Stantec

# Steamboat Water Supply Master Plan

November 2008

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# 1.0 Introduction

## 1.1 BACKGROUND

The City of Steamboat Springs ("City") and the Mount Werner Water and Sanitation District ("District") have developed a joint water supply and treatment system to provide drinking water to customers of their respective service areas within the greater Steamboat Springs area. The primary water source comes from the 22 - square mile Fish Creek watershed. Raw water is diverted for filtration at a conventional treatment plant currently rated at 7.5 million gallons per day (mgd) capacity. Additionally, a seasonal water supply is provided by three infiltration galleries which can sustain flows up to 1.8 mgd and which typically is used during peak demand periods in the summer. These supplies are chlorinated and stripped of iron and manganese prior to distribution.

Historically water shortages have not been an issue for the City nor the District. However continued growth of the community has raised concerns regarding the ability of both entities to continue to reliably meet the water supply needs of the community. A comprehensive evaluation of the existing and anticipated water demands as well as supplies available to the City and the District is needed to address concerns regarding present and future water supply for the community.

## 1.2 PURPOSE AND SCOPE

The objective of this project is to assess the City's and the District's ability to continue to provide reliable water service to their growing service areas and their general vulnerability to drought and other potential threats to the communities water supply. Additionally, an evaluation of supply enhancement and demand management strategies will be reviewed and evaluated as a basis for recommendations to address deficit supply issues and to reduce risk of shortages.

This water supply assessment will allow the City and the District to better plan for and implement vital improvements to the water supply system to meet future needs, and accommodate for growth while safeguarding the health, wellness and public safety of the community and citizens.

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# 2.0 Water Demand

## 2.1 SERVICE AREA

### 2.1.1 Overview

The City and the District service areas are shown on Figure 1-1. The District includes the area of Steamboat Springs lying south of Fish Creek, near the base of the ski resort. In general terms, the District serves the resort portion or mountain area of Steamboat Springs. The City of Steamboat Springs service area includes all other areas of the City not serviced by the District.

The District was formed in 1965 to provide water and sanitation services for the then newly developing Steamboat Ski Area and Resort. The District was formed as a Special District pursuant to State Statute and is a political subdivision of the State of Colorado.

Initially, the District developed separately and distinctly from the City. As the District and the City grew, the need arose for the water facilities of both to become physically integrated and combined. The Fish Creek Filtration Plant, initially constructed by the District, became a joint operation when the State Health Department required the City to add filtration to its water system in 1983. The District and the City reached an agreement to add capacity to the District's Fish Creek Filtration Plant that would meet the City's demand. Other shared facilities include Fish Creek Reservoir and the Yampa River infiltration galleries.

### 2.1.2 Historic Population

Population data for the City of Steamboat Springs is available from the U.S. Census Bureau. However, data detailing the split in the service populations between the City and the District population do not exist. Historical population data for the community are summarized in Tables 2-1 and Figure 2-2. As these data show, the population of Steamboat Springs has grown steadily at rates varying from approximately 2% to 8% per year. In recent decades since 1980, Steamboat Springs has experienced an average annual growth rate of about 3.0%.

**Table 2-1. Historic Population Data**

| Year | City of Steamboat Springs Population | Avg. Growth Rate over Decade (%) |
|---|---|---|
| 1960 | 1,843 | |
| 1970 | 2,340 | 2.4% |
| 1980 | 5,098 | 8.1% |
| 1990 | 6,695 | 2.8% |
| 2000 | 10,115 (1) | 4.2% |
| 2007 | 11,362 (2) | 1.7% |
| Average Population Growth Rate (since 1980) | | 3.0% |

Source: U.S. Census Bureau; (1) Corrected U.S. Census Bureau data.
(2) DOLA estimate

Figure 2-1 Service Area Map

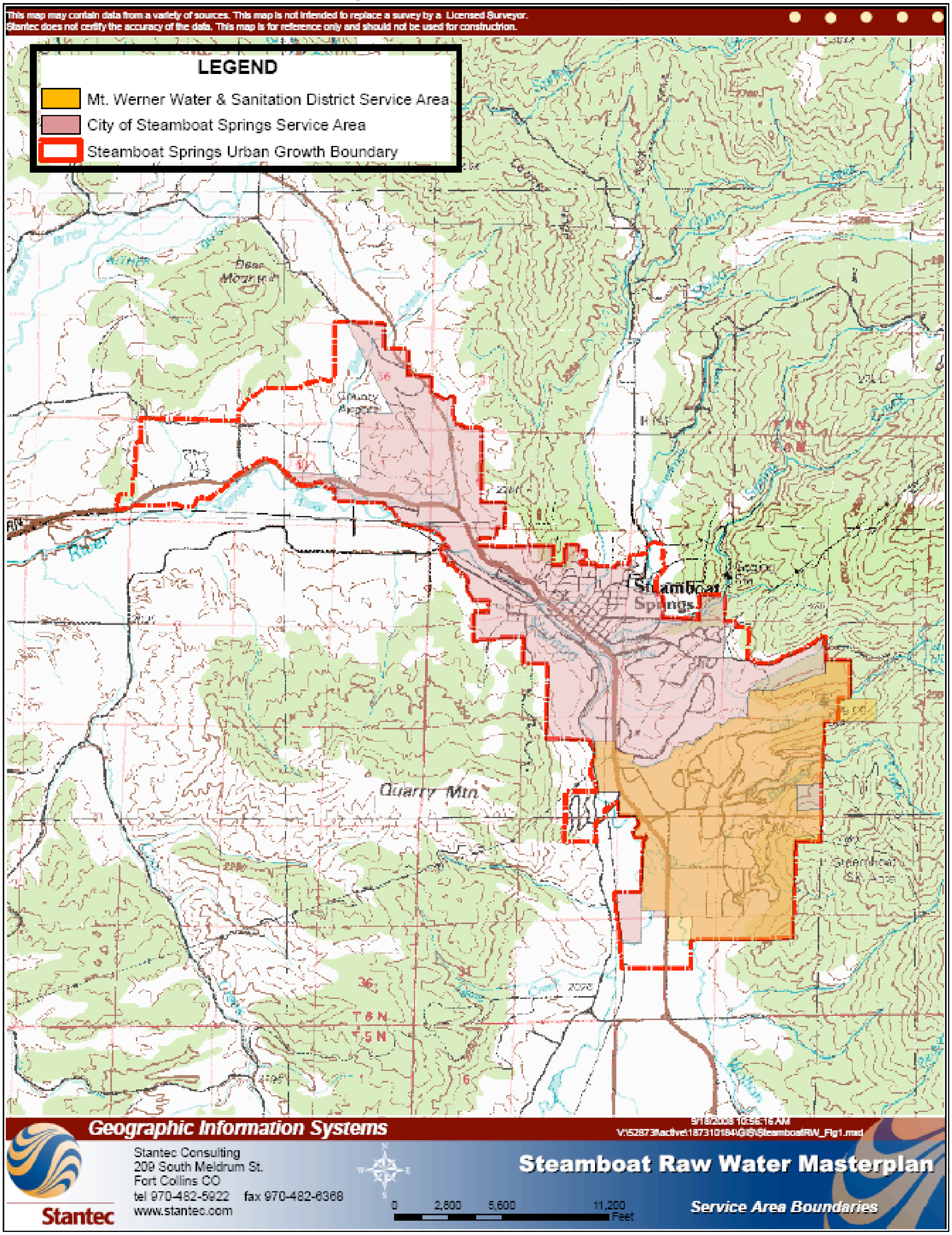
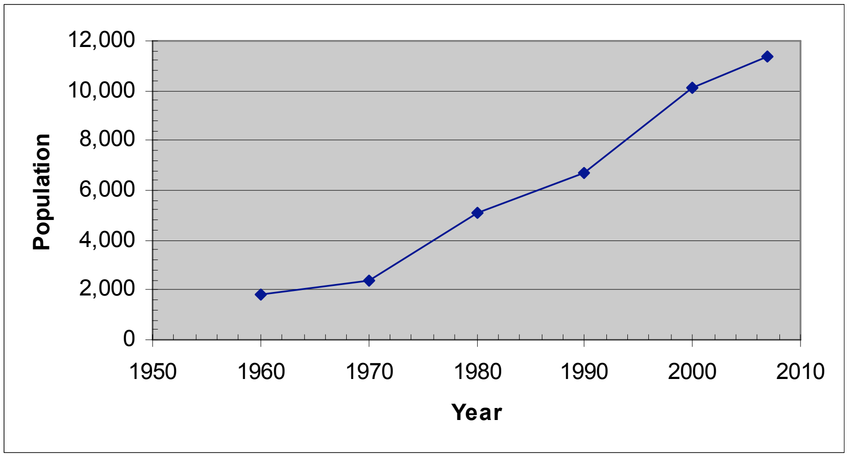


Figure 2-2. Steamboat Springs Total Population




## 2.2 HISTORIC DEMAND

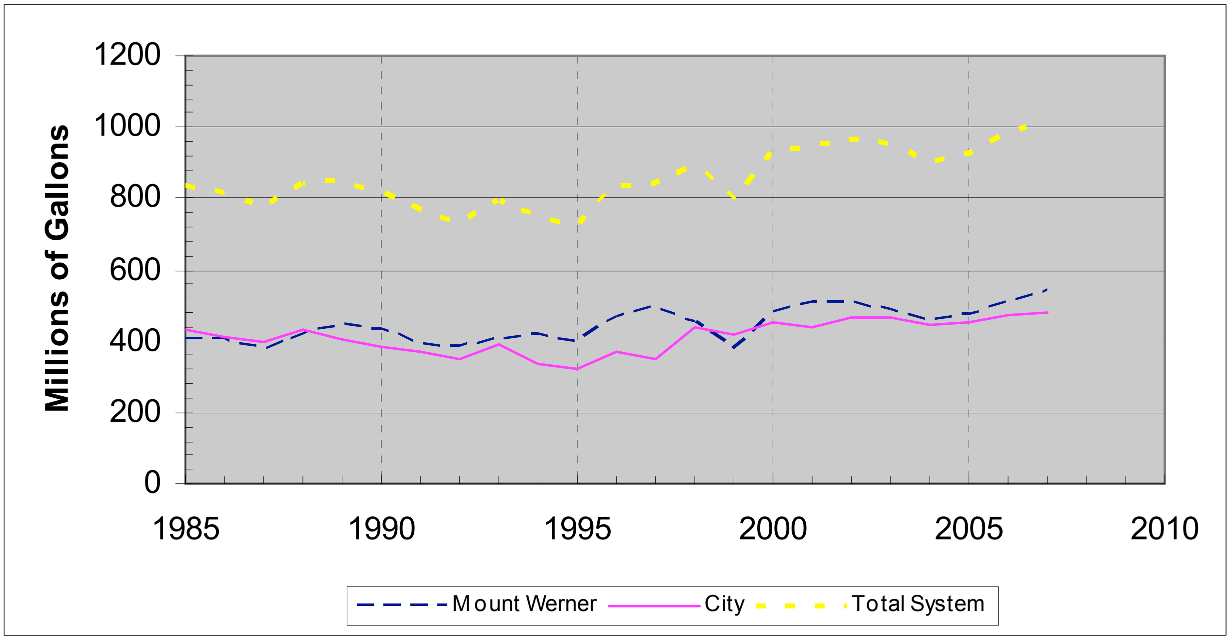
### 2.2.1 Annual Demand

Twenty-three years of historic operating data were provided for the City and District water demands. These data are considered to represent a good cross-section of water usage in both wet and dry years. These water demand data are summarized in the following table and figure.

Table 2-2. Historic Annual Total Water Demand

| | Annual Water Use (MG) | | | |
|---|---|---|---|---|
| Year | City | District | Total System | Total (AF) |
| 1985 | 430.32 | 406.44 | 836.76 | 2,568 |
| 1986 | 411.22 | 401.77 | 812.99 | 2,495 |
| 1987 | 400.50 | 376.76 | 777.26 | 2,385 |
| 1988 | 429.85 | 415.99 | 845.85 | 2,596 |
| 1989 | 402.92 | 447.80 | 850.72 | 2,611 |
| 1990 | 386.72 | 432.41 | 819.12 | 2,514 |
| 1991 | 372.05 | 393.15 | 765.20 | 2,348 |
| 1992 | 347.47 | 386.26 | 733.72 | 2,252 |
| 1993 | 391.20 | 403.43 | 794.62 | 2,439 |
| 1994 | 338.12 | 418.09 | 756.21 | 2,321 |
| 1995 | 321.84 | 400.32 | 722.16 | 2,216 |
| 1996 | 367.11 | 468.49 | 835.60 | 2,564 |
| 1997 | 347.25 | 492.86 | 840.11 | 2,578 |
| 1998 | 439.21 | 450.34 | 889.55 | 2,730 |
| 1999 | 417.06 | 378.51 | 795.57 | 2,442 |
| 2000 | 450.75 | 481.85 | 932.61 | 2,862 |
| 2001 | 440.90 | 507.06 | 947.96 | 2,909 |
| 2002 | 463.00 | 505.00 | 967.77 | 2,970 |
| 2003 | 467.30 | 485.64 | 952.95 | 2,924 |
| 2004 | 444.85 | 462.03 | 906.88 | 2,783 |
| 2005 | 450.74 | 473.31 | 924.06 | 2,836 |
| 2006 | 475.26 | 506.51 | 981.77 | 3,013 |
| 2007 | 480.40 | 543.15 | 1023.56 | 3,141 |

**Figure 2-3. Historic Water Demand**




As with the population trends, both the City and the District have experienced a steady growth in water demand. Growth on the average is significantly less than the approximate 3.0% population growth since 1980. Average annual growth rates in water demand for the City and the District since 1985 are as follows.

| | |
|---|---|
| District | = 1.33% (or 5.94 mg/year) |
| City | = 0.50% (or 2.18 mg/year) |
| Total | = 0.92% (or 8.12 mg/year) |

The lower growth rate in water demand than population can be explained by increases in water efficiency and reduced per capita demand rates and is not unusual.

Average daily demands for this same time period are summarized in the following table.

**Table 2-3. Historic Water Use (MGD)**

| Year | City Average Day | Mt Werner Average Day | Total System Average Day |
|---|---|---|---|
| 1985 | 1.179 | 1.114 | 2.292 |
| 1986 | 1.127 | 1.101 | 2.227 |
| 1987 | 1.097 | 1.032 | 2.129 |
| 1988 | 1.178 | 1.140 | 2.317 |
| 1989 | 1.104 | 1.227 | 2.331 |
| 1990 | 1.059 | 1.185 | 2.244 |
| 1991 | 1.019 | 1.077 | 2.096 |
| 1992 | 0.952 | 1.058 | 2.010 |
| 1993 | 1.072 | 1.105 | 2.177 |
| 1994 | 0.926 | 1.145 | 2.072 |
| 1995 | 0.882 | 1.097 | 1.979 |
| 1996 | 1.006 | 1.284 | 2.289 |
| 1997 | 0.951 | 1.350 | 2.302 |
| 1998 | 1.203 | 1.234 | 2.437 |
| 1999 | 1.143 | 1.037 | 2.180 |
| 2000 | 1.235 | 1.320 | 2.555 |
| 2001 | 1.208 | 1.389 | 2.597 |
| 2002 | 1.268 | 1.384 | 2.651 |
| 2003 | 1.280 | 1.331 | 2.611 |
| 2004 | 1.219 | 1.266 | 2.485 |
| 2005 | 1.235 | 1.297 | 2.532 |
| 2006 | 1.302 | 1.388 | 2.690 |
| 2007 | 1.316 | 1.488 | 2.804 |

Current annual demands for the City and the District can be estimated by examining the last four years (2004 – 2007) as follows:

**Table 2-4. Current Water Demand (MGD)**

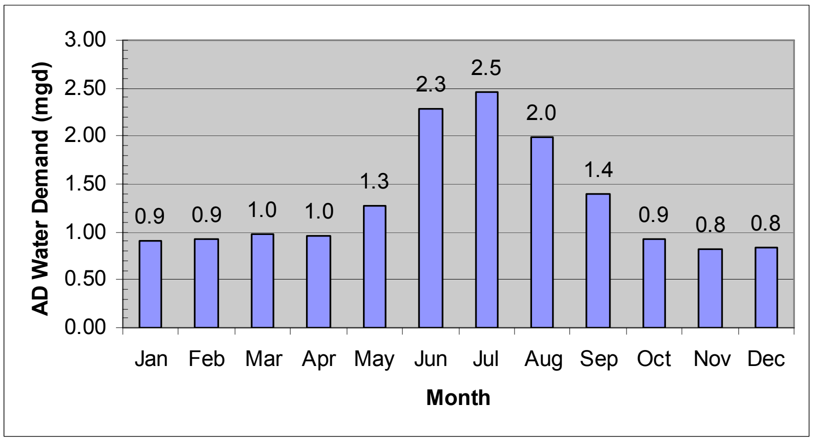
| | Annual Water Use (MG) | | |
|---|---|---|---|
| **Year** | **City** | **District** | **Total System** |
| 2004 | 444.85 | 462.03 | 906.88 |
| 2005 | 450.74 | 473.31 | 924.06 |
| 2006 | 475.26 | 506.51 | 981.77 |
| 2007 | 480.4 | 543.15 | 1023.56 |
| **Average** | **463** | **496** | **959** |
| **AF/Year** | **1,420** | **1,523** | **2,943** |
| **mgd** | **1.27** | **1.36** | **2.63** |

### 2.2.2 Monthly Distribution of Demands

The monthly distribution is useful in determining demand trends throughout a given year or study period. For most systems, demand peaks in the summer months due to increased outdoor irrigation requirements.

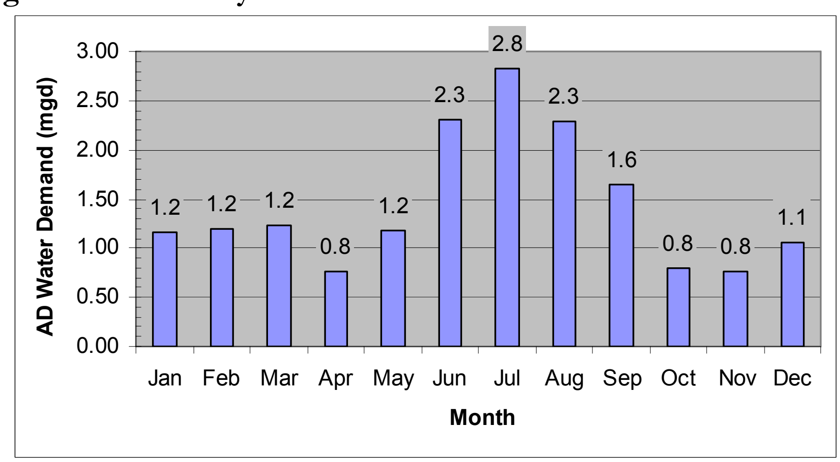
The monthly distribution for City water demand was derived using 2006 and 2007 monthly water usage data. Figure 2-4 shows the projected monthly distribution of total City water demand. It can be seen that demand peaks in the summer months when the irrigation demands are at their highest.

**Figure 2-4. Monthly Distribution of City Water Demand**



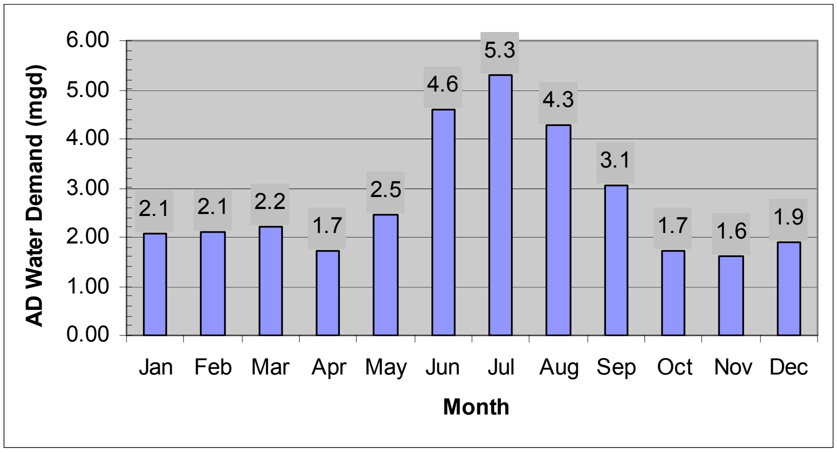

The monthly distribution for District water demand was estimated from 2006 and 2007 monthly water usage data. Figure 2-5 shows the projected monthly distribution of total Mount Werner water demand. It can be seen that demand peaks in the summer months when the irrigation season occurs. A second peak can also be seen during the ski season due to the large number of winter visitors in the District service area.

**Figure 2-5. Monthly Distribution of Mount Werner Water Demand**



The monthly distribution for the combined total water demand for the City and the District is shown in Figure 2-6.

**Figure 2-6. Monthly Distribution of Total System Water Demand**




The following table summarizes these data on both a million gallons per day basis and as a percent of the average annual demand.

**Table 2-5. Monthly Water Demands**

| | Mount Werner | | | | | City | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2006 (mgd) | 2007 (mgd) | Average (mgd) | Total, (mg) | **% of Annual Demand** | 2006 (mgd) | 2007 (mgd) | Average (mgd) | Total (mg) | **% of Annual Demand** |
| January | 1.077 | 1.259 | 1.168 | 36.21 | **6.9%** | 0.914 | 0.914 | 0.914 | 28.33 | **5.9%** |
| February | 1.100 | 1.278 | 1.189 | 33.59 | **6.4%** | 0.927 | 0.927 | 0.927 | 26.19 | **5.4%** |
| March | 1.227 | 1.232 | 1.230 | 38.12 | **7.3%** | 0.975 | 0.975 | 0.975 | 30.23 | **6.3%** |
| April | 0.714 | 0.813 | 0.764 | 22.91 | **4.4%** | 0.955 | 0.955 | 0.955 | 28.65 | **6.0%** |
| May | 1.064 | 1.301 | 1.183 | 36.66 | **7.0%** | 1.270 | 1.270 | 1.270 | 39.37 | **8.2%** |
| June | 2.372 | 2.249 | 2.311 | 69.32 | **13.2%** | 2.291 | 2.291 | 2.291 | 68.73 | **14.3%** |
| July | 2.651 | 3.002 | 2.827 | 87.62 | **16.7%** | 2.193 | 2.721 | 2.457 | 76.17 | **15.8%** |
| August | 2.301 | 2.271 | 2.286 | 70.87 | **13.5%** | 1.929 | 2.053 | 1.991 | 61.72 | **12.8%** |
| Sept. | 1.607 | 1.691 | 1.649 | 49.47 | **9.4%** | 1.314 | 1.488 | 1.401 | 42.03 | **8.7%** |
| October | 0.670 | 0.910 | 0.790 | 24.49 | **4.7%** | 1.031 | 0.826 | 0.929 | 28.78 | **6.0%** |
| November | 0.748 | 0.793 | 0.771 | 23.12 | **4.4%** | 0.828 | 0.825 | 0.827 | 24.80 | **5.2%** |
| December | 1.085 | 1.025 | 1.055 | 32.71 | **6.2%** | 0.870 | 0.816 | 0.843 | 26.13 | **5.4%** |
| Total | | | | 525.06 | **100%** | | | | 481.13 | **100%** |

### 2.2.3 Unit Demands

To remove the effects of increasing population and to provide a basis for projecting water demands it is often useful to examine water demands on a per unit basis. Two of the most common and useful means of accomplishing this are by examining Per Capita Demands and Per Equivalent Residential (EQR) Unit Demands.

#### 2.2.3.1 Per Capita Demands

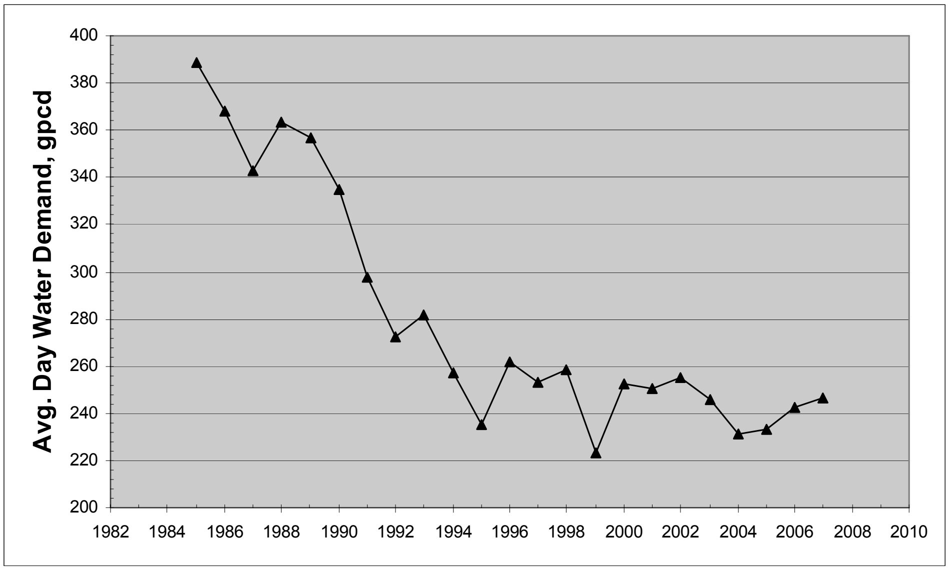
Per capita water demands were calculated from data provided by the City. While demographic data are available for the entire Steamboat Springs municipal area, population data for the City's and the District's separate water service areas are not. Therefore, the analysis of per capita demands is performed on the total combined water demands of both the City and the District. It should be cautioned, however, that for resort communities like Steamboat Springs, per capita analysis can mask the demands of a transient tourist and second-homeowner population.

Figure 2-7 shows the per capita Total System water usage for each year of record. A significant downward water usage trend can be seen starting in the year 1985 and continuing through the mid 1990's. This trend can be attributed to the installation of water meters by the City starting in 1988 and by the District starting in 1993. Other factors such as conservation, leakage prevention in the existing distribution system, accuracy of flow measuring devices and errors in the population data also affect the yearly recorded water demand. From the graph, it appears that per capita water use varies considerably from year to year from the mid 1990's to 2007. A large portion of this variation is due to climate conditions that drive outdoor irrigation requirements from year to year.

**Table 2-6. Total System Historic Annual Demand Water Use (GPCD)**

| Year | Total System Annual Water Demand, mg | Population | Average Annual Unit Demand, gpcd |
|---|---|---|---|
| 1985 | 836.76 | 5,897 | 389 |
| 1986 | 812.99 | 6,056 | 368 |
| 1987 | 777.26 | 6,216 | 343 |
| 1988 | 845.85 | 6,376 | 363 |
| 1989 | 850.72 | 6,535 | 357 |
| 1990 | 819.12 | 6,695 | 335 |
| 1991 | 765.2 | 7,037 | 298 |
| 1992 | 733.72 | 7,379 | 272 |
| 1993 | 794.62 | 7,721 | 282 |
| 1994 | 756.21 | 8,063 | 257 |
| 1995 | 722.16 | 8,405 | 235 |
| 1996 | 835.6 | 8,747 | 262 |
| 1997 | 840.11 | 9,089 | 253 |
| 1998 | 889.55 | 9,431 | 258 |
| 1999 | 795.57 | 9,773 | 223 |
| 2000 | 932.61 | 10,115 | 253 |
| 2001 | 947.96 | 10,375 | 250 |
| 2002 | 967.77 | 10,402 | 255 |
| 2003 | 952.95 | 10,607 | 246 |
| 2004 | 906.88 | 10,742 | 231 |
| 2005 | 924.06 | 10,846 | 233 |
| 2006 | 981.77 | 11,083 | 243 |
| 2007 | 1023.56 | 11,362 | 247 |
| Years 1985 to 2000 US Census & Interpolation | | | |
| Years 2001 to 2007 based on DOLA estimates | | | |

**Figure 2-7. Total System Historic Average Daily Water Use (1985-2007)**




As a basis for water demand projections it would not be suitable to use values from the eighties. There does appear to be some leveling off of the annual average per capita water demand in recent years. Based on discussion with City and District staff it was decided that the last four years, (2004 to 2007) be selected as a reasonable estimate of average annual demand on a per capita basis for this study. On this basis then a reasonable estimate for projected average water demand is 239 gallons per capita per day (gpcd) as illustrated in the following table.

**Table 2-7. Projected Average Daily Water Demand (GPCD)**

| Year | Total System Annual Water Demand, mg | Population | Average Annual Unit Demand, gpcd |
|---|---|---|---|
| 2004 | 907 | 10,742 | 231 |
| 2005 | 924 | 10,846 | 233 |
| 2006 | 982 | 11,083 | 243 |
| 2007 | 1,024 | 11,361 | 247 |
| | | **Average** | **239** |

### 2.2.3.2 Per Equivalent Residential (EQR) Unit Demand

The equivalent residential (EQR) unit method of normalizing historic demand is another means of normalizing water demands. For communities like Steamboat, with a large transient population due to the resort nature of the community, it may provide a more accurate measure of historic and projected unit water demand. The EQR method translates commercial and residential development into a standard unit or EQR. A single EQR unit was has been determined by the City and the District to be 140 Fixture Units (FU) (Wright Water Engineers, 1998).

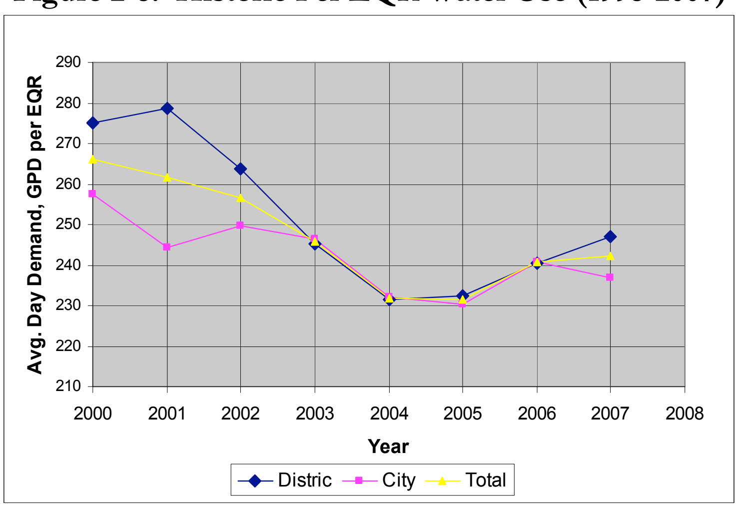
To conduct this analysis EQR data were determined from FU counts provided by the City and the District. The City and the District use FU counts to determine the amount of water plant investment fees that are to be charged for individual water service connections. Annual EQR counts include developments which have received building permits and may be under construction for several years before they place demands on the water system. Therefore, based on direction from City and District personnel, it was determined that EQR counts should be lagged by two years to obtain a more realistic projection of water demand. Table 2-8 lists EQR data for the last 8 years for the City, the District and the Total System.

**Table 2-8. Historic EQR Data**

| Year | City, Lagged EQR data by 2-years | Total City Annual Water Demand, MG | **City, gpd per EQR** | District Lag EQR data by 2-years | Total District Annual Water Demand, MG | **District, gpd per EQR** | Total Annual Demand, MG | Total EQR | **Total, gpd per EQR** |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 4,798 | 451 | **257** | 4,800 | 482 | **275** | 933 | 9,598 | **266** |
| 2001 | 4,944 | 441 | **244** | 4,988 | 507 | **279** | 948 | 9,932 | **261** |
| 2002 | 5,083 | 463 | **250** | 5,249 | 505 | **264** | 968 | 10,332 | **257** |
| 2003 | 5,195 | 467 | **246** | 5,425 | 486 | **245** | 953 | 10,620 | **246** |
| 2004 | 5,251 | 445 | **232** | 5,469 | 462 | **231** | 907 | 10,720 | **232** |
| 2005 | 5,361 | 451 | **230** | 5,579 | 473 | **232** | 924 | 10,940 | **231** |
| 2006 | 5,406 | 475 | **241** | 5,768 | 507 | **241** | 982 | 11,174 | **241** |
| 2007 | 5,555 | 480 | **237** | 6,021 | 543 | **247** | 1,024 | 11,576 | **242** |

Historic per EQR water use was calculated for the City, Mount Werner and the Total System service areas can be found in Figure 2-8 for 2000 through 2007. It can be seen that historic per EQR water use varies considerably from year to year. However, it appears that a declining trend exists in the early 2000's followed by a leveling in recent years.

**Figure 2-8. Historic Per EQR Water Use (1998-2007)**



Based on data from 2004 to 2007, a reasonable estimate for projected average water demand is 237 gpd per EQR as illustrated in the following table is a reasonable value for both the City and the District. Both the City and the District averages are very close to this value.

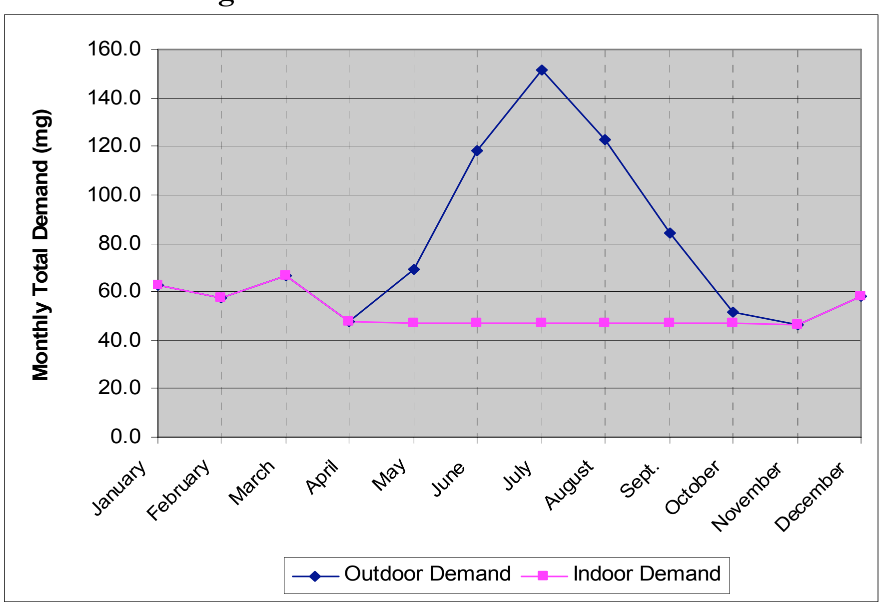
**Table 2-9. Projected Average Daily EQR Water Demand (gpd per EQR)**

| Year | City, gpd per EQR | District, gpd per EQR | Total, gpd per EQR |
|---|---|---|---|
| 2004 | **232** | 231 | 232 |
| 2005 | **230** | 232 | 231 |
| 2006 | **241** | 241 | 241 |
| 2007 | **237** | 247 | 242 |
| **Average** | **235** | 238 | **237** |

### 2.2.4 Indoor and Outdoor Demands

The following figure illustrates a typical water demand hydrograph for Steamboat Springs. Generally, the months of May through October exhibit an increase in water use, primarily attributable to outdoor irrigation. It is often useful to quantify outdoor demand and indoor demands to evaluate potential demand reductions that might be reasonable if it was deemed necessary to implement watering restrictions during drought conditions.

**Figure 2-9. Indoor-Outdoor Demand**




Indoor demands are calculated by subtracting total outdoor irrigation from total water demand. Outdoor irrigation demand was calculated by subtracting base demand from total monthly flow for the irrigation season (May to October). During the summer period, base or indoor demand was estimated as the average of April and November demand.

Table 2-10. Historic System Indoor/Outdoor Water Use (MGD)

| District | | | | | | |
|---|---|---|---|---|---|---|
| | Avg Day Usage, mgd | | | | | |
| | 2006 | 2007 | AVG, mgd | mg | Indoor | Outdoor |
| Jan | 1.08 | 1.26 | 1.17 | 36.2 | 36.2 | 0.0 |
| Feb | 1.10 | 1.28 | 1.19 | 33.6 | 33.6 | 0.0 |
| Mar | 1.23 | 1.23 | 1.23 | 38.1 | 38.1 | 0.0 |
| Apr | 0.71 | 0.81 | 0.76 | 22.9 | 22.9 | 0.0 |
| May | 1.06 | 1.30 | 1.18 | 36.7 | 23.0 | 13.6 |
| Jun | 2.37 | 2.25 | 2.31 | 69.3 | 23.0 | 46.3 |
| Jul | 2.65 | 3.00 | 2.83 | 87.6 | 23.0 | 64.6 |
| Aug | 2.30 | 2.27 | 2.29 | 70.9 | 23.0 | 47.9 |
| Sep | 1.61 | 1.69 | 1.65 | 49.5 | 23.0 | 26.5 |
| Oct | 0.67 | 0.91 | 0.79 | 24.5 | 23.0 | 1.5 |
| Nov | 0.75 | 0.79 | 0.77 | 23.1 | 23.1 | 0.0 |
| Dec | 1.09 | 1.03 | 1.06 | 32.7 | 32.7 | 0.0 |
| Apr & Nov Avg. | | | 0.77 | 23.01 | | |
| Total, mg | | | | 525.1 | 324.7 | 200.4 |
| % | | | | | 62% | 38% |

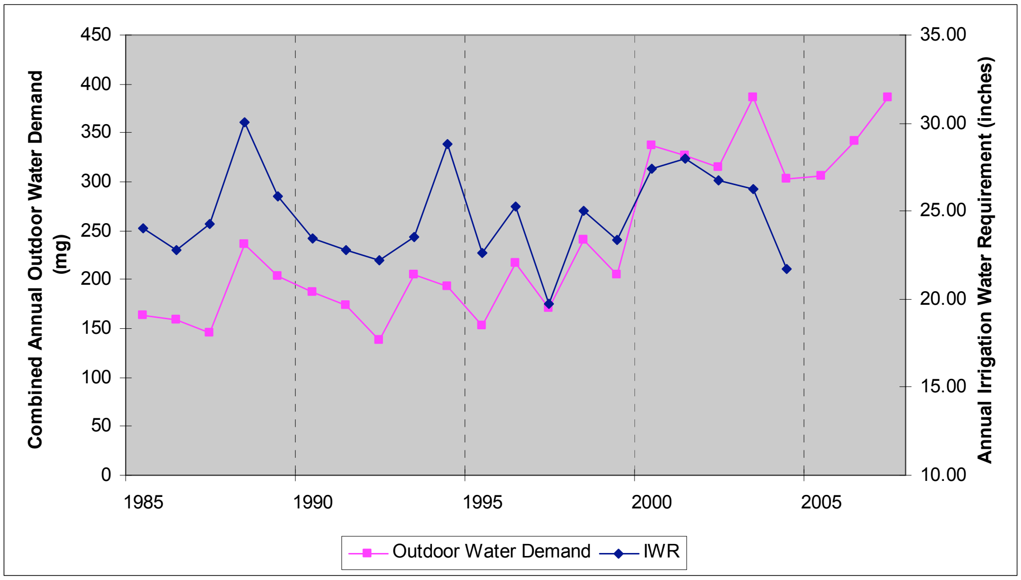
| City | | | | | | |
|---|---|---|---|---|---|---|
| | Avg Day Usage, mgd | | | | | |
| | 2006 | 2007 | AVG, mgd | MG | Indoor | Outdoor |
| Jan | 0.91 | 0.91 | 0.91 | 28.3 | 28.3 | 0.0 |
| Feb | 0.93 | 0.93 | 0.93 | 26.2 | 26.2 | 0.0 |
| Mar | 0.98 | 0.98 | 0.98 | 30.2 | 30.2 | 0.0 |
| Apr | 0.96 | 0.96 | 0.96 | 28.7 | 28.7 | 0.0 |
| May | 1.27 | 1.27 | 1.27 | 39.4 | 26.7 | 12.6 |
| Jun | 2.29 | 2.29 | 2.29 | 68.7 | 26.7 | 42.0 |
| Jul | 2.19 | 2.72 | 2.46 | 76.2 | 26.7 | 49.4 |
| Aug | 1.93 | 2.05 | 1.99 | 61.7 | 26.7 | 35.0 |
| Sep | 1.31 | 1.49 | 1.40 | 42.0 | 26.7 | 15.3 |
| Oct | 1.03 | 0.83 | 0.93 | 28.8 | 26.7 | 2.1 |
| Nov | 0.83 | 0.83 | 0.83 | 24.8 | 24.8 | 0.0 |
| Dec | 0.87 | 0.82 | 0.84 | 26.1 | 26.1 | 0.0 |
| Apr & Nov Avg. | | | 0.89 | 26.72 | | |
| Total, mg | | | | 481.1 | 324.7 | 156.5 |
| % | | | | | 67% | 33% |

| Combined (City and District) | | | | | | |
|---|---|---|---|---|---|---|
| | Avg Day Usage, mgd | | | | | |
| | 2006 | 2007 | AVG, mgd | MG | Indoor | Outdoor |
| Jan | 1.99 | 2.17 | 2.08 | 64.5 | 64.5 | 0.0 |
| Feb | 2.03 | 2.21 | 2.12 | 59.8 | 59.8 | 0.0 |
| Mar | 2.20 | 2.21 | 2.20 | 68.3 | 68.3 | 0.0 |
| Apr | 1.67 | 1.77 | 1.72 | 51.6 | 51.6 | 0.0 |
| May | 2.33 | 2.57 | 2.45 | 76.0 | 49.7 | 26.3 |
| Jun | 4.66 | 4.54 | 4.60 | 138.0 | 49.7 | 88.3 |
| Jul | 4.84 | 5.72 | 5.28 | 163.8 | 49.7 | 114.1 |
| Aug | 4.23 | 4.32 | 4.28 | 132.6 | 49.7 | 82.9 |
| Sep | 2.92 | 3.18 | 3.05 | 91.5 | 49.7 | 41.8 |
| Oct | 1.70 | 1.74 | 1.72 | 53.3 | 49.7 | 3.5 |
| Nov | 1.58 | 1.62 | 1.60 | 47.9 | 47.9 | 0.0 |
| Dec | 1.96 | 1.84 | 1.90 | 58.8 | 58.8 | 0.0 |
| Apr & Nov Avg. | | | 1.66 | 49.73 | | |
| Total, mg | | | | 1006.2 | 649.4 | 356.8 |
| % | | | | | 65% | 35% |

Examining the combined results above show that Indoor Demands account for roughly two-thirds of the Total System demand and Outdoor Irrigation Water requirements account for roughly one-third of the total system demand. Outdoor irrigation demand was calculated by subtracting base flow from total monthly flow for the irrigation season (May to October).

Irrigation demand is driven by consumptive use requirements of plants and turf in the study area. Crop consumptive use requirements since 1985 were obtained for the City of Steamboat Springs. Figure 2-10 show the irrigation water requirement (inches) for this time period (CDSS, 2008) along with the combined outdoor water demand of the City and the District (in million gallons per month). It can be seen that historical peaks in the irrigation water requirement are generally reflected in outdoor water demand experienced by the City and the District.

**Figure 2-10. Historic Irrigated Water Requirement**



### 2.2.5 Park Irrigation Requirements

The City currently irrigates 74.42 acres of parks using raw and treated waters. In the park areas using treated water, application rates have varied between 1,800 gpd/ac to 7,425 gpd/ac, with an average application rate of 4,000 gpd/ac (Weber, 2008a). A review of the annual irrigation water requirement (IWR) for Steamboat Springs for the last 55 years (1950 to 2004) are summarized in Table 2-11

**Table 2-11. Yearly Park Irrigation Requirements**

| | In./Year | Acres | Irrigation Efficiency Rate | IWR (Acre-Feet) | IWR (Million Gallons) |
|---|---|---|---|---|---|
| Max. (1988) | 30.06 | 74.42 | 70% | 266 | 86.8 |
| Min. (1965) | 19.29 | 74.42 | 70% | 171 | 55.7 |
| Avg. | 24.45 | 74.42 | 70% | 217 | 70.6 |

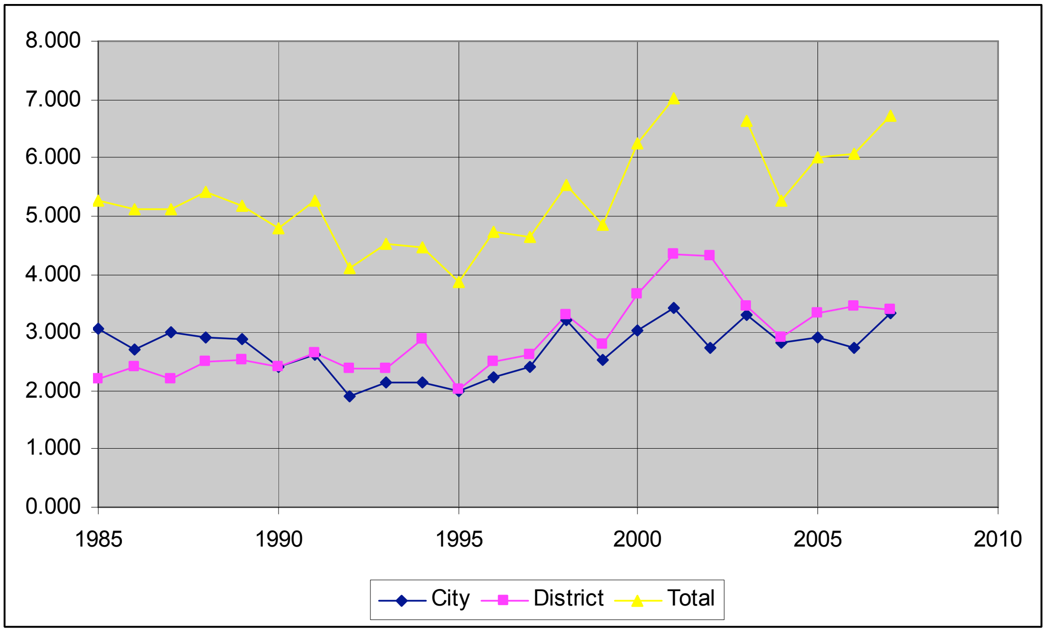
### 2.2.6 Maximum Day Demand

The Maximum Day Demand is an important parameter for water utilities as it represents the typical peak rate of water supply that must be made available to meet customer demands. Historical maximum day demand data for the City and the District are summarized in the following table and figure.

**Table 2-12. District and Total System Max Day Demands, MGD**

| Year | City Maximum Day Demand (MGD) | District Maximum Day Demand (MGD) | Total Maximum Day (MGD) |
|---|---|---|---|
| 1985 | 3.055 | 2.200 | 5.252 |
| 1986 | 2.698 | 2.405 | 5.103 |
| 1987 | 3.016 | 2.200 | 5.116 |
| 1988 | 2.909 | 2.510 | 5.419 |
| 1989 | 2.877 | 2.538 | 5.187 |
| **1990** | 2.404 | 2.396 | 4.800 |
| 1991 | 2.618 | 2.653 | 5.271 |
| 1992 | 1.891 | 2.366 | 4.112 |
| 1993 | 2.141 | 2.377 | 4.518 |
| 1994 | 2.150 | 2.893 | 4.460 |
| 1995 | 1.982 | 2.010 | 3.879 |
| 1996 | 2.216 | 2.500 | 4.716 |
| 1997 | 2.400 | 2.610 | 4.640 |
| 1998 | 3.220 | 3.290 | 5.540 |
| 1999 | 2.520 | 2.800 | 4.850 |
| **2000** | 3.048 | 3.644 | 6.235 |
| 2001 | 3.416 | 4.350 | 7.029 |
| 2002 | 2.741 | 4.320 | ------- |
| 2003 | 3.304 | 3.464 | 6.634 |
| 2004 | 2.829 | 2.903 | 5.275 |
| 2005 | 2.914 | 3.321 | 6.010 |
| 2006 | 2.749 | 3.454 | 6.066 |
| 2007 | 3.317 | 3.403 | 6.720 |

Figure 2-11. Historic Irrigated Water Requirement




The combined maximum day demand is frequently slightly less than the combined values for the City and the District due to the fact that these never occur on the exact day. As previously discussed, the last four years have been selected as being representative of current demand levels for the City and the District. Based on an analysis of these data the average maximum day demand for the City is approximately 2.95 mgd and approximately 3.27 mgd for the District. The theoretical Combined Maximum Day Demand is 6.02 mgd.

Another parameter related to Maximum Day Demand that is typically of value to water system planners is the ratio of Maximum Day to the Average Day. Historical data related to this ratio for the City, District and Combined total system are presented in the following table.

Table 2-13. Maximum Day/Average Day Demand Ratio (Peaking Factor)

| Year | City Maximum Day Demand (MGD) | Avg. Day (mgd) | Ratio (Peaking Factor) | District Maximum Day Demand (MGD) | Avg. Day (mgd) | Ratio (Peaking Factor) | Combined Total Maximum Day | Avg. Day (mgd) | Ratio (Peaking Factor) |
|---|---|---|---|---|---|---|---|---|---|
| 1985 | 3.055 | 1.179 | 2.59 | 2.200 | 1.114 | 1.98 | 5.252 | 2.292 | 2.29 |
| 1986 | 2.698 | 1.127 | 2.39 | 2.405 | 1.101 | 2.18 | 5.103 | 2.227 | 2.29 |
| 1987 | 3.016 | 1.097 | 2.75 | 2.200 | 1.032 | 2.13 | 5.116 | 2.129 | 2.40 |
| 1988 | 2.909 | 1.174 | 2.48 | 2.510 | 1.137 | 2.21 | 5.419 | 2.311 | 2.34 |
| 1989 | 2.877 | 1.104 | 2.61 | 2.538 | 1.227 | 2.07 | 5.187 | 2.331 | 2.23 |
| **1990** | 2.404 | 1.060 | 2.27 | 2.396 | 1.185 | 2.02 | 4.800 | 2.244 | 2.14 |
| 1991 | 2.618 | 1.019 | 2.57 | 2.653 | 1.077 | 2.46 | 5.271 | 2.096 | 2.51 |
| 1992 | 1.891 | 0.949 | 1.99 | 2.366 | 1.055 | 2.24 | 4.112 | 2.005 | 2.05 |
| 1993 | 2.141 | 1.072 | 2.00 | 2.377 | 1.105 | 2.15 | 4.518 | 2.177 | 2.08 |
| 1994 | 2.150 | 0.926 | 2.32 | 2.893 | 1.145 | 2.53 | 4.460 | 2.072 | 2.15 |
| 1995 | 1.982 | 0.882 | 2.25 | 2.010 | 1.097 | 1.83 | 3.879 | 1.979 | 1.96 |
| 1996 | 2.216 | 1.003 | 2.21 | 2.500 | 1.280 | 1.95 | 4.716 | 2.283 | 2.07 |
| 1997 | 2.400 | 0.951 | 2.52 | 2.610 | 1.350 | 1.93 | 4.640 | 2.302 | 2.02 |
| 1998 | 3.220 | 1.203 | 2.68 | 3.290 | 1.234 | 2.67 | 5.540 | 2.437 | 2.27 |
| 1999 | 2.520 | 1.143 | 2.21 | 2.800 | 1.037 | 2.70 | 4.850 | 2.180 | 2.23 |
| **2000** | 3.048 | 1.232 | 2.47 | 3.644 | 1.317 | 2.77 | 6.235 | 2.548 | 2.45 |
| 2001 | 3.416 | 1.208 | 2.83 | 4.350 | 1.389 | 3.13 | 7.029 | 2.597 | 2.71 |
| 2002 | 2.741 | 1.268 | 2.16 | 4.320 | 1.384 | 3.12 | -------- | 2.651 | ------ |
| 2003 | 3.304 | 1.280 | 2.58 | 3.464 | 1.331 | 2.60 | 6.634 | 2.611 | 2.54 |
| 2004 | 2.829 | 1.215 | 2.33 | 2.903 | 1.262 | 2.30 | 5.275 | 2.478 | 2.13 |
| 2005 | 2.914 | 1.235 | 2.36 | 3.321 | 1.297 | 2.56 | 6.010 | 2.532 | 2.37 |
| 2006 | 2.749 | 1.302 | 2.11 | 3.454 | 1.388 | 2.49 | 6.066 | 2.690 | 2.26 |
| 2007 | 3.317 | 1.316 | 2.52 | 3.403 | 1.488 | 2.29 | 6.720 | 2.804 | 2.40 |
| **Avg.** | | | **2.40** | | | **2.36** | | | **2.27** |
| **Max** | | | **2.83** | | | **3.13** | | | **2.71** |

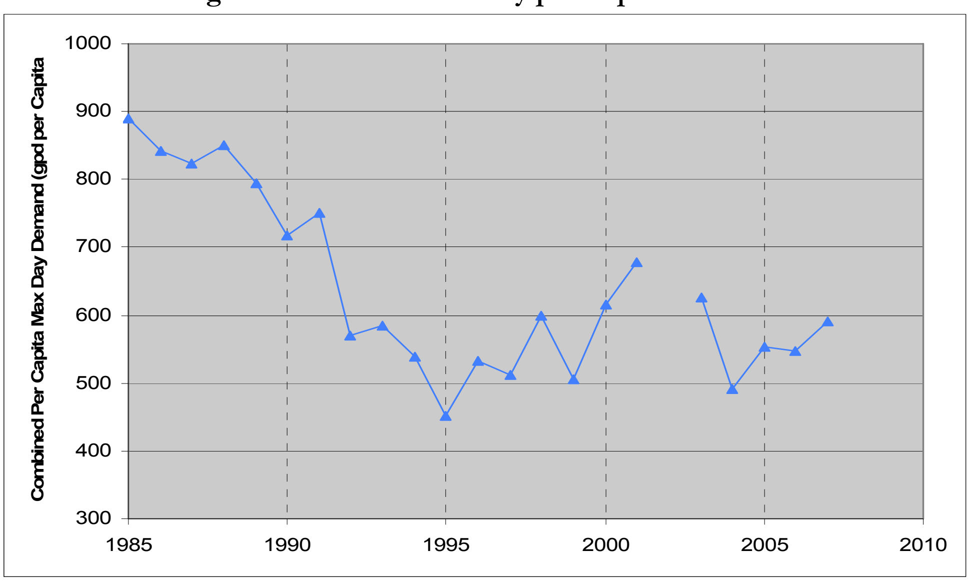
These data suggest that an average peaking factor value of about 2.4 is suitable for the City and District systems' individually. The combined peaking factor of approximately 2.3 is likely representative of the combined, total service area. Usage records show that peaking factors during extremely dry summer periods can increase to approximately 3.0. By comparison, published normal values suggest that a factor 1.8 (with a range of .5 to 3.0) is typical (Zipparro and Hansen, 1993). Given the community's resort nature, it is not surprising that historical factors are near the high end of this scale. Peak inflow data for the wastewater plant similarly reflect and support the notion of high peaking factors for the community. In 2006 maximum daily inflows were recorded to the plant equivalent to a service population of over 50,000 (Weber, 2008b).

Table 2-14 and Figure 2-12 presents a summary of Maximum Daily Demand on a per capita basis for the combined City and District water demand.

Table 2-14. Ratio of Maximum Day/Average Day Demands

| Year | Combined Total Maximum Day, mgd | Total Population | Maximum Day Demand (gpd per capita) |
|---|---|---|---|
| 1985 | 5.252 | 5,897 | 891 |
| 1986 | 5.103 | 6,057 | 842 |
| 1987 | 5.116 | 6,217 | 823 |
| 1988 | 5.419 | 6,377 | 850 |
| 1989 | 5.187 | 6,537 | 793 |
| 1990 | 4.800 | 6,695 | 717 |
| 1991 | 5.271 | 7,013 | 752 |
| 1992 | 4.112 | 7,221 | 569 |
| 1993 | 4.518 | 7,726 | 585 |
| 1994 | 4.460 | 8,278 | 539 |
| 1995 | 3.879 | 8,608 | 451 |
| 1996 | 4.716 | 8,851 | 533 |
| 1997 | 4.640 | 9,058 | 512 |
| 1998 | 5.540 | 9,259 | 598 |
| 1999 | 4.850 | 9,575 | 507 |
| 2000 | 6.235 | 10,115 | 616 |
| 2001 | 7.029 | 10,375 | 677 |
| 2002 | ---------- | 10,402 | ---------- |
| 2003 | 6.634 | 10,607 | 625 |
| 2004 | 5.275 | 10,742 | 491 |
| 2005 | 6.010 | 10,846 | 554 |
| 2006 | 6.066 | 11,083 | 547 |
| 2007 | 6.720 | 11,362 | 591 |

Figure 2-12. Maximum Day per Capita Demands




As with Per Capita total demands, Maximum Day per capita demand has decreased over time. Based on the last four years, as summarized in the following table, current Maximum Day per Capita demand is approximately 546 gpcd.

**Table 2-15. Current Maximum Day Per Capita Demand**

| Year | Total Maximum Day, mgd | Total Population | Maximum Day Demand (gpd per capita) |
|---|---|---|---|
| 2004 | 5.275 | 10,742 | 491 |
| 2005 | 6.010 | 10,846 | 554 |
| 2006 | 6.066 | 11,083 | 547 |
| 2007 | 6.720 | 11,362 | 591 |
| Average | | | **546** |

An examination of Maximum Day demands on the basis of Equivalent Residential (EQR) Units is summarized in the following table.

**Table 2-16. Current Maximum Day Per EQR Demand**

| **District** | | | |
|---|---|---|---|
| Year | District Maximum Day, mgd | Lag EQR data by 2-years | Maximum Day Demand (gpd per EQR) |
| 2004 | 2.90 | 5,469 | 531 |
| 2005 | 3.32 | 5,579 | 595 |
| 2006 | 3.45 | 5,768 | 599 |
| 2007 | 3.40 | 6,021 | 565 |
| | | Average (2004-07) | 573 |

| **City** | | | |
|---|---|---|---|
| Year | City Maximum Day, mgd | Lag EQR data by 2-years | Maximum Day Demand (gpd per EQR) |
| 2004 | 2.83 | 5,251 | 539 |
| 2005 | 2.91 | 5,361 | 544 |
| 2006 | 2.75 | 5,406 | 509 |
| 2007 | 3.32 | 5,555 | 597 |
| | | Average (2004-07) | 547 |

| **Combined** | | | |
|---|---|---|---|
| Year | Combined Maximum Day, mgd | Lag EQR data by 2-years | Maximum Day Demand (gpd per EQR) |
| 2004 | 5.28 | 10,720 | 492 |
| 2005 | 6.01 | 10,940 | 549 |
| 2006 | 6.07 | 11,174 | 543 |
| 2007 | 6.72 | 11,576 | 581 |
| | | Average (2004-07) | 541 |

## 2.3 PROJECTED DEMANDS

This section evaluates projected water demands for the City and the District. It is generally acknowledged that projecting growth is an uncertain endeavor at best. It is also relevant that water supply expansions generally take many years to achieve and require significant lead times for water rights, legal, engineering, environmental, and construction processes to be completed. It was therefore determined that a conservative approach should be taken in regards to projecting water demands.

The growth in water demands presented in the following sections should therefore be considered as an envelope curve and represent the maximum growth that might be reasonably considered for the City and the MWWD under the most aggressive scenario. These projections include expansion of the Urban Growth Boundary to the west of Steamboat as well as account for an increase in housing densities throughout the water service area. Increasing development density is consistent with trends experienced at many resort communities where real-estate is a premium.

### 2.3.1 City Projected Water Demand

The City's service area is predominantly located in a number of separate municipal Planning Areas. The western portion of the City's service area is the main focus of growth.

#### 2.3.1.1 West Steamboat Growth

West of Steamboat Springs is planned to be the main future growth area for the Steamboat Springs community. The adopted West of Steamboat Springs Area Plan (WSSAP) proposes a series of new neighborhoods for this planning area. New retail development and other community commercial uses are also proposed as a Village Center that will be central to and integrated with new residential neighborhoods and designed to also serve existing residential areas west of Old Town. The plan envisions a total of approximately 2,600 dwelling units, including existing units. The Steamboat 700 development comprises a majority of the development in the West of Steamboat Springs planning area; there are also large parcels between the Steamboat 700 development and the Steamboat II development, which also lie within the Urban Growth Boundary. The Urban Growth Boundary is a line established by the Steamboat Springs Area Community Plan in 1995 to identify which lands should be annexed into the City and developed for urban use and which lands should be retained in their existing rural use.

The Steamboat 700 Conceptual Master Plan consists of 1,837-2,243 new residential units and 272,000-331,000 square feet of commercial/ non-residential uses. Civil Design Consultants, Inc. of Steamboat Springs has estimated the future average daily water demands of Steamboat 700 community as outlined in Table 2-17 and 2-18 (Civil Design Consultants, 2008).

**Table 2-17. Steamboat 700 Future Demands at Full Buildout**

| | |
|---|---|
| Domestic (gpd) | 572,150 |
| Irrigation (gpd) | 433,007 |
| Total (gpd) | 1,084,022 |
| Maximum Day, mgd | 1.86 |
| AF/Yr | 927.5 |

**Table 2-18. Steamboat 700 Future Demands By Year**

| Year | Average Day Demand, mgd | Maximum Day Demand, mgd | Comment |
|---|---|---|---|
| 2010 | 0.10 | 0.22 | |
| 2011 | 0.20 | 0.44 | |
| 2012 | 0.30 | 0.67 | |
| 2013 | 0.40 | 0.89 | |
| **2014** | **0.49** | **1.11** | Phase I Buildout (Years 1-5) |
| 2015 | 0.53 | 1.19 | |
| 2016 | 0.56 | 1.27 | |
| 2017 | 0.60 | 1.35 | |
| 2018 | 0.63 | 1.43 | |
| 2019 | 0.67 | 1.51 | |
| 2020 | 0.70 | 1.59 | |
| 2021 | 0.74 | 1.66 | |
| **2022** | **0.77** | **1.74** | Phase II Buildout (Years 6 - 13) |
| 2023 | 0.80 | 1.80 | |
| **2024** | **0.83** | **1.86** | Phase III Buildout (Years 14-15) |

#### 2.3.1.2 Other Growth

Old Town and other Planning Areas within the City's service area are also projecting steady growth through the infill on vacant parcels, redevelopment of underutilized parcels, and development of new affordable housing units. Generally the neighborhoods are a mix of very low density single family development and duplex units. It is assumed that these areas of Steamboat Springs will grow at a rate commensurate with the State Demography Office projections for Routt County as a whole as presented in Table 2-19.

**Table 2-19. Projected Population Growth in Routt County**

| Year | Growth Rate | Year | Growth Rate |
|---|---|---|---|
| 2007 | 2.52% | 2020 | 2.37% |
| 2008 | 2.37% | 2021 | 2.33% |
| 2009 | 2.52% | 2022 | 2.18% |
| 2010 | 2.66% | 2023 | 2.34% |
| 2011 | 2.62% | 2024 | 2.38% |
| 2012 | 2.70% | 2025 | 2.47% |
| 2013 | 2.75% | 2026 | 2.36% |
| 2014 | 2.73% | 2027 | 2.31% |
| 2015 | 2.59% | 2028 | 2.22% |
| 2016 | 2.71% | | |
| 2017 | 2.65% | | |
| 2018 | 2.52% | | |
| 2019 | 2.48% | | |
| | | | |
| Growth Projections from Colorado Dept. of Local Affairs (DOLA, 2008). | | | |

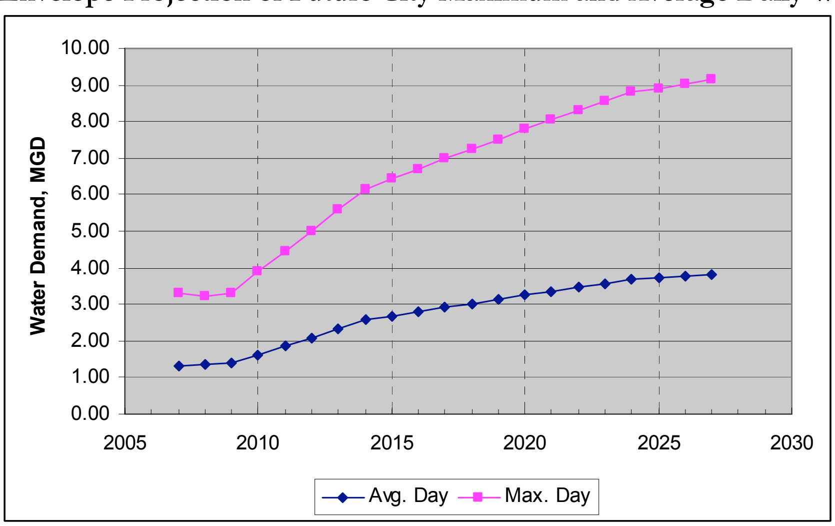
#### 2.3.1.3 Envelope Projected City Water Demand

An envelope curve for the projected total City Demand including Steamboat 700 is shown in Table 2-20 and in Figure 2-13. In this analysis it was considered reasonable and conservative to double the projected water demands for Steamboat 700 to account for additional growth in the western portions of the community, both within and beyond the existing service area boundary.

**Table 2-20. Envelope Projected City Water Demands (MGD)**

| Year | City Other, mgd | Steamboat 700, mgd | Additional Western Growth | **Avg. Day Total City, mgd** | **Maximum Day, mgd (MD/AD = 2.40)** |
|---|---|---|---|---|---|
| 2007 | | | | ***1.32*** | ***3.317*** |
| 2008 | 0.03 | | | 1.35 | 3.23 |
| 2009 | 0.03 | | | 1.38 | 3.32 |
| 2010 | 0.04 | 0.10 | 0.10 | 1.62 | 3.88 |
| 2011 | 0.04 | 0.20 | 0.20 | 1.85 | 4.44 |
| 2012 | 0.04 | 0.30 | 0.30 | 2.09 | 5.01 |
| 2013 | 0.04 | 0.40 | 0.40 | 2.33 | 5.58 |
| 2014 | 0.04 | 0.49 | 0.49 | 2.57 | 6.16 |
| 2015 | 0.04 | 0.53 | 0.53 | 2.68 | 6.42 |
| 2016 | 0.04 | 0.56 | 0.56 | 2.79 | 6.70 |
| 2017 | 0.04 | 0.60 | 0.60 | 2.90 | 6.97 |
| 2018 | 0.04 | 0.63 | 0.63 | 3.02 | 7.24 |
| 2019 | 0.04 | 0.67 | 0.67 | 3.13 | 7.52 |
| 2020 | 0.04 | 0.70 | 0.70 | 3.24 | 7.79 |
| 2021 | 0.04 | 0.74 | 0.74 | 3.36 | 8.06 |
| 2022 | 0.04 | 0.77 | 0.77 | 3.47 | 8.32 |
| 2023 | 0.04 | 0.80 | 0.80 | 3.57 | 8.56 |
| 2024 | 0.05 | 0.83 | 0.83 | 3.67 | 8.80 |
| 2025 | 0.05 | 0.83 | 0.83 | 3.72 | 8.92 |
| 2026 | 0.05 | 0.83 | 0.83 | 3.76 | 9.03 |
| 2027 | 0.05 | 0.83 | 0.83 | 3.81 | 9.15 |

**Figure 2-13. Envelope Projection of Future City Maximum and Average Daily Water Demand**



### 2.3.2 Mount Werner Projected Water Demand

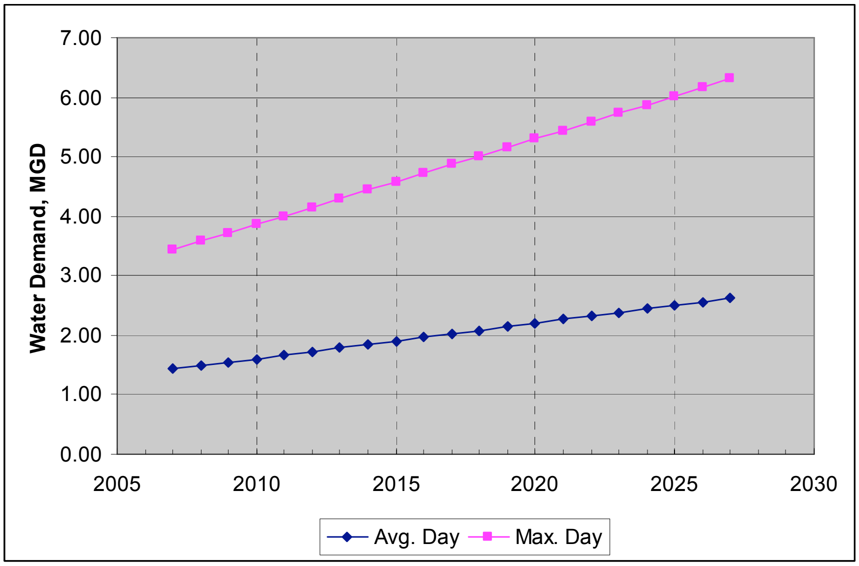
The District is almost entirely located in the City of Steamboat Spring Mountain planning area. The Mountain area serves as the primary base facility for the Steamboat Ski Area and houses the majority of the resort accommodations in the community. It is the center for commercial resort activities. Resort and recreation commercial activity is concentrated around the horseshoe of the "Base Area". The District's service area also contains several of the community's commercial shopping centers at US 40 and Pine Grove Road, and at US 40 and Mount Werner Road. The District annually updates its actual EQR count based upon tap fee calculations for the previous year and estimates projected EQR's based upon remaining available lots and estimates for re-developed properties. The District has estimated its future EQR build-out as presented in Table 2-21. Previously determined per EQR water demand rates are applied to derive estimates of average daily and maximum day water demands.

**Table 2-21. Projected District Future Water Demands (MGD)**

| Year | EQR's | Average Daily Demand, MGD (238 gpd per EQR) | Peak Daily Demand, MGD (573 gpd per EQR) |
|---|---|---|---|
| **2007** | 6,021 | ***1.488*** | ***3.403*** |
| 2008 | 6,273 | 1.49 | 3.59 |
| 2009 | 6,491 | 1.54 | 3.72 |
| 2010 | 6,743 | 1.60 | 3.86 |
| 2011 | 6,994 | 1.66 | 4.00 |
| 2012 | 7,245 | 1.72 | 4.15 |
| 2013 | 7,497 | 1.78 | 4.29 |
| 2014 | 7,748 | 1.84 | 4.44 |
| 2015 | 7,999 | 1.90 | 4.58 |
| 2016 | 8,250 | 1.96 | 4.72 |
| 2017 | 8,502 | 2.02 | 4.87 |
| 2018 | 8,753 | 2.08 | 5.01 |
| 2019 | 9,004 | 2.14 | 5.16 |
| 2020 | 9,256 | 2.20 | 5.30 |
| 2021 | 9,507 | 2.26 | 5.44 |
| 2022 | 9,758 | 2.32 | 5.59 |
| 2023 | 10,010 | 2.38 | 5.73 |
| 2024 | 10,261 | 2.44 | 5.88 |
| 2025 | 10,512 | 2.50 | 6.02 |
| 2026 | 10,764 | 2.56 | 6.16 |
| 2027 | 11,015 | 2.62 | 6.31 |

Graphically, these results are illustrated below.

Figure 2-14. Projected Maximum and Average Daily Mt. Werner District Water Demand



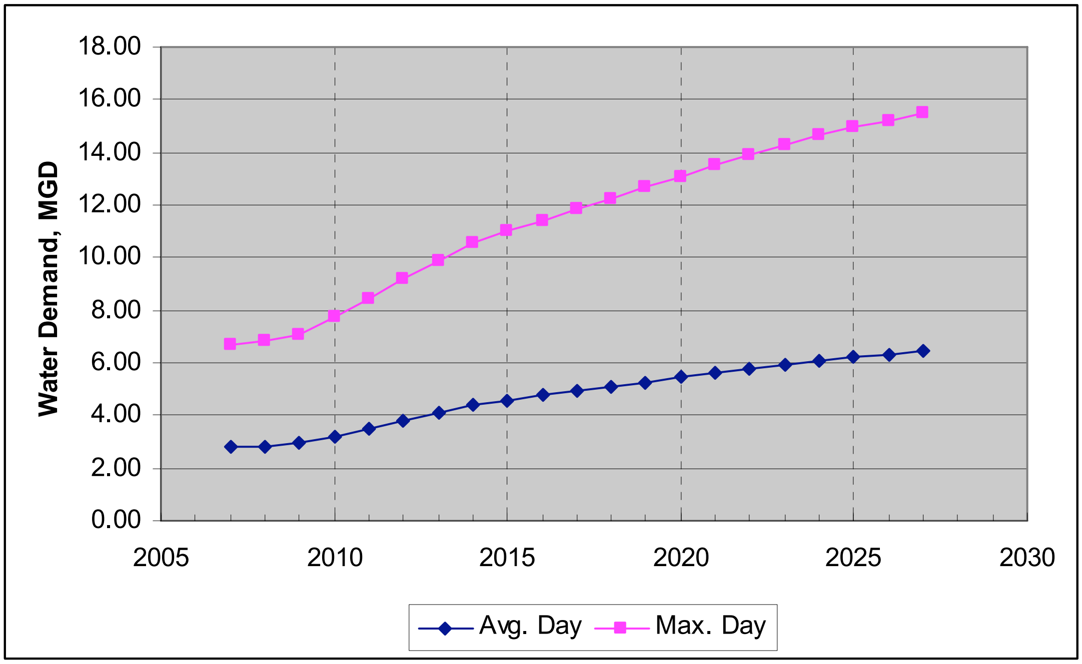

### 2.3.3 Combined Projected Water Demands

Combining the previously determined estimates of future water demands for the City and the District (Table 2-22), the following combined water demand envelope curve results.

Table 2-22. Total System Future Demands

| | City (mgd) | | District (mgd) | | Combined | | |
|---|---|---|---|---|---|---|---|
| Year | Avg. Day | Max. Day | Avg. Day | Max. Day | Avg. Day (mgd) | Annual (AF) | Peak Day (mgd) |
| **2007** | **1.316** | **3.317** | **1.488** | **3.403** | **2.804** | 3,141 | **6.720** |
| 2008 | 1.35 | 3.23 | 1.49 | 3.59 | 2.840 | 3,181 | 6.825 |
| 2009 | 1.38 | 3.32 | 1.54 | 3.72 | 2.926 | 3,277 | 7.032 |
| 2010 | 1.62 | 3.88 | 1.60 | 3.86 | 3.220 | 3,607 | 7.738 |
| 2011 | 1.85 | 4.44 | 1.66 | 4.00 | 3.514 | 3,937 | 8.445 |
| 2012 | 2.09 | 5.01 | 1.72 | 4.15 | 3.811 | 4,269 | 9.158 |
| 2013 | 2.33 | 5.58 | 1.78 | 4.29 | 4.109 | 4,603 | 9.874 |
| 2014 | 2.57 | 6.16 | 1.84 | 4.44 | 4.409 | 4,939 | 10.593 |
| 2015 | 2.68 | 6.42 | 1.90 | 4.58 | 4.580 | 5,130 | 11.003 |
| 2016 | 2.79 | 6.70 | 1.96 | 4.72 | 4.753 | 5,325 | 11.421 |
| 2017 | 2.90 | 6.97 | 2.02 | 4.87 | 4.927 | 5,520 | 11.839 |
| 2018 | 3.02 | 7.24 | 2.08 | 5.01 | 5.100 | 5,713 | 12.255 |
| 2019 | 3.13 | 7.52 | 2.14 | 5.16 | 5.274 | 5,907 | 12.671 |
| 2020 | 3.24 | 7.79 | 2.20 | 5.30 | 5.446 | 6,101 | 13.085 |
| 2021 | 3.36 | 8.06 | 2.26 | 5.44 | 5.619 | 6,294 | 13.500 |
| 2022 | 3.47 | 8.32 | 2.32 | 5.59 | 5.790 | 6,485 | 13.910 |
| 2023 | 3.57 | 8.56 | 2.38 | 5.73 | 5.947 | 6,662 | 14.289 |
| 2024 | 3.67 | 8.80 | 2.44 | 5.87 | 6.106 | 6,840 | 14.671 |
| 2025 | 3.72 | 8.92 | 2.50 | 6.02 | 6.216 | 6,963 | 14.935 |
| 2026 | 3.76 | 9.03 | 2.56 | 6.16 | 6.324 | 7,084 | 15.195 |
| 2027 | 3.81 | 9.15 | 2.62 | 6.31 | 6.433 | 7,206 | 15.456 |

**Figure 2-15. Combined Total Projected Water Demand Envelope Curve**



# 3.0 Water Supply

This section presents historical data and analysis regarding the water supply potential of existing and proposed water sources available to the City and the District. Included in the water sources analyzed are:

- Fish Creek Basin,
- Yampa River Wells,
- Elk River, and
- Other

Currently the City and the District primarily rely upon the resources of the Fish Creek Basin and the Yampa River Wells.

Each supply source has two distinct supply characteristics relating to the physical availability of water and the legal or water right availability for the City and District to divert and use water in association with exiting or new water rights. This chapter will deal only with the physical availability of water for the various water supply sources

## 3.1 SUPPLY SYSTEM OVERVIEW

### 3.1.1 Existing Facilities

#### 3.1.1.1 Fish Creek Filtration Plant

The Fish Creek Filtration Plant was originally constructed by the Mount Werner Water District in 1971. The District secured a special use permit from the Forest Service and built 2 filter bays. The plant served the resort/ mountain area of Steamboat Springs and had a total capacity of approximately 1.5 million gallons per day. The District later completed a land swap with the Forest Service and obtained the 59.62 acre filtration plant parcel.

In 1983, the EPA required the City of Steamboat Springs to treat and filter their water supply. Negotiations between the City and District resulted in the City adding capacity to the Fish Creek Filtration Plant to meet its new requirement for treated and filtered water. The City built four filter bays with a capacity of approximately three million gallons per day.

In 2000, the Mount Werner Water District reached its allotted capacity which triggered expansion at the Fish Creek Filtration Plant. To take advantage of cost savings, four filter bays were added. The District paid for the construction of two complete filter bays and brought the bays on-line in 2001. The City paid for the construction of two filter bays, but decided not to complete the piping, controls and filter components as it did not require additional capacity at that time. With the completion of the two filtration bays by the District, the Fish Creek Filtration Plant had eight filter bays on line.

In 2007, the City agreed to complete the two unfinished filter bays and lease back the capacity of one filter bay to the Mount Werner Water District which was once again reaching capacity in its system. There are currently ten filter bays on-line at the filtration plant. Four of the filter bays are owned by the District and six filtration bays are owned by the City. The capacity of one City filter bay is currently leased back to the District.

The current capacity of the Fish Creek Filtration Plant is approximately 7.5 million gallons per day, using 10 filter bays whose capacity is split 50/50 between the City and the District. To process 7.5 million gallons per day, approximately 11.6 cubic feet per second of raw water is required. The Fish Creek Filtration Plant is capable of treating in excess of 12 million gallons per day with the installation of additional filtration bays. However, the current configuration of the chemical feeding systems limits production to 12 million gallons per day. Major unit processes include chemical feed, flocculation, sedimentation and multimedia filtration. An on-site hypochlorite generation system produces a hypochlorite solution for disinfection. A clearwell and a two million gallon finished water storage tank allows for chlorine contact prior to distribution (Gallagher, 2003).

#### 3.1.1.2 Fish Creek Reservoir and Long Lake

Fish Creek Reservoir and Long Lake provide raw water storage for the City of Steamboat Springs and the District. Fish Creek Reservoir has storage rights for 4,167 acre-feet and Long Lake has storage rights for 396 acre-feet. The storage reservoirs are located high in the drainage basin and fill to capacity during the spring runoff. Water is drawn from the reservoirs during low flow months to augment supply to the Fish Creek Filtration Plant (ACZ, 1992).

#### 3.1.1.3 Yampa River Infiltration Galleries

In 1974, the Mount Werner Water District initially installed vertical wells A-F to augment the water demand needs of the Sheraton Golf Course. A 200-foot infiltration gallery (Infiltration Gallery G) was constructed in 1983 to increase output. In 1990 the District installed a 440-foot infiltration gallery (Infiltration Gallery H). A third infiltration gallery (Infiltration Gallery A) was constructed in 1991 by the City on the west side of the Yampa River along with piping to connect to the Mt. Werner pump station. In 1998, the Mt. Werner Water District constructed the Yampa River Well Filtration Plant to remove high levels of iron and manganese which resulted in improved water quality.

The Yampa River Well Filtration Plant has a capacity of approximately 2 million gallons per day. Water from the plant is fed into the distribution system to meet increased demand. The wells are typically used June through September during peak demand periods. There is no segregation of the City water and the Mount Werner water (Gallagher, 2003).

#### 3.1.1.4 Current Supply Capacity

The City of Steamboat Springs Utilities Division currently has a treatment capacity of 3.75 million gallons from the Fish Creek Filtration Plant and an additional 0.8 million gallons from the Yampa River Infiltration Galleries for a total peak capacity of 4.55 million gallons per day. The City of Steamboat Springs service area experienced an average day demand of 1.316 million gallons per day and a maximum day demand of 3.317 million gallons per day in 2007. The City is currently operating at 72.9 percent of its hydraulic capacity based on 2007 water demands.

The Mount Werner Water District currently has a treatment capacity of 3.75 million gallons from the Fish Creek Filtration Plant and an additional 1 million gallons from the Yampa River Infiltration Galleries for a total peak capacity of 4.75 million gallons per day. The District experienced an average day demand of 1.488 million gallons per day and a maximum day demand of 3.403 million gallons per day in 2007. On this basis, the District is currently operating at 71.6 percent of its hydraulic capacity.

The Total System currently has a treatment capacity of 7.5 million gallons from the Fish Creek Filtration Plant and an additional 1.8 million gallons from the Yampa River Infiltration Galleries for a total peak capacity of 9.30 million gallons per day. The combined average day water demand is 2.804 million gallons per day with a maximum day demand of 6.720 million gallons per day in 2007. The Total System is currently operating at 72.3 percent of its hydraulic capacity based on 2007 water demands.

## 3.2 WATER RIGHT OVERVIEW

The City and the District hold a large variety of water rights. Based on a review of provided documentation, summaries for each basin are provided in Appendix A. The water rights review conducted for this study is not intended to present a comprehensive legal documentation of said rights, but rather provides an overview as necessary and relevant to the issue of water supply planning. The water rights analysis in this report is based on information provided to Stantec. Stantec makes no representation that the water rights identified herein are all of the water rights that belong to the City and/or the District. This report is not a title opinion. The omission or inclusion of any water right on this list should not and cannot be taken as evidence of ownership or abandonment of any particular water right. This information was used in the subsequent analysis of the firm yields that can be anticipated from various supply sources available to the City and the District. The firm yield represents the amount of water that can be considered to be available 100% of the time, even during the most severe drought conditions.

### 3.2.1 Fish Creek Basin

The City and the District have significant water right interest in the Fish Creek Basin. Fish Creek is the primary source of existing water supplies and the City and the District share joint reservoir, diversion, and water treatment facilities utilizing this source. A summary of the City and the District's water rights on Fish Creek are presented in Appendix A. A synopsis of the Fish Creek water rights is provided in Table 3-1 and Figure 3-1.

Table 3-1. Fish Creek Water Rights

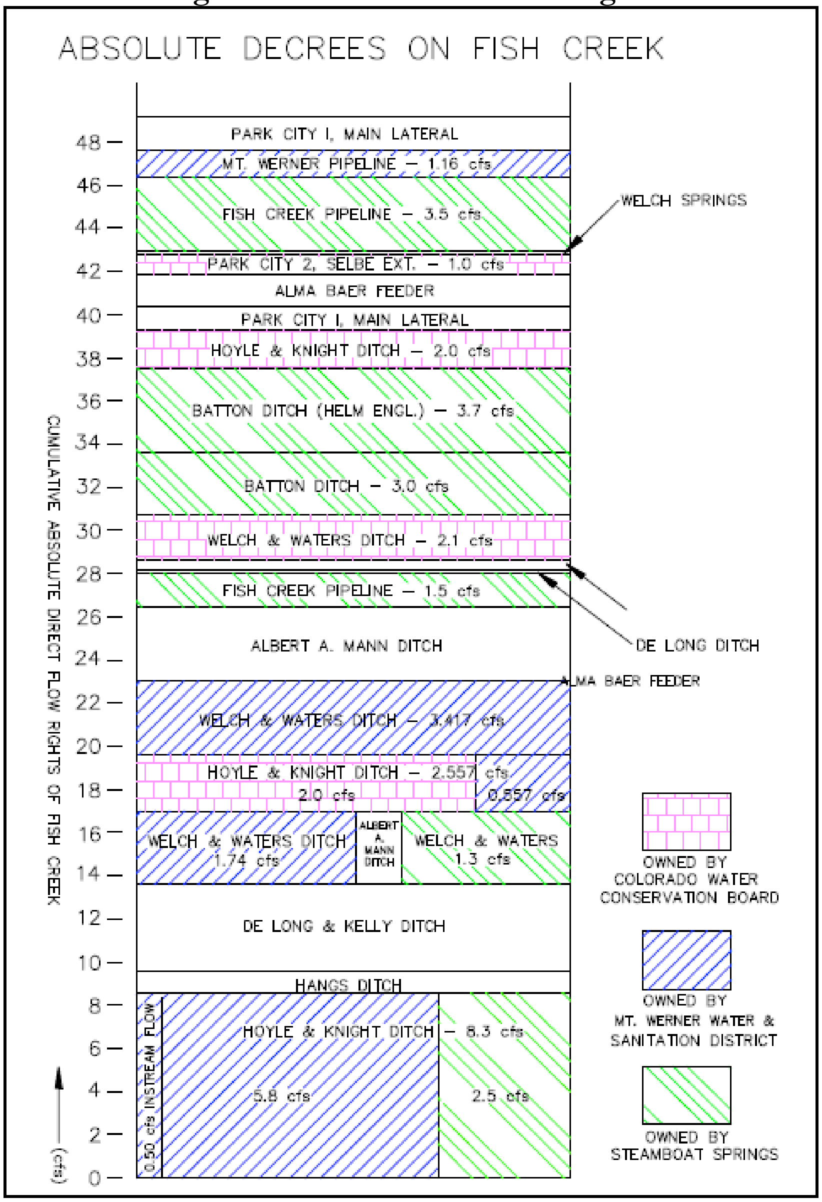
| PRIORITY | WATER RIGHT | MWW | CITY | OTHER | TOTAL | NOTES (1) |
|---|---|---|---|---|---|---|
| 1 | Hoyle & Knight, 1892 | 5.8 | 2.5 | 0.5* | 8.30 | *0.50 cfs, CWCB for instream flow against and subordinate to MWW right (2) |
| | Hangs Ditch | | | | | |
| | De Long & Kelly Ditch | | | | | |
| 2 | Welch & Waters, 1904 | 1.74 | 1.30 | | 3.04 | |
| 3 | Hoyle & Knight, 1911 | 0.56 | | 2.00 | 2.56 | 2.00 cfs, CWCB for instream flow |
| 4 | Welch & Waters, 1912 | 3.42 | | | 3.42 | |
| | Albert A. Mann Ditch | | | | | |
| 5 | Fish Creek Pipeline, 1923 | | 1.50 | | 1.50 | |
| | De Long Ditch | | | | | |
| | Alma Baer Feeder | | | | | |
| 6 | Welch & Waters, 1946 | | | 2.10 | 2.10 | 2.10 cfs, CWCB for instream flow |
| 7 | Batton, 1953 | | 3.00 | | 3.00 | |
| 8 | Batton, 1953 | | 3.70 | | 3.70 | |
| 9 | Hoyle and Knight, 1957 | | | 1.00 | 1.00 | 1.00 cfs, CWCB for instream flow |
| 10 | Hoyle and Knight, 1957 | | | 1.00 | 1.00 | |
| 11 | Park City No. 2, 1964 | | | 1.00 | 1.00 | |
| 12 | Fish Creek Pipeline, 1972 | | 3.50 | | 3.50 | |
| 13 | Mt. Werner Pipeline, 1972 | 3.86 | | | 3.86 | |
| | **Totals** | **15.29** | **15.59** | **7.10** | **37.98** | |

*Notes:* *(1) These are estimate proportions of water rights and not a conclusion of titled water rights*.
(2) Case W-959-76 states in paragraph H: "….In addition to these [CWCB] rights, the maintenance of a 0.5 cfs rate of flow in Fish Creek to support fish and recreational needs will be accomplished by bypassing at least 0.5 cfs of the senior Hoyle and Knight water right past the Fish Creek water treatment plant. This water will be allowed to flow downstream to the original point of diversion of the Hoyle and Knight Ditch and then downstream to the confluence with the Yampa River….In the event of municipal potable water shortages, the minimum flow of 0.5 cfs in Fish Creek shall be subject to whatever diminution or total cessation as may be necessary to meet domestic requirements of the Applicant [Mt. Werner Water]."

The City and the District share the senior most right totaling 8.3 cfs. The flow in Fish Creek often drops below this amount. During such periods of low flow, the flow is divided between the City and the District proportionally.

Reservoir storage in the Fish Creek Basin above the water treatment plant intake is a critical supply resource for the City and the District. During much of the year the natural in-stream flow in Fish Creek at the intake is very low. During such times the ability to release stored water from Fish Creek and/or Long Lake Reservoir is critical for providing adequate flows to meet water demand while maintaining sufficient streamflows for riparian health.

**Figure 3-1. Fish Creek Water Rights**




(These are estimate proportions of water rights and not a conclusion of titled water rights.)

Detailed information on the water rights associated with each reservoir are provided in Appendix A. Fish Creek Reservoir has four adjudicated storage rights dating from 1946. The most recent enlargement brought the total Fish Creek Reservoir volume to 4,167 AF. This storage is allocated as illustrated in the Figure 3-2. As shown, 1,030 AF are dedicated as a fisheries conservation pool. The agreement does allow the City/District to draw water from this pool during times of drought or emergency or as necessary for repairs and maintenance. An additional 200 AF are set aside to provide releases to maintain minimum in-stream flows.

The City's Four-Counties Ditch No. 1 water rights, dating from 1946, are essential to the spring run-off filling and post-run-off refilling of the Fish Creek Reservoir each year. The City's Four-

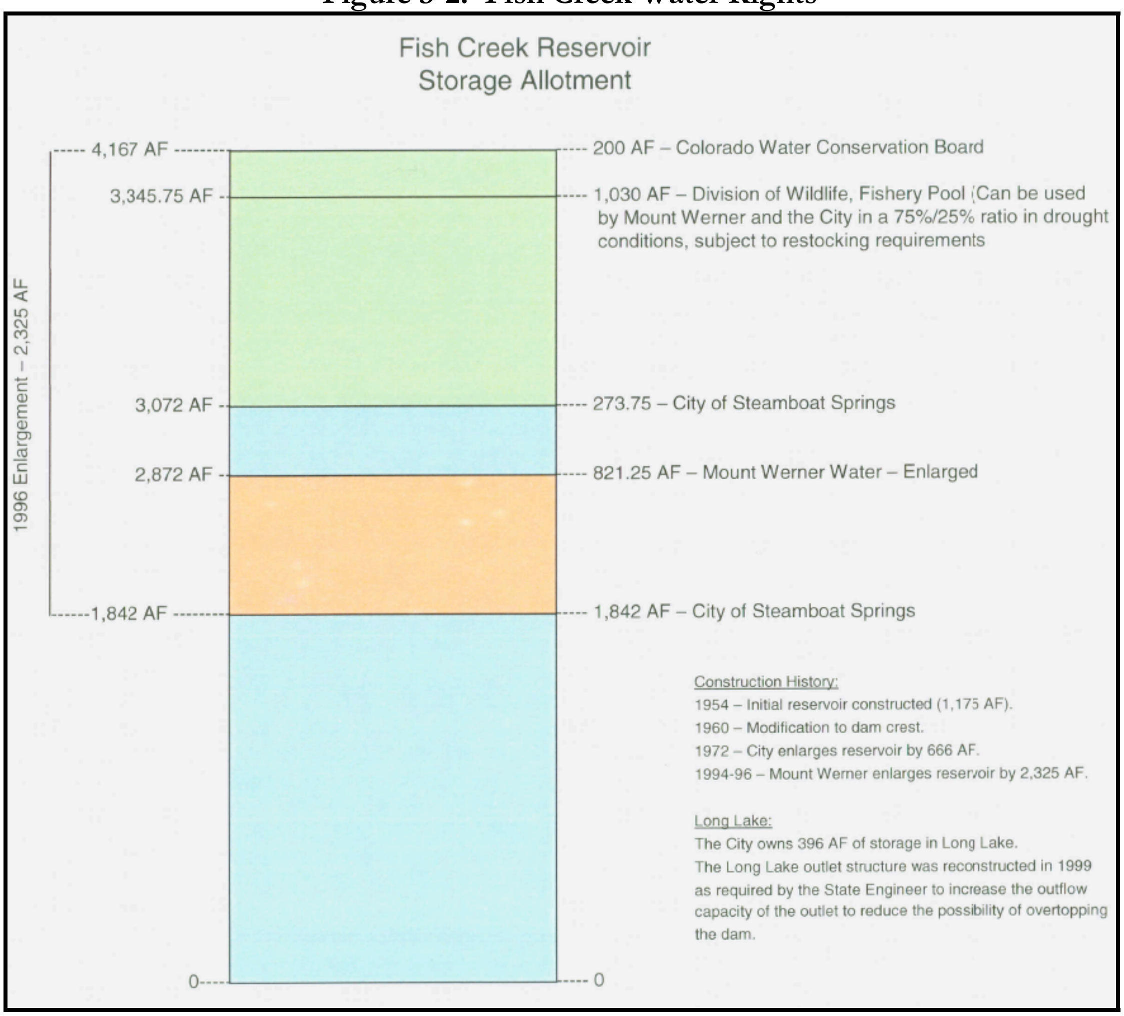
Counties Ditch No. 1 water rights are measured at three virtual headgates on the Middle Fork Fish Creek and on Granite Creek above Fish Creek Reservoir. The City will be applying to the water division to significantly increase the absolute portion of these rights following a reservoir filling and elevation monitoring exercise conducted by the District as operator June 16-17, 2008. As mandated by the State Engineer in 2007, the filling order is as follows- most senior to most junior:

1. City's original storage right (1175.43 AF (1946), 666.63 AF (1964)

2. Four-Counties Ditch No. 1 in-stream water rights conditional (decreed 1964) and partial absolute (1999) on headgates 5, 6, and 7.

Each year, the Four-Counties Ditch No. 1 in-stream water rights are sufficient each year to complete the reservoir fill and, in most years, partially re-fill the reservoir (Gallagher, 2008). The CWCB storage right of 200AF and Fish Creek Reservoir First Expansion storage right of 2000AF remain conditional.

**Figure 3-2. Fish Creek Water Rights**



Long Lake Reservoir also provides storage above the intake. The entire capacity of Long Lake is owned by the City. The storage rights on Long Lake have an adjudication date of 1946. Releases for instream flow are not required from Long Lake Reservoir.

The CWCB has adjudicated eight minimum instream flow water rights on various reaches of Fish Creek and its tributaries. These rights are all junior to the City and the District's direct flow rights and the original storage rights in Fish Creek Reservoir (City's original and District's Four Counties). These water rights are listed in the following table (Wright Water Eng., 2002).

**Table 3-2. Fish Creek Minimum Instream Flow Rights**

| Reach Location | Amount, in cfs | Adjudication Date |
|---|---|---|
| Outlet of Long Lake to confluence of South Fork Fish Creek with North Fork | 4.0 | 12/31/1977 |
| Mt. Werner PL to Yampa River | 2.0 | 12/31/1979 |
| Confluence of North Fork to Mt. Werner PL | 9.0 | 12/31/1979 |
| Headwaters of Granite Creek to Fish Creek Reservoir | 4.0 | 12/31/1977 |
| Headwaters of Middle Fork to Fish Creek Reservoir | 2.0 | 12/31/1977 |
| Fish Creek Reservoir to confluence with North Fork Fish Creek | 2.0 | 12/31/1977 |
| Headwaters of North Fork to confluence with Middle Fork Fish Creek | 2.0 | 12/31/1977 |
| Confluence of Middle Fish Creek to Fish Creek below falls | 5.0 | 12/31/1977 |

Data source: 1993 *Fish Creek Reservoir Expansion Final Environmental Impact Statement*

### 3.2.2 Yampa River Wells

The City and the District maintain a water supply from three infiltration galleries or wells as a supplemental supply during peak demand periods. The infiltration galleries are approximately 30 feet deep and draw groundwater from the Yampa River alluvium. The water has a relatively high mineral content. Water quality issues include alkalinity, hardness, dissolved solids, iron, and manganese. Water from the galleries is subject to treatment for removal of iron and manganese before being pumped into the distribution system

Water from the City and the District's galleries is diverted under Yampa River diversion water rights. Appendix A details the various water rights held by the City and the District associated with the infiltration galleries and are summarized below.

**Table 3-3. Yampa River Well Rights**

| Name | Admin No. | Amount, cfs | Annual Volume Limitations, AF | Ownership | |
|---|---|---|---|---|---|
| | | | | Steamboat Springs | Mount Werner |
| Mt. Werner Well G | 48868.00000 | 1.8 | na | 0 | 1.8 |
| Mt. Werner Well H | 51134.46721 | 3.0 | na | 0 | 3.0 |
| Steamboat Municipal Well A | 51494.00000 | 6.67 | 1,568 | 6.67 | 0 |

### 3.2.3 Other Water Rights

In addition to the main supply rights in the Fish Creek Basin and the Yampa Well rights, the City and District hold a variety of additional water rights. Information on these rights is provided in

Appendix A. Perhaps the most significant of these is the City's conditional Elk River water right. This water right totaling 8 cfs has been tentatively identified as a potential future water supply. Subsequent sections will evaluate the potential yield associated with development of this water right.

Other water rights held by the City and the District can be categorized as follows:

- Park, Garden & Springs (City)
- Haymaker Golf Course Rights (City)
- More Property Infiltration Gallery No. 1 (MWWD)
- Soda Creek Water Rights (City)
- Spring Creek Water Rights (City)

### 3.2.4 Lease Agreements

In addition to these rights, the City and District also lease storage rights in Stagecoach Reservoir, which is located approximately 20 miles south of Steamboat on the Yampa River. Stagecoach Reservoir is owned and operated by the Upper Yampa Water Conservancy District and has a total storage capacity of 33,274 acre-feet. The District also leases water in Yamcolo Reservoir, which is located approximately 24 miles upstream of Stagecoach Reservoir and has a total capacity of 9,580 acre-feet. Yamcolo Reservoir is also owned and operated by the Upper Yampa Water Conservancy District. All agreements are renewable, 30-year, long term leases. Details on these lease agreements are summarized in the following summary table (NFS, 1993).

**Table 3-4. Water Lease Agreements**

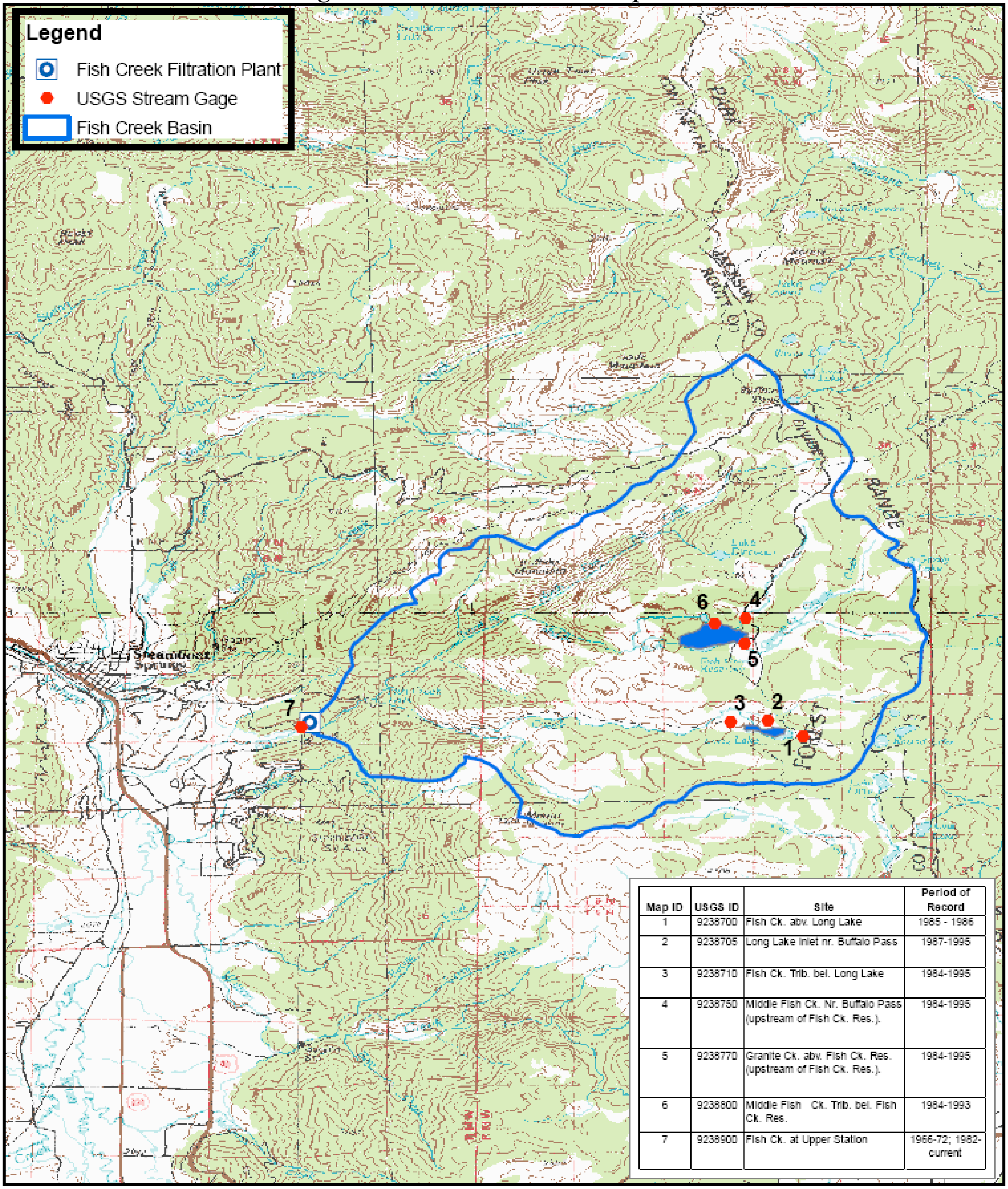
| Lessee | Reservoir | Amount, AF | Notes |
|---|---|---|---|
| City | Yamcolo | -------- | |
| | Stagecoach | 500 | Releases limited to period between 7/15 to 4/1 |
| | | | |
| District | Yamcolo | 300 | Releases limited period between 7/15 to 3/1 |
| | Stagecoach | 200 | Releases limited to period between 7/15 to 4/1 |

## 3.3 FISH CREEK BASIN SUPPLY

### 3.3.1 Hydrology

The Fish Creek drainage figures prominently in the water supply for both the City and the District. Figure 3-3 illustrates the location of gages and water supply facilities within the Fish Creek Basin. Historical streamflow data for these gages are included in Appendix B.

Figure 3-3. Fish Creek Basin Map




| Map ID | USGS ID | Site | Period of Record |
|---|---|---|---|
| 1 | 9238700 | Fish Ck. abv. Long Lake | 1985 - 1986 |
| 2 | 9238705 | Long Lake Inlet nr. Buffalo Pass | 1987-1995 |
| 3 | 9238710 | Fish Ck. Trib. bel. Long Lake | 1984-1995 |
| 4 | 9238750 | Middle Fish Ck. Nr. Buffalo Pass (upstream of Fish Ck. Res.). | 1984-1995 |
| 5 | 9238770 | Granite Ck. abv. Fish Ck. Res. (upstream of Fish Ck. Res.). | 1984-1995 |
| 6 | 9238800 | Middle Fish Ck. Trib. bel. Fish Ck. Res. | 1984-1993 |
| 7 | 9238900 | Fish Ck. at Upper Station | 1966-72; 1982-current |

Table 3-5. Streamflow Gages in the Fish Creek Basin

| USGS ID | Site | Period of Record | Drainage Area (sqmi.) | Avg. Annual Discharge (AF) |
|---|---|---|---|---|
| 09238700 | Fish Ck. abv. Long Lake | 1985 - 1986 | 0.71 | |
| 09238705 | Long Lake Inlet nr. Buffalo Pass | 1987-1995 | 0.71 | 1,109 |
| 09238710 | Fish Ck. Trib. bel. Long Lake | 1984-1995 | 1.03 | 1,134 |
| 09238750 | Middle Fish Ck. Nr. Buffalo Pass (upstream of Fish Ck. Res.). | 1984-1995 | 1.37 | 2,825 |
| 09238770 | Granite Ck. abv. Fish Ck. Res. (upstream of Fish Ck. Res.). | 1984-1995 | 2.82 | 4,737 |
| 09238800 | Middle Fish Ck. Trib. bel. Fish Ck. Res. | 1984-1993 | 4.79 | 5,114 |
| 09238900 | Fish Ck. at Upper Station | 1966-72; 1982-current | 25.8 | 46,053 |

Of these, Gages 09238700 and 09238705 reflect inflows to Long Lake Reservoir as the initial gage installation was slightly relocated in 1987. For the purposes of this study, the data however from these gages can be combined to create one continuous record of inflows to Long Lake Reservoir from 1985 to 1995.

The Middle Fork of Fish Creek and the two branches of Granite Creek are the water sources for Fish Creek Reservoir. Gages 09238750 and 09238770 lie on these tributaries flowing into Fish Creek Reservoir. By adding these flows together a record of historical total inflows to Fish Creek Reservoir can be produced. On this basis, the average annual inflow to Fish Creek Reservoir (over the period 1985 to 1995) is approximately 7,560 acre-feet.

Following the expansion of Fish Creek Reservoir in 1996, the Granite Creek gage was relocated, slightly upstream of the previous location. This gage is owned and operated by the District.

### 3.3.2 Streamflow Analysis

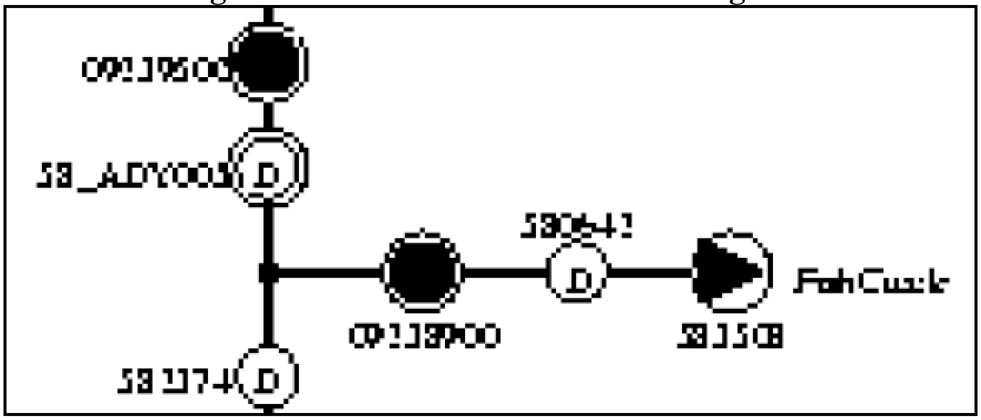
**<u>Flows Available for Diversion</u>**

To better ascertain the availability of streamflows within the Fish Creek basin, a longer period of record would be preferred than that provided by the historical gaging data alone. To accomplish this, it is necessary to extend historical streamflow gages through correlation with other gages which have streamflow records extending back to the early 20$^{th}$ century.

As part of the State of Colorado's CDSS (Colorado Decision Support System) model for the Yampa River Basin (CDSS, 2008a), a historical record of streamflows for Fish Creek was created based on correlation with other historical gages extending from 1909 to 2005. It is generally acknowledged however that the data prior to 1930 is less reliable.

The CDSS model for of the Fish Creek basin has been simplified as shown below.

**Figure 3-4. Fish Creek CDSS Nodal Diagram**



Due to the extreme extent of the modeling efforts in developing a model for the entire Yampa River Basin, it is not uncommon for tributaries to be simplified in the model. In this case, Fish Creek and Long Lake Reservoirs have been combined into one reservoir to simplify system analysis. Inflows were then synthesized for two locations on Fish Creek; at the Upper station gage and above Fish Creek/Long Lake Reservoir. Examination of the model data suggests that the Upper Station data just below the Fish Creek Filtration Plant is of a higher quality than that developed to represent Fish Creek/Long Lake Reservoir aggregate inflows.

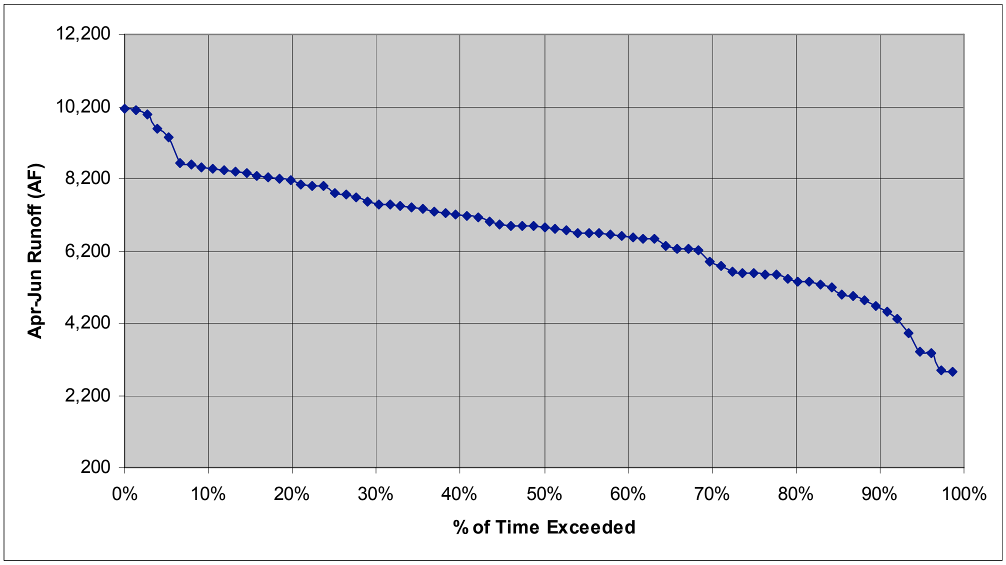
Regression analysis of the 11 years of historical data against the synthesized 1930 - 2005 flows at Upper Station were conducted resulting in a synthesized gage record (1930 - 2005) of inflows to Long Lake and Fish Creek Reservoirs. Also, by subtracting these flows from the total flow at the Upper Station Gage, it was possible to establish a record of un-regulated inflows in the Fish Creek basin. These data represent inflows from all areas of the Fish Creek basin that are not tributary to either Fish Creek Reservoir or Long Lake Reservoir. These synthesized data are presented in Appendix B. A summary of the resulting flows is provided in the following table.

**Table 3-6. Fish Creek Basin Extended Period Streamflow Summary Statistics**

| | Average Annual (AF) | Minimum Annual (AF) | Maximum Annual (AF) |
|---|---|---|---|
| Long Lake Reservoir Inflows | 1,233 | 432 | 2,641 |
| Fish Creek Reservoir Inflows | 8,369 | 3,222 | 16,644 |
| Un-Regulated Fish Creek Basin Flows | 37,249 | 16,163 | 66,228 |
| Fish Creek at Upper Station | 46,852 | 20,022 | 85,513 |

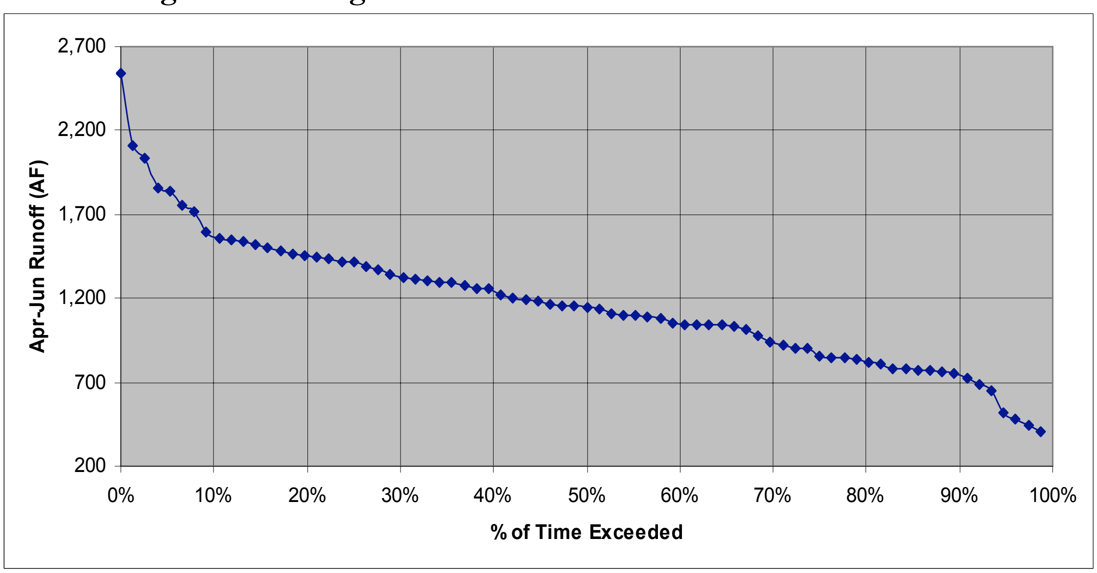
To examine the probability of Fish Creek Reservoir and Long Lake Reservoir filling each year, flow duration curves were produced of the April through June runoff volumes entering each reservoir. The resulting curves are presented in Figures 3-5 and 3-6.

Figure 3-5. Fish Creek Reservoir Inflow Flow Duration Curve




For Fish Creek Reservoir inflows, the minimum runoff through the period of April through June was in 1934 and totaled 2,846 AF. On this basis the probability of filling Fish Creek's 3,137 AF active pool (4,167 total capacity minus 1,030 AF conservation pool) is very good. Only 2 years out of 75 do not show more than 3,137 AF of cumulative runoff during the months of April through June. This analysis also disregards any fills that might result earlier or later in the year. The lowest annual flow entering Fish Creek Reservoir was 3,222 AF (1934).

Figure 3-6. Long Lake Reservoir Inflow Flow Duration Curve



For Long Lake Reservoir inflows, the minimum April through June runoff also occurred in 1934 and totaled 389 AF. On this basis the probability of consistently filling Long Lake Reservoir's 395.5 AF active pool is very good. No years exhibit less than 389 AF of cumulative runoff during the months of April through June. This analysis also disregards any fills that might result earlier or later in the year. The minimum total annual flow entering Long Lake Reservoir was 432 AF (1934).

### 3.3.3 Firm Yield of Fish Creek Drainage

While the previous analysis suggests that the probability of Fish Creek and Long Lake Reservoir filling each year, even under extreme drought conditions is very good, an analysis of the total yield available to the City and District on the basis of existing water rights and storage facilities is needed to ascertain the reliable yield of the Fish Creek basin as a whole.

To resolve this issue the CDSS Yampa River model was used (CDSS, 2008b). As previously discussed this model includes some simplification of the Fish Creek basin; however modification of the existing model was beyond the scope of this work. Some minor inaccuracies in the model were however resolved so that the results would accurately reflect diversion availability at the Fish Creek Filtration Plant.

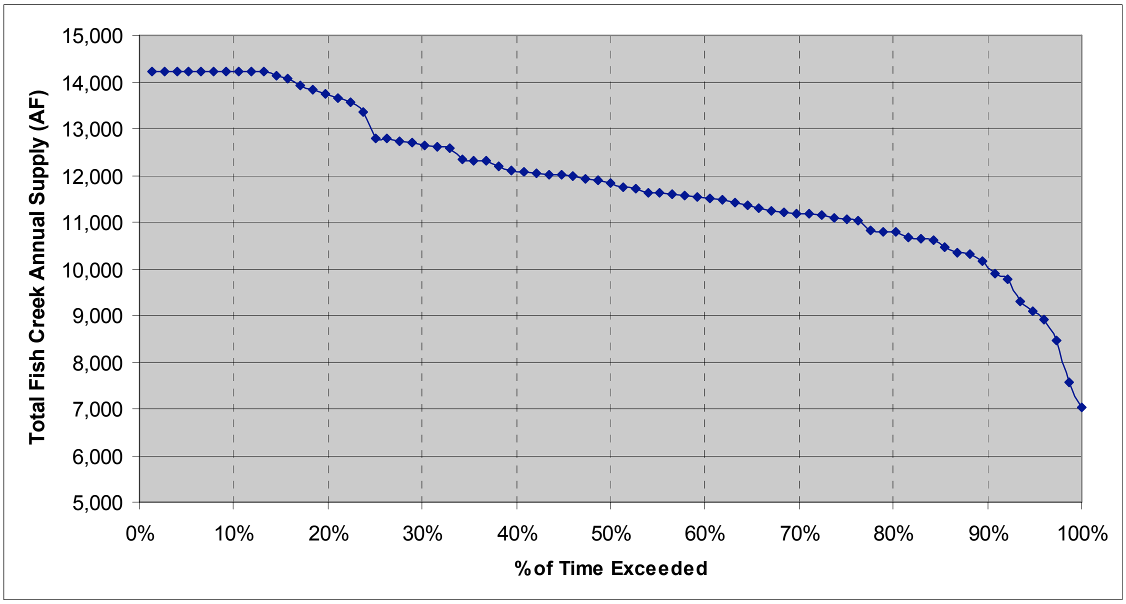
To determine average and minimum reliable yields available from the Fish Creek basin, the following monthly demand sequence was used. This demand sequence is based on previously presented monthly demand distribution depicted previously in Figure 2-6. The maximum day demand was set at 33 cfs, which corresponds to the peak diversion rate available under all of the City and District's combined Fish Creek water rights.

**Table 3-7. Total Municipal Water Demand used in Model Evaluation**

| | **Municipal Water Demand** | | |
|---|---|---|---|
| | **AF/Mo** | **%** | **Avg. Monthly Rate (mgd)** |
| Oct | 894 | 6.3% | 9.40 |
| Nov | 801 | 5.6% | 8.70 |
| Dec | 942 | 6.6% | 9.91 |
| Jan | 1,084 | 7.6% | 11.39 |
| Feb | 937 | 6.6% | 10.81 |
| Mar | 1,089 | 7.7% | 11.44 |
| Apr | 757 | 5.3% | 8.22 |
| May | 1,059 | 7.4% | 11.13 |
| Jun | 1,352 | 9.5% | 14.69 |
| Jul | 2,026 | 14.2% | 21.30 |
| Aug | 1,777 | 12.5% | 18.68 |
| Sep | 1,503 | 10.6% | 16.33 |
| **TOTAL** | **14,221 AF/Yr** | | **12.69** |

The resulting demands total over 14,000 AF per year, which is a little less than five times the current 2,943 AF total annual demand for the City and the District. Using this maximum water right as a demand, the analysis then examined the ability and reliability of the Fish Creek Basin to meeting these demands over the historical 75-year period of 1930 to 2005. The Flow-duration curve presented in Figure 3.7 illustrates the resulting water supply available.

**Figure 3-7. Fish Creek Basin Water Yield Flow Duration Curve**




While substantially more is readily available in wet years (up to the full 14,000 AF/year) the amount of water available in very dry years is more important for water planning purposes. An examination of the ten lowest years of water supply illustrates this concept and is provided in Table 3-8. These results suggest that the reliable firm yield of the Fish Creek basin is approximately 7,000 AF per year as this represents the amount of flow that is available or exceeded 100% of the time even during the most severe drought conditions (as represented in the period 1930-2005).

**Table 3-8. Ranked Drought Years and Available Annual Water Supply**

| Year | Available Annual Supply, AF | Rank | % of Times Available Annual Supply is Equaled or Exceeded |
|---|---|---|---|
| 2002 | 7,029 | 1 | 100% |
| 1977 | 7,565 | 2 | 99% |
| 1934 | 8,470 | 3 | 97% |
| 1989 | 8,908 | 4 | 96% |
| 1940 | 9,100 | 5 | 95% |
| 2001 | 9,311 | 6 | 93% |
| 1937 | 9,769 | 7 | 92% |
| 1954 | 9,904 | 8 | 91% |
| 1935 | 10,166 | 9 | 89% |
| 1955 | 10,312 | 10 | 88% |

Other informative results that can be taken from this evaluation are summarized in the following table. Model results are included in Appendix C.

Table 3-9. Municipal Water Supply Results for Fish Creek Basin

| | Annual Demand (AF/yr.) | Avg. Supply From Direct Diversion (AF/yr.) | Avg. Supply From Reservoir Release (AF/yr.) | Total Supply (AF/yr.) | Shortage (AF/yr.) |
|---|---|---|---|---|---|
| Average | 14,221 | 8,256 | 3,607 | 11,864 | 2,357 |
| % | | 70% | 30% | | |
| Min. (2002) | 14,221 | 5,592 | 1,277 | 7,029 | 7,192 |
| % | | 80% | 18% | | |

These results show that during an average year, approximately 11,900 AF is available to the City and the District from the Fish Creek Basin. Of this, 8,300 AF is provided by direct diversion and 3,600 AF by reservoir releases. During the driest year on record (2002), the Fish Creek Basin was still able to provide 7,000 AF of water.

Because the existing CDSS model is based on a simplification with an aggregated reservoir, it was important to confirm these results with a spreadsheet model. Model results indicate that 2002 is the critical year in the historical hydrologic sequence. Spreadsheet modeling of 2002 suggests that approximately 8,000 AF were be available for municipal water supply in 2002 (including releases from Conservation Pool). This result was taken to validate the model's results and suggests a firm yield of between 7,000 and 8,000 AF per year for the Fish Creek watershed even during the driest year on record.

## 3.4 YAMPA RIVER WELLS SUPPLY

The CDSS Yampa River Basin model was also used to evaluate the reliable water supply available to the City and the District's Yampa River wells. These facilities hold water rights more junior to those on Fish Creek and there is concern that they may be subject to being called out by other senior water users in low runoff years.

To determine the maximum reliable yield associated with these water rights, demand were input to the model equal to the total water right and distributed monthly as previously discussed. Additionally, City and District storage accounts in Stagecoach Reservoir were allowed to release water to the wells in the event that the river was not able to fully satisfy demand due to either senior rights or insufficient streamflows. Model results are included in Appendix C and summarized in the following table.

Table 3-10. Municipal Water Demand Model Summary Results for Yampa River Wells

| | | Demand | | From River By | | |
|---|---|---|---|---|---|---|
| | | Total | Priority | Storage | Total | Total |
| | | | Div | Supply | Supply | Short |
| | | | | | | |
| **MWWD Well G** | | 1.8 cfs | | | | |
| | **Average (AF/yr)** | **775** | **692** | **83** | **775** | **0** |
| | **Min. (AF/yr)** | **775** | **486** | **289*** | **775** | **0** |
| | | | | | | |
| **MWWD Well H** | | 2.29 cfs | | | | |
| | **Average (AF/yr)** | **1,294** | **1,141** | **88** | **1,229** | **65** |
| | **Min. (AF/yr)** | **1,294** | **811** | **418*** | **1,229** | **65** |
| **Total MWWD** | | | | | | |
| | **Average (AF/yr)** | 2,069 | 1,833 | 171 | 2,004 | 65 |
| | **Min. (AF/yr)** | 2,069 | 1,297 | 707* | 2,004 | 65 |
| **City of Steamboat Well A** | | 6.67 cfs | | | | |
| | **Average** | **1,464** | **1,316** | **148** | **1,464** | **0** |
| | **Min.** | **1,464** | **637** | **827*** | **1,464** | **0** |
| **Combined** | | | | | | |
| | **Average (AF/yr)** | 3,533 | 3,149 | 319 | 3,468 | 65 |
| | **Min. (AF/yr)** | 3,533 | 1,934 | 1,534* | 3,468 | 65 |

* represents maximum reservoir augmentation releases

These results demonstrate that the combined reliable yield of the well system, based on the minimum annual supply results is about 2,000 acre-feet per year. On the average, approximately 319 AF of release annual from Stagecoach Reservoir are required to meet full to supply shortfall in municipal well diversions under priority diversions.

Further expansion of the District's Yampa River Wells is limited by existing geographical factors. However, modest expansion of the City's Yampa River Wells does seem to be a practical possibility.

## 3.5 ELK RIVER RIGHT SUPPLY

The City possesses a conditional water right for 8 cfs (492 AF month or 5.17 mgd, peak demand in July) on the Elk River. The CDSS Yampa River Basin Model was used to evaluate the reliable water supply available under this right. To determine firm yield available from the Elk River Right a monthly demand sequence based that previously presented for the City in Figure 2-4 was developed setting the maximum average monthly demand equal to the water right amount of 8 cfs, as illustrated in the following table. This produces a total annual water demand of 3,452 AF per year (equivalent to 3.08 mgd or 4.8 cfs average daily demand). Table 3-12 summarizes the results of this evaluation.

**Table 3-11. Municipal Water Demand Model Summary Results for Elk River Water Right**

| Month | City Monthly Demands as % of Avg. Day | Simulated Elk River Demands | |
|---|---|---|---|
| | | CFS | AF/Month |
| Jan | 90% | 4.3 | 263 |
| Feb | 86% | 4.1 | 228 |
| Mar | 90% | 4.3 | 264 |
| Apr | 65% | 3.1 | 184 |
| May | 88% | 4.2 | 257 |
| Jun | 116% | 5.5 | 328 |
| Jul | 168% | 8.0 | 492 |
| Aug | 147% | 7.0 | 431 |
| Sep | 129% | 6.1 | 365 |
| Oct | 74% | 3.5 | 217 |
| Nov | 68% | 3.3 | 194 |
| Dec | 78% | 3.7 | 229 |
| TOTAL | | | 3,452 |
| AVERAGE | | 4.8 | |

**Table 3-12. Municipal Water Demand Model Summary Results for Elk River Water Right**

| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Demand (AF)** | 217 | 194 | 229 | 263 | 228 | 264 | 184 | 257 | 328 | 492 | 431 | 365 | 3,452 |
| **(CFS)** | 3.5 | 3.3 | 3.7 | 4.3 | 4.1 | 4.3 | 3.1 | 4.2 | 5.5 | 8.0 | 7.0 | 6.1 | 4.8 |
| **Diverted (AF):** | | | | | | | | | | | | | |
| Avg | 73.07 | 83.61 | 91.45 | 57.47 | 78.63 | 240.8 | 184.0 | 257.0 | 328.0 | 451.8 | 206.8 | 53.01 | 2,106 |
| Max | 217.0 | 194.0 | 229.0 | 263.0 | 228.0 | 264.0 | 184.0 | 257.0 | 328.0 | 492.0 | 431.0 | 365.0 | 3,452 |
| Min | 0 | 0 | 0 | 0 | 0 | 0 | 184 | 257 | 328 | 0 | 0 | 0 | 769 |

These results show that the firm yield of the Elk River water right is approximately 769 acre-feet per year. Additionally, the water right is reliably available only during the runoff months of April through June. Storage will be required to fully utilize this water right. Simulating augmentation releases from Stagecoach Reservoir were not successful in increasing the yield of the right. This is because the limiting factor was the minimum instream flow right on the Elk River itself and which can not be offset by releases from Stagecoach Reservoir. Storage within the Elk River watershed itself is necessary to maximize the potential yield of this water right.

To evaluate the appropriate amount of storage required further simulations were performed based on these modeling results. For this analysis diversions were allowed into a hypothetical storage facility at the maximum diversion rate of 8 cfs when legally and physically available in the Elk River. Withdrawals were based on the typical municipal demand distribution. The results of this analysis are provided in Table 3-13 and Figure 3-7. These results illustrate that between 2,000 to 4,000 AF seem to provide the optimal storage capacity requirement for this water right. Beyond approximately 5,000 AF or storage capacity increases in the firm yield of the system begin to diminish.

A water treatment plant constructed to use this right would need to be sized to accommodate the anticipated maximum daily demands. Using a 2.4 peaking factor, based on the previous analysis of water demands, Table 3-13 shows the resulting WTP capacities that would be required based on the amount of storage developed and the annual demand to be serviced by the facilities.

**Figure 3-8. Elk River Water Right Yield versus Storage Capacity Curve**

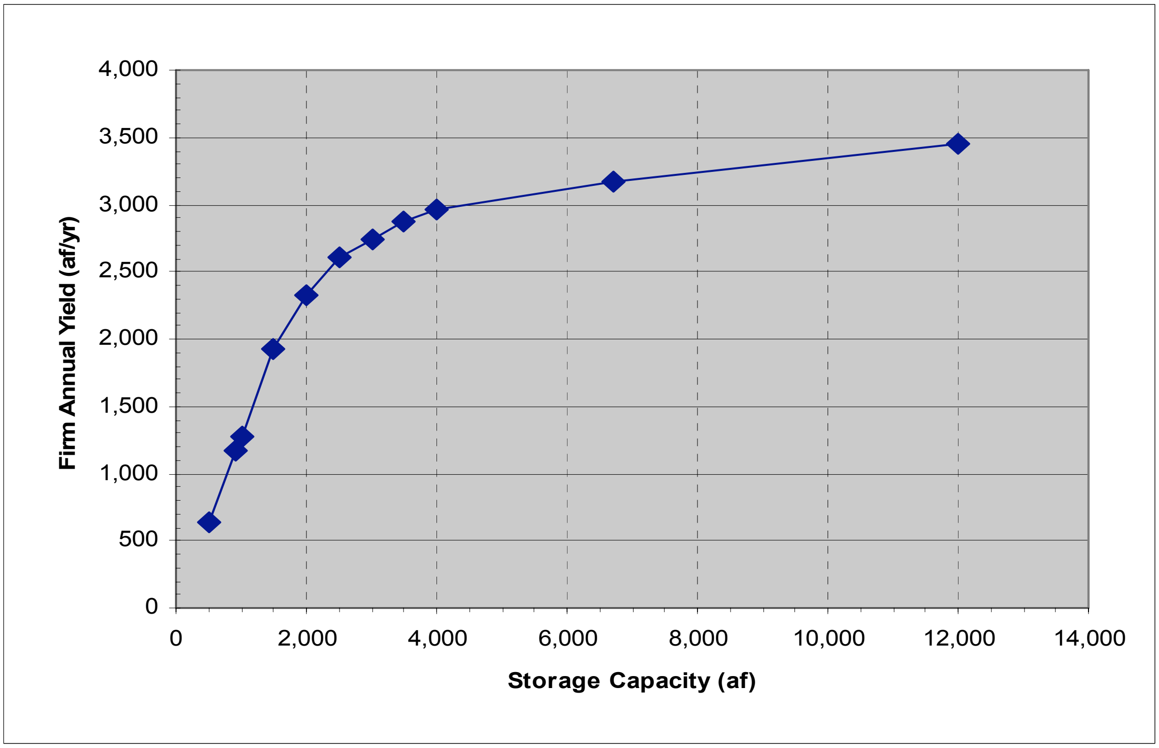



**Table 3-13. Elk River Water Right Storage versus Firm Annual Yield and Anticipated Maximum Day Demand**

| Reservoir Size | Firm Annual Yield | Avg. Day Demands | | Peak Factor | Anticipated Max Day Demand |
|---|---|---|---|---|---|
| AF | AF | CFS | MGD | | MGD |
| 500 | 639 | 0.88 | 0.6 | 2.4 | 1.4 |
| 900 | 1,167 | 1.61 | 1.0 | 2.4 | 2.5 |
| 1,000 | 1,277 | 1.76 | 1.1 | 2.4 | 2.7 |
| 1,500 | 1,919 | 2.65 | 1.7 | 2.4 | 4.1 |
| 2,000 | 2,330 | 3.22 | 2.1 | 2.4 | 5.0 |
| 2,500 | 2,610 | 3.61 | 2.3 | 2.4 | 5.6 |
| 3,000 | 2,748 | 3.80 | 2.5 | 2.4 | 5.9 |
| 3,500 | 2,879 | 3.98 | 2.6 | 2.4 | 6.2 |
| 4,000 | 2,965 | 4.10 | 2.6 | 2.4 | 6.4 |
| 6,700 | 3,176 | 4.39 | 2.8 | 2.4 | 6.8 |
| 12,000 | 3,452 | 4.77 | 3.1 | 2.4 | 7.4 |

## 3.6 SPRING AND SODA CREEKS

The City and the District own a number of minor water rights on Spring, Soda, and Stuckey Creeks. These rights are typically small and the available flows are limited. The quantification of yields associated with each of these rights is not easily achieved because these tributaries are not included in the CDSS Yampa River model. Additionally, historic streamflow records are quite sparse. Nevertheless the following table summarizes some options that could be considered to better and more fully utilize these water supplies for the City and the District.

**Table 3-14. Spring and Soda Creek Water Supply Expansion Opportunities**

| Option | Work Needed | Objective |
|---|---|---|
| Continue operation as currently in use | Maintenance of existing system of diversions, storages, pumps and pipelines. | To continue irrigation, recreational use, and aesthetics use |
| Divert water at alternate points of diversion at mouths of Spring and Soda Creek | Added measuring facilities to determine divertible amounts at the mouths of the streams. Amounts would equal the legal entitlements less water diverted at the current diversion points. Physical facilities to divert, store, and convey water to Fish Creek. | To add water to the municipal system, while continuing essential existing uses. |
| Divert water at original and alternate points of diversion on Soda and Spring Creek | Additional measuring facilities, additional storage and facilities to convey water to Fish Creek or construct separate water treatment facility. | To add water to the municipal system, while continuing essential existing uses. |
| Divert (withdraw) water from the Yampa River at one or more of the municipal well locations | Apply for alternate point(s) of diversion on the Yampa River for the Spring and Soda Creek rights. Added measuring facilities on Spring and Soda Creek to determine divertible amounts on the Yampa River. | To provide greater seniority to the wells on the Yampa River.<br>For example, the Administration Numbers for the respective water rights are:<br>Stuckey - 20349.19531<br>Mount Werner Well G - 48868.00000<br>Mount Werner Well H - 51134.46721<br>Steamboat Mun. Well A - 51494.00000 |
| Divert (withdraw) water from the Yampa River to supply new water treatment facility to serve the western portions of the community. | Apply for alternate point(s) of diversion on the Yampa River for the Spring and Soda Creek rights. Added measuring facilities on Spring and Soda Creek to determine divertible amounts on the Yampa River. | To provide greater seniority to a Yampa River diversion for a new Water Treatment Plant to serve the western portions of the community. |

# 4.0 Ability to Meet Future Demands

## 4.1 SUPPLY EXPANSION AVERAGE DEMANDS/VOLUME

From Section 2, the following projected water demands were developed for the City and the District.

**Table 4-1. Total System Future Demands**

| | City (mgd) | District (mgd) | Combined | |
|---|---|---|---|---|
| Year | Average Day | Average Day | Average Day (mgd) | Annual (AF) |
| **2007** | **1.316** | **1.488** | **2.804** | 3,141 |
| 2008 | 1.35 | 1.49 | 2.840 | 3,181 |
| 2009 | 1.38 | 1.54 | 2.926 | 3,277 |
| 2010 | 1.62 | 1.60 | 3.220 | 3,607 |
| 2011 | 1.85 | 1.66 | 3.514 | 3,937 |
| 2012 | 2.09 | 1.72 | 3.811 | 4,269 |
| 2013 | 2.33 | 1.78 | 4.109 | 4,603 |
| 2014 | 2.57 | 1.84 | 4.409 | 4,939 |
| 2015 | 2.68 | 1.90 | 4.580 | 5,130 |
| 2016 | 2.79 | 1.96 | 4.753 | 5,325 |
| 2017 | 2.90 | 2.02 | 4.927 | 5,520 |
| 2018 | 3.02 | 2.08 | 5.100 | 5,713 |
| 2019 | 3.13 | 2.14 | 5.274 | 5,907 |
| 2020 | 3.24 | 2.20 | 5.446 | 6,101 |
| 2021 | 3.36 | 2.26 | 5.619 | 6,294 |
| 2022 | 3.47 | 2.32 | 5.790 | 6,485 |
| 2023 | 3.57 | 2.38 | 5.947 | 6,662 |
| 2024 | 3.67 | 2.44 | 6.106 | 6,840 |
| 2025 | 3.72 | 2.50 | 6.216 | 6,963 |
| 2026 | 3.76 | 2.56 | 6.324 | 7,084 |
| 2027 | 3.81 | 2.62 | 6.433 | **7,206** |

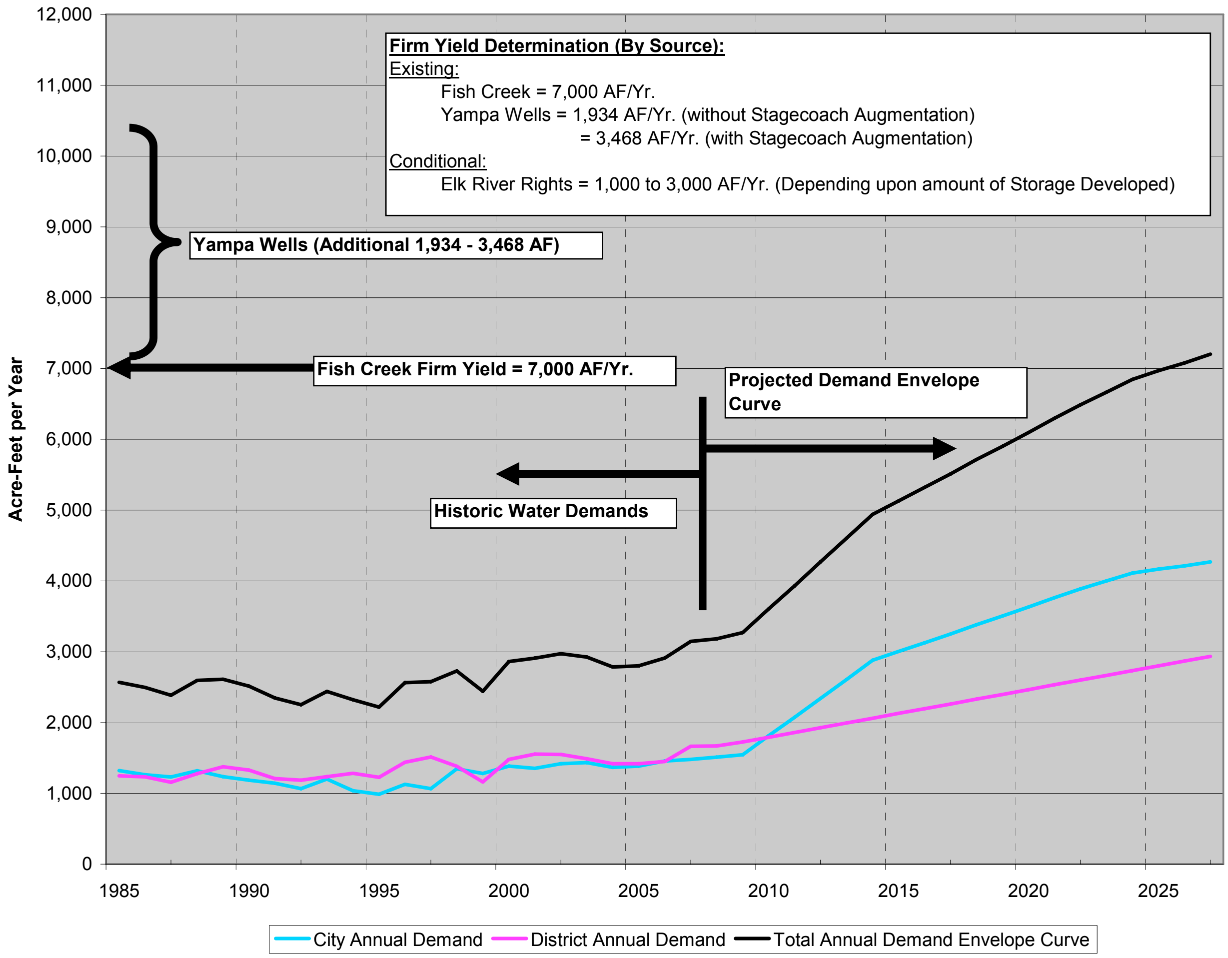
At total buildout projected demands approach 7,200 acre-feet per year. Analysis in Chapter 3 suggest the following firm yields from the existing water supply sources

Fish Creek Basin = 7,000 to 8,000 acre-feet per year

Yampa River Wells = 2,000 acre-feet per year

Additionally, evaluation of the Elk River water right suggests that, if storage were developed or otherwise obtained within the Elk River watershed, the yield of this water right could provide 1,000 to 3,000 acre-feet of reliable supply depending upon the amount of storage developed in conjunction with the water right. Without storage, this water right is likely unsuitable for municipal water supply development as its availability is typically limited to the high runoff months of April through June. Graphically, this comparison is provided in Figure 4-1.

**Figure 4-1. Steamboat Water Demands and Available Supply**




Additionally, continued development of water conservation measures and reduced per capita use rates could extend existing available supplies beyond that projected herein.

## 4.2 MAXIMUM DAY DEMANDS AND CAPACITY

From Section 2, the following projected maximum day water demands were developed for the City and the District.

**Table 4-2. Total System Future Maximum Day Demands**

| Year | City (mgd) Max. Day | District (mgd) Max. Day | Combined Max. Day (mgd) |
|---|---|---|---|
| **2007** | **3.317** | **3.403** | **6.720** |
| 2008 | 3.23 | 3.59 | 6.825 |
| 2009 | 3.32 | 3.72 | 7.032 |
| 2010 | 3.88 | 3.86 | 7.738 |
| 2011 | 4.44 | 4.00 | 8.445 |
| 2012 | 5.01 | 4.15 | 9.158 |
| 2013 | 5.58 | 4.29 | 9.874 |
| 2014 | 6.16 | 4.44 | 10.593 |
| 2015 | 6.42 | 4.58 | 11.003 |
| 2016 | 6.70 | 4.72 | 11.421 |
| 2017 | 6.97 | 4.87 | 11.839 |
| 2018 | 7.24 | 5.01 | 12.255 |
| 2019 | 7.52 | 5.16 | 12.671 |
| 2020 | 7.79 | 5.30 | 13.085 |
| 2021 | 8.06 | 5.44 | 13.500 |
| 2022 | 8.32 | 5.59 | 13.910 |
| 2023 | 8.56 | 5.73 | 14.289 |
| 2024 | 8.80 | 5.87 | 14.671 |
| 2025 | 8.92 | 6.02 | 14.935 |
| 2026 | 9.03 | 6.16 | 15.195 |
| 2027 | 9.15 | 6.31 | 15.456 |

The currently configured water treatment plant has a capacity of approximately 7.5 mgd and is readily expandable to 12 mgd through the addition of filter bays. The Yampa River Well currently can contribute approximately 2 mgd toward meeting maximum day demands. To avoid expansion of the water treatment plant beyond 12 mgd, it will be necessary to expand well production to approximately 3.5 mgd to meet projected maximum day demands.

## 4.3 WATER CONSERVATION

Experience in Denver and other regional communities have shown it is possible to reduce water consumption by 10 to 15 percent without implementing severe restrictions. If implemented, such a program could have the reasonable effect of reducing maximum day water demands by approximately 0.7 to 2 mgd and effectively defer the need for water treatment plant and/or Yampa Well capacity expansion.

# 5.0 Conclusions and Recommendations

## 5.1 CONCLUSIONS

The following summary presents the most salient conclusions developed as part of this study.

### 5.1.1 Demand

1) Historical population growth for Steamboat Springs has averaged approximately 3% per year since 1980.

2) Over the same period water demand in Steamboat Springs has grown at approximately 1% per year. Water demands have grown at a lower rate than the general population because of a number of factors including the installation of water meters in the 1980's and 90's.

3) Current Water Demand levels based on the last four years of data:

| | City | District | Total |
|---|---|---|---|
| Annual Demand (AF) | **1,420** | **1,523** | **2,943** |
| Average Daily Demand (mgd) | **1.27** | **1.36** | **2.63** |
| Avg. Daily Per Capita Demand (gpcd) | | | 239 |
| Avg. Daily EQR Unit Demand (gpd per EQR) | **235** | 238 | **237** |
| Indoor Water Use (%) | 62% | 67% | 65% |
| Outdoor Water Use (%) | 38% | 33% | 35% |
| Max. Day (mgd) | 2.95 | 3.27 | 6.02 |
| Ratio of Max. Day to Avg. Day | 2.33 | 2.41 | 2.29 |
| Max. Day Per Capita Demand (gpcd) | | | 546 |
| Max. Day EQR Unit Demand (gpd per EQR) | 547 | 573 | 541 |

4) Projected Water Demands:

| | **City (mgd)** | | **District (mgd)** | | **Combined** | | |
|---|---|---|---|---|---|---|---|
| **Year** | **Avg. Day** | **Max. Day** | **Avg. Day** | **Max. Day** | **Avg. Day (mgd)** | **Annual (AF)** | **Max. Day (mgd)** |
| **Current (2004 - 07)** | **1,420** | 2.95 | **1,523** | 3.27 | **2,943** | **2,943** | 6.02 |
| **2007** | **1.316** | **3.317** | **1.488** | **3.403** | **2.804** | 3,141 | **6.72** |
| 2010 | 1.62 | 3.88 | 1.60 | 3.86 | 3.22 | 3,607 | 7.74 |
| 2015 | 2.68 | 6.42 | 1.90 | 4.58 | 4.58 | 5,130 | 11.00 |
| 2020 | 3.24 | 7.79 | 2.20 | 5.30 | 5.45 | 6,101 | 13.09 |
| 2025 | 3.72 | 8.92 | 2.50 | 6.02 | 6.22 | 6,963 | 14.94 |
| 2027 | 3.81 | 9.15 | 2.62 | 6.31 | 6.43 | 7,206 | 15.46 |

### 5.1.2 Supply

1) Current Capacity:

| | City | District | Combined |
|---|---|---|---|
| Fish Creek Filtration Plant | 3.75 mgd | 3.75 mgd | 7.5 mgd |
| Yampa River Wells | 0.8 mgd | 1.0 mgd | 1.8 mgd |
| Total | 4.55 mgd | 4.75 mgd | 9.30 mgd |

2) Water Rights:

| | **City** | **District** | **Other** | **Combined** |
|---|---|---|---|---|
| **Fish Creek:** | | | | |
| Direct Flow (cfs) | 15.59 | 15.29 | 7.10 | 37.98 |
| Storage (AF) | 2,511.25 | 821.25 | 1,230 | 4,562.5 |
| **Yampa River Wells (cfs):** | 6.67 | 4.8 | | 11.47 |
| | | | | |
| Elk River (Conditional) (cfs) | 8.0 | | | 8.0 |

3) Fish Creek Basin Hydrology

| | Min. Annual Flow (AF) | Average Annual Flow (AF) |
|---|---|---|
| Long Lake Reservoir Inflows | 432 | 1,233 |
| Fish Creek Reservoir Inflows | 3,222 | 8,369 |
| Un-Regulated Fish Creek Basin Flows | 16,163 | 37,249 |
| Total Flow at Upper Station Gage | 20,022 | 46,852 |

4) Firm Yield

- Fish Creek Basin: Firm Yield = 7,000 AF/yr. (Average annual Yield = 11,864 AF/yr.).

- Yampa Wells:

| | **Firm Yield (AF/yr.)** | | |
|---|---|---|---|
| | **District** | **City** | **Combined** |
| Without augmentation from Stagecoach Res. | 1,297 | 637 | 1,934 |
| With augmentation from Stagecoach Res. | 2,004 | 1,464 | 3,468 |

- Elk River:
  Firm Yield = 769 AF/yr. (from Direct Flow only)
  Firm Yield = 1,000 - 3,000 AF/yr. (with 1,000 - 4,000 AF of storage)

### 5.1.3 Ability to Meet Future Demands

The ability for the City and the District to meet anticipated future demands is quite good, based on the following comparison of the projected 20-year Water Demands envelope curve and the calculated firm yield of existing water supply sources available to the City and the District.

| | City | District | Combined | |
|---|---|---|---|---|
| | **Average Day (mgd)** | **Average Day (mgd)** | **Average Day (mgd)** | **Annual (AF/yr.)** |
| **Current (2007) Demand** | 1.32 | 1.49 | 2.80 | **3,141** |
| **2027 Projected Demand:** | 3.81 | 2.62 | 6.43 | **7,206** |
| **Firm Yield/Supply:** | | | | |
| Fish Creek Basin | | | | **7,000** |
| Yampa River Wells | | | | **2,000 – 3,500** |
| Elk River Right (conditional) | | | | **769 (w/o storage)<br><br>1,000 – 3,000 (depending upon amount of storage developed)** |

## 5.2 RECOMMENDATIONS

### 5.2.1 Demands

1) Both the City and the District should continue to monitor demand trends within their respective service areas. Such data provide an invaluable basis for water planning efforts and regular updates of the Water Supply Master Plan.

2) A Water Conservation Plan should be developed for the community. The objectives of the plan would be to establish water conservation goals and to recommend appropriate regulations and improvements to ensure that the identified goals are achieved. Controlling the growth in water demand and ensuring that existing supplies are being efficiently used are cost-effective means of deferring expensive water supply system expansions thus reducing overall water costs and improving water supply reliability. Reductions in the future unit water demands could significantly extend existing supplies over that suggested in this study.

3) Drought Response Plan(s) should be developed for the City and the District. The goals of these plans would be to establish means to affect demand during times of shortage or other emergencies that may disrupt the community's water supply.

4) In order to provide the most flexibility in administering water rights the combining of the City and the District into a single entity should be re-examined and re-considered. In general, a single water provider with the combined resources of both entities would have greater resources, more flexibility, and improved efficiency.

### 5.2.2 Supply

1) Both the City and the District have a reliable long-term supply source in the Fish Creek Basin capable of meeting projected demands throughout the next twenty years. Additionally, the existing Yampa River Wells provide a valuable backup and peaking supply source. Maintaining the reliability of these sources and associated infrastructure is critical to the water supply security for the community and should be zealously pursued.

2) Further expansion of the District's Yampa River Wells is limited by existing geographical factors. However, modest expansion of the City's Yampa River Wells does seem to be a practical possibility.

3) The heavy reliance of the community on the Fish Creek Basins is largely unavoidable and emphasizes the need to protect this critical water supply. Impacts due to natural disasters such as forest fire could be severe if this water source were to be interrupted or significantly altered.

   Fire in the Fish Creek watershed threatens source water quality in several ways. The obvious is an increased in turbidity levels due to erosion. Additionally, slopes become less stable and land slides can impair streams and reservoirs. Another water quality problem is caused by the release of inorganics such as manganese. Following the 2002 Hayman Fire in the South Platte watershed, for example, it was reported that the manganese levels in the source water rose dramatically and, upon chlorination, precipitated from solution clogging numerous components in the water treatment plant. On-line instruments failed and the basic operation of the water treatment plant was jeopardized.

   The potential impacts of fire within the Fish Creek watershed should be examined and potential impacts identified. Counter-measures and response plans should be developed to address this possibility. The plan should also consider implementation of preventative measures such as heavy forest thinning and creation of fire breaks and watershed restoration efforts in the aftermath to ensure the speedy return to normal conditions.

4) The City and the District should continue to consider and pursue the development of alternative water supply sources to increase redundancy in the community's water supply. The most significant opportunity is the development of the City's Elk River water right.

### 5.2.3 Ability to Meet Future Demands

These results indicate that the community in general has several decade to identify, design, and implement the next significant expansion of water supplies for the community. Given the environmental, regulatory, financial, legal, and other requirements associated with the development of water resources, it is not too early to initiate said investigations.

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## APPENDIX A – WATER RIGHTS TABLES

**Table 1 – Municipal Supply**

**Table 2 – Parks, Gardens & Springs**

**Table 3 – Haymaker Golf Course**

**Table 4 - Parks, Gardens & Springs**

**Table 5 – Potentially Conflicting Conditional Water Rights on the Yampa River held by Others**

**Table 6 – Soda Creek**

**Table 7 – Spring Creek**

**Table 8 – Stuckey Creek**

# APPENDIX B – STREAM GAGE DATA

**Table 1 – Long Lake Reservoir Gaged Inflows**

**Table 2 - Fish Creek Reservoir Gaged Inflows**

**Table 3 - Fish Creek Gage Flows at Upper Station**

**Table 4 - Extended Historical Long Lake Reservoir Inflows**

**Table 5 - Extended Historical Fish Creek Reservoir Inflows**

**Table 6 - Extended Historical Fish Creek Natural Flows at Upper Station**

## APPENDIX C – YAMPA RIVER BASIN MODEL RESULTS