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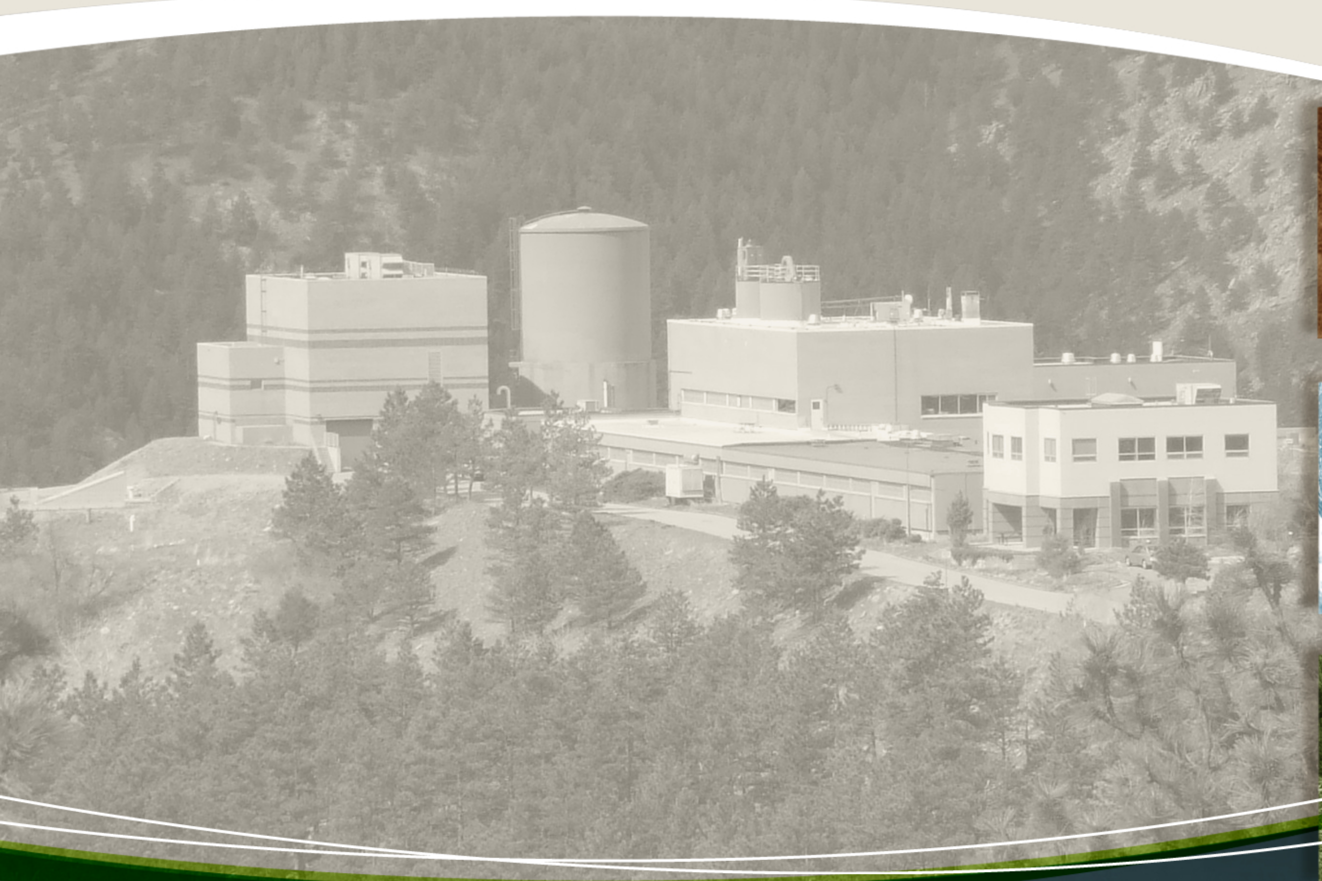
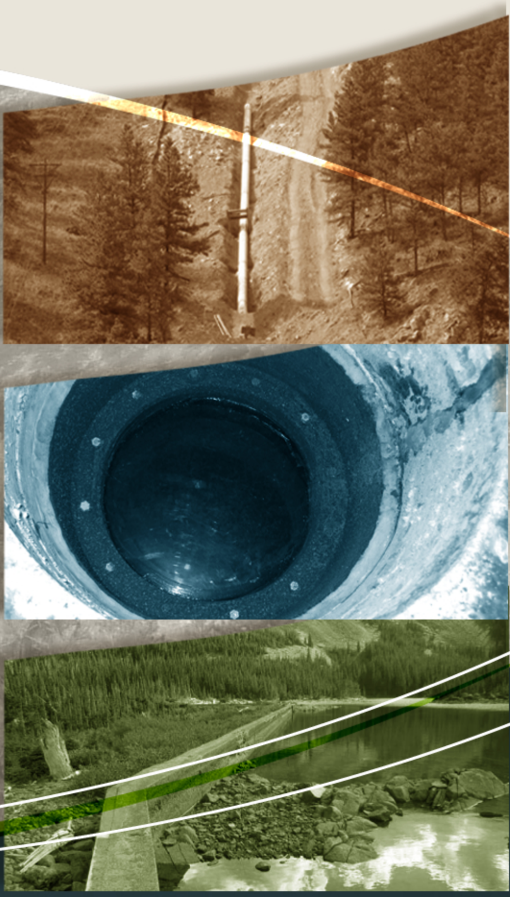
CITY OF BOULDER

General Planning Information

OCTOBER 2011





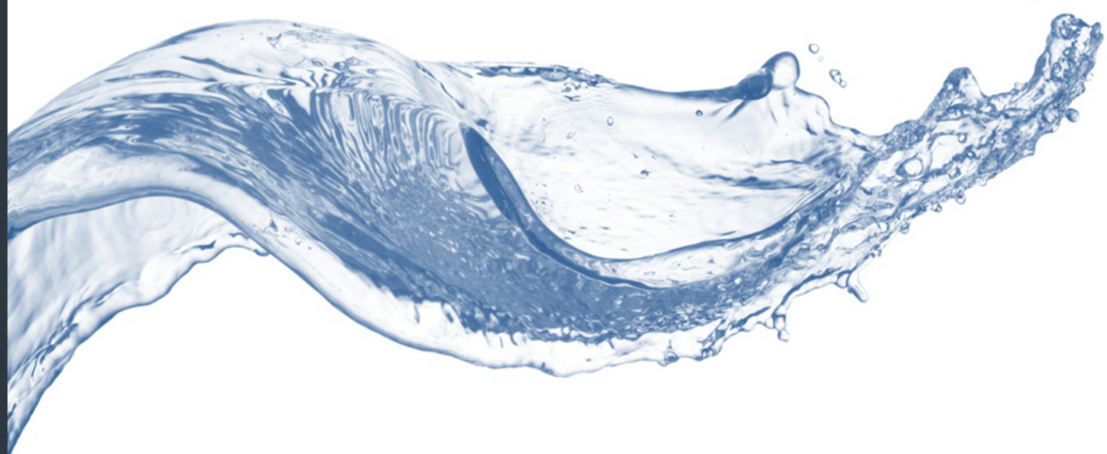
WUMP VOLUME 2

MWH®
BUILDING A BETTER WORLD

Volume Two

City of Boulder

General Planning Information



October 2011

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Acknowledgements

City Council
Susan Osborne – Mayor
Ken Wilson – Deputy Mayor
Suzy Ageton
Matt Appelbaum (former Mayor)
KC Becker
Macon Cowles
Crystal Gray
George Karakehian
Lisa Morzel

Water Resources Advisory Board (WRAB)
William DeOreo – Chair
Susan Iott
Charles Howe
Kate Ryan
Vicki Scharnhorst

City of Boulder Staff
Jane S. Brautigam, City Manager
Maureen F. Rait, Executive Director of Public Works
Robert E. Williams, Director of Public Works for Utilities
Randy Crittenden, Coordinator of Water Treatment
Carol Ellinghouse, Coordinator of Water Resources and Hydroelectric
Felix Gallo, Coordinator of Transportation & Utilities Maintenance
Robert Harberg, Coordinator of Utilities Planning and Projects
Bret Linenfelser, Coordinator of Water Quality and Environmental Services
Carol Linn, Utilities Financial Manager
Bronwyn Weygandt, Billing Services Supervisor
Erin Kintzle, Financial Analyst
Chris Meschuk, Planner II

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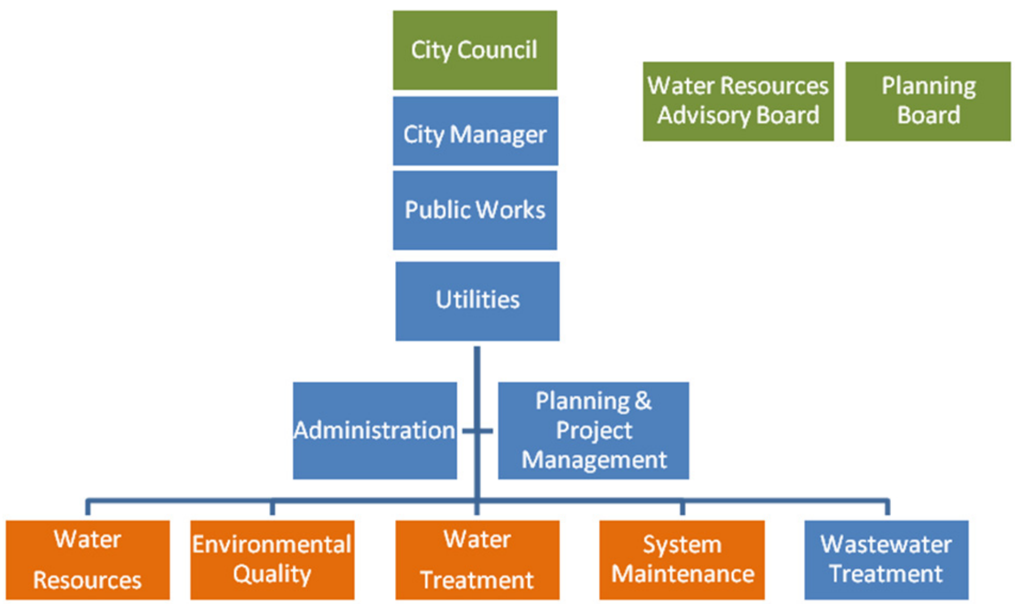
Appendix A: Recommended Practices to Meet Goals A-1

1 Water System Overview

The Utilities Division of the Public Works Department provides water, sewer and stormwater services. The City operates the three systems as individual "enterprises" Designated enterprise funds are mostly exempt from the revenue constraints imposed by Colorado's Taxpayer's Bill of Rights (TABOR).

The City's utilities department is organized as shown in **Figure 2-1**. The Water Utility Master Plan (WUMP) covers areas including water resources, environmental quality, water treatment and distribution, and system maintenance. The Water Resources Advisory Board (WRAB) is an advisory board to City Council and works with staff on water-related issues including reviewing and providing recommendations on master plans, policies, programs, and capital improvements. Utilities Division Master Plans require Planning Board and City Council approval.

Figure 2-1. Utilities Division Organization Chart



The physical facilities of the water system are described below in terms of source water, water treatment, and distribution system components.

1.1 Source Water

The City gets its water from sources on the East Slope and West Slope as follows:

- East Slope supplies are primarily from the Boulder Creek Basin. The system includes about 7,200 acre-feet of reservoir storage space in the Silver Lake Watershed on North Boulder Creek and 11,686 acre-feet of storage in Barker Reservoir on Middle Boulder Creek. Most Boulder Creek basin supplies are delivered to the Betasso Water Treatment Facility (WTF) through the Barker system pipelines, the Silver Lake Pipeline and the Lakewood Pipeline. Water can also be delivered from Boulder Creek through Farmers Ditch to the Boulder Reservoir WTF.

- West Slope supplies are delivered through the Colorado-Big Thompson (C-BT) Project and Windy Gap Project, which are both operated by the Northern Colorado Water Conservancy District (NCWCD). Boulder receives western slope water at the Boulder Reservoir WTF via C-BT facilities including Carter Lake and the Boulder Feeder Canal. At present, West Slope deliveries to Boulder can only be made from April through October of each year due to winter operating limitations on canals. West Slope deliveries that are not used directly from the canal can be stored within the City's 8,500 acre-feet in Boulder Reservoir or exchanged for additional storage or diversions at the City's upper Boulder Creek facilities. The CBT system also delivers a small amount of water to Boulder from St. Vrain Creek as an exchange with Left Hand Water District.

Flows in the watershed basins supplying each source are highly variable from year to year. Because of this, the amount of water derived from each of Boulder's water sources and delivered into the municipal system also varies. The City operates four hydroelectric plants (hydros) on raw water transmission pipelines: Lakewood, Betasso, Boulder Canyon, and Silver Lake. Four additional hydros are on treated water pipelines: Orodell, Sunshine, Kohler, and Maxwell. Electricity generated at these plants is sold to Xcel Energy.

The source water facilities are shown in relation to the City in Figure 4-6 of the SWMP.

1.2 Water Treatment

The City's water is treated at the Betasso and Boulder Reservoir water treatment facilities.

The Betasso WTF, located west of the City near Sugarloaf Mountain, was originally constructed in 1964. The Betasso WTF has since been upgraded and has a design capacity of about 46 million gallons per day (MGD) with an operational limitation of approximately 40 MGD.

The location of the Betasso WTF on a hilltop, see **Figure 2-2**, limits opportunity for expansion.

Figure 2-2 Betasso WTF

The Boulder Reservoir WTF was originally constructed in 1971 to provide summer peaking capacity and to treat water from the C-BT and Windy Gap projects. It is now routinely operated on a year-round basis to manage Boulder Creek water supplies and has a firm capacity of about 16 MGD. The facility can treat water from the Boulder Feeder Canal or from Boulder Reservoir.

1.3 Distribution System

The water distribution system services areas with elevations ranging from 5,750 feet on the west side of the City to 5,150 feet in the eastern section. Due to this large elevation differential, the system is divided into three pressure zones to keep water pressures within practical limits. Zone 1 serves areas generally below an elevation of 5,270 feet, Zone 2 serves areas between 5,270 and 5,450 feet and Zone 3 serves areas above an elevation of 5,450 feet. Excess water pressure that develops in each zone as water is delivered from the Betasso WTF is reduced by pressure reducing valves and four small hydroelectric facilities. The power that is generated is sold to Xcel Energy. Water from the Boulder Reservoir WTF is pumped to Zone 1 and can be delivered to Zones 2 and Zone 3 by pump stations.

The water distribution system consists of a grid of approximately 458 miles of interconnected mains varying in size from 4 to 30 inches.

The City operates six covered tanks, ranging in capacity from 2.0 million gallons (MG) to 9.5 MG, with a total storage capacity of 38.9 MG. There is also a clearwell at each of the treatment facilities.

There are seven pressure-regulating stations in the system that regulate pressure and flow between pressure zones or into storage tanks. There are four booster pumping stations in the system, as well as a pumping station at the Boulder Reservoir WTF. These booster pumping stations are able to pump water from a lower elevation pressure zone into a higher elevation pressure zone (see Section 1.4 for additional details).

The City operates four hydroelectric facilities on treated water transmission lines at locations that also have parallel pressure-reducing valves: Orodell, Sunshine, Maxwell, and Kohler (see Section 1.4 for additional details). Contracts for the sale of power from these facilities to Xcel Energy are described in Section 3 of the SWMP.

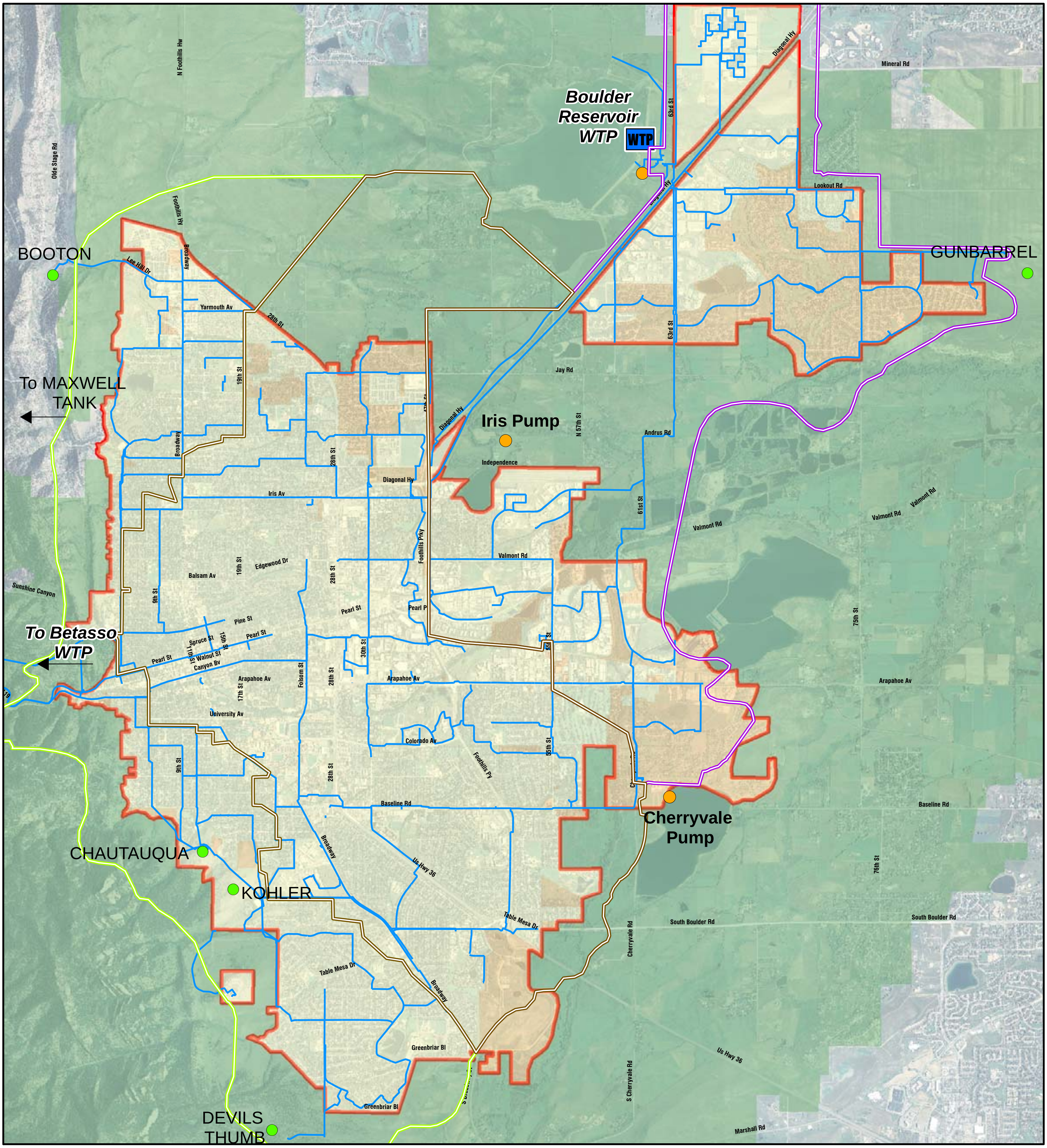
Map 1 shows the water utility planning area boundary, pressure zone boundaries and the location of important water system features.

1.4 Water System Inventory

Table 2-1 through **Table 2-6** provides brief informational summaries of the City's water utility facilities.

Table 2-1. Source Water Storage

Reservoir	River Basin	Estimated Storage (AF)
Skyscraper	Middle Boulder Creek	146 (drought reserve)
Barker Reservoir	Middle Boulder Creek	11,686
Kossler Reservoir	Middle Boulder Creek	165
Green Lake 1 Green Lake 2 Green Lake 3 Green Lake 4 Green Lake 5	North Boulder Creek	88 (active operating capacity) 333 (design capacity, pending repairs) 285 (active operating capacity) 116.1 (decreed) 73.8 (decreed)
Albion Lake	North Boulder Creek	1,111 (capacity)
Silver Lake	North Boulder Creek	3,996 (active operating capacity)
Island Lake	North Boulder Creek	333 (active operating capacity)
Goose Lake	North Boulder Creek	900 (active operating capacity)
Lakewood Reservoir	North Boulder Creek	35
Boulder Reservoir	Colorado River from CBT and Windy Gap projects, St. Vrain Creek, main Boulder Creek	storage shared with NCWCD, Boulder's share is 8,500 in winter and 5,143 in summer; total capacity of 13,100



Legend

- Tanks
- Pumps
- WTP Water Treatment Plants
- Pipes, 12 inches or greater
- Water Utility Study Area Boundary

BVCP Area Boundaries

- Area 1
- Area II
- Area III

Water Pressure Zones

- Zone 1
- Zone 2
- Zone 3

N

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Miles

Water Utility Planning Area Boundary and BVCP Area Boundaries

Map 1

Table 2-2. Source Water Conveyance

Pipeline	Source	Termination	Comments
Silver Lake Pipeline	North Boulder Creek	Lakewood Reservoir and Silver Lake Hydro	3.5 miles, replaced in 1997, 27-in diameter, nominal capacity 20 MGD
Lakewood Pipeline	North Boulder Creek through Lakewood Reservoir	Betasso WTF and Lakewood Hydro	11 miles, replaced in three sections from 1994 through 2004, 27 to 36-inch diameter, design flow of 20 MGD (30 MGD emergency), Phase III section has weld defects
Barker Gravity Line	Barker Reservoir	Kossler Reservoir	12 miles, 36-inch diameter, capacity of 43 cfs, originally constructed in 1909; purchased in 2001, ongoing repair of sections
Boulder Canyon Hydro Penstock	Kossler Reservoir	Boulder Canyon Hydro (BCH)	44- to 56-inches diameter, constructed in 1909
Betasso Penstock	Boulder Canyon Hydro Penstock upstream of BCH	Betasso Hydro and Betasso WTF	Replaced 2009 with 30-inch diameter pipeline
Boulder Feeder Canal (NCWCD)	Carter Lake	Boulder Reservoir and intake pipeline to Boulder Reservoir WTF	200 cfs capacity, operated by NCWCD

Table 2-3. Water Treatment Facilities

Process	Betasso	Boulder Reservoir
Raw water	Lakewood intake (Lakewood Hydro) Barker intake (Betasso Hydro)	Reservoir intake (pumps) Boulder feeder canal intake
Settling	4 × flocculation/sedimentation basins	3 DAF units
Filtration	8 × mixed media filters	4 × mixed media filters
Clearwells	2	1
Residuals storage	2 × residuals lagoons 2 × residuals drying beds	4 × residuals lagoons

Table 2-4. Treated Water Distribution System Pump Stations

Facility	Number of Pumps	Pump Information
Boulder Reservoir High Service	6	250 hp, 2,800 gpm
Iris #1	2	Peerless (6AE18) 150 hp 2,200 gpm at 205 feet Horizontal Mounted Axial Split Case Single Stage Double Suction Pump
Iris #2	2	
Cherryvale	3	Aurora Pump Centrifugal 125 hp; 1750 gpm at 185 feet
Kohler	2	100 hp each.; 1740 gpm at 285 feet (pumps in series)

Table 2-5. Treated Water Storage Tanks

Facility	Capacity (MG)	Material
Gunbarrel	2.0	Steel
Maxwell	9.5	Concrete
Booton	3.5	Concrete
Devil's Thumb	5.0	Steel
Kohler	9.4	Concrete
Chautauqua	8.0	Concrete

Table 2-6. Hydroelectric Facilities

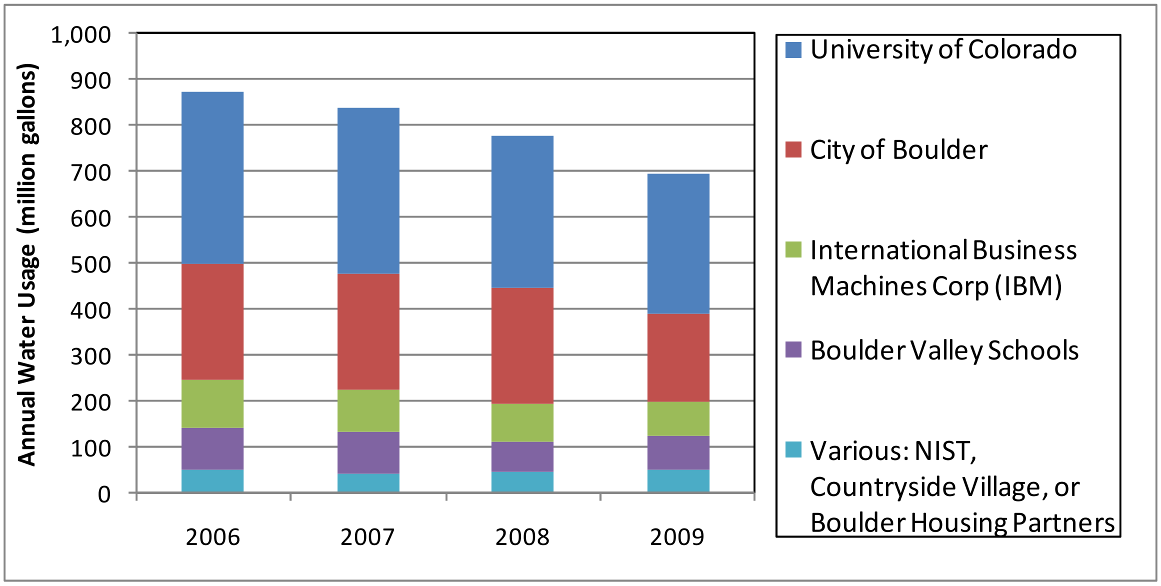
Facility	Pressure Source	Nameplate Capacity (kW)
Maxwell	Treated Water (Zone 3 to Zone 2)	95
Kohler	Treated Water (Zone 3 to Zone 2)	150
Orodell	Treated Water (Orodell Pipeline)	225
Sunshine	Treated Water (Sunshine Pipeline)	800
Betasso	Raw Water (Betasso Penstock)	3,100
Silver Lake	Raw Water (Silver Lake Pipeline)	3,309
Boulder Canyon	Raw Water (Boulder Canyon Penstock)	10,000
Lakewood	Raw Water (Lakewood Pipeline)	3,695

1.5 Large Water Users and Private Water Systems

A number of private water systems are connected to the City's treated water distribution system. These systems serve large institutions, commercial or industrial installations, and certain residential areas. The systems are privately owned, operated and maintained. The City provides water to one or more connection points on the private system and the system owner has the responsibility for delivering the water to the end users. Water delivery to the system is metered and the system owner is billed by the City as a single customer.

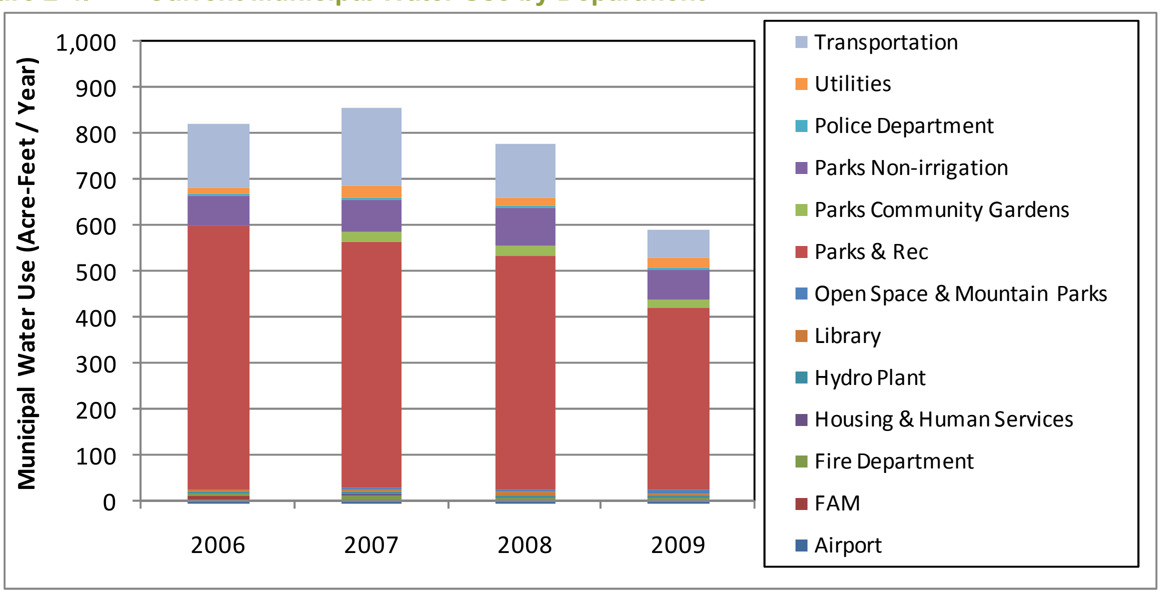
The top four largest water users consistently include the University of Colorado, the City of Boulder, IBM, and Boulder Valley Schools. There are a few entities that have recently been the fifth top water user including the National Institute of Standards (NIST), Boulder Housing Partners, and Countryside Village, a mobile home community. **Figure 2-3** depicts the recent historical water usage of the top five water users. Total water use by these large water users decreased between 2006 and 2009.

Figure 2-3. Recent Annual Water Use of Top Five Water Users



Municipal water use was further broken out by department, as shown in **Figure 2-4**. The greatest water use was for Parks and Recreation, followed by Transportation. Municipal water usage, which is primarily for irrigation, trended with the plant water needs, which was greatest in 2007 based on the weather.

Figure 2-4. Current Municipal Water Use by Department



There are a couple of wholesale water customers who are charged a flat rate for water. The Lefthand Water District supplies water to large rural areas of Boulder County to the north and northeast of Boulder. Almost all of Lefthand's water supply comes from its own sources and treatment facility, but it has interconnects and a wholesale customer agreement with the City. The Hoover Hills Water and Sewer District serves a residential area located in southeast Boulder north of Baseline Reservoir and east of Cherryvale Road. There are three mobile home parks considered wholesale customers: Boulder Meadows (a.k.a. Countryside Village), Orchard Grove and Mapleton. There are two water truck providers, A-1 Discount Water and Mile Hi Water.

2 Water System History

The most recent overarching water utility master plan was completed in 1992. A Treated Water Master Plan (TWMP) was completed in 2000; and then in 2009 both a Water Quality Strategic Plan and SWMP were completed. The WUMP updates the 2000 TWMP and incorporates the more recent Water Quality Strategic Plan and SWMP in their entirety as separate volumes.

The history of the City's water system has been extensively documented in several previous studies, most recently in the 2000 TWMP and 2009 SWMP. Section 2.1 contains a summary of the water system history through 2000 as documented in the TWMP. Section 2.2 summarizes system changes that have occurred since 2000. Relevant treatment and distribution planning studies completed since 2000 for the water utility are summarized in Volume 5.

2.1 Water System History Prior to 2000

The following water system history information is from the 2000 TWMP[1] and provides an overview of the entire water utility development up to the year 2000.

2.1.1 1875 to 1900; A Period of Supply Development

Development of the water City's system began in the mid-1870s, with the completion of the Town of Boulder Reservoir and its upstream sand filter. Both reservoir and filter were located at the mouth of Boulder Canyon, southwest of Red Rocks on what was then known as the Fox Farm.

After the Town of Boulder Reservoir was built, the City began further development of its water distribution network. Pipe was first laid to Twelfth Street (Broadway), then down to the public square where many Boulder residents got their water. The network was also extended to schools and other public buildings and enabled the installation of fireplugs.

The key issue in the late 1800s was supply. In 1879, the Town of Boulder Reservoir was considered inadequate for the City's growing needs and the citizens demanded and received an enlarged reservoir. Problems with this source included murky water and insufficient quantity of supply for watering lawns during dry periods. After ten years of use, the reservoir had become totally inadequate. In 1887, excavation began on the new Sunshine Reservoir, located near the base of Sunshine Canyon on Gallup Ranch land. It was designed to hold five million gallons (mg) of runoff water, thus eliminating the need for Town of Boulder Reservoir water.

Continued population growth however, necessitated that the old Town of Boulder Reservoir be reactivated. Again, there were complaints of murky water. The Water Superintendent's solution was to use Sunshine Reservoir water during the day when the customers could see it and then use Boulder Reservoir water at night when they could not. Less than a decade later, in 1898, another reservoir at the south end of town was needed, and by 1902 the first Chautauqua Reservoir was completed. This facility should not be confused with the present Chautauqua Reservoir built in 1922.

2.1.2 1900 to 1922; Talk of Conservation, Supply, and Energy Development

In 1902, water use was restricted due to drought conditions. Water-powered motors in printing plants and other industries were shut down, and other heavy water users were told to conserve. In 1904, engineers called for the metering of water both to conserve supplies and to sell "the rents" at a fairer rate, but nothing was immediately done. It was not until 1908 that the Colorado and Southern Railroad became the first business to be metered because of its extensive water use. Two years later, the Central Colorado Power Company and larger dairies were metering for the same reason. Not all businesses and institutions were required to be metered. The City Council decided that a cement plant would be accorded a flat rate, and the newly opened Hotel Boulderado would receive free water to encourage tourists to sample Boulder's "famous" water. In 1918, a $20,000 deficit in "water rents" necessitated more industries to be metered. As a result of the increased metering, a $30,000 profit was realized the next year.

In January 1904, the City purchased its first parcels of land in the Silver Lake Watershed, which contained the Triple Lakes and Oval Lake. In 1906, the City purchased the land at Albion Lake. The City also purchased the land and reservoirs at Silver Lake and Island Lake, which had been created by dams built by J.P. Maxwell for the Silver Lake Ditch & Reservoir Company in 1887 and 1890, respectively. Boulder bought a large parcel of land in the Silver Lake Watershed from the United States Government in 1907 after receiving permission to do so in the form of a Congressional Grant. Through this first of three Congressional Grants, the City purchased 2,600 acres, which included land near Albion Lake and the Green Lakes on Albion Creek and land on North Boulder Creek. The earthen dam at Oval Lake was replaced in 1908 with a rock-fill timber-crib structure, 30 feet high, to hold 55 million-gallons of water in the enlarged reservoir now called Goose Lake. .Construction of a dam to enlarge Albion Lake was started in 1911 and completed in 1913.

In order to protect the water supplies derived from the City's newly-acquired lands and reservoirs in the Silver Lake Watershed, the City decided to build pipelines to prevent contamination as the water was delivered into Boulder. In 1906, the City constructed the Boulder City Pipeline with an intake from North Boulder Creek at the newly-constructed Lakewood Reservoir north of Nederland. The upper portion of this pipeline would later be called the Lakewood Pipeline. The City discontinued most use of the Lower Intake near the mouth of Boulder Canyon.

In 1910, the Central Colorado Power Company completed construction of Barker Dam on the Middle Boulder, east of Nederland. The power utility conveyed Barker Dam water through the Barker Gravity Pipeline to Kossler Lake, then by penstock to Boulder Canyon Hydro, located at Orodell across from the City's Lower Intake. The Boulder Canyon Hydro powerhouse , comprised of two generators capable of producing 10,000 kilowatts of power, provided the first electricity for Boulder and much of the surrounding Front Range area. After several mergers, ownership of Boulder Canyon Hydro transferred to Public Service Company of Colorado in 1924. By World War I, Boulder's water supply was thought to be polluted with tungsten material and human wastes necessitating, for the first time, chemical treatment. In 1917, a plant was built at Lakewood to treat Boulder water with chlorine and ammonium sulfate. The treatment method was crude, and chemicals were dumped into the water supply at irregular seasonal intervals. In order to further protect the water from pollution, the City approached its congressional delegation about additional purchases of federal land. A second Congressional Grant, which allowed the City to purchase land below Silver Lake, was approved in 1919. The City constructed an extension of the Boulder City Pipeline, which was later named the Silver Lake Pipeline, running from a point on North Boulder Creek at the eastern edge of the Silver Lake Watershed to Lakewood Reservoir.

In 1922, the Chautauqua Reservoir was considered too low and the new Chautauqua Reservoir was built.

2.1.3 1922 to 1955 - Water Rights and the Great Depression

In the early 1900s, the City Council had first discussed purchasing land from the United States government in the Silver Lake Watershed up to the Continental Divide and including Arapaho Glacier. In 1927, the U.S. Congress approved the third and final Congressional Grant allowing the City to purchase federal land and, in 1929, President Herbert Hoover signed a deed to the City for the land surrounding Arapaho Glacier. The purchase included four peaks along the Continental Divide and, combined with the City's earlier acquisitions from both private owners and the federal government, gave the City ownership of much of the land now contained in the Silver Lake Watershed. The City bought Green Lakes Nos. 1 through 5, located on Albion Creek in the Silver Lake Watershed in 1935. A private developer had constructed dams at Green Lakes 1 through 3 from 1902 to 1906 to raise the natural lake levels. The City would later make additional minor purchases of inholdings to complete its ownership of the Silver Lake Watershed area. The Silver Lake Watershed was closed to public access in the late 1920s after a cholera outbreak in order to protect water quality.

In 1929, the City lowered the outlet pipe on the existing Silver Lake Dam to gain access to water in the natural lake area that had existed prior to creation of the reservoir. The entire original rockfill timber crib dam structure was replaced with an earthen embankment in 1940. The dam was enlarged in 1956 and again in 1966.

During the Great Depression, public works projects continued to be built. Workers from the Work Projects Administration repaired the Goose Lake Dam and construction started on a new concrete dam at Island Lake to replace the dirt-fill wall. A steel-faced dam was built at Green Lake No. 3 and a 220-foot dam was built at Green Lake No. 2 to replace the existing dams.

Following the dry years of the 1930s Dust Bowl, in 1937, the United States Bureau of Reclamation, in collaboration with farmers, ranchers, cities, and towns in northern Colorado formed the Northern Colorado Water Conservancy District (NCWCD).. Facilities were built to bring Western Slope water into Lake Granby, though the Adams Tunnel over the Continental Divide and to the East Slope for use as a supplemental water supply. In 1947, the first of the Western Slope water flowed from the Colorado-Big Thompson (CBT) Project and into the South Platte drainage.

In 1948, Public Service Company improved Barker Dam. The City entered into its first agreement with Public Service Company to use water from the Barker system by exchanging for water on North Boulder Creek in 1954.

A new chlorination plant was built at Lakewood in 1949 because City water customers complained about the taste of City water at the irregular times when chemicals were applied at Lakewood. The City began adding chlorine to the water year-round so that customers would not notice a change of taste. Maxwell and Kohler Reservoirs were built and later covered.

Boulder joined NCWCD in 1953. Boulder Reservoir was built in 1955 at the southern end of NCWCD. CBT water, from Carter Lake near Loveland flowed passed Lyons through the St. Vrain Canal and Boulder Feeder Canal, to Boulder Reservoir. The Bureau of Reclamation built a supply canal from Boulder Reservoir to Boulder Creek to deliver CBT water to downstream farmers and to carry CBT water for Boulder to exchange for additional water diversions at the municipal system intakes in the upper Boulder Creek basin.

The Betasso surge chamber, having a 60,000-gallon capacity, was built in the 1950s on the Lakewood Pipeline portion of the Boulder City Pipeline near Orodell. Two chambers dissipated the energy that developed in the water as it flowed 3,000 feet down the mountain. Unfortunately, the surge chamber caused air to become entrained in the water, which then caused sediment and contaminants to remain suspended in the water and increased its turbidity.

2.1.4 1959 to 2000; Growth Management, Metering, and Treatment

Public sentiment against the negative effects of rapid growth dates back more than 50 years to the formation of PLAN-Boulder in 1959. Its primary purpose was to slow and direct growth in Boulder in order to preserve the college town's special qualities.

The topic of metering came up again and found less opposition. A $4 million bond issue was proposed; $700,000 of that money would be used for the construction of meter pits near 7,500 Boulder households (prior to the election, the City Manager was accused of faking the need to conserve water by asking for summer restrictions for lawn watering). The bond issue passed. By 1962, 865 meters had been installed, and by 1965, the City was completely metered.

In 1959, the City of Boulder and the Public Service Company signed a new agreement giving the City the right to use some of Public Service's water in Barker Reservoir, but the City could still only use Barker water indirectly through exchange for more water at Lakewood Reservoir. This changed with the construction of the Betasso treatment plant, which began in 1963. In 1964, the Betasso surge chamber was abandoned when the new Betasso treatment plant was put into service. A new agreement between the City and Public Service Company enabled the City to begin directly using Barker Reservoir water by delivery through new piping from the Boulder Canyon Hydro powerhouse to Betasso Water Treatment Plant. Barker Reservoir water traveled through a penstock to the hydro plant then crossed Boulder Creek in a 20-inch pipe and terminated at Betasso's pressure-reducing chamber.

An additional agreement between the City and Public Service Company was signed in 1968 that allowed for storage of 4,000-acre feet of City water. Eventually, the City gained the right to store 8000 acre feet of City water. Boulder purchased additional CBT Project water beginning in 1964 to increase the amount of water available at Barker Reservoir by exchange. Devil's Thumb Reservoir (formerly called Shanahan Reservoir) was completed during this period with a 5-million gallon capacity. The 2-million gallon Gunbarrel Reservoir was also constructed.

In 1966, six northern Colorado communities (Boulder, Estes Park, Fort Collins, Loveland, Greeley, and Longmont) began discussions on the possibility of increasing their water supplies with the formation of a municipal subdistrict under the Northern Colorado Water Conservancy District. In 1969, the "Six Cities" group developed the Windy Gap Project, which would use the facilities of the CBT Project to carry water supplies eastward across the mountains and take advantage of the unused capacity of the CBT system. In 1979, the Colorado Supreme Court approved a conditional decree issued by the Water Court for 48,000 acre feet of Western Slope water to be divided by the six communities, of which Boulder received 8,000 acre feet. Construction of Windy Gap facilities began in 1981 and the project was dedicated during the summer of 1985.

Fluoridation of Boulder water was on the November 1969 ballot. Fluoridation had been defeated three times before, but in 1970, after weeks of discussion and argument, Boulder approved fluoridation.

In 1968 a bond issue passed providing $3 million to build Boulder's second treatment plant, the Boulder Reservoir WTF, east of Boulder Reservoir on 63rd Street. The plant was in operation by 1971 with a capacity to treat 8-mg of water per day during the summer months, April through October. Betasso doubled its capacity to a nominal 50 mgd in 1976 with a $2.4 million expansion. Water delivered to Boulder Reservoir from the CBT and Windy Gap Projects can be treated at the Boulder Reservoir Treatment Plant or exchanged to the City's municipal intakes on upper Boulder Creek for treatment at

Betasso. Betasso also treats most of the water derived from the City's native Boulder Creek water rights, but some Farmers Ditch water can be delivered to Boulder Reservoir plant.

In the early 1980s, the City began to develop plans for hydroelectric plants that would generate electricity using the high pressures developed within the City's source water and treated water systems. Renewable energy generation by the City began when the Maxwell Hydro Plant began operating in 1985. In 1984, the City negotiated a power sales agreement with PSCo for three proposed hydroelectric projects on the City's raw water transmission pipelines—Betasso, Lakewood and Silver Lake Hydros. During 1986 and 1987, Kohler, Orodell, Sunshine and Betasso hydroelectric facilities were completed. The Silver Lake Hydro was completed in 1998, and the Lakewood Hydro went into operation in June 2004. Xcel Energy purchases the hydroelectric power.

2.2 Water System History Update (Since 2000)

A recent major event that impacts the City's entire water utility was the drought of 2002, the most severe single drought year in three hundred years. The drought resulted in mandatory water use restrictions in the City that caused water use to drop by 20 percent. Water use, discussed in further detail in Section 5 has not returned to historical levels. In 2008, the City fully implemented a water budget rate structure, where each user is assigned an amount of water they are expected to use based on water needs. Water rates per 1,000 gallons drastically increase once a customer's actual water usage exceeds the water budget. The water budget rate structure could potentially result in additional water conservation as users adjust their water use.

An AWWA QualServe™ Report of Peer Review[2] which reviewed the City's entire Utilities Division was published in 2008. This report presented strengths and opportunities for improvement for every aspect of the utility from Human Resources and leadership to customer service and water treatment. As with the other studies, the recommendations are covered in Volume 5.

Since 2000 the Utilities Division attempted to coordinate their activities to a greater extent, considering outage scenarios in terms of how the entire water system would be affected:

- One major source water system not available
- One WTF out of service
- One treated water transmission pipe out of service

2.2.1 Source Water

The following source water and water planning studies have been completed since 2000:

- Water Conservation Futures Study
- Drought Plan
- Watershed Dams Evaluation
- Lakewood Pipeline evaluations
- Barker Facility assessments
- Middle Boulder Creek Water Source Management Work Plan
- Boulder Reservoir Watershed Management Resource and Information Guide
- Source Water Impact Assessment
- Instream Flow Studies
- Water Conservation Plan
- Climate Change Consequences for Boulder's Water Supply

Relevant conclusions from these studies are discussed in detail in Volume 4, SWMP.

There is extensive source water system history information included in Volume 4, SWMP. Major changes in the source water system since 2000 include:

- Barker Reservoir and the Boulder Canyon Hydro Project facilities were purchased from PSCo in 2001. Work to repair segments of the Barker Gravity Line has been ongoing since the purchase.
- In 2004, the Lakewood Pipeline reconstruction was completed and the new pipeline went into service along with Lakewood Hydro.
- Environmental and planning work has continued with NCWCD and other participants for the proposed Carter Lake Pipeline, for C-BT and Windy Gap water supplies from Carter Lake to Boulder Reservoir WTF. NCWCD is currently considering alignment alternatives for the project.
- In 2009, a new 30-inch pipeline was installed to replace the Betasso Penstock. The existing Betasso Penstock was re-plumbed to become the Orodell Pipeline/Penstock, and the existing Orodell Pipeline/Penstock was re-plumbed to become the discharge line to allow excess raw water to flow back to Boulder Creek instead of entering Betasso WTF during capacity tests or run-of-river operations for Lakewood and Betasso Hydros. .
- In 2009, the City worked with the Town of Nederland regarding upgrades to their wastewater treatment facility to improve the City's source water quality.

2.2.2 Water Treatment Facilities

Since 2000, several studies have been completed including. Relevant conclusions from the following studies are discussed in Volume 5, TWMP Update:

- Boulder Reservoir WTF Predesign Report (2003), including an evaluation of mid-term and long-term improvements for the facility.
- Boulder Reservoir WTF Source Water Quality Planning Study (Phase I Study) (2003)
- Betasso WTF Facility Improvement Plan (2005)
- Integrated Evaluation of the Boulder Reservoir WTF Source Water Protection and Treatment Improvements (Integrated Study) (2007).

Improvements to the water treatment plants since the 2000 TWMP are described below.

2.2.2.1 Improvements at Betasso WTF

Improvements to the existing solids handling facilities and the settling basins were completed in 2001.

Near-term improvements were made to the Betasso WTF in 2007, including modifications to the residuals handling facilities to better accommodate contract dewatering, upgrades to the south lagoon, installation of a pump diffusion flash mixer and improvements to the carbon dioxide and polyaluminum chloride systems.

Fast Maint by iGlobalCare preventive maintenance computer program was used extensively for the first time during 2008 at Betasso.

An inspection of the Betasso WTF clearwell exterior paint in 2010 indicated that although the finish coat was oxidized and some of the coating was spalling, the underlying rust inhibitor coat was in good shape and no corrosion was evident. Therefore, the re-painting anticipated for 2010 can be delayed for an indefinite time period and City staff will continue to monitor the paint condition.

2.2.2.2 *Improvements at Boulder Reservoir WTF*

During 2001, the chlorine gas disinfection system at the Boulder Reservoir WTF was replaced with a mixed oxidant (MIOX) system. In 2009 this system was replaced with a sodium hypochlorite system.

Near-term Improvements completed in 2005 increased the capacity of the plant from 8 to 16 MGD. Improvements included installation of two flocculation dissolved air flotation (DAF) trains within the existing flocculation/clarifier building; new residuals lagoons for dewatering the solids removed in the treatment process, installation of baffles within the existing treated water reservoir to improve chlorine contact time; the addition of two new high service pumps inside the existing filter building to pump water from the treatment plant into the distribution system.

In order to reduce the turbidity and concentration of manganese in the plant influent, the City modified the Boulder Reservoir Intake Structure in 2005 by raising the elevation ten feet from the bottom of the reservoir.

Boulder Reservoir WTF Mid-Term Improvements are ongong as of 2011 and include the addition of a third flocculation/DAF train for redundancy, addition of a fourth raw water pump for the reservoir source pump station (also for redundancy), addition of pretreatment carbon dioxide pH adjustment system, new flow monitoring, increased SCADA signal capacity, and improved operational flexibility with yard piping changes. These improvements will secure a firm capacity of 16 MGD for the WTF.

2.2.3 Treated Water Distribution System

The City systematically conducts distribution system rehabilitation. Although the City has been using a point system to prioritize pipes for replacement since 2002, between 2007 and 2009, the analysis became more rigorous. The City considers the following types of information for prioritizing pipes for replacement: age, material, break history, type of break, diameter, system pressure and soil type. This information is used in a statistical model based on the Weibull function. The City has adopted a goal of keeping annual breaks below 120, to stay within the range of “below average” breaks for municipalities in the region, based on AWWA benchmarking of utility performance.

The City has been upgrading the Boulder Canyon and Sunshine Transmission system carrying water from Betasso into the City since 2000. In order to take the Sunshine Canyon pipeline out of service to make changes to the Sunshine Hydro, upgrades were required to the Boulder Canyon Pipeline. A bypass pressure reduction valve station was added outside the Orodell Hydro Station to allow more water past the hydraulic restriction at Orodell and the Fourmile Valve House was abandoned.

A Report on Chautauqua, Kohler, and Maxwell Reservoirs was completed in 2002. As a result, Kohler Reservoir was relined in 2003 to effectively reduce leakage.

In 2003, the water utility formed a water distribution system quality group to find ways to improve, or maintain, the water quality in the distribution system as the treated water was passed from the treatment plants to the customers.

A program was developed in 2004 to remove the existing zone isolation valves from the distribution system. The purpose of the project was to prevent the accidental mixing of different pressure zones. This program has been ongoing.

In 2005 a static mixer was installed as part of the Booton[1] Tank Water Quality Enhancements Project. Also installed were sampling lines in the tank that sample at various depths and remote monitoring of some water quality parameters. Control valves were installed to provide surge protection and remote control of opening and closing the tank inlet line.

Work on the Unidirectional Flushing Program began in 2007 with MACTECH and then Merrick. MWH Soft took over development of Boulder's UDF design which was completed in 2009.

The City has been evaluating the feasibility of using Sunshine Reservoir as a temporary storage facility for use during Sunshine Hydro Capacity Tests since 2007.

An "all pipes" distribution system model, based on Infowater software, was calibrated by City staff in 2008. The model was calibrated so that all the modeled tank levels in the system matched to within 10 percent of monitored levels for a selected 24-hour period during the peak demand month. After calibration was completed, a long time period model run was made to locate the oldest water in the system to comply with the Stage 2 Disinfectants and Disinfection Byproducts Rule.

Zone 1 Transmission System Improvements were needed to be able to supply more water to the system from the Boulder Reservoir WTF. The improvements include a new 24-inch diameter pipeline from the Boulder Reservoir WTF to the Iris Pump Station, which was completed in 2005. Upgrades to the Iris and Cherryvale Pump Stations were completed in 2010 to move 12.6 mgd from Zone 1 into Zone 2. A sister station was added at the Iris location and pumps, motors and the electrical system were replaced at Cherryvale. Water quality monitoring equipment was added at both pump stations.

The TWMP (2000) identified two problems in pressure Zone 2. There is an area of very high pressures in east Zone 2 which was recommended to be isolated into a new reduced pressure zone. The TWMP also found pipes and PRVs in Zone 2 that have very high velocities during high flow conditions which should be corrected near the 101 Pearl Pressure Reduction Station. More recently, a study of the Zone 1 Distribution System identified pipes with high velocities in Zone 2 near the Iris Pump Station that could become problematic. In 2008, the velocities in the pipes in Zone 2 around the Iris Pump Station were checked and found to be lower than initially thought. Therefore, no pipe enhancement or replacement was required to assure performance of the Iris and Cherryvale pump station improvements.

In 2008, Chautauqua Finished Water Reservoir Water Quality Improvements were completed, separating the inlet and outlet piping to enhance mixing potential, sampling lines and water quality monitoring meters were installed and the SCADA system was improved to allow remote monitoring of water quality.

In 2008 a system-wide vulnerability assessment was completed. The vulnerability assessment prioritizes and recommends improvement measures for water system assets. Due to the confidential nature of the recommendations, they are not discussed in detail in the WUMP, although the budgets for the recommendations will be part of the CIP.

An inspection of the Gunbarrel Reservoir in 2009 showed that the interior will require maintenance in the near future. Water quality sampling equipment was also installed at the Gunbarrel Reservoir.

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[1] a.k.a. North Terminal Water Storage Tank.

3 Planning Approach and Assumptions

The analysis includes estimates of demand and upgrades required for current conditions as well as the planning years 2015, 2025, and 2035. Water demands are estimated for the following user types:

- Single family residential
- Multi-family residential
- Commercial/Industrial
- Municipal

Demands are developed for average daily, peak month, peak day, and peak hour conditions. Peak demands are developed using peaking factors. Demand information is summarized in Section 5.

When recommendations are made for system improvements based on conditions in the planning years, the recommendations will be compared to buildout conditions, so that recommended improvements meet system needs beyond the planning year 2035. This approach is consistent with the lifetime of assets in Boulder's water system, which may exceed 100 years.

3.1 Study Area

The Boulder Valley Comprehensive Plan (BVCP) sets a course for the future growth and development of the City and the lands just outside the City's boundaries. The plan is jointly adopted by the City of Boulder and Boulder County. The BVCP defines three planning areas within the Boulder Valley:

- Area I is that area within the City of Boulder which has adequate urban facilities and services and is expected to continue to accommodate urban development.

- Area II is area now under county jurisdiction, but is planned for annexation and extension of City services.

- Area III is the remaining area in the Boulder Valley, generally under county jurisdiction. Area III-Rural Preservation Area includes lands designated to remain rural in character. Area III-Planning Reserve is an area where the City and County intend to maintain the option of expanded urban development beyond the 25 year planning period

The study area includes Areas I and II, which form the City Service Area.

3.1.1 Population and Employment

Population and employment numbers and spatial distribution were provided by the City Planning Department for 2010[3], the planning years 2015, 2025, and 2035, as well as buildout. Planning population and employment numbers are based on recent conditions and trends. Buildout population and employment are based on the limits of current zoning and may not occur for decades. Buildout and year 2035 population are equal, but over 46,000 additional jobs are expected to be created between 2035 and buildout.

Table 2-7. Summary of Planning Population and Employment

	2010	2015	2025	2035	Buildout
Single Family Residential Population	55,554	55,832	56,191	57,395	55,554
Multifamily Residential Population*	60,326	62,708	67,739	72,775	60,326
Total Population	115,880	118,540	123,930	130,170	130,170
Employment	99,750	103,890	111,180	119,180	165,230
*Includes population living in group quarters.					

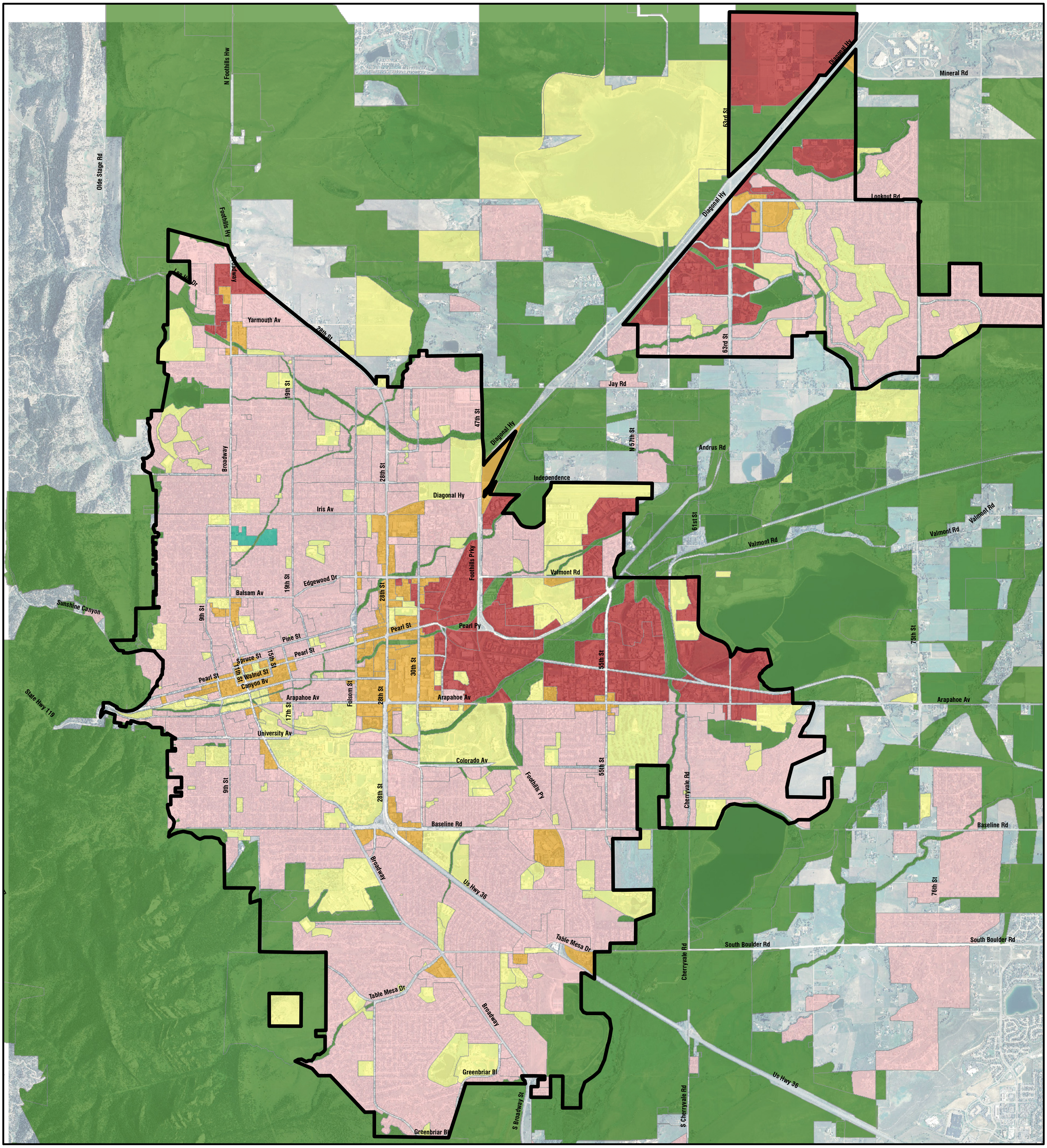
3.2 Land Use

Land use information, consistent with the BVCP was provided by the City Planning Department. Land use for buildout conditions, as shown in Map 2, is very similar to current land use, with only a few areas expected to change.

Population and employment are divided into the City's planning subcommunities (refer to **Table 2-1**) for current and 2035 according to **Table 2-8**. Between 2010 and 2035, employment is expected to increase by about 20 percent in each subcommunity but South Boulder, which would increase by 8 percent. Increases in population are more varied across the subcommunities with Crossroads, East Boulder, and Palo Park increasing by at least 30 percent and the remaining subcommunities increasing by 15 percent or less.

Table 2-8. Summary of Population and Employment by Subcommunity – Current and Projected

Area I + Area II	2010 Employment	2035 Employment	Buildout Employment	2010 Population	2035/Buildout Population
Central Boulder	22,280	26,710	27,670	31,260	32,400
Colorado University	10,280	12,480	14,520	8,730	9,480
Crossroads	15,870	19,300	29,410	7,180	10,850
East Boulder	21,460	25,440	39,450	3,920	6,170
Gunbarrel	15,260	18,130	29,280	10,480	12,030
North Boulder	4,590	5,480	7,070	11,910	12,670
Palo Park	360	430	2,580	3,330	4,330
South Boulder	4,900	5,300	5,300	16,730	17,050
Southeast Boulder	4,750	5,910	9,950	22,350	25,220
Total	**99,750**	**119,180**	**165,230**	**115,880**	**130,170**



Legend

WUSA Boundary

Land Use

- Agriculture
- Business
- Commercial
- Community
- Industrial
- Natural Lands
- Residential

N

0 1 2
Miles

MWH

Current Land Use

Map 2

4 Laws, Policies, and Goals

The actions of the Water Utility are guided in many ways by laws, City codes, ordinances, and policies. The major codes, policies and criteria impacting the utility's operations are summarized below.

4.1 Federal and State Laws

The City must abide by all applicable federal, state, and local laws. The most prominent set of laws the water utility must consider in day to day operations are the Safe Drinking Water Act, the Colorado Department of Public Health and Environment (CDPHE) Drinking Water Program, and Colorado Water Law.

4.1.1 Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) was originally passed by Congress in 1974 to protect public health by regulating the nation's public drinking water supply. The law was amended in 1986 and 1996 and requires many actions to protect drinking water and its sources, including rivers, lakes, reservoirs, springs, and ground water wells. The SDWA authorizes the United States Environmental Protection Agency (US EPA) to set national health-based standards for drinking water to protect against both naturally-occurring and man-made contaminants that may be found in drinking water. The agency in charge of water quality regulation and enforcement in Colorado is the Colorado Department of Public Health and Environment (see Section 4.1.2).

Originally, the SDWA focused primarily on treatment as the means of providing safe drinking water at the tap. The 1996 amendments greatly enhanced the existing law by recognizing source water protection, operator training, funding for water system improvements and public information as important components of safe drinking water. This approach ensures the quality of drinking water by protecting it from source to tap.

To ensure that drinking water is safe, the SDWA sets up multiple barriers against pollution. These barriers include source water protection, treatment, distribution system integrity and public information. Public water systems are responsible for ensuring that contaminants in tap water do not exceed the standards. Water systems treat the water and must test their water frequently for specified contaminants and report the results to states. If a water system is not meeting these standards, it is the water supplier's responsibility to notify its customers.

The City of Boulder has actively participated in Colorado's Source Water Assessment and Protection (SWAP) program (a requirement of SDWA) and has developed an internal monitoring program to characterize source water quality and identify sources of pollution.[2]

[2] Source water protection activities are described further in the SWMP.

Additional discussion of water treatment and distribution regulations including their applicability and requirements for the City is included in Volume 5.

4.1.2 CDPHE Safe Drinking Water Program

The Safe Drinking Water Program of CDPHE is housed within the Water Quality Control Division which administers two major federal statutes as authorized by Colorado law: the Clean Water Act and the Safe Drinking Water Act. In addition to administration, including Colorado regulation development and enforcement, of the Safe Drinking Water Act and other Federal drinking water regulations, CDPHE's Safe Drinking Water Program provides the following services:

- **Capacity Development** This service is a problem prevention service aimed at assisting public water systems in reducing and eliminating technical, managerial, and capacity weaknesses by providing tools and assistance.

- **Compliance Assurance** This service is provided to assist public water systems understand the regulations, monitoring requirements, and public notification requirements. This portion of the program also assures compliance through an escalating enforcement program.

- **Excellence Program** This service is aimed at continuously improving public water system performance and public health protection in Colorado.

- **Outreach and Assistance Program** This service administers the federal Drinking Water Revolving Loan Fund which provides low-interest loans for eligible public water system projects. In addition to loans for capital projects, this service provides small grants for pre-loan planning and design projects.

- **Operator Certification** This program component requires that all public water systems in Colorado, including Community, Transient Non-Community and Non-Transient Non-Community systems, be under the control of a certified Operator in Responsible Charge for both Treatment and Distribution (for systems that serve more than 100 people). The Colorado Water and Wastewater Facility Operators Certification Board (WWFOCB) maintains a program for the certification of operators of water treatment plants, municipal and industrial wastewater treatment plants, water distribution systems and wastewater collection systems in order to assure protection of public health and the environment.

- **Plans and Specification Reviews** This program component requires every new public water system, or substantial addition or improvement to such a system, obtain approval of the plans and specifications by the Water Quality Control Division. The reviews are required to ensure that all regulatory issues are covered and that the design will result in the water quality improvements expected. Additionally, the review is conducted to ensure that the system operator will have the resources necessary to operate the systems.

- **Security and Emergency Response** This program component provides assistance to public water systems as they strengthen their security program and prepare and implement emergency response plans. The program also provides continual updates of security information to systems that subscribe to the Security Listserve.

- **Source Water Protection** This program service provides the public consumer information about their drinking water, as well as ways to get involved in protecting the quality of their drinking water. The program encourages community-based protection and preventive management strategies to ensure that all public drinking water resources are kept safe from future contamination

- **Technical Assistance** This program component sponsors activities that aid public water systems achieve compliance, optimize their operation, or provide education and training to their employees throughout the state and throughout the year. The program also provides telephone consultation, as well as on site assistance, training seminars, and workshops in technical, managerial and financial management topics.

Discussion of the water treatment and distribution regulations including their applicability and requirements for the City is included in Volume 5.

4.1.3 Colorado Water Law

The City's right to use its water sources falls within the framework of Colorado Water Law. The doctrine of prior appropriation, often referred to as "first in time, first in right", is the basis of Colorado's water law system. The City's diversions into treatment and hydroelectric facilities, water it leases to irrigated agriculture, and flows left in streams for environmental purposes must all comply with Colorado water law.[3] Colorado's water courts have jurisdiction over water right decrees and review cases related to water rights. The Colorado Division of Water Resources/State Engineer's Office has the authority to administer surface and tributary groundwater within Colorado.

Boulder owns a diverse portfolio of water rights and water delivery contracts, which allow the City to use water both from the local Boulder Creek basin and from tributaries of the Colorado River to provide municipal water supply. These include direct flow rights, storage rights, exchange rights, and contract water delivery rights. Use under Boulder's many water rights is defined and limited by the terms of each water decree and water use contract. These terms can include limitations on types of use, diversion location, if and where water can be stored, season of diversion, if reuse after the first municipal use is allowed, maximum flow rate for the diversion, maximum storable amount, minimum instream flow levels and the all-important priority date as compared to other water rights.

4.2 State Constitution and City Code

The City provides water, sewer and stormwater services by virtue of Article XX of the State Constitution (Home Rule of Cities and Towns) and the City Charter. The Utilities Division of the Public Works Department directs the day to day operations of the three utilities. The City operates its water, sewer, and stormwater systems as individual "enterprises" as defined in Article X, Section 20 of the State Constitution and Section 11-1 of the City Code.[4]

There are many ordinances contained in the City Code, B.R.C. 1981[4] that affect the water utility. The following sections are of particular importance:

- Section 4-20 Fees, including the various fees charged by the water utility
- Section 11-1-13 When Connections with Water Mains are Required
- Section 11-1-14 Permit to Make Water Main Connections
- Section 11-1-19 Water and Ditch Rights
- Section 11-1-20 Taps or Connections to Water Mains

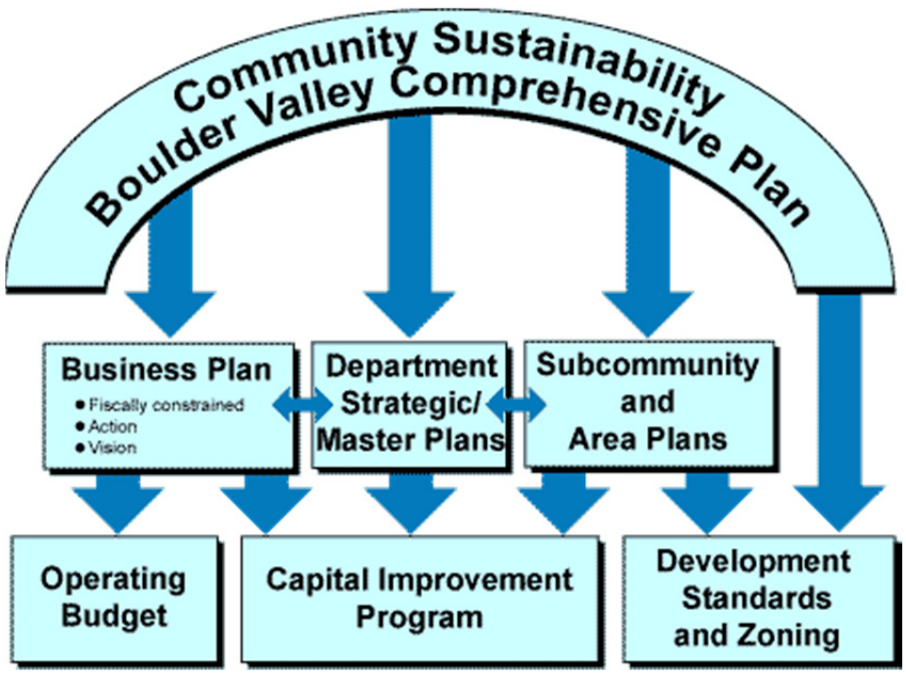
[3] Colorado water law and contracts related to water use are discussed in further detail in Chapter 3 of the SWMP.
[4] The water utility status as an enterprise is discussed further in Chapter 3 of the SWMP.

- Section 11-1-42 Agreement to Extend Water Mains
- Section 11-1-43 Reimbursement of Costs for Water Main Extension

Presently, the code requires immediate hook-up to the water utility upon annexation for commercial or public facilities if structures exist or are proposed and if they are adjacent to a water main. Private properties with existing or proposed structures must also connect if they abut a water main.

4.3 Boulder Valley Comprehensive Plan

Since 1970, the City and Boulder County have jointly adopted a comprehensive plan that guides land use decisions in the Boulder Valley. The facilities and services section of the Boulder Valley Comprehensive Plan[5] (BVCP) establishes policies linking growth to service standards and provisions found in the WUMP and other master plans. The following figure shows how the BVCP is intended to provide overarching guidance to City departments via their master plans, which feeds in to business planning and the Capital Improvement Program.



The following paragraphs of the BVCP are related to the water utility.

- **Protection of Water Quality –** Water quality is a critical health, economic and aesthetic concern. The City and County will protect, maintain and improve water quality within the Boulder Creek watershed as a necessary component of existing ecosystems and as a critical resource for the human community. The City and County will seek to reduce point and nonpoint sources of pollutants, protect and restore natural water system, and conserve water resources. Special emphasis will be placed on regional efforts such as watershed planning and priority will be placed on pollution prevention over treatment.

- **Water Resource Planning and Acquisition –** Water resource planning efforts will be regional in nature and incorporate the goals of water quality protection, and surface and ground water conservation. The City will continue to obtain additional municipal water supplies to insure adequate drinking water, maintain instream flows and preserve agricultural uses. The City will seek to minimize or mitigate the environmental, agricultural and economic impacts to other jurisdictions in its acquisition of additional municipal water supply to further the goals of maintaining instream flows and preventing the permanent removal of land from agricultural production elsewhere in the state.

- **Drinking Water –** The City and County will continually seek to improve the quality of drinking water and work with other water and land use interests as needed to assure the integrity and quality of its drinking water supplies. The City and County will employ a system-wide approach to protect drinking water quality from sources waters to the water treatment plant and throughout the water distribution system.

- **Minimum Flow Program –** The City will pursue expansion of the existing in-stream flow program consistent with applicable law and manage stream flows to protect riparian and aquatic ecosystems within the Boulder Creek watershed.

- **Surface and Ground Water** – Surface and groundwater resources will be managed to prevent their degradation and to protect and enhance aquatic, wetland and riparian ecosystems. Land use and development planning and public land management practices will consider the interdependency of surface and groundwater and potential impacts to these resources from pollutant sources, changes in hydrology, and dewatering activities.

- **Water Conservation –** The City and County will promote the conservation of water resources through water quality protection, public education, monitoring and policies that promote appropriate water usage. . The City will endeavor to minimize water waste and reduce water use during peak demand periods. New development and redevelopment designed to conserve water will be encouraged.

- **Wastewater –** The City will pursue sustainable wastewater treatment processes to achieve water quality improvements with greater energy efficiency and minimal chemical use. Pollution prevention and proactive maintenance strategies will be incorporated in wastewater collection system management. The county will discourage the installation of private on-site wastewater systems where municipal collection systems are available or where a potential pollution or health hazard would be created.

- **Consistency of Utility Extensions with Comprehensive Plan –** The installation and extension of all utilities will be consistent with the provisions of the comprehensive plan and with the responsibilities of the respective utility providers.

- **Efficient Extension of Utilities –** Nothing within the comprehensive plan will prohibit the City from denying the provision of utility services to any property within the Boulder Valley for utility-related reasons.

- **Utility Provision to Implement Community Goals** – The City will consider the importance of the other objectives of the comprehensive plan in the planning and operation of the water, wastewater, stormwater and flood management utilities. These other objectives include in-stream flow maintenance, enhancement of recreational opportunities, water quality management, preservation of natural ecosystems, open space and irrigated agricultural land, and implementation of desired timing and location of growth patterns.

- **Out of City Utility Service –** In furtherance of policies 2.01, 2.02, 2.04, 3.08, 3.09 and 3.10, and not withstanding Policy 3.03, the City and County agree that it is appropriate for the City to: a) Decline support for utility provision in Area III and Area II when its provision would defeat Boulder Valley Comprehensive Plan goals. b) Extend limited utility service in Area III and Area II in circumstances that further comprehensive plan goals. c) Evaluate opportunities for cooperation with other utility service providers, in concert with the county, to further comprehensive plan goals.

4.3.1 BVCP Urban Service Standards

According to the BVCP:

- The urban service standards set the benchmark for providing a full range of urban services in the Boulder Valley.
- These standards are intended to be minimum requirements or thresholds for facilities and services that must be delivered to existing urban development, or new urban development and redevelopment to be considered adequate.

Five criteria are to be used in the determination of the adequacy of proposed or existing urban facilities. The water utility has developed service standards to meet each of these criteria as indicated below.

1) Responsiveness to public objectives

a) Provide a sufficient degree of reliability for raw water, treated water, and an efficient transmission/distribution system capacity to meet the demands of the population 24 hours per day[5].
b) Provide full-time personnel 24 hours per day at the water treatment plant to assure water quality, monitor equipment and make emergency repairs.
c) Have personnel on call 24 hours per day for water service emergencies.

2) Sufficiency and dependability of financing

a) Have revenue sources that are guaranteed so that revenues are available for water related materials, capital improvement projects, equipment, facilities and personnel.
b) Use Plant Investment Fees as possible revenue for water rights acquisition, raw/treated water storage, treatment plant improvements/expansions and construction of water mains.
c) Be organized to request and receive state, federal, and Northern Colorado Water Conservancy District funds, when available, for equipment, facilities and projects.
d) Have the ability to obtain financing through the use of revenue bonds.

3) Operational effectiveness

Measures of operational effectiveness include current and long range project forecasting, coordination with other urban service programs, maximization of economies of scale in urban service provision, and the incorporation of operational processes and organizational methods that have proven effective in similar situations.

a) Use annual budget for personnel, equipment, projects, facilities and materials.
b) Meet standard specifications as exemplified by the American Water Works Association.

[5] Specific reliability criteria are discussed in Section 4.5. There are infrequent exceptions when not all of the demand for water will be met.

c) Meet or surpass acceptable levels of federal and state water quality standards.
d) City of Boulder Design and Construction Standards should be used for standards for water main design for the Boulder Valley.

4) Proficiency of personnel

a) All water treatment plants will be staffed by personnel who have obtained the appropriate Water Operator Certification.
b) All water maintenance crews will be staffed by personnel who have obtained the appropriate Water Distribution System Certification.

5) Location and adequacy of equipment and facilities

a) Have capacity to deliver sufficient treated water to maximum day demand conditions.
b) Have existing treatment plant capacity with planned expansion that will be capable of serving projected population of the Service Area.
c) Plan and provide treatment capability to meet required water quality standards.
d) On the divided highways, place hydrants on each side of highway.
e) In single family residential areas, fire hydrant spacing shall be no greater than 500 feet. No dwelling unit shall be over 250 feet of fire department access distance from the nearest hydrant measured along public or private roadways or fire lanes that are accessible and would be traveled by motorized fire fighting equipment.
f) In multiple family, industrial, business or commercial areas, fire hydrant spacing shall not be greater than 350 feet. No exterior portion of any building shall be over 175 feet of fire department access distance from the nearest hydrant measured along public or private roadways or fire lanes that are accessible and would be traveled by motorized fire fighting equipment.
g) Provide essential equipment and vehicles for water maintenance activities and emergency use.

4.4 Utilities Division Mission and Guiding Principles

The Utilities Division's mission is to provide quality water services, as desired by the community, in a manner which emphasizes efficient management of fiscal and natural resources, and protects human and environmental health.

The Guiding Principles Utilities will use to fulfill its mission include:

- Providing reliable utility services
- Complying with all City, county, state and federal laws, taking direction from both regulatory standards and community goals
- Planning work activities and expenditures in a manner which demands fiscal responsibility and accountability
- Incorporating environmental stewardship, public health, and public safety in all aspects of our work
- Understanding that our community is dynamic, not static, and as a result, so must be plans and programs
- Treating people with respect, dignity and honesty
- Setting high standards and consistently managing performance to achieve those standards
- Promoting staff as a team and resource
- Maintaining a safe work environment

- Realizing that the quality of our work is as important as the quantity of our work
- Promoting personal responsibility, contributions and growth
- Recognizing that we are a part of a larger organization and, as such, strive to understand other needs and use resources in a collaborative manner

4.5 Reliability Criteria

Water provided by the City serves a variety of purposes ranging from those uses that require an assured supply such as drinking water and firefighting, to those uses that can tolerate occasional restrictions, such as lawn irrigation and car washing. It is recognized that no municipal water supply can ever be 100 percent reliable against all risk factors and that the economic and environmental opportunity costs of reducing the risks of occasional water shortages are significant. The City has previously adopted reliability criteria for the source water and treated water systems.

The reliability standards for the City's municipal water supply that were adopted by City Council in 1989 based on the 1988 Raw Water Master Plan are:

a) For those water uses deemed essential to the maintenance of basic public health, safety and welfare such as indoor domestic, commercial, industrial uses and firefighting uses, the City shall make every effort to ensure reliability of supply against droughts with occurrence intervals of up to 1,000 years.
b) For the increment of water use needed to provide continued viability of outdoor lawns and gardens, the City shall make every effort to ensure reliability of supply against droughts with occurrence intervals of up to 100 years.
c) For the increment of water needed to fully satisfy all municipal water needs, the City shall make every effort to ensure reliability of supply against droughts with occurrence intervals of up to 20 years.

The City's Drought Plan (2003, 2004 and 2009 revisions)[6] includes four drought stages associated with increasing levels of water shortage severity. Drought stages will be declared based on review of a drought trigger formula specific to Boulder's water system and other relevant factors. Drought response measures appropriate to each drought stage are contained in the 2009 revision of the Drought Plan. Water budget reductions will be used as a primary tool at each drought stage.

- **Stage 1: Moderate,** expected 20 to 50 year recurrence, reduce overall municipal water use by 8%, emphasis on wise water use.
- **Stage 2: Serious,** expected 50 to 100 year recurrence, reduce overall municipal water use by 14%, surcharges and fines to eliminate wasteful use, more water use limitations such as decreased lawn irrigation.
- **Stage 3: Severe,** expected 100 to 1,000 year recurrence, reduce overall municipal water use by 22%, measures to reduce excessive water use, outdoor use limitations with some loss of lawns, shrubs and minor trees.
- **Stage 4: Extreme,** expected less than 1,000 year frequency, reduce overall municipal water use by 40% implement measures to eliminate most outdoor and non-essential water use,

The City's efforts to maintain a diverse water supply, from both the east and west slopes, reduces the effects on water delivery from droughts or emergencies occurring in any one source watershed. The City has modeled the source system for both current environmental conditions and a range of climate change scenarios. Without considering emergencies such as wildfires or a transmission system failure, the City is expected to meet the reliability criteria for current environmental conditions. Boulder would meet the most critical 100-year and 1000-year reliability criteria in all but one of eighteen climate scenarios modeled. The less significant 20-year criteria resulted in more frequent episodes of "nuisance level" minor water use reductions in one-third of the modeled climate change scenarios.

The reliability criterion of meeting all water demands with the exception of once in 20 years is the same for the source water and treated water system. The frequency of water use restrictions for essential uses and outdoor water use differ:

a) The City will ensure the delivery of the water required to satisfy essential needs including the maintenance of basic public health, safety and welfare such as indoor domestic, commercial and industrial uses and fire fighting uses, except for droughts and system failures having a frequency of no more than once in 100 years. *The average winter consumption plus a fire-flow reserve demand is established as a measure of this demand.*

b) The City will ensure delivery of the water required to provide for the continued viability of exterior landscaping, except for droughts and system failures having a frequency of no more than once in 50 years. *The following method is used to establish a measure of this demand:*

$$ELD = AWC + 0.65 * (PMD - AWC)$$

where:

ELD = Exterior Landscaping Demand
AWC = Average Winter Consumption
PMD = Peak Month Demand

As an alternative, 75 percent of the peak month demand may be established as a measure of this demand.

c) The City will ensure delivery of the water required to fully satisfy all uses, except for droughts and system failures having a frequency of no more than once in 20 years. *The peak hour demand or the peak day demand plus a fire-flow reserve demand is established as a measure of this demand.*

4.6 Goals

A variety of goals have been developed for different documents and internal use within the water utility. This section consolidates those goals, updates where necessary, and includes new goals developed through the WUMP process. In some cases, specific practices are suggested for meeting the identified goals.

4.6.1 Overall Water Utility Goals

The following six overarching goals apply to the water utility as a whole.

1) **Provide safe and high quality drinking water**
2) **Minimize interruptions to the delivery of water**
3) **Operate cost effectively**
4) **Consider other community goals in operating the water utility**
5) **Provide informative and responsive customer service**
6) **Foster communication and coordination among water utility staff in different locations**

There are five water quality goals described in the Water Quality Strategic Plan. The first three of these goals are intended to help integrate water quality and environmental considerations into capital projects and decisions regarding land use policies and activities. They include “provide safe and high quality drinking water”, listed above. The next two goals, focus on wastewater and stormwater, but relate to the water utility in terms of source water protection:

7) Manage pollutants from wastewater and other point-sources
8) Manage pollutants from stormwater and other non-point sources

The remaining goals represent the water utility’s commitment to wise use and management of water and the environment, including operation of the Boulder Creek instream flow program and the water conservation program:

9) Protect, preserve, and restore natural water systems
10) Conserve water resources in a manner appropriate for Boulder’s water supplies and system

4.6.2 Source Water Goals

The various goals for the City’s water rights and source water system are balanced against each other during implementation using the practices identified in Appendix A. These recommended practices serve to achieve the best balanced outcomes for meeting the following goals:

11) Deliver the highest quality water sources available for immediate delivery after allowing for needed storage reserves
12) Maintain sufficient reservoir drought reserves to achieve drought reliability criteria
13) Maintain sufficient reservoir reserves to assure continuous water supply to Betasso WTF throughout the year and in emergencies
14) Maximize hydroelectric production
15) Address instream flow needs
16) Protect and enhance the yield of City's water rights portfolio
17) Maintain and protect source water system infrastructure and lands
18) Support local ditch company operations that complement the municipal system
19) Protect source water from point and non-point pollutants[6]
20) Encourage stewardship and regional cooperation, particularly with those entities affecting source waters and source water lands[7]
21) Improve source water quality when possible through operational or other means

[6] The source water protection goals, described in the SWMP, have not been presented to City Council for formal adoption of an ordinance or policy statement, staff uses them as guidelines for operations and management.

[7] The City does not own or control most of the lands that affect its water supplies, except in the Silver Lake Watershed and on North Boulder Creek, and cooperation with land-use management entities and interests is necessary.

4.6.3 Water Treatment Goals

The following goals were documented in the Boulder Reservoir WTF Integrated Source Water and Treatment Study[7]. The City has established finished water quality goals that in many cases are more stringent than the water quality standards. These numeric goals are discussed along with water quality standards in Volume 5 of the WUMP. Appendix A includes recommended practices to meet the following goals.

22) Comply with all drinking water regulations and meet secondary standards.
23) Use best practices to maintain high quality treated water.
24) Seek alternative methods to increase delivered water quality.
25) Deliver similar and consistent finished water quality from both plants.
26) Ensure daily reliable plant operations at design flows
27) Integrate public health risk factors into source water and treatment management decisions.
28) Improve knowledge of emerging contaminant occurrence

4.6.4 Distribution System Goals

The following distribution system goals have been established as part of this and previous planning efforts. Appendix A includes recommended practices to meet the following goals.

29) Remain in the "below average" category for water main breaks for municipalities in the region
30) Design and operate distribution system with adequate storage to meet fluctuating customer demands and provide for emergency service
31) Maintain safe and consistent water quality throughout the distribution system.

4.7 City of Boulder Design and Construction Standards

The City publishes design and construction standards including a chapter about water[8]. BVCP requires that water mains be constructed according to these standards. The design and construction standards are all related to the distribution system and are described in detail in Volume 5.

4.8 Additional Master Plan Design Criteria

Criteria for the design of specific facilities serve as an important guide in evaluating the facilities and in making recommendations for current and future improvements. This section recommends criteria in addition to those contained in the BVCP and Design and Construction Standards for use by the City in this and future planning efforts. These criteria build upon those published in the TWMP (2000) including the American Water Works Association (AWWA), the National Fire Protection Association (NFPA), Uniform Fire Code (UFC), Uniform Plumbing Code (UPC), and the Insurance Services Office (ISO).

4.8.1 Source Water System

Adequate design capacities and appropriate operational guidelines for the source water system cannot be derived solely by looking at average water availability from each water source. This is due to significant variation in year to year and seasonal availability of water from each of the City's water sources. In addition, conditions in one location in the watershed can have impacts in another part of the watershed in unexpected ways due to water rights interactions and interrelated aquifer and river hydrology. Therefore, extreme hydrologic events and variations in water availability between east slope and west slope sources need to be considered when setting design criteria for facilities. This can best be done by reviewing design criteria in conjunction with output from the City's Boulder Creek Watershed Model, which models long-term operation of the source water system through a range of expected hydrologic conditions.

System modeling shows that the currently available amount of reservoir storage space will allow the City's existing raw water supplies to be capable of meeting buildout water demands up to the level of the City's adopted drought reliability criteria. In order to achieve this level of reliability, the City must follow operational practices that maximize use of direct flow water rights and emphasize adequate use of treatment capacity at Boulder Reservoir WTF in order to retain sufficient reserve storage water in the City's upper Boulder Creek reservoirs.

In most years, there is enough streamflow at the City's Boulder Creek diversion points for a few weeks to a few months during spring runoff of mountain snowmelt for all of the City's then-occurring water demands to be met through direct flow diversions without pulling water from storage reservoirs. This is known as the "direct flow season". Streamflows usually are also high enough at this time to fill reservoirs. However, natural streamflows drop significantly by late summer and are only a few cubic feet per second during the winter. During these seasons, the City must draw water from its reservoirs to supplement direct diversions in order to meet municipal water demands. In years in which the City's reservoirs do not fill in the spring, municipal water needs must be met by drawing down drought storage reserves carried over in reservoirs from wetter years. Therefore, the City must maintain sufficient reservoir storage capacity to even out water availability between seasons and between wet and dry years. On-going use of Boulder Reservoir WTF during all months but the direct flow season helps to protect the City against drought shortages. Improving the ability to deliver water to the Boulder Reservoir WTF during the winter, such as with the construction of the Carter Lake Pipeline, will support efforts to be prepared for drought.

An additional portion of upper Boulder Creek reservoir storage in each basin should be dedicated to holding an emergency reserve to assure continued deliveries to Betasso WTF in the event of an emergency. It is important that Betasso WTF be able to operate with very few interruptions in order to prevent the possibility of pressure loss in the upper zones of the distribution system in the City. The disruptions in Betasso operations that do occur should be limited to no more than a few days.

Each of the City's water sources should have facilities that are designed with sufficient redundancy to assure that there will always be at least one source of raw water available to the treatment plants in the event of an emergency. Each water source should be able to independently provide at least the essential buildout water demands of the City in order to provide the greatest protection against unplanned outages that might jeopardize public health or safety. Raw water pipelines to Betasso WTF should be maintained with sufficient capacity to meet the maximum treatment capacity of the plant when both pipelines are operating.

The City sets water budgets for individual customers based on an evaluation of the amount needed for their household and irrigation water needs. Outdoor use allocations in the summer months are generally based on calculations of evapotranspiration for bluegrass lawns. However, budgets for May and June are purposefully set higher to avoid discouraging water use during the direct flow season. This practice maximizes beneficial use of water for landscaping irrigation during periods when it will not affect the City's drought resiliency. It takes advantage of the alluvial aquifer feeding Boulder Creek ability to act as another reservoir by encouraging irrigation practices that will recharge the aquifer. Water from the aquifer then returns to Boulder Creek on a delayed basis at times when streamflows are naturally dropping in summer and fall. In addition to supporting streamflow, the return flows soften the water rights call on the river and preserve the City's ability to continue diverting under its water rights in the upper Boulder Creek basin. Therefore, the City's water pipeline capacities should be designed and maintained so that all of the City's demands can be met through direct flow deliveries, mostly through Betasso, during the period of about mid-May to late June in most years. In addition, water conservation programs and water budget amounts should be designed in a manner that considers the broader watershed effects and benefits of City water use.

The City has used the Boulder Creek Watershed Model to design the Drought Response Plan. The drought reliability criteria have been used in the modeling as assumptions on the percentage of water use reductions that will be in place during drought years. In order to achieve the model results of having the City meet the drought reliability criteria over time, the City must design and implement its drought response activities to achieve the assumed percentage of use reductions. A key component of this reduction effort will be reductions in customer water budgets. It should be noted that the water budget reductions currently in the drought plan are based on the current ratio of 60% indoor use and 40% outdoor use.

4.8.2 Water Treatment Plants

The City deliveries as much of its municipal water supplies as possible without jeopardizing drought resiliency through the Betasso WTF in order to maximize hydropower production and to minimize treatment and pumping costs. It can cost up to five times as much to deliver the same amount of water from Boulder Reservoir WTF as from Betasso. However, all water supplies available under the City's water rights for the Boulder Creek basin in any given year are not delivered to Betasso in that year because some is held in reservoirs for balancing seasonal availability of supplies, as a drought reserve, or for an emergency with one of the City's water sources. This is a risk calculation that can be guided by water system modeling and staff experience with the goal of assuring that there will always be a source of water to feed Betasso, even under the most severe conditions.

The City's Colorado-Big Thompson Project (CBT) water supplies are considered a supplemental water supply to native basin water. In years when eastern slope watersheds are yielding less than average, the NCWCD board sets a higher quota for CBT water. Therefore, during drier periods, Boulder will likely need to treat more water at the Boulder Reservoir WTF. In severely dry years, more than half of the City's annual water supply may be treated and delivered from Boulder Reservoir WTF. This may not be the case, if river flow conditions on Boulder Creek allow the City to exchange its CBT water for more water at the upper Boulder Creek diversions. This exchange potential varies from year to year as well.

Boulder's exchange rights allow it to divert additional supplies at its upstream points of diversion, which provides for diversion of higher quality water, gravity delivery, and more water stored in the City's 18,000 acre-feet of mountain reservoirs. The City's exchange rights allow the cost-effective movement of water from the City's lower water system into its upper water system without the need to construct an expensive pipeline or pumping system. The increase in water available to the City's upper water system also increases hydropower generation. Water treatment costs are reduced due to use of the exchange because it is less expensive to treat the higher quality water available to Betasso WTF than water at Boulder Reservoir WTF. Also, water from Betasso WTF can be delivered into the City by gravity instead of by pumping, as is required for Boulder Reservoir WTF water. This both saves money and reduces greenhouse gas emissions associated with the electricity for the pumps.

Water system facility capacities and water operations are based on the assumption of Boulder's continued use of its Boulder Creek exchange rights. Boulder can add to water available under direct flow water rights by exchanging CBT or Windy Gap water for direct delivery to Betasso WTF at rates of more than 20 cfs (13 MGD). Concurrently, at buildout, the City might deliver water via the Boulder Reservoir WTP at rates of 8 to 12 MGD in order to meet Boulder's summer demands. Shifting the delivery of the water used to drive Boulder's direct use exchanges to the Boulder Reservoir WTP would therefore require an increase in the treatment capacity of that plant by up as much as a total capacity of 25 MGD. Other facilities, such pumping plants and transmission pipelines from the Boulder Reservoir WTP into the City, would also need to be increased in size. Therefore, without the river exchange, significant capital investment would be required on one side of the water system along with abandonment of full use of existing facilities capacity on the other side of the water system. For these reasons, use of the Boulder Creek exchange should be maximized.

Operational modeling of water availability at each of the City's treatment plants shows that, at buildout, on average over many years, Betasso WTF will treat 56% of the City's water and Boulder Reservoir WTF will treat 44%. In wetter years, the amount treated at Betasso could increase to 67%. In drier years, the ratio will be closer to 50/50. There are monthly variations within the annual variations. In some months, Betasso may be supplying all of the City's water with a maximum of about 1060 acre-feet in a month or 45 MGD average. However, Betasso may shut down for a few days in winter months during drought years with Boulder Reservoir WTF supplying most of the 13 to 15 MGD needed in those months.

By the time of the City's full buildout, Boulder Reservoir WTF will need to run at a fairly constant base load between 10 to 16 MGD for about ten months of each year in order to balance use of available water supplies in a manner that protects drought resiliency. It may need to run at a continuous rate of up to 16 MGD during some of the summer months in order to adequately balance use of Boulder's available water supplies and maintain appropriate drought reserves in the upper Boulder Creek reservoirs. At buildout, Betasso WTF will operate almost every day of the year, with low flows through the facility in winter and high flows in summer.

4.8.3 Hydro Facilities

The City has developed much of the environmentally and economically feasible hydroelectric generation potential in its raw and treated water delivery system. This potential exists because of large changes in elevation between the City's diversion points and delivery points for its municipal water pipelines. The City's eight existing hydroelectric generators produce electricity with minimal environmental impact since the water supply infrastructure is already in place. There are additional sites within the water system that may have hydro development potential if the electricity can be sold at a price that returns the investment in equipment.

The potential hydro development sites on current water system facilities that have been identified based on the available pressure or the amount of flow available are:

- 101 Pearl
- Discharge line from Betasso (Tram Hill Hydro)
- Barker Dam outlet to Boulder Creek (Hannah Barker Hydro)

Of these, only the Hannah Barker Hydro proposal appears to be financially feasible, but only after a new outlet works is constructed at Barker Dam as planned to meet water system operational needs. The other two sites appear to have insufficient flows either in volume or over time to justify the expenditure for hydro equipment, but this might change at some point in the future.

Other hydro sites might be identified or become feasible when new facilities are built or older ones are refurbished. For example, the proposed Carter Lake Pipeline should have hydro potential at the discharge at Boulder Reservoir WTF. Consideration of the possible addition of hydro facilities should be a design consideration for any water system project involving an untapped source of water pressure.

4.8.4 Distribution System Capacity and Pressure

Water system improvements proposed in this study are designed to supply peak requirements as determined from water use studies. In designing transmission system and distribution system components, consideration is given to peak day demands and fire flow requirements as well as peak hour demands. It is assumed that fire flow will be provided coincidentally with demands at the peak day rate.

Within the existing treated water distribution system, pressures at some locations can reach over 160 psi. System additions, however, should be designed in such a manner that pressures in new areas would be about 80 psi and limited to approximately 100 psi. The Uniform Plumbing Code requires individual house pressure regulators for pressure above 80 psi. Minimum NFPA required residual pressure at fire hydrants is 30 psi under normal service conditions and 20 psi under fire flow conditions. The BVCP design criteria listed earlier in this section call for a minimum pressure of 40 psi in residential areas during periods of peak hour flow. Distribution system additions should also be designed to limit the daily pressure variation at any point in the system, which occurs as demand varies from minimum to maximum, to approximately 20 psi.

4.8.5 Treated Water Storage

Storage facilities are required to: a) provide equalization of peak demands, b) meet fire flow demands, and c) meet emergencies. When possible, storage should be provided in elevated tanks which "float" on the distribution system pressure. Such storage is more reliable than clear well or offline storage, which requires pumping. Storage tanks should be designed to meet the following standards as applicable: NFPA 22, Water Tanks for Private Protection Standards; and AWWA standards for steel tanks, standpipes, reservoirs, and elevated tanks.

4.8.5.1 Equalization

A storage volume equivalent to 25 percent of the peak day demand should be provided to equalize daily demand fluctuations. The storage volume should be determined separately for each pressure zone in the system.

4.8.5.2 Reserve for Emergency Purposes

Provision of emergency reserve is governed primarily by considerations of mechanical and power outages. In this regard, it must be assumed that mechanical failures could result in the random outage of any single supply component for a period of several hours to several days. On the other hand, the duration of power outages varies with location and relationship to the power distribution network. The Betasso WTF for example experiences power outages lasting from 10 minutes to over 24 hours from winter storm events. The Boulder Reservoir WTF experienced a significant number of power outages in the 2002 to 2005 timeframe due incoming power line issues. Since replacement of the line and power pole in 2005, power outages have nearly ceased and the supply is considered very reliable. However, it is assumed that outages could occur at any one location coincident with a fire flow requirement.

4.8.6 Treated Water Storage Operating Criteria

Storage reservoirs should be operated such that they drain during the day when system flow is high and fill during the night when system flow is low. This tends to level off treatment plant flow variations resulting in more stable operation and helps maintain an adequate chlorine residual in the reservoirs. However, no reservoir should be allowed to drop below the level that represents a stored volume equal to the required fire flow plus emergency reserve for the zone served by that reservoir.

4.8.7 Fire Flow and Hydrant Requirements

Fire flow rates and durations for various types of development are given in **Table 2-9** together with the storage volume required to meet these demands. In applying these standards, the worst case of fire flow is assumed for each zone. Fire flow is calculated independent of equalization storage because these are assumed to be concurrent.

Table 2-9. Fire Flow Requirements Breakdown

Land Use	Fire Flow (gpm)	Duration (hours)	Fire Storage Required (gallons)
Single Family Residential	1,500	2	180,000
Multifamily Residential	3,500	3	630,000
Commercial	3,500	3	630,000
Schools	2,500	2	300,000
Hospitals	6,000	4	1,440,000
Industrial	3,500	3	630,000

Fire storage should be determined and provided separately for each pressure zone within the distribution system. Recommended storage requirements for the City of Boulder from the TWMP (2000) are:

Zone	Fire Fighting Storage (million gallons)
1	0.63
2	1.44
3	1.44

In addition to the BVCP criteria, fire hydrants should be located so that each will serve between 80,000 and 150,000 square feet of developed area[9].

An ISO fire insurance classification completed in 1995 found that the City's water supply system for fire suppression was very good, receiving 38 out of 40 possible points. This evaluation reviewed water main capacity and hydrant distribution[10].

4.8.8 Pressure Reducing Stations

These facilities should utilize automatic pressure reducing valves as opposed to manually actuated valves whenever possible, to reduce the potential for human error. This will provide for consistent system operation under all conditions. If additional control is desired, a manually actuated valve can be placed in series with an automatic pressure-reducing valve.

4.8.9 Distribution System Mains and Valves

The piping system which is used to deliver water from the treatment plant to customers normally consists of transmission mains and distribution mains. Transmission mains deliver water from treatment plants and storage to major subdivisions of the service area, and are generally 12-inch diameter and larger. Distribution mains convey water from the transmission system to individual users and are generally 10-inch diameter and smaller. In planning future improvements, it is assumed that existing mains will be fully utilized.

Transmission mains are sized to deliver the greater of either peak hour demand or peak day demand plus fire flow. Maximum velocity should not exceed 10 feet per second. Sizing of transmission mains is based on the results of hydraulic analyses of the distribution system.

It is recommended that transmission main piping be manufactured of lined steel or lined ductile iron, meeting the requirements of AWWA C200 or C100, respectively. Distribution mains are recommended to be constructed of PVC or polyethylene wrapped lined ductile iron, meeting the requirements of AWWA C900 or C100, respectively.

On transmission pipelines valves should be spaced at approximately 1,200 feet[11].

4.8.10 Pumping Capacity

Pumping facilities should be designed to meet peak day demand with the largest pump out of service. In addition, design of pumping plants should consider extreme events, such as an outage of one major part of the system. City staff should consider if pumping facilities should be designed with the capacity to meet demands when one major part of the water system is out of service.

5 Water Use

This section discusses historical water use, baseline water use (for the period 1994 to 1996), current water use, peaking factors, and projected water use.

5.1 Historical Water Use

The following is brief a summary of the historical water use discussion in the SWMP, which can be found in Volume 4, Section 5 of this WUMP.

Figure 2-5 shows the long term trend in the City's total treated water use. Water use followed an increasing trend from the early 1970s until 2000. The drought of the 2002 resulted in lower total water use, and levels have remained similar since **Figure 2-6** depicts long-term historical outdoor water use, compared to outdoor water use requirements (based on evapotranspiration, or ET). Although outdoor water use can vary greatly from year to year based on weather conditions, indoor water use in the last few years has been similar to usage in the 1980s. This suggests that permanent structural changes have been made, such as the installation of water efficient toilets and appliances. Outdoor water use has fluctuated since the drought of 2002 and it is not clear if outdoor water conservation noted during the drought year will be permanent.

Figure 2-5. Long-term Trend in Total Water Use, 1971-2009[12]

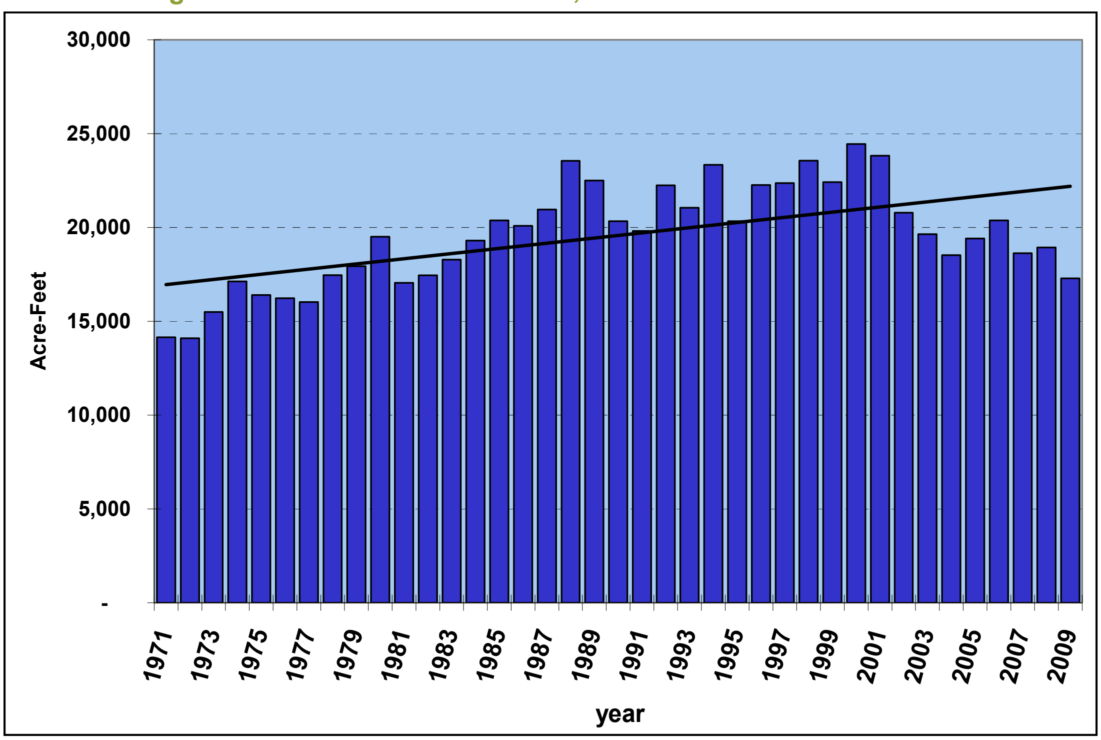
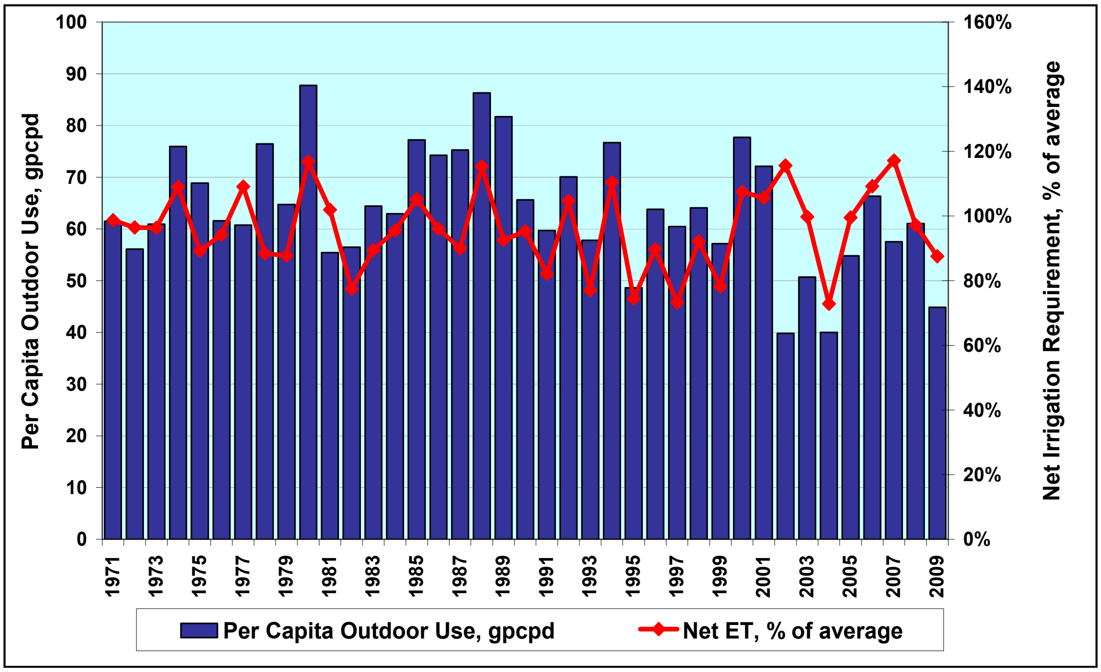


Figure 2-6. Long-term Trend in Outdoor Water Use and Net Irrigation Requirement[13]



5.2 Baseline Water Use (1994 to 1996)

The Water Conservation Futures Study involved a detailed study of water usage in the City and established baseline water usage data by customer type that are still relevant to the WUMP. The baseline water usage data, summarized in **Table 2-10**, were for the years 1994 through 1996, with an adjustment for the low evapotranspiration requirements of that period. These data constitute a baseline because water conservation goals adopted by the City Council in 2000 are relative to these figures.

Table 2-10. Baseline Water Usage from Water Conservation Futures Study (1999)

Water Use Sector	Total Usage (AFY)	Sector Units	Sector Unit Usage (1994-1996) (gallons per unit per day)
Single Family Residential (detached)	7,681	46,072 persons	148
Multi-family Residential (attached)	6,217	61,584* persons	90
Commercial/Industrial	5,924	85,401 employment	62
Municipal	724	Total use	646,000
Lost	1,899	Total use	1,695,000
Total Produced	22,446	107,655 Total Population	186
*Includes group quarters population, estimated as 8,000 persons.			

The data published in the Water Conservation Futures Study was slightly modified in coordination with City staff as the numbers were not published in the format of **Table 2-10** and some of the numbers could not be directly reproduced[14].

5.3 Current Water Use

Based on the consensus of staff, current water usage should be based the four year period 2006 through 2009[15]. **Figure 2-7** and **Table 2-11** show how current usage has varied and how it is divided into sectors. Water production varied from 20,372 acre-feet in 2006 to 17,280 acre-feet in 2009. Water production did not trend exactly with the net irrigation requirement, which varied from 88 percent of average in 2009 to 117 percent of average in 2007. The average production of 18,800 acre-feet shows that water usage has been reduced compared to the baseline period (1994 to 1996) when there was over 22,000 acre-feet of total water use. Over the four year period, net irrigation requirements based on evapotranspiration (ET) effects were 103 percent of the long-term average[16]. Therefore, to account for this ET variation the average 2006-2009 period production has been adjusted to 18,587 acre-feet per year and this is used as the estimate of current water use.

Figure 2-7. Historic Water Usage – 2006 through 2009 and Period Average

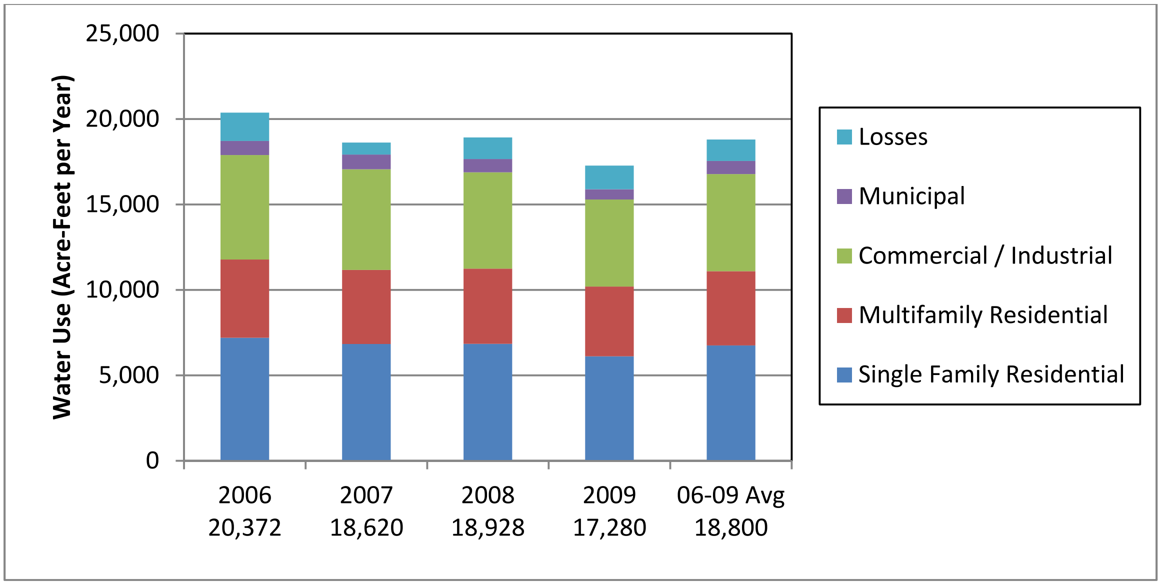


Table 2-11. Historic Water Usage – 2006 through 2009 and Period Average (acre-feet per year)

Sector	2006	2007	2008	2009	Average	ET-adjusted Average
Single Family Residential	7,207	6,835	6,849	6,115	6,751	6,662
Multifamily Residential	4,572	4,342	4,398	4,086	4,349	4,313
Commercial/Industrial	6,115	5,884	5,631	5,094	5,681	5,624
Municipal	821	860	778	592	763	745
Total Consumption	18,714	17,920	17,656	15,886	17,544	17,344
Losses	1,658	700	1,272	1,394	1,256	1,243
Total Production	20,372	18,620	18,928	17,280	18,800	18,587
Net Evapotranspiration Requirements	109%	117%	97%	88%	103%	NA

Table 2-12. Current Water Usage Based on ET-Adjusted Average of 2006 through 2009

Water Use Sector	Total Usage (AFY)	Sector Units (based on 2008 population and employment)	Average Usage (gallons per day per person)
Single Family Residential	6,662	49,500 persons	117
Multifamily Residential	4,313	63,600* persons	62
Commercial/Industrial	5,624	100,500 employment	50
Municipal	745	Gallons per day (gallons per capita per day)	665,000 (5.9)
Losses	1,243	Gallons per day (gallons per capita per day)	1,110,000 (9.8)
Total Produced	18,587	113,100 Total Population	147
*Includes group quarters, estimated as 9,733 persons.			

5.4 Projected Water Use

Projected water usage is based on historical water usage, planned population and employment and conservation goals adopted by City Council. The conservation goals, which are applied to the baseline water usage (summarized in **Table 2-12**) are as follows:

- A 22 percent reduction in per-meter use for the single-family residential sector
- A 26 percent reduction in per meter use for multifamily residential sector
- A 14 percent reduction in per meter use for the commercial/industrial sector
- A one percent reduction in overall municipal use
- A 15 percent reduction in losses

Table 2-13 summarizes baseline, current, and full conservation unit water usage. In nearly every case, the conservation goals have already been exceeded. Total municipal water use has slightly increased in total, but has decreased per capita. Although it appears that the single family sector goals have not been met, this is likely due to differences in how the population is counted compared with how water use is tracked.

Table 2-13. Baseline and Current Water Usage Compared to Conservation Goals (gallons per unit per day)

Sector	Baseline (1994-1996)	Conservation Goal	Current (2006-2009)	Units
Single family Residential	148	115	117	Gallons per person per day
Multifamily Residential	90	67	62	Gallons per person per day
Commercial/Industrial	62	53	50	Gallons per employee per day
Municipal	646,000 (6.0)	640,000 (5.9)	665,000 (5.9)	Gallons per day (gallons per capita per day)
Losses	1,695,000 (15.7)	1,440,000 (13.4)	1,110,000 (9.8)	Gallons per day (gallons per capita per day)
Total production	186	149	147	Gallons per capita per day

For planning purposes, the current unit water usage rates have been applied to projected population. The planned densification of Boulder's population, where new developments cover a smaller area per person, and its expected effect of reducing per capita water usage, is at least partially reflected in the WUMP due to the shift of the population to more multifamily housing. Although it is possible that residents will continue to reduce unit water consumption in each sector through conservation, the likely level of future conservation has not been studied in detail and new goals have not been established. If warmer and drier conditions occur in the future due to climate change, the additional need for outdoor water use may counteract some of the conservation efforts. One of the recommendations of this plan is that a study of likely future water usage be conducted in order to better plan for the water utility.

Table 2-14 and **Figure 2-8** summarize total service area water usage used for planning in the WUMP, based on population information summarized in **Table 2-7**.

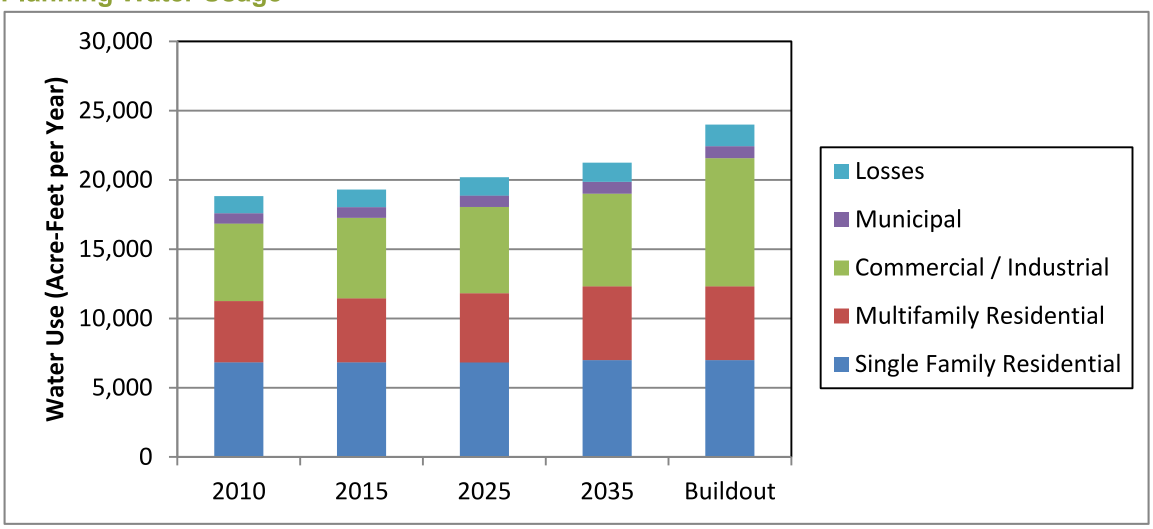
Table 2-14. Planning Water Usage

Customer Type	Units	2010	2015	2025	2035	Buildout
Single Family Residential	AFY	6,830	6,830	6,820	6,990	6,990
Multi-family Residential	AFY	4,420	4,620	5,000	5,330	5,330
Commercial/Industrial	AFY	5,590	5,810	6,230	6,680	9,250
Municipal	AFY	760	780	820	860	860
Losses[1]	AFY	1,230	1,260	1,320	1,390	1,570
Total Produced	AFY	18,830	19,300	20,190	21,250	24,000
Total Produced[2]	MGD	16.8	17.2	18.0	19.0	21.4

[1] Losses estimated as 7 percent of total demand, not on a per capita basis.

[2] In accordance with Distribution System Goal No. 30 and its associated recommended practices (see Appendix A), an additional 10% "reserve capacity" is added to these numbers for distribution system planning and analysis to allow a degree of planning flexibility and mitigate water delivery problems that might be caused by operator error.

Figure 2-8. Planning Water Usage



5.5 Peaking Factors

Typically, treatment facilities are designed with adequate capacity to meet annual peak day demands and distribution system facilities to meet peak hour demands plus fire flow. City of Boulder reliability criteria were used as the basis for selecting appropriate ratios of peak day and peak hour to average day demand. The reliability criteria stipulate that the City's treated water system should have the ability to satisfy demands except for droughts and system failures having a frequency of not more than once in 20 years. The reliability criteria mean that the system should be designed to meet the 95th percentile of the historical annual peak demands.

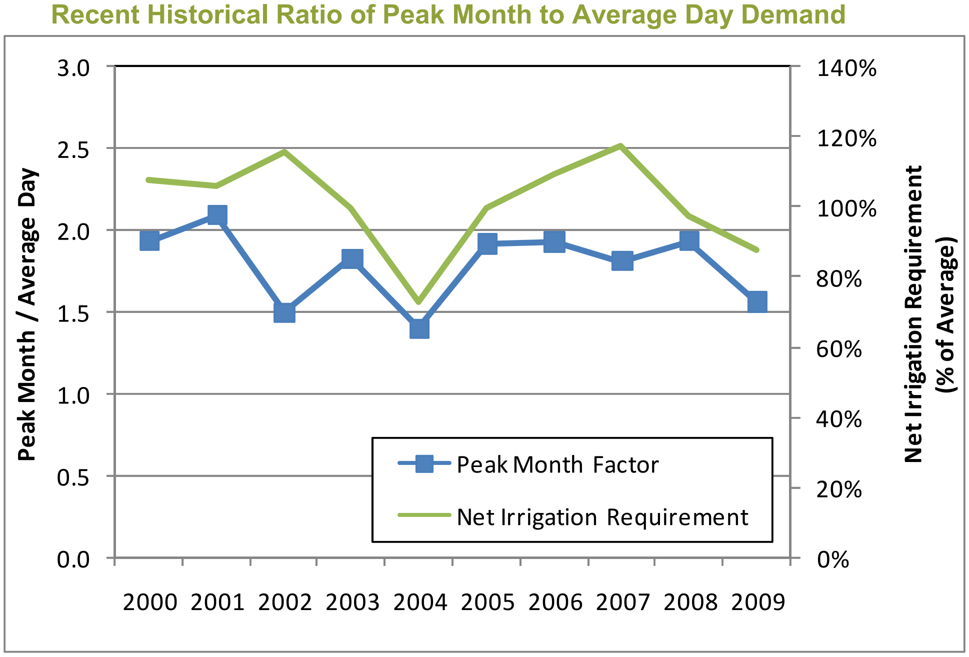
Long-term trends in peaking factors are presented as available in the following sections for consideration. However, as the composition and water usage of the City has changed over the decades, it may not be appropriate to use statistics based on a period longer than 10 years. Therefore, statistics presented are based on the 10-year period 2000 through 2009. Peak factors selected for use in the WUMP are based on discussion with City staff to ensure that the factors are acceptably conservative. All peaking factors are calculated in comparison to the estimated current water use consumption of 18,587 acre-feet per year, or 16.59 MGD average day demand, based on the period 2006 through 2009.

5.5.1 Peak Month

The peak month of demand occurs in the summer due to the height of irrigation water use. The peak month demand was not discussed in the 2000 TWMP, but can be useful for understanding how water usage changes throughout the year. Analysis of recent water usage data[17], as shown in **Figure 2-8**, establishes that the 95th percentile peak month factor is 2.0, which will be used for any analysis requiring a monthly peaking factor, as this corresponds to the City's reliability criteria.

Figure 2-9, shows that although there is variation in peak month to average month demand from year to year, there is no apparent trend with time. However, peak month factors do trend somewhat with the net irrigation requirement. Hot, dry summers would tend to increase summer water usage compared to the long-term average, resulting in higher monthly peaking factors. Between 2000 and 2009 the ratio of peak month to average month varied from 1.4 to 2.1 with an average of 1.8 and 95th percentile of 2.0.

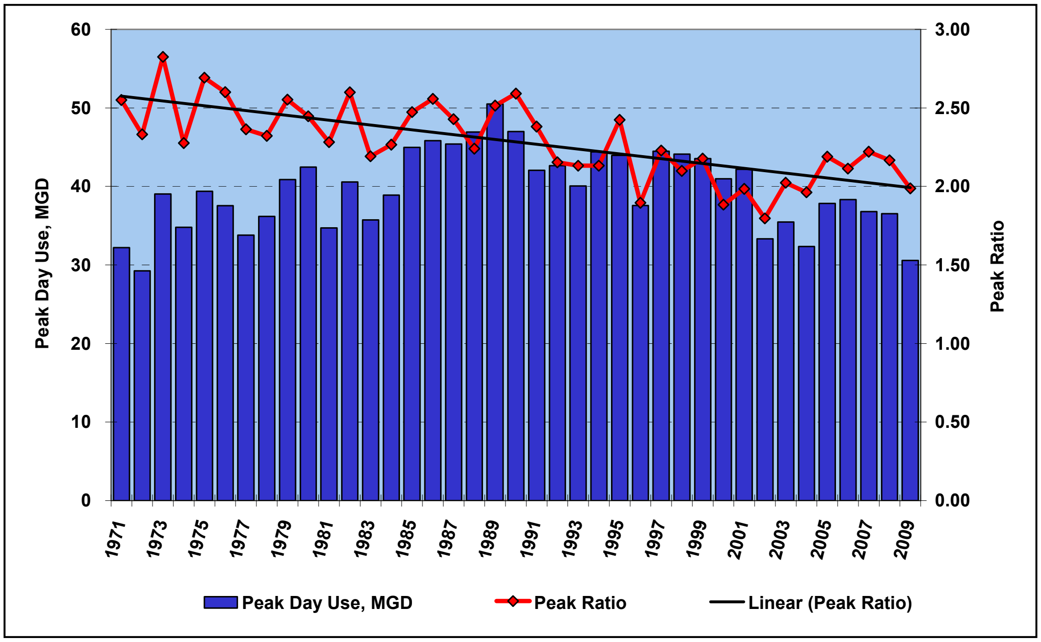
Figure 2-9. Recent Historical Ratio of Peak Month to Average Day Demand



5.5.2 Peak Day

Figure 2-10 shows how peak day water usage has changed over the years since 1971 as calculated using the actual average water use for each corresponding year. The 1990 master plan used a peak day to average day demand factor of 2.81. The 2000 TWMP noted a five year average peak day factor from 1994 to 1998 of 2.4, but selected a more conservative peak day factor of 2.6.

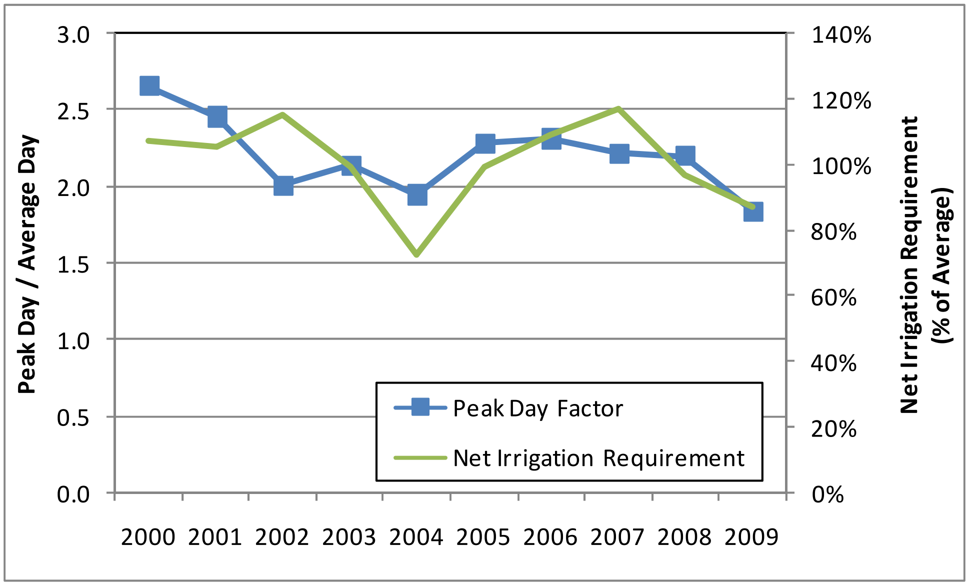
Figure 2-10. Long-Term Trend in Peak Day Water Usage, 1971-2009[18]



Although the average peaking factor is trending lower, there is significant variation from year to year. To be consistent with the reliability criteria, it is important that this variation be acknowledged. Subsequent to the drought of 2002, peak day use has varied from 30.6 mgd in 2009 to 38.3 mgd in 2006, a variation of over 25 percent. It is also appropriate to use the 2006-2009 average water use in calculating the peak day factor rather than the actual average water use for the corresponding year.

Based on these considerations, from 2000 through 2009, the peak day factor fluctuated between 1.8 and 2.7 (see **Figure 2-11**). The average and 95th percentile daily peaking factors for this period were 2.2 and 2.6, respectively.19 The peak day factor has not exceeded 2.3 since the year 2001. To be conservative and in consideration of the reliability criteria the 95th percentile peak day factor of 2.6 is considered appropriate for planning purposes at this time.

Figure 2-11. Recent Historical Ratio of Peak Day to Average Day Demand

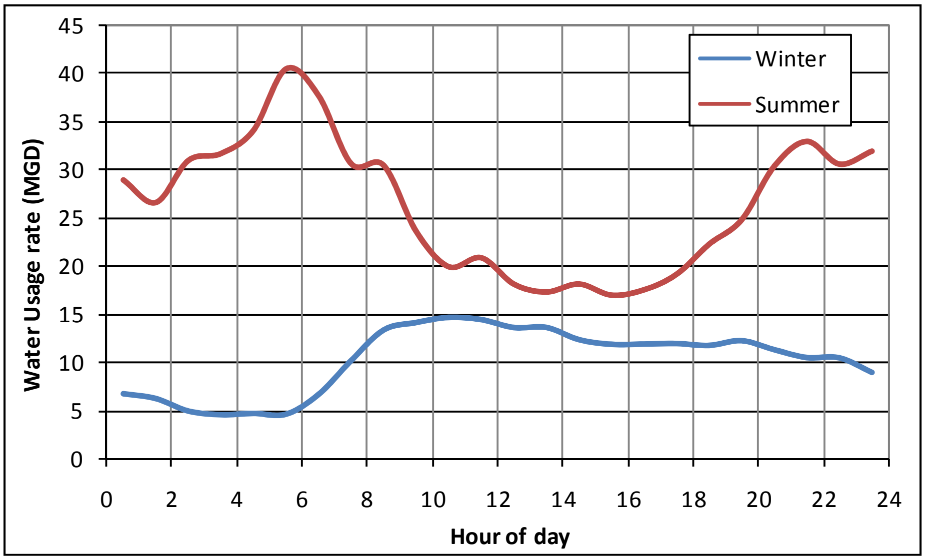


5.5.3 Peak Hour

The 2000 TWMP found that historic data from 1971 through 1989 had a 95th percentile peak hour to average day ratio of 4.45. More recent data were not available at that time for a peaking analysis. The TWMP concluded that the peak hour factor is highly variable and may not be following a downward trend. Therefore, a peak hour to average day demand factor of 4.4 was used.

For the WUMP, the diurnal pattern was evaluated as well as recent hourly water usage data to determine an appropriate hourly peaking factor. Due to changes in the City's data management, hourly data are only available back to June of 2006[19]. **Figure 2-12** shows the diurnal water usage pattern in Boulder during summer (June through August) and winter (November through February). The diurnal curve is substantially different depending on the time of the year. In the summer, the peak hour occurs between 5 and 6 in the morning at a rate of about 40 MGD, presumably when irrigation water usage is highest. Water usage peaks again in the evening, between 9 pm and midnight. During the winter, water usage is steadier throughout the day, with peak water usage of about 15 MGD occurring mid-morning.

Figure 2-12. Water Usage Diurnal Curve



For the period June 2006 through May 2010 the 95th percentile hourly water usage was 35.3 MGD, a peaking factor compared to the average day of 2.1. Since a relatively short period was analyzed (relative to the 1 in 20 year reliability criteria), the 99th percentile statistic was calculated as a point of reference. The 99th percentile of hourly water usage was 44.9 MGD, a peaking factor of 2.7. Since this peaking factor is close to the maximum day peaking factor, the historical data was reviewed again during the hydraulic modeling workshop held on July 1, 2010. Data review revealed a few peak hour data points above the 2.7 peaking factor. As a result, a peak hour peaking factor of 3.6 was selected as conservative for the planning period purposes.

5.5.4 Summary of Planning Period Peaking Factors and Flows

Table 2-15 presents a summary of the planning period peaking factors used for evaluation and analysis throughout the master plan.

Table 2-15. Planning Period Peaking Factors

Period	Peaking Factor[1]				
	2010	2015	2025	2035	Buildout
Minimum Day	0.6	0.6	0.6	0.6	0.6
Minimum Month	0.6	0.6	0.6	0.6	0.6
Peak Month	2.0	2.0	2.0	2.0	2.0
Peak Day	2.6	2.6	2.6	2.6	2.6
Peak Hour	3.6	3.6	3.6	3.6	3.6
[1] To be multiplied by average daily flow (ADF) to obtain flow value					

Table 2-16 presents a summary of the planning period flow rates based on the peaking factors from **Table 2-15**.

Table 2-16. Planning Period Flows

Period	Flow (MGD)				
	2010	2015	2025	2035	Buildout
Minimum Day	10.1	10.3	10.8	11.4	12.8
Minimum Month	10.1	10.3	10.8	11.4	12.8
Average Day	16.8	17.2	18.0	19.0	21.4
Peak Month	33.6	34.4	36.0	38.0	42.8
Peak Day	43.7	44.7	46.8	49.4	55.6
Peak Hour	60.5	61.9	64.8	68.4	77.0

5.6 Water Conservation Program

5.6.1 Overview

Based on recommendations in the 1988 City of Boulder's (City) Raw Water Master Plan (RWMP) and 1990 Treated Water Master Plan (TWMP), in 1990 City Council approved implementation of an enhanced water conservation program with the primary purpose of deferring the expansion of the Boulder Reservoir Water Treatment Facility (WTF). The Water Conservation Program was formally established in May 1992 to direct the efforts of reducing overall water consumption within the City of Boulder (Boulder) and specifically to reduce summer peak demand usage. The Water Conservation Program was designed to promote water conservation through voluntary measures that create a greater public awareness of the resource and encourage wise water use.

The Water Conservation Program was adopted by City Council as a single staff (one full-time equivalent) program and is currently managed under the Utilities Department in the Water Quality and Environmental Services (WQES) Group. Since the Water Conservation Program was initiated in 1992 it has been expanded beyond the initial scope of the program to address additional water conservation initiatives and support additional programs such as the popular water conservation rebate program.

The Water Conservation Program is supported under City of Boulder's (City) Boulder Revised Code (BRC). Changes to BRC regarding water conservation will be proposed to City Council in early 2011, as follows:

> ***Section 11-1-48: Water Conservation Program***
>
> The water conservation program will be an ongoing effort to promote efficient water use that is compatible with the City's water supply system, water resource management strategy and the values of the community. The water conservation program will create incentives for water conservation by users of the water supply of the City, to prevent unnecessary depletion of the raw and treated water supply of the City, to attempt to supply a continuing level of satisfactory service to existing water utility customers, and to insure the City's ability to meet the present and future basic water needs of the City's residents and will be implemented pursuant to the City of Boulder Water Conservation Plan.

Proposed changes to BRC Section 11-1-52 – Enforcement of Drought Response Measures, also supports the Water Conservation Program during a declared drought.

In June 2008 the Water Conservation Program Supervisor left the City and a process was initiated to fill the vacant position. In early 2009, prior to filling the Water Conservation Supervisor position, City management recommended not filling the position due to budget concerns and to re-evaluate filling the position in 2010. Currently, the Water Conservation Supervisor position is still vacant due to on-going budget concerns and the Water Conservation Program is being implemented through support from multiple WQES Group staff.

5.6.2 City of Boulder Water Conservation Limitations

Reducing water demand through water conservation efforts improves the City's ability to fill reservoirs in the spring reservoir fill season and reduces the rate of reservoir drawdown during the City's reservoir release season from about August until May. Therefore, water conservation efforts during certain times of the year enhance the City's ability to weather droughts by maintaining adequate storage reserves. However, in any given year, once the City's storage reservoirs are full and the City is meeting water needs through direct diversion of water from the stream, reductions in water demand from water conservation efforts have no benefit for susainability of the City's raw water supply. Savings from water conservation during the direct flow period reduces the amount the City diverts, but the City cannot store the savings for later use or assign the saved water to another use. Streamflow below the City's intakes would increase until the water reached the next headgate of an in-priority water rights owner able to make use of the water (SWMP, April 2009).

5.6.3 Water Conservation Futures Study

The 2000 Water Conservation Futures Study developed baseline water demands for the City's urban service area for the year 1995 based on monthly metered end use data. Various adjustments were made to accommodate factors such as annual weather variations and unaccounted-for water. Total demand and demand by various end use categories (sectors) was projected from the base year of 1995 through 2020. The study also developed demand projections for a number of water conservation scenarios of varying degrees of intensity.

City Council selected the Water Conserv ation Futures Study Comprehensive Conservation Scenario which was designed to address both indoor and outdoor water use patterns. The scenario was intended to result in a 10 percent reduction in total water use at build-out (approximately 2025) when compared to the Water Conservation Program structure that was in place in 2000, and about a 25 percent overall reduction in water use when compared to no conservation program being in place. Adoption of the Comprehensive Conservation Scenario required substantial revisions to the Water Conservation Program and an increase in annual funding to support various water conservation initiatives.

5.6.4 Water Savings Goals By Sector

The City's 2000 TWMP estimated water use reduction by sector to achieve the overall water use reduction goal set by the 2000 Water Conservation Futures Study Comprehensive Conservation Scenario. Utilizing elements of the Comprehensive Conservation Scenario, baseline water usage defined as 1994 through 1996 water use, and population and employment projections, water use reductions by sector were developed. Water use reduction targets, by sector, are as follows:

- 22 percent reduction in per-meter use for the single-family residential sector
- 26 percent reduction in per-meter use for multifamily residential sector
- 14 percent reduction in per-meter use for the commercial/industrial sector
- 1 percent reduction in overall municipal use
- 15 percent reduction in lost water

Achieving these targets was expected to reduce the overall annual water demand by approximately 19 percent at build-out as compared to water use at build-out absent the Comprehensive Conservation Scenario. The emphasis of the Water Conservation Program was modified to focus on water use reductions in each sector and resources were allocated as needed.

5.6.5 Water Budget Rate Structure

An additional water conservation goal of the 2007 implementation of water budget based rates was to have all water customers in the service area stay within their allocated water budget. The City had a flat water rate structure until 1988 when it first implemented as an increasing block rate structure. In December of 2004, the City Council adopted a new structure, the water budget rate structure, which was implemented in 2007. Beginning in January 2007, the City converted to a five-block rate structure based on established "water budgets" for each type of customer. As the amount of water use increases and moves into the next block, the cost per thousand gallons increases.

The water budget approach is a unique method of computing monthly water bills by giving each water customer monthly water budgets that are tailored to reflect each customer's indoor and outdoor water needs. The Water Conservation Program has been integral in assisting water customers with staying within their water budget by offering indoor and outdoor water conservation rebates and outdoor water audits. Some examples include supporting low-flow fixtures indoors and water efficient outdoor irrigation.

5.6.6 Water Conservation Plan

In 2009, the City updated the Water Conservation Program Water Conservation Plan to meet the requirements set by the Colorado Water Conservation Board (CWCB). The Water Conservation Plan was submitted to the CWCB for review and was approved by CWCB in August 2009. The Water Conservation Plan serves multiple purposes including: 1) complying with state law requiring water providers delivering 2000 acre-feet or more of retail water to submit a water conservation plan to the CWCB; 2) provide guidance in updating and implementing the City’s Water Conservation Program in a way that is compatible with the City’s water supply system, water rights, existing water conservation programs, water resources management strategy, and values of the community; and, 3) allow the City to pursue grants from the CWCB to support water conservation projects with some of the City’s largest water users.

The Water Conservation Plan includes information regarding the City’s historical and projected water demands and supplies. It also includes a discussion of the City’s water conservation goals and the greatest potential water savings through conservation, as well as a portfolio of conservation measures and programs. Implementation and monitoring methods are also addressed to assess the effectiveness of each measure and program.

5.6.7 Current Water Conservation Program Efforts

The Water Conservation Program is currently being implemented with a primary focus on the following activities and program.

5.6.7.1 Rebate Program

The water conservation rebate program has been in place since 1997 and includes residential and commercial rebate opportunities. Rebate items include low-flow toilets (1.28 gallons per flush or less), high efficiency (27 gallons per load or less) clothes washers, and residential and commercial irrigation systems and soil amendments. The annual rebate totals have ranged from a low of 112 rebates in 1997 to a high of 676 rebates in 2003. Since 2000, the Water Conservation Program has tracked rebate totals by rebate type and a summary is provided in Attachment A.

5.6.7.2 *Center for Resource Conservation*

The Water Conservation Program contracts with the Center for Resource Conservation (CRC) to provide assistance with three water conservation programs. A summary of these programs, and results for the year 2009, is provided below.

- **Slow the Flow Program.** This program includes a free residential irrigation water audits for Boulder residents receiving City water. In 2009, 98 residential irrigation audits and five Home Owner Association (HOA) irrigation audits were performed in the City of Boulder.

- **Water Wise Plant Sale,** which includes Garden-in-a-Box, Garden Essentials, and Trees Across Boulder.

  - **Garden-In-A-Box** is a program that provides low-cost, professionally designed, pre-planned xeric gardens to Boulder residents. Three designs are made available to choose from. Each garden includes a design layout, 30 or more plants and some helpful tips about xeriscape gardening, including planting and maintenance instructions for all of the plants. In 2009, 159 Garden-In-A-Box were sold.

  - The **Garden Essentials** program takes the Garden-in-a-Box concept one step further, and in addition to supplying the plants, CRC also offers the option to purchase low-cost mulch, compost, and drip irrigation systems, all of which are necessary components for creating a successful water-wise garden. In 2009, 106 Garden Essentials kits were sold.

  - Through the **Trees Across Boulder** program, eight different tree species chosen by the City's Urban Forestry Department for their ability to thrive in Boulder, are made available to Boulder water customers. In 2009, 90 trees were sold.

- **Water Wise Landscape Seminars.** The Water Wise Landscape Seminar series focuses on helping Boulder residents increase water use efficiency, adhere to best management practices, and reach conservation goals. In 2009, 170 Boulder residents attended the Water Wise Landscape Seminars.

5.6.7.3 *Public Information and Outreach*

In 2009 water conservation information and outreach efforts were revised to focus less on Water Conservation Program advertising through magazines and journals and more on working with the City's largest water users, teaming with other local efforts and enhancing public education and outreach in the community. Advertising efforts are evaluated each year to ensure the water conservation message supports current water conservation goals and the location of advertisements (magazines, etc.). Outreach efforts vary from direct contact with the public through school programs and the annual Boulder Water Festival to providing specific water conservation messages utilizing City utility bill inserts. Substantial outreach efforts have also focused on two of the City's largest water users, the University of Colorado (CU) campus and the Boulder Valley School District (BVSD). Multiple meetings have been held with CU facilities and sustainability staff to identify joint City and CU efforts to implement and promote water conservation on and off campus. Water conservation efforts have focused on promoting rebates and providing educational information and presentations. The City is also working with BVSD on a grant funding opportunity through the CWCB utilizing the City's approved Water Conservation Plan.

The City has also coordinated with groups like Boulder County Longs Peak Energy Conservation program to implement water conservation into Energy Sweeps Programs held in the City of Boulder. The Water Conservation Program is currently working with the City's Local Environmental Action Division to continue developing partnerships which help synergize the overlap between energy and water conservation efforts.

5.6.7.4 *Commercial, Industrial and Institutional Water Use Study*

Of the City's approximate 29,000 water billing accounts 2,000 are Commercial, Industrial, and Institutional (CII) accounts. Based on 2004 through 2008 water use data, the CII customer class used an average of 26 percent of the City's total water sales. Compared to the residential sector, less is known about the water use characteristics of the CII sector since it has dissimilar customers with regard to the purpose of water use. The historic lack of benchmark measurements of the quantity of water used, or needed, for a particular type of CII customer makes it difficult to design a CII water efficiency program that can be integrated into a water billing system, such as the City's water budget rate structure, or a water conservation program.

In late 2009, City staff initiated a phased approach to completing a CII water use study to better characterize water use patterns and evaluate possible options for developing sector-specific water use efficiency benchmarks. Phase I work included the following:

- Compilation and Review of Existing CII Water Use and Benchmark Information
- Evaluation of the City of Boulder's Utility CIS Billing System CII Sector Information
- Select CII Sector Sub-Categories for Further (Phase II) Evaluation

Phase II will be initiated in early 2011 and will focus on evaluating data and information gathered under Phase I and possibly perform a Pilot Study to collect account-specific data for the selected sub-categories. Efforts will focus on gathering additional information from a sub-set of the selected sub-categories through site visits and audits and developing and implementing methodologies to evaluate available data and information to develop appropriate efficiency benchmarks. Benchmarks should reflect the quantity of water used in specific CII sector sub-categories which allow the business to perform its required functions, while incorporating business growth, with the efficient use of water. The following activities will also be considered under Phase II.

- Identify customers within each sub-category evaluated that may currently be implementing efficient water use practices and are already at, or close to, an efficiency benchmark level of water use.
- Evaluate appropriate normalizing factors to be used in evaluating collected data and information. Normalizing factors should focus on data and information from multiple customers in the same sub-category that can be used for other accounts in the same sub-category.
- If possible, disaggregate indoor water uses into individual end-use categories (toilet/urinal flushing, sinks, showers, etc.).
- Evaluate options for developing efficiency benchmarks for CII sector sub-categories.
- Develop efficiency benchmarks for CII sector sub-categories.
- Determine CII sectors and or sub-categories for additional City water conservation support.

It is anticipated that Phase II will be completed in late 2011, and the project completed in 2012.

5.6.7.5 *Grant Funding*

Pursuant to the CWCB's approval of the City's Water Conservation Plan in 2009, the Water Conservation Program is now eligible to apply for CWCB Water Efficiency Grants. The CWCB offers four types of Water Efficiency Grants, including:

- Water Conservation Planning Grants
- Water Conservation Implementation Grants
- Drought Mitigation Planning Grants
- Water resource Conservation Public Education and Outreach Grants

The City plans to pursue CWCB grants as opportunities arise. Currently, the City is working to support the CII water use study along with goals outlined in the Water Conservation Plan by applying for a Water Conservation Implementation Grant from the CWCB. The proposed project will work with Boulder Valley School Districts, the City's fourth largest water user, to reduce water consumption in two key schools.

5.6.8 Water Conservation Accomplishments

Water conservation in Boulder has been a major driver in the City's ability to defer capital improvements at water treatment facilities and to achieve water savings goals that support the Comprehensive Conservation Scenario developed as part of the 2000 Water Conservation Futures Study, and adopted by City Council. Water conservation efforts, along with other factors such as climate and the Water Budget Rate Structure, which incorporates water conservation measures, have impacted water use and the need for capital projects.

5.6.8.1 Status of Water Conservation Goals

Baseline water use and water conservation goals, by sector, were developed as part of the 2000 TWMP and the overall water use reduction goal set by the 2000 Water Conservation Futures Study Comprehensive Conservation Scenario. Percent water use reduction goals, by sector, are discussed in Section 4.3, above. **Table 2-17** summarizes the baseline water use, water use conservation goal and current water use. For most sectors the conservation goals have already been exceeded. Total municipal water use has slightly increased in total, but has decreased per capita. Although it appears that the single family sector goals have not been met, this is likely due to differences in how the population is counted compared with how water use is tracked. The initial projection for meeting the water conservation goals was by buildout, which was defined as the year 2025 in the 2000 TWMP.

Achieving the water conservation goal for each sector is expected to generate an overall water use reduction of 19 percent at build-out as compared to water use at build-out absent the Comprehensive Conservation Program. Per capita water use at build-out is expected to be greater than 2007 levels due to increases in the jobs to population ratio, but will be less than without the Water Conservation Program.

Table 2-17. Baseline and Current Water Usage Compared to Conservation Goals (gallons per unit per day)

Sector	Baseline[1]	Conservation Goal	Current[2]	Units
Single Family Residential	148	115	117	Gallons per person per day
Multifamily Residential	90	67	62	Gallons per person per day
Commercial/ Industrial	62	53	50	Gallons per employee per day
Municipal	646,000 (6.0)	640,000 (5.9)	665,000 (5.9)	Gallons per day (gallons per capita per day)
Unaccounted for	1,695,000 (15.7)	1,440,000 (13.4)	1,110,000 (9.8)	Gallons per day (gallons per capita per day)
Total production	186	149	147	Gallons per capita per day

*For additional detail on water use and water use projections see Volume 2, Section 5, of the Water Utility Master Plan.
[1] Baseline water use is based on water use from 1994 through 1996.
[2] Current water us is based on water use from 1996 through 1999.

5.6.8.2 Delays in Capital Improvement Projects

In the 1990 TWMP recommendations were made to increase the Boulder Reservoir WTF capacity by 10 million gallons per day (mgd) by 1994 at a cost of over $12,000,000 if water conservation measures were not implemented. Through implementation of effective water conservation measures, and other factors, such as water budgets and weather, expansion of the Boulder Reservoir WTF was delayed until 2005 when the City completed an expansion from 8 mgd to 16 mgd firm capacity. This was an 11 year delay in capital costs to expand the WTF and the expansion is expected to meet City of Boulder water needs through build-out. Delays in capital improvements at the Betasso WTF have also occurred.

5.6.9 Water Conservation Program Recommendations

An overarching goal for future Water Conservation Program efforts is to tailor water conservation to the City's unique water system and focus on the nexus between water and energy conservation, and to support water related environmental enhancements. At the tap level this will include a re-evaluation of current programs to align them with stated goals. On a planning level this will include Water Conservation Program support for using less west slope water supplied through the Colorado Big Thompson and Windy Gap projects which minimize energy intensive west slope to east slope water transfers and help conserve westslope water. Water conservation measures that support maximizing raw water use from the Boulder Creek watershed will also be considered to support additional hydroelectric power generation throughout the City's system. It should be recognized that future water conservation measures of this kind may be limited due to the City's water rights, structure of the raw water system and location of water treatment facilities.

Fill Vacant Water Conservation Supervisor Position. Since June 2008, the Water Conservation Supervisor position has been vacant and the Water Conservation Program has been jointly managed by multiple WQES Group staff. Due to budget constraints, approval to fill the Supervisor position has not been granted and the Water Conservation Program is being implemented at a reduced level. In the August 2010 the Colorado Water Wise *Guidebook of Best Practices for Municipal Water Conservation in Colorado* was released and was developed to promote and facilitate the efficient use of water in Colorado and was funded by the CWCB. One of the 14 Best Practices in the guidebook is to have a Conservation Coordinator which is responsible of managing an entities water conservation program and implementing water conservation efforts to meet water conservation goals of the community and the State of Colorado. For larger communities, such as Boulder, it is recommended that the Conservation Coordinator position be a full time position.

It is recommended that the City hire a full time Water Conservation Program Supervisor to adequately manage the Program and effectively implement water conservation measures in Boulder. The Water Conservation Supervisor will have the responsibility of making sure the Water Conservation Program meets the current and future water conservation needs of Boulder and the City.

Continue to Fund the Water Efficiency Fund. The Water Conservation Program Water Efficiency Fund was initiated in 2003 and implemented through 2009. The goal of the Water Efficiency Fund was to provide matching funds for City projects which focused on water savings. All City Departments were eligible for funds at a rate of a 50/50 match. In 2010, the Water Efficiency Fund was eliminated due to limited funding, but was reinitiated in 2011 at a level of $50,000. It is recommended that the Water Efficiency Fund continue to be funded at a minimum of $50,000 per year. The program should also be evaluated annually and modified as needed to meet City facility water use goals.

It is also recommended that a funding matrix be developed to prioritize projects and distribution of the Water Efficiency Fund budget. The matrix can be based on factors such as total water savings, block 4 and 5 water users, achieving specific water savings goals (department or City-wide), size of the project (financially or physically), ability to further leverage the project for additional water savings and the potential for energy savings.

Evaluate Municipal Water Use and Support Water Use Reduction Measures. In 2008 water budgets were developed for municipal (City) accounts, which include City facilities, departments, divisions, work groups and or funds. Currently, municipal accounts are not charged for water, but the goal is to have all municipal accounts stay within their water budget. A pilot project was initiated in mid 2008 to evaluate municipal account water usage compared to water budgets with an emphasis on encouraging efficient operations and reduce water usage, specifically in blocks 4 and 5 (i.e., penalty blocks). The Water Conservation Program should assist those City facilities that have water use in blocks 4 and 5 through technical and public awareness support, and utilize the Water Efficiency Fund.

Evaluate Existing Water Conservation Rebate Program. Currently, the City provides rebates for residential and commercial accounts for the following items:

- Toilets (HET- high efficiency toilets with 1.28 gallons per flush, or less)
- Washers (high efficiency washers with 27 gallons per load, or less)
- Irrigation systems (multiple components)

Since 1994, only low flow toilets with a 1.6 gallon per flush (gpf) rate or less have been available through retail sale. An evaluation should be completed to determine if the City should continue to offer toilet rebates since higher water use toilets are no longer available through the retail market. The evaluation should consider, to the degree possible, whether the number of old toilets (greater than 1.6 gpf) being replaced would decrease if rebates were not available.

A process should be developed to track what type of toilets (gallons per flush) are being replaced when a rebate is requested. This information will help make a determination of how many low flow, or high efficiency, toilets (including WaterSense approved or waterless urinals) are being replaced and a rebate requested, and whether rebates should be offered for the replacement of a toilet with similar or equivalent water use.

Currently, a large majority (85 percent) of the annual water conservation rebates, support indoor water conservation. Shifting the rebate, and general Water Conservation Program focus, to outdoor water savings should be evaluated since peak water use is driven by outdoor watering during the irrigation period. Further indoor water use reductions can be considered “passive savings” that could continue with little or no rebate support due to the fact that most water using devices currently available are already considered to be water efficient.

Consideration should also be given to adding additional rebate options, which could include:

- Low-flow shower heads
- Faucet aerators
- Efficient landscape design
- Rain sensor-based controls for irrigation systems
- Commercial or industrial water audits conducted by a certified professional
- Low-flow Pre-Rinse Spray nozzles
- Prevention of Once-Through Water Use (i.e., Cooling Towers, Ice Makers, etc.)

Automate Existing Water Conservation Rebate Program Process. Water conservation program rebates are a known cost and as such can be budgeted for and evaluated by a cost-benefit ratio. However, rebate processing time represents a hidden cost inherent in each rebate processed. Staff estimate that each rebate takes an average of 20 minutes to process when standard rebate processing are combined with the multiple rebates which are incorrectly filled-out or lack the necessary attachments which often requires lengthy customer follow-up. Additionally, there are costs associated with the financing department "cutting" rebate checks to customers. Reducing these processing costs would maximize Water Conservation Program effectiveness as time and money currently spent on rebates could be recaptured and used to support additional programs.

Currently, the Water Conservation Program is evaluating a computer program which would allow customers to complete rebates on-line and would require customers upload necessary documents before a rebate could be submitted. Additionally, the Water Conservation Program is working with the City's Financing Department to see if rebates can be added as credits to customer's accounts to eliminate costs associated with sending rebate checks to customers. It is recommended that the Water Conservation Program move forward with both efforts to increase the efficiency of the water conservation rebate program.

Water Budget Rate Structure Education. A significant water conservation development was the adoption of the water budget rate structure in 2007. A great deal of information has already been disseminated regarding the rate structure and it is important that the information continues to be refined and provided to water customers so they understand the importance of using water efficiently and staying within their water budget.

Evaluate Control of System Water Loss. The City's water distribution system water loss rate is approximately 10 percent. Currently, there are no state or national standards for water loss and water loss goals are typically set to meet in-house goals or standards. The CWCB, in their Statewide Water Supply Initiative *2010 Municipal and Industrial Water Conservation Strategies Report*, recommends that "real" water loss should be in the range of 6 to 7 percent. Water losses can be considered a "real" water loss (leaks or other problems in the system) or an "apparent" water loss (meter inaccuracy, unauthorized consumption, data evaluation errors), and the methods of correction will differ between the two types of losses. The benefits of reducing system water loss are multiple, including financial savings, raw water conservation, enhanced drought preparedness and setting an example for the public**.**

It is recommended that the Water Conservation Program support (staff support or monetarily) conducting a leak detection study initially focusing on known water loss areas within the distribution system. Utility costs for water loss control vary depending on the level of lost water and the cost of repairs to reduce or eliminate water leaks. It is suggested that a two step process be implemented, which includes conducting a Water Audit then conducting a Water Balance. It is recommended that the American Water Works Association (AWWA) 2009 *Water Audits and Loss Control Program Manual of Water Supply Practices (M36)* be used as guidance for performing a Water Audit and Water Balance whether the study is conducted internally or contracted. A free ™Excel-based program from AWWA is available for internal, or contractor use, and can be used as a starting point in any water loss study.

Develop a Monitoring, Evaluation and Reporting Program. To ensure that the Water Conservation Program is accomplishing established goals, a monitoring evaluation and reporting program should be established. Efforts should focus on quantifying water savings through the water conservation rebate program, for both indoor and outdoor rebates, and outdoor water audits performed through the Slow-the-Flow Program. Reports should be developed annually and submitted to Public Works Utilities and the

Water Resources Advisory Board. The reports should include recommendations for making adjusts to the Water Conservation Program to meet the needs of the City and its water customers.

Evaluate and Enhance Raw Water Irrigation Opportunities. Additional opportunities to use raw water for irrigation purposes, for the City and non-City entities, should continue to be evaluated in a joint effort with the City's Water Resources Group and the Parks and Recreation Department. Initial steps have already been taken to identify potential sites for raw water irrigation by matching a location, such as a park, with a stream or irrigation ditch in close proximity. In some cases the available water right may not allow the intended raw water irrigation use and legal action may be required to change the use. Water Conservation Program efforts, and the use of the Water Efficiency Fund, should focus on projects that would require limited legal action, if possible.

Develop City-Wide Water Conservation and Water Conservation Program Goals. Water conservation is not an end in itself and water providers should specify how water conservation fits with the needs of the water system and its customers. Often this means setting goals for achieving water savings that an entity identifies as being either:

- Required to balance future water demand with future available water supply; or

- Cost-effective based on the incremental or marginal costs of new water supplies.

Other benefits of water conservation may be incorporated into goal statements. In all cases, water conservation goals should provide a "yardstick" for measuring the effectiveness of the conservation plan's implementation. Setting goals related to the amount of water that "will be saved" through future conservation efforts is a requirement of the Water Conservation Act of 2004. Goals should be stated in terms that are measurable, achievable, and reasonable, and have a specific time frame plus be relative to water system conditions and anticipated water demand by sector.

As discussed in Section 4.6.1 above, the City is close to achieving, or has already achieved, water use goals by sector which were developed for a 2025 build-out date. The Water Conservation Program has also developed and implemented successful water conservation strategies that have meet the initial intent of the Water Conservation Program. New City-wide water use goals, by sector, should be considered and support updated water demand forecasting that will be performed using results of this Water Utility Master Plan. Water use goals should also consider, and account for, refinements to water budgets for the multi family and commercial, industrial and institutional sectors that are currently being evaluated.

Community involvement should also be part of the water conservation goal setting process and can involve representatives of various groups in the community (or stakeholders). Community involvement emphasizes an open process that involves potentially affected groups so that they can have an opportunity to express their interests and concerns. Involving the community in goal development also serves an important public education function. Moreover, it is widely believed that involving the community in developing goals, as well as in the implementation process, can greatly enhance the success of conservation programs. Members of the community who might be interested in water conservation include:

- Residential water consumers
- Commercial water consumers
- Industrial water consumers
- Wholesale customers
- Environmental groups

- Business and commerce groups
- Recreational water users
- Agricultural users
- Educational institutions
- Government agencies

In addition, community participants also can have an ongoing role in the implementation of the selected conservation measures and programs. Ongoing involvement can help maintain and build support for achieving conservation goals and can help "get the word out" about the conservation effort. Participants can act as a focus group for exploring specific conservation measures and/or programs and can also provide valuable linkages to key groups—consumers, businesses, and institutions—who might be involved in implementing certain conservation measures.

Table 2-18. Water Conservation Rebate Program Summary – 2000 through 2009

Rebate Type	Year									
	2000		2001		2002		2003		2004	
	Dollars	Total Number	Dollars	Total Number	Dollars	Total Number	Dollars	Total Number	Dollars	Total Number
Residential Washer	$34,200	342	$38,900	389	$29,625	390	$38,475	513	$30,000	400
Commercial Washer	$0	0	$0	0	$0	0	$1,125	15	$450	9
Residential Toilet	$0	0	$0	0	$0	0	$6,000	120	$5,500	110
Commercial Toilet	$0	0	$0	0	$0	0	$0	0	$450	18
Irrigation System and Soil Supplements	$2,505	15	$5,428	23	$5,295	17	$15,265	28	$7,300	72
Total for Year	**$36,705**	**357**	**$44,328**	**412**	**$34,920**	**407**	**$60,865**	**676**	**$43,700**	**609**
Rebate Type	**Year**									
	2005		**2006**		**2007**		**2008**		**2009**	
	Dollars	**Total Number**	**Dollars**	**Total Number**	**Dollars**	**Total Number**	**Dollars**	**Total Number**	**Dollars**	**Total Number**
Residential Washer	$21,225	284	$22,625	302	$23,775	317	$31,050	414	$24,075	321
Commercial Washer	$23,625	189	$9,600	18	$0	0	$750	3	$550	4
Residential Toilet	$300	4	$1,650	21	$4,275	55	$12,700	141	$15,520	207
Commercial Toilet	$0	0	$0	0	$738	7	$750	2	$2,900	16
Irrigation System and Soil Supplements	$4,932	21	$8,039	54	$14,308	54	$12,259	82	$8,921	72
Total for Year	**$50,082**	**498**	**$41,914**	**395**	**$43,096**	**433**	**$57,509**	**642**	**$39,656**	**620**

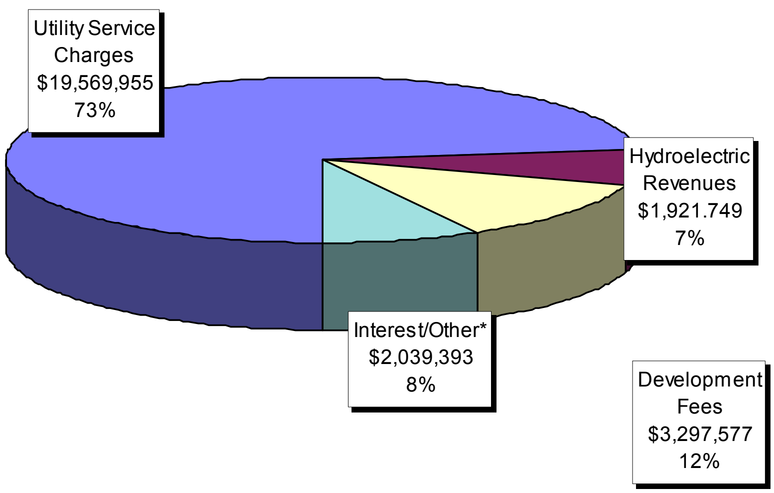
6 Finance and Administration

The following sections present a discussion of various administrative and financial aspects of the City's Water Utility.

6.1 Sources of Funds

The Water Utility is funded primarily through monthly user fees which account for approximately 73% of annual water revenues. Other significant revenue is derived from plant investment fees, interest on investments, sale of hydroelectric power and bond proceeds. The sources of funds are depicted in the figure below.

Figure 2-13. Average 2006-2009 Sources of Funds ($26,828,674)



*Excludes 2006 Lakewood Settlement of $19.5 million, and 2007 Bond refunding of $25.9 million

6.1.1 Monthly User Charges

Monthly water charges consist of a fixed service charge that is based on meter size and inside or outside City classification, and a consumption charge based upon metered water use. The consumption charge consists of five rate blocks. As the amount of water use increases and moves into the next rate block, the cost per thousand gallons of water increases. This increasing block rate structure is used to encourage the efficient use of water.

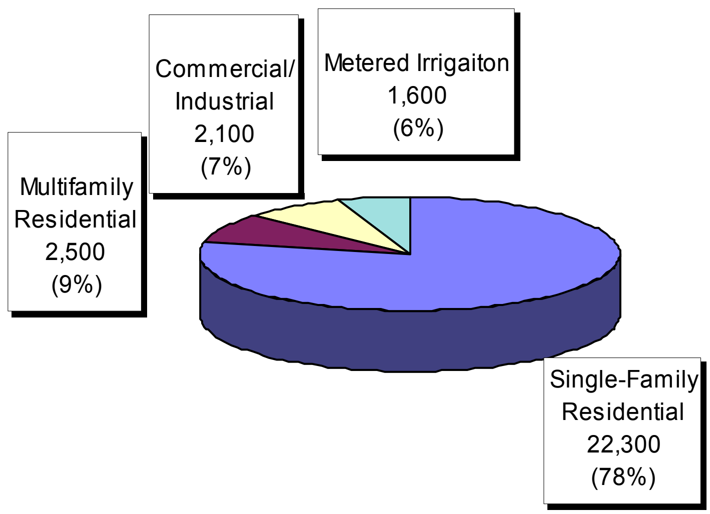
In 2007, the City began using monthly water budgets to determine the appropriate rate block to be used for billing. A monthly water budget is developed for every customer using criteria such as number of people in the household, historic usage and specific irrigable area. The budgets for residential customers and irrigation-only accounts are shaped throughout the year to reflect outdoor watering patterns. Water use above a monthly water budget is billed at increasingly higher rates than water use that is within a monthly water budget. The block rate structure for the quantity charge portion of the water bill is shown in the following table.

Table 2-19. Water Quantity Charges - Block Rate Structure

	Rate Per 1,000 Gallons	Water Usage (Gallons) Billed in Each Rate Block
Block 1	¾ the Block 2 Rate	Usage up to 60% of the monthly budget
Block 2	Block 2 Rate	Usage between 60-100% of the monthly budget
Block 3	2 times the Block 2 Rate	Usage over monthly budget up to 150% of monthly budget
Block 4	3 times the Block 2 Rate	Usage between 150% and 200% of monthly budget
Block 5	5 times the Block 2 Rate	Usage over 200% of monthly budget

The City of Boulder currently has 28,500 water accounts that are identified by four major customer classes or account types. Accounts by customer class are shown in the figure below.

Figure 2-14. Number and Percent of Water Customers by Customer Class



6.1.2 Plant Investment Fees

Plant Investment Fees (PIFs) are system development fees charged to new and existing customers who need additional utility service to recapture initial capital investments into the water utility infrastructure. In 2009 PIF revenues accounted for 12% of annual water revenues.

PIFs were recently reviewed in 2008-2009 and were revised to reinforce the goals and objectives of the water budget rate structure. The water utility infrastructure inventory and valuation was also reviewed and updated. PIFs meet the requirements of Colorado Revised Statutes for Impact Fees (§ 29-20-104.5).

PIFs are established using the buy-in methodology which results in new customers paying their proportionate share of the costs of facilities required to serve them. The fees are dependent on the capacity required to serve a customer and the unit cost of existing facilities expressed as dollars per unit of capacity.

6.1.3 Other Revenue Sources

The water utility also receives about $2 million annually from the sale of hydroelectric power that is generated from its eight hydroelectric facilities. Other miscellaneous revenue sources include interest earnings, sale of goods and capital assets and special assessments. Major capital projects and improvements are sometimes funded by issuing revenue bonds.

6.1.4 Comprehensive Rate Study Updates

Comprehensive rate reviews by an outside consultant occur approximately every five to seven years:

- Water Rate Study (as part of the implementation of water budgets), Red Oak Consulting, 2006
- Plant Investment Fee Study, Red Oak Consulting, 2008

6.2 Administration

The Water Utility is administered by the City's Public Works Department – Utilities Division.

6.2.1 Organizational Structure

Primary work groups in the Water Utility include:

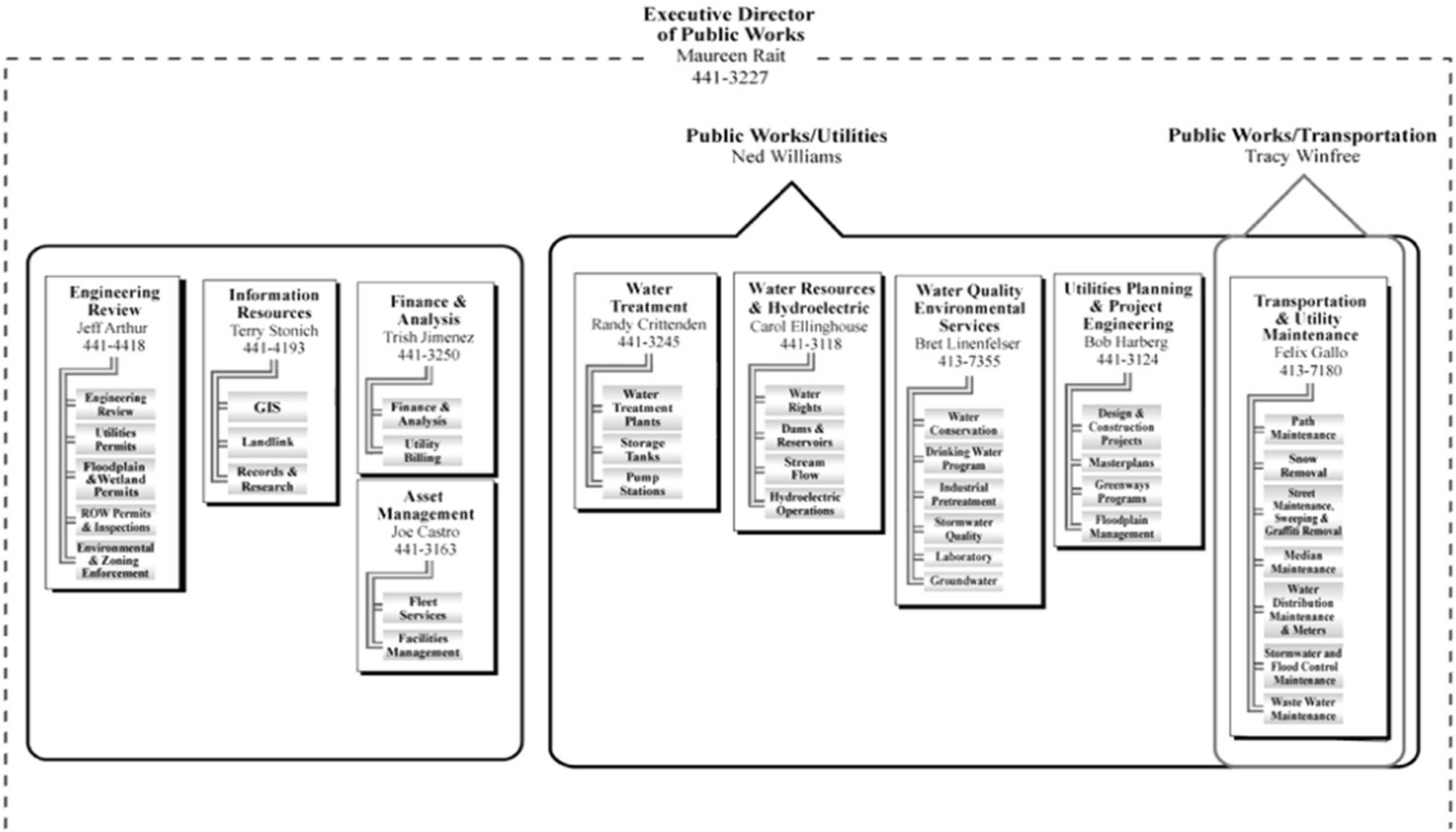
- Water Resources and Hydroelectric Operations
- Water Treatment Operations
- Water Quality and Environmental Services
- Utilities Planning and Project Management
- Utilities System Maintenance

Other work groups in the Public Works Department that support the Water Utility include:

- Information Resources
- Finance and Analysis (includes Utility Billing)
- Engineering Review
- Asset Management

The figure below presents the organizational structure for work groups that support the Water Utility.

Figure 2-15. Public Works Department Organization Structure



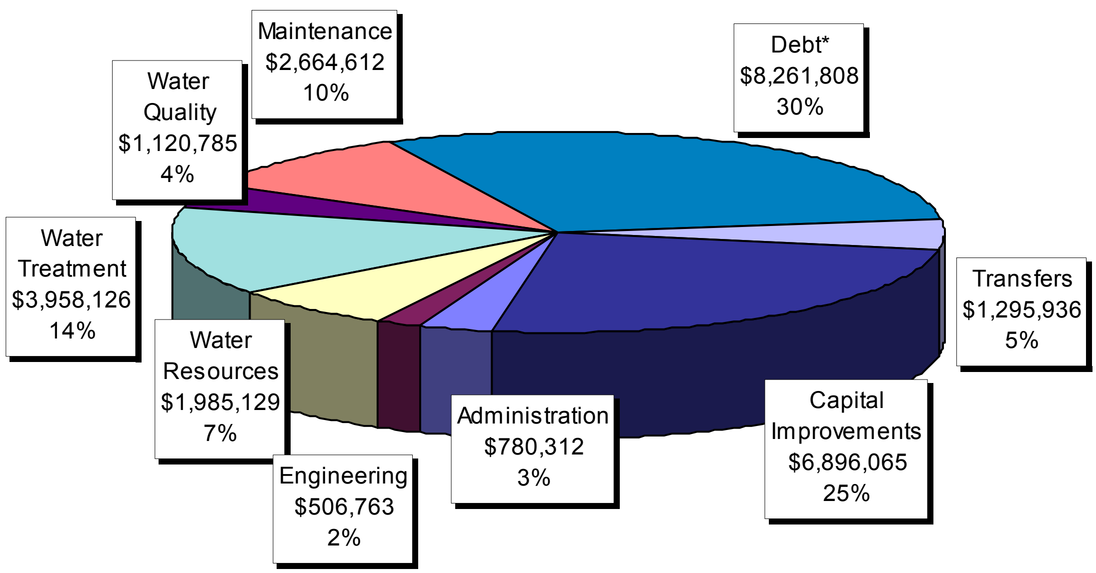
6.2.2 Enterprise Status

The water utility, which is predominantly self-supported by user charges, is established as an enterprise fund designed to separately finance and account for its facilities and services. Per the Boulder Revised Code, it is intended that the Water Utility shall at all times and in all ways conduct its affairs so as to continue to qualify as a "water utility enterpise" within the meaning of Section 37-45.1-102, C.R.S. and as an "enterprise" within the meaning of Article X, Section 20 of the Colorado Constitution. Specifically, but not be way of limitation, the Water Utility is not authorized and shall not receive ten percent or more of its annual revenue in grants.

6.2.3 Use of Funds

Funds are allocated to the various functions of the Water Utility as summarized in the figure below.

Figure 2-16. Average 2006-2009 Uses of Funds ($27,469,536)



*Excludes 2007 bond refunding of $30.3 million

6.2.4 Asset Valuation

Assets are compiled and updated periodically to support financial reporting requirements. The following table summarizes the asset valuation of the City's Water Utility as of 2007 (*Source: Water, Wastewater, and Stormwater Plant Investment Fees Study, June 2008*).

Table 2-20. Asset Valuation of the City's Water Utility

	Asset Valuation			
Description	Original Cost	Replacement Cost	Accumulated Depreciation at RC	Replacement Cost Less RCLD
Water Rights Land	$30,654,000	$30,654,000	-	$30,654,000
Water Rights	$363,419,000	$363,419,000	-	$363,419,000
Total	**$394,073,000**	**$394,073,000**	**$0**	**$394,073,000**
Land	$238,022,704	$238,022,704	-	$238,022,704
Water Services	$96,908,414	$120,259,939	$21,890,692	$98,369,247
Boulder Reservoir WTP	$28,129,023	$59,234,126	$25,075,720	$34,158,406
Storage Reservoirs	$7,180,093	$42,774,165	$25,072,467	$17,701,699
Hydroelectric Plants	$13,558,209	$57,670,110	$33,438,756	$24,231,235

Description	Asset Valuation			
	Original Cost	Replacement Cost	Accumulated Depreciation at RC	Replacement Cost Less RCLD
Betasso WTP	$42,734,974	$106,066,814	$51,423,486	$54,643,328
Hydrants	$5,426,832	$14,550,252	$6,437,704	$8,112,549
Vehicles	$0	$0	$0	$0
Valves	$3,728,665	$9,764,470	$4,340,560	$5,423,910
Treated Distribution Mains	$165,053,358	$480,759,569	$226,749,107	$254,010,462
Treated Water Storage Tanks	$4,781,553	$29,685,371	$20,582,371	$9,103,000
Treated Water Pump Stations	$415,303	$1,398,135	$1,024,939	$373,196
Non-Plant Equipment	$0	$0	$0	$0
Buildings	$1,050,765	$3,325,622	$1,907,980	$1,517,642
Computers	$0	$0	$0	$0
Raw Water Transmission Lines	$50,340,446	$652,492,305	$11,899,940	$50,592,365
Total Backbone Facilities	**$657,330,339**	**$1,226,003,582**	**$429,743,749**	**$796,259,833**
Less:				
Developer Contributions	$0	$28,710,120	$13,541,060	$15,169,060
Outstanding Principal	$6,460,000	-	-	$6,460,000
BRWTP 1996 Revenue Bond: Refunding in 2005	$24,960,000	-	-	$24,960,000
2007 Refunding of the 1999 and 2000 Revenue Bonds	$22,495,000	-	-	$22,495,000
Total Contributions and Liabilities	**$53,915,000**	**$28,710,120**	**$13,541,060**	**$69,084,060**
Net System Investment	**$997,488,339**	**$1,591,366,462**	**$416,202,689**	**$1,121,248,773**

In accordance with the City's revised asset valuation procedures, asset values will be updated yearly using the Engineering News Record (ENR) Cost Index for Denver. The ENR index is deemed to represent cost factors affecting the replacement cost of the city's water utility infrastructure assets. Periodically the asset values will be updated more comprehensively using more sophisticated construction cost estimating techniques.

6.2.5 Budgeting and Accounting

This City's fiscal year coincides with the calendar year. Annually staff prepares a six-year planning spreadsheet that includes projected revenues and expenditures for both operations and capital projects. Any future needed increases in monthly utility rates or bond issuances are identified. For the upcoming fiscal year a detailed budget is also prepared. While the six-year planning spreadsheet is presented to City Council, they only adopt or authorize the budgeted expenditures for the next fiscal year.

Beginning in 2011 the City-wide budget is developed using a priority-based budgeting approach that scores or rates individual program to community defined results (or goals) to ensure resources are being allocated to areas deemed most important to the community. Budget proposals are reviewed and modified by successive levels of management within the department until a final proposal is approved by the Executive Director of Public Works. The department budget proposal is then submitted to the Water Resources Advisory Board and the Planning Board for their review and recommendation. The City Manager considers these recommendations, along with public comment, before submitting the staff recommended budget to City Council, which makes the final determination regarding the budget. While the Water Utility's budget is developed in a cohesive manner (e.g.,programs or projects that affect more than one utility fund or City department), the water utility's budget is entirely independent since it relies upon separate revenues and is maintained as a separate accounting entity.

The planning period inflation rate for budgeting purposes is assumed to be 3% per year. This assumption is based on historic records of the ENR Cost Index for Denver. The ENR index has escalated at a normalized rate of over 3 percent per year for the last 10 (3.42%), 20 (3.72%) and 30 (3.90%) year periods of time. It is anticipated these trends will continue in the future. The assumed rate of inflation should be reviewed annually and adjusted as appropriate.

6.2.6 Yearly Audit

The City Charter and State Law require that an audit of City financial records be conducted each year by an independent certified public accountant. After the audit is complete a Comprehensive Annual Financial Report (CAFR) is finalized.

6.2.7 Revenue Bonds

The Water Utility may issue revenue bonds for major capital projects and improvements. City Council can approve the issuance of bonds without voter approval. Revenues from both the City's Water and Wastewater Utilities are typically cross-pledged for repayment of any bonds issued for the Water Utility.

Net revenues (total gross revenues minus operating expenditures) before debt service shall be at least equal to 1.25 times its debt payment requirements on an annual basis. These debt service coverage requirements are established as part of the utility's bond covenants.

The current ratings for the Water and Wastewater Utility revenue bonds are Aa1 from Moody's and AAA from Standard and Poor's. These are excellent ratings for this type of bond in Colorado. Credit ratings are made after analyzing the credit worthiness of the issuer and the quality of the bond being issued. The ratings are then used by potential buyers of the bonds as one of the determinations in whether they will purchase the bonds or not. The highest investment grade rating given is AAA and the lowest is BBB.

Current outstanding bonds related to Water Utility projects are summarized in the following table:

Table 2-22. Outstanding Bonds

Project	Outstanding Principal as of December 2010	Year Bonds Paid Off
Improvements to the Boulder Reservoir WTF	$4,540,000	2016
Misc projects: Silver Lake Pipeline, Betasso WTF, Automated Meter Reading and Caribou Ranch	$17,910,000	2019
Reconstruction and Replacement of Lakewood Raw Water Pipeline	$18,705,000	2021

6.2.8 Reserve Policies

The recommended rate and financial plan for the Water Utility is designed to fund programs and projects, satisfy debt service coverage requirements and maintain required reserves. Reserves are established for bond issuances, employee compensation liabilities, emergencies/stabilization and special purposes.

A review of the various financial reserve levels for each of the City's three utilities was conducted in 2006 by Red Oak Consulting and is documented in the Utility Reserves Analysis and Survey, January 2007. The review included a survey of the reserve policies of ten other utilities in the Front Range and Southwestern United States. Based on the study's findings, the water utility maintains a 25% operating reserve and a separate capital reserve. The amount of the capital reserve is based on the minimum annual renewal replacement costs for capital. The capital reserves are initially set at $2,000,000 for the Water Utility.

Having both an operating and capital reserve provides greater financial stability and flexibility should emergencies or revenue shortfalls occur. Water revenues can be significantly lower during either a very wet or very dry year and it is financially prudent to have reserves available. In addition, bond rating agencies generally favor higher reserve levels and this can contribute to higher bond ratings.

6.2.9 AWWA Performance Indicators/Benchmarks

In 2005, the American Water Works Association (AWWA) developed a report called Benchmarking – Performance Indicators for Water and Wastewater Utilities: Survey Data and Analysis Report (by Angela K. Lafferty and William C. Lauer) to assess the performance of water and wastewater utilities using a set of identified and tested high-level performance indicators. The indicators are designed to help participating utilities improve their operational efficiency and effectiveness. The AWWA Benchmarking Report provides summary data and comparative analyses of survey data collected from 202 utilities during the years 2003 and 2004. AWWA has continued to publish annual reports which summarize survey data from an increasing number of participating utilities. The current publication used for comparison purposes is the 2009 Benchmarking Report which contains data collected from nearly 350 utilities.

These utilities can be broadly categorized according to three criterion measures: geographic region: population size; and type (i.e., water, wastewater, or combined). For the purposes of this study, the City of Boulder is a combined utility in the western region (roughly the Pacific and Mountain time-zones) serving a population of approximately 100,000 customers. Beginning with data collected from 2005, Boulder has participated in the AWWA Benchmarking Study on in every year since.

Of the 22 total performance indicators included in the survey, the City of Boulder chose to evaluate 19 which were deemed applicable and attainable.

- Employee Health and Safety Severity Rate
- Training Hours per Employee
- Customer Accounts per Employee & Million Gallons per Day (MGD) Water Delivered
- Technical Quality Complaints
- Disruptions of Water Service
- Residential Cost of Water/Sewer Service
- Debt Ratio
- System Renewal/Replacement Rate
- Return on Assets
- Drinking Water Compliance Rate
- Distribution System Water Loss
- Water Distribution System Integrity
- Operations and Maintenance Cost Ratios
- Planned Maintenance Ratio

Each performance indicator within this report is presented using median-range charts. AWWA provides summary statistics of industry data which includes the median, 25th percentile, and 75th percentile values. There are both advantages and disadvantages to this method of data reporting. It is advantageous in that it illustrates the industry norm for each indicator. Unfortunately, it lacks the ability to describe absolute high and low values, extreme outliers, or the underlying distribution of the data. The inherent shortcomings of the median-range charts were imposed by the survey in an effort to protect utility confidentiality. Also for this reason, the survey does not provide any correlation between individual data points and utility names.

The most recent performance indicators are summarized in the 2009 Utilities Division Annual Report. In most cases, Boulder's Water Utility falls within the 25th to 75th percentile range. However, in several cases Boulder's performance is outside of this range:

- Customer Accounts per Employee – Lower 25th percentile
- Disruptions of Water Service – Upper 25th percentile
- System Renewal/Replacement Rate – Upper 25th percentile
- Return on Assets – Lower 25th percentile
- Water Distribution System Integrity – Upper 25th percentile
- O&M Cost per Account – Lower 25th percentile

6.3 Current Staffing

Day to day operation of the water utility is performed by employees of the City of Boulder Utilities Division of the Public Works Department with personnel from several different programs as discussed in the administration section above. **Table 2-23** shows the staffing levels for the Water Fund. Overall, the Water Fund includes a total of 75.13 full time equivalent (FTE) positions. In addition, the Utilities have Wastewater, Stormwater, and Transportation Funds (not shown in table) that along with the Water Fund in total comprise 155.90 utilities FTEs.

Table 2-23: City of Boulder Utilities Water Fund Staffing Levels

Title	FTE	Program FTEs
Admin – Water		2.13
Director of Public Works	0.40	
Financial Manager	0.35	
Admin Specialist II	0.35	
Project Admin.	0.40	
Rate/Data Analyst	0.63	
Billing Services – Water		2.85
Supervisor	0.54	
Representative	2.00	
CIS Support	0.31	
Support Services – 510		0.64
Communication Specialist	0.20	
Communication Coordinator	0.14	
Administrator	0.30	
Engineering Ops – Water		5.76
Draftsperson II	0.60	
Engineering Project Manager	2.50	
Admin Specialist I	0.08	
Admin Specialist II	0.40	
Admin Supervisor	0.18	
Senior Engineering Tech	2.00	
Water Resources Operations		2.00
Water Resources Coordinator	1.00	
Water Source Specialist	1.00	

Title	FTE	Program FTEs
Watershed Operations		2.00
Water Source Manager	1.00	
Water Source Operations	1.00	
Hydroelectric Operations		3.00
Hydro Tech. II	2.00	
Hydroelectric Manager	1.00	
BWTF Operations		13.75
Industrial Mechanic	2.00	
Treatment Plant Supervisor	1.00	
Plant Operator A	2.00	
Plant Operator B	1.00	
Admin. Specialist II	0.75	
Chief Plant Operator	5.00	
Lead Mechanic	0.50	
Treatment Plant Coordinator	0.50	
Process Optimization Specialist	1.00	
BRWTF Operations		9.25
Industrial Mechanic	1.00	
Chief Plant Operator	2.00	
Treatment Plant Supervisor	1.00	
Admin. Specialist II	0.25	
Plant Operator D	1.00	
Lead Mechanic	0.50	
Plant Operator A	2.00	
Treatment Plant Coordinator	0.50	
Process Optimization Specialist	1.00	
System Controls		3.00
Electronics Tech II	2.00	
SCADA System Admin.	1.00	
Water Quality Operations		6.78
Water Quality Planner	0.10	
Water Quality Project Manager	1.00	
Water Source Operations Manager	2.00	
Water Quality Coordinator	0.20	
Drinking Water Quality Lab	1.00	
Water Quality Inspector	1.00	
Admin. Specialist II	0.20	
Laboratory Supervisor	1.00	
Analytical Chemist	0.20	
Watershed Educations Specialist	0.08	
Water Conservation		1.66
Water Quality Planner	0.10	
Water Quality Coordinator	0.20	
Program Specialist	1.00	
Admin. Specialist I	0.20	
Watershed Outreach Coordinator	0.16	

Title	FTE	Program FTEs
Distribution System Maintenance		14.95
Maintenance Person I	1.00	
Maintenance Person II	2.00	
Maintenance Person III	3.00	
Maintenance Person IV	3.20	
Maintenance Supervisor	1.00	
Utility Maintenance Coordinator	0.20	
Program Planner	0.60	
Standby Utility	0.50	
Utility Locator	1.00	
Material Supply Specialist	0.80	
Valve Operator	1.00	
Admin. Specialist II	0.45	
Program Admin. MGR	0.20	
Meter Operations-Water		7.36
Meter Service Tech	5.52	
Meter Service Operations	0.92	
Shop Water Meter Service Tech	0.92	
Total Water FTEs		**75.13**

6.3.1 Staffing Summary

The 2005 *Lafferty and Lauer* AWWA Benchmarking Performance Indicators for Water and Wastewater Utilities: Survey Data and Analyses Report provides a benchmark for the number of employees per MGD treated. This data, and a comparison for the City of Boulder can be found in **Table 2-24**.

Table 2-24: Benchmark Comparison of Employee-Related Performance

Performance	City of Boulder Actual for Year 2009	AWWA "All" Participant Median	AWWA "West" Participant Median
Water Treated Per Employee[1]	0.29 MGD/FTE	0.25 MGD/FTE	0.29 MGD/FTE
[1] Water Treated = year 2009 annual average daily water treated of 22 MGD (12 MGD from BWTF and 8 from BRWTF) and Employees = 75.13 (year 2009 water fund FTEs).			

This comparison shows that the City of Boulder's 2009 data is near the averages reported in 2005 from AWWA's study.

It is important that the City of Boulder continue to devote resources to workforce planning. While the existing staffing levels and distributions are appropriate for the City's needs, several factors in today's labor market are converging to create significant problems in the utility workforce. A mass exodus of utility employees is expected to occur due to retirement in the next 10 years and fewer U.S. college graduates are earning science or technical degrees than ever before, despite the fact that utilities are understaffed most particularly in engineer and operator positions. As more and more components of the City's water supply, treatment, and distributions systems are being automated and becoming more focused on Instrumentation and Control, it is becoming more crucial to find the right person for the right job, and to have systems in place to transfer knowledge to new staff. As stated in a February 3, 2009 AWWA Streamlines article (Volume 1, Number 3), the highest workforce development challenges for Water Utilities are:

- Recruitment and selection
- Knowledge retention
- Classification issues and staff training.

This can be difficult during a weakened economy when budget cuts are on the rise. Indications are that utilities, instead of laying off workers, tend to be striving to keep up with attritions due to the high number of retirees.

The State's Public Employees' Retirement Association (PERA) has indirectly assisted the City of Boulder in retaining and transferring knowledge within the City. Many of the employees that retire are able to come back to work after a set amount of time under the PERA program and work for 110 days per year. This has enabled the City to bring some retired employees back into the work staff in order to assist in knowledge transfer/training of new employees. This only extends the workforce temporarily, and cannot be used as a long term plan.

Several strategies should be investigated in order to be prepared for the changing labor environment. The main "attractors" of a water utility include the salary and benefits, but other attractors should be identified to more effectively engage the younger generation. Studies indicate that the top three attractors to a position for current students and young professionals are work that enables learning and growth, work that is enjoyable, and work that is personally stimulating. It may also be beneficial to brand the Utility by passively advertising the attractors of the organization. A method to broaden the pool of potential applicants could be to develop relationships with high schools and universities in order to broaden and deepen applicant pools. It is important that the City develop a viable workforce strategy as a key component of its long term strategic business planning in order to ensure a sustainable workplace in a dynamic labor environment.

The City should also be investing time and money into staff training to ensure that knowledge is easily transferred within the organization.

According to the AWWA Peer Review Report of 2008, the City should decide if it is best to staff all (or near all) needs, or to staff for a base level and employ contractors, consultants, and others for needs above the established base.

6.4 Metering and Billing

The following sections present information regarding the metering and billing program.

6.4.1 Metering

The City has installed Badger meters on all accounts in the City. The City has a meter testing program in place and tests meters 3 inches and larger according to AWWA policy.

- 6" and 8" meters are tested once a year.
- 4" meters are tested every two years.
- 3" meters are tested every three years

In 1996, the City began installing Trace transponders in order to read the meters via radio frequency. In 2006, it was decided to replace the Trace transponders, which were approaching the end of the 10 year battery life and replace them with Orion transponders. The Orion transponders use new technology and allow customers to read their meters with water monitors.

The City began offering water monitors to customers in 2008 at a cost of $200 to cover both the cost of the monitor and the upgrade to the new transponder. A new price of $75 has been approved as part of the 2011 budget process since half of the City's transponders will have been upgraded as of 2011.

During the next transponder replacement cycle, currently scheduled for the 2019-2024 time frame, an advanced metering infrastructure (AMI) should be considered. AMI is the term used to represent the networking technology supporting real time metering capabilities. Metering data is logged and made available to consumers via the internet. The data can be used for a variety of purposes including water usage profiling, time of use billing, demand forecasting and response feedback, leak detection, flow monitoring, water conservation enforcement and remote shutoff.

6.4.2 Billing

Utility Billing manages approximately 29,000 billing accounts for the approximately 113,000 residents that live within and immediately surrounding the City limits. Meters are read via radio frequency once a month and uploaded into the billing system for bill generation. The Billing Services Representatives visually check and validate the meter reads against a number of criteria, such as zero reads and high/low variance, before releasing them for billing. The breakdown of billing by account type for 2009 is as follows:

- Single family residential – 22,525
- Multi-family residential – 2,517
- Commercial/industrial/institutional – 2,110
- Metered irrigation – 1,306

The City uses Advanced Utilities' Infinity Customer Information System (CIS) for utility billing and payments. This system was installed in 2006 to be used in implementing the water budget methodology in 2007. The billing system generates an electronic billing file sent to an outside vendor for printing and mailing of invoices. The bills are delivered to the post office on the same day they are produced.

The City has plans to upgrade to version 3 of the billing system in 2011 in a new virtualized server environment in accordance with the Green Initiative proposed by IT.

The City has a planned replacement of the billing system scheduled for 2017 if it is deemed necessary.

In January 2010 the Utility Billing office released a new online bill/payment website called MyBoulderUtilityBill (MYBUB). The website allows customers to view account information, select ebills instead of paper bills and make a payment by credit card. As of November 2010, the City has 3,000 registered users and processes over 1,000 credit card payments a month.

In accordance with City code, payments are due ten days after the bill is issued and the City receives payments in several ways. The following summarizes 2009 payments:

- Approximately, 12,300 payments per month were processed by a lockbox processing center at the City's bank. This payment information is uploaded into the billing system and posted to the appropriate account.
- Approximately 5,400 payments per month were withdrawn from customers' bank accounts (ACH Debit program)
- Approximately 4,000 customers paid by credit card every month with the Recurring Credit card program or in person or by phone.
- Approximately 2,700 customers paid with on-line banking payments.

Utility Billing also receives payments by mail and accepts payments at the walk-in customer service window located in the Municipal Building.

In May 2009, Utility Billing implemented the Utility Billing Red Flag Identity Theft Prevention Policy in accordance with Federal Trade Commission regulations. Utility Billing now requires photo identification or other identification before changing the name on a utility account. Utility Billing also notifies owners by letter of any name changes on an account.

The Utility Billing office complies with all City policies and the Peripheral Component Interconnect (PCI) security regulations when taking credit card payments.

Although collections are an important financial function to the City, the City does not turn unpaid accounts over to a collection agency. Instead, the water service is turned-off and unpaid utility bills are certified annually to the county for inclusion on the property tax bills of the specific property. Throughout the year the City uses multiple techniques, such as courtesy reminder letters (60 days past due), final notice letters (90 days past due), 48 hour hang tags and payment agreements to avoid turn-offs and the certification process. In 2009, the City averaged 17 turn offs per month; 92 percent of final notices and hang tags generated payments before turn-off was necessary and Utility Billing only certified 16 unpaid balances to Boulder County for collection.

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[1] As summarized in the 2000 TWMP from Smith, Phyllis. 1986. History of Water Works of Boulder, CO.
[2] AWWA and WEF. 2008. QualServe Report of Peer Review for City of Boulder. October.
[3] Meschuk, 2010.
[4] City of Boulder. 1981. Boulder Revised Code (B.R.C.). Available at: www.colocode.com/boulder2/index.htm.
[5] BVCP.
[6] City of Boulder. 2003 with 2004 and 2009 revisions. Drought Plan Volumes 1 and 2.
[7] Black and Veatch. 2007. BRWTF Integrated Source Water and Treatment Study.
[8] City of Boulder. 2000. Design and Construction Standards. Available: http://www.bouldercolorado.gov/index.php?option=com_content&task=view&id=209&Itemid=482
[9] City of Boulder. 2000. Treated Water Master Plan
[10] ISO Commercial Risk Services, Inc. 1995. Letter to Tim Honey, City Manager re: Public Fire Protection, Boulder, Colorado. June.
[11] City of Boulder. 2000. Design and Construction Standards. November.
[12] City of Boulder. 2010. Utilities Annual Report. April.
[13] City of Boulder. 2010. Utilities Annual Report. April.
[14] Calculations of baseline water use documented in internal memo. Kosloff, MWH, May 19, 2010.
[15] Meeting notes, April 2, 2010.
[16] Calculations of current water use documented in internal memo. Kosloff, MWH, May 19, 2010.
[17] Production spreadsheet provided by Carol Ellinghouse on 4-3-2010, exception of year 2000, based on annual report data for that year.
[18] City of Boulder. 2010. Utilities Annual Report. April.
[19] Spreadsheet provided by Suzanne Givler on May 17, 2010.

Appendix A:

Recommended Practices to Meet Goals

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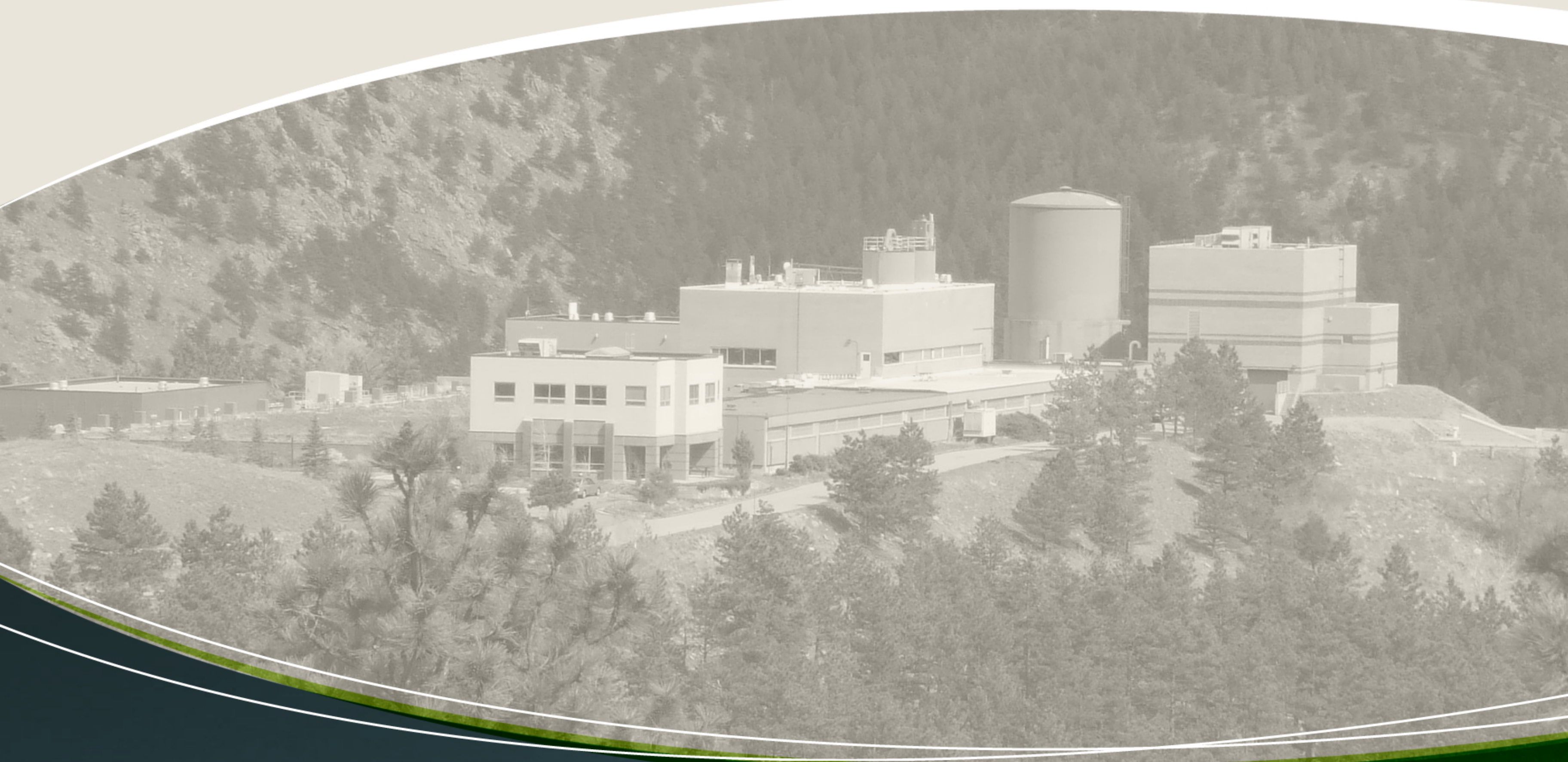

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MWH®

BUILDING A BETTER WORLD

Overall

1. **Customer Service**
   a) Evaluate causes of past customer complaints
   b) Develop program for system flushing
   c) Implement program for customer response to complaints
   d) Update web site with summarized customer survey results, water quality "frequently asked questions," water quality data, annual CCR
   e) Participate in QualServe (AWWA)

Source Water

11. Deliver the highest quality water sources available for immediate delivery after allowing for needed storage reserves

    a) Use the highest quality water sources after giving consideration to the need to maintain sufficient reservoir levels for seasonal source changes, emergencies, and drought reserves
    b) Maximize use of direct flow water rights and direct exchange to the greatest extent possible to maintain reservoir reserves
    c) Maximize use of Boulder Creek exchange potential in order to increase the amount of Boulder Creek water available for delivery to Betasso WTF, increase hydropower production, and decrease water treatment and delivery costs while also increasing drought resiliency through use of available Boulder Reservoir supplies
    d) Maximize water deliveries to Betasso WTF in wet years when effects on carryover storage are minimal

12. Maintain sufficient reservoir drought reserves to achieve drought reliability criteriaa) Maintain carryover storage from wet years to dry years sufficient to meet drought reliability criteria by maintaining the minimum level reached for Silver Lake Watershed each spring above a twenty year running annual average of 6100 af and a minimum annual level reached in the spring for Barker Reservoir above a twenty year running average of 8500 acre-feet

    a) Operate Boulder Reservoir plant for a sufficient number of months each year to provide the necessary level of system drought resiliency

13. Maintain sufficient reservoir reserves to assure continuous water supply to Betasso WTF throughout the year and in emergencies

    a) Balance deliveries from each water source during the year to assure adequate usage of each and prevent excessive draw on upper Boulder Creek reservoirs
    b) Maintain minimum extreme drought reserve pool in Barker Reservoir of 2200 acre-feet, in the Silver Lake Watershed reservoirs of 1700 acre-feet and in Boulder Reservoir of 800 acre-feet for fail-safe ability to meet essential indoor needs in an extraordinary and unanticipated severe drought event

14. Maximize hydroelectric production by managing hydroelectric production to increase water utility revenues and generate "green" power without impacting source water reliability and quality

    a) Use Boulder Canyon Hydro storage right to store water for hydropower generation and strategic release to soften call at critical times
    b) Use Betasso discharge line to maximize capacity tests
    c) Use excess capacity in raw water transmission pipelines to run additional hydro water

15. Address instream flow needs

    a) Provide water for instream flow needs without significantly reducing municipal water system reliability
    b) Comply with CWCB agreements
    c) Continue voluntary instream flow releases at Barker Reservoird)Balance instream flow needs with municipal needs during drought by exercising drought reservation clause in CWCB agreements if neededSupport outdoor water use from the municipal system during periods when system demands can be wholly met through direct flow diversions, including use of larger customer water budgets in May and June, in order to increase water levels in the alluvial aquifer feeding Boulder Creek and other area creeks with instream flow support

16. Protect and enhance yield of city's water rights portfolio

    a) Participate in water court proceedings to establish new water rights for the city and to protect the yield of the city's existing water rights
    b) Pursue strategic water supply acquisitions that complement and enhance the city's existing water supplies and facilities to improve municipal water system operations or drought resiliency
    c) Maintain and improve the Boulder Creek Watershed model to enhance understanding of the city's source water supplies and operations
    d) Monitor climate change science developments and track climate and streamflow measurements to evaluate if local hydrology has shifted outside of the historic range of variability
    e) Complete water rights accounting sufficient to meet state requirements and to support city evaluation of water rights yields and uses over time

        i) Keep daily records of all diversions
        ii) Compile detailed summary reports monthly and annually

17. Maintain and protect source water system infrastructure and lands

    a) Continue existing ordinances and policies that protect source water system infrastructure and adopt new ones where needed
    b) Maintain closure of the Silver Lake Watershed
    c) Continue to improve security equipment and operations
    d) Maintain policies that prevent infestation of city reservoirs with nuisance species

18. Support local ditch company operations that complement the municipal system.

    a) Continue existing ordinances and policies that protect community ditch water supplies for local use by providing municipal protection against sales out of the Boulder Creek basin
    b) Advocate with water commissioner and others for use of ditch company water rights in a manner that supports yield of city water rights
    c) Support maintenance efforts for ditches that supply municipal infrastructure

19. Protect source water from point and non-point pollutants

    a) Operate a source water pollution prevention program
    b) Contain and secure treatment plant, water supplies, and intake structures from potential contamination per vulnerability assessment
    c) Consider human and domestic animal access to water supplies when considering land use access and changes
    d) Initiate water quality patrol position for Boulder Reservoir and Boulder Feeder Canal
    e) Implement Middle Boulder Creek Water Source Management Work Plan
    f) Develop and implement Boulder Reservoir Management Plan
    g) Coordinate with Parks on S. Shore Business Plan to include water quality protection measures
    h) Participate in point and non-point pollution regulatory development permits and source assessments
    i) Reduce potential water quality impacts from septic systems by promoting proper installation and management through the Boulder County Septic Smart Program and converting to existing collection system
    j) Reduce risk of emerging contaminants by reducing and controlling contamination from wastewater sources
    k) Implement best management practices where needed to protect water supplies from existing potential contamination
    l) Enhance, protect, and maintain source water riparian and wetlands areas

        i) Establish conservation easements and riparian and wetlands buffer zones in source water areas
        ii) Maintain and improve stream channels and wetland features to reduce erosion and enhance treatment by natural systems
        iii) Develop outreach and education programs regarding the importance of riparian areas and soil and water conservation practices

    m) Monitor source water quality

        i) Continue source water monitoring and evaluation program to track water quality conditions
        ii) Continue to track unregulated contaminants to determine risk and evaluate monitoring need
        iii) Improve knowledge of emerging contaminant occurrence, prevention and treatment options

n) Adopt ordinances and policies protective of source water quality, such as a Watershed Ordinance to protect source water areas

  i) Designate source water protection areas to be regulated
  ii) Prohibit land use activity in designated source water areas which may creates risk of contamination or injury to the City's water supply or waterworks[1]
  iii) Restrict public access to protected watersheds and maintain closure of the Silver Lake Watershed to public access
  iv) Provide regulatory mechanism to enforce illegal discharges into source water areas
  v) Prohibit illegal discharges and regulate land-use activities in designated source water areas
  vi) Manage recreation uses to protect drinking water supplies
  vii) Establish watershed permitting system to regulate activities within the designated source water protection areas

o) Adopt a city-wide source water anti-degradation policy[2]

  i) Give preference to alternatives that maintain, protect, or enhance the quality of the water supply sources for decisions regarding resource use and resource development
  ii) Consider public water supply use as the highest priority when evaluating competing uses for the water sources

20. Encourage stewardship and regional cooperation, particularly with those entities affecting source waters and source water landsEducate and coordinate with local governments and private landowners to manage and protect drinking water supplies

  a) Coordinate with local environmental groups to protect water supplies
  b) Coordinate with Boulder County on Boulder Feeder Canal recreational uses
  c) Investigate and cooperatively resolve pollution issuese) Coordinate with Northern Colorado Water Conservancy District on water system operations and improvements
  d) Work with Forest Service on Boulder Creek watershed management issues
  e) Pursue water conservation efforts that are tailored to Boulder's needs and do not impair yield of downstream water users, such as emphasizing wise indoor water use

21. Improve source water quality when possible through operational or other means

  a) Implement a manganese control strategy using source management techniques (e.g., in situ aeration)
  b) Coordinate with NCWCD to maximize flow through Boulder Reservoir
  c) Determine best source based on treatability, quality, and source water supply outlook

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[1] The SWMP contains a link to a sample ordinance.
[2] An example is the American Water Works Association Statements of policy on public water supply matters retrieved January 15, 2009 from http://www.awwa.org/files/about/OandC/PolicyStatements/1209426115078.pdf.

Water Treatment

22. Comply with all drinking water regulations and meet secondary standards

    a) Continue high quality treatment
    b) Evaluate DBP compliance forecast and establish DBP reduction plan, if needed.

23. Use best practices to maintain high quality treated water

    a) Jar test regularly
    b) Evaluate filter media on a regular basis
    c) Investigate problem filters when they become apparent

24. Seek alternative methods to increase delivered water quality

    a) Implement necessary upgrades to the Boulder Reservoir WTF to ensure a multi-barrier system.
    b) Improve clarification treatment.
    c) Implement procedures and reporting requirements to obtain Partnership for Safe Water – Phase III status.
    d) Implement the AWWA Standard for Water Treatment Plant Operations and Management (G200-09)
    e) Join Water Research Foundation (formerly AWWARF)
    f) Continued improvement of disinfection

25. Deliver similar and consistent finished water quality from both plants

    a) Set uniform levels for water quality parameters.
    b) Develop program to bring water from both plants into consistent range for measured parameters.
    c) Control pH and/or ORP of finished water.
    d) Minimize effect of mixing regions by implementing consistent multiple-plant finished water quality program

26. Ensure daily reliable plant operations at design flows

    a) Implement maintenance management program

27. Integrate public health risk factors into source water and treatment management decisions.

    a) Develop a Public Health Protection Index (PHPI) or Risk Index
    b) Establish Stakeholder group to assist in PHPI process
    c) Establish consensus of internal and external decision-makers on the PHPI applications.

28. Improve knowledge of emerging contaminant occurrence

    a) Perform the monitoring program included in the Unregulated Contaminant Monitoring Regulation.
    b) Continue to track unregulated contaminants to determine risk and evaluate monitoring need.

Distribution System

29. Remain in the "below average" category for water main breaks for municipalities in the region

    a) Keep annual breaks below 120
    b) Continue distribution system rehabilitee program and track performance

30. Design and operate distribution system with adequate storage to meet fluctuating customer demands and provide for emergency service

    a) A reserve capacity of 10 percent will be maintained in the water delivery system. The maintenance of such a reserve capacity will allow a degree of planning flexibility and mitigate water delivery problems that might be caused by operator error.
    b) Provide sufficient storage to meet daily demand fluctuations and fire flow protection

31. Maintain safe and consistent water quality throughout the distribution system

    a) Develop a monitoring program for the distribution system and a plan for adjusting water quality where necessary.
    b) Investigate Pb/Cu corrosion behavior and status.
    c) Maintain a minimum chlorine residual throughout the distribution system.
    d) Maintain minimal levels of bacteria in the distribution system
    e) Develop a plan to meet DBP criteria for reduced monitoring under Stage 1 DBPR and Stage 2 DBPR.
    f) Develop a plan to maintain water quality in distribution system reservoirs
    g) Implement and maintain effective backflow prevention program.[3]
    h) Ensure integrity of all distribution system storage tanks.

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[3] Additional details of such a program are included in Black and Veatch (2007).