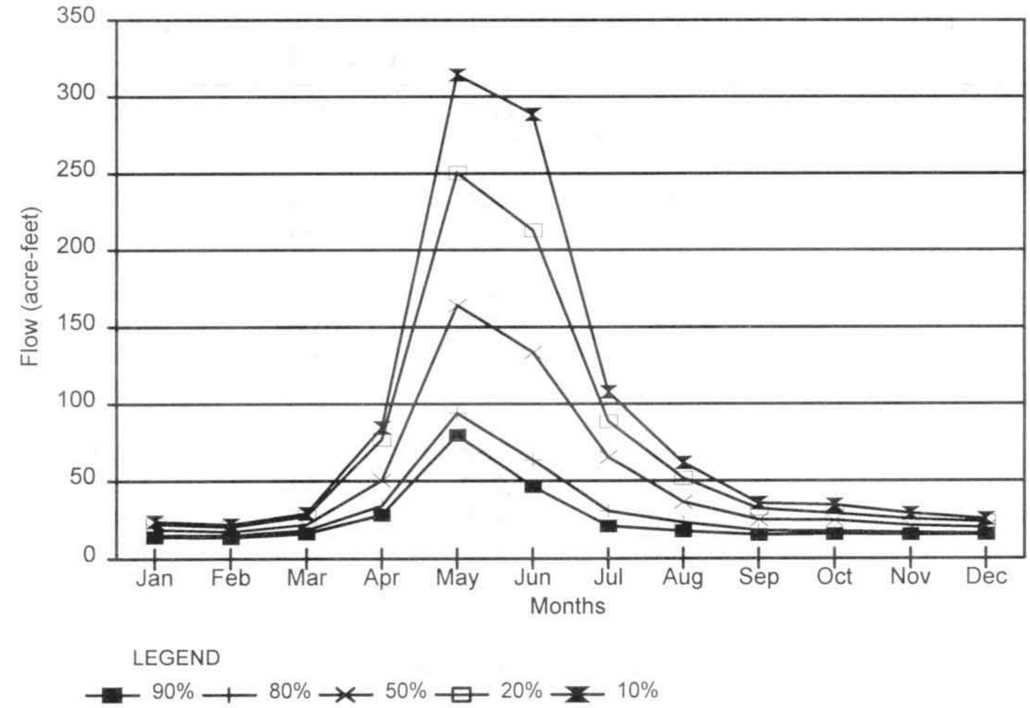


Figure 5-8
MONTHLY STREAMFLOW PROBABILITIES
Coal Creek Near Cedar City

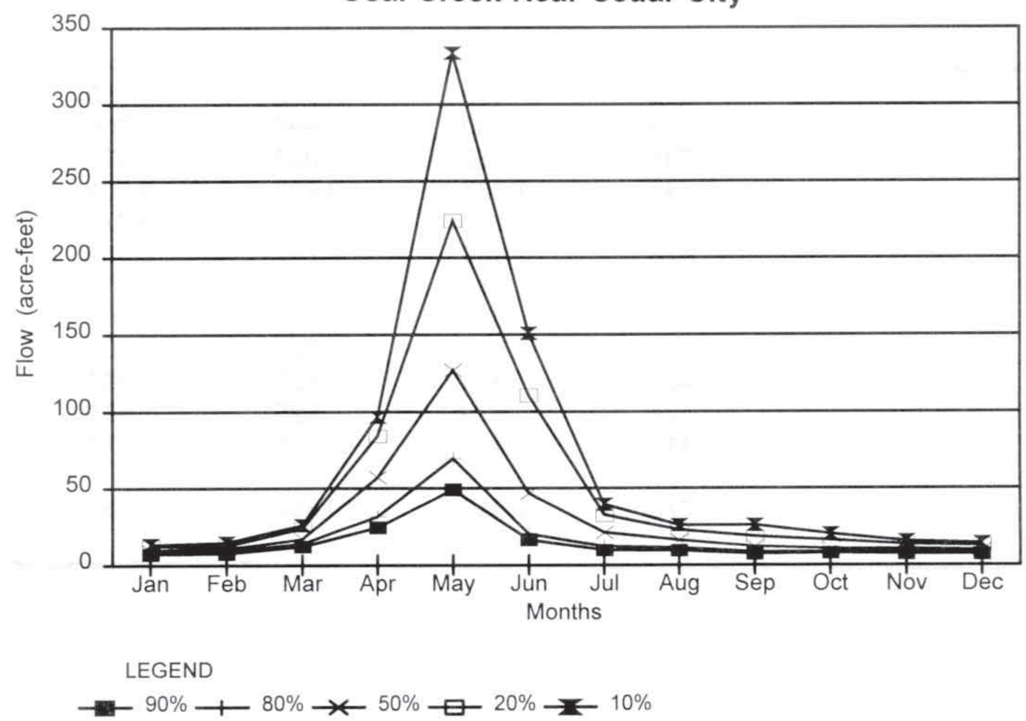


Table 5-2
MONTHLY STREAMFLOW PROBABILITIES OF OCCURRENCE, BEAVER RIVER AT BEAVER, 1915-1993

MONTH	90%	80% (Acre-feet)	50%	20%	10%
January	865	921	1,142	1,361	1,470
February	740	825	960	1,129	1,215
March	989	1,126	1,350	1,680	1,794
April	1,664	2,007	2,985	4,580	5,039
May	4,896	5,785	10,084	15,407	19,330
June	2,752	3,770	7,939	12,676	17.170
July	1,291	1,873	4,023	5,448	6,630
August	1,086	1,413	2,224	3,181	3,789
September	892	1,057	1.492	1,898	2,117
October	971	1,079	1,502	1,774	2,112
November	920	985	1,251	1,497	1,720
December	944	980	1.219	1,435	1,559
Annual	11,388	13,010	18,338	52,351	86,153

Table 5-3
MONTHLY STREAMFLOW PROBABILITIES OF OCCURRENCE, COAL CREEK NEAR CEDAR CITY, 1916-1919 AND 1936-1993

MONTH	90%	80% (Acre-feet)	50%	20%	10%
January	442	459	595	758	826
February	419	480	596	706	824
March	738	862	1,042	1,478	1,607
April	1,447	1,883	3,402	5,006	5,748
May	3,022	4,280	7,813	13,775	20,500
June	975	1,205	2,787	6,582	8,969
July	588	762	1,292	2,017	2,427
August	577	692	1,004	1,404	1,605
September	429	502	720	1,107	1,548
October	480	516	666	990	1,249
November	424	520	625	796	924
December	417	470	595	772	883
Annual	5,770	6,849	10,353	27,656	60,850

Table 5-4
TOP 10 PEAK FLOWS FOR THE BEAVER RIVER AT BEAVER, 1914-1993

Year	Date	Flow (cfs)
1936	July 22, 1936	1080
1984	May 24, 1984	1060
1983	June 19, 1983	940
1979	June 30, 1979	841
1922	May 25, 1922	785
1944	June 8, 1944	780
1920	May 30, 1920	760
1926	May 19, 1926	740
1957	June 6, 1957	732
1914	May 24, 1914	710

Note: Peak flows are the largest for highest 10 years.

Table 5-5
TOP 10 PEAK FLOWS FOR COAL CREEK NEAR CEDAR CITY, 1916-1919 AND 1936-1993

Year	Date	Flow (cfs)
1969	July 23, 1969	4620
1975	July 12, 1975	4440
1985	July 19, 1985	3840
1967	July 16, 1967	3340
1936	July 9, 1936	2910
1989	July 31, 1989	2500
1968	August 8, 1968	2440
1974	July 16, 1974	2400
1958	September 12, 1958	2360
1965	August 17, 1965	2340

Note: Peak flows are the largest for highest 10 years.

Table 5-6
FLOOD FREQUENCY FOR BEAVER RIVER NEAR BEAVER

Return Period	Probability[a]	Value (cfs)
2 Years	50	361.4
5 Years	20	611.9
10 Years	10	782.3
25 Years	4	994.3
50 Years	2	1,147.9
100 Years	1	1,296.6
200 Years	0.5	1,439.9
500 Years	0.2	1,623.5

[a] Computed by Log Pearson Type III Distribution

Table 5-7
FLOOD FREQUENCY FOR COAL CREEK NEAR CEDAR CITY

Return Period	Probability[a]	Value (cfs)
2 Years	50	760.2
5 Years	20	1,674.5
10 Years	10	2,483.6
25 Years	5	3,733.4
50 Years	2	4,822.1
100 Years	1	6,038.4
200 Years	0.5	7,395.1
500 Years	0.2	9,403.7

[a] Computer by Log Pearson Type III Distribution

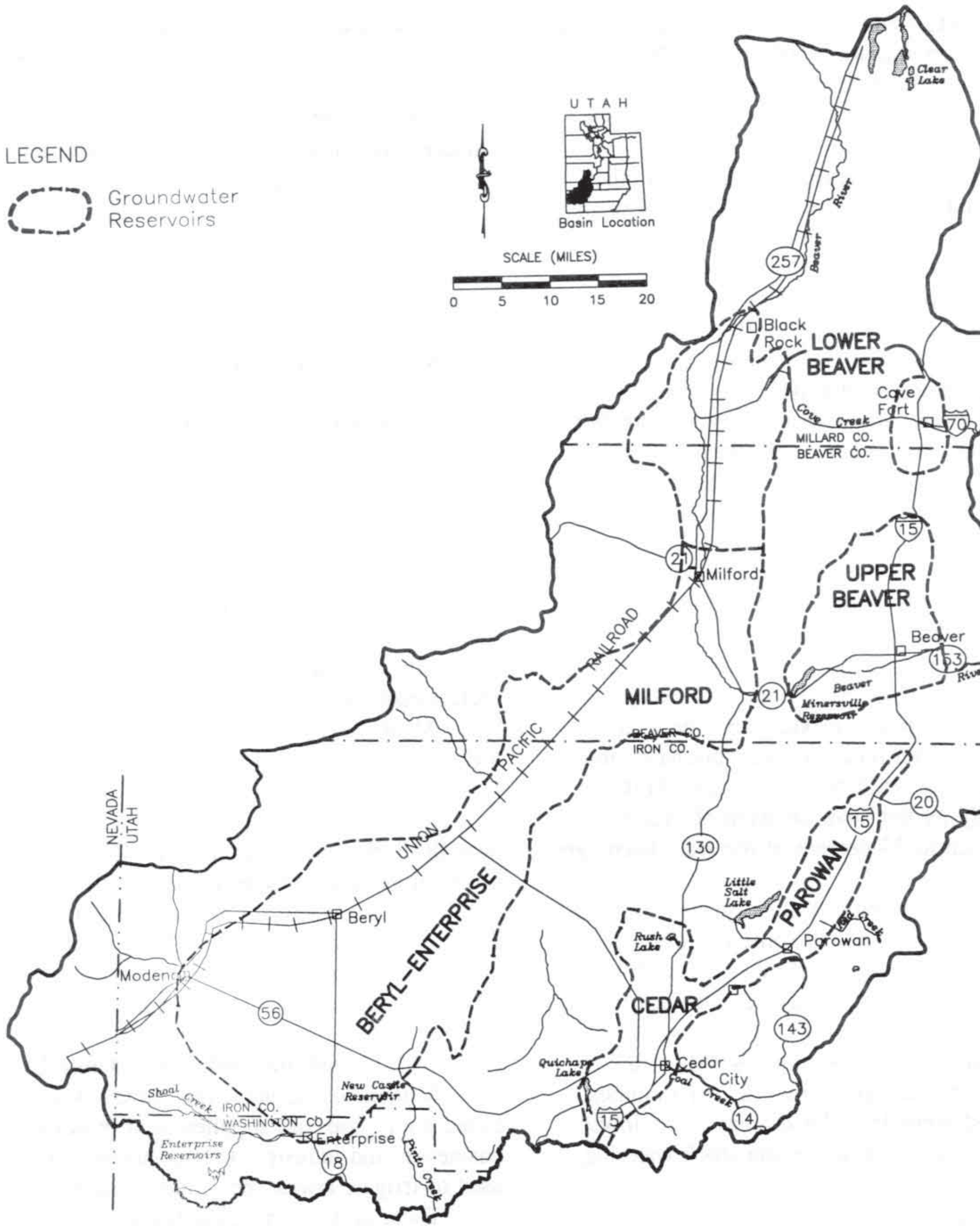
Table 5-8
WATER BUDGET AREA TRIBUTARY INFLOWS[22]

Water Budget Area	Inflow (Acre-feet)
Upper Beaver	57,400
Milford	1,970[a]
Parowan	37,510
Cedar	29,300
Beryl-Enterprise	32,490
Lower Beaver	1,930
TOTAL	160,600

Note: There is also a transbasin diversion from the Santa Clara River drainage into the Enterprise area of 2,616 acre-feet and groundwater inflow from Pavant Valley into Clear Lake of 14,900 acre-feet.

[a] Does not include the Beaver River inflow.

Figure 5-9
GROUNDWATER RESERVOIRS
Cedar/Beaver Basin



SOURCE: ADAPTED FORM TECHNICAL PUBLICATIONS, DIVISION OF WATER RIGHTS

When the level of the groundwater reservoir is high, water will move from one area to another with the volume of movement depending on the groundwater level. In the Cedar/Beaver Basin, groundwater movement estimated by the U.S. Geological Survey is as follows: Beaver area to Milford area (300 ac.-ft.); Parowan Valley into Cedar Valley (neg.); Cedar Valley into the Beryl-Enterprise area (500 ac.-ft.); Beryl-Enterprise area into the Milford area (1,000 ac.-ft.); and outflow from the Milford area (neg.). Also, see Figure 5-1.

Groundwater is discharged in three ways other than subsurface outflow. These are springs and seeps, evapotranspiration and wells. In most of the basin, the springs and seeps are a minor part of the discharge. However, in the upper Beaver Valley area, the discharge from springs and seeps is about 28,000 acre-feet of the total for the basin estimated at 29,250 acre-feet. The areas where phreatophytes use groundwater are extensive, but they are generally located outside the irrigated cropland areas. As a result, they do not always have a large effect on the water budget determinations. The evapotranspiration by phreatophytes is about 25 percent of the total groundwater discharge. The major withdrawals in the irrigated areas are from wells.

The average discharge from wells in each of the groundwater reservoirs for the period 1964-1993 is shown in Table 5-9. This includes all uses except geothermal water for power production. The U.S. Geological Survey determined the well discharge in the Beryl-Enterprise area could be as much as 100,000 acre-feet. A study by the Utah Division of Water Rights indicated up to 25 percent of the well discharges were not measured.

Most of the communities utilize springs for their culinary water supplies although some use wells. Enoch obtains all of its municipal and industrial water from wells located in Cedar Valley. Cedar City obtains about 2.5 million gallons per day, or 65 percent, from springs. The balance comes from wells. All of the springs used are in drainages above the communities. Some springs and seeps in isolated areas in the lower areas are used for domestic water and stock watering.

5.4 Water Use

The primary use for surface water and groundwater is for irrigation of cropland. The next largest use is for municipal and industrial needs, which includes culinary and industrial (including self-supplied) uses. These are followed by smaller water uses, including private domestic and livestock. The latter are generally small wells around ranches and in rangeland areas. A substantial amount of water is also consumptively used by phreatopytes and riparian vegetation. Power generation is an important although non-consumptive use.

5.4.1 Agricultural Water Use

Water for irrigation of croplands is diverted from every river and stream flowing into the valley areas. About 42 percent of the water diverted for irrigation is surface water and 58 percent is groundwater from wells.[22] Surface water is diverted from direct streamflows and from surface storage reservoirs. Groundwater comes from wells drilled throughout the irrigated area. Some wells are used only to supply supplemental irrigation water during the drier years for late season shortages.

Surface water storage reservoirs make it possible to store water during periods of high runoff so it can be used during periods of low streamflows. This also makes irrigation feasible on the higher areas of the valley floors where groundwater is generally not available or too costly to pump. Without these reservoirs, however, flows would continue to the lower valley areas and become recharge to groundwater. The existing surface water storage reservoirs are shown in Section 6, Table 6-1 and on Figure 6-1. Many of the reservoirs are also used for flood control and recreational purposes along with agricultural uses.

Most of the irrigated lands are in five major areas. These are the upper Beaver River area, Minersville-Milford area, Parowan area, Cedar Valley area and Beryl-Enterprise area. There are minor areas near Black Rock and Sulphurdale. The areas of land, diversions and depletions are shown in Table 5-10. Where records are available, volume of water diverted is obtained from the Division of Water Rights or from the irrigation companies. Irrigation companies are shown in Section 6, Management.

5.4.2 Municipal and Industrial Water Use

Municipal and industrial (M&I) water use, also called public use, are supplies used in homes, businesses and industry. It also includes culinary water used to irrigate lawns and gardens and for other outside uses. There is not a large industrial base in the basin requiring large quantities of water. As a result, population determines the demand for M&I water.

All of the culinary water used comes from groundwater, either springs or wells. In some cases, these are treated by chlorination to bring them up to

Table 5-9 GROUNDWATER DISCHARGE FROM WELLS[18]	
Groundwater Reservoirs	Discharge[a] (Acre-feet)
Upper Beaver	8,230
Milford	50,140
Parowan	25,430
Cedar Valley	28,390
Beryl-Enterprise	76,470
Lower Beaver	3,210[22]
TOTAL	191,870

[a] All uses, 30-year average.

standard. Refer to Section 11, Drinking Water, for more information.

The Division of Water Rights collects data under the Utah Water Use Program[26] in cooperation with the U.S. Geological Survey. Data are collected from public water suppliers and industries using self-supplied water.

There are eight hydroelectric power plants and two geothermal power plants in the basin.[32] A total of eight plants are now in operation. See Section 18 for more information.

The diversions and depletions for current culinary water use are summarized by county in Table 5-11. Depletions are calculated as a percentage of the water diverted which does not return to the river or stream system. This data shows the estimated total use, which includes the public community water supplies as well as use by small private and domestic systems.

5.4.3 Secondary Water Use

Water from secondary (dual) systems is used to irrigate lawns and gardens, parks, cemeteries and golf courses. These systems use untreated water and may be owned and operated by municipalities, irrigation companies, special service districts or other entities. Communities with secondary systems include Beaver, Paragonah, Parowan, Summit, New Castle and part of Cedar City. Other communities, special service districts and entities have installed secondary water systems to serve selected areas. Estimates of diversions and depletions for current secondary water use are summarized in Table 5-12.

5.4.4 Wetland and Riparian Water Use

Wetland and riparian areas include land and vegetation adjacent to rivers, streams, springs, bogs wet meadows, lakes and ponds. These areas account for about 1 percent of the total land area. Wetlands and riparian areas are important habitat for migrating waterfowl and raptors during the winter months. They are also important for year-long wildlife residents. The Clear Lake Waterfowl Management Area is very important for waterfowl in the Pacific Flyway. Other areas used for nesting and resting include Rush Lake, Quichapa Lake and Little Salt Lake during wetter years.

5.5 Interbasin Diversions

The interbasin diversion from the Santa Clara River (Grass Valley) in the Virgin River Basin into Pinto Creek (Stream gage 09408500) is the only one in the Cedar/Beaver Basin. This diversion has historically averaged about 2,600 acre-feet annually.

Groundwater inflow from the Sevier River Basin into the Cedar/Beaver Basin has been estimated at 2,000 acre-feet annually. This was determined during a study of the water and related-land resources of the Sevier River Basin during the 1960s.[63] The average flow of Clear Lake Springs is about 14,900 acre-feet annually. The source of most of this water is groundwater outflow from Pavant Valley in the Flowell area.

5.6 Water Quality

Streams in the Cedar/Beaver Basin originate in areas that are considerably different from each other in geology, land use, vegetation and altitude. This effects the quality of water flowing from a given area.

The quality of the groundwater reservoirs is impacted by the recharge water. This water comes from surface tributary inflow recharging the groundwater as it flows over alluvial fans and from groundwater tributary inflow. Groundwater is also supplied by losses from surface streams, canals and deep percolation from irrigation of croplands.

The quality of surface water and groundwater supplies varies throughout the basin. This affects the use and management of these water resources. Refer to Sections 12 and 19 for data on the water quality. ■ ■

Table 5-10
CURRENT IRRIGATION WATER USE[17,22]

Basin/County	Area[a] (Acres)	Diversions (Acre-feet)	Depletions[b] (Acre-feet)
Upper Beaver	16,590	38,730	20,670
Lower Beaver	1,070	2,910	1,350
Minersville-Milford	21,450	83,840	36,350
Total-Beaver County	39,110	125,480	58,370
Lower Beaver	380	1,030	460
Total-Millard County	380	1,030	460
Parowan Valley	19,060	37,790	32,640
Cedar Valley	17,000	44,030	22,550
Beryl	32,680	102,380	59,990
Total-Iron County	68,740	184,200	115,180
Enterprise	2,580	8,080	4,730
Total-Washington County	2,580	8,080	4,730
BASIN TOTAL	110,810	318,790	178,740

[a] Acreages include fallow and idle overgrown areas.
[b] Depletions do not include precipitation.

Table 5-11
CURRENT CULINARY WATER USE[19]

County	Diversions (Acre-feet)	Depletions (Acre-feet)
Beaver	1,580	820
Iron	6,360	3,310
Washington	670	350
TOTAL	8,610	4,480

Note: Data is based on 1992 values.

Table 5-12
CURRENT SECONDARY WATER USE[19]

County	Diversions (Acre-feet)	Depletions (Acre-feet)
Beaver	1,350	810
Iron	1,980	1,190
Washington	-0-	-0-
TOTAL	3,330	2,000

Note: Data is based on 1992 values.

Section 6 Contents

Management

6.1 Introduction

The demand for water is moving from agricultural to municipal and industrial uses, particularly in Cedar Valley. Although irrigated crop production is a major industry in the basin, increasing requirements for culinary water may result in conflicts over use of the existing supplies. Along with this comes the need for innovative management. This section describes present water management and discusses potential management alternatives.

6.2 Setting

With the settlement of Parowan in 1851, the first water was diverted from Center Creek to irrigate crops. Water was diverted from Coal Creek a year later for the same purpose. As the number of settlements increased, usually at the mouth of a canyon or near a stream, water continued to be developed, primarily for culinary and agricultural uses. Some areas were founded because of other activities, such as Milford which was developed because of mining and the coming of the railroad near the turn of the century.

It soon became evident more permanent water control structures were needed to withstand the effects of floods on the various water systems. As a result, more efficient facilities were installed to divert and convey water and to utilize it better. Modern pipelines are now used to convey water from wells and springs to the place of use on agricultural lands and in communities and individual homes. There has been a vast improvement from agricultural practices in the early days of settlement. The modern delivery of culinary water is a far cry from carrying or hauling it in buckets or barrels from streams and ditches to the individual homes.

Surface water storage reservoirs have been constructed on most of the rivers and streams. They have become an important part of the management of water delivery systems throughout the basin. Related benefits include flood control, water-based recreation and improved fisheries. Some of the lakes are not used for storage, but they are shown for information only. The existing lakes and surface water storage reservoirs are described in Table 6-1 and shown on Figure 6-1.

All water supplies are delivered and distributed according to state law by various entities who have the rights to use and distribute this resource. This includes not only the quantity of water by appropriated right but also there is increasing pressure to regulate the quality of water distributed. Quality is

■ Water is the most valuable natural resource. For this reason, its management is a primary concern of local water users. This becomes even more important since water is often in short supply.

Beaver County Courthouse

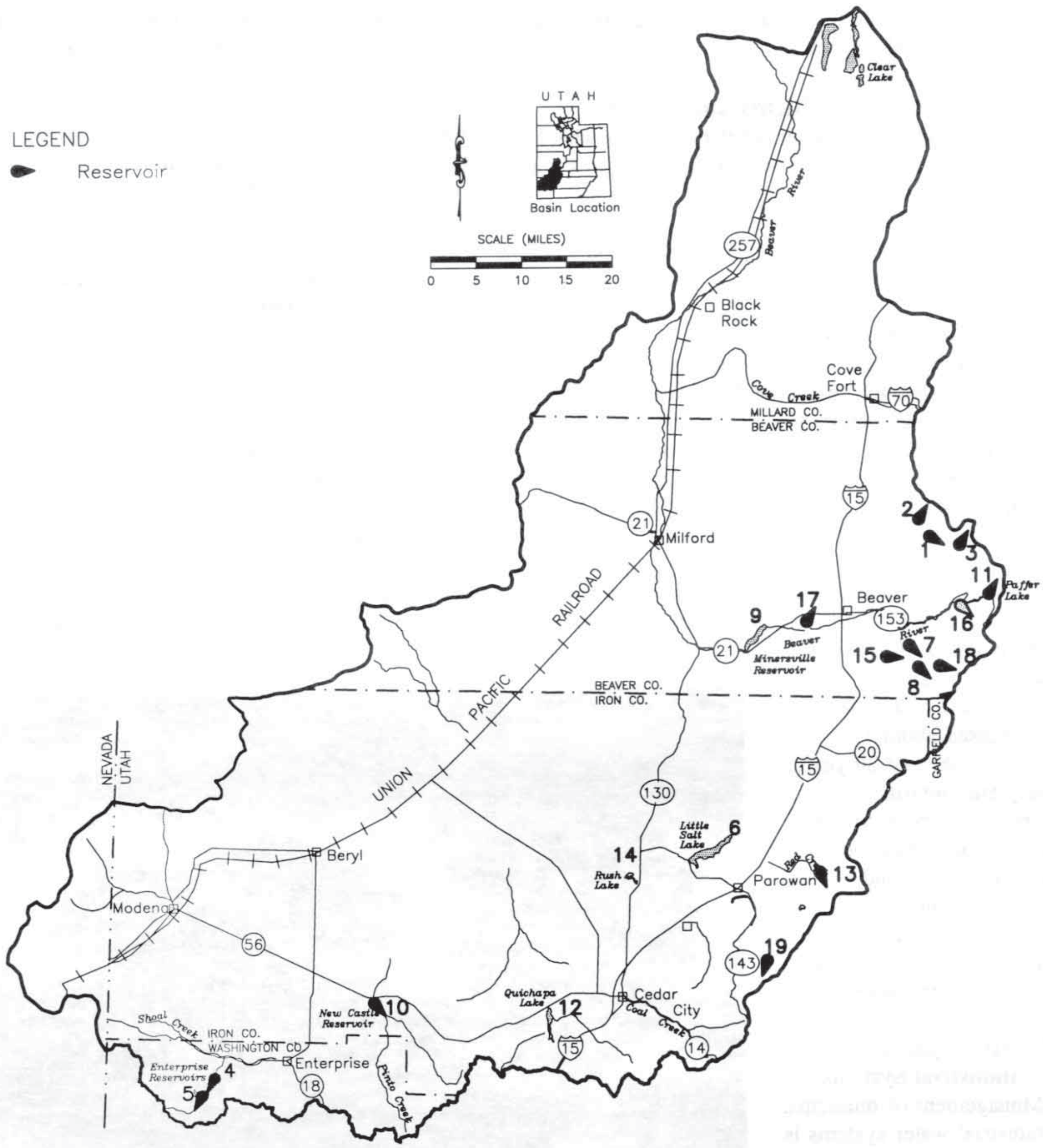
Table 6-1
EXISTING LAKES AND WATER STORAGE RESERVOIRS[62]

Name	Stream	Location T	R	S	Capacity (Acre-feet)	Surface Area (Acres)	Purpose[a]
1 Beaver Dam, #1[b]	Indian Creek	27S	6W	36	350	25	I
2 Beaver Dam, #2[c]	Indian Creek	27S	6W	250	110	9	I [e]
3 Blue Lake	So.Fk. of N.Cr.of Beaver R.	28S	5W	4	370	20	I
4 Enterprise Lower #1	Little Pine Creek	37S	18W	34	2,672	75	I, F, FC
5 Enterprise Upper #2	Little Pine Creek	37S	18W	34	9,950	335	I, F,MI,FC
6 Little Salt Lake	Parowan, Red, Summit, etc.	33S	9W	29	Varies		Itm
7 Lower Kent's Lake	South Fork of Beaver River	29S	5W	21	180	15	
8 Middle Kent's Lake	South Fork of Beaver River	30S	5W	6	975	40	I
9 Minersville [d]	Beaver River	30S	9W	11	21,000	1,177	I, FC
10 Newcastle	Pinto Creek	36S	15W	22	5,290	100	I, FC
11 Puffer Lake	Stream	29S	5W	1	897	75	F[f]
12 Quichapa	Coal Cr, Duncan Cr., etc.	36S	12W	28	Varies		Itm
13 Red Creek	Red Creek	34S	7W	7	1,360	50	I, FC
14 Rush Lake	Braffits Creek, etc.	34S	11W	12	Varies	Varies	Itm
15 South Creek	South Creek	30S	7W	1	300	15	I
16 Three Creeks	Three Creeks, Beaver River	29S	5W	9	2,069	60	I, P, FC
17 Tipperary	North Creek	29S	8W	26	125	30	I
18 Upper Kent's Lake	South Fork of Beaver River	30S	5W	5	155	30	I
19 Yankee Meadows	Bowery Creek	35S	8W	20	1,200	60	F,P, I

[a] Purpose: F- Fishing; FC- Flood Control; I- Irrigation; MI- Municipal and Industrial; P- Power; Itm - Intermittent.

[b] aka, Manderfield; [c] aka, Upper Beaver Dam; [d] aka, Rocky Ford; [e] Breached, 1994; [f] Dam washed out

Figure 6-1
EXISTING LAKES AND RESERVOIRS
Cedar/Beaver Basin



SOURCE: USDA WATER AND RELATED LAND RESOURCES SUMMARY REPORT, BEAVER RIVER BASIN & STATE ENGINEERS OFFICE.

particularly important where water is used for culinary purposes.

6.3 Policy Issues and Recommendations

There are no policy issues discussed in this section. Refer to Section 7 for a discussion on the issue of "Groundwater Management."

6.4 Management Problems and Needs

There are irrigation water delivery systems where improved management would deliver more of the water to the place of use. Alternate sources of supply may be advisable in some cases. See Section 10 for additional discussion of irrigation water systems and Section 11 concerning drinking water.

6.4.1 Irrigation Systems

The lack of storage and high sediment yields, both watershed and channel, make the distribution and use of water from Coal Creek difficult. See Section 10.5 for more information. Storage would provide better timing of water availability from Little Creek, Meadow Creek and East Fork of Pinto Creek. See Section 9, Table 9-5 and Figure 9-1 for data on potential storage reservoirs.

Even though most of the irrigation systems have relatively high delivery efficiencies, there is still room for improvement. It is estimated the basin conveyance efficiency has been increased about 15 percent over the last 20 years. Delivery and onfarm efficiencies can be improved through proper irrigation water management and installation of sprinklers, gated pipe, canal lining, pipelines or land leveling. Table 6-2 lists the irrigation companies.

6.4.2 Municipal and Industrial Systems

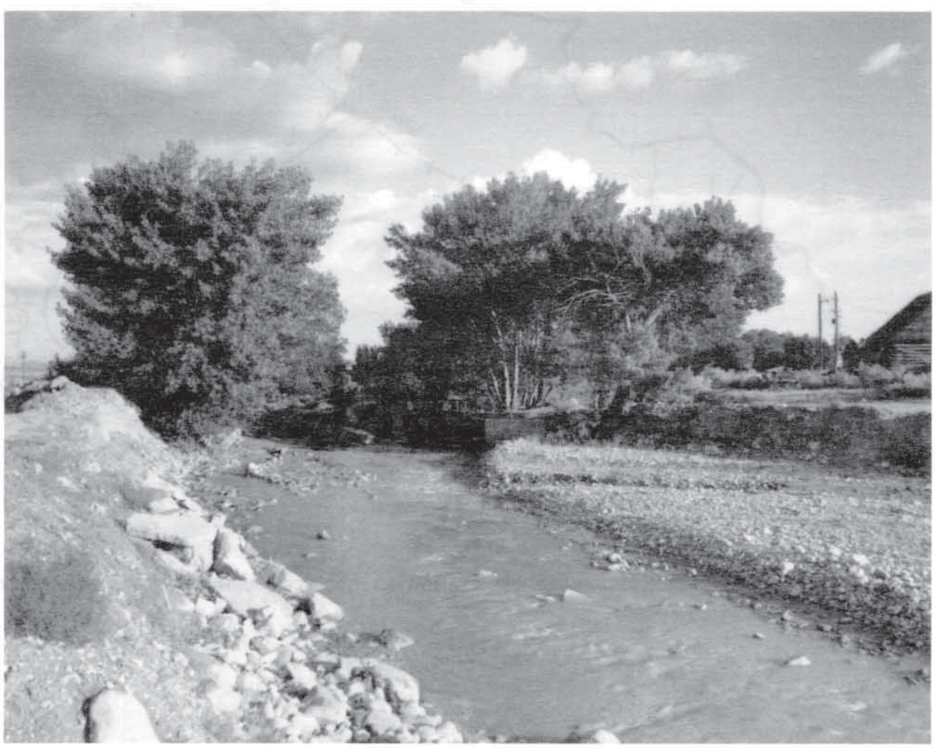
Management of municipal and industrial water systems is a key to the maintenance or improvement of the quality and quantity of existing supplies. Areas around springs can be protected to avoid contamination. Often there are opportunities for spring development to increase flows. Although it is more difficult, areas around wells can be protected to reduce the chance of pollutants entering the groundwater supply or directly into the pumping facility. Timely maintenance of conveyance and distribution systems can reduce the volume of water lost through leaks and prevent contamination from entering culinary pipe lines.

There may be a need to further study the available groundwater supplies to obtain additional data so future courses of action can be determined. This is especially important because most if not all of the additional supplies will come from groundwater.

6.5 Alternatives for Management Improvement

There are always alternatives for those with management responsibility to consider to improve their capability. All alternatives should be considered and the most likely options selected to make the best use of the water resources available. The concept of total area management of surface water and groundwater should be considered. This would coordinate management of all systems and provide the intertia needed to make optimum use of all water resources. Water conservation practices are valid for all uses.

Where new subdivisions are being developed, an



Coal Creek near Cedar City

Table 6-2
IRRIGATION COMPANIES[25,62]

Company	Irrigated Area (acres)	Conveyance Efficiency (percent)
Beaver County		
Aberdare Bench Canal Company	800	77
Adobe Yard Slough and Patterson Dam Company	640	
Allred Ditch	40	
Bald Hills Irrigation Company		
Barton Ditch Association	400	78
Beaver Dam Reservoir and Irrigation Company		
Benson Ditch Irrigation Company		
Cache Valley Dairy Association	70	
County Road Drain	150	75
Emerson Ditch		
Furnace Ditch	300	
Greenville Field Upper Ditch Company	300	88
Harris-Willis Irrigation Company		
Kents Lake Reservoir Company	500	60
Lindsay Ditch	110	90
Mammoth Canal & Irrigation Company	1,400	86
Manderfield Irrigation & Reservoir Co.,Inc.	1,500	80
Minersville Reservoir & Irrigation Company	2,000	95
North Creek Irrigation Company	2,700	89
Patterson Ditch	640	70
Pine Creek	400	86
Rocky Ford Irrigation Company	4,000	88
Second Northeast Bench Canal & Irrigation Co.	670	77
Second Northwest Canal and Irrigation Company	700	70
Second South Bench Reservoir & Irrigation Co.	500	77
Second South Field Ditch Company	400	78
Shepard Ditch	330	65
Southcreek Primary "A" Water Users Irr. Co.	700	85
Southcreek Ranch Water Company	110	81
Southern Utah Water Resources Dev. Corp.		
West Field Canal & Irrigation Company	600	68
West Side Irrigation Company	1,300	80
Willis Canal and Irrigation Company	500	70
Yardley Cattle Company	500	60

adequate water supply and distribution system should be required as part of the permit requirements. Secondary systems can conserve high quality water for culinary use by using lower quality water for outside residential uses.

The improvement and conservation of all water uses are discussed in other appropriate sections of this plan. Refer to sections 9, 10, 11, 12 and 17 for more information. ■ ■

Table 6-2 (Continued)		
Company	Irrigated Area (acres)	Conveyance Efficiency (percent)
Iron County		
Angus Water Company, Inc.		
Bauer Irrigation Company		
Bulldog	500	85
Cedar North Field Reservoir & Irr. Co.	670	75
Coal Creek Irrigation Company	8,030	80
East Extension Irrigation Company	750	92
East Union Irrigation Company	1,000	75
Hamilton Fort Irrigation Company	480	95
Hamlin Valley Water Users Association		
Highway 18 Water Company		
Linealsam Water Company, Inc.		
Little Creek Canal Company	800	89
Navajo Ridge Water Company, Inc.		
Newcastle Reservoir Company	3,000	90
Northfield Irrigation Company	670	90
Northroad Water Company, Inc.		
Northwest Field Irrigation Company		
Old Fort & Old Field Reservoir Irr. Co.	520	87
Paragonah Canal Company	1,300	93
Parowan Fields Irrigation Company		
Parowan Reservoir Company	3,100	85
South and West Field Irrigation Company	550	87
Summit Irrigation Stock Company	1,000	95
Union Field Irrigation Company	1,000	88
Washington County		
Black Canyon Irrigation Company		
Enterprise Reservoir and Canal Company	2,500	85
Enterprise Valley Pumpers, Assn.		
Knell Ditch Company		
Meadow Canyon Creek	100	90
Pinto Irrigation Company	200	90
Tullis Ditch	200	40

Note: Data are not available where there are blank spaces.

Section 7 Contents

Regulation/Institutional Considerations

7.1 Introduction

This section presents a brief discussion of the several regulations now in place to protect and manage the water resources of the Cedar/Beaver Basin. It also discusses the major related problems and needs.

The Department of Environmental Quality and the Division of Water Rights are the primary state agencies responsible for water regulation. Water quality is regulated by the Division of Drinking Water and the Division of Water Quality in the Department of Environmental Quality. These agencies operate in accordance with the Utah Safe Drinking Water Act and the Utah Water Quality Act. Water quality is also regulated by various federal regulations. The Division of Water Rights, Department of Natural Resources, is responsible for water allocation and distribution according to state water law. The detailed functions of these agencies are described in the Utah State Water Plan, sections 7, 11 and 12. The Division of Water Resources regulates the cloud seeding program as described in Section 9 and is responsible for state water planning.

7.2 Setting

Water regulation is generally carried out under the direction of state agencies, although some federal agencies become involved when it includes their mandates. Local public and private institutions and entities usually manage and operate the various water systems at the basin level.

7.2.1 Current Regulation

Water law, based on the doctrine of prior appropriation, is administered by the Utah State Engineer. The Division of Water Rights has a regional engineer in Cedar City who carries out the day-to-day activities.

The District Court of the Fifth Judicial District in Iron County has ordered the adjudication of the water rights of all the several parts of the Cedar/Beaver Basin. These "Proposed Determination of Water Rights" are found as follows: Escalante Valley Division; Books 1-5 covering Enterprise, Beryl, Milford and Millard County areas, including a supplement; Cedar City Valley Division; Books 1-4, including a supplement; Parowan Valley Division; Books 1-3, including a supplement; and Beaver River Division; Books 1-4, including a supplement.

The quality of water is determined under standards for allowable contaminant levels according to the use designations. These designations and the standards are published by the Utah

■ Consideration of water rights, water quality and the environment are prerequisite to the management of the water resources. Regulations are required to avoid or resolve conflicts as they arise and for protection of the water user.

Department of Environmental Quality in the "Standards of Quality for Waters of the State." The Utah Water Quality Board implements the regulations, policies and activities necessary to control water quality. These are carried out by the staff of the Division of Water Quality.

The Utah Safe Drinking Water Board is responsible for assuring a safe water supply for domestic culinary uses. They regulate any system defined as a public water supply. These may be publicly or privately owned. The Safe Drinking Water Board has adopted State of Utah Public Drinking Water Regulations to help assure pure drinking water. There is also a Drinking Water's Source Protection Program. This includes monitoring delivered drinking water quality as well as water source protection. These responsibilities are carried out by the staff of the Division of Drinking Water.

7.2.2 Existing Local Institutions and Organizations

Local organizations generally carry out the distribution of water under water rights and rules and regulations administered by the state engineer. These local institutions, entities and organizations have also completed most of the water development in Utah. Distribution systems along with local entities formed under specific enabling legislation are described below.[68]

Distribution Systems - The local distribution systems were created in response to a petition to the court or state engineer and are administered by the Division of Water Rights. An appointed "commissioner" is charged with distribution and/or measurement of surface and/or underground waters. Assessments are made to pay the commissioner and for other costs. Members in each system elect a board that represents them and conducts business as required. In this basin, the five systems are:

- Beaver River - Surface water
- Milford Area - Underground water
- Beryl-New Castle Area - Surface and underground water
- Parowan Valley - Surface and underground water
- Cedar Valley - Surface and underground water

Water Conservancy Districts - These are created under Title 17A-2-1401 of the *Utah Code Annotated*. They are established by the district court in response to a formal petition and are governed by a board of directors appointed by the county commission when the district consists of a single county. Directors for multicounty districts are appointed by the governor. Water conservancy districts have very broad powers. They include constructing and operating water systems, levying taxes and contracting with government entities. These districts include incorporated and unincorporated areas. The only district in the basin, Washington County Water Conservancy District, covers a large part of the Shoal Creek drainage, the Enterprise area and part of the Pinto Creek drainage.

Mutual Irrigation Companies - These are the most common water development and management entities in the basin. They may be either profit or non-profit; most are non-profit. They are formed under the corporation code. In general, stockholders are granted the right to a quantity of water proportional to the number of shares they hold and assessments are levied similarly. There are over 50 mutual irrigation companies in the Cedar/Beaver Basin.

Water Companies - These are entities, such as special service districts, formed to provide water to subscribers. Private water companies operated for profit are regulated by the Division of Public Utilities. There are over 15 water companies in the basin.

City Water Utilities - These are utilities operated by incorporated cities and towns to provide water to residents and subscribers. Municipalities can form corporations to deliver water inside of all or any part of a city boundary. Counties have the same authority in unincorporated areas. The *Utah Code Annotated* and local ordinances provide the legal framework for water operation. Local entities may pass ordinances regulating water use.

Water User Associations - The organizations are groups formed to deliver water for various purposes. They are often informal groups, but they can also be incorporated under Utah law. There are about 15 such groups in the basin.

Other - The National Park Service delivers water to the Cedar Breaks National Monument for culinary purposes. The Division of Parks and Recreation, Forest Service and Bureau of Land Management provide culinary water in the state parks, campgrounds and picnic areas. Also, individuals in isolated locations have private systems for domestic water purposes.

7.3 Policy Issues and Recommendations

There is one issue regarding water regulations and institutional considerations. It is groundwater management.

7.3.1 Groundwater Management

Issue - There is a need for coordinated groundwater management.

Discussion - The groundwater reservoirs are influenced by the inflow of surface water supplies, direct precipitation and infiltration from canals and irrigation. Surface water flows and subsurface inflows from the mountains are the primary sources of recharge. The major withdrawals are by individuals for irrigated cropland. Other withdrawals are by private companies and municipalities for municipal and industrial uses.

All of the groundwater reservoirs are well developed and are near to or have exceeded optimum utilization. Existing conditions are already causing excessive depletion, ground subsidence and intrusion of contaminated water into areas of high quality. If the present groundwater level trends continue, more intensive management will be required to insure safe yields from the aquifers are not exceeded.

The quality of the groundwater reservoirs is being reduced because of the recirculation of irrigation water and mining in localized areas. This increases the salinity level which in turn can limit potential uses. As irrigation water becomes more saline, more salt is deposited in the soil requiring additional leaching. This requires more water to mature crops. Water used for culinary purposes will require treatment to meet water quality standards.

One area of concern is the source of high quality water used to supply the municipal and industrial needs of Cedar City. Most of the city's wells are located in the southwestern part of the groundwater basin where there is high quality water. The groundwater quality deteriorates toward the middle of the valley. If the high quality water is pumped to create a zone of depression, low quality water may infiltrate and contaminate the culinary supplies.

Groundwater management plans for individual basins would optimize the use of this resource. Plans should include maps showing the location of various levels of water quality, depth to the principal aquifers and recharge areas. Pumping rates and well locations should also be included. Local water user organizations could be used in an advisory capacity. See the issue for groundwater monitoring in Section 12.3.1.

Recommendation - The Division of Water Rights should institute groundwater management plans in each of the basins. Local entities and individuals should assist as requested.

7.4 Problems and Needs

Problems are developing in some areas where summer homes are becoming popular. In these areas, potable water is generally obtained by drilling individual wells or maybe one well serving two or three homes. Sewage disposal in these same areas is through septic tanks. Current zoning and lot sizes sometimes allow interference between septic tank disposal fields and wells for drinking water. There is a need to provide controls so the wells are not contaminated by the wastes in the immediate area.

Historic Frisco west of Milford

7.5 Water Rights Regulation

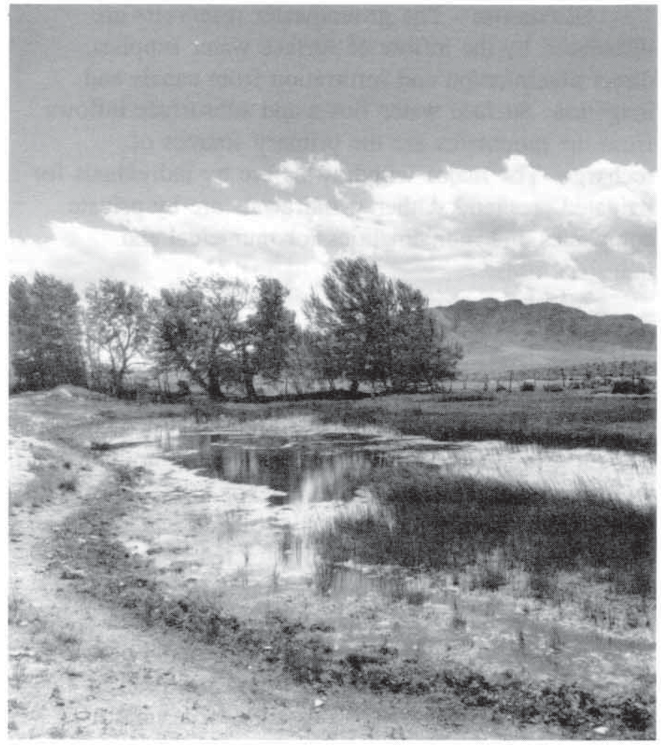
The state engineer is responsible for determining whether there is unappropriated water and if additional applications will be granted. This is accomplished through data analysis and consideration of public input.

Before approving an application to appropriate water, the state engineer must find: (1) There is unappropriated water in the proposed source, (2) the proposed use will not impair existing rights, (3) the proposed plan is physically and economically feasible, (4) the applicant has the financial ability to complete the proposed works, and (5) the application was filed in good faith and not for the purpose of speculation or monopoly. The state engineer shall withhold action on or reject an application if he determines it will interfere with a more beneficial use of water or prove detrimental to the public welfare or the natural resource environment.

Utah water law allows changes in the point of diversion, place of use, and/or nature of use of an existing right. To accomplish such a change, the water user must file a change application with the state engineer. The approval or rejection of a change application depends largely on whether or not the proposed change will impair other vested rights; however, compensation can be made, or conflicting rights may be acquired. Perfect water rights are considered real property. Pending application and stock in mutual water companies are considered personal property. As such, they can be bought and sold in the open market.

In the appropriation process, the state engineer analyzes the available data and, in most cases, conducts a public meeting to present findings and receive input before adopting a final policy regarding future appropriation and administration of water within an area. Through regulatory authority, the state engineer influences water management by establishing diversion limitations (duty of water, usually 4.0 acre-feet per acre for irrigation in this area) for various uses and by setting policies on water administration for surface water and groundwater supplies. There are some fears that when irrigation efficiency is improved, it may be possible to lose part of a water right. This would be particularly true when groundwater is used. However, there is always the right to file on that water through the appropriation process for use on other land.

The Division of Water Rights is responsible for a number of functions which include: (1) Distribution of water in accordance with established water rights, (2) adjudication of water rights under an order of a state district court, (3) approval of plans and specifications for the construction of dams and inspection of existing structures for safety, (4) licensing and regulating the activities of water well drillers, (5) regulation of geothermal development, (6) authority to control streamflow and reservoir storage or releases during a flooding emergency, and (7) regulation of stream channel alteration activities. In addition, the state engineer works with federal agencies on water rights as needed. These are handled according to the state water laws.



Antelope Springs

7.6 Water Quality Control

The discharge of pollutants is regulated by the Utah Water Quality Act (UWQA). The Utah Water Quality Board (UWQB) implements the rules, regulations, policies, and continuing planning processes necessary to prevent, control, and abate new or existing water pollution, including surface water and groundwater.[73,74,75] This is carried out through the Utah Department of Environmental Quality, Division of Water Quality.

Utah Water Quality Rules developed under authority of *Utah Code Annotated (UCA)* 26-11-1 through 20, 1953, amended, have been implemented by the UWQB under authority of the UWQA. They are described in Section 7 of the *State Water Plan*.

Water quality certification by the state is under Section 401 of the Federal Water Pollution Control Act, 1977, as amended (Clean Water Act, CWA).[30] This act states that any applicant for a federal license or permit to conduct any activity which may result in discharge into waters, and/or adjacent wetlands of the

United States, shall provide the licensing or permitting agency a certification from the state in which the discharge originates or will originate. These activities include, but are not limited to, the construction or operation of the discharging facilities. Any discharges will comply with applicable state water quality standards and the applicable provisions of the Clean Water Act.

In addition, Ground Water Protection Regulations[4] were adopted and are now enforced by the UWQB. These regulations are the building block for a formal program to protect the present and probable future beneficial uses of groundwater in Utah.

The three main regulatory concepts are: (1) To prohibit the reduction of groundwater quality, (2) prevent groundwater contamination rather than clean up after the fact, and (3) provide protection in all areas based on the different existing groundwater quality. The five significant administrative components are: (1) Groundwater quality standards, (2) ground-classification, (3) groundwater protection levels, (4) aquifer classification procedures, and (5) groundwater discharge permit system. Statutory authority for the regulations is contained in Chapter 19-5 of the *Utah Code Annotated*, authorizing the Water Quality Board.[68]

These regulations contain a groundwater discharge permitting system which will provide the basic means for controlling activities that may effect groundwater quality. A groundwater discharge permit will be required if, under normal circumstances, there may be a release either directly or indirectly to groundwater. Owners of existing facilities will not be obligated to apply for a groundwater discharge permit immediately. An existing facility is defined as a facility or activity that was in operation or under construction before February 10, 1990. Owners of these facilities should have notified the executive secretary of the UWQB of the nature and location of their discharge.

The regulations contain provisions for a permit by rule for certain facilities or activities. Many operations which pose little or no threat to groundwater quality or are already adequately regulated by other agencies, are automatically extended a permit and need not go through the formal permitting requirements. Therefore, facilities qualifying according to the provisions of Section R448-6-6.2 will administratively be extended a groundwater discharge permit (Permit by Rule). However, these operations are not exempt from the applicable class TDS limits or groundwater quality standards.

The authority for CWA, Section 401 certification, commonly known as 401 Water Quality Certification, is delegated to and implemented administratively through the Utah Water Quality Board by the Division of Water Quality. The Clean Water Act provides the focus for and the delegation of responsibility and authority to the U.S. Environmental Protection agency (EPA) to develop and implement its provisions. Whether or not EPA administers a CWA program directly within a state or indirectly by delegation to a state, EPA retains the oversight role necessary to insure compliance with all rules, regulations, and policies.

Local communities may want to set up and carry out a "Local Aquifer Protection Management Plan." If so, they can contact the Division of Water Quality for information.

7.7 Drinking Water Regulation

The Safe Drinking Water Board is empowered to adopt and enforce rules establishing standards prescribing maximum contaminant levels in public water systems. This authority is given by Title 26, Chapter 12, Section 5 of the *Utah Code Annotated, 1953(5)*.[68] The rules and regulations setting drinking water standards were adopted after public hearings.[54] These standards govern bacteriologic quality, inorganic chemical quality, radiologic quality, organic chemical quality and turbidity. Standards are also set for monitoring frequency and procedures.

The Safe Drinking Water Board, through the Division of Drinking Water, also operates under the federal Safe Drinking Water Act. This act sets federal drinking water standards and regulations. The Safe Drinking Water Act is up for reauthorization. One of the amendments being considered is to authorize a new revolving loan program to provide money to states to construct drinking water treatment plants. It also relaxes some Environmental Protection Agency requirements for setting standards for drinking water and provides more flexibility for small and rural systems.

The Division of Drinking Water serves as staff for the Safe Drinking Water Board to assure compliance with the standards. At the local level, considerable reliance is placed on public water supply operators. Those operating systems serving over 800 people are currently required to have state certification. Water systems serving fewer than 800 people will only need to have a certified operator if the water system has some sort of treatment facility in place. The systems serving over 800 people are listed in Table 7-1.

Table 7-1[19]
CULINARY WATER SYSTEMS SERVING OVER 800 PEOPLE

System	People Served
Beaver County	
Beaver	1,998
Milford	1,107
Iron County	
Cedar City	13,443
Enoch	1,947
Parowan	1,873
Washington County	
Enterprise	936

Source: U.S. Census for 1990. These data may vary from information furnished to the Utah State Engineer.

Table 7-2
HIGH HAZARD RESERVOIR DAMS

Name	Location	Height (ft.)	Capacity (ac.-ft.)
Beaver County			
Manderfield[a]	Indian Creek	31	350
Three Creeks	Beaver River	91	2,029
Kents Lake No. 2 (middle)	Birch Creek	30	900
Kents Lake No. 1 (upper)	Birch Creek	16	300[b]
Rocky Ford[c]	Beaver River	68	1,000
Iron County			
Yankee Meadow	Bowery Creek	34	1,200
Greens Lake No. 3	Un-named	37	54[d]
Red Creek	Red Creek	76	1,360
Newcastle	Pinto Creek	83	5,290
Greens Lake No. 4	Un-named	11	29[d]
Greens Lake No. 2	Un-named		28[d]
Washington County			
Enterprise (upper)	Little Pine Cr.	73	9,850
Enterprise (lower)	Little Pine Cr.	56	1,672

Source: Division of Water Rights.
[a] aka Beaver Dam #1.
[b] Includes conservation pool.
[c] aka Minersville Reservoir
[d] Floodwater storage.

7.8 Dam Safety

All dams creating reservoirs in Utah which store water where failure may cause loss of life are assigned a hazard rating. Hazard ratings (the potential effects of failure) are either high, moderate, or low, thus determining the frequency of the inspection. High-hazard dams are inspected yearly; moderate, every other year; and low, every fifth year.

Table 7-2 shows the reservoir dams currently classified as high hazard in the Cedar/Beaver Basin. Following an inspection, the state engineer may suggest maintenance needs and requests specific repairs. He may declare the dam unsafe and order it breached or drained. Efforts are always made to work with dam owners to schedule necessary actions.

The state engineer has design standards which are outlined in a publication entitled *Rules and Regulations Governing Dam Safety in Utah*.[24] Plans and specifications must be consistent with these standards. Dam safety personnel monitor construction to insure compliance with plans, specifications and design reports. Any problems are resolved before final approval is given.

The Dam Safety Act requires all high hazard dams to pass the Probable Maximum Precipitation (PMP) flood. The assessment also includes the ability of the dam to withstand earthquakes. Flood control structures, such as Greens Lake No. 2 debris basin, are exempt from the minimum standards. ■ ■

Section 8 Contents

Tables

Water Funding Programs

8.1 Introduction

This section briefly describes the state, federal and local funding sources available to help conserve the water resources in the Cedar/Beaver Basin.[51] State and federal agencies have funds available for planning as well as for development. Some also have funds to provide various levels of management assistance. Generally, the planning funds are not a part of the project funds available for construction.

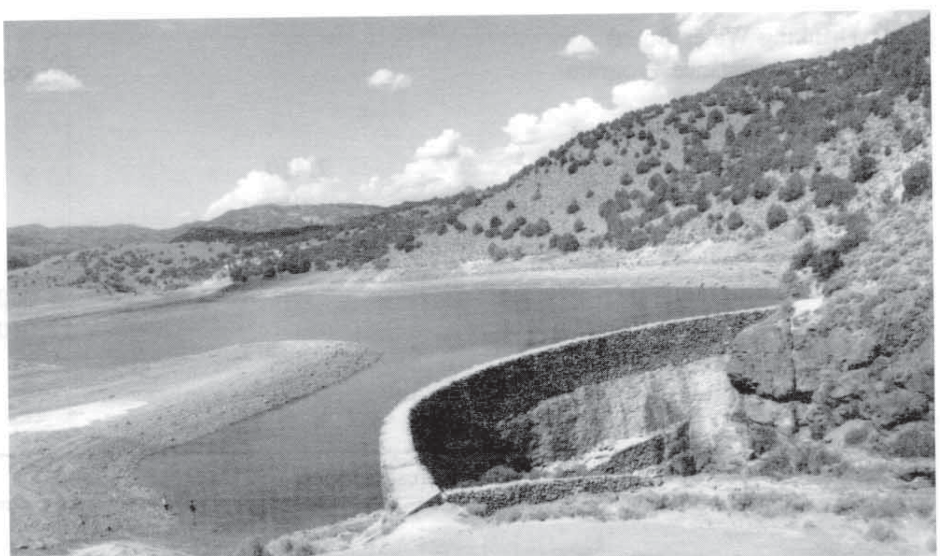
Some of the planning programs are discussed in various sections of this basin plan. Specific agency activities and responsibilities are discussed. River basin planning by the Division of Water Resources and others responsible for preparing this document is discussed in Section 3. Other planning programs include the Division of Water Rights funding for groundwater and related studies, U.S. Geological Survey stream gaging and groundwater measurement and modeling, Bureau of Land Management and Forest Service watershed management planning, Corps of Engineers flood control studies, and Natural Resources Conservation Service river basin planning. Refer to the *State Water Plan* (1990); Section 3, Introduction, and Section 8, State and Federal Water Resources Funding Programs, for additional information.

8.2 Background

Soon after the basin was settled, the initial installation of culinary water systems to provide drinking water began. Since then, nearly all projects were related to agricultural development. During the last 10 years, there has been an increase in projects for municipal and industrial purposes. Still, the majority of the projects were constructed for agricultural purposes.

Beaver City installed a secondary water system costing about $1.33 million, stressing the importance of

■ Funding water development requires the combined efforts of all concerned. It requires cooperation, persistence and ingenuity. This was true in the early days of establishment in the basin and is still required today.



Lower Enterprise Reservoir

saving high quality drinking water supplies. The Soil Conservation Service (Natural Resources Conservation Service), in cooperation with local entities, completed a flood control project near Cedar City in 1962 at a cost of over $290,000. Residents in the Minersville-Milford area sponsored a multiple purpose project for flood control, secondary water and irrigation water conservation and efficiency improvement. The project, costing over $5 million, was started in 1962 and completed in 1978. Studies were made over several years for a multiple purpose project on Coal Creek and nearby drainages. It was determined the project was not feasible and planning was terminated.

Total funds spent historically for planning and implementation of water and water-related projects in the Cedar/Beaver Basin are difficult to calculate. One thing is certain, local entities and individuals provided the vast majority of financing from their own resources or by some payback arrangement.

Tables 8-1 and 8-2 show the recent funding provided by state and federal agencies for water-related projects. The time periods shown vary because of data availability. Funding can be both grants and loans and can be provided by more than one agency. However, it is not legal to match federal funds from one agency with other federal monies.

Table 8-1
STATE WATER-RELATED FUNDING EXPENDITURES

Funding Agency Program	Grants	Loans ($1,000)	Period
Board of Parks and Recreation	545[a]		1994
Land and Water Conservation Fund			
Board of Water Resources			
Cities Water Loan Fund		5,509	1974-93
Construction and Development Fund		8,654	1978-93
Revolving Construction Fund		12,750	1947-93
Community Development			1990-93
Community Dev. Block Grants	436		
Permanent Community Impact Board			
Permanent Community Impact Fund	113		1983
Disaster Relief Board Fund			
Safe Drinking Water Board			
Financial Assistance Program		898	1990-92
Soil Conservation Commission			
Agriculture Resource Dev. Loan	2,430		1988-94
Priority Watershed Program	-0-		
Water Quality Board			
State Loan Program		4,000	1974-93
State Revolving Loan Program		12,010	1974-93
Federal Construction Grants	4,364		1974-93
EPA 314 Clean Lakes Program	91		1991-93

[a] Includes $16,000 matching funds from Forest Service

Table 8-2 FEDERAL WATER-RELATED FUNDING EXPENDITURES			
Funding Agency Program	Grants	Loans ($1,000)	Period
Agriculture Conservation & Stabilization Program			
Agriculture Conservation Program	1,968		1984-94
Conservation Reserve Program	[a]		
Emergency Conservation Program	[a]		
Corps of Engineers			
Civil Works	218		
Emergency Activities	86		
Farmers Home Administration			
Rural Development	776	1,269	N/A
Resource Conservation & Development			
Federal Emergency Management Agency			
Presidential Declared Disaster	461		1983
Flood Plain Management			
Soil Conservation Service			
Watershed Protection & Flood Prevention	2,669		
Resource Conservation & Development	281[b]		1985-92
Emergency Watershed Program			

[a] Included in ACP total.
[b] Does not include 759,000 matching funds.

8.3 State, Federal and Local Funding Programs and Resources

Tables 8-3, 8-4 and 8-5 indicate some of the funding programs that can provide grants and loans through state, federal and local agencies and entities. These programs can accelerate water resources development by providing sufficient funds for total projects. Where the planning covers a large, complex project, it may be more efficient to proceed in phases rather than construct complete systems that are only partially used for many years. ■ ■

Table 8-3
STATE FUNDING PROGRAMS

Entity/Program	Contact	Purpose	Type
Board of Parks & Recreation			
Land & Water Conservation Fund	Div. of Parks and Rec.	Recreation facilities	Cost-share
Riverway Enhancement Program			
Board of Water Resources			
Revolving Construction Fund	Div. of Water Res.	Small irr./cul. projects.	Loans
Cities Water Loan Fund		Municipal cul. systems	Loans
Conservation & Development Fund		Large water projects	Loans
Community Dev. Block Grants			
Block Grants	Div. of Community Dev.	Rural living envir. imp.	Grants
Perm. Community Impact Board			
Permanent Community Impact Fund	Div. of Community Dev.	Rural living envir. imp.	Grts/Loans
Disaster Relief Board Fund		Disaster repair	Grants
Safe Drinking Water Board			
Financial Assis. Program	Div. of Drinking Water	Drinking water system	Loans
Soil Conservation Commission			
Agri. Resource Development Loan	Dept. of Agriculture	Improve private ag. land	Loans
Priority Watershed Program		Watershed improvement	Grants
Utah Wildlife Board			
Dingle-Johnson Act	Div. of Wildlife Res.	Fish habitat restor./dev.	Grants
Water Quality Board			
Revolving Const. Loan Program	Div. of Water Quality	Wastewater treat. facil.	Loans
Federal Construction Grants		Wastewater treat. facil.	Grants
State Loan Program			Loans

Table 8-4
LOCAL FUNDING PROGRAMS

Entity	Purpose	Type
Private financial institutions	Any approved water-related project	Loan
Washington Co. Water Conservancy District	Group water projects	Loans, Cost-share
Western Farm Credit Bank	Water-related projects	Loan

Table 8-5
FEDERAL FUNDING PROGRAMS

Agency	Program	Purpose	Type
Department of Agriculture			
Agricultural Stabilization and Conservation Service	Agriculture Conservation Program	Soil, water, energy conservation	Grants
	Emergency Conservation Program	Rehabilitation of farmland damaged by disasters	Grants
	Conservation Reserve Program	Reduce erosion/maintain wetlands	Grants
Farmers Home Administration	Rural Development	Water supply/wastewater disposal	Grants/Loans
	Resources Conservation & Dev.	Multi-purpose water, land conservation facilities	Loans
Soil Conservation Service	Protect Watershed & Prevent Floods	Flood control & water	Grants
	Resource Conservation and Dev.	Multi-purpose water & related facilities	Grants/Cost share
	Emergency Watershed Program	Reduce sedimentation & flooding	Grants/Cost share
Department of the Army			
Corps of Engineers	Civil Works	Flood control, water supply, recreation	Cost share
	Continuing Authorized Programs	Flood control & protection	Cost share
	Emergency Activities	Flood control & protection	Grants
Environmental Protection Agency		Water quality	Grants
Department of the Interior			
Bureau of Reclamation	Investigation Programs	Water storage, delivery	Loans
	Loan Programs	Small multi-purpose projects	Loans
Economic Development Administration	Public Works & Economic Dev.	Water development	Grants/Loans
Federal Emergency Management Agency	Presidential Declared Disaster	Damage mitigation	Grants
	Flood Plain Management	Structure acquisition-flood plains	Grants

Section 9 Contents

Section 9 State Water Plan - Cedar/Beaver Basin

Water Planning and Development

9.1 Introduction

This section describes the major existing and proposed water planning and development activities in the Cedar/Beaver Basin. The existing water supplies are vital to the existence of the local communities while also providing aesthetic and environmental values. State, federal and local agencies as well as other interested parties need to coordinate their activities regarding water resources.

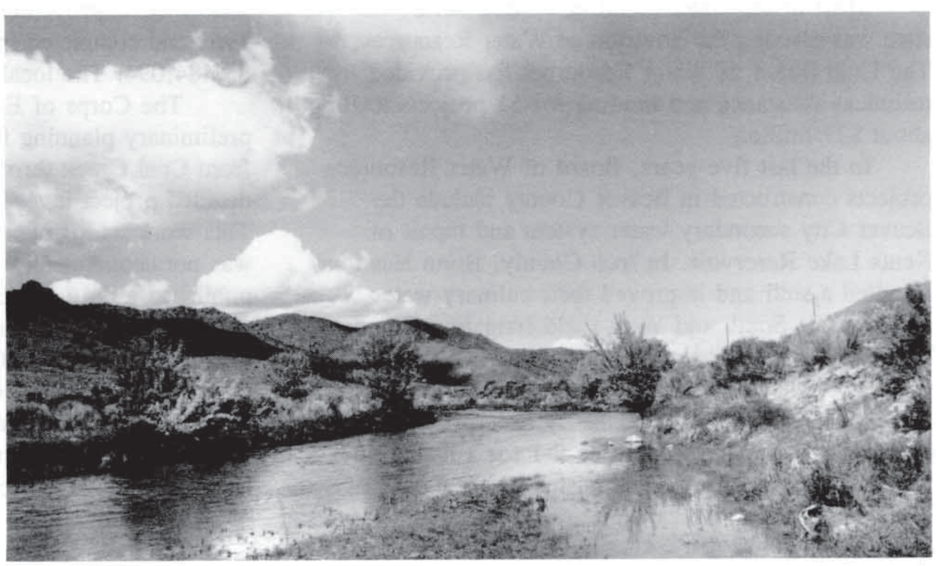
One goal of the Utah Division of Water Resources is to assist other state and federal agencies in effective, coordinated, water-related activities. However, the decision making process is still the responsibility of the local people. This plan provides local decision makers with data to solve existing problems and to plan for future implementation of the most viable alternatives.

9.2 Background

Development in the 1850s was by groups of individuals with a common cause. It was a matter of surviving in a newly settled area. Later, it was found more convenient to organize formal groups such as irrigation companies and cities and towns. Since then, a water conservancy district has been formed covering the Washington County part of the basin. There are also a variety of other entities, such as special service districts, that have been formed to develop needed water and related resources.

As demands for municipal and industrial (M&I) water increase, supplies will come primarily from agricultural water right transfers, drilling new wells and conservation. Additional water supplies could come from transbasin diversions and cloud seeding activities. Of the total water diverted for all uses, (not including riparian vegetation and wetlands) about 96 percent is for

■ Water development, with conservation, is essential to meet the demands and needs of the future. This requires wise planning and the cooperation of all government agencies and local organizations.



Beaver River below Minersville Reservoir agricultural purposes, including livestock watering needs. As other uses increase, this percentage will decrease. The current diversion for M&I water is 3 percent, but this will increase in the future, especially in Cedar Valley. Single family domestic and secondary uses are about 1 percent.

9.2.1 Past Water Planning and Development

At the time of the earliest settlements, individuals and groups generally did their own planning and development of the water needed for various uses. Later, technical and financial assistance became available from state and federal agencies.

Many projects and facilities have been constructed over the years to develop the needed water resources. Seven storage reservoirs with capacities over 1,000 acre-feet have been constructed, primarily for irrigation purposes. See Table 6-1 for a detailed listing of existing reservoirs. Many smaller reservoirs for single and multiple purposes have been built for irrigation, flood control, stock watering and fishing. The total surface water storage capacity in the basin is about 47,000 acre-feet.

Other past developments include canal lining, pipelines for irrigation and culinary water supplies, storage tanks, wells, secondary water systems, diversions and sewage lagoons. One early project, which is now abandoned, was construction of a canal to divert water from the Sevier River drainage of Brian Head Peak into Parowan Valley. More recently, needed flood control structures and flood channels have been constructed.

Most of the water planning carried out by the state was through the Division of Water Resources. The Utah Board of Water Resources has provided technical assistance and funding for 51 projects totaling about $27 million.

In the last five years, Board of Water Resources projects constructed in Beaver County include the Beaver City secondary water system and repair of Kents Lake Reservoir. In Iron County, Brian Head has installed a well and improved their culinary water system. The South and West Field Irrigation Company has installed a low-head irrigation pipeline. The last project installed in the Washington County portion of the basin (1982) was a pipeline by Enterprise Reservoir and Canal Company. See Table 9-1 for a listing of water development projects assisted by the Board of Water Resources.

Other projects have been carried out through the Agricultural Conservation Program and the Agricultural Resource Development Loan program. These include sprinklers, pipelines and other agricultural-related projects.

The Soil Conservation Service (now Natural Resources Conservation Service) spent considerable effort planning for a proposed watershed project in the Cedar City area. This covered the drainages from Shurtz Creek on the south to Parowan Creek on the north. The project was to reduce erosion; provide sediment, floodwater and irrigation water storage; and conveyance systems and onfarm improvements. Planning was terminated because the estimated high development cost made the project infeasible.

Two major projects were completed by the Soil Conservation Service (NRCS). One, Green's Lake Watershed Project near Cedar City, was a flood control project. It consisted of five debris basins and related floodwater channels to protect the south side of Cedar City. The upper watershed was also treated by brush and tree removal and reseeding with grass to reduce erosion and floodwater runoff. This project was started in 1957 and completed in 1962 at a cost of $290,357. The only local cost was for easements and rights-of-ways. The value of this project has increased because of expansion of the residential and business area.

The second was the Minersville Watershed Project, constructed to prevent and control floodwater and sediment deposition, increase irrigation efficiencies and improve the upper watershed areas. The project consisted of debris basins, concrete pipelines, canal lining, sprinkler and flood irrigation systems, and upper watershed improvements. The project was started in 1962 and completed in 1978 at a total cost of $5,484,094. The local cost was $3,105,007.

The Corps of Engineers carried out some preliminary planning for controlling and passing floods from Coal Creek through Cedar City in 1977. A detailed project investigation was initiated in 1978. This work was dropped in 1980 because the project was not economically feasible. The Corps recently published a draft report presenting the findings of flood control investigations in the Sevier Lake drainage.[10] They have concluded that although there were flood threats to the Cedar City area, there were no potentially feasible flood control alternatives.

The Corps completed a flood control project on Big Wash above Milford in 1961. This project consists of a diversion dam 34 feet high and 2,400 feet long,

Table 9-1
BOARD OF WATER RESOURCES DEVELOPMENT PROJECTS

Sponsor	Type	Year
	BEAVER COUNTY	
Abadare Canal Company	Irr-Well	1961
Beaver City	Cl-Tank	1977
Beaver City	Ss	1990
Harris-Willis Irr. Co.	Spk	1984
Kents Lake Reservoir Co.	Dam-Res	1948
Kents Lake Reservoir Co.	Dam-Rep	1952
Kents Lake Reservoir Co.	Dam-Rep	1973
Kents Lake Reservoir Co.	Dam-Rep	1977
Kents Lake Reservoir Co.	Dam-Rep	1994
Manderfield Cul. Water Co.	Cl	1977
Manderfield Irrigation Co.	CNL	1963
Milford City	Cl-Well	1976
Minersville Res. & Irr. Co.	Pr-Pipe	1972
Minersville Res. & Irr. Co.	Div-Dam	1987
Minersville Town	Cl-Well	1976
Rocky Ford Irrigation Co.	Dam-Res	1953
Rocky Ford Irrigation Co.	CNL	1973
Rocky Ford Irrigation Co.	CNL	1975
Rocky Ford Irrigation Co.	Dam-Rep	1977
Southcreek Prim. A WU Irr. Co.	Dam-Res	1982
Westside Irrigation Co.	CNL	1953
Westside Irrigation Co.	Pr-Pipe	1972
BEAVER COUNTY TOTAL	22	
	IRON COUNTY	
Newcastle Reservoir Co.	Dam-Res	1955
Newcastle Reservoir Co.	CNL	1961
Newcastle Reservoir Co.	Dam-Enl	1974
Newcastle Reservoir Co.	Spk	1980
Newcastle Reservoir Co.	Dam-Rep	1958
Newcastle Water Co.	Ss	1994
Brian Head Town	Cl-Tank	1979
Brian Head Town	Cl-Well	1993
Brian Head Town	Misc.	1993
Cedar North Fields Irr. Co.	CNL	1958
Enoch City	Cl-Tank	1977
Enoch City	Cl-Tank	1980
Enoch City	Cl-Pipe	1985
Mountain View SSD	CL	1985
Paragonah Canal Co.	Dam-Enl	1979
Paragonah Canal Co.	Pr-Pipe	1966
Paragonah Canal Co.	Pr-Pipe	1986
Paragonah Canal Co.	Div-Dam	1988
Parowan City	Cl-Pipe	1979
Parowan City	Ss	1987
Parowan Reservoir Co.	Dam-Enl	1985
South & West Field Irrigation Co.	Lh-Pipe	1990
Spring Creek & La Verkin Creek Irrigation Co.	Dam-Res	1948

Table 9-1 (Continued)
BOARD OF WATER RESOURCES DEVELOPMENT PROJECTS

Sponsor	Type	Year
Summit Irrigation Stock Co.		
Summit Irrigation Stock Co.	CNL	1959
Summit SSD	Sprinkle	1985
	Cl-Pipe	1982
IRON COUNTY TOTAL		
	25	
WASHINGTON COUNTY		
Enterprise City	Spr-Dev	1981
Enterprise Res. & Canal Co.	CNL	1961
Enterprise Res. & Canal Co.	Spk	1982
Enterprise Res. & Canal Co.	Dam-Res	1980
WASHINGTON COUNTY TOTAL	4	

Note:	CL-Culinary line	Rep-Repair
	CNL-Canal lining	Res-Reservoir
	Div-Diversion	Spk-Sprinkler
	Lh-Low Head	Ss-Secondary system
	PL-Pipeline	WS-Water System
	Pr-Pressure	

a 325 acre-foot detention basin and a 4,500 foot-long channel and levee to divert flood flows up to 15,500 CFS to Hickory Wash away from existing development. The Corps also constructed a flood control dike in the Shoal Creek drainage near Enterprise.

Another major planning effort was the Bureau of Reclamation Dixie Project. As conceived, this project included agreements for Cedar City to obtain water from Kolob Reservoir on the North Fork of the Virgin River. This would be a transbasin diversion. This is discussed in more detail in Section 9.6.5.

9.2.2 Current Water Planning and Development

Recently, a study was completed of alternatives for bringing water from the Virgin River drainage into the Cedar City area for culinary purposes.[6] Possible sources include tributaries to the North Fork of the Virgin River including Kolob Reservoir, the Santa Clara River and Ash Creek.

New Castle has just completed installation of a pressurized secondary water system. Eight irrigation companies have applied for assistance to complete investigations to comply with the 1990 Utah Dam Safety Act. These are Southcreek Primary "A" Water Users Irrigation Company, Beaver Dam Reservoir Company, Enterprise Reservoir and Canal Company, Paragonah Canal Company, Newcastle Reservoir Company, Kents Lake Reservoir Company, Parowan Reservoir Company and Rocky Ford Irrigation Company.

There is one project currently under construction where financial assistance is provided by the Board of Water Resources. It is the reconstruction of Upper Kents Lake Reservoir in Beaver County.

The Natural Resources Conservation Service has recently completed a feasibility study in the Fiddlers Canyon area. It was determined a project to control the flood water and sediment is currently infeasible.

9.2.3 Environmental Considerations

Water is often viewed as a commodity for people's use with little thought given to other purposes and processes of the hydrologic cycle. Precipitation produces the river and stream flows that can be enjoyed by everyone for many reasons. The Beaver River flows through forested lands providing opportunities for camping, fishing, hunting, hiking and many other recreational activities. Coal Creek and Parowan Creek provide scenic beauty which can be enjoyed in the comfort of an automobile or by exploring these and other areas on horseback, by hiking or other means. To some, sprinklers irrigating green crops in a desert climate provide a pastoral beauty not found in many arid areas. Proper development can provide an adequate quantity and quality of water for all uses including those so crucial to maintaining healthy wildlife habitats.

Providing instream flows as a beneficial use to maintain fish and wildlife populations, riparian vegetation and stream channels is widely recognized as important. Although construction of reservoirs such as Kents Lake and Red Creek cover some riparian habitat, they provide instream flows during the summer when streams would normally be too low to support a fishery. This is a side benefit to the primary purpose of storing and releasing irrigation water. This should be considered early in future designs.

Other important factors that could affect water use and development are wilderness areas and wild and scenic rivers designations. There is only one designated wilderness area in the basin. This is the Ashdown Gorge Wilderness Area in Coal Creek on the Dixie National Forest. There are no others proposed at this time. There have been some preliminary inventories made of wild and scenic rivers. There are no plans to pursue these any further until a statewide procedure can be established as requested by the governor.

The Cedar/Beaver Basin contains many historic places and artifact sites tieing the present to the past. There are also archeological sites around the area. Future development should take all of these into consideration.

9.3 Policy Issues and Recommendations

One issue is discussed concerning long-range planning.

9.3.1 Long-Range Planning

Issue - Coordinated long-range planning is needed at all levels in the use and management of the water and water-related land resources.

Discussion - The natural resources of the Cedar/Beaver Basin, particularly those related to water, are vitally important to every individual, organization and government entity involved in their conservation, development and use. This makes all aspects of planning, development and use of resources important to all concerned. The ultimate use and disposition of resources should be coordinated among all appropriate entities, including individuals. Land owners, resource users, and administrators of federal, state, and local agencies should strive for acceptable compromises and have a willingness to work toward a common goal.

Long-range plans are a tool to help develop and conserve the existing resources to meet future demands. Water and land provide the basics to support life. Other important considerations include preserving areas for recreation and leisure activities and providing wildlife and habitat for the enjoyment of future generations.

With a growing population, future culinary water use in the basin will increase. To meet this demand, some agricultural land may be taken out of production, water could be imported, or efficiencies could be increased. About the only way water for agricultural lands with short supplies can be firmed up is by reducing irrigated acreages or by increasing application efficiencies.

Federal reserved water claims, instream flows and designation of wild and scenic river segments could also effect future availability of surface water and groundwater. Other withdrawals that could effect water availability include areas of critical environmental concern, special recreation management areas, and Visual Resource Management Class I and II.

Snow making machine at Brian Head

Resource planning can also help where federal laws and mandates dictate use of lands. One example is the growing problem of finding suitable areas for landfills. Local long-range resource plans can require federal agencies to take local desires and needs into consideration.

Long-range planning can also assist in coordinating the development and use of the resources. For example, Parowan, Summit, Paragonah, and north Iron County water companies, Brian Head and Parowan Pumpers Association, all share a common basin and many of the same problems. The upper Beaver Valley and the Minersville-Milford area also have common problems to be resolved.

Past planning has dealt more with resource quantities. Future planning should also emphasize the quality aspects of resources. To assist with this, the present state policy is to provide technical assistance to help counties conduct resource inventories and prepare plans. The resources of the Governor's Office of Planning and Budget have been made available when needed. Additional planning assistance is also available from several state and federal agencies.

Recommendation - Local governments and water user groups should prepare long-range plans concerning the basin's natural resources. Counties should take the lead through their land-use planning process with assistance from state and federal agencies.

9.4 Water Resources Problems

There are several water resources problems to be addressed. These include water quality issues, municipal and industrial water supplies, and irrigation water shortages. Another problem comes up when water use is transferred or from upstream developments. This may involve water rights, change applications, conveyance costs and environmental concerns. Mining of groundwater reservoirs, particularly in the Escalante Valley area, is a major concern. Mining of groundwater with the resultant lowering of the water table will dry up springs, affect water quality and reduce or eliminate some riparian areas.

Many locations in the basin are subject to flash flooding from summer thunderstorms resulting in high instantaneous peak flows causing erosion, sediment deposition and other property damage. In most of the storage reservoirs, part of the capacity is eventually used for sediment storage which reduces the effective water storage capacity.

9.4.1 Water Quality

Water quality is becoming a more serious problem as increasing demands are made on the resource. In most cases, groundwater quality is deteriorating at a faster rate than the surface water quality. Surface water quality measurements were conducted on selected streams during the 1960s. Groundwater quality tests were conducted in the five basins during studies in the 1970s. Refer to Sections 12 and 19 for data on water quality.

9.4.2 Irrigation Water Shortages

Groundwater is either the primary or supplemental source of irrigation water in most areas. In some areas, the groundwater use exceeds the recharge, resulting in declining groundwater levels or mining. If mining of groundwater continues, cost of pumping for irrigation will become prohibitive. This is particularly true in the Beryl-Eterprise area.

Surface water flows fluctuate widely from year to year, as well as between individual months within the year. This is characteristic of surface water supplies in the basin, particularly Coal Creek. (See Section 5, Water Supply and Use). Coal Creek is the only major stream in the Cedar/Beaver Basin without any water storage reservoirs to reduce the flow fluctuations. This results in more pumping of groundwater in some areas during dry years. Coal Creek is a short, steep drainage lacking in adequate vegetative growth to inhibit extreme sediment producing runoff flow volumes. These watershed characteristics separate Coal Creek from most other streams in the basin.

The streamflow volumes in all drainages vary with the precipitation cycles of wet and dry years. There is inadequate reservoir capacity available to provide carry over storage and level out year-to-year supplies. Also, the water supplies are inadequate to allow much additional storage. Where there is reservoir storage for irrigation water, the supplies are more evenly spread over the crop growing season. However, those areas depending primarily on direct flow rights divert most of their irrigation water early in the season when the snow-melt flows are high. These same areas are more likely to experience shortages during the late part of the growing season.

9.4.3 Municipal and Industrial Water Problems

The Cedar City area population is the fastest growing in the basin, mainly because it is the economic and cultural hub. There are also many recreation facilities to attract people. This can create a shortage of good quality culinary water. Currently, all of the culinary supplies come from either springs or wells. To overcome municipal and industrial shortages in the future, agricultural water, most likely groundwater, will have to be purchased to provide culinary supplies.

9.5 Water Resources Demands and Needs

Municipal and industrial (M&I) water demands will continue to be the catalyst for the transfer of water from other uses. Estimates of population growth given in Section 4 are used to project M&I water needs. Agricultural water uses will decrease slightly as supplies are reallocated to satisfy M&I demands.

9.5.1 Culinary Water Demands

It is estimated the culinary water use will increase by 72 percent or 6,160 acre-feet by the year 2020. This also reflects a conservation factor. See Section 11. The current and projected culinary water diversions and depletions are shown in Table 9-2.[19]

If groundwater is used for culinary water, it will generally not need treatment. The same is true if additional springs can be developed. Surface water will need to be treated to meet culinary water standards.

9.5.2 Secondary Water Needs

Secondary (dual) water systems provide irrigation water for residential and municipal areas.[19] These systems allow the use of lower quality water for landscape and turf irrigation. Parks, golf courses and other large grass areas are ideal candidates for secondary systems along with any other outside uses not requiring water of culinary standards. Many communities in the basin have installed secondary water systems so the potential is not as much here as in other parts of the state. Current and projected diversions and depletions for secondary systems are shown in Table 9-3. The projected diversion needed by the year 2020 is an additional 1,090 acre-feet.

9.5.3 Irrigation Water Needs

The area of the irrigated cropland increased by about 30 percent from 1965 to 1989. As the future population grows, particularly in the Cedar Valley area, some of the new residential and commercial developments may displace presently irrigated farmland. This may result in the irrigation of some new lands. Overall, the irrigated land area is expected to change only slightly in the next 30 years.

Surface supplies are the major source of irrigation water in Beaver Valley, the Minersville area and Parowan Valley. Groundwater supplies the majority of irrigation water in the Milford area, Cedar Valley, and in the Beryl-Enterprise area. Overall, about 42 percent of the irrigation water supply comes from surface water sources. See Section 5.5.1. Also, Table 10-7 in Section 10 shows the current and projected irrigation water diversions and depletions.

9.5.4 Fish and Wildlife Water Needs

There is a requirement to maintain or improve the wetlands and riparian areas, especially those associated with open water areas. These are important habitats for fish and wildlife.

Some areas should be preserved to accommodate amphibians and non-game species. There are areas where habitat can be improved from poor or fair condition to good condition. Waterfowl areas can be

Table 9-2
CURRENT AND PROJECTED CULINARY WATER USE

Year	County			Total	
	Beaver	Iron	Washington (Acre-feet)	Diversion	Depletion
1992	1,580	6,360	670	8,610	4,480
2000	2,440	8,190	770	11,400	5,930
2010	2,590	9,690	940	13,220	6,870
2020	2,630	11,040	1,100	14,770	7,680

Table 9-3 CURRENT AND PROJECTED SECONDARY SYSTEMS WATER USE					
Year	County			Total	
	Beaver	Iron	Washington (Acre-feet)	Diversion	Depletion
1992	1,350	1,980	-0-	3,330	2,330
2000	1,410	2,190	-0-	3,600	2,520
2010	1,560	2,590	-0-	4,150	2,910
2020	1,600	2,820	-0-	4,420	3,090

improved by interseeding, stabilizing the water areas and provided nesting facilities. Fisheries can be rehabilitated by using stream bank and channel measures to stabilize streambeds and provide pools. Priorities should be given to areas where there is greater potential for improvement. The current wetland and riparian water uses in the valley areas are shown in Table 9-4.

9.5.5 Recreational Demands

The Cedar/Beaver Basin contains two state parks, one national monument, two national forests, two ski resorts and numerous other recreational areas of various kinds. The recreational activities range from camping, hiking, nature study, hunting, golfing and water sports in the summer to cross-country skiing, snowmobiling, hunting, skiing and sledding in the winter.

Sightseeing is popular at any time of the year. Opportunities for recreation range from the colorful Cedar Breaks National Monument and the majestic Tushar Mountains to the wide expanse of desert landscapes and the old ghost towns from the heyday of mining. Desert flowers and the changing colors of leaves provide vistas of beauty, each in its own way.

Water-based recreation is provided by the lakes and reservoirs in the basin. Minersville Reservoir and the Upper Enterprise Reservoir provide water skiing and boating as well as fishing. Other major water attractions include Red Creek, Yankee Meadows, Puffer Lake, the Kents Lakes, Newcastle and the Lower Enterprise reservoirs. Camping and picnicking facilities are provided at many of these as well as at other locations.

9.6 Water Development and Management Alternatives

There are ways to enhance the existing water supplies. These include reservoir storage, protection of recharge areas, cloud seeding, upper watershed rehabilitation and water conservation.

Making more efficient use of existing water supplies increases the availability for future demands.

Table 9-4 CURRENT WETLAND WATER DEPLETIONS	
County	Depletions (Acre-feet)
Beaver/Millard	16,450
Iron/Washington	8,960
Total	25,410

9.6.1 Water Supply Management

Even though much has been accomplished, there are additional opportunities to improve the efficient use and management of the water resources. This applies to all uses. Users can better manage their water supplies by increasing efficiencies which in turn can reduce costs, and by using prudent application of water for landscaping and other outside residential purposes. There is a need to properly manage the groundwater reservoirs in the Cedar/Beaver Basin. Some fears have been expressed that saving of water can result in loss of the right to that water. Provisions should be made to accommodate water savings and protection of water rights. Water managers should always be searching for ways to conserve the available supply so development of other costly sources can be eliminated or postponed. Education and training can be an effective tool.

One of the tools used in planning and design of water projects is computer modeling. This can be used to simulate river systems to determine reservoir yields, hydroelectric power production, water shortages and the effect on the river systems as new developments become operational. Reservoir operation procedures can be fine-tuned with models to maximize the available water for use and minimize any problems associated with changing flow regimes. Computer models are also a useful tool for simulating operation of a groundwater reservoir.

Water conservancy districts can be a means for carrying out resource planning and development. At the present time, there is some support for creating a district in the Cedar Valley area. There is no support for a district in the Parowan Valley or New Castle-Beryl areas. Also, there is no interest in Beaver County for creating a district.

9.6.2 Surface Water Storage Facilities

Over the years, many potential reservoir sites have been investigated to varying degrees of detail. Investigations have been made by the Utah State Engineer, Division of Water Resources, Corps of Engineers and Soil Conservation Service (SCS). Local entities also have conducted investigations on reservoir sites. In 1973, the SCS documented 44 potential reservoir sites.[62] They evaluated these sites on the basis of geology, availability of water, topography, local interest and better utilization of water resources. The SCS selected 10 sites, which appeared favorable, for future analysis. Nine of these, and one other site subsequently selected by other entities, are included in Table 9-5 and on Figure 9-1. Future water storage reservoirs will only be feasible if constructed as multipurpose projects. Planning for these projects generally includes biological surveys, but these surveys should always be made.

One alternative is construction of a storage reservoir on Urie Creek. This structure would store high quality water for municipal and industrial use in Cedar City. However, the project would reduce the flow of high quality water into Coal Creek, thus increasing the concentration of total dissolved solids. This project may also decrease the recharge to the Cedar Valley groundwater reservoir.

9.6.3 Water Conveyance and Delivery Systems

Much has been done to improve the conveyance and delivery systems for all uses. Pipelines and canal lining have been installed to reduce the loss of irrigation water. Many off-farm systems have been installed, but there is still a potential for installing over 50 miles of pipelines and canal lining. Water management with sprinkler systems is very effective in increasing on-farm efficiencies. Gated pipe is also effective where pressurized systems are not available or too costly.

Improvements have been made in systems delivering and distributing municipal and industrial water. However, there are still locations where systems need to be upgraded. By keeping distributions systems in good condition, current water supplies can be stretched to meet most of the future needs.

9.6.4 Groundwater Management

The Cedar/Beaver Basin area consists of five major groundwater basins in varying degrees of development. There is also a smaller groundwater reservoir in the Sulphurdale area. Groundwater is the primary water source for much of the area (Refer to Section 5, Water Supply and Use and Section 19, Groundwater).

Present withdrawals are mostly by individuals, private companies or municipalities. The withdrawals are not coordinated except through the legal appropriations system administered by the state engineer. Existing groundwater use is lowering the water table in some basins, drying up some seeps and springs, causing ground subsidence and allowing water from lower quality zones to intrude into better quality zones. See Section 7.3.2 for a discussion on groundwater management.

9.6.5 Transbasin Diversions

A proposal was investigated to divert water from Deep Creek in the upper Virgin River basin into Coal

Table 9-5 **POTENTIAL RESERVOIRS**[62]						
No.	Name	Stream	Location T R S	Capacity (Ac-ft)	Surface Area (Ac)	Dam Height (ft)
1	Coop Valley Sinks	Hoosier Creek	34S 8W 25	2,390	150	[b]
2	Indian Creek[a]	Indian Creek	27S 7W 35	1,110	40	83
3	Milk Ranch[a]	Indian Creek	27S 6W 34	800	32	84
4	North Creek	North Creek	28S 6W 29	790	26	87
5	Little Creek	Little Creek	33S 7W 32	1,100	59	71
6	Summit	Summit Creek	34S 10W 36	1,500	80	[b]
7	Urie	S Creek Coal Cr	37S 10W 8	5,000	85	170
8	Holt Canyon	Meadow Creek	37S 16W 10	1,250	80	54
9	Upper Pinto	E Fork Pinto Cr	38S 15W 1	1,060	57	64
10	Indian Rock	Shoal Creek	37S 17W 7	1,680	122	97

[a] Alternate sites for water storage.
[b] Value unknown.

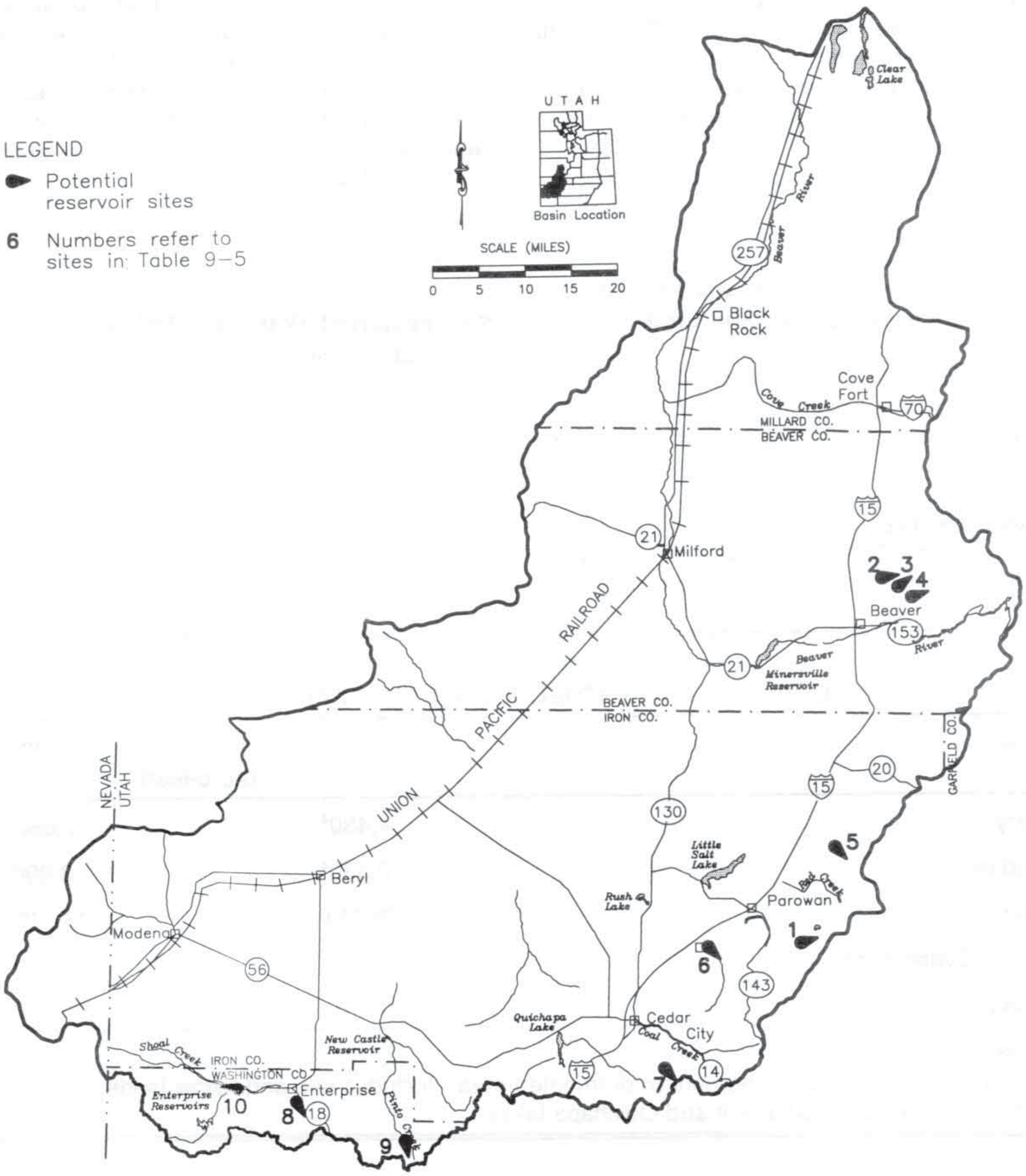
Creek. This water would then flow into the Cedar City area to provide municipal and industrial water and recharge the groundwater reservoir.

During the early 1950s, a discussion between Iron County and Dixie Project officials was held to explore diverting Virgin River water into Cedar City. Assisting in the discussion, the Utah Water and Power Board appointed a committee to consider the needs of Washington and Iron counties. After some preliminary considerations, Cedar City looked to Kolob Creek in the Virgin River basin. In August 1953, Cedar City entered into an agreement with Washington County and the newly formed Kolob Reservoir and Storage Association (water users from Hurricane and Washington Fields). The agreement was to construct the Kolob Dam and Reservoir with Cedar City repaying two-fifths of the cost of construction and allowing them to acquire the entire water supply in Kolob Reservoir when the Dixie Project was completed. When the Dixie Project was abandoned in the early 1970s, a substitute reservoir was needed to comply with the agreement. A study was completed in 1982 by the Utah Division of Water Resources for conveying water from Kolob Reservoir to Cedar City and constructing Bullock Dam for use by Washington County water users as a replacement supply for Kolob water.

In 1984, an agreement between Cedar City and Washington County Water Conservancy District (WCWCD) outlined opportunities for Cedar City to develop water in the Virgin River basin. The agreement provided that if Cedar City decided not to construct facilities for transbasin diversion of water from the upper Virgin River drainage by December 1994, WCWCD would reimburse Cedar City for the amount paid plus interest towards the cost of construction of the Quail Creek project. The WCWCD would then purchase Cedar City's two-fifths interest in Kolob Reservoir along with associated water rights and property.

Cedar City and the Division of Water Resources completed a study in March 1993 to evaluate water supply, demand and development opportunities for Cedar City. The report includes an updated evaluation of several transbasin diversion alternatives, some of which have been previously studied.[6] Some of these alternatives are briefly described below.

Figure 9-1
POTENTIAL RESERVOIR SITES
Cedar/Beaver Basin



SOURCE: USDA WATER AND RELATED LAND RESOURCES SUMMARY REPORT, BEAVER RIVER BASIN & STATE ENGINEERS OFFICE.

The existing diversion of water from the upper Santa Clara River in Grass Valley could be increased by diverting water upstream from Pine Valley Reservoir. This water could then be delivered to Cedar City by way of Newcastle Reservoir or by direct pipeline. Pumping water from Quail Creek Reservoir in the Virgin River basin directly to Cedar City has been considered. This would require staged pumping to gain 3,300 feet in elevation. Pumping costs and maintenance would be high.

Another alternative entails pumping water directly from Ash Creek Reservoir in the Virgin River Basin into the Cedar City area. This water would recharge the groundwater reservoir near the city well by Quichapa Lake. The pumping costs would be high, although less than pumping from Quail Creek Reservoir.

In December 1994, Cedar City opted not to pursue the Quail Creek-Kolob Reservoir diversion of water from the Virgin River Basin into the Coal Creek drainage.

9.6.6 Cloud Seeding

One way of developing additional water resources is through cloud-seeding. This is an acknowledged method of increasing the water supply within a selected area. To be the most effective, the right conditions must exist. The state of Utah recognized this need and, through the Division of Water Resources it has given financial assistance to a winter cloud-seeding project.

By seeding the clouds during the winter months, additional snowpack can be produced in the mountains with a subsequent increase in the spring runoff. When comparing the amount of precipitation in the seeded or target area to that of a nearby control (unseeded) area, average seeding effects were estimated to be 12-16 percent. A conservative economic evaluation of this increase indicates water is being developed for about one dollar per acre-foot.

9.6 Projected Water Depletions

Current and projected water depletions in the Cedar/Beaver Basin are shown in Table 9-6. Irrigation uses are expected to remain about the same or decline slightly as more water is transferred to culinary use. Most of the declines will occur in Cedar Valley. ■ ■

Table 9-6
CURRENT AND PROJECTED WATER DEPLETIONS

Use	1990	2020
	(Acre-feet)	
Culinary	4,480[a]	7,680
Secondary	2,330[a]	3,090
Irrigation	178,740	178,740[b]
Reservoir Evaporation	2,120[c]	2,120[c]
Total depletion	187,670	191,630

[a] 1992 data
[b] Assumed no change in cropping pattern or irrigated area. Includes idle and fallow lands.
[c] Does not include Rush, Little Salt and Quichapa lakes.

Section 10 Contents

Section 10 State Water Plan - Cedar/Beaver Basin

Agricultural Water

10.1 Introduction

This section describes the agricultural industry in the basin. It also discusses the problems, needs and future of agriculture.

The success of the agricultural industry is dependent on the climate and the water supply. Refer to Section 3.3.2 for a more complete discussion of the area climate. Section 5.4 gives information on the total water supply available.

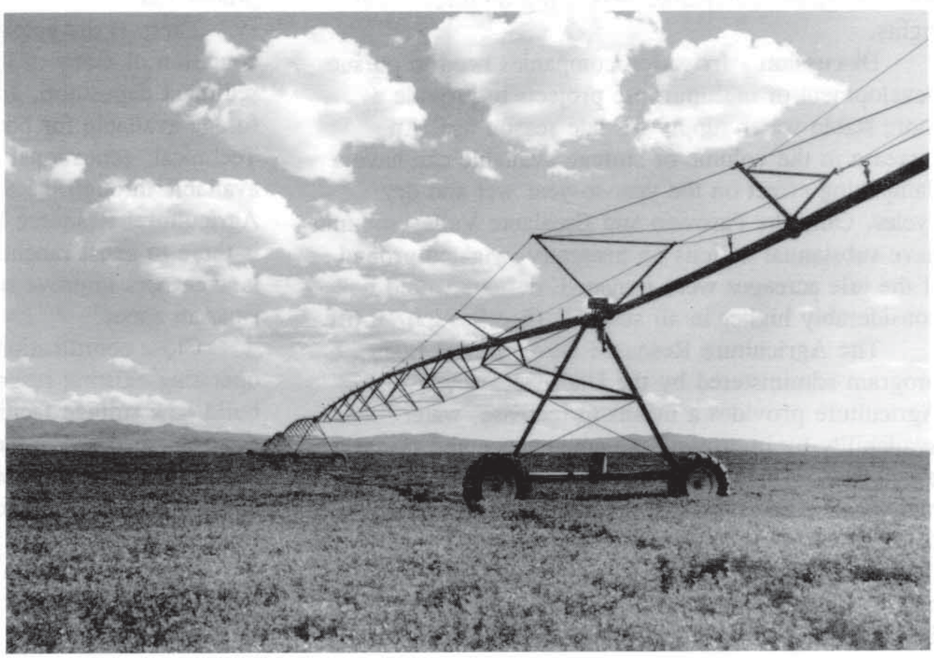
With agriculture being a major industry in the basin, it has a direct impact on the economy of the area. Spinoff from agriculture helps support employment and production in other sectors along with providing economic diversity.

Much of the basin contains arable soils but they cannot be cropped because of lack of irrigation water or insufficient precipitation. Other areas are restricted because of the topography, i.e., rolling hills, cliffs and mountains. Nearly all of the area is suitable for grazing, although it is not all utilized. Typically, the irrigated cropland is in the valley bottoms where the land is relatively flat. Much of the non-irrigated, dry cropland areas are located in the higher mountain valleys and benches where there is arable land and sufficient precipitation.

■ Agriculture is the largest industry in the basin, growing mostly crops to support livestock production and for export. Late season water shortages are a problem.

10.2 Background

There are about 130,450 acres included in the water-related land use inventory of the Cedar/Beaver Basin.[17] This includes 6,010 acres of wet areas and open water and over 13,630 acres of residential and industrial areas. Irrigated cropland amounts to about 110,810 acres or only 3.1 percent of the total basin area of 3.62 million acres.



Near Enterprise

Rangeland is found from the low lying desert areas to the high mountain forest lands.

The number of farms has decreased by about one-third over the years.[69] This has been accompanied by an increase in the average farm size. This reflects the need for more acreage to maintain a viable farm unit. An increase in the number of hobby farms may offset this trend. Also, as more farmers seek outside employment and they in effect, become part time farmers, the average farm size may decline. The average farm in the basin contains about 1,050 acres. The average farm size has about doubled since 1950. There may be a continual adjustment as existing irrigated cropland is converted to other uses and additional land is brought into agricultural production. Water for agriculture is limited. Over the long-term, the acreage will probably decline slightly, reversing past increases.

Cattle production is currently the major farm-related industry. This industry consists primarily of cow-calf operations with some beef feeding and dairies. Most of the crops grown are used to support these activities along with the pasture and rangelands.

10.3 Policy Issues and Recommendations

There are two policy issues involving agriculture. These are late season irrigation water shortages and watershed areas with critical erosion.

10.3.1 Agricultural Water Supply Shortages

Issue - Late season water supply shortages effect some irrigation companies depending on direct flow rights.

Discussion - Irrigation companies need to pursue development of multipurpose projects to provide a more stable water supply for late season use. An increase in the volume of storage available can have a dampening effect on the year-to-year wet and dry cycles. Only the Parowan and Escalante Valley subunits have substantial deficits on presently irrigated ground. If the idle acreages were irrigated, deficits would be considerably higher in all subunits (See Section 10.6).

The Agriculture Resource Development Loan program administered by the Utah Department of Agriculture provides a means to increase water availability by improving the conveyance and on-farm efficiencies. This can be accomplished by the timely maintenance and repair of diversion and delivery facilities. In some areas, new structures and canal lining or pipelines are needed. However, structural measures can be ineffective without good management. On-farm best management practices can be a boon to efficient water conservation goals as well as increasing profits for farmers.

One adverse effect of increasing water use efficiency in some areas is the reduction in deep percolation. This reduces the recharge to the groundwater reservoir. To offset this, however, there is a reduction in the leaching of salts into the groundwater and the maintenance of a higher quality of water.

Recommendation - Irrigation companies, with the assistance of the appropriate local, state and federal agencies, should move to protect and improve their water supplies by implementing water conservation programs and multipurpose projects where possible.

10.3.2 Watershed Management

Issue - Many areas of severe and critical erosion exist in watersheds of the basin.

Discussion - Excessive sediment yield from both natural source areas and man's activities result in lower value wildlife habitat, degraded fishery values, less rangeland forage for grazing and poorer surface water quality. This indicates some lands are out of ecological balance in many of the sensitive areas around the basin.

Considerable work has been accomplished to improve the rangeland conditions in some areas. Rangeland improvement was part of the Minersville and Greens Lake Watershed projects. Other smaller tracts of rangeland have been improved at locations around the basin. These all generally consist of chaining brush and pinyon-juniper stands and reseeding with grasses to reduce erosion and increase feed production.

There is the potential to improve the watershed condition of many of these lands, reduce erosion and sediment deposition, and at the same time increase the forage available for both livestock and wildlife. Technical, educational and financial assistance are available through the Soil Conservation Commission's Agricultural Resource Development Loan program. It is there to assist ranchers and farmers and other private land owners improve rangeland, cropland, wetlands and riparian zones.

Close coordination among agencies and entities operating existing reservoirs or proposing to enlarge or build new storage facilities is needed. Improvement of the watershed above these structures could be carried out to maximize the use of available resources. In other areas, rehabilitation and management of the watershed can reduce erosion and increase forage production.

Recommendation - The Soil Conservation Commission and its local soil conservation districts, working closely with the Natural Resources Conservation Service, Forest Service, Bureau of Land Management and private land owners, should evaluate all lands of the watersheds for potential improvement projects and implement those which are feasible.

10.4 Agricultural Lands

Lands used for agriculture cover a major portion of the Cedar/Beaver Basin. These lands are in all kinds of ownership and administration categories: private, state and federal. Most of the acreages used for grazing are under federal administration.

10.4.1 Irrigated Cropland

Lands used for farming can be defined according to their agricultural production ability and potential. There are two major categories defining the best farmlands: prime farmlands and farmlands of statewide importance. The national definitions for farmlands of statewide importance have been modified for application to the state of Utah. Land designated as prime may not be the most productive. It will, however, have the best combination of physical and chemical characteristics for producing food, feed, forage and other crops. To insure long-term production, these lands must be managed according to their inherent capabilities. There are about 38,000 acres of prime farmlands and 16,000 acres of farmlands of statewide importance.

Prime farmlands have a dependable water supply (eight or more years out of 10 years), favorable climate, little flooding or erosion, good quality soils and no water table problems. Farmlands of statewide importance have a dependable water supply (five to eight years out of 10 years), good climate, some flooding or erosion, good quality soils and a water table that does not prevent crop production. Farmlands of statewide importance do not qualify as prime farmland because the water supply is less dependable, lands are steeper with more erosion and they require more management.

The Division of Water Resources completed a water-related land use survey of Cedar/Beaver Basin cropland areas in 1989 and determined there are 110,810 acres of irrigated cropland. The major crops grown include alfalfa, 61 percent; pasture, 11 percent; small grains, 8 percent; potatoes, 3 percent and corn silage, 2 percent. There is a substantial portion (13 percent) of the cropland in any given year that is either idle or fallow. The irrigated land by crop is shown in Table 10-1.

Most of the crop production is used to support the livestock industry although alfalfa is shipped out of the area, primarily to Nevada and California. Most of the

Early May's morning sun harvests frost and icicles from alfalfa and fences near Beaver.

exported alfalfa is from the Milford and Beryl-Enterprise areas.

There has been an increase in the area of irrigated land over the years. In 1949, the total irrigated area was 58,490 acres. This had increased to 85,910 acres by 1965 and 110,810 acres by 1989. Some of this can be attributed to increased on-farm irrigation efficiencies through land leveling, canal and ditch lining, and pipelines with gravity sprinklers. Better irrigation water management has also helped increase the irrigated acres. Increased use of groundwater is the supply for the majority of the irrigation of additional acres of cropland. Installation of sprinklers in pump areas has increased the irrigation efficiency, which in turn accounted for some increase in the total acres irrigated. These trends are shown in Table 10-2. Most of the changes reflect the available water supply. Also see Table 5-10 for more detail on the current irrigation water use.

10.4.2 Dry Cropland

There are about 38,460 acres of dry cropland (non-irrigated) in the basin. Nearly 60 percent of this is located in Parowan Valley and Cedar Valley. About two-thirds of the total dry cropland is either idle, fallow or not cropped for other reasons on any given year. Most of the dry cropland produces grasses that are grazed by livestock. These grasses are native and exotic varieties. Very little dry cropland is used for small grain production.

10.4.3 Rangelands

Over 90 percent or 3.3 million acres of the Cedar/Beaver Basin area is used for grazing purposes. Some of this land is forested, but it is also grazed. Much of the grazed area is located in the lower elevations, making it suitable for winter grazing.

Permitted grazing on public lands declined after the 1940s, but since then it has remained stable or

Table 10-1
IRRIGATED LAND BY CROPS[17]

Crop	Beaver	Iron	Millard (Acres)	Washington	Total
Fruit	0	15	0	0	15
Small grain	2,361	6,229	11	221	8,822
Corn Silage	1,902	648	26	5	2,581
Vegetables	0	94	0	1	95
Potatoes	100	3,250	0	191	3,541
Onions	0	0	0	0	0
Beans	0	0	0	0	0
Other Row Crops	0	0	0	0	0
Alfalfa	22,800	43,207	29	1,149	67,185
Grass Hay	1,397	464	0	104	1,965
Grass/Turf	21	64	0	0	85
Pasture	6,305	4,790	82	384	1,561
Fallow	435	1,368	0	75	1,878
Idle Overgrown	3,379	8,603	232	457	12,671
Pasture (surf. & subs.)	266	0	0	0	266
Grass Hay (surf. & subs.)	0	0	0	0	0
Surface Subtotal	38,966	68,732	380	2,587	110,665
Subsurface Subtotal	141	7	0	0	148
Total	39,107	68,739	380	2,587	110,813

Table 10-2
IRRIGATED CROPLAND CHANGES (Acres)

Subarea/County	1949	1965	1989
Beaver[a]	8,980	13,100	18,040
Milford	13,230	19,450	21,450
Beaver County	22,210	32,550	39,490
Cedar	11,410	16,780	17,000
Parowan	5,460	8,030	19,060
Beryl	17,990	26,470	32,680
Iron County	34,860	51,280	68,740
Enterprise	1,420	2,080	2,580
Washington County	1,420	2,080	2,580
TOTAL	58,490	85,910	110,810

Source: Data for 1949 were taken from the Beaver River Basin Summary Report, USDA-DNR Cooperative Study which referenced the U.S. Census of Agriculture.

Data for 1965 were from an inventory made cooperatively by the Soil Conservation Service and the Division of Water Resources and summarized in Appendix II, Present and Projected Resource Use and Management, completed as part of the above cooperative study.

Data for 1989 were taken from Water-Related Land Use Inventory of the Cedar/Beaver Study Unit conducted by the Division of Water Resources.

[a] Includes 380 acres in Millard County.

increased slightly in some areas. There has been considerable work done in localized areas to increase livestock and wildlife forage on rangelands with practices such as pinyon-juniper and brush chaining and reseeding with grass. Management practices have been improved over the years. The rangeland condition shown in Table 10-3 indicates opportunity for improvement. Forage production varies greatly between types of vegetation, range condition, and good and bad years. Range in fair condition produces only 50 to 80 percent as much forage as range in good condition. Variations from good to bad years can reduce forage production 40 to 70 percent.

There are about 325,000 animal unit months (AUMs) of grazing produced in the basin. An AUM is the amount of forage needed to sustain one 1,000 pound cow and a calf for one month. Table 10-4 shows the number of AUMs produced by land status. The Bureau of Land Management has allocated about 11,000 AUMs for wildlife and 8,000 AUMs for wild horses in Beaver and Iron counties. The Forest Service estimates about 10 percent of the total AUMs on national forest lands is utilized by wildlife.

10.5 Watershed Management

Watershed management is the protection, conservation and use of all the natural resources of a specific watershed in such a way as to keep the soil mantle in place and productive. It is also to assure water yield and water quality meet the existing and potential uses. If not properly protected, watershed lands are readily damaged from erosion, floods, sediment and fire. Following are some of the treatment measures used to keep the watersheds a viable producer of resources.

- Livestock and wildlife grazing management.
- Vegetation improvement of the cropland, rangeland, pastures, forest land, pasture land, wetlands, riparian zones and other areas. Also,

W.S. No.	Name	Total Area (Acres)	Rangeland Area (Acres)	Rangeland Condition Excellent/ Good (Acres)	Rangeland Condition Fair (Acres)	Rangeland Condition Poor/Very Poor (Acres)
1	Clear Lake	462,900	407,900	48,900	308,600	50,400
2	Black Rock	341,400	311,400	62,200	211,800	37,400
3	Cove Fort	49,800	48,800	4,900	29,300	14,600
4	Beaver	323,100	298,100	35,000	221,600	41,500
5	Twin M	357,600	327,100	33,700	205,100	88,300
6	Fremont Wash	249,800	230,800	21,200	186,500	23,100
7	Thermo	648,300	573,500	41,200	377,500	154,800
8	Escalante Valley	567,700	520,700	51,300	365,300	104,100
9	Coal Creek	309,600	294,600	29,500	183,600	81,500
10	Pinto	166,900	153,900	21,600	103.800	28,500
11	Shoal Creek	139,700	132,700	13,300	95,800	23,600
Total		3,616,800	3,299,500	362,800	2,288,900	647,800
	Percent of Rangeland		100	11	69	20

Table 10-3
RANGELAND CONDITIONS

Note: Rangeland condition total acres do not agree with basin total as some areas are not used as rangeland or were not rated.

Table 10-4
AUM PRODUCTION

Land Status	Production (AUMs)
Private	98,000
State	16,000
Public Domain	185,000
National Forests	26,000
TOTAL	325,000

conservation tillage protection on cropland in the lower watershed coordinated with grazing management. Improved cropping sequences, pasture and hayland management and improved irrigation systems and management are important.

- Structural measures, such as contour trenching, debris basins, gully control, and stream channel stabilization, all in conjunction with vegetation improvement and grazing management.
- Spring areas protected from wildlife and livestock by fencing. Watering facilities provided outside the fenced area.

For the purposes of this plan, the basin has been divided into 11 watershed units as shown in Figure 10-1. These watershed delineations were made during the interagency Conservation Needs Inventory. Table 10-3 gives the areas and describes their range condition. These are areas where the use, treatment and conservation of resources can be carried out as a unit.

Erosion is a problem in parts of the basin. This is particularly true in areas where sparse plant cover provides little protection to the soil. Intense thunderstorms frequently produce flash floods, eroding the landscape. Heavy rains soon after fires also causes increased erosion. In these areas, a majority of the erosion is geologic or background, but in some areas it has been accelerated by mans activities and wildlife mismanagement.

The degree of erosion can be measured by the amount of soil eroded in tons/acre/year or inches of soil lost. It can also be described by the sediment yield condition. This is the measured percent of total area that is yielding a given percent of the sediment. The higher the percent of yield and the smaller the yielding area; the greater the erosion problem. For purposes of this report, sediment yield class is used to describe areas with high erosion rates where there is a need for watershed improvement. These classes are described below.

Areas where erosion is critical can be divided into two categories; one where erosion is background or geologic and another where erosion has been accelerated by man's activities. Both of these categories are eroding at a rate greater than 0.010 inches per year and are included in Class 2. The areas of accelerated erosion for drainages where watershed treatment is needed are shown in Table 10-5.

CLASS 2 (high yield) - 12 percent of the total area is yielding 35 percent of the sediment;

CLASS 3 (moderate high yield) - 48 percent of the total area is yielding 51 percent of the sediment;

CLASS 4 (moderate yield) - 24 percent of the total area is yielding 12 percent of the sediment and;

CLASS 5 (low yield) - 16 percent of the total area is yielding 2 percent of the sediment.

Sediment yields from CLASS 2 (also called critical or accelerated erosion) areas are at least three times the modelled rates for land in good condition. This is due to man's activities, mostly overgrazing and some timber harvesting, along with wildlife management issues. This excessive sediment production is depleting the watershed values. It is reducing wildlife habitat, degrading fishery values, increasing sediment deposition and decreasing rangeland grazing values.

The accelerated erosion areas (Class 2, high yield) for each of the watersheds are shown on Figure 10-1. The erosion (sediment yield) data was derived from regional broadbase assessments. Detailed studies would be necessary to characterize the present and future sediment yield condition.

10.6 Agricultural Water Problems and Needs

The water budget analysis for the Cedar/Beaver Basin determined the water supply, use and outflow. The budget shows the consumptive use deficit on presently irrigated cropland, not including idle and fallow lands, is 4,930 acre-feet. The deficit by subarea is as follows: Upper Beaver, 0 acre-feet; Milford, 20 acre-feet; Lower Beaver, 0 acre-feet; Parowan, 1,790 acre-feet; Cedar, 270 acre-feet; and Escalante Valley, 2,850 acre-feet.

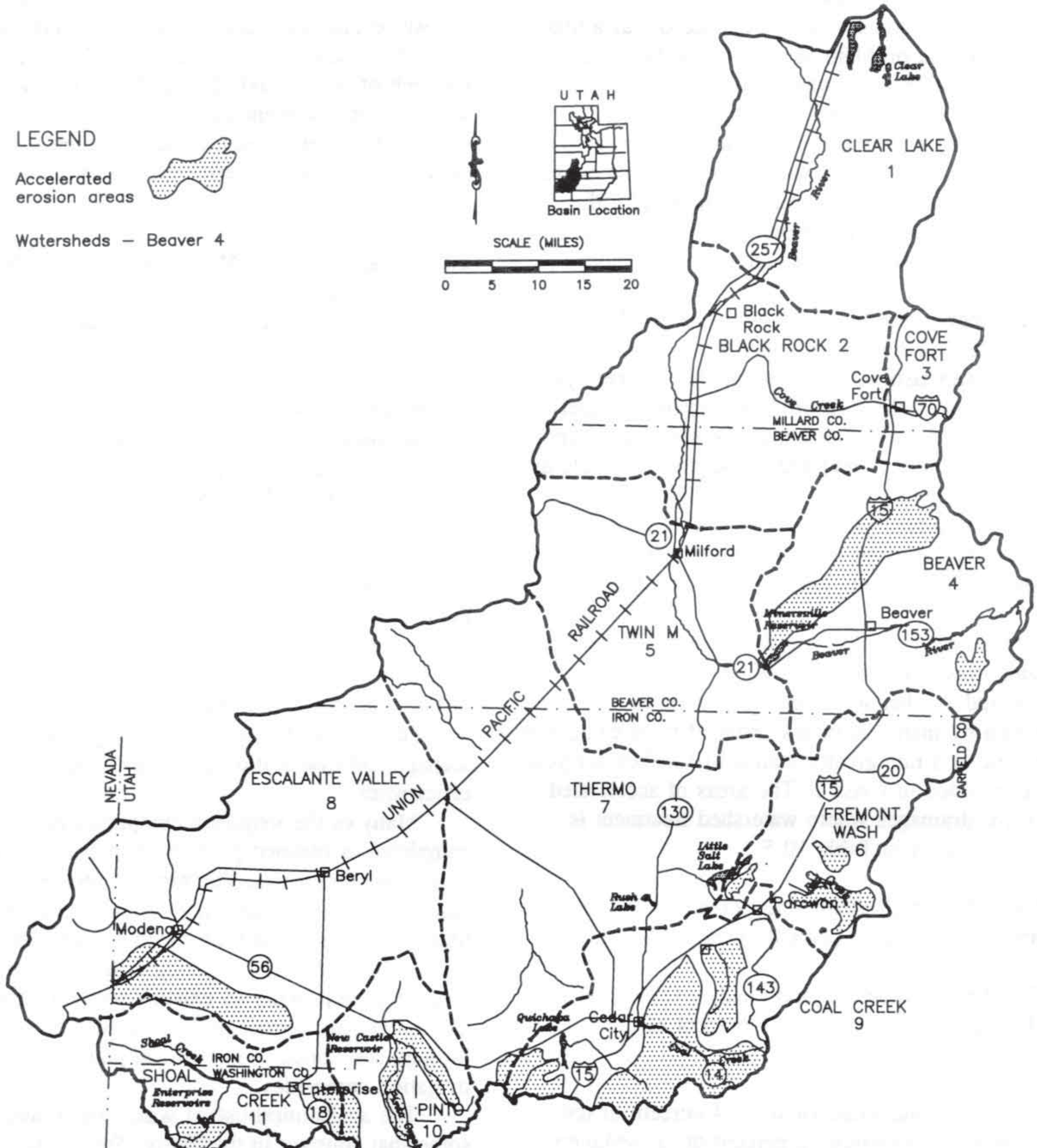
Irrigation of crops on presently irrigated lands depletes 188,510 acre-feet of water annually. Water budget and other background information shows there is an agricultural water deficit in the Parowan and Escalante valleys. The deficit amounts to only 4 percent of the total irrigated cropland consumptive use. The water deficit can be reduced in many cases by reducing seepage and evaporation and improving irrigation efficiencies.

Many of the irrigation companies have already completed or planned projects to improve overall irrigation efficiencies. The projects include reducing seepage losses by improving system management, lining canals and installing pipelines. Projects to reduce onfarm losses include selecting a different irrigation method or improving an existing method. Operation and maintenance procedures have been recommended through soil conservation district plans to some of the irrigation companies.

The agricultural use of water will remain somewhat constant in the future. Some lands will be taken out of production as existing water supplies are transferred to other uses. In some areas, new replacement lands may be developed if some of the existing water is available for agricultural uses. Current and projected areas, diversions and depletions for irrigated cropland are shown in Table 10-6.

In some areas, particularly where rangeland is used for grazing, water quality may be impacted where

Figure 10-1
ACCELERATED EROSION AREAS
Cedar/Beaver Basin



SOURCE: USDA WATER AND RELATED LAND RESOURCES SUMMARY REPORT, BEAVER RIVER BASIN.

Table 10-5 ACCELERATED EROSION	
Drainage	Accelerated Erosion (Acres)
Indian Creek	4,400
Wildcat Creek	30,400
Beaver River	2,800
South Creek	400
Little Creek	6,400
Red Creek	4,300
Parowan Creek	,900
Summit Creek	10,900
Braffits Creek	6,600
Fiddlers Creek	6,700
Coal Creek	30,900
Shurtz Creek	14,800
Quichapa Creek	4,500
Pinto Creek	4,400
Little Pinto	5,000
Meadow Creek	3,900
Shoal Creek	13,100
TOTAL	154,400

livestock and wildlife concentrate for watering. There is a need to improve and provide watering facilities to better distribute livestock and wildlife.

10.7 Agricultural Water Conservation and Development Alternatives

One way of reducing the groundwater contamination and realizing additional monetary benefits from the existing water supply is to improve water use efficiency. Water use efficiency can be evaluated in two parts: off-farm conveyance and on-farm application. Delivery systems can be upgraded by lining high seepage areas in canals with concrete or installing pipelines. Installing or upgrading diversion structures and effective measurement and management controls can also increase efficient use of water. Construction of additional reservoir storage, if it can be done as part of a project for other purposes to make it affordable, can also help make better use of the existing water supplies (See Section 9.6.2, Surface Water Storage Facilities).

Irrigation practices on individual farms have more potential to improve water use and management than any other activity. Conveyance system improvements to reduce seepage can help maintain groundwater quality.

There are many incentives to improve efficiencies and conserve water. Where there is a shortage of irrigation water, increased efficiencies can make water go further and increase the number of acres with a full supply. Increasing irrigation efficiencies can also reduce the cost of irrigation. By applying less water to irrigate crops, there will be less deep percolation into the groundwater reservoir. This will reduce leaching of salts and help maintain a good quality groundwater. Financial incentives are available through several state and federal programs. See Section 8 for more information on funding. ■ ■

Table 10-6
CURRENT AND PROJECTED IRRIGATED CROPLAND WATER USE[22]

Year	Area (Acres)	Diversions (Acre-feet)	Depletions (Acre-feet)
1990	110,810	318,790	178,740
2000	110,810[a]	312,410[b]	178,740[c]
2020	110,810[a]	299,910[b]	178,740[c]

[a] Assumes no net change in total irrigated lands.
[b] Reflects an increase in overall irrigation efficiency of 0.2 percent per year.
[c] Assumes no cropping pattern change and that idle and fallow land acreages remain constant.

Section 11 Contents

Drinking Water

11.1 Introduction

This section discusses the public and private water supplies in the Cedar/Beaver Basin. It reviews the systems and their condition. Even though public and private water suppliers provide water for other uses, the primary purpose is for the benefit of people. A public water supply system is defined as one serving at least 15 connections or 25 people 60 days per year.

11.2 Setting

The water supply for all public and private systems in the basin comes from springs and wells. The earliest settlers were quick to pipe spring water to the community to assure a high quality, readily available supply. The quality of the water from springs used for culinary purposes has remained about the same. However, protection of spring areas is mandatory to prevent pollutants from entering these sources of culinary water.

It is expected that most future demands will be met from groundwater supplies. Surface water is not readily available and is also more expensive to develop and treat.

Since a heavy industrial base does not exist, population is the main factor controlling water demand. The amount of culinary water used for irrigating lawns and gardens can substantially impact the daily culinary water use. Culinary water use is measured in gallons per capita per day (GPCD).

The Division of Water Resources recently contracted to obtain more detailed data of current municipal and industrial water use in the Cedar/Beaver Basin.[19] Data from this study were used to determine current uses based on the year 1992.

The total system capacity to deliver water to customers was determined. This is generally less than the volume of supply (source capacity) available. If not, it indicates system capacity will have to be enlarged when the number of

■ Culinary water is always in demand and constant protection is needed to assure a high quality supply. Expected growth will require additional supplies.

Newcastle Reservoir

customers increases. This data are shown in Table 11-1.

The total municipal and industrial (M & I) use is also shown. This is the volume of water delivered to all customers served by the public community water suppliers. This does not include other uses not served by a public community system. It includes residential uses inside and outside the home and commercial, industrial and municipal uses. All of these uses are delivered from water supplies suitable for culinary use.

As can be seen, some communities have reached the limit of their source and/or system capacity. When the demand for deliveries increases, additional water supplies will have to be found. The gallons per capita day (GPCD) use is shown in Table 11-2. The

Table 11-1
PUBLIC COMMUNITY WATER SUPPLY AND USE[19]

Water Supplier	Total Source Capacity (Acre-feet)	Total System Capacity (Acre-feet)	M & I Use (Acre-feet)
Beaver	1,572	700	677
Manderfield	306	127	18
Milford	2,194	934	395
Minersville	960	403	315
Beaver County Total	5,032	2,164	1,405
Angus	142	61	22
Brian Head	604	259	259
Cedar City	14,741	6,354	4,314
Enoch	639	637	639
Escalante Valley	40	21	13
Meadows Ranch	437	184	96
Mid-Valley Estates	181	77	21
Monte Vista	60	44	42
Mt. View	100	47	47
New Castle	150	149	150
Old Meadows	140	61	20
Paragonah	212	98	55
Park West	74	43	42
Parowan	1,606	745	297
Rainbow Ranchos	65	33	16
Summit	171	71	73
Iron County Total	19,362	8,884	6,106
Enterprise	1,043	537	538
Washington County	1,043	537	538
Basin Total	25,437	11,585	8,049

Note: Totals do not include uses outside public water supplier areas. Data based on 1992 values.

Table 11-2 CULINARY WATER DIVERTED PER CAPITA DAY[19]			
Water Supplier	Per Capita Use (Gallons)	Water Supplier	Per Capita Use (Gallons)
Beaver County	253	Mt. View	446
Beaver	188	New Castle	518
Manderfield	402	Old Meadows	509
Milford	321	Paragonah	152
Minersville	464	Park West	375
Unincorporated	253	Parowan	143
Iron County	268	Rainbow Ranches	107
Brian Head	304	Summit	393
Cedar City	277	Unincorporated	268
Enoch	268	**Washington County**	411
Escalante Valley	134	Enterprise	411
Meadows Ranch	411	Unincorporated	411
Mid-Valley Estates	312	**Basin Average**	272
Monte Vista	250	**Statewide Average**	265

use appears to be quite variable. Much of this can be attributed to use of culinary water to irrigate lawns and gardens and for golf courses, parks, cemeteries and other outdoor facilities. Use can also vary for different times of the year as there is more outside use during the summer months than during the winter.

The 1992 basinwide average culinary water use per capita day (GPCD) is 272 gallons. The statewide average was 265 gallons in 1991. The GPCD use in the cities and towns ranges from 143 in Parowan to 464 gallons in Minersville. The use rate for other public community systems ranges from 107 at Rainbow Ranchos to 518 at New Castle. The use at New Castle is now considerably less (140-160) since the town installed a secondary system. The GPCD for Brian Head was modified to account for the high proportion of visitors throughout the year.

Much of the variability between cities can be attributed to the amount of culinary water used for outside irrigation. For instance, data for New Castle were gathered before they installed a secondary system which will reduce their GPCD use. The low rates in Parowan and Paragonah indicate the effect of a secondary system.

11.3 Policy Issues and Recommendations

There are no policy issues presented in this section. Refer to Sections 7, 12 and 19 for issues that impact groundwater quality.

11.4 Local Regulatory Organizations

All public drinking water supplies are subject to the Utah Safe Drinking Water Act and the Utah Public Drinking Water Regulations. Laws and regulations are administered by the Utah Department of Environmental Quality, Division of Drinking Water, that is represented by a district engineer stationed in St. George to service the five-county area. The district engineer generally does not attempt to resolve problems.

Towns, cities and counties all have primary responsibilities for drinking water control within their respective entities. These responsibilities and authorities are contained in Sections 10, 11, 17, 19 and 73 of the *Utah Code Annotated, 1953*, amended. Private water suppliers (i.e., those serving fewer than 15 connections or 25 people) are not regulated.

In addition, the Board of Health, Southwest Utah Public Health Department, has responsibilities for controlling drinking water and individual water well installation and construction. These responsibilities and duties are carried out through their staff. They work closely with the Utah Department of Environmental Quality on related regulations.

When private water systems are proposed to serve new developments, local planning commissions often ask the local health department to evaluate the feasibility of the water supply. However, there are no specific standards regarding the design and construction of these private systems once planning commission approval is received.

11.5 Drinking Water Problems

The demand for high quality water and the potential for contamination of drinking water supplies will increase as the population increases. Much of the drinking water delivered in the basin is pumped from the groundwater reservoirs, so culinary water supplies will be impacted by declining groundwater quality.

Problems can originate from several sources. One source of poor water quality that cannot be controlled is caused by geologic (background) conditions. Other sources of contamination include refuse from human activities such as landfills, chemical contamination from agricultural activities, land use abuse, mineral exploration, mining, construction and accidental hazardous waste spills.

Sediment and salt loading from severely eroding rangeland also contributes to poor water quality. These pollutants are transported downstream to the recharge areas. See Sections 10 and 12 for more information.

There is development taking place in many of the recharge areas. This makes the groundwater recharge areas on the alluvial fans susceptible to contamination which eventually pollutes the underground water reservoirs.

These reservoirs are also used to supply water for various agricultural uses, especially irrigation. Some of the water applied to irrigate crops percolates down through the root zone and returns to the groundwater reservoirs. Through this process, which is carried out year after year, salts are leached from the soil and carried to the groundwater reservoirs. If the volume of this water exceeds the natural recharge of fresh water from other sources, the quality of the groundwater deteriorates. As a result, contamination of groundwater used for drinking has increased gradually over the years. When the groundwater supplies become contaminated with various chemical constituents to the point they do not meet the state drinking water standards, treatment will be required.

There are 43 drinking water systems in the basin including industrial self-supplied. Of these, 21 are classified "Public Community" and 22 are "Public Non-community" systems. There are 400 households in Beaver County and 900 in Iron County with private water supplies. The public community systems are rated by the Utah Division of Drinking Water. These ratings are summarized in Table 11-3. Systems with below standard water quality are not approved when no action is being taken to correct the problem. When corrective action is underway, this is indicated in the rating.

Population projections for the cities and towns in Beaver, Iron and Washington counties were made by the Governor's Office of Planning and Budget. Table 4-1, Figure 4-1 and Figure 4-2 show these projections. These estimates of future population growth are used to project culinary water needs. Most public water suppliers expect an increased demand in the next 20 to 30 years.

Cedar City for example, increased its municipal water delivery by 47 percent from 1981 to 1991. This demand is expected to double by the year 2020. Other public water systems can probably expect increases, although the amount will vary depending on such things as whether a secondary system is in place. Table 11-4 shows the current and projected culinary water diversions for incorporated cities and towns. The projected use is based on the assumption conservation is applied (See Section 17). This conservation factor is applied so the per capita use is reduced 1 percent per year from 1995 until 2010 and one-half percent per year until 2020. This value will vary from community to community.

Table 11-3
PUBLIC COMMUNITY WATER SYSTEMS RATINGS

Rating	Beaver	Iron	Washington	Total
Approved	4	14	1	19
Not Approved	0	1	0	1
Corrective Action Required	0	1	0	1
Total	4	16	1	21

Table 11-4
CURRENT AND PROJECTED CULINARY WATER DIVERSIONS BY INCORPORATED CITIES AND TOWNS

City/Town	Year			
	1992	2000	2010	2020
	(Acre-feet)			
Beaver County				
Beaver	680	760	800	800
Milford	400	570	550	530
Minersville	310	510	540	540
Iron County				
Brian Head	260	320	380	440
Cedar City	4,310	5,010	5,760	6,460
Enoch	640	810	910	1,000
Paragonah	60	60	70	70
Parowan	300	420	470	510
Washington County				
Enterprise	540	530	600	670

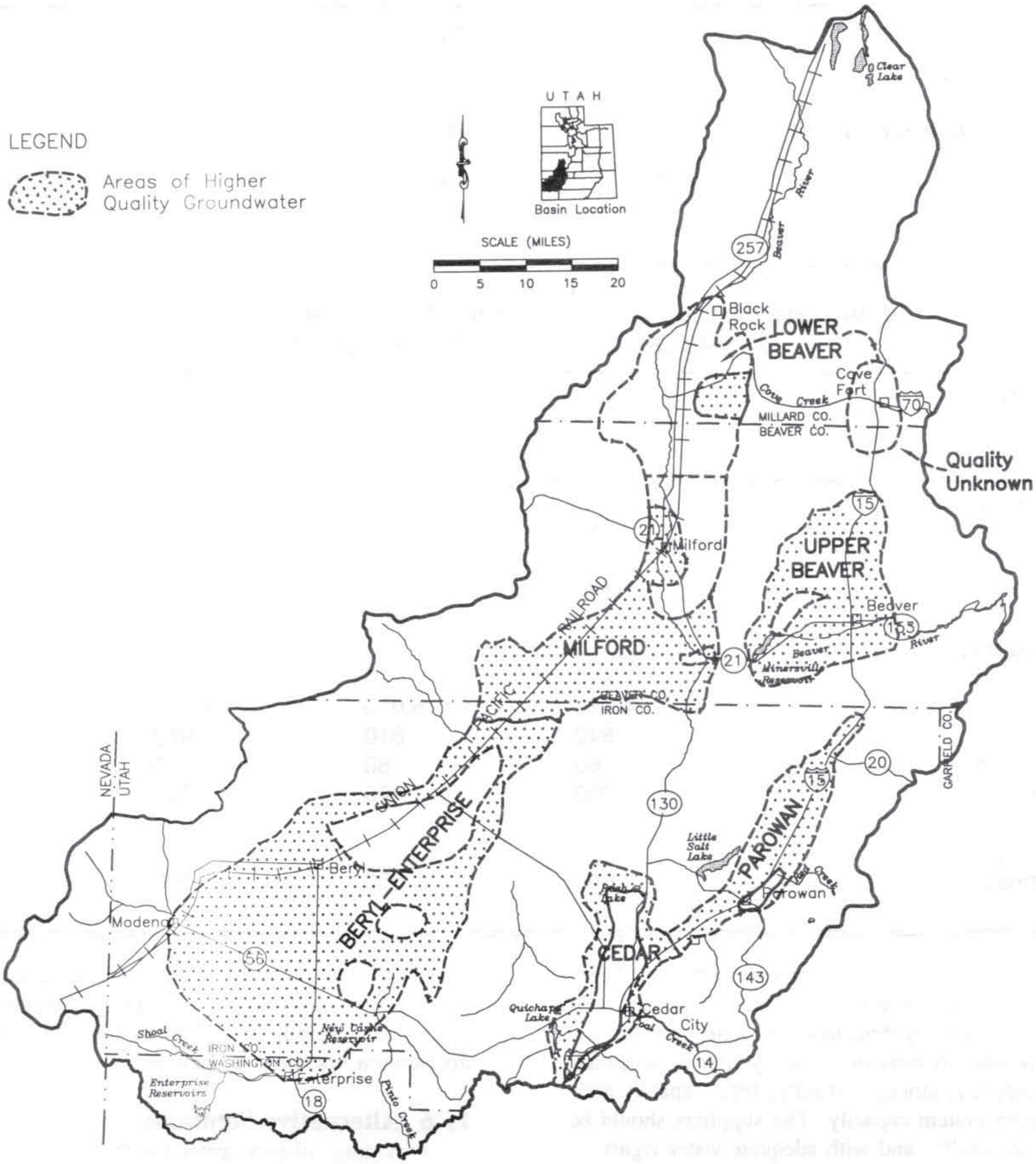
These water use projections can be used to help determine when new water supplies will be needed to meet future culinary demands. All water suppliers should be able to meet demands by four dimensions: source capacity, storage capacity, legal capacity and distribution system capacity. The suppliers should be able to physically, and with adequate water rights, meet the peak daily flow as well as the annual volume.

Storage facilities must have sufficient capacity to meet indoor water demands, lawn and garden irrigation and fire flow demands. During drought years, outside watering could be curtailed. The water distribution system capacity must be adequate to meet demands at the point of use. Even if there is adequate water at the supply source and storage sufficient to meet peak demands, it will all be for naught if the distribution system is inadequate.

11.6 Alternative Solutions

Providing culinary water for the basin's expanding population will determine the development required. The water needed could come from several sources. These include developing surface water and groundwater rights, constructing new reservoirs and converting agricultural water to municipal and industrial uses.

Figure 11-l
HIGHER QUALITY GROUNDWATER AREAS
Cedar/Beaver Basin



SOURCE: ADAPTED FORM TECHNICAL PUBLICATIONS, DIVISION OF WATER RIGHTS

Purchase of the Utah International water right at the iron mines would be an alternative supply for Cedar City. The possibility of a transbasin import from Kolob Reservoir or other sources in the Virgin River Basin has also been considered. But this alternative was recently rejected (See Section 9.6.5).

The current and projected culinary water use from wells by groundwater basin is shown in Table 11-5. At present, some of the water comes from springs, generally in the upper watershed areas. It is expected the increased use of culinary water will come from wells. Purchase of agricultural water rights has the best potential. Use of this water would have to be selective so as to use the best quality water in a given groundwater basin. The groundwater basin areas are shown in Figure 11-1.

Because of the connections between surface water and groundwater, care must be taken when either source is utilized. This situation reiterates the need for regional management of the water resources. ■ ■

Table 11-5[22]
CULINARY WATER USE FROM WELLS

Groundwater Basin	1990	2000	2010 (Acre-feet)	2020
Beaver Area	1,040	1,040	1,130	1,140
Milford Area	640	690	740	720
Parowan	840	890	1,040	1,130
Cedar Valley	1,380	1,850	2,570	2,720
Beryl-Enterprise	870	900	1,130	1,330
Total	4,770	5,370	6,610	7,040

Section 12 Contents

Tables

WATER QUALITY

12.1 Introduction

Passage of the Utah Water Pollution Control Act of 1953 ushered the state into maintaining high quality water resources. The Federal Water Pollution Control Act in 1972 brought about major changes, particularly in the wastewater treatment plant program.

The Utah Water Quality Board has adopted regulations and set water quality standards. These are enforced statewide. Significant progress has been made on improving water quality since 1972, but there is still much to be accomplished.

In 1984, the Governor of Utah issued an executive order to prepare and implement a plan for the protection of groundwater. As a result, the Utah Department of Environmental Quality prepared, and after public comment, implemented the *Ground Water Quality Protection Strategy for the State of Utah*.[4]

12.2 Setting

There are two types of water pollution, background pollution from geologic contributions and those that are man caused. Man caused pollution comes from either point or non-point sources (NPS).

Pipe discharges from such things as industrial processes or wastewater treatment plants are examples of point sources. Cedar City is the only discharge permittee in the Cedar/Beaver Basin. Many of the communities use individual family septic tanks. The balance of the communities use lagoons. The communities with wastewater treatment facilities are listed in Table 12-1.

NPS pollution comes from diffuse sources such as overland flow from agricultural land or from gully erosion. Other NPS pollution comes from rangeland uses, mining, construction and urban runoff. For example, there is the potential for groundwater contamination from runoff from mine tailings around the area. Also, where these materials are used in construction, an additional source of pollution is introduced.

Streams in the basin flow from areas considerably different from each other in geology, land use, vegetation, altitude and climate. Water quality is measurably affected by these differences. The kinds of minerals dissolved in water and affecting water quality are determined by rock and soil composition, climate, biological effects of plants and animals, and water management and use as the water flows downstream.

Geologic pollution of surface water comes from areas where sediments are eroded from the land surface and are washed into rivers and streams. The sediments

■ Safeguards to protect water quality must be provided by society as this resource is very important and often fragile. Natural environmental processes can remove pollutants from water to some extent, but there are definite limits.

Windmill near Milford

Table 12-1 WASTEWATER TREATMENT FACILITIES		
Facility	Type	Disposal Method
Beaver	Lagoon	Total containment
Cedar City	Mechanical	Discharging
Enterprise	Lagoon	Total containment
Milford	Lagoon	Total containment
Minersville	Lagoon	Total containment
Parowan	Lagoon	Total containment

contain various chemicals depending on the source. Geologic contamination of groundwater occurs as it moves through bedrock and alluvial aquifers, leaching out the chemicals. This type of pollution is difficult to control.

When natural erosion levels are high, it is generally because of low densities of native vegetation, steep gradients and unstable substrates. This erosion can contribute to sediment loading, turbidity, concentration of trace elements, high biological oxygen demand and salinity. Accelerated erosion from man-caused sources compounds these same problems.

The Division of Water Quality is initiating a more formal water quality planning process called the Watershed Approach. This will be a systematic effort to be carried over a five-year cycle which will cover an entire watershed and/or groundwater recharge area and will incorporate all of the divisions water quality programs. This will allow an intensified monitoring program and will fit the National Point Discharge Elimination System programs licensing cycle.

12.3 Policy Issues and Recommendations

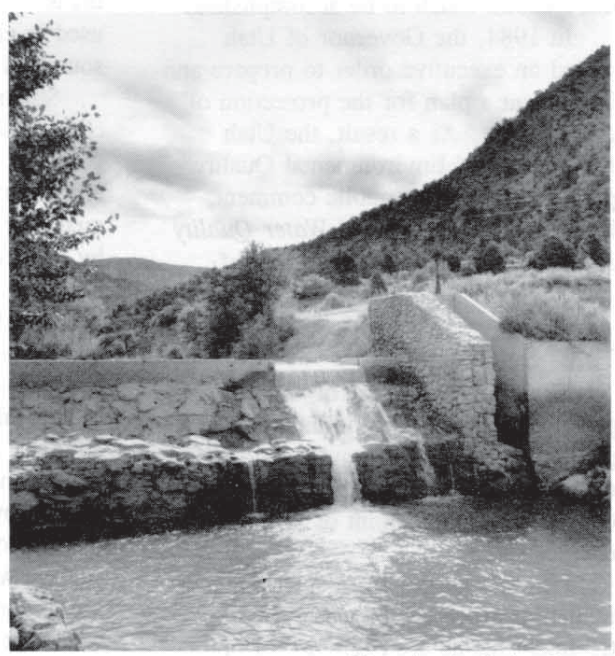
There are two issues pertaining to water quality. These concern water quality monitoring and management throughout the basin.

12.3.1 Groundwater Quality Monitoring

Issue - There is a need for more water quality data. A more intensive water quality monitoring program is needed to provide data for better groundwater management

Discussion - The water quality in all of the groundwater reservoirs in the basin is deteriorating at varying rates. This is caused by continued use resulting in recirculation of the groundwater, primarily from current irrigation practices. Water is pumped from the groundwater reservoir for irrigation and applied to the cropland. Water applied in excess of crop needs percolates beyond the root zone and returns to the groundwater reservoir. During this process, chemicals are leached from the soil into the groundwater, reducing the water quality. A more intensive water quality monitoring program will provide data for better groundwater management.

The water quality is deteriorating in the Milford and Beryl-Enterprise areas at a faster rate than elsewhere in the basin. The quality in Cedar Valley and Parowan Valley is declining slightly, while Beaver Valley groundwater quality remains fairly constant. Groundwater reservoirs are shown on Figures 5-9, 11-1 and 19-1.



Diversion in Cedar Canyon

There is potential for contamination of groundwater around Rush Lake, Little Salt Lake and especially in the Quichapa Lake area. A large part of the Cedar City culinary water supply comes from this area. If the high quality water is over pumped, a cone of depression may develop. This would allow lower quality water from the central part of the valley to intrude, contaminating the high water quality area.

In addition, more data will be needed to evaluate the new hog production facility and how it may or may not impact the groundwater quality. Data will also be needed to determine any future changes. Existing permits allow the proposed disposal of the solid and liquid wastes by a combination of anaerobic sewage lagoons and land application of lagoon-treated water to field crops. The treated water will be mixed with irrigation water and applied to crops, probably alfalfa, by sprinkler systems. Both of these, the sewage lagoons and the application of waste water to fields, will need to be monitored. This is especially a concern where there may be a possible contamination of the culinary water supplies in the future. A report is being prepared by the U.S. Geological Survey on a study of this situation.

The impact of groundwater quality problems is likely to increase in the future. Increased long-term monitoring is imperative in order to manage the groundwater reservoirs. This will require an increase in program funding. The monitoring program funding should be shared at the local, state and federal levels. However, current technology for better nutrient management and other practices to reduce or eliminate pollution of the groundwater should be used now.

Cedar Canyon

Recommendation - The Water Quality and Water Rights divisions, in cooperation with the U.S. Geological Survey, should develop and carry out a groundwater quality monitoring program with assistance from local units of government.

12.3.2 Areawide Water Quality Management Plan

Issues - The areawide water quality management plan for this area, prepared a number of years ago, is now outdated.

Discussion - A water management plan was prepared for this area over 10 years ago. This plan now needs to be updated to better deal with the existing conditions in the basin. There is a greater demand now for high quality culinary water. This need will increase into the future. In order to provide water of adequate quality for all uses, data is needed so the various water suppliers can best manage their resources. The demands for municipal and industrial water will increase faster than all other uses. Recreational demands for water-based facilities will also increase.

Recommendation - The Division of Water Quality, with assistance from other entities as needed, should update the *Five-County Areawide Water Quality Management Plan* to reflect current problems and solutions.

12.4 Local Regulatory Organizations

Towns, cities and counties all have primary responsibilities for water quality within their respective entities. These responsibilities and authorities are contained in Titles 10, 11, 17, 19 and 73 of the *Utah Code Annotated, 1953*, amended.

The Board of Health, Southwest Utah Public Health Department, also has certain responsibilities for the control of public waste water, water pollution, septic tank construction and installation, and vector (mosquito) control. These duties are carried out through their staff. The Southwest Utah Public Health Department and the Utah Department of Environmental Quality work together on related regulations and activities.

12.5 Water Quality Problems

The Five-County Association of Governments, Utah Department of Environmental Quality, U.S. Geological Survey and others have reports and data on the water quality in the Cedar/Beaver Basin.[61] These should be studied by those interested in more detailed information than is presented in this report.

Water quality problems in the basin can be caused by one or more of several sources. Pollution from natural geologic conditions is almost impossible to control. This type of pollution becomes more evident as the high water quality in the upper watersheds decreases as the rivers and streams flow downstream.

Other sources of pollution include contaminants from man-caused non-point sources. Runoff from pastures and over-fertilization of agricultural croplands can also pollute water supplies. Concerns have been expressed about contamination from sewer lagoons and dense concentrations of septic tanks. There are also concerns about water treatment plant effluent contaminating the groundwater. Bacterial contamination can be a problem along with chemical pollution.

To help control the water quality, the streams and lakes in the state of Utah are assigned standards for maximum contaminant levels according to four major beneficial use designations.

These uses are (1) As a source for drinking water (2) for swimming and indirect contact recreation, (3) stream/lake/wetland dependent fish and wildlife and (4) agriculture.

12.5.1 Surface Water Quality Problems

Surface water quality measurements were conducted on selected streams during the 1960s.[62] Coal Creek yields more sediment volume than any other stream in the basin. Concentrations varied from 200 to 500 mg/l during base period flows of 20 to 30 cubic feet per second (cfs). Flood flows of 1,200 cfs yielded sediment concentration of nearly 700,000 mg/l or 2.3 million tons per day. The total dissolved solids (TDS) ranged from 447 mg/l to 1,410 mg/l.

Sediment loads in the Beaver River ranged from 2 mg/l to over 1,200 mg/l. The TDS ranged from 64 mg/l to 163 mg/l near Beaver. At Adamsville, the TDS ranged from 160 mg/l to 526 mg/l.

Nine streams have been targeted for monitoring of water quality, but only two have been assessed. These are listed in Table 12-2. Eight lakes/reservoirs have been assessed. These are listed in Table 12-3.

Two watersheds, Shoal Creek and Beaver River, are on the Division of Water Quality Section 319, Nonpoint Source Priority Watershed list. There is a Section 314 Clean Lake Project underway on Minersville Reservoir.[40] Other funds have been received under the Section 319 Program for a Nonpoint Source Demonstration Project on the Beaver River between Beaver City and Minersville Reservoir. A local steering committee is being formed to start the Coordinated Resource Management Plan.

The Beaver River and Minersville Reservoir do not fully support the use classes for a cold water fishery and water-related recreation activities. Nutrients (including dairy wastes), sediments and hydrologic modification to the riparian zone, primarily from agricultural sources, are the predominate pollutants.

Fishing in Minersville Reservoir is impaired due to the warm water temperatures in late summer which permits the growth of a parasitic species. This parasite impacts the health of fish and makes them less desirable to fishermen. Water-skiing and swimming are impaired due to large amounts of algae growth in the summer months. Preliminary data indicates the reservoir stratifies, causing dissolved oxygen depletion to a point that anoxic conditions exist in the lower hypolimnion.

Coal Creek near Cedar City does not support the cold water fishery beneficial use class. This is caused by a high level of the metals iron and copper coming from natural sources accelerated by man induced erosion.

12.5.2 Groundwater Quality Problems

Many potential sources of groundwater pollution exist. These include sources from agricultural operations, various types and methods of waste disposal, and operations such as mining and oil and gas exploration. See Figures 5-9, 11-1 and 19-1 for location of the groundwater reservoirs.

Groundwater recharge areas for consolidated rock and alluvium are critical to water quality. Some aquifers, where high quality water is now found, are vulnerable to pollution by the activities of people. In potential recharge areas where the aquifer is exposed, it can be contaminated by precipitation and streamflow leaching pollutants left in or on the land. Alluvial aquifers are especially vulnerable to pollution. In some cases, the aquifers have already been adversely affected by the activities of people.

Refer to Figure 11-1 in Section 11 which shows the five groundwater reservoirs and the areas of higher quality water. Each of the groundwater reservoirs and water quality are discussed below.

Beaver River[45] - Groundwater is generally of good quality with most samples containing 300 mg/l or less of total dissolved solids (TDS). The TDS in the groundwater reservoir is lowest in the upper or younger unconsolidated alluvium and increases with depth as well as toward the southwest end of the valley. The lower part of the reservoir consists primarily of the Sevier River formation with TDS reaching as high as 1,000 mg/l.

Milford[46] - The TDS ranges from 226 to 4,600 mg/l north of T. 29 S. and from 253 to 1,100 mg/l to the south. This is probably because of the difference in deep percolation of irrigation water and the amount of fine grained soils in the area. In general, the quality of water pumped from wells has deteriorated over the years. This is probably the result of recycling of irrigation water and encroachment of groundwater from outside the area.

In the area south of Milford, the quality of water from one well increased from about 400 mg/l total dissolved solids (TDS) in 1950 to over 1,400 mg/l in 1992. One year, 1983, was exceptionally high with a TDS of over 1,900 mg/l.

In general, the TDS for culinary water used in the area slightly exceeds the standard recommended by the state of Utah, although the sulfate, chloride and nitrate concentrations are below the limits. Irrigation water is classed as low-sodium hazard with medium to high salinity concentrations. These classifications are acceptable under proper management practices, particularly with the high salinity.

Parowan Valley[7] - The public water supply systems all deliver water that meets the standards established by the state of Utah. The groundwater is generally classified as sodium, calcium or magnesium bicarbonate. The irrigation classification is low sodium hazard and low to high salinity concentrations. The quality of water is high in the upper watershed areas but deteriorates as it flows downstream. However, the irrigation water meets the standards for agricultural use.

The groundwater quality from selected wells and springs ranges from 158 to 481 mg/l of total dissolved solids (TDS). The groundwater underlying Little Salt Lake has a high mineral concentration, mostly sodium chloride. During dry periods, the surface water in the lake can contaminate the surrounding aquifers.

Samples from a well west of Paragonah have tested fairly constant at concentrations between 275 mg/l total dissolved solids and 325 mg/l. There was a peak in 1973 to about 875 mg/l.

Cedar City Valley[7] - The groundwater in the Cedar City Valley area is generally classified as a calcium or magnesium sulfate type. The total dissolved solids (TDS) measured from selected wells and springs ranges from 408 to 2,100 mg/l. The groundwater is classified as very hard. Generally the water used for public supply systems is below the recommended maximum limits.

The groundwater has a low sodium hazard, but it has medium to very high salinity concentrations. All water in the basin is suitable for agricultural uses. In one well in the southern part of the basin, there was an indication of a general increasing trend from 380 mg/l in 1974 to 540 mg/l in 1985. There has been a sharp decrease to 350 mg/l since, declining to the lowest level since 1969.

Beryl-Enterprise Area [44,47] - The concentration of TDS in the groundwater in the Beryl-Enterprise area is highest at the water table surface and decreases with depth. This is caused by return flows from irrigation of water leaching salts out of the soils. However, most of the wells are perforated from top to bottom so the samples are a composite of the tapped aquifer. A few of the wells tested exceed 1,000 mg/l but the majority are between 500 and 1,000 mg/l. One exception is a narrow belt between Enterprise and Beryl where it is less than 500 mg/l.

North of New Castle, the sulfate and chloride concentrations exceed the maximum standards for domestic use. In the southern part of the valley, five wells showed concentrations of nitrate exceeding the limit. Most of the water is hard to very hard.

Most of the water in the area has a low sodium hazard except for the area north of Newcastle to Table Butte where it increases. The salinity concentrations are medium to high. All of the water in the area is suitable to use for irrigation and for livestock watering.

The groundwater near the recharge areas is of higher quality than in those areas farther downgradient. This is because of deep percolation of irrigation water and evapotranspiration in the bottom land areas. The recharge is primarily from drainages in the southern part of the valley. These are Pinto Creek, Meadow Creek, Spring Creek and Shoal Wash. The surface water quality is good, generally less than 500 mg/l TDS.

The quality of the groundwater in the Beryl-Enterprise area is decreasing. The total dissolved solids in a well south of Beryl was 460 mg/l in 1967, increasing to about 650 mg/l in 1992.

12.6 Water Quality Needs

Man-caused pollution along with natural causes effect the water quality in the Cedar/Beaver Basin. In addition, recent and future growth and development will create changes in water use and will further impact the water quality. The following ongoing water quality and monitoring programs are needed so the basin water resources can be adequately analyzed.

Table 12-2
RIVERS/STREAMS ASSESSED FOR WATER QUALITY

Stream	Assessment
Shoal Creek and tributaries	Not assessed
Pinto Creek and tributaries	Not assessed
Coal Creek and tributaries	Impaired
Parowan Creek and tributaries	Not assessed
Summit Creek and tributaries	Not assessed
Little Creek and tributaries	Not assessed
Red Creek and tributaries	Not assessed
Beaver River and tributaries	Impaired
Cove Creek and tributaries	Not assessed

Table 12-3
LAKES/RESERVOIRS ASSESSED FOR WATER QUALITY

Lake/Reservoir	Assessment
Upper Enterprise Reservoir	Eutrophic[a]
Newcastle Reservoir	Eutrophic
Red Creek Reservoir	Mesotrophic[b]
Anderson Meadow Reservoir	Mesotrophic
LaBaron Lake	Mesotrophic
Puffer Lake	Mesotrophic
Three Creeks Reservoir	Mesotrophic
Minersville Reservoir	Eutrophic

[a] Water very rich in nutrients, low dissolved oxygen and high BOD
[b] Water with a moderate amount of nutrients.

- Routine and intensive monitoring is needed. There may be locations where monitoring is needed of exceptional events.
- A detailed inventory of severely eroding watersheds is needed. (Refer to Section 10.5 and Figure 10-1 for more information.) This will provide a base for monitoring of best management practices (BMPs) applied to critical areas. Also, testing of surface water as well as groundwater is needed to determine if and where nutrient (fertilizer) and/or pesticide contamination has occurred.
- Further studies and sampling are needed of lakes and reservoirs, and of water quality near mines and geothermal wells.
- Contamination and its extent due to faulty septic tanks and leaking underground storage tanks can be determined by monitoring.

In addition, riparian communities need to be re-established along parts of the river corridors where recreational impacts and grazing have destroyed the vegetation and compacted the soils. These impacts increase runoff which in turn increases salt and suspended solid in the streams. Many of the stream segments where riparian vegetation has been severely damaged are located in areas where there is accelerated erosion. Refer to Section 10-5 and Figure 10-1 for more information.

12.7 Alternative Solutions

Non-point sources are the biggest contributors to water pollution in the Cedar/Beaver Basin. These sources are primarily geologic, but are also man-caused.

Pollution caused by man's activities can be controlled or at least reduced. Landfill locations can be controlled by elected officials and government agencies working together. They should be located in areas where surface water or groundwater will not become contaminated through leaching or runoff. Controls on construction and other land surface disturbances will also reduce pollution.

Over irrigation is contributing to pollution of the groundwater reservoirs by leaching chemicals out of the soil. There is technology available to help reduce this source of pollution. The use of pesticides has also contributed to the problem and better control of this use would help reduce pollution. Basically, increasing irrigation efficiencies can go a long way toward reducing this problem. Nutrient management, hayland management, cropping sequence and waste utilization are good alternative solutions.

In some areas, domestic livestock and/or wild animals or other causes have depleted the land cover. Practices to re-establish vegetation will reduce erosion and the resulting pollution.

All local government entities should work with state agencies in implementating local groundwater protection programs. Groundwater recharge areas should be identified, zoned and use controlled where there is danger of contamination. Two critical areas are the Parowan Creek and Coal Creek fans.

The Environmental Protection Agency 301k program administered by the Division of Water Quality and carried out by the Utah Department of Agriculture can provide funds and technical assistance to reduce non-point pollution in critical watersheds. Some of the critical watersheds are shown in Figure 10-1. In these areas, controlling erosion and the resultant sediment production can reduce contamination of surface water flows. ■ ■

Section 13 Contents

Disaster and Emergency Response

13.1 Introduction

This section discusses flood hazard mitigation and disaster response related to possible predisaster or immediate actions at the time of the disaster to protect the water resources. It also describes programs and mechanisms now in place along with those needed.

It is generally inefficient to react to a disaster or emergency after it has occurred. This wastes time, money and other resources. There is also the possibility of loss of life and threats to health and welfare. Predisaster activities such as floodplain management, hazard mitigation and mitigation planning are the preferred approaches.

13.2 Background

All levels of government have the statutory authority to carry out disaster related programs, including pre- and post-disaster hazard activities. There is one problem. No one entity has all of the necessary authority to implement actions to mitigate a specific hazard or disaster. The *Utah State Water Plan* (1990)[21] discusses the specific authorities and assistance programs available to the various agencies. These are discussed in Section 3, Introduction; Section 13, Disaster and Emergency Response; and Section 16, Federal Water Planning and Development. The Division of Comprehensive Emergency Management (CEM) is responsible for disaster and emergency response at the state level while the Federal Emergency Management Agency and the Corps of Engineers are responsible at the federal level. Requests for federal assistance should be made through CEM.

■ Society must always be prepared to provide immediate response to any disaster or emergency. Preparedness is the key to alleviating traumatic experiences for those affected.

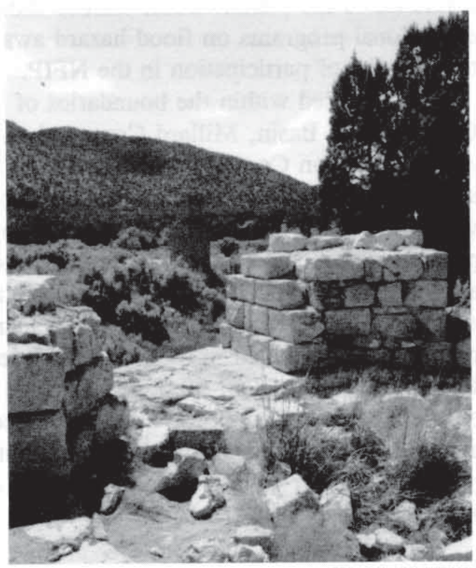
13.3 Policy Issues and Recommendations

Policy issues regarding hazards, disasters and emergencies are discussed below. Local units of government have the prime responsibility for carrying out most of these issues. Refer to the *Utah State Water Plan* (1990), Section 13, for related issues and information.

13.3.1 Hazard Mitigation Plans

Issue - Hazard mitigation plans are needed to help protect life and property in communities.

Discussion - A hazard mitigation plan is a joint effort requiring input from each involved office or agency to list many of the hazards (natural and



Old Iron Town

technological) facing a jurisdiction and outlining what strategies can be implemented to eliminate or lessen the impact from that hazard. These strategies are prioritized and include estimated costs and time frames to address the proposed mitigation.

Hazard mitigation may include structural and non-structural activities as they relate to flood prevention. Continued active involvement in the National Flood Insurance Program (NFIP) is essential to ensure adequate floodplain management objectives to reduce flood losses. Hazard mitigation plans can be implemented by communities to deal with identified hazards in the region such as flooding, earthquakes and hazardous materials.

The Division of Comprehensive Emergency Management performs functions relating to hazard mitigation plans at the state level. They are responsible to prepare, implement and maintain mitigation plans and programs.

Recommendation - Local towns, cities and counties should prepare hazard mitigation plans with assistance from the Division of Comprehensive Emergency Management.

13.3.2 Floodplain Management

Issue - Local governments need to become aware of their responsibilities as it relates to floodplain management.

Discussion - The National Flood Insurance Program (NFIP) was established by Congress in 1968 as a result of large federal outlays for structural measures and disaster relief. Its purpose is to (1) reduce flood loses, (2) prevent unwise development in floodplains, and (3) provide affordable flood insurance to the public. Local entities should conduct educational programs on flood hazard awareness and the benefits of participation in the NFIP.

As defined within the boundaries of the Cedar/Beaver Basin, Millard County, Iron County and Washington County participate in the NFIP. Four separate participating communities are also located within the basin. The basin has approximately 58 policies in force and a total dollar coverage of approximately $4,112,000. A community agrees to enact and enforce minimum floodplain management requirements as stated in the Code of Federal Regulation (CFR), Part 60.3. In exchange for enforcing these regulations, flood insurance is made available within the participating community. These regulations apply to new construction and substantial improvements.

The Division of Comprehensive Emergency Management is the State Coordinating Agency for the NFIP. The office can assist local participating communities in the implementation of the floodplain management objectives defined by the NFIP.

Also, the Corps of Engineers, through its Flood Plain Management Program, can develop flood plain boundary maps at no cost for those communities which need one or update those which do not adequately reflect current conditions.

Recommednation - Non-participating local entities should become qualified to participate in the National Flood Insurance Program. The Division of Comprehensive Emergency Management can assist communities in these objectives.

13.3.3 Disaster Response Plans

Issue - All communities should have a disaster response plan.

Discussion - Local governments need to increase their ability to respond to natural disasters and emergencies. Emergency Operations Plans (EOPs), also referred to as Disaster Response Plans, address disaster response and recovery activities following a disaster. These plans should be prepared ahead of time allowing counties, cities and towns to coordinate efforts and define responsibilities. Decisions should be made on leadership positions and activation of response activities. Millard, Beaver, Iron and Washington counties have EOPs in place. These plans identify hazards in the counties. They also can address disruption, contamination or exceptional shortfall in water supplies that can occur during emergency situations and may result in a temporary limitation of available water. When this happens, water deliveries may need to be prioritized in order to ensure critical needs are met first.

Emergency Action Plans (EAPs) have also been developed, or are in the process of being developed, for all dams in the state. The Division of Comprehensive Emergency Management reviews the private dam EAPs to ensure an adequate call down list is incorporated in the plan. This review is done in cooperation with the Office of the State Engineer, Dam Safety Section.

The Division of Comprehensive Emergency Management has the statewide responsibility of planning for, responding to, recovering from and mitigating emergencies. They have developed statewide plans for disaster response. This agency can assist local entities prepare response plans for emergency situations.

Recommendation - Local communities should develop disaster response plans with the assistance of the Division of Comprehensive Emergency Management.

13.3.4 Flood Prevention and Floodwater and Sediment Control

Issue - Measures need to be taken to prevent future damages from flooding problems.

Discussion - There are records of floods occurring since the earliest settlements in the basin. These floods have mostly damaged agricultural developments and facilities. In recent times, they have caused increasing damage to residential areas. Water control structures can be constructed for floodwater control and sediment storage or these features can be included in storage reservoirs constructed for other purposes. There are various other measures for controlling floodwater and sediment. These include non-structural and structural measures as well as proper management activities in the upper watershed areas. Cedar City is particularly vulnerable to flood damages. These damages could be reduced by floodplain zoning.

There are several state and federal agencies with programs and funding for floodwater and sediment control. These agencies should be consulted for assistance to local entities.

Recommendation - Counties should establish floodwater control committees to develop and carry out flood prevention plans and to assist other entities with flood problems. Appropriate state agencies should assist.

13.3.5 Droughts

Issue - Each county should have a drought response plan in place.

Discussion - Every part of the state has experienced droughts in the past and will continue to have them in the future. Drought cycles can be as short as one season or can last for several years. The affects of drought can be alleviated by preparing ahead of time. The most significant impacts will be on agriculture, culinary water supplies, tourism and wildlife. Electric power generation and water quality can also be affected. As the demand for water increases in the future, the impacts of drought may be more devastating and far reaching.

If drought plans are prepared, communities can be ready to deal with water shortages. Drought plans should establish priorities of water use and alternative sources of supply. Plans can also bring about the timely application of the resources available statewide.[20]

It may be desirable for two or more counties or parts of counties to join together and prepare one drought plan. This is particularly true where they are similar in climate and physiography as well as having similar socio-economic factors.

Recommendation - Each county should prepare or have available a drought response plan.

13.4 Local Organizational Structure

The cities and counties have primary responsibility for disaster response. This is particularly pointed out in Titles 10 and 17 of *Utah Code Annotated, 1953*, amended. Most entities have delegated disaster responsibilities to specific individuals in their respective organizations. The position responsible for disaster response in each county is shown in Table 13-1.

13.5 Water-Related Problems

Water-related problems are going to occur; it's just a matter of where and when. Preparing ahead of time can reduce the effects of disasters and emergencies, saving time, money, suffering and possibly even preventing loss of life.

13.5.1 Floodwater Problems

Flooding in the Cedar/Beaver Basin area is caused by three types of storms. One of these is the general winter storm occurring between November and April, producing the upper watershed snowpack. The other two are the general storms occurring between May and October and the summer thunderstorms which normally occur between July and October.

Sustained flooding is usually a result of extremely high snow packs in the upper watershed areas. Floods of this nature usually impact the Beaver River, Coal Creek, Parowan Creek, Red Creek and sometimes Little Creek. Higher peak flood flows are the result of local thunderstorms concentrating in smaller areas. These smaller flood producing areas are often localized in a small subwatershed of a larger watershed. These can effect the drainages mentioned above and in addition can cause damage in smaller watersheds such as Fiddlers Canyon, Holt Canyon, Spring Creek, Meadow Creek and Shoal Creek.

Natural and man-made obstructions such as bridges across streams, brush, large trees and other

Table 13-1 DISASTER RESPONSE RESPONSIBILITY	
County	Responsible Position
Beaver	Sheriff
Iron	Sheriff
Washington	Emergency Management Director

vegetation growing along streambanks in floodplain areas can also effect flooding. In general, obstructions restrict flood flows and can cause over-bank flows; unpredictable areas of flooding; destruction of or damage to bridges, homes and businesses; and increased flow velocity immediately downstream resulting in channel scouring.

In many years when floods were reported, several communities were affected. But many of the flood events were isolated, impacting only one or two areas. The highest recorded peak flow occurring on the Beaver River was on July 22, 1936, of 1,080 cfs and on Coal Creek on July 23, 1969, of 4,620 cfs. See Tables 5-4 and 5-5 for additional peak flows on these two streams.

On the afternoon of August 1, 1989, a storm yielded some 4-5 inches of rain in the Fiddlers Canyon area in an estimated 15 minutes. The Soil Conservation Service estimated the peak of the Fiddlers Canyon flash flood at 4,080 CFS. This event impacted numerous structures located on this alluvial fan.

Alluvial fan flooding is usually characterized by unpredictable flow paths and high velocities that occur with little advance warning time. Development pressure on alluvial fan areas is intensifying, creating a critical need to provide guidance to communities, developers and citizens on how to safely accommodate growth while protecting lives and property. Floods of the same or larger magnitude of those that have occurred in the past could take place in the future.

13.5.2 Droughts

The effects of droughts are accentuated with reduced amounts of precipitation. Also, most droughts seem to recur in somewhat regular cycles although of varying length and magnitude. This, coupled with the cyclic dry and wet periods, is a sure harbinger of periodic droughts.

Drought is a continuing problem because most of the basin is low in elevation with only the eastern rim, the Markagunt Plateau and the Tushar Mountains, rising high enough to have a major orographic effect. The relatively low snowpack limits the annual water yield rates along with corresponding streamflow volumes and groundwater aquifer recharge. Refer to Section 5, Water Supply and Use, for streamflow data and to Section 19, Groundwater, for aquifer information.

The relatively hot summer climate makes frequent irrigation of crops necessary. By mid-season, streamflows are low and in some cases, non-existent where there are no storage facilities. As a result, crops suffer. Even in the higher elevations, rangeland production of feed for livestock is reduced.

13.5.3 Other Water-Related Disaster Responses

There are other disasters where water supplies can be impacted. Generally these are more localized in nature than flooding or drought. These disasters include such things as structural failure of water supply facilities, toxic spills, landslides and earthquakes. Toxic spills are most likely to occur along highways such as those in Beaver Canyon, Coal Creek Canyon and Parowan Canyon. Coal Creek Canyon is especially vulnerable to landslides. The Hurricane, Paragonah and Beaver Basin fault zones are areas of high risk.

13.6 Flood Prevention and Drought Reduction Alternatives

For the most part, water storage reservoirs only have a moderate effect on the flood flows in major drainages. Their effect would be greater as the drainages become smaller. Studies should be made to determine the flood control possibilities of reservoirs on the major drainages where there are recurring floods. Recent studies of the Cedar/Beaver Basin, including Coal Creek, by the Corps of Engineers have determined flood control structures are not economically justified from a federal perspective. However, local efforts should be undertaken as flood control funds become available. See Section 9.6.2 for data on potential reservoir sites that could include flood control features.

In conjunction with the flood control studies, investigations should be conducted in the upper watershed areas to determine the possibility of long-range flood reduction through installation of non-structural measures and applying good management activities. Floodplain management may be the most viable alternative where they serve as groundwater recharge zones. This is especially true in Coal Creek and Fiddlers Canyon.

The groundwater reservoirs could be managed to alleviate the impact of droughts. They can act as storage facilities, filled during the wetter cycles and used during the drier years to compensate for low streamflows.

The volume of precipitation can be increased by weather modification through cloud seeding. However, this requires the right conditions to be the most effective. During prolonged periods of drought, it may not be possible to significantly increase the precipitation. Generally, this is a viable alternative on a long-range continuing basis. By doing this, the upper watershed soil moisture will remain higher which will tend to moderate the effects of drought.

All of the groundwater reservoirs are currently being used to supplement the surface water inflows. This is less true in the Beaver Valley groundwater basin. See Section 5, Section 9.6.4 and Section 19 for information on groundwater.

13.7 Disaster Response Recommendations

It is always more effective to have plans and/or facilities in place prior to any disaster response requirements. There are several actions that could be put in place to alleviate disaster situations. Suggested actions include the following:

- Development of disaster response plans by individual communities and counties,
- Investigation and construction of water storage and floodwater prevention projects,
- Continuation of cloud seeding programs,
- Family emergency plans,
- An assessment of sediment/debris flows that would be expected after wildfires.

The Division of Comprehensive Emergency Management suggests all residents prepare a 72-hour emergency survival kit. According to experts in the field, this will allow adequate time for relief efforts to reach most residents. Along with preparing this kit, families should develop their own emergency plan outlining each member's responsibility during a disaster. Emergency preparedness drills are a good way to familiarize family members with their duties and help ensure the safety of each.

Hazard mitigation may include structural and non-structural activities as they relate to flood prevention. Continued active involvement in the National Flood Insurance Program is essential to ensure adequate floodplain management objectives are in place to reduce flood loses. Hazard mitigation plans can be implemented by communities to deal with specific identified potential disasters, such as flooding and alluvial fan development. ■ ■

Section 14 Contents

Fisheries and Water-Related Wildlife

14.1 Introduction

This section describes the fisheries and other water-related wildlife in the Cedar/Beaver Basin. It also describes associated problems and presents alternatives to improve this resource. All forms of wildlife depend on water. The multifaceted recreational opportunities provided by wildlife and fishing can be enjoyed by all ages regardless of their situation.

The character and quality of the riparian zone directly impacts the fishery resources in several ways. Riparian vegetation helps determine water temperature which in turn determines fish species, composition, population size and influences the available nutrients. Water is being developed for various uses, impacting the existing regimes and the associated riparian communities.

For these reasons, it is important to understand the relationship of fisheries and wildlife to other water-related resources. This basin has unique ecosystems supporting a diversity of species.

14.2 Setting

The Utah Division of Wildlife Resources has responsibility for the management, protection, propagation and conservation of the state's wildlife resources. Some federal agencies have limited authority for wildlife management on lands they administer.

There are about 2,000 acres of wetlands and 4,000 acres of open water areas in the irrigated cropland areas within the water budget area surveyed by the Division of Water Resources.[17] In addition, there are another 15,000 acres of wetlands/riparian areas and about 1,000 acres of open water in the valley areas outside the irrigated areas of the Cedar/Beaver Basin.[62] Most of the

■ **The area wildlife varies from those found in the alpine environments of the Tushar Mountains and Markagunt Plateau to those living in the west desert environs.**

Clear Lake Waterfowl Management Area

vegetation is greasewood, rabbitbrush and saltgrass. The only wetland managed specifically for waterfowl is the Clear Lake Waterfowl Refuge (1,050 acres of open water) in the extreme northern part of the basin. There is also the Cedar City Upland State Game Sanctuary.

Determining wildlife habitat needs is recognized as an integral part of basin planning. Fishing, hunting and non-game wildlife activities contribute financially to the economy and need to be considered in water development plans. The Division of Wildlife Resources will assume the lead role in determining potential impacts (positive and negative) to wildlife resources from water development projects. The role of the Division of Wildlife Resources in water planning is to:

1. Assess water development plans and, specifically,
   a. Identify potential benefits to wildlife and their habitats,
   b. Identify potential adverse impacts to wildlife and their habitats,
   c. Recommend a course of action to mitigate project impacts to wildlife and their habitat for the public interest,
   d. Recommend termination if mitigation is not feasible or possible.
2. Provide factual information to decision makers regarding consequences of unmitigated and mitigated impacts to wildlife resources.

14.3 Policy Issues and Recommendations

This section discusses one policy issue. It deals with wetlands and riparian habitat.

14.3.1 Wetlands and Riparian Habitat

Issue - There is a need to protect the wetlands and riparian habitat.

Discussion - There are about 17,000 acres of wetlands and riparian areas in the Cedar/Beaver Basin valleys. Of this total, about 2,000 acres are within the irrigated cropland areas. Clear Lake Waterfowl Management Area is the only managed waterfowl habitat. There are a few other locations which provide resting areas during wetter periods such as Quichapa Lake, Rush Lake and Little Salt Lake. Other areas include farm ponds, reservoirs and other water sources including springs and seeps. These are used primarily as resting areas for migrating birds although some species live year-round in these areas. Wetlands should be protected because of their importance to wildlife and the human populations. The Division of Wildlife Resources should be contacted during project planning to provide input and suggest mitigation practices.

Riparian areas include land directly influenced by sufficient water to sustain growth. Even though the riparian areas account for a minor part of the total land area in the basin, the vast majority of the wildlife species are associated with them at some point in their life cycle. As such, they are important areas to wildlife. Where spring areas have been impacted by wildlife and livestock, rehabilitation should be investigated.

When riparian areas are in good condition, they provide streambank stability, maintain channel contours, regulate water flow and enhance water quality. A good riparian community has abundant and diverse plant life covering most of the soil and showing a spread in age distribution.

Most of the major drainages support good quality riparian habitat throughout most of their lengths. These include the Beaver River and tributaries above Beaver; Little Creek, Red Creek, Parowan Creek, Summit Creek, Coal Creek, Pinto Creek, Spring Creek, Meadow Creek and Little Pine Creek above their canyon mouths; and parts of Shoal Creek and the Beaver River below Minersville. These areas support a multitude of wildlife species. The state should seek primacy status so they can better manage the habitat areas.

Recommendation - The Division of Wildlife Resources should identify wetlands and riparian areas with significant values to aid in their protection.

14.4 Fish, Wildlife and Habitat Problems and Needs

Many people are attracted to live and play in this area because of the unique year-round attractions and facilities. This results in more pressure on the environment as a whole and on the water resources in particular. Most of the canyons are heavily used in the summer for various recreational pursuits. This is particularly true in Beaver Canyon, Red Creek Canyon, Parowan Canyon and Coal Creek Canyon. Many summer homes are also being constructed in the upper watershed areas. All of these and other activities tend to degrade these areas, making them more susceptible to deterioration of the resources.

Conflicts are going to increase in the future due to the finite water resources and an expanding population. There are some groups that advocate preserving the resources from all development and use while other groups depend on these and other resources to be developed for their livelihood.

Most of the perennial streams in the basin are either captured in storage reservoirs or are diverted, primarily for irrigation, during the growing season. Some stream channels are enlarged by erosion from cloudburst floods. Most of the streams are cool with gravelly and sandy channel bottoms. Many of them support a cold water fishery. The Beaver River with its several storage reservoirs provides the best cold water fisheries in the basin. Reservoirs on the other streams also provide good cold water fish habitat. There is a need to preserve these fisheries.

Riparian areas are important wildlife habitat for many species. Such areas generally offer all four major habitat components: food, water, cover and living space. Where there is adequate water and deep soils, production of plant and animal biomass increases. The contrast with the surrounding desert-like vegetation in the western part of the basin increases the habitat diversity. The linear lines of the riparian areas increase the "edge" between these contrasting vegetation types. With different combinations of humidity, transpiration, vegetation heights, shading and air drainages, various microclimates are produced. Linear riparian zones serve as connectors between habitat types and provide travel lanes and migration routes for such animals as birds, bats, deer and elk.

There are areas where damage is caused by ATV travel, other recreational uses and dewatering of streams. These can cause a reduction in vegetation and associated wildlife values, loss of streambank stability, and siltation. There is a need to provide more ATV trails and restrict areas vulnerable to erosion.

14.5 Alternative Solutions

There is generally always more than one way to carry out an activity that may impact fish and wildlife. Often this can include mitigation. Where possible, it is easier and better to plan development projects to avoid the necessity for mitigation. Where mitigation becomes necessary, it can be made a part of project plans. Water-related mitigation alternatives include maintenance of native fish communities and habitat or replacement of these values with similar facilities in a nearby location.

Habitat can be classified according to value. Four categories of habitat are used in Utah. These are: critical, high-priority, substantial-value and limited-value. Mitigation goals vary with habitat value, wildlife species and project plans.

There are several approaches to mitigation. These are listed below in order of importance.

- Avoiding the impact altogether by not taking a certain action.

- Minimizing impacts by limiting the magnitude of an action or its implementation.

- Rectifying the impact by repairing, rehabilitating or restoring the affected environment.

- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.

- Compensating for the impact by replacing or providing substitute resources or environment within the same area.

Whenever reservoir storage projects are constructed, consideration should be given by interested groups and the Utah Division of Wildlife Resources to purchase conservation pools or storage water. This may enhance the fish and wildlife values, provide holdover storage during dry periods and enhance instream flows for sport fisheries. Purchase of conservation pools should also be considered in existing reservoirs. Rehabilitation of disturbed areas should also be a part of projects.

One way to defer use of riparian areas by livestock and wildlife use is by providing water upland from stream banks. Options include upstream ponds, horizontal wells and wind power or solar energy to pump water to upland areas. Another way to defer use of riparian habitat includes fencing the worst areas to control access.

Another technique to assist with acceleration of regrowth on riparian areas is construction of instream structures. These include small impoundments or low head dams, (much like those built by beavers), rock weirs, streambank protection, sediment traps, building up water tables, vegetative plantings and/or anchoring trees or rocks to streambanks to prevent further erosion. ■ ■

Section 15 Contents

Water-Related Recreation

15.1 Introduction

This section describes the water-related recreational aspects, facilities and resources found in the Cedar/Beaver Basin. Data are presented from the Utah State Comprehensive Outdoor Recreation Planning (SCORP) process.[16] This process provided information for the preparation of a priority list of key water-related recreational and environmental issues to be addressed in the future. Information includes consumer or participant's expressions of outdoor recreation needs/demands, issues and alternative solutions.

15.2 Setting

The western part of the Cedar/Beaver Basin contains large areas of land where the eight inches of annual rainfall produces mainly desert shrubs and grasses. The southern and eastern parts of the basin are more productive with extensive areas of irrigated cropland blending into high mountain watersheds where most of the water supplies originate. The reservoirs, clear streams, alpine scenery and red rock plateaus are prime attractions. In contrast, there are old historic towns and the remains of a once booming mining industry. The skiing industry is fast becoming a major recreation activity resulting in a favorable impact on the economy. These are the resources supporting the recreation base throughout the basin. They can accommodate a variety of seasonally appropriate outdoor recreation activities. As would be anticipated, sites associated with water are most often preferred.

The major public land managers are the Bureau of Land Management, U.S. Forest Service, National Park Service and the Utah School and Institutional Trust Lands Administration. These four agencies control about 80 percent of the basin area. These areas of public lands contain most of the water-related recreational facilities and settings. This gives them responsibility as well as control over much of the recreation in the basin. There are developed as well as primitive areas located in various environments. In addition, there are two small areas of Indian Tribal lands, one in the Cedar City area and one near Cove Fort.

The Utah Division of Parks and Recreation manages two state parks: Iron Mission in Cedar City and Minersville which includes the reservoir between Beaver and Minersville. The Utah School and Institutional Trust Lands Administration has the responsibility for about 283,000 acres of school trust lands. Most of these lands are in scattered sections and are used primarily for livestock grazing and wildlife habitat. Because of the arid climate, there is little potential for

■ Outdoor recreation is generally enhanced when it is based in a water-related setting. Surface water reservoirs provide flat-water recreational opportunities. Free-flowing streams are an important part of the recreational scene.

water-based recreation, although other recreational pursuits are followed. The Utah Division of Wildlife Resources administers the Clear Lake Waterfowl Management Area. This area is feed by springs supplying about 15,000 acre-feet of water annually. Clear Lake is located on the Pacific Flyway.

There are three major points of interest: Old Cove Fort, Old Irontown and the Jefferson Hunt Historical Site. There are many parks, picnic areas and campgrounds along with undeveloped areas where outdoor activities can be enjoyed. Swimming pools and golf courses are located in some of the communities. There are fisheries in most of the perennial streams while the reservoirs and lakes provide fishing and flat-water activities. Ski resorts are located at Brian Head at the head of Parowan Canyon and Elk Meadows in Beaver Canyon.

Outdoor recreation and tourism are becoming major economic activities in Utah and in the Cedar/Beaver Basin area. They impact lodging, transportation, food and retail sales bringing much needed income into this rural area. Over 2,800 jobs are related to tourism in the Southwest Multi-County District according to a recent outdoor recreation household survey.

The Beaver Canyon Scenic Byway, U-153, is the only one in Beaver County. It runs from Beaver for 17 miles to Elk Meadows, ascending the Tushar Mountains in the Fish Lake National Forest and then on to Junction and U.S. Highway 89. This road provides access to the Mt. Holly Ski Resort.

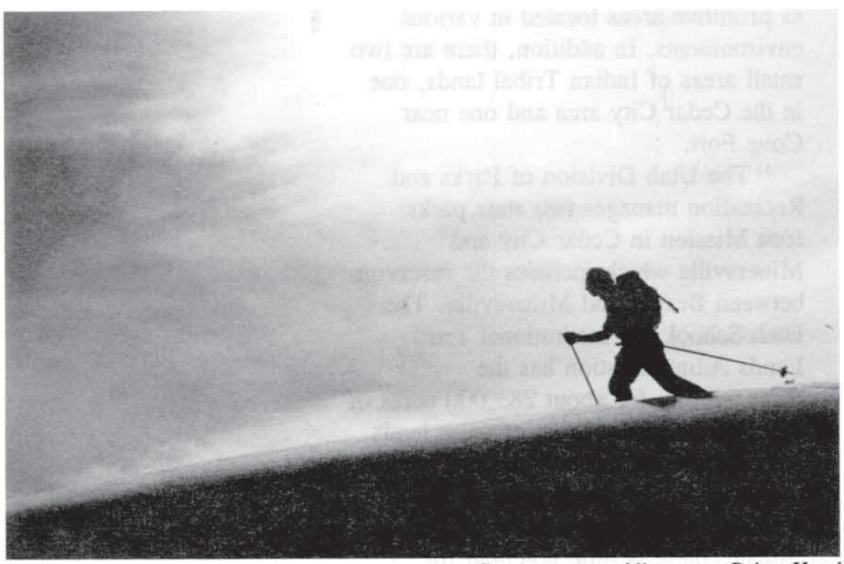
There are three scenic byways and two backways in Iron County. The Brian Head-Panguitch Lake Scenic Byway runs from Parowan along U-143 up Parowan Canyon, past Brian Head and through Cedar Breaks National Monument for about 17 miles before leaving the basin on its way to Panguitch via Panguitch Lake. It passes through alpine stretches of the Dixie National Forest and past Brian Head Ski Resort.

The Cedar Breaks Scenic Byway, U-148, runs between U-14 and U-143 through the Dixie National Forest and Cedar Breaks National Monument. The Markagunt Scenic Byway runs from Cedar City to the Long Valley Junction on U-14. It runs up beautiful Cedar Canyon into the Dixie National Forest for 16 miles before leaving the basin.

The Kolob Reservoir Backway runs from Virgin north to U-14 six miles east of Cedar City. The north part of the backway travels through about six miles of thick forests in the basin. The Dry Lakes/Summit Backway runs from Summit through private land and Dixie National Forest for 19 miles before joining U-143 eight miles south of Parowan.

There are four recreational motorized and non-motorized trails projects funded by the Division of Parks and Recreation. Two of these, Piute ATV Trail on the Tushar Mountians and Virgin River Rim Trail on the Markagunt Plateau, are on the basin periphery. The Elk Valley Trail is in Beaver County in the upper Beaver River area. The Brian Head Trail System is located in and around the Brian Head Ski Resort.

Nine projects have been assisted through the federal Land and Water Conservation Fund program administered by the National Park Service. These include three in Beaver County with total grants of nearly $224,800 and six in Iron County using over $321,000 grant funds.



Cross-country skiing near Brian Head

15.3 Policy Issues and Recommendations

A public meeting was held in Cedar City in September, 1990. The following major issues were brought forth and prioritized by those present.

- Improved highway and site signage to give directions to public and private facilities.

◦ A critical need to provide stable and/or new recreation funding sources.

◦ Improve and update recreation facility and support facility infrastructure to encourage revenue generation from tourism.

◦ Provide more winter recreation opportunities and make a longer season for tourism and leisure service business.

◦ Improve the comprehensive planning process for the allocation of natural resources; i.e., look at all uses/conflicts/opportunities for any water, highway or other resources development.

◦ Plan and construct a comprehensive localized and connecting trail system linking key resource areas such as reservoirs; lakes; forests; national, state, and community parks; Great Western Trail; and American Discovery Trail.

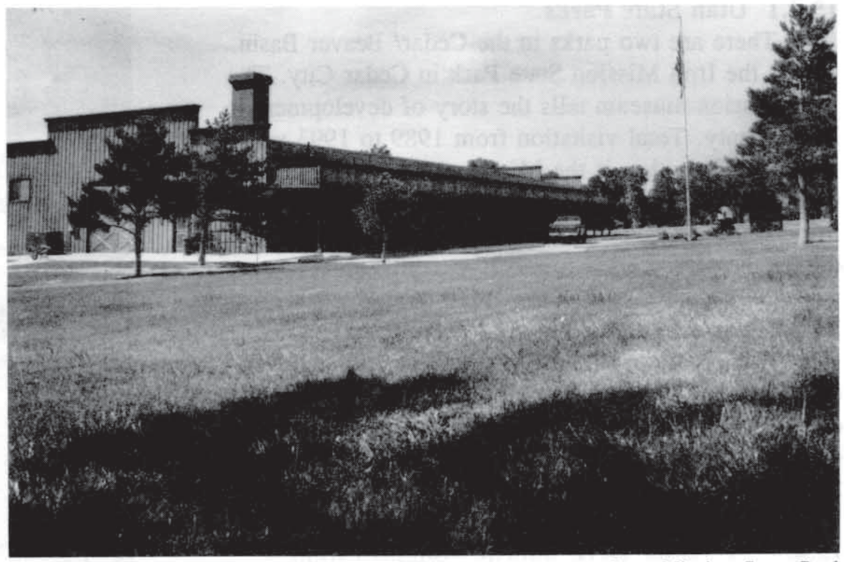
◦ Improve government agency cooperation and coordination to reduce costly redundancies, dispose of federal wilderness issues and, one way or another, get on with it!

It has also been noted that alternatives are needed to protect areas such as lower Coal Creek. This and similar areas are easily abused by ATV users.

Some of the participants noted that over 50 percent of all tourists visiting the state of Utah pass by Cedar City and Beaver on I-15. These visitors can be attracted by well designed and accommodated facilities.

A similar request, again as part of the Utah SCORP process, was made to recreation providing agencies in early 1991. They were asked their major concerns or issues. These are listed below.

- Inadequate funding of respective agencies.
- Need for interagency coordination.
- Assuring environmental quality.
- Public and private cooperation--partnerships, coordination.
- Vandalism.
- Need for recreation development and infrastructure improvement.
- Rising cost of liability insurance.
- Deteriorating facilities and systems.
- Securing volunteers--importance of volunteerism.



Iron Mission State Park

- Communicating and justifying the economic significance of recreation.
- Overcrowding of existing recreation facilities and resources.
- Law enforcement.
- Access to public lands--closures by private land owners.
- Recreation water allocations--leaving enough for recreation and fisheries.
- Environmental education--reducing conflicts, damage and management costs.

Over 23 issues were identified by government agencies. These range from funding to wetland and cultural site protection, application of computer technology, greenways and trail development needs. It was understandably different from issues identified by resource users who had a few common concerns for funding, new facilities, wilderness, government coordination and access problems. Many of these issues can be realized or obviated by good design, adequate capitalization, public participation in the planning process, and coordination and good management of water resources development or river corridor protection.

15.4 Outdoor Recreational Use

The use of recreational areas has been rapidly increasing during the past number of years. This use is expected to increase even faster in the future.

15.4.1 Utah State Parks

There are two parks in the Cedar/ Beaver Basin. One is the Iron Mission State Park in Cedar City. The Iron Mission museum tells the story of development in Iron County. Total visitation from 1989 to 1993 was 158,526. The other is the Minersville State Park which provides boating, fishing and camping on and around Minersville Reservoir. There were 52,365 visitors during the period 1989 to 1993.

15.4.2 Cedar Breaks National Monument

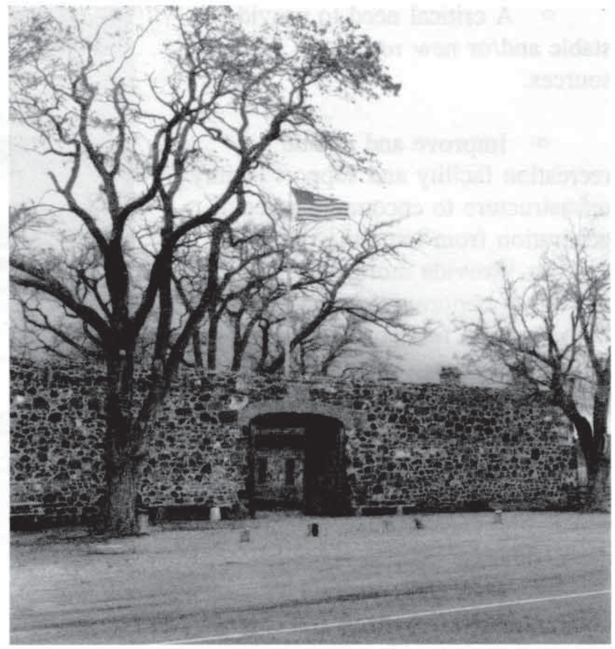
The visitation to the monument has not changed significantly during the last five years. Visitations during these years were: 1989, 498,472; 1990, 430,268; 1991, 469,133; 1992, 406,477; and 1993, 578,268.

15.4.3 Economic Development Administration Tourism Study

In 1992, the Economic Development Administration conducted a study which developed an inventory of tourism support facilities in the Southwest Multi-County District. There are 12 airports (nine have no services), 12 roadside rest areas, 118 campgrounds, 123 cultural/recreational sites and over 5,500 rooms in 200 motels. Several general conclusions reached in the study include:

- Tourism represents one of the most important activities in the Utah economy.
- Prospects for continued growth in the industry are favorable.
- Impacts on state and local revenues are generally positive.
- Tourism can help stabilize and diversify the economic base without displacing other industries.
- Although the infrastructure to support tourism is substantial, improvements and/or additions are needed, particularly in state and federal parks/recreation areas.
- Many sources exist to finance tourism infrastructure improvements.

The study concludes with the importance of resident and non-resident tourism. Most data is related to non-resident tourism. High quality recreation facilities are critical to the success of tourism and marketing in the state of Utah. Major funding and the discovery and utilization of new sources of revenue continue to be of the highest priority. Water development should incorporate adequate infrastructure for leisure services and facilities and provide continued support for operation and maintenance.

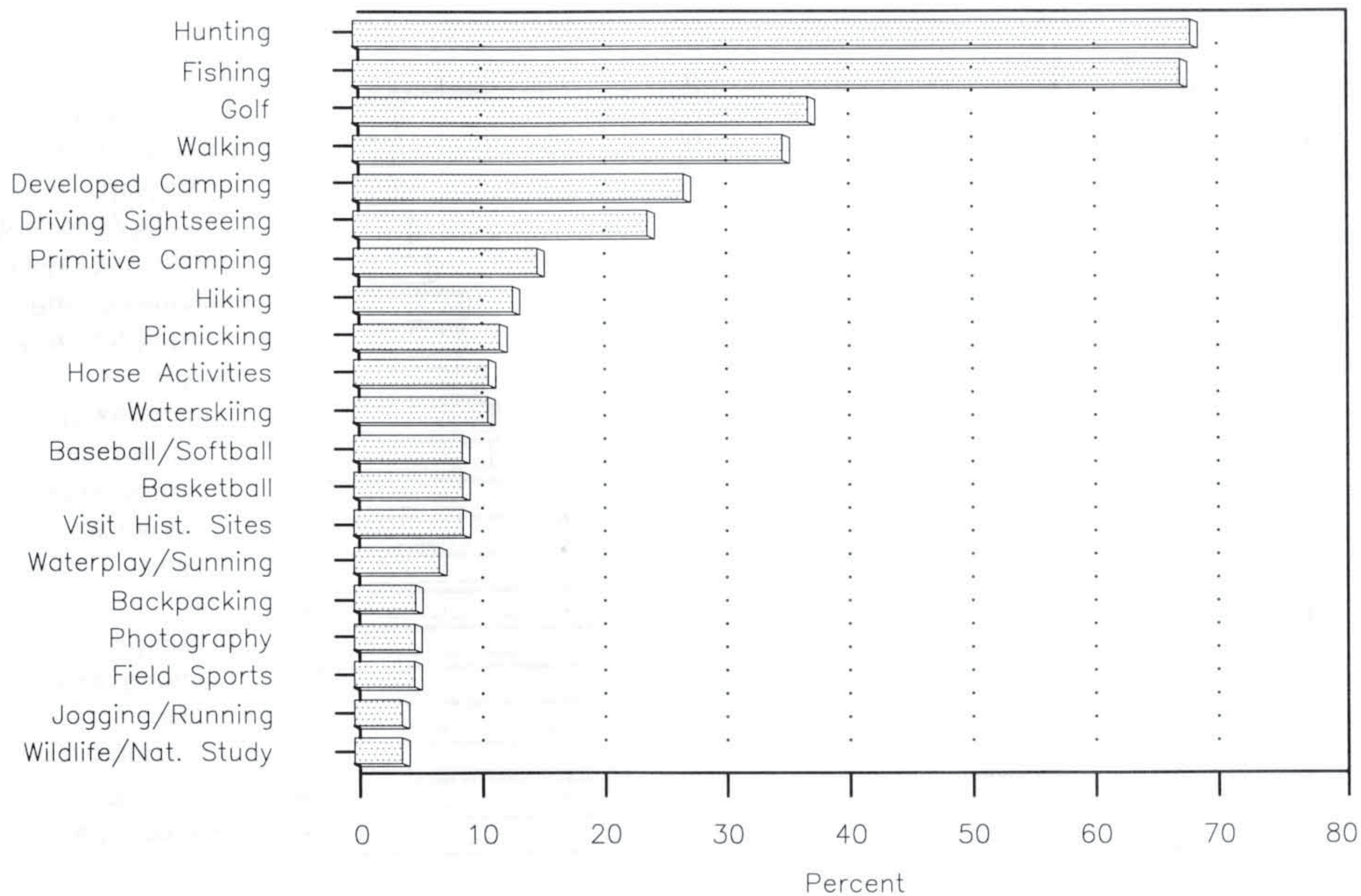


Cove Fort

15.5 Outdoor Recreation Activity Needs

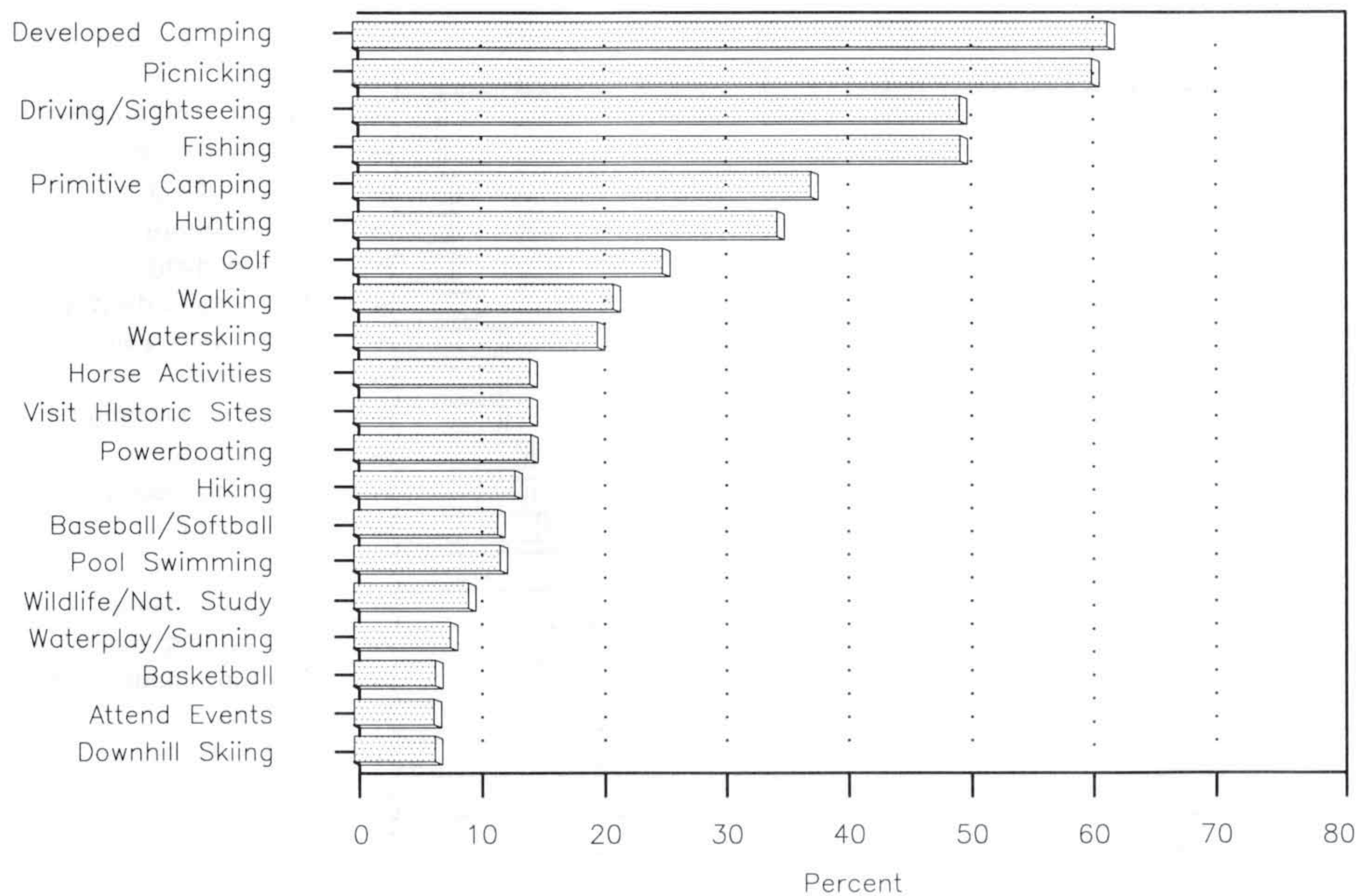
Figures 15-1 through 15-5 are from the 1990-91 Utah SCORP Household Survey that received input from over 2,400 homes in Utah.[15] The figures describe the top 20 favored "individual" outdoor recreation activities, the top 20 favorite "family" activities (we do different things in a group or with a family), new "community" facilities that are needed, "statewide" facilities needing improvement, and new "statewide" facilities needed. Many activities and facilities are preferred near water, while a few, like fishing and boating, are clearly dependent on water or water developments such as reservoirs. ■ ■

Figure 15-1
TOP 20 FAVORITE INDIVIDUAL ACTIVITIES



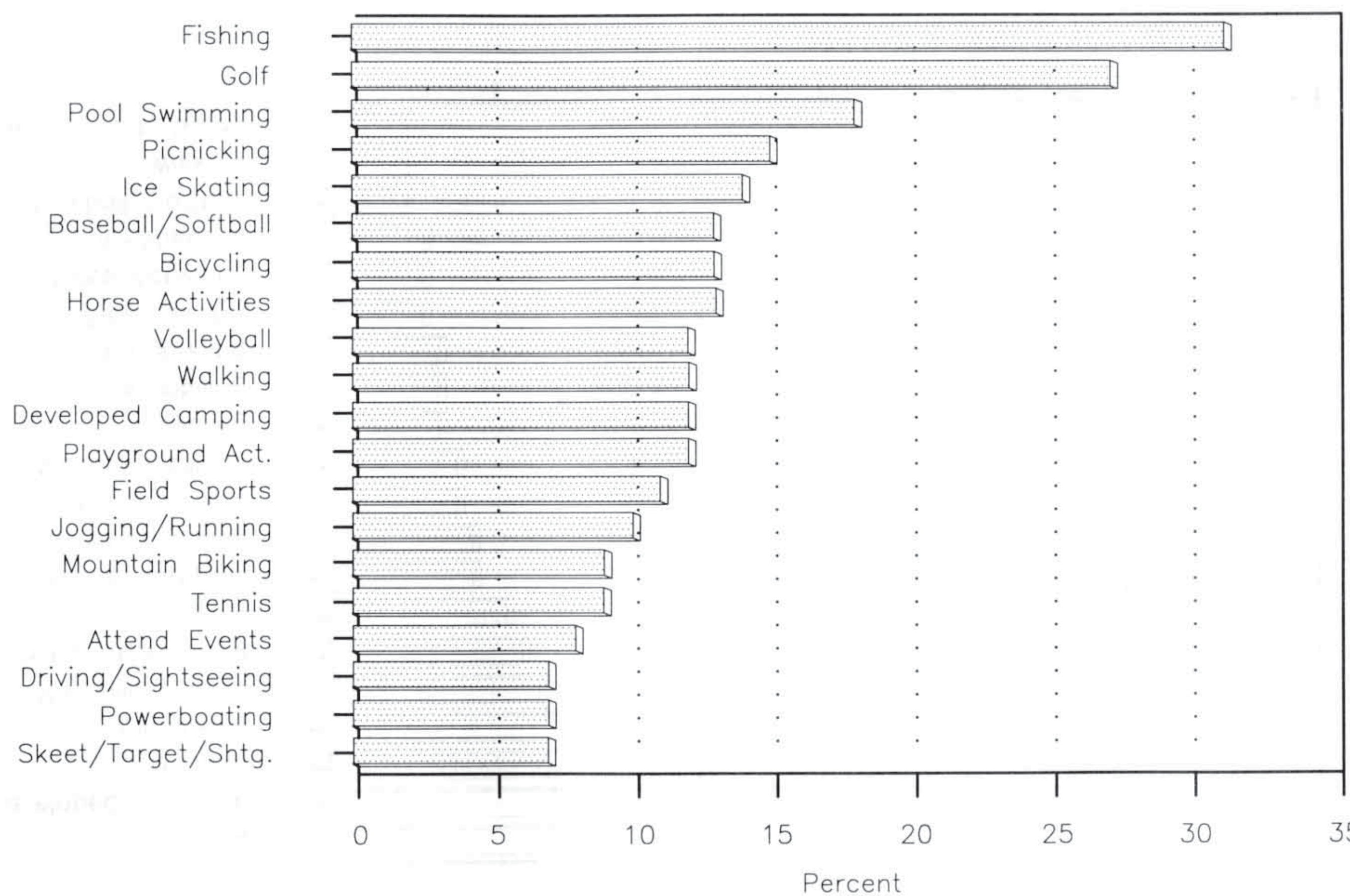
Note: Includes all of the Southwest Multi-County District
435 Resondents

Figure 15-2
TOP 20 FAVORITE FAMILY ACTIVITIES



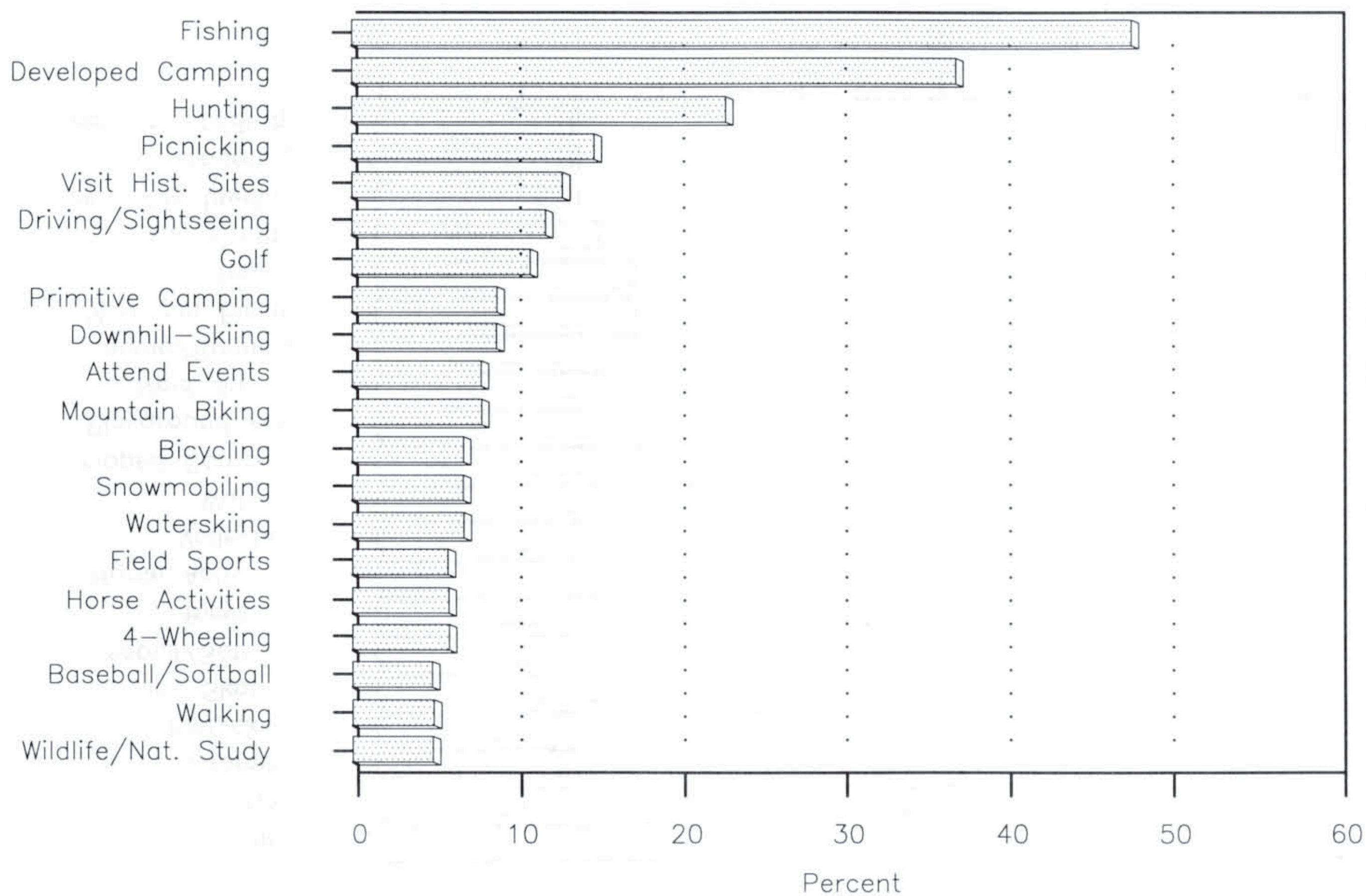
Note: Includes all of the Southwest Multi–County District
435 Resondents

Figure 15-3
NEW COMMUNITY FACILITIES NEEDED



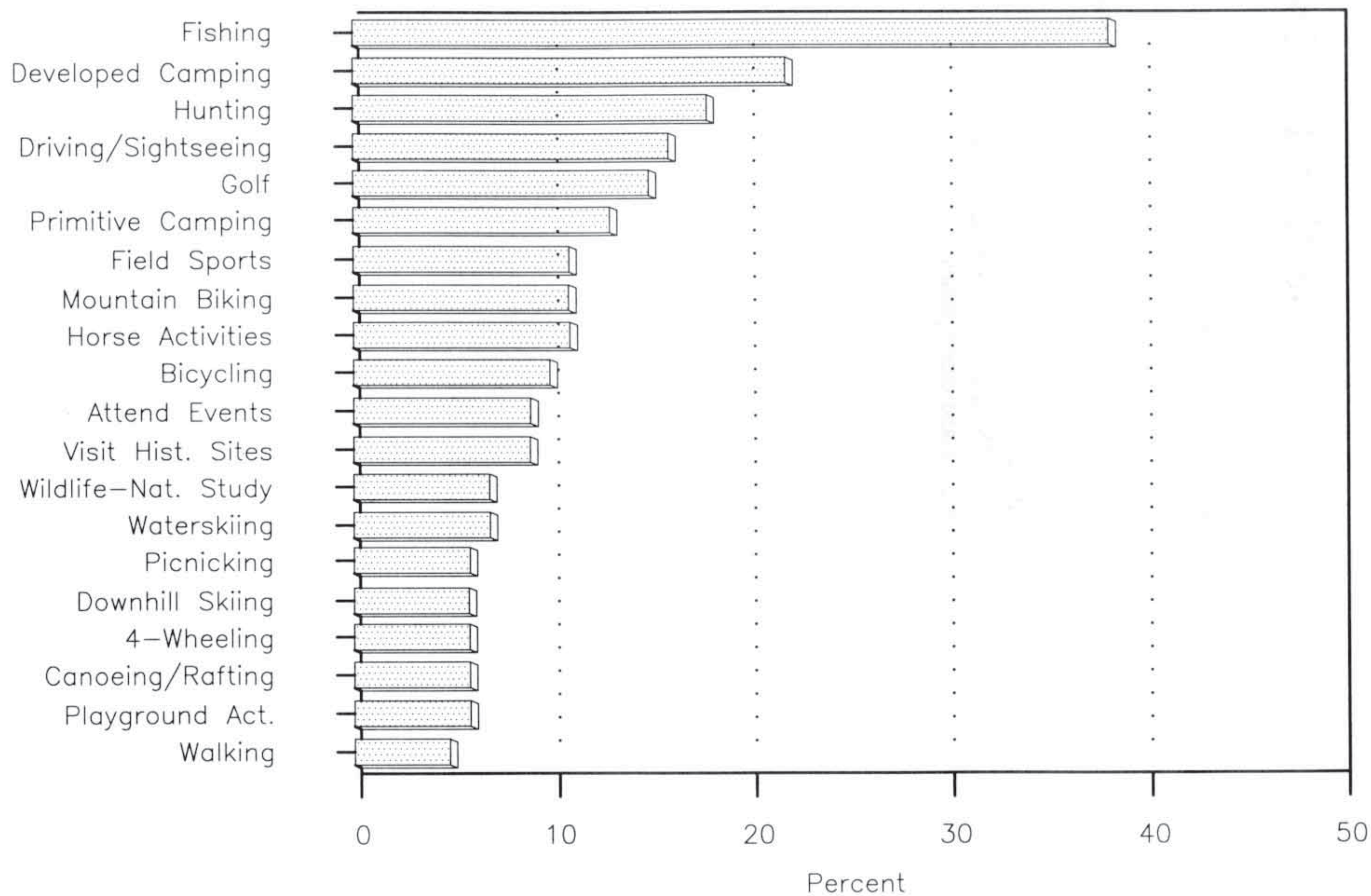
Note: Includes all of the Southwest Multi-County District

Figure 15-4
STATEWIDE FACILITIES NEEDING IMPROVEMENT



Note: Includes all of the Southwest Multi-County District

Figure 15-5
STATEWIDE NEW FACILITIES NEEDED



Note: Includes all of the Southwest Multi–County District

Section 16 Contents

Tables

Federal Water Planning and Development

16.1 Introduction

This section discusses the roles of the 14 federal agencies involved with water resources programs in the Cedar/ Beaver Basin. Although the activities of federal agencies are changing, there are still many programs available to benefit basin residents. To make the best use of those available programs requires the local entities to be knowledgeable of ways to access these benefits. With this information, it is possible to develop better interagency and local working relationships.

16.2 Background

With an increase in the regulatory requirements by federal agencies, there is a greater need for the state to fill the void with technical assistance and funding. More and more, the federal government is requiring higher standards for resources use without providing funding to perform the requirements. This is an added cost to state and local governments. This in turn reduces the availability of state and local funds to accomplish existing water resources regulation, conservation and development programs. These federal mandates are influencing the ability of the state to respond to local requests.

16.3 Federal Concerns

Four concerns were identified in the *1990 State Water Plan*[21] by federal agencies. The last three of these apply to the Cedar/Beaver Basin. These concerns were (1) reserved water rights, (2) interrelated planning, (3) stream and riparian habitat loss, and (4) water rights filings. Progress has been made on all of these concerns.

One other concern has been raised since the *State Water Plan* was published. This is the lack of coordination between federal, state and local officials during the planning and implementation of the various programs and projects. There has been a coordinating committee organized in southwestern Utah and chaired by the governor. This committee is actively trying to coordinate all water and related-land activities at the state, federal and local level. However, there is still more that can be accomplished to promote better working relationships and understanding.

■ The role of the federal government is changing from one of construction and development to one of management, preservation, conservation and maintenance. Federal funding programs are decreasing while regulatory programs are increasing.

16.4 Federal Programs and Projected Planning and Development

The various federal agencies and the programs they can provide are briefly described on the following pages.[1,67] (Also see Section 8). Some projected planning and implementation being considered by various agencies are also discussed. On October 20, 1994, the Secretary of Agriculture signed a memorandum implementing the reorganization authorities contained in H.R. 4217, the Federal Crop Insurance Reform and Department of Agriculture Reorganization Act of 1994, Public Law No. 103-354. This reorganization changes the name and activities of some federal agencies involved in the state water planning effort. These changes, as they effect the *State Water Plan*, are briefly discussed in the following subsections.

16.4.1 Agricultural Stabilization and Conservation Service (Abolished, see Subsection 16.4.5, Consolidated Farm Service Agency)

The Agricultural Stabilization and Conservation Service is now part of a new agency: "Consolidated Farm Services Agency." The old agency description follows. The Beaver, Iron and Washington counties Agricultural Stabilization and Conservation (ASC) committees meet periodically with their respective County Program Development Groups. Their goal is to identify problems and develop conservation practices to solve them. This assures effective conservation on the ground.

Agricultural Conservation Program (ACP) - The ACP is designed to help reduce soil erosion and water pollution, protect and improve productive farm and ranch land, conserve water used in agriculture, preserve and develop wildlife habitat and encourage energy conservation measures.

Only those practices significantly contributing to these objectives and also those not required as a condition of receiving assistance through other federal programs are eligible for cost-share assistance. The ACP is administered by state and county committees composed of lay members working under the general direction of the Agricultural Stabilization and Conservation Service. The Soil Conservation Service, Forest Service and Utah Division of Sovereign Lands and Forestry are responsible for providing technical program guidance. The County Cooperative Extension Service provides educational support.

Emergency Conservation Program (ECP) - The ECP provides emergency cost-share funds to rehabilitate farmlands damaged by wind erosion, floods or other natural disasters and for carrying out emergency water conservation measures during periods of severe drought.

Conservation Reserve Program (CRP) - The CRP was created by the Food Security Act. It calls for removing highly erodible lands from production so they can be protected. It also promotes maintaining wetlands for wildlife habitat and water quality.

16.4.2 Bureau of Indian Affairs

The Bureau of Indian Affairs, under the trusteeship exercised by the Secretary of the Interior, works cooperatively with the Indian people and their tribal leaders. Their goal is to assure the most effective and productive use and development of their resources, including water resources. There is a band of Southern Paiutes now living in northeastern Cedar City where a headquarters has been established. They have tracts of reservation lands south of Cedar City and north of Cove Fort.

16.4.3 Bureau of Land Management

The Federal Land Policy and Management Act gives the Bureau of Land Management (BLM) authority for inventory and comprehensive planning for all public lands and resources under its jurisdiction.[29] This includes water resources with the mandate to comply with applicable laws. They are also responsible for managing the existing and proposed wilderness areas, wild and scenic rivers and all recreational uses associated with these rivers.

Water resources, in quantity and quality, are key factors in managing all terrestrial and aquatic resources on public lands in the Cedar City and Richfield districts. Water resources are often small and dispersed sources. Water sources on public lands are rapidly becoming a major determinant of resources management alternatives. The BLM manages riparian habitats of springs, seeps, streams, lakes, reservoirs and ponds to help provide high quality water resources for beneficial downstream uses.

Collection of water resources quantity and quality data is needed for all programs. The BLM is also responsible for planning the use of these resources on the public lands in coordination with state and other agencies. All of these data become a part of a draft "resource management plan" (RMP) for a given area. After public input, these become management plans for resources on BLM administered land. The published *Cedar, Beaver, Garfield, Antimony Resource Management Plan* covers all of the Cedar/Beaver Basin except for the Clear Lake area north of Black Rock, the Warm Springs area and the area in Washington County.

16.4.4 Bureau of Reclamation

There are four broad categories of water resources programs administered by the Bureau of

Reclamation. These are investigations, research, loans and service, all requiring close cooperation with the concerned entities.

Investigation Programs - General investigations are conducted for specific and multipurpose water resources projects. These include an environmental assessment.

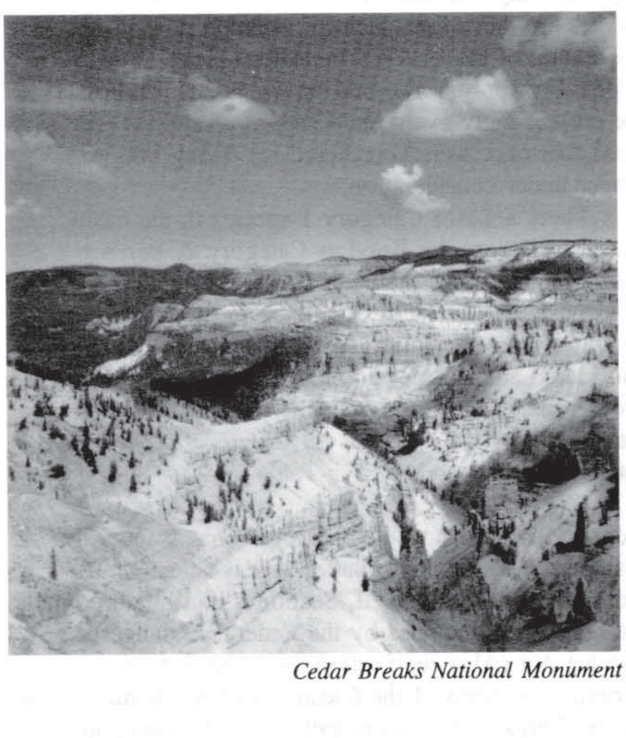
Research Programs - Reclamation conducts research on water-related design; construction; materials; atmospheric management; and wind, geothermal and solar power. Most programs are conducted in cooperation with other entities.

Loan Programs - These programs provide federal loans and assistance to qualified organizations wishing to construct or improve smaller and generally less complex water resources development.

Service Programs - These are intergovernmental specialized technical service programs designed to provide data, technical knowledge and expertise to states and local government agencies to help avoid duplication of special service functions. Local governments pay for requested services.

16.4.5 Consolidated Farm Service Agency (New agency)

The Consolidated Farm Service Agency, along with other authorities, has responsibility for the conservation reserve and agricultural conservation programs presently performed by the Agricultural Stabilization and Conservation Service, farm-related agricultural credit programs presently performed by the Farmers Home Administration, and such other programs related to farm services as may be assigned.



Cedar Breaks National Monument

16.4.6 Cooperative State Research, Education, and Extension Service (New agency)

This agency will be assigned responsibility for all cooperative state and other research programs presently performed by the Cooperative State Research Service, all cooperative education and extension programs presently performed by the Extension Service, and such other functions related to cooperative research, education, and extension as may be assigned.

16.4.7 Corps of Engineers

If local interests are unable to cope with a large water resources problem, they may petition their congressional representatives for assistance. Requests for assistance with smaller problems may be made directly to the Corps of Engineers. This allows the Corps to investigate the economic and technical feasibility and social and environmental acceptability of remedial measures. When the directive covers an entire river basin, it is studied as a unit and a comprehensive plan is developed. Close coordination is maintained with local interests, the state and other federal agencies.

Two studies have been completed (1980 and 1994) to determine the feasibility of controlling floods from Coal Creek at Cedar City. The second study (which encompassed the entire Cedar/Beaver Basin) concluded there were still serious flood threats but no potentially feasible federal alternatives.

16.4.8 Environmental Protection Agency

Environmental Protection Agency programs dealing with water resources include the safe drinking water program under the Federal Safe Drinking Water Act and the water pollution control program under the Clean Water Act. The Federal Safe Drinking Water Act, 1974, as amended in 1986, substantially increased the number of regulated drinking water contaminants, added new required treatment methods and made other revisions. The act is currently being considered by Congress for reauthorization.

There are several aspects of the Clean Water Act, including the following:

National Pollutant Discharge Elimination System (NPDES) - The NPDES program (Clean Water Act, Section 402) regulates the discharge of point sources of pollutants to waters of the United States.

Construction Grants - This program originally provided grant funds for construction of needed municipal wastewater treatment facilities. It was phased out in 1990 and replaced with a revolving loan fund managed by the state.

Water Quality Management Planning and Non-point Source Pollution Control - Section 205(j) of the Clean Water Act provides funds to states to carry out water quality management planning. Section 319 of the act authorizes funding for implementation of non-point source pollution control measures under state leadership.

16.4.9 Farmers Home Administration (Abolished, see subsections 16.4.5 and 16.4.15)

The Farmers Home Administration is authorized to provide financial assistance for water and waste disposal facilities in rural areas and towns of up to 10,000 people. Priority will be given to public entities in areas smaller than 5,500 people to restore, improve or enlarge a water facility. To be eligible for loan and grant funds, water or waste disposal systems must be consistent with state or subdivisions development plans and regulations. The FmHA also makes loans for RC&D projects.

16.4.10 Federal Emergency Management Agency[27,28]

Federal Emergency Management Agency (FEMA) programs are related to disaster preparedness, assistance and mitigation. They provide technical assistance, loans and grants.

Presidential Declared Disaster - After a presidential declaration of a major disaster, usually after a state request, grants are available to state and local governments for mitigation of disaster related damage.

Assistance Grants - The FEMA can provide grants on a matching basis to help the state develop and improve disaster preparedness plans and develop effective state and local emergency management organizations. Also, grants are available to develop earthquake preparedness capabilities.

Flood Plain Management - FEMA provides technical assistance to reduce potential flood losses through flood plain management. This includes flood hazard studies to delineate flood plains, advisory services to prepare and administer flood plain management ordinances and assistance in enrolling in the National Flood Insurance Program. FEMA can also assist with the acquisition of structures in the flood plain subject to continual flooding.

16.4.11 Fish and Wildlife Service

The U.S. Fish and Wildlife Service (USFWS) is responsible for achieving part or all of the mandates of the Endangered Species Act, Fish and Wildlife Coordination Act, Clean Water Act and Migratory Bird Treaty Act. There are no land or water areas in the basin directly managed by the USFWS.

Table 16-1 lists the species considered threatened or endangered and which occur in the Cedar/Beaver Basin. These lists change over time as other species are added when they become threatened or species are removed when they recover. When any activity is planned which may impact a threatened or endangered species, it is the responsibility of the sponsor to take actions to protect them.

The USFWS compiles lists of animal and plant species native to the United States that are being reviewed for possible addition to the List of Endangered and Threatened Species. Such species are generally referred to as candidates. These are assigned to status categories. Category 1 species are those for which the USFWS has on file sufficient information on biological vulnerability and threat(s) to support addition to the endangered and threatened list. Category 2 species are those for which information now in the possession of the USFWS indicates proposing it to list is possibly appropriate, but for which sufficient data are not currently available. Category 3 species are those that once were considered for listing but are no longer under consideration.

There are two Category 1 species in the basin. There are 29 species listed as Category 2. Ben's beardtongue will be added to the next candidate list. These lists are constantly changing to reflect existing conditions. Even though not all of the species are considered aquatic, development for human population growth includes water availability considerations. This may also impact the habitat for terrestrial species. The category species are listed in Table 16-2.

When rights-of-way permits are required on federal lands, the consultation requirement under the Fish and Wildlife Coordination Act is actuated. If federal funds are involved, Section 7 consultation with the USFWS is required by the Federal Endangered Species Act (Also see Section 14). The Section 404 permitting process of the Clean Water Act administered by the Corps of Engineers calls for U.S. Fish and

Table 16-1
THREATENED OR ENDANGERED SPECIES

Bald eagle	Peregrine falcon
Utah prarie dog	Arizona willow[a]

[a] Proposed endangered species.

Table 16-2
CANDIDATE SPECIES

Category 1

Mountain Plover
Least Chub

Category 2

Pinyon penstemon	Plateau catchfly
Cinnamon pika	Cedar Breaks biscuitroot
Navajo Lake milkvetch	Bonneville cutthroat trout
Frisco Clover	Cow plaster wild-buckwheat
Pink egg milk-vetch	Ferruginous hawk
Ostler pepper-grass	Nevada willowherb
Spotted bat	Cedar Breaks goldenbush
White-faced ibis	Reveal indian paintbrush
Black tern	Allen's big-eared bat
Western burrowing owl	Northern goshawk
Western small-footed myotis (bat)	Western least bittern
Yuma myotis	Pygmy rabbit
Long-legged myotis	Pale Townsend's big-eared bat
Long-eared myotis	Big free-tailed bat
Fringed myotis	

Wildlife Service response on impacts to wetlands as well as threatened or endangered species.

Under the Migratory Bird Treaty Act, all birds are protected with the exception of starlings, English sparrows and pigeons. The Endangered Species Act also prohibits the "taking" of a protected species. Any unpermitted activity on any land that results in "take" of federally listed species constitutes violation of Section 9 of the Endangered Species Act. "Take" under the act is defined as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect or to attempt to engage in any such conduct." This can include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering.

16.4.12 Forest Service

Water-related programs of the Forest Service include watershed management; special use authorization for water development projects; and coordination with local, state and federal agencies. They also manage wilderness areas located on national forest lands.

Watershed Management - Watershed protection insures that activities do not cause undue soil erosion and stream sedimentation, reduce soil productivity or otherwise degrade water quality. Water yields may be affected primarily through snowpack management as a result of timber harvest using well-planned layout and design. Potential increases may approach one-half acre-foot per acre for some treated areas, but multiple-use considerations and specific on-site conditions may limit actual increases.

Special Use Authorization - Construction and operation of reservoirs, conveyance ditches, hydropower facilities and other water resources developments require special use authorization and usually an annual fee. Authorization contains conditions necessary to protect all other resources use. Coordination of water developments by others require communication early in the planning process to guarantee environmental concerns are addressed.

The Forest Service has prepared draft EIS and Land and Resource Management Plans for the Dixie and Fishlake national forests. Final plans will be published after public comment.

16.4.13 Geological Survey

The U.S. Geological Survey (USGS), through its Water Resources Division (WRD), investigates the occurrence, quantity, distribution and movement of surface water and groundwater and coordinates federal water data acquisition activities. This is accomplished through programs supported by the USGS, independent of, or in cooperation with, other federal and non-federal agencies.

The USGS manages continuing programs in cooperation with various state agencies. These include water quality and water level changes in the Cedar/Beaver Basin groundwater reservoirs. They also read and evaluate surface water stream gages.

16.4.14 National Park Service

The National Park Service (NPS) was established in 1916 to promote and regulate the use of national parks, monuments and similar reservations to "conserve the scenery and the natural historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." (39 Stat. 535; 16 U.S. Code 1). The long-range objectives of the NPS are as follows.

1. To conserve and manage the parks for their highest purpose; the natural, historical and recreational resources.
2. To provide the highest quality of use and enjoyment by increased millions of visitors.
3. To develop the parks through inclusion of additional areas of scenic, scientific, historical and recreational value.
4. To communicate the cultural, natural, inspirational and recreational significance of the American heritage.

In fulfillment of these objectives, NPS performs the following functions.

- Manages the 6,300 acres in Cedar Breaks National Monument, 5,360 acres in the Cedar/Beaver Basin.
- Conducts the recreational aspects of water project implementation studies.
- Conducts congressionally authorized Wild and Scenic River and National Historic and Scenic Trail studies.
- Through cooperative agreements, administers recreation on lands under the jurisdiction of other federal agencies.
- Provides professional and administrative support to the national, regional and park advisory boards.

In federal water resources project pre-authorization studies, the NPS may provide technical assistance in general development planning. In post-authorization studies, it may provide technical assistance in development planning, site planning, consultation pertaining to the development, interpretation and operation of recreations areas, management planning, negotiation of agreements for administration of reservoir recreation areas, and follow-up on the administration of such agreements.

16.4.15 Natural Resources Conservation Service (New Agency)

The Natural Resources Conservation Service has responsibility for all soil and water conservation programs previously performed by the Soil Conservation Service; the Wetlands Reserve, Water Bank, Colorado River Basin Salinity Control, and Forestry Incentives programs presently performed by the Agricultural Stabilization and Conservation Service; the Farms for the Future Act program presently performed by the Farmers Home Administration; and other functions related to natural resources conservation as may be assigned.

16.4.16 Rural Utilities Service (New agency)

The Rural Utilities Service has responsibility for loan programs presently performed by the Rural Electrification Administration, water and waste facility loans and grants presently assigned to the Rural Development Administration, and such other functions related to rural utility services as may be assigned.

16.4.17 Soil Conservation Service[65] (Abolished, see Subsection 16.4.15)

Soil Conservation Service (SCS) authorities and programs are provided in the Soil and Domestic Allotment Act of 1935. This act calls for the development and implementation of a continuing program of soil and water conservation on all lands, regardless of ownership, when so requested. Over the years, additional programs have been added.

Several soil surveys have been completed in Iron County and the Enterprise area in Washington County. The SCS snow survey program in the basin provides for and coordinates surveys and prepares forecasts of seasonal water supplies. This is a cooperative program with state and other federal agencies for the benefit of water users. Two projects have been completed under the Watershed Protection and Flood Prevention Act (Public Law 83-566), as amended (See Section 9).

The Resource Conservation and Development (RC&D) program began with the Food and Agriculture Act of 1962 (Public Law 87-703), as amended. It provides assistance to government and non-profit organizations in multiple-jurisdictional areas. The Cedar/Beaver Basin is located within the Color Country RC&D Project area.

The Emergency Watershed Program provides technical and financial assistance to relieve eminent hazards to life and property. These hazards include floods and products of erosion created by natural disasters causing sudden impairments. Considerable assistance was provided during flooding in the wet years of 1983-4. ■ ■

Section 17 Contents

Water Conservation/Education

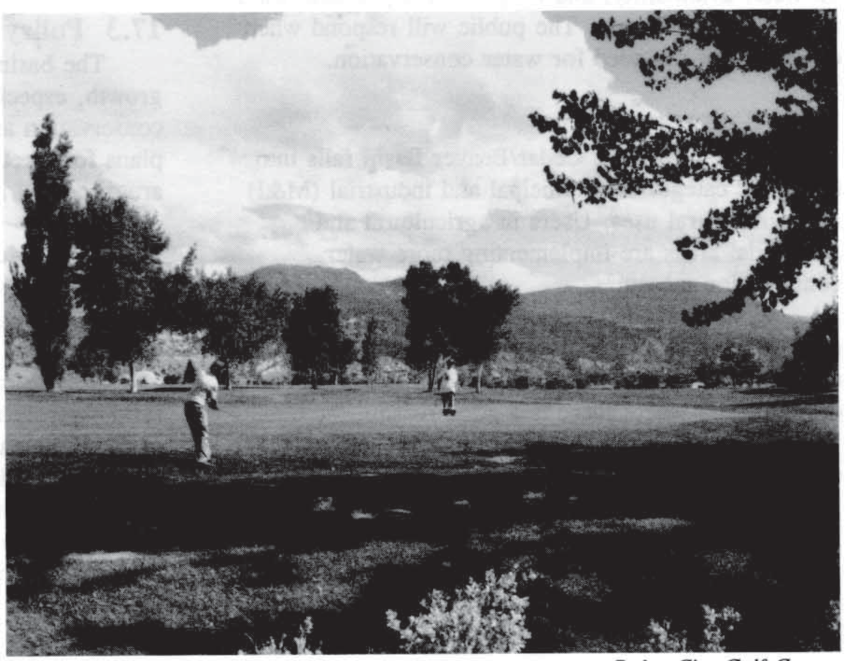
17.1 Introduction

During shortages caused by droughts, system failures or pollution episodes, a plan to conserve water can alleviate the impacts and stretch available supplies to meet priority demands. It is important to recognize that significant water use reductions can be achieved when people understand the reasons to conserve. The public has demonstrated a willingness to temporarily reduce water use during times of drought. By educating the public on the benefits of implementing long-term water conservation efforts, people will be more likely to accept conservation and will provide support and funding necessary to implement them. A well-managed water conservation program for all uses may postpone or eliminate the need for building new facilities and finding additional supplies.

The most effective conservation program combines measures incorporated into the design and operation of water supply systems, includes devices and practices employed by water users, and provides incentives to encourage people to save water. The first is accomplished as providers operate their systems more efficiently, the second as users make special efforts to reduce water use, and the third as water providers institute programs to discourage water waste.

To understand water conservation programs, there is a need to recognize the difference between depletions and diversions. Depletions consist of the water put to the desired end use and consumed and thus made unavailable for return to the system. Diversions must be sufficient to provide the depleted water supply along with any losses associated with delivery to the point of use. If a system were 100 percent efficient, diversions and depletions would be equal.

■ Conservation has been a way of life for many in Utah for generations. The state supports and promotes the conservation and wise use of water for all beneficial purposes.



Cedar City Golf Course

Some water conservation can be accomplished by decreasing depletions through changes in lifestyle, landscaping and economic activity. However, it is easier to conserve water by increasing the use efficiency and thereby decreasing the diversions.

Water quality also has to be considered in the water conservation process. All of the culinary water in the Cedar/Beaver Basin is supplied from springs or wells. This high quality water, suitable for culinary use, is more valuable to municipalities than lower quality supplies because of the treatment costs and social non-acceptance associated with odors and taste. In order to maintain an adequate reserve to meet growing demands and for use during temporary shortages, there should be a cushion between the existing supply of water and the anticipated needs. This can be accomplished by conserving existing supplies. In Cedar Valley, there is also another reason to maintain a reserve. Wells in the southwest part of the valley provide most of the culinary supplies. If the groundwater use exceeds the recharge, lower quality water may encroach into the well field and contaminate the higher quality supplies. Conservation can help reduce the pumpage and preserve this high quality water supply.

Generally, everyone supports water conservation. But nothing happens until someone takes the leadership for preparing and implementing a specific program. Over the long-term, education is the key to water conservation by making people more aware of the hydrologic cycle, including the limitations nature places on water availability, and by providing practical ways for more efficient use. The public will respond when convinced of the need for water conservation.

17.2 Background

Water use in the Cedar/Beaver Basin falls into two basic categories; municipal and industrial (M&I) and agricultural uses. Users in agricultural and residential areas are implementing more water conservation measures.

When water is inexpensive and plentiful, conservation is not popular, especially when additional costs are required for implementation. During times of drought, and where there is a good reason, the public will respond over the short-term to a request to conserve.

17.2.1 Municipal and Industrial Water

High quality water for M&I use is in short supply in some communities and is anticipated to constitute the largest share of future growth needs. Cities and towns are moving toward secondary systems to supply landscaping, gardens and industry with lesser quality water. The higher quality supplies are then reserved for culinary uses. While there are some secondary systems currently installed, several communities are investigating their feasibility for future development.

New light industry is moving into the basin. Included are a milk processing plant in northwest Cedar Valley, an explosive testing firm in the vicinity of the silver mine west of Beryl, and a prefabricated furniture plant near Cedar City.

17.2.2 Agricultural Water

A major agricultural geothermal water user is the greenhouse operation in New Castle. There is a large hog production operation under construction southwest of Milford and an ultra high temperature milk processing plant is locating near Cedar City. Crop production is the largest user of water in the basin.

Farmers have been installing sprinkler irrigation systems at an increasing rate over the last two decades. Some of the systems serve lawns and gardens as well as agricultural land such as the one in Paragonah.

Current irrigation practices allow room for improvement in distribution and application efficiencies. During preparation of the water budgets by the Division of Water Resources in 1994, estimates were made of conveyance and on-farm efficiencies. The water budgets indicate this is one of the most efficient areas in the state. The estimated efficiencies are shown in Table 17-1.

17.3 Policy Issues and Recommendations

The basin is experiencing considerable population growth, especially in the Cedar City area. This makes conservation an important component in the overall plans for meeting future water needs. Five policy issues are discussed in this section.

17.3.1 Residential Water Conservation Plans

Issue - Residential water conservation is needed to stretch existing supplies to help meet future growth demands.

Discussion - With an increasing population, residential water use is the fastest growing component of future demands. Developing additional sources of water for residential use is increasingly costly. Stretching high quality water sources by conservation to serve portions of future growth is and will be increasingly competitive with the cost of developing new supplies.

Table 17-1
IRRIGATION WATER USE EFFICIENCIES[22]

Water-Budget Area	Conveyance	On-farm (Percent)	Overall
Upper Beaver	85	55	47
Milford Area	85	55	47
Parowan Valley	95	65	62
Cedar Valley	85	55	47
Escalante Valley	93	63	59
Lower Beaver	85	55	47

As additional water sources are needed, residential water conservation is a valid measure to meet the growing M&I demand. Water suppliers need to identify conservation goals in relation to supplies and demands. Alternatives to provide water to meet projected demands should be identified. There is also a need to inventory present water supplies along with system capacities, demand projections and recommendations to meet future needs.

Recommendation - Water management and conservation plans should be developed by Beaver, Cedar City, Enoch, Milford and Minersville. Conservation measures should be among the alternatives investigated.

17.3.2 Secondary Water Systems

Issue - Secondary water systems can reduce the demand for high quality water.

Discussion - Supplies of high quality culinary water are limited. Treating lower quality surface water supplies is costly. For these reasons, municipal water providers may consider delivering low quality water for certain uses. A large portion of existing municipal supplies are used for landscape irrigation where there is no need for water meeting culinary standards.

To meet future demands, supplies presently used by agriculture can be converted to secondary uses and eliminate the need to find more distant sources of higher quality water. This will delay or, in the case of some slower growing communities, may eliminate the need for developing more municipal water for many years, thus reducing future financial outlays.

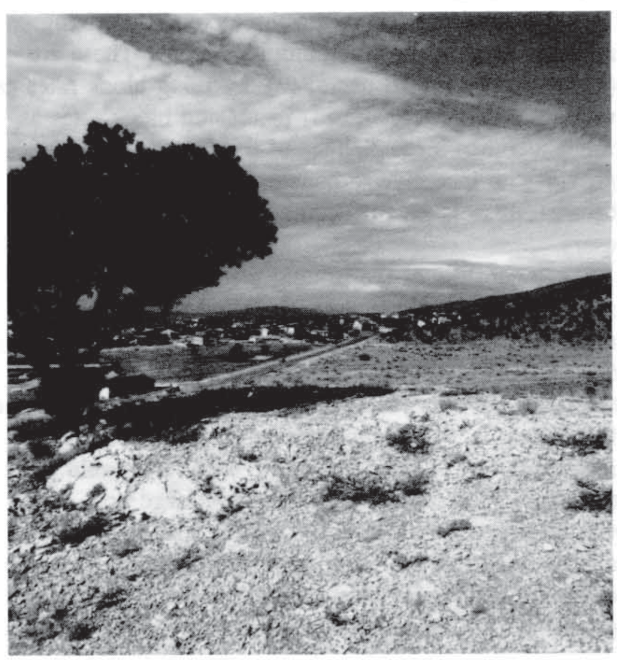
Recommendation - Cedar City, Enterprise and Minersville should undertake studies to determine the feasibility of constructing secondary water systems.

17.3.3 Xeriscape Landscaping

Issue - The use of water conserving landscapes can reduce the need for limited supplies.

Discussion - Landscapes use a major portion of the culinary water in most communities. Although extensive turf around homes has become the normal landscaping practice, this can be adjusted to conserve water and still maintain appealing, attractive landscapes.

Xeriscaping uses a combination of native plants, low water using exotic plants, mulched flower beds, hardscaping (decks, patios and rock gardens), and smaller and selective turf areas to achieve a pleasing mix. Correctly designed xeriscaping can also meet the needs for recreation and entertainment areas along with



Fiddler Canyon area in Cedar City

beautification. This can reduce water use up to 50 percent of that required for a typical monoculture of turf grass. A list of low water use plants applicable to the Cedar/Beaver Basin can be obtained from nurseries and landscape designers in the area. In addition, the Division of Water Resources has similar information available.

New residential construction lends itself best to xeriscape type landscapes. Installation is more expensive than costs for current landscaping, but it will achieve an aesthetic, functional design. Installation costs can be recaptured through more economical operation and maintenance outlays. Replacing existing landscaping can be very costly; however, it does provide an opportunity to redecorate the outside areas while conserving water. Feasibility will depend on the cost of water and individual desires. New subdivisions, such as those around Cedar City, would especially have good potential for xeriscape type landscapes. The Division of Water Resources, Utah Nurseryman's Association and home builders in the state are developing a brochure that will encourage new home owners to implement xeriscape-type landscapes.

Recommendation - Communities, particularly Cedar City and Enoch, should install model water conserving landscape demonstration projects on city property.

17.3.4 Water Pricing

Issue - Some water pricing rate structures can affect water use.

Discussion - There are three common pricing methods used in most communities today. These are (1) level rates for all users, (2) declining block rates as water use increases, and (3) increasing block rates as water use increases. Neither of the first two methods provides an incentive to conserve water, primarily because there is no financial saving to most of the users.

Regardless of the pricing method used, any reduction in water use through water conservation reduces revenues to the suppliers without a reduction in the fixed costs of the facilities. This puts a burden on the water supplier. Increasing the base rate to cover the fixed costs of system operation and implementing an increasing rate for use above the base rate would place the burden for additional supplies on large or extravagant users. Provisions can be made for low and/or fixed income families similar to systems used by other utilities. Using this method, as use increases, prices and the associated consumer cost would increase. This would provide an incentive for water conservation.

Recommendation- Water purveyors should establish base rates to cover fixed costs and set increasing block rates for use above the minimum.

17.3.5 Cropland Irrigation Efficiency

Issue - Irrigation efficiency improvement is an effective means of conserving water and maintaining quality.

Discussion - The technology for improvement of irrigation efficiencies is well-proven and accepted. Improvement of irrigation efficiencies can have an impact on the largest use of water in the basin. The biggest hurdle is the capital costs. Funding programs to aid irrigators defray these costs hold potential for increasing water conservation efforts. These funding programs are discussed in Section 8.

When irrigation conveyance and application efficiencies are improved, less water needs to be diverted to meet the same crop needs. This can reduce labor costs as well as deliver more water to the crop root zone where it is needed. This in turn reduces the percolation of water beyond the root zone and into the groundwater reservoir, thus reducing the leaching of salts and helping to maintain the quality of water in the groundwater reservoirs.

Recommendation - The Utah Department of Agriculture, Consolidated Farm Service Agency, Cooperative Extension Service, Natural Resources Conservation Service and Division of Water Resources need to continue providing technical and financial assistance to agricultural water users to make more efficient use of existing supplies.

17.4 Water Conservation Needs

Conservation of resources is always a good practice. Because of the limited water supplies, especially for culinary use in Cedar Valley, conservation can be the most economical and efficient way to meet a significant portion of the future demands.

The basin population is projected to increase from about 26,500 in 1990 to 56,600 in 2020, an increase of nearly 115 percent. If water diverted for culinary purposes increases at the same rate without applied conservation, an additional 9,170 acre-feet of water will be needed by the year 2020. The population of Cedar City is projected to increase from 13,443 in 1990 to 26,194 in 2020. This increase will require an additional 4,000 acre-feet of water annually. Water conservation can reduce this by over 2,000 acre-feet.

However, averages do not reflect the total picture. Some areas may have ample water, even in times of drought. Other areas may be short of water when drier than normal years come and could be in dire need during prolonged drought periods.

There is a need for additional agricultural water, primarily in late summer, in most of the basin. Installing conservation practices can help meet this need.

17.5 Water Conservation Alternatives

There are several methods and/or programs to conserve water.[14] These include well-designed and operated systems, installation of water saving devices and practices, and an incentive/penalty program to encourage conservation. Structural and nonstructural means can be used to accomplish water conservation.

The largest demand for additional supplies will come from municipal and industrial (M&I) water uses. This will also be the most costly whether it comes from groundwater or from surface water where treatment will be required. Effective conservation should be concentrated on reducing demand. For example, if M&I water diversions are reduced by 25 gallons per capita day in Cedar City, by the year 2020 there would be a saving of about 730 acre-feet annually.

Xeriscaping has the greatest potential for water saving, especially where new construction is involved. Other opportunities exist for reducing water use inside as well as outside the home in existing residential areas. These include installing flow restrictors for showers and faucets, toilet dams, and providing leak detection kits and lawn watering guides. Recent legislation now requires water saving fixtures in new construction or when old ones are replaced. Reducing outside water use can also benefit areas where homes are constructed on collapsible soils such as areas in Cedar City.

Agriculture provides the best opportunity volume-wise for conservation of water. Farmers have been installing sprinkler irrigation systems at an increasing rate over the years and finding them cost effective, especially where gravity pressure can be used. As an example, the gravity sprinkler system in Paragonah serves lawns and gardens as well as agricultural land. There is still room for improvement in the distribution and on-farm irrigation efficiencies. If it is possible to increase the overall irrigation efficiency by 5 percent, there is the potential to reduce irrigation water diversions by about 15,300 acre-feet annually. This would leave more water in surface storage reservoirs for late season use. It would also decrease pumping from groundwater thus reducing deep percolation and the accompanying chemical contamination.

The most effective way to establish a conservation program is under the direction of managers responsible for M&I water supply and distribution. Irrigation companies can reduce losses in distribution systems, but the most effective conservation can be accomplished by the individual farmers increasing their on-farm irrigation efficiencies. Any saved water can be filed on for use on other land through the state's appropriation process.

One of the best ways to implement long-term water conservation is through public education. This can result in public realization of the value of and result in more public support for conservation programs. This is critical both to the people of this area as well as to the wildlife and ecological systems. A big part of a public education program is just teaching how life works and how it depends on water. ■ ■

Section 18 Contents

Industrial Water

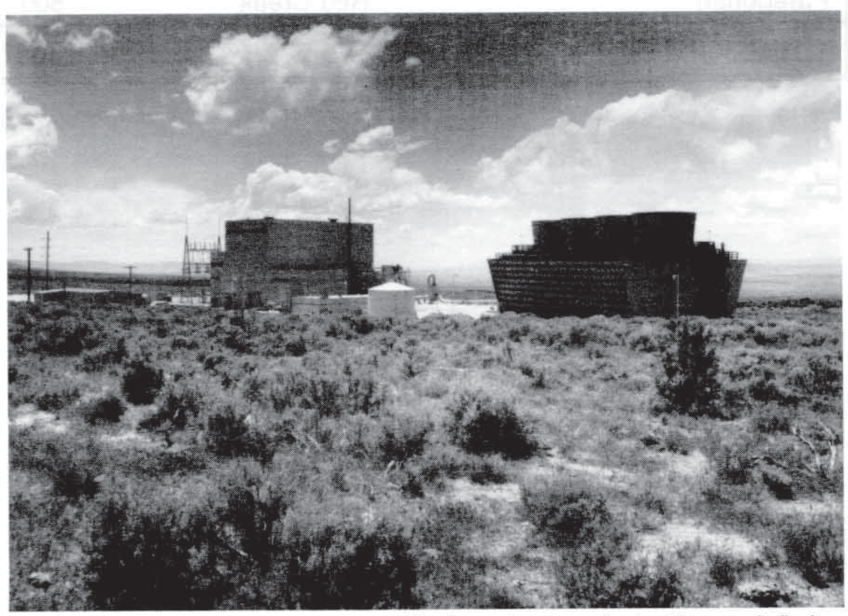
18.1 Introduction

The current uses of water by industry are small, but they are likely to increase in the future. At present, two of the largest water using enterprises are under construction. They are Circle Four Farms near Milford and Western Quality Foods in Cedar City. Projections of future demands by industry must be anticipated with the best accuracy possible. It is important, however, that suitable water be available for industry attracted to the basin. This section discusses the present uses of water for industrial purposes and highlights uses that may expand in the years ahead.

18.2 Background

The primary use of water for industrial purposes is geothermal and hydroelectric power production. These are uses that do not deplete the water resources. Six hydroelectric power plants are now in operation; four on the Beaver River above Beaver, one on Center Creek at Parowan, and one on Red Creek above Paragonah. The existing hydroelectric power plants are shown in Table 18-1. One plant on the Beaver River and one on Pinto Creek are not currently in operation. Utah Power operates a geothermal power plant at Roosevelt Springs and Mother Earth Resources operates one at Sulphurdale. There is a greenhouse operation in New Castle using geothermal water as well as cold groundwater for its operation. Other industrial users include Cache Valley Cheese in Beaver, Circle Four Farms hog production facility southwest and Continental Lime Company north of Milford, and an air bag propellent manufacturing plant northwest of Cedar City. All of these, except for the greenhouse, the dairy and the hog facility are minor users of water with some having their own wells.
There are always some human needs in connection with the industrial uses. Often, water is also used for aesthetic

■ Although the use of water by industry is small, it serves many purposes and carries a high value. Water is used as a solvent for temperature control, to carry away wastes, for human needs, and for aesthetics.



Geothermal power plant at Roosevelt Springs purposes such as lawns and landscaping. All of these uses are generally minor.

18.3 Policy Issues and Recommendations

There is relatively little industrial water use in the Cedar/Beaver Basin and most of the supply is delivered through municipal systems. There are some self-supplied uses. There are no policy issues or recommendations in this section.

18.4 Projected Industrial Water Development

Heavy industrial requirements for water is not expected to increase. Light industry is being attracted to the area and this will increase the total industrial water use. A load-out area for a coal project is being considered in the Iron Springs area and an explosives testing firm is considering locating in the vicinity of the silver mine southwest of Beryl. An ultra high temperature milk processing plant (Western Quality Foods) in Cedar City will be a large water user. Circle Four Farms hog production facilities near Milford will use large quantities of water.

There may be additional power generating plants but this is unlikely in the near future. Possible sites have been identified at Minersville Reservoir and Three Creeks at Kents Lake on the Beaver River, on the First and Second Left Hand Fork and at the Coop Reservoir site on Parowan Creek, and at Newcastle Reservoir on Pinto Creek. ■ ■

Table 18-1[32]
HYDROELECTRIC POWER PLANTS

Name	River	Installed Capacity (kw)	Owner
Beaver No. 1	Beaver	275	Beaver City Corp.
Beaver No. 2	Beaver	650	Beaver City Corp.
Beaver No. 3	Beaver	675	Beaver City Corp.
Beaver Upper	Beaver	2,400	Utah Power
Center Creek	Center Creek	600	Parowan City Corp.
Paragonah	Red Creek	500	Parowan City Corp.
TOTAL		5,100	

Section 19 Contents

Groundwater

19.1 Introduction

The Beryl-Enterprise area is one of the few parts of the state where groundwater mining (long-term overdraft beyond that necessary to develop the groundwater reservoir) is a current method of operation. This is because of the very large and easily tapped groundwater reserves and the absence of conflicting surface water rights.

The Cedar-Beaver Basin consists of five major structural basins containing unconsolidated deposits which form the primary aquifers. These are Beaver Valley, Milford Valley of the Escalante Desert (lower Beaver River), Parowan Valley, Cedar Valley and the Beryl-Enterprise area of the Escalante Desert. These are shown on Figure 19-1. The groundwater reservoir in the Sulfurdale area is not discussed in this report.

The alluvial fill in each of these basins essentially forms an isolated groundwater reservoir. There is very little subsurface water movement between the groundwater reservoirs. Also see Subsection 5.4.2.

19.2 Groundwater Budget

The groundwater budget for the Cedar/Beaver Basin is summarized in Table 19-1. Basinwide, there is an estimated 38 million acre-feet of recoverable water in storage, although the quality varies within each basin as well as from basin to basin.

Withdrawals from wells are more than half of the total groundwater basin discharge. The annual withdrawals are less than one-half percent of the estimated recoverable reserves. Groundwater data are available in digital form from the U.S. Geological Survey. Data on withdrawals from wells, published annually in *Groundwater Conditions in Utah*[18], are summarized in Table 19-2. These data do not include the recent non-consumptive withdrawal and re-injection of water at the Roosevelt geothermal station and Sulfurdale and the Escalante silver mine. Data on discharge, recharge and recoverable reserves are from various published reports, as noted. Most were published in the 1970s during the peak years of groundwater pumping and may exaggerate the basin overdraft compared to 1993 data.

"Recoverable Reserves" indicates the amount of water which could reasonably be extracted with present technology if society were willing to stand the social, economic, and environmental consequences. The "safe yield" (Section 5.3.3) of each basin depends on local aquifer and environmental conditions and is substantially less than the recoverable reserves.

There are substantial hydrologic differences between the individual groundwater reservoirs. These are

■ The Cedar/Beaver Basin depends more on groundwater than any other basin in Utah. Large scale groundwater development for irrigated agriculture has been practiced since the early 1900s.

Figure 19-1
PRIMARY GROUNDWATER RESERVOIRS SHOWING WELL CONCENTRATIONS
Cedar/Beaver Basin

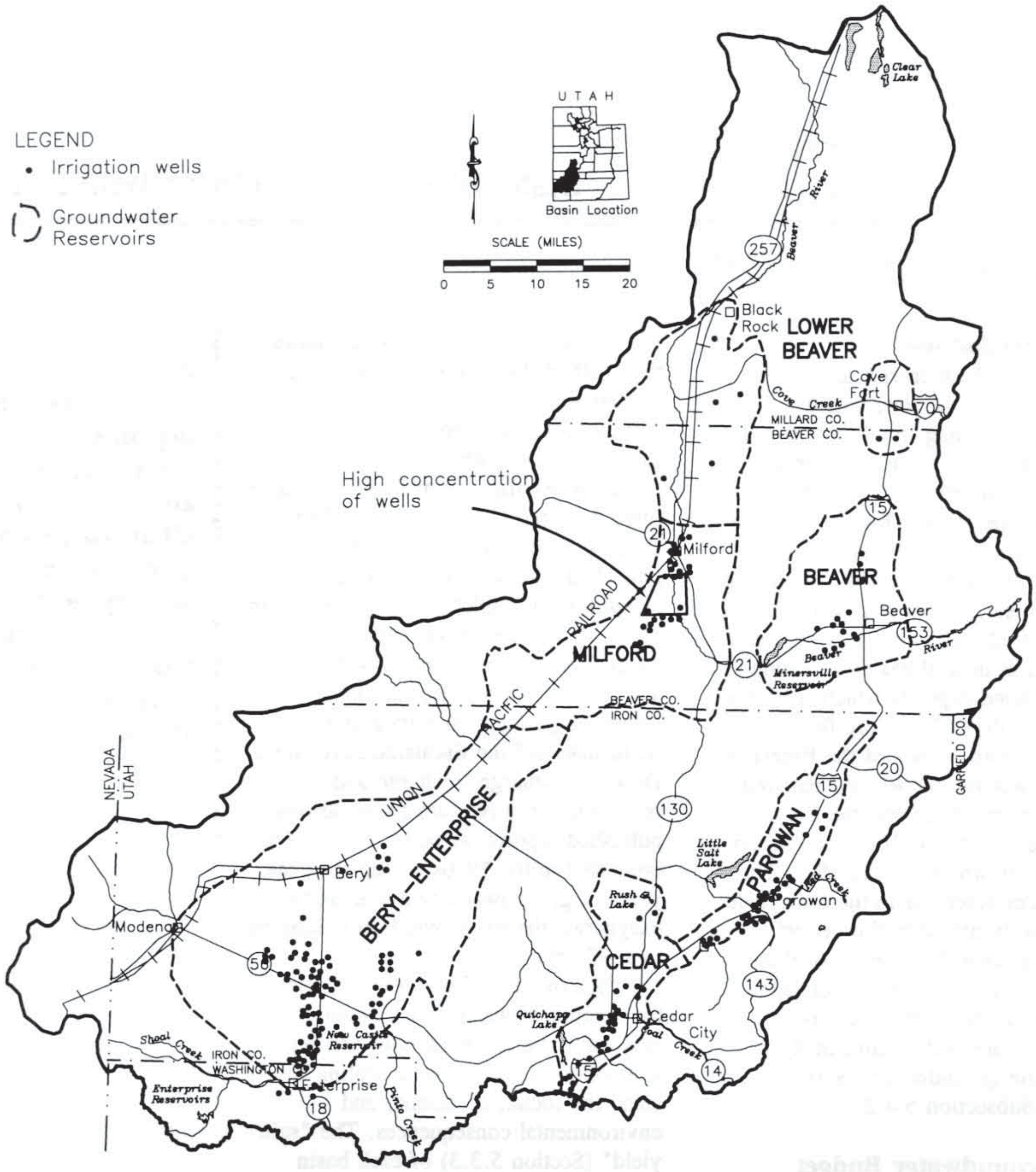


Table 19-1
GROUNDWATER BUDGET AND CHEMICAL QUALITY

Basin Name	Annual Discharge (1000 Ac.ft)	Annual Recharge (1000 Ac.ft)	Annual Withdrawals from wells[a] (1000 Ac.ft.)	Recoverable Reserves (1000 Ac.ft.)	Chemical Quality	Date Basin Closed to Approptn.
Beaver	56.2[d]	55.6[d]	7.3	4,000	Good[b]	1971
Milford	81.0[e]	58.2[e]	39.7	10,000	Good[b]	1956
Parowan	43.0[f]	40.0[f]	26.3	4,000	Good[c]	1971
Cedar	44.0[f]	40.0[f]	26.3	4,000	Good[c]	1966
Beryl-Enterprise	88.0[g]	48.1[g]	76.3	16,000	Good[b]	1956
TOTAL	312.2	241.9	175.9	38,000		

[a] 10-year average, March, 1984-March, 1994, Table 19-2.
[b] Contains some local areas of lower quality.
[c] Small areas of high sodium chloride concentration associated with playas in undrained depressions.
[d] Based on measurements made in 1974; ref. 8.
[e] Estimated for 1970-71; ref. 10.
[f] Estimated for 1974; ref. 2.
[g] Estimated for 1977; ref. 9.

Note: The annual withdrawals are included in the annual discharge.

Table 19-2
CEDAR/BEAVER BASIN GROUNDWATER PUMPAGE

(1000 Acre-feet)

Year	Beaver[a]	Milford[b]	Parowan	Cedar	Beryl[c]
1930					
1931		10.86			
1932		13.72			
1933		12.56			
1934		13.60			
1935		15.82			
1936		14.81			
1937		14.56			2.94
1938		10.13	5.05	10.00	
1939		13.34	6.00	11.90	
1940		18.00	6.03	12.40	2.57
1941		15.12			
1942		13.13			
1943		18.00			
1944		16.64			
1945		18.77	9.27	13.26	5.83
1946		20.45	9.58	16.14	16.62
1947		22.76	9.33	13.73	20.90
1948		21.06	9.53	14.20	33.49
1949		22.76	9.82	13.41	38.45
1950		30.89	10.04	16.63	51.32
1951		33.68	11.32	17.75	45.02
1952		33.09	10.61	11.48	46.99
1953		41.53	11.46	15.41	50.05
1954		39.92	12.50	16.80	54.30
1955		40.86	13.20	16.70	51.30
1956		43.77	15.40	17.90	60.10
1957		41.03	13.00	13.90	56.20
1958	6.00	38.53	12.60	13.04	50.40
1959	6.00	42.98	13.30	18.70	57.20
1960	6.00	48.30	14.30	17.80	65.10
1961	6.00	41.46	11.00	15.30	59.00
1962	6.00	42.96	12.00	19.00	62.00
1963	6.15	42.45	14.00	22.00	64.00
1964	6.10	45.81	16.00	22.00	72.00
1965	4.40	45.51	15.00	16.00	70.00
1966	5.80	51.69	19.60	24.80	78.90
1967	6.20	46.21	17.60	25.80	71.40
1968	7.20	49.07	21.60	29.60	74.20
1969	6.90	53.21	20.30	27.20	84.00
1970	8.30	56.50	25.60	31.40	70.00
1971	7.90	57.71	24.10	35.70	74.90

Table 19-2 (Continued)
CEDAR/BEAVER BASIN GROUNDWATER PUMPAGE

Year	Beaver[a]	Milford[b]	Parowan	Cedar	Beryl[c]
1972	8.90	59.30	28.00	34.90	77.10
1973	8.30	51.60	25.60	26.80	74.00
1974	10.00	70.20	30.70	42.30	93.40
1975	8.00	60.00	28.00	28.00	85.00
1976	11.50	65.00	34.00	37.00	79.00
1977	12.30	65.00	33.00	38.80	81.00
1978	12.00	58.00	29.00	31.00	71.00
1979	11.40	49.00	30.00	32.00	79.00
1980	10.10	61.00	28.00	28.00	71.00
1981	11.10	69.00	27.00	29.00	76.20
1982	9.80	55.00	25.00	28.00	80.80
1983	8.20	38.80	22.00	21.00	67.80
1984	7.10	32.20	22.00	20.00	66.70
1985	7.20	43.70	25.00	23.00	81.40
1986	7.00	37.70	23.10	19.00	73.40
1987	6.80	37.50	22.00	21.00	73.90
1988	7.00	33.95	20.00	20.00	68.50
1989	7.50	40.00	29.00	28.50	85.00
1990	7.50	42.40	31.00	30.00	86.00
1991	7.40	48.40	32.00	34.00	78.40
1992	7.90	36.40	30.60	34.00	72.00
1993	7.10	44.40	28.00	33.00	78.00
Averages[d]					
5-Year	7.48	42.32	30.12	31.90	79.88
10-Year	7.25	39.67	26.27	26.25	76.33
15-Year	8.21	44.63	26.31	26.70	75.87
20-Year	8.85	49.38	27.47	28.88	77.38
25-Year	8.69	50.64	26.92	29.34	77.10
30-Year	8.23	50.14	25.43	28.39	76.47

[a] Records Prior to 1958. The 1958-1962 & 1967-1973 pumpage was estimated.
[b] Does not include the 1985-1993 approximately 6,000 ac-ft per year pumped for geothermal power production and then reinjected as there is zero loss.
[c] Does not include the 1981-1988 approximately 20,300 ac-ft per year pumped to dewater a mine and then spread nearby for recharge as there was zero loss.
[d] Calculated from 1993 back in time.
Note: Pumping for geothermal power production at Sulphurdale is not included.

outlined in the following sections. The water-related terms are defined in Section A.

19.2.1 Beaver Valley[45]

The principal groundwater reservoir of Beaver Valley consists of unconsolidated basin fill which has been divided into three units. The Sevier River Formation of Tertiary age consists of unconsolidated to partly consolidated deposits of sand, gravel, silt and clay of alluvial and lacustrine origin. Overlying the Sevier River formation in the central part of the valley are younger and older alluvial units of Quaternary age. All units are lenticular in nature, with water-bearing gravel interbedded with less permeable layers of silt and clay.

Recharge - Of the 55,600 acre-feet of recharge to the groundwater reservoir, 39,000 acre-feet is by infiltration of excess water from irrigated fields and canals. The remainder comes from direct precipitation, streambed infiltration and subsurface inflow from bedrock.

Discharge - Because of the relatively large surface water supply, there has been less reliance on groundwater in Beaver Valley than in the rest of the basin. Roughly half the discharge from the groundwater reservoir (28,000 acre-feet) comes from springs. The remainder is from wells (10,000 acre-feet in 1974; 7,250 acre-feet from 1984 to 1994) and evapotranspiration (18,000). See Figure 19-2. About 300 acre-feet per year is believed to leave the valley as subsurface flow. Unconsumed spring discharge flows into Minersville Reservoir, from where it is released downstream to Milford Valley as surface flow.

Storage - The alluvial basin fill is believed to be 500 to 800 feet thick in the central part of the Beaver Valley. Assuming a specific yield of 0.20, about 4 million acre-feet of water is contained in the upper 200 feet of valley fill.

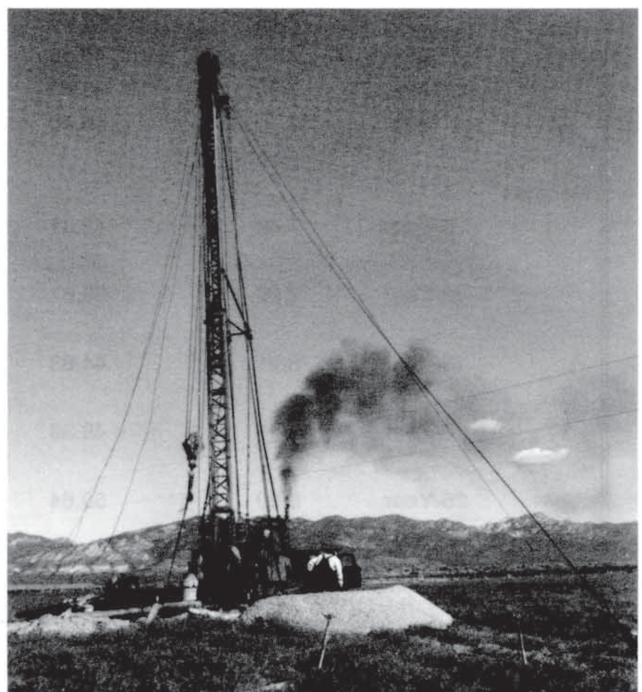
Change in Storage - The estimated discharge is within 1 percent of the estimated recharge, indicating there is little long-term change in groundwater storage. The hydrographs of pumped wells show a strong annual fluctuation, but little interannual change. Examination of well hydrographs show that groundwater levels are high in the summer and decline in the winter, responding more to infiltration of surface water than to groundwater pumping. The alluvial basin is therefore functioning more as a drainage system than a reservoir.

Water Quality - The quality of groundwater is generally good. Most samples contain 300 mg/l or less of TDS (total dissolved solids). Dissolved solids tend to increase toward the southwest end of the valley, and to increase with depth, being higher in the older, less permeable basin fill units. Groundwater quality is discussed further in Section 12. There appear to be no sources of brackish water which could cause long-term deterioration of quality by intrusion.

19.2.2 Milford Area[46]

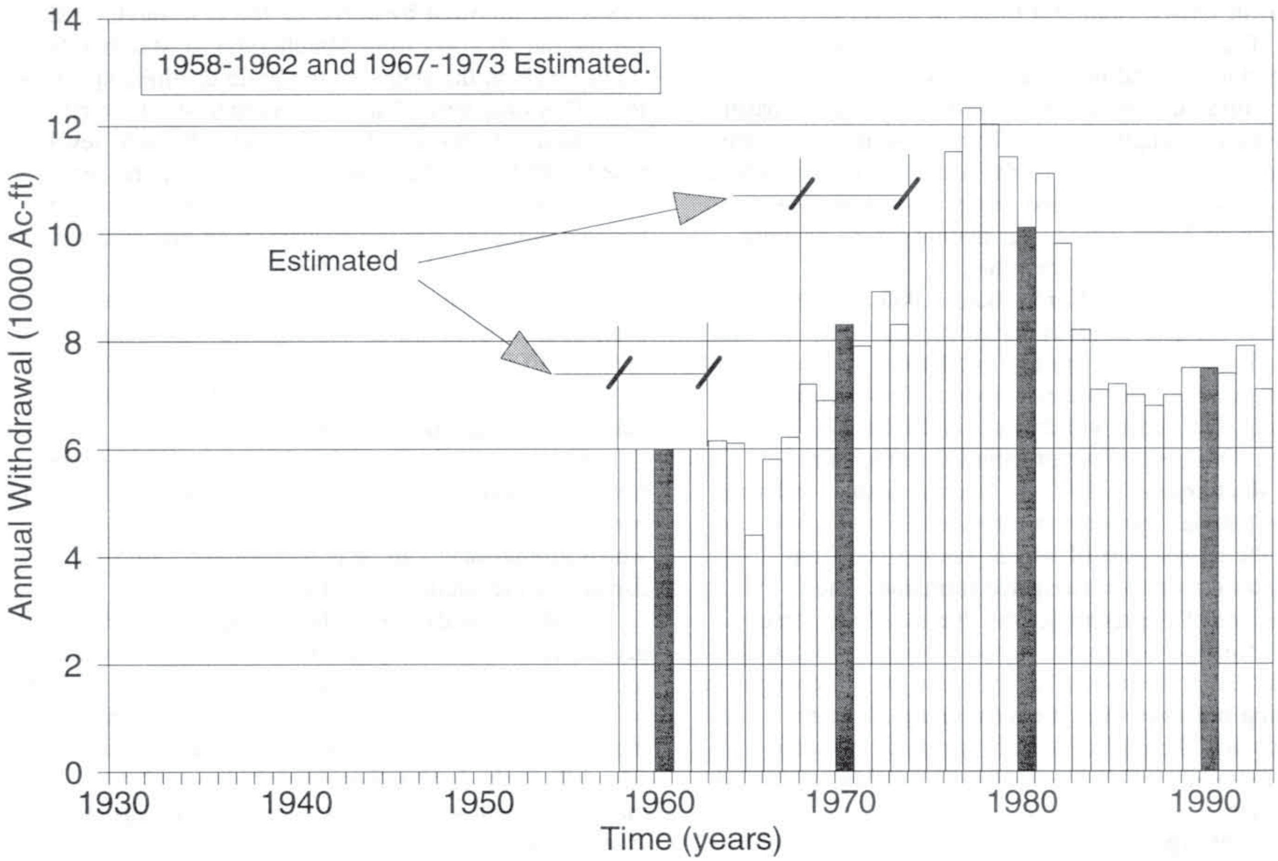
The Milford Valley groundwater basin extends from Rocky Ford Dam on the Beaver River downstream to where the Beaver River disappears in the Black Rock Desert. The alluvial basin underlying the Escalante Desert continues southward into the Beryl-Enterprise area; the Milford Valley is arbitrarily divided from the rest of the Escalante Desert at the narrow neck just south of the Beaver-Iron County line. Groundwater development for irrigation began early in this century and was well underway by the 1920s.[11]

The alluvial basin fill constitutes the primary groundwater reservoir, and consists of interbedded gravel, sand and clay. Little exploration has been conducted in bedrock, except for testing reserves in the Roosevelt Hot Springs geothermal area and a recent



Well drilling near Beaver

Figure 19-2
BEAVER VALLEY GROUNDWATER PUMPAGE



deep well at the Continental Lime Company plant on the east flank of the Cricket Mountains.

Measured hydraulic conductivity in the alluvial basin fill ranges from 500 ft/day in gravel to 1 ft/day in clay. The clay beds are most likely laterally discontinuous, and pump tests in the principal agricultural area south of Milford show that the basin behaves as a single aquifer. Transmissivity ranges from 1,000 ft^2/day to 40,000 ft^2/day south of Milford where a thick section of sand and gravel is present. Many wells yield 2,000 gallons per minute (gpm) or more with a few exceeding that value.

Northeast of Milford, about 6,000 acre-feet of hot water is pumped annually from fractured igneous rock at the Roosevelt Hot Springs geothermal station, cooled in the power plant, and re-injected. This pumpage is not included under withdrawals in Tables 19-1 and 19-2, and the injection is not included in recharge.

Recharge - In 1972 the average annual recharge to the alluvial aquifer was estimated to be 58,000 acre-feet, the largest part of which was derived from infiltration from over-irrigated farmland. The remainder of the recharge was due mostly to losses from stream channels and canals. Present sources of recharge may be somewhat different, due to changes in farming practices over the intervening 20 years, particularly the replacement of canals by pressure pipelines and conversion of flood irrigation systems to sprinkler.

Discharge - In 1972 the average annual discharge was estimated to be 81,000 acre feet, most of which was from pumpage of wells, which at that time was near the all-time peak of 59,300 acre-feet (Figure 19-3). The 10-year average pumpage from March of 1984 to March of 1994 was 45,000 acre-feet (Table 19-2), substantially less than 1972. Most of the remaining discharge (24,000 acre-feet) was attributed to evapotranspiration from 95,000 acres of "phreatophytes", which included but was not limited to riparian and wetland areas of the valley where the water table is shallow.

Subsurface outflow from the basin is negligible. Thermo Hot Spring, the one spring which rises within the alluvial basin, discharges about 100 acre-feet per year which is consumed locally by evapotranspiration.

Storage - In the center of the basin the alluvial fill is at least 1,000 feet thick. An estimated 10 million acre-feet of water could be recovered from storage from the upper 200 feet of the basin fill. This is more than 100 times the estimated annual discharge.

Change in Storage - Groundwater levels in the Milford area trended downward from 1950 to 1970, then leveled off in the 1970s. A sharp rise in the early 1980s was followed by declining levels through 1992.[56] During the 30 years from March 1963 to March 1993, water levels in the center of the basin declined up to 19 feet. This long-term change is less than shorter term fluctuations. From March 1983 to March 1985, levels rose by 30 feet in the center of the basin as the result of recharge from large flows in the Beaver River and reduced pumpage due to unusually high precipitation. Then from March 1988 to March 1993, water levels in the center of the basin declined more than 20 feet, as most of this stored water was depleted. The long term decline, 30 feet in 60 years at well number (C-29-11)13aad-1 five miles south of Milford,[56] is no larger than some of the shorter 10-year fluctuations.

Some land subsidence has been noted in the most heavily pumped parts of the valley, suggesting that parts of the Milford basin may be nearing the limit to which groundwater can be pumped down without damage to the aquifer or surface structures.

Water Quality - The chemical quality of the groundwater is generally good. The concentration of total dissolved solids (TDS) of 35 samples measured in 1972 ranged from 224 mg/l to 4,600 mg/l, with a median value of 569 mg/l. Well water in the Milford area falls in the low sodium hazard class and the medium to high salinity hazard class. In the agricultural area, the upper 100 to 200 feet of the aquifer has poorer quality due to the infiltration of excess irrigation water bearing dissolved minerals concentrated by evaporation, soil leachates, fertilizers and pesticides. Many wells show a long-term downward trend in water quality. This is probably due to the infiltration of excess irrigation water, but some may be due to the lateral intrusion of naturally occurring poor quality water. Cross contamination from poorly constructed wells is also a source of groundwater pollution. The 1962 map of groundwater quality, shows areas of brackish water along the west margin of the valley, both north and south of Milford, and near Thermo Hot Spring. Groundwater quality is discussed further in Section 12.

19.2.3 Parowan Valley[7]

Parowan Valley is a topographically closed basin with a low divide through which it has spilled toward Cedar Valley during wetter climates in the geological past. Since settlement, water has been known to flow through the Parowan Gap into Cedar Valley. Parowan

Figure 19-3
MILFORD VALLEY GROUNDWATER PUMPAGE

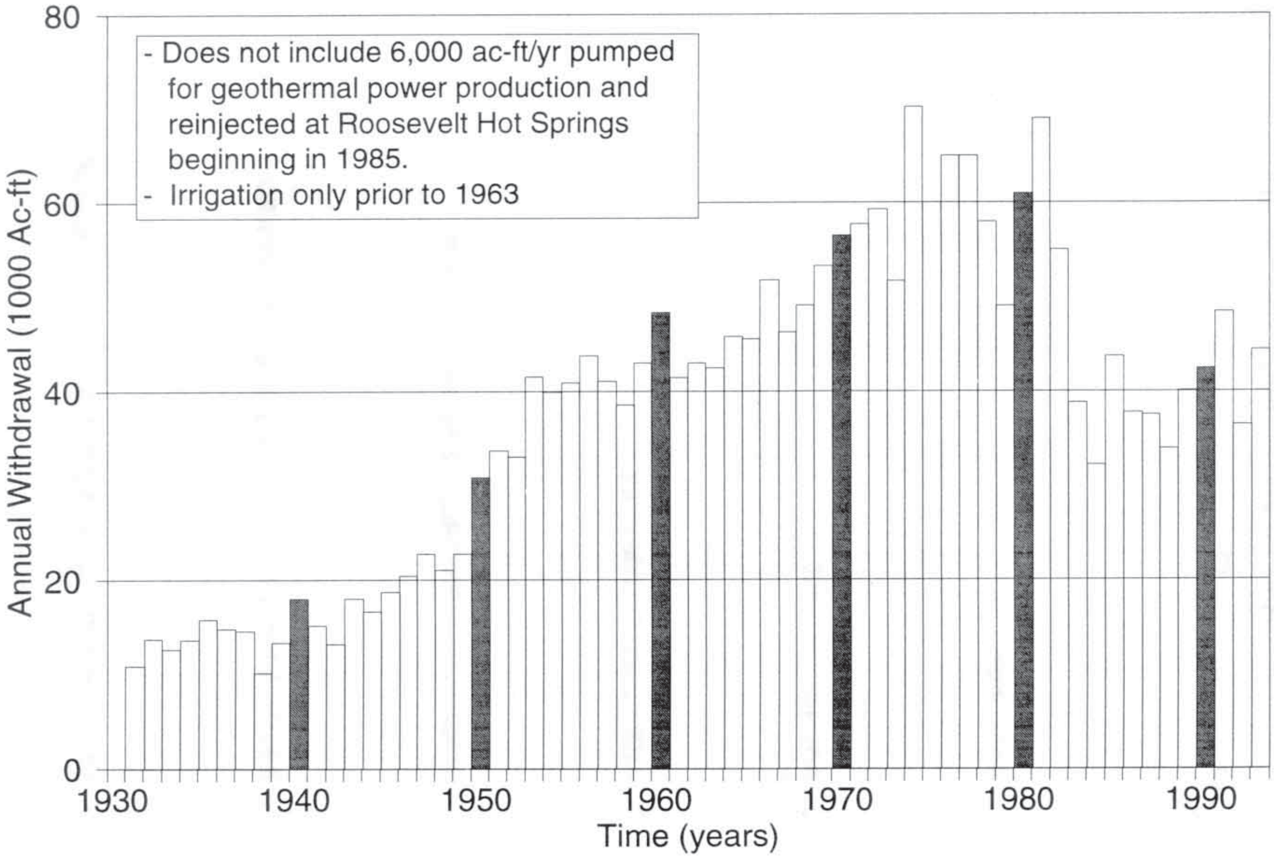
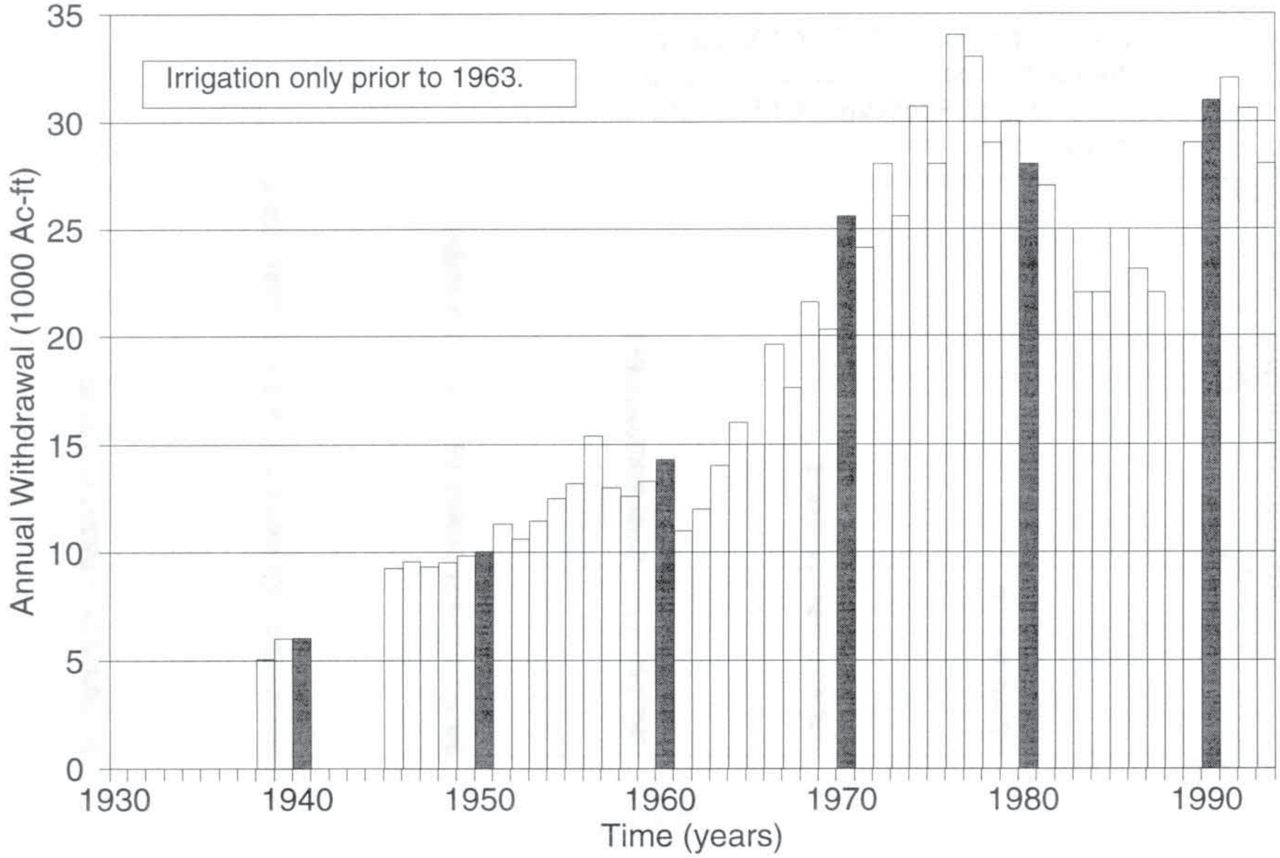


Figure 19-4
PAROWAN VALLEY GROUNDWATER PUMPAGE



Valley receives runoff from several perennial streams draining the Markagunt Plateau which recharge the groundwater system during wet years. The undrained bottom of the valley is occupied by Little Salt Lake, an ephemeral playa-lake.

The alluvial basin fill constitutes the groundwater aquifer, and consists of interbedded gravel, sand and clay, generally coarser near the edges of the basin and fining toward the center. Precipitated salt is found in the bed of Little Salt Lake, and locally basalt is interbedded with the alluvium. Consolidated sedimentary rocks around the basin margins yield water to springs, but little groundwater exploration has been conducted in the consolidated rock units.

Interbedded clay layers provide barriers to vertical movement of water in the central part of the valley creating perched and artesian conditions. The area of flowing wells had decreased from 46 square miles in 1940 to 36 square miles in 1974.

Recharge - Total annual recharge to the Parowan Valley groundwater basin is estimated to be 40,000 acre-feet. Most of this comes from stream infiltration into the gravelly deposits of alluvial fans at the mouths of canyons. Most of the remainder is infiltration of excess irrigation water. Some water may recharge the alluvial basins from the consolidated rock of the mountain blocks, but the quantity is unknown. Trans-basin inflow is believed to be negligible.

Discharge - Average annual discharge is estimated to be 43,000 acre-feet, more than half of which is from wells in the alluvial basin fill. About 12,000 acre-feet is estimated to be discharged from the groundwater system by evapotranspiration from salt grass meadows, other phreatophytes, and the bed of Little Salt Lake. The largest spring on the valley floor, Willow Spring, discharges about 40 gpm (65 acre-feet per year).

Groundwater pumpage increased steadily since records began in 1938 until the mid-1970s (Figure 19-4). Since then, pumping has fluctuated in a broad, decadal cycle, reflecting the wetter years in the early 1980s and the drought of the late 1980s. The 10-year average pumpage from March 1984 to March of 1994 was 26,300 acre-feet, which is not much different from the 30-year average.

Springs issuing from the consolidated rock in the mountains are the source of most of the culinary water in municipal systems. These also provide base flow in the streams.

Storage - The total water contained in the basin fill is estimated to be 20 million acre-feet. Approximately 20 percent, or 4 million acre-feet, are recoverable reserves (Table 19-1).

Change in Storage - During the 30 years from 1963 to 1993, water levels declined throughout Parowan valley where records are available. The area of greatest decline, more than 40 feet, is centered on the Parowan Creek alluvial fan at the town of Parowan.[37] The declines extend nearly to the edge of Little Salt Lake. Short term fluctuations have also been substantial. During wet years the pattern of change is similar, centered around the Parowan Creek and Summit Creek alluvial fans where most of the recharge takes place. From March 1983 to March 1985, water levels rose throughout the valley, with an increase of nearly 30 feet near Parowan.[18] The stored water was subsequently lost to continuing declines through 1992.[37] The hydrograph of well (C-34-8)5bca-1 near Paragonah[37] shows a declining water level from 1950 into the 1960s, then levelling off with fluctuations until 1985, then continuing a decline to the present. The observation well (C-34-10)24cbc-2 near Summit shows a more or less continuous decline of 45 feet from 1950 to the present.

The alluvial basin is providing carryover storage on a decade time scale. However, there is also a long-term (40-year) downward trend in groundwater levels which is continuing. The presence of artesian conditions in the center of the basin and the absence of land subsidence related to groundwater pumping suggests that groundwater overdraft is not yet a serious problem.

Water Quality - Water quality throughout the Parowan Valley is generally good. Even around the margins of Little Salt Lake TDS does not exceed 300 mg/l. There appears to have been little decrease in quality over the years. The playa salt pan of Little Salt Lake was probably generated over a long time by the evaporation of water, slowly seeping upward under artesian pressure from the confined aquifers at depth. As long as the aquifers remain pressurized, there is no potential for intrusion of brine from the lake. At the present time, the artesian pressure is seasonal; that is, most artesian wells flow only in the winter when irrigation wells are not being pumped. As groundwater levels continue to decline, the average pressure gradient at Little Salt Lake could be reversed and the lake may become a source of contamination.

19.2.4 Cedar Valley[7]

Cedar Valley is geologically similar to Parowan Valley, being a structural basin bounded by faults on the east, and probably on the west as well, and containing a thick section of unconsolidated alluvial basin fill. The principal surface stream is Coal Creek, which drains from the Markagunt Plateau to the east. Deposition of the large alluvial fan of Coal Creek has divided the valley topographically into two closed depressions; Quichapah Lake to the south and Rush Lake to the north.

The alluvial basin fill consists of interbedded gravel, sand and clay. The clay layers are sufficiently continuous to isolate the granular layers into confined aquifers. Although no flowing wells remain today, Thomas and Taylor[59] in 1939 found flowing wells in an area of more than 50 square miles. Transmissivities measured from pump tests range from 2,500 to 52,000 ft^2/d, and hydraulic conductivities range from 13 to 250^2 ft/d. The high transmissivities associated with the Coal Creek alluvial fan decline to the north, west and south toward the distal parts of the fan. High transmissivities are also reported south of Quichapah Lake where alluvium is derived from tertiary volcanic rocks, and near and north of Rush Lake where volcanic rocks are interbedded with the alluvium.

Some water has been found in, and produced from, consolidated rocks in the basin, primarily the Navajo Sandstone and some of the igneous rock units. To date, this source has not received much exploration. In 1980 Cedar City explored for groundwater in the Navajo sandstone adjacent to Coal Creek in Cedar Canyon[43] and found a productive well with water of good quality. Because of low production, the Red Hill well has not been used.

Water Rights - When the Utah groundwater law was passed in 1935, Cedar Valley was one of the areas of concern because of declining water levels. The groundwater in the valley was considered to be fully appropriated, and the state engineer approved no further applications for drilling additional irrigation wells pending an investigation.[60] Upon completion of studies in 1940, the central part of the valley was closed to new appropriation. But appropriations were granted in outlying areas such as Enoch, Quichapah and Hamilton's Fort. The entire sub-basin was closed in 1966.

Recharge - Most of the recharge to the unconsolidated deposits is by infiltration from streambeds on the gravelly upper portions of their alluvial fans. Coal Creek is the primary contributor to the Cedar Valley groundwater basin. Surplus undiverted flow in Coal Creek continues to recharge the groundwater system, but as continuing urbanization has crowded the channel, progressively less channel and alluvial fan area has been available for flood flows to spread out and infiltrate. More flood flows are now channeled out into the valley where less favorable recharge areas exist. Average annual recharge may therefore now be somewhat less than the 40,000 acre-feet estimated in 1974.[2] Some recharge is derived from the infiltration of precipitation and excess irrigation, which may also be decreased by urbanization.

Discharge - The annual discharge from the Cedar Valley groundwater basin was estimated in 1974 to be about 43,500 acre-feet. Most of this is discharged from pumped wells, which in 1974 produced 42,300 acre-feet of water. At the present time, pumpage has decreased to 34,000 acre-feet per year from 1991 to 1993(Table 19-2). Annual pumpage responded to surplus and drought in the 1980s as shown in Figure 19-5.

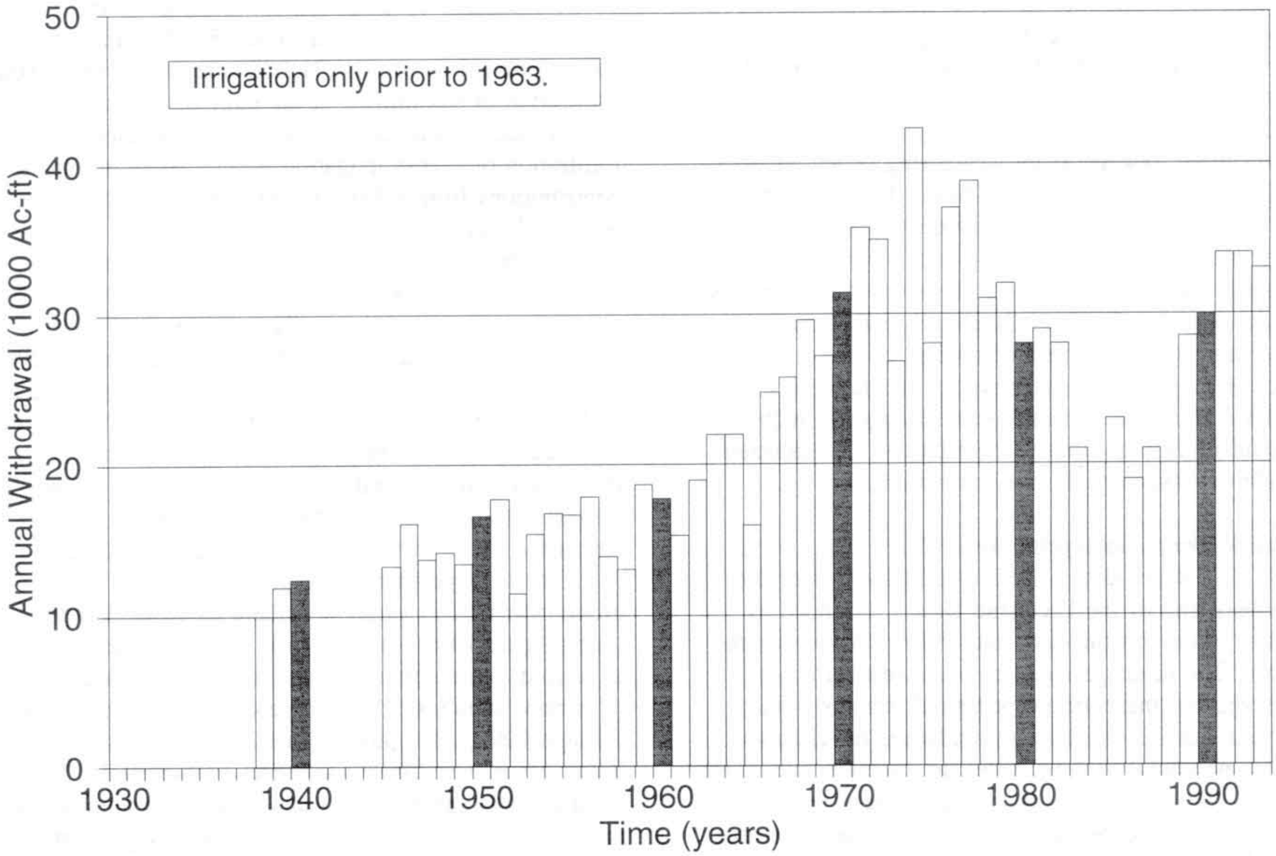
Discharge by evapotranspiration from phreatophytes in the valley bottoms and the playas of Quichapah and Rush lakes was estimated in 1978 to be 2,000 acre-feet, and probably remains about the same. An estimated 500 acre-feet was estimated to flow in the subsurface westward from Cedar Valley to the Beryl-Enterprise Valley via Iron Springs Gap.[59] Although Barnett and Mayo[1] show 1,500 acre-feet per year leaving the basin as subsurface flow to the Virgin River basin to the south, later USGS work[2] found no evidence for it.

Storage - Total volume of water in storage in the alluvial aquifer is estimated to be 20 million acre-feet. An estimated 20 percent or 4 million acre-feet is recoverable. There may be some water in the bedrock aquifers as well, but these reserves have not been explored. The recoverable reserves are large in comparison to the annual discharge, giving the Cedar Valley groundwater reservoir the capacity for substantial holdover storage to buffer wet and dry periods.

Change in Storage - The 30-year change map[5] shows relatively little change in water level in the Cedar Valley from 1963 to 1993. Declines greater than 10 feet are confined to the area west of Quichapah Lake. This indicates that long-term recharge and discharge are more or less in balance in most of the valley. The basinwide decline in water levels which generated concern in the 1960s[5] appears to have ceased.

On a shorter time scale, however, water levels on the Coal Creek alluvial fan have risen and fallen by more than 20 feet showing that the alluvial basin is performing as a storage reservoir on the decade time scale. Barnett and Mayo[5] found a linear relationship between average annual water level change in eight monitoring wells and the difference between the discharge of Coal Creek and annual groundwater

Figure 19-5
CEDAR VALLEY GROUNDWATER PUMPAGE



pumpage, thus showing the direct and immediate response of groundwater to pumping and recharge by Coal Creek. As calculated in 1966, there is a one-foot change in groundwater level for each 5,600 acre-feet of difference between recharge and pumpage.

Water Quality - Groundwater in Cedar Valley is hard, but is generally satisfactory for most uses. Most samples are of the calcium or magnesium sulfate type. The sulfate ions are from weathering of abundant gypsum-bearing rocks in the basin. In parts of the valley with heavy groundwater development, water contains greater concentration of dissolved solids, possibly due to recycling of irrigation water. Shallow water near the playas of Quichapah and Rush Lakes have high concentrations of sodium chloride, and could present a source of contamination to the basin in general if increased pumpage or changes in recharge should reverse groundwater gradients. Groundwater quality is discussed further in Section 12.

19.2.5 Beryl-Enterprise Area[44,47]

The Beryl-Enterprise subbasin consists of the southern end of the Escalante Desert, bounded by Cedar Valley on the east, and Milford Valley on the north. The drainage basin extends westward into Nevada, but there are no perennial streams in the Nevada portion and little groundwater development. Three perennial streams water the southern end of the valley, but otherwise tributary drainages are intermittent or ephemeral. The Beryl-Enterprise area has the least potential recharge in relation to the groundwater in storage of any of the five groundwater reservoirs in the Cedar/Beaver Basin. Cedar City Valley probably contributed to the Escalante Valley during wetter climates in the geologic past through Iron Springs gap. Presently, the flow of Pinto Creek is augmented by a transbasin diversion from the Santa Clara River. Flood flows in excess of those needed for irrigation run into the basin for groundwater recharge.

The Beryl-Enterprise area is a structural basin, partly fault-bounded, containing at least 1,000 feet of unconsolidated alluvial fill consisting of interbedded layers of sand, gravel and clay. Northwest of Enterprise, water is also produced from layered volcanic rock which is permeable and appears connected to the alluvial aquifer. The water-bearing deposits are lenticular in nature, with greater permeability in the horizontal than vertical direction, and becoming finer toward the center of the basin. Pump tests indicate that in a time frame of months or longer, the entire basin can be treated as a single aquifer.

Values of transmissivity calculated from pump tests range from 200 to 120,000 ft^2/d. The highest values are in the area between Enterprise and Beryl Junction.

Recharge - Average annual recharge to the alluvial basin was estimated to be 48,100 acre-feet in 1977. Two-thirds of this (31,000 acre-feet) comes from infiltration of streamflow at the edge of the basin. Most of the remainder (16,300 acre-feet) comes from infiltration of excess irrigation water. There are small contributions from subsurface inflow from outside the basin and from infiltration of precipitation.

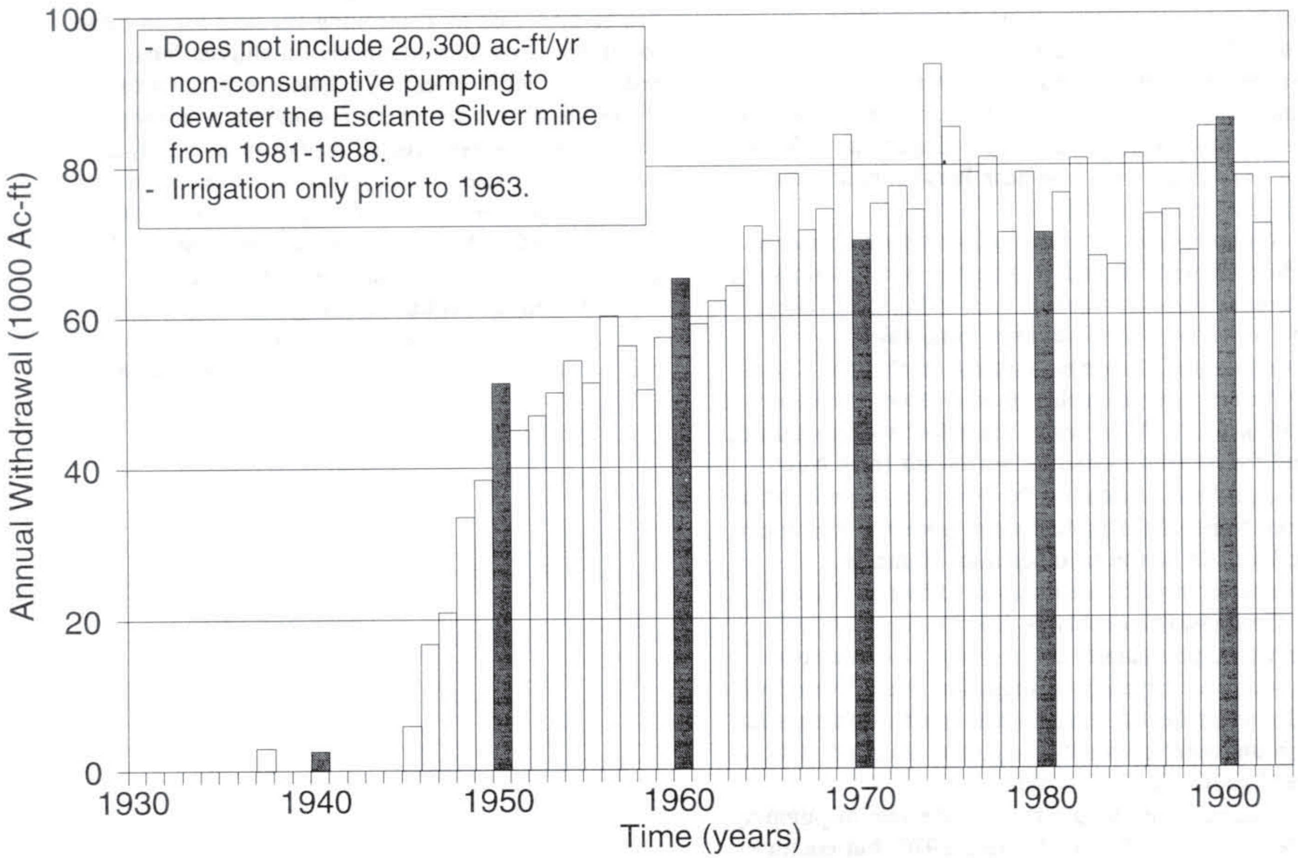
Discharge - Discharge from the basin was estimated to be 81,000 acre-feet in 1977. Discharge is mostly by pumpage from wells, with most of the rest (6,000 acre-feet) due to evapotranspiration from native vegetation in areas of shallow water table. There are no springs which drain the alluvial aquifer, and there is no evidence that there were any before groundwater pumping began. A small amount of subsurface flow, estimated to be 1,000 to 2,000 acre-feet per year, leaves the basin northward to the Milford Valley.

The average annual pumpage from the groundwater basin varies considerably from year to year (Figure 19-6), and depends on crop water demand as related to temperature, rainfall, and the availability of surface supplies. The five-year average from 1989 through 1993, after pumping ceased at the Escalante Silver Mine, was 79,880 acre-feet (Table 19-2). The pumpage average over 30 years, excluding pumpage at the silver mine, is 76,470 acre-feet. Pumpage alone, exclusive of natural basin discharges, has exceeded the average recharge every year since 1950.

Storage - The total volume of water in storage is estimated to be 72 million acre-feet. The volume of water which could be produced by dewatering the upper 200 feet of saturated basin fill as it existed in 1978 is estimated to be 16 million acre-feet of recoverable reserves (Table 19-1).

Change in Storage - Groundwater withdrawals since 1937 have greatly modified the groundwater regime in the south-central third of the area. Groundwater levels have declined by as much as 70 feet in the area between Enterprise and Beryl Junction, creating an artificial depression in the water table, and reversing the natural gradient. Change maps for all periods show decreasing water levels in most of the area.[18] The five-year change map, March 1988 to March 1993,[9] shows declines throughout the basin except for the alluvial apron of the Wah Wah Mountains between Zane and Lund. The 30-year change map shows the long-term decline in the

Figure 19-6
BERYL-ENTERPRISE GROUNDWATER PUMPAGE



southern end of the basin between Enterprise and Beryl exceeding 30 feet over much of the area. The change map for March 1983 to March 1984[18] is one of the few examples of rising water levels in the general downward trend, and illustrates the effect of storage of excess water in the groundwater reservoir. Groundwater levels rose three feet or more at the basin margins near Enterprise and New Castle due to heavy spring runoff in 1983, and near Beryl Junction due to recharge of mine drainage.

Water Quality - The quality of groundwater in the Beryl-Enterprise area is generally good, with some small areas of poorer quality. As in Milford Valley, water at the top of the saturated zone has a concentration of dissolved solids several times that of deeper water, due to recharge from deep percolation of irrigation water. Most water has a low sodium hazard, except for an area extending northward from New Castle, probably related to the New Castle geothermal source. None of the groundwater is known to contain toxic levels of boron or other trace elements. Groundwater quality is discussed further in Section 12.

Groundwater quality is deteriorating slowly in some wells, particularly in the Beryl Junction area, mostly due to recycling of irrigation water. Near New Castle, water quality changes are noted as changes in the groundwater gradient change the direction of flow of local sodium-bearing water.

Mining - The long-term average rate of pumping has been more or less stable since 1970, but continues to exceed estimates of recharge. The continued decline in water levels shows that overdraft is taking place. The state engineer expressed concern over groundwater mining when pumpage in the Escalante Valley increased rapidly from 1945 to 1953.[58] The water table in the pumping district is declining at a rate of less than two feet a year, so that the energy requirement for lifting the water is increasing rather slowly.

19.3 Policy Issues and Recommendations

The only issue discusses the need to preserve groundwater recharge areas.

19.3.1 Groundwater Recharge Areas

Issue - Groundwater recharge areas are susceptible to pollution from man's activities and they need to be preserved.

Discussion - Recharge areas are environmentally sensitive and will become more susceptible to pollution as man's activities increase. Pollution spills in the recharge areas as well as in streams or ephemeral drainages have the potential to contaminate the groundwater reservoirs. Pollution can also come from improperly located land fills, high use recreation areas and improper use of rangeland areas. Recharge areas can be protected by controlling the land use in these locations. Growth, particularly on alluvial fans, can reduce the aerial extent of existing recharge areas. There are also areas where groundwater recharge facilities can be constructed as part of overall land use development. Excavations, gravel pits and even open areas can be used for recharging the groundwater. Protection of recharge areas should be a part of local government zoning and management planning.

Recommendation - Local government entities and water users should make protection of recharge areas a part of their zoning and management plans. ■ ■

Section A

Acronyms, Abbreviations and Definitions

A.1 Acronyms and Abbreviations

Many names, titles, programs, organizations, legislative acts, measurements and activities are abbreviated to reduce the volume of words and to simplify communications. A few of the abbreviations and acronyms used in the Cedar/Beaver Basin Plan are listed below.

A.1.1 State and Local Agencies and Organizations

CEM	Division of Comprehensive Emergency Management
DWLR	Division of Wildlife Resources
DWRE	Division of Water Resources
MCD(MCPD)	Multi-County Planning District
SCC	Soil Conservation Commission
UBWR	Utah Board of Water Resources
UP&L	Utah Power
USDWB	Utah Safe Drinking Water Board
UWQB	Utah Water Quality Board

A.1.2 Federal Agencies

ASCS	Agricultural Stabilization and Conservation Service
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BR	Bureau of Reclamation
CFSA	Consolidated Farm Service Agency
CE	Corps of Engineers
EPA	Environmental Protection Agency
FmHA	Farrmers Home Administration
FEMA	Federal Emergency Management Agency
FWS(USFWS)	Fish and Wildlife Service
FS	Forest Service
GS(USGS)	Geological Survey
NPS	National Park Service
NRCS	Natural Resources Conservation Service
SCS	Soil Conservation Service
USDA	U. S. Department of Agriculture
WRD	Water Resources Division (Geological Survey)

A.1.3 Programs/Acts

ACP	Agricultural Conservation Program
ARDL	Agricultural Resource Development Loan
CRP	Conservation Reserve Program
CWA	Clean Water Act
ECP	Emergency Conservation Program
ES(T&E)	Endangered Species Act
FLPMA	Federal Land Policy and Management Act
LWCF	Land and Water Conservation Fund
MBTA	Migratory Bird Treaty Act
NFIP	National Flood Insurance Program
NPDES	National Pollution Discharge Elimination System
NPS	Non-point Source Pollution
RC&D	Resource Conservation and Development
SCORP	State Comprehensive Outdoor Recreation Plan
SDWA	Safe Drinking Water Act
UCA	Utah Code Annotated
UWPCA	Utah Water Pollution Control Act
WSR	Wild and Scenic Rivers Act

A.1.4 Measurements

Ac	Acre
Ac-Ft	Acre-feet
AUM	Animal Unit Month
CFS(cfs)	Cubic Feet Per Second
Ft	Feet
GPCD	Gallons Per Capita Day
mg/l	Miligrams Per Liter
pH	Acidity of Soil
TDS	Total Dissolved Solids
Yd^3	Cubic Yards

A.1.5 Miscellaneous

ATV	All Terrain Vehicle
BMP	Best Management Practices
FIRE	Finance, Insurance and Real Estate
M&I	Municipal and Industrial
RMP	Resource Management Plan
RV	Recreational Vehicle
TCPU	Transportation, Communications and Public Utilities
UPED	Utah Process Economic and Demographic
W&S	Wage and Salary

A.2 Water Resources Definitions

Many terms used in the water business have different meanings depending on the source, and they are sometimes confusing. Some words are used interchangeably. A few commonly used water terms are defined for use in this document.

A.2.1 Water Use Terms

Water is often said to be "used" when it is diverted, withdrawn, depleted, or consumed. But it is also "used" in place for such things as fish and wildlife habitat, recreation and hydropower production.

Cropland Irrigation Use - Water used for irrigation of cropland. Residential lawn and garden uses are not included.

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

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

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

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

Municipal and Industrial (M&I) Use - This term is commonly used to include residential, commercial, municipal and industrial uses. It is sometimes used interchangeably with the term "public water use."

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.

Diversion - Diverted from supply sources such as streams, lakes, reservoirs, springs or groundwater for a variety of uses including cropland irrigation, residential, commercial, municipal and industrial purposes. The terms diversion and withdrawal are often used interchangeably.

Withdrawal - Water withdrawn from supply sources such as lakes, streams, reservoirs, springs or groundwater. This term is normally used in association with groundwater withdrawal.

Depletion - Water lost or made unavailable for return to a given designated area, river system or basin. It is intended to represent the net loss to a system. The terms consumption and depletion are often used interchangeably, but they are not the same. For example, water exported from a basin is a loss or depletion to that system as it is not consumed within the basin.

Water diverted to irrigated crops in a given system, but not returned for later use is depletion. Precipitation that falls on irrigated crops is not considered a part of the supply like surface water and groundwater diversions. For this reason, precipitation falling on and consumed by irrigated crops is not considered as being a depletion to the system.

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

A.2.2 Water Supply Terms

Water is supplied by a variety of systems for many users. Most water supply systems are owned by an irrigation company or a municipality, but in some cases the owner/operator is a private company, or is a state or federal agency. Thus, a "public" water supply may be either publicly or privately owned. Also, systems may supply treated or untreated water.

Culinary Water Supply - Water meeting all applicable safe drinking water requirements for residential, commercial and municipal uses. This is also known as potable water.

Municipal Water Supply - A supply that provides culinary grade water for residential, commercial, municipal and light industrial uses. The terms municipal, community and city are often used interchangeably.

Public Water Supply - Includes culinary water supplied by either privately or publicly owned community systems which serve at least 15 service connections or 25 individuals at least 60 days per year. Water from public supplies may be used for residential, commercial, municipal and industrial purposes, including irrigation of publicly and privately owned open areas.

Secondary Water Supply - Pressurized or open ditch water supply systems that supply untreated water for irrigation of privately and publicly owned lawns, gardens, parks, cemeteries, golf courses and other open areas. These are sometime called "dual" water systems and provide water in addition to the culinary supply.

A.2.3 Groundwater Terms

Aquifer - A saturated body of rock or soil which will yield water to wells or springs.

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

Mining - Long-term overdraft of groundwater in excess of recharge.

Phreatophyte - A "groundwater plant." A plant species which extends it roots to the saturated zone under shallow water table conditions and transpires groundwater. Includes such species as tamarisk, greasewood, willows and cattails.

Recharge - Water contributed to the groundwater reservoir or the process of adding water to the groundwater reservoir. Commonly occurs by infiltration of surface water into the subsurface from precipitation, streamflow or irrigation.

Recoverable Reserves - The amount of water which could be reasonably recovered from the groundwater reservoir with existing technology. Recovery assumes groundwater mining, and may be associated with economic, environmental or social costs. It is often estimated as a percent of the total water in storage, or as the water which could be produced by dewatering an upper layer of aquifer of a given thickness, or by reducing aquifer pressure by some amount.

Safe Yield - In general, it is meant to indicate the amount of water which can be withdrawn from an aquifer on a long-term basis without serious environmental, quality or social consequences, or seriously depleting the reservoir.

Total Water in Storage - A volume of water derived by estimating the total volume of saturated aquifer and multiplying by the porosity (intergranular space containing water).

A.2.4 Other Water Terms

Some water terms are peculiar to the water industry. These are briefly defined in order to better understand the information presented.

Carrier Water - Water needed for the hydraulic operation of a delivery system.

Drinking Water - Water that is used or available for use as a culinary supply. The quality is typically the highest available in the locality.

Export Water - A man-made diversion of water from a river system or basin other than by the natural outflow in rivers, streams and groundwater.

Instream Flow - Water flow maintained in a steam for the preservation and propagation of habitat and for aesthetic values.

Open Water Areas - Include lakes, ponds, reservoirs, streams and other areas completely or partially inundated.

Reuse - The reclamation of water diverted from a wastewater conveyance system. The reuse can be either direct or indirect and may or may not be treated to bring it to acceptable standards. This water is recovered from municipal and industrial discharges. Irrigation runoff and hydroelectric power generation return flows are not included.

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

Wetlands - Wetlands are open water areas surrounded by water loving vegetation and also include areas where vegetation is associated with wet and/or high water table conditions.

Section B

Bibliography

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■ **State Water Plan** - Cedar/Beaver River Basin

Prepared by the State Water Plan Coordinating Committee

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