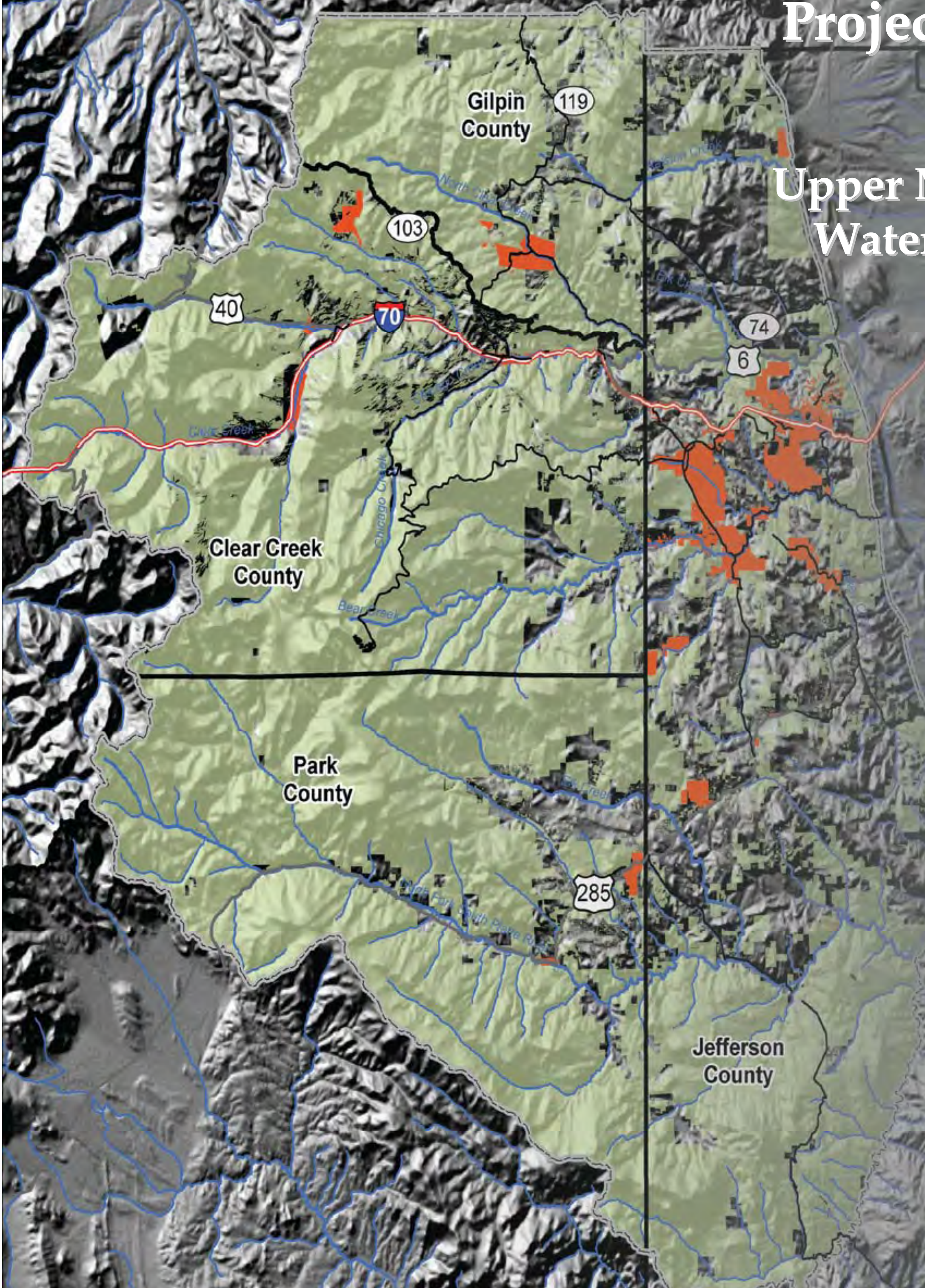
Upper Mountain Counties Aquifer Sustainability Project – Final Report

Prepared for:

Upper Mountain Counties Water Need Consortium

Clear Creek County
Gilpin County
Jefferson County
Park County

December 29, 2010



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Definitions

Census Tract. A small, relatively permanent statistical subdivision of a county delineated by a local committee of census data users for the purpose of presenting data. Boundaries normally follow visible features, but may follow governmental unit boundaries and other non-visible features in some instances; they always nest within counties. Tracts average about 4,000 inhabitants and may be split by any sub-county geographic entity.

Community Plan Areas. Unincorporated areas that share similar geography and characteristics.

Community Water Providers. A water system that serves at least fifteen service connections used by year-round residents or regularly serves at least 25 year-round residents. (Year- round is defined as permanent residence greater than six months.) Examples include water utilities, mobile home parks, apartment buildings, nursing homes.

Crystalline Bedrock Aquifer. Igneous or metamorphic rocks, such as granites, basalts, where the intergranular pore spaces are negligible and groundwater flow occurs through cracks and fractures. Degree of groundwater flow depends on fracture aperture and connectivity (Banks and Robins, 2002).

Non-transient, Non-Community Water Providers. A water provider that serves at least 25 of the same persons for six months or more per year. Examples include schools, office buildings, and factories.

Planned Development Parcels. Area of land that contains a mixture of residential buildings (homes), non-residential buildings (shops or industrial buildings), and open land (parks).

Water Provider. Entity, public or private, that is responsible for providing water to four or more residences.

Acronyms

AFY	Acre Feet per Year
BFI	Base Flow Infiltration
CDOT	Colorado Department of Transportation
CDSS	Colorado's Decision Support System
CWCB	Colorado Water Conservation Board
DOM	Domestic
DWR	Division of Water Resources
EPA	Environmental Protection Agency
ES	Elementary School
gcpd	Gallons per Capita per Day
GIS	Geographic Information System
gpm	Gallons per Minute
HS	High School
HRUs	Hydrologic Response Units
HUO	Household-Use Only Wells
IPPs	Identified Projects and Processes
MD	Metropolitan District
MHP	Mobile Home Park
MS	Middle School
ODP	Official Development Plan
OSC	Open Space Commission
PD	Planned Development Parcel
SDO	Colorado State Demography Office
SDWIS	EPA Safe Drinking Water Information System
SPD	Site Development Plan
SWP	Surveyed Water Provider
SWSI	Colorado Surface Water Supply Index
UMC	Upper Mountain County Region
WC	Water Company
WD	Water District
WSD	Water & Sanitation District

Section 1
Introduction

1.1 Project Background

In 2004, the Colorado Water Conservation Board (CWCB) completed the Statewide Water Supply Initiative (SWSI) in order to assess the water supply conditions in the major river basins of the state. This was followed in 2005 by the enactment of House Bill (HB) 05-1177, the Colorado Water for the 21st Century Act, which provides for the creation of Basin Roundtables. Each Basin Roundtable is charged with formulating a water needs assessment, conducting an analysis of available un-appropriated water, and proposing projects or methods for meeting those needs. In 2006, HB 06-1400 was signed into law, providing a funding mechanism for the Basin Roundtables to conduct such studies.

The original SWSI study was conducted for each major river basin and included general estimates of water demands for municipal, industrial, and agricultural sectors. Concerns were raised by representatives from Clear Creek, Gilpin, Jefferson, and Park counties in the South Platte River Basin that the scale of the SWSI study was too large to accurately characterize the unique climate, geography, and water supply needs for these counties. The four counties formed the Upper Mountain Counties (UMC) Water Needs Consortium. An application for a CWCB Water Supply Reserve Account grant was prepared and submitted through the South Platte Basin Roundtable and the Metro Roundtable. The application was approved, a grant was awarded, and Camp Dresser and McKee Inc. (CDM) was selected as contractor to perform the work.

1.1.1 Study Area

The study area is the 1,400-square-mile region west of Denver, Colorado that consists of Clear Creek County, Gilpin County, and the portion of Park County east of Kenosha Pass, and the mountainous portion of Jefferson County. The study area was delineated in Jefferson and Park Counties using geologic mapping and encompasses the crystalline aquifer geologic units. A map of the study area is presented in Figure 1-1.

1.2 Project Objectives

The objective of the UMC Water Needs Assessment and Water Supply Analysis are to identify water needs, available water supplies, and any shortages that may exist in the region. This assessment will also identify projects and/or actions that may be needed to address shortages in areas serviced by community water supplies or areas where depletions of the aquifer systems may be occurring or expected to occur.

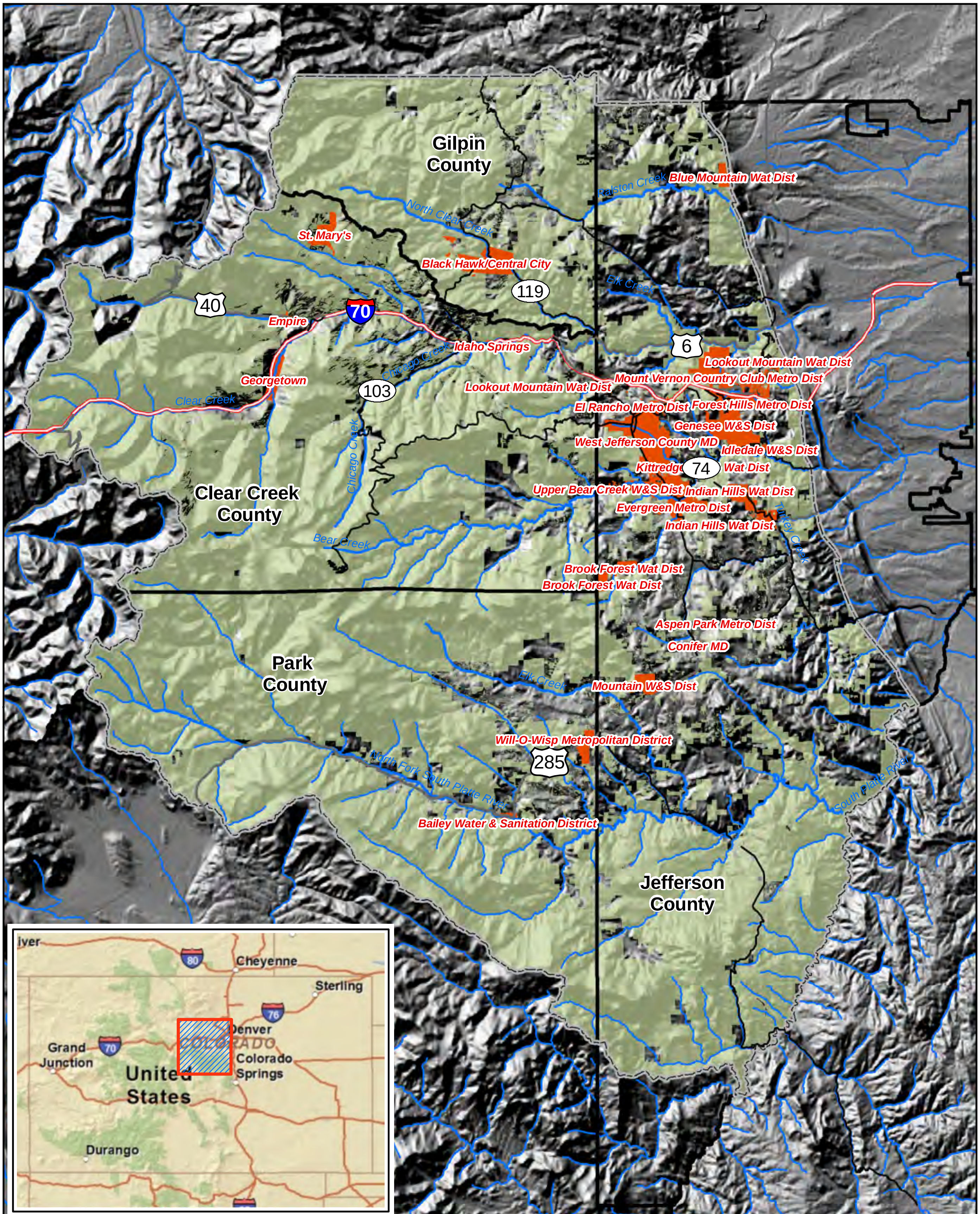

Figure 1.1 UMC Study Area

UMC Water Needs Assessment
Water Supply Analysis

1 inch = 7 miles

0 4 8 Miles

N

Roads

- Interstate/Limited Access
- U.S. Highways
- State/CO Highways
- Main Streams
- County Lines
- UMC Study Area
- Park and Public Land
- Surveyed Water Provider Area

Specific objectives of the UMC Water Needs Assessment and Water Supply Analysis are as follows:

- Determine current and future populations and land use types projected to 2050 based on interviews with UMC counties. This is discussed in further detail in Section 2 of the report.
- Interview UMC water providers for current and future water demands to 2050. This includes water demands related to recreation and tourism. This is discussed in further detail in Section 2 of the report.
- Identify water demands related to tourism outside of water provider areas that may result from future recreational projects. This is discussed in further detail in Section 2.7 of the report.
- Identify existing improved and unimproved plats outside of water provider areas to estimate the water demand based on build-out assumptions. This is discussed in further detail in Section 2.8 of the report.
- Evaluate long-term water supplies and water sustainability based on recharge estimates from existing geology and precipitation data. This is discussed in further detail in Section 3 of the report.
- Assess the long-term sustainability of the various aquifer systems based on recharge and water demands related to current and future water needs. This is discussed in further detail in Section 4 of the report.

1.3 Acknowledgements

Funding for this study was provided by a CWCB Water Supply Reserve Account grant awarded through the South Platte and Metro Basin Roundtables. In addition, CDM would like to acknowledge the valuable efforts, input, and data that were supplied by the participant county staff, technical review board, and Colorado Division of Water Resources (DWR) Staff, including the following personnel:

- Janet Bell (Jefferson County, ret.)
- Russ Clark and Roy Laws (Jefferson County)
- John Deagan (Park County)
- Dan Garner (Water Districts 9 & 80 Water Commissioner)
- Jim Hall (Water Division 1 Engineer)
- Reiner Haubald (Colorado DWR, ret.)
- Walt Knudsen (Colorado DWR, ret.)

- Stanton La Breche (Jefferson County Open Space Program)
- Lisa McVicker (Center of Colorado Conservancy District)
- Tony Peterson (Gilpin County)
- Gray Samenfink (Water District 7 Water Commissioner)
- Dave Stannard (U.S. Geological Survey [USGS])
- Kim Steele (Clear Creek County)
- Ralf Topper (Colorado Geological Survey)
- Bert Weaver (Clear Creek County)
- Forrest Whitman (Gilpin County)

Many other water providers were instrumental to the findings of this report by providing responses to a survey regarding current and future water demands.

Section 2
Current and Future Water Demands

2.1 Introduction

The UMC study area is located in the headwaters of the South Platte River, which is the most populous river basin in the state (Figure 1-1). Water demands in the UMC study area are dwarfed by the demands of adjacent Denver Metro and northern Front Range communities, and consequently need to be analyzed differently. In order to accurately estimate the current (2010) and future (2050) water demands and to build on previous SWSI findings, the following sources of information were identified for assessment.

- Results from SWSI (Section 2.2)
- County-wide population projections (Section 2.4)
- Information from a survey of water providers in the study area (Section 2.6)
- Demands related to future recreational projects (e.g., new or expanded ski areas, whitewater parks, etc.) not within a surveyed water provider service area (Section 2.7)
- Analysis of available parcel and zoning data provided by the study participants (Section 2.8)
- Analysis of the Colorado DWR well permit database (Section 2.8.3)

2.2 SWSI Findings

The SWSI report (CWCB 2004) provided a statewide assessment of water supplies and demands. The UMC study area includes the headwaters of the South Platte River, representing a portion of the most populous river basin in the state. Due to the large population in the Denver Metro and northern Front Range communities compared to the UMC study area, water demands in the UMC study area are much less but are quantified together in the SWSI report since they are in the same river basin. Section 6 of the SWSI report qualitatively recognizes the issues within the study area:

The Upper Mountain areas primarily rely on groundwater for M&I [municipal and industrial] demands. These areas will have the challenge of limited physical availability of groundwater. Much of the groundwater is in fractured bedrock and well yields can be highly variable and decline as additional growth occurs. Certain areas in the basin may have self-limiting growth due to the lack of sufficient groundwater and the inability to deliver surface water supplies. Many of these areas already experience reduced well production. Park County has approximately 25,000 pre-1972 platted lots [not all of these lots are in the UMC study area], which are not required to provide augmentation. Many of these lots are platted with high densities.

These approved densities may impact well yields, [and] trucked water or onsite storage tanks may be required to meet peak demands for some in-home domestic uses if additional development occurs. Jefferson County is in the process of regulating densities in certain mountain areas in order to prevent over development of the limited groundwater resources.

The crystalline bedrock aquifer in the UMC study area was not identified as a major aquifer in the SWSI report. A map of wells with yields greater than or equal to 500 gallons per minute (gpm) showed approximately 10 such wells in the study area, compared with over 6,000 in the overall South Platte Basin.

In addition, SWSI projected population growth on a county basis. Jefferson and Park Counties, which are located only partially within the study area, have significant growth areas outside of the UMC study area (e.g., Denver metro area, Fairplay). Clear Creek and Gilpin Counties were both projected to experience an average annual growth rate of 1.5 percent from 2000 to 2030. Jefferson County and Park County were projected to experience average annual growth rates of 1 percent and 6 percent, respectively. However, these growth rates include areas outside of the study area and will be reviewed in finer detail in Section 2.4.

SWSI assigned a county-wide weighted average water use rate for all water users. For the UMC area, per capita water use in units of gallons per capita per day (gpcd) and percent of population served by providers surveyed (in parenthesis) at the time of the original SWSI study or subsequent updates were as follows:

- Clear Creek County – 298 gpcd (26 percent)
- Gilpin County– 177 gpcd, (N/A - Used South Platte Basin average, no providers responded to survey)
- Jefferson County– 159 gpcd, (59 percent)
- Park County– 254 gpcd (2 percent)

M&I users were assumed by SWSI to have a 35 percent consumptive use rate. Recent updates to SWSI (CWCB 2010) estimate 195 acre-feet per year (AFY) of water use for snowmaking in Clear Creek County, staying constant through 2050. This volume of snowmaking water was computed using estimated acres of snowmaking at the two Clear Creek County ski areas (Loveland, 160 acres; Echo Mountain, 50 acres) and a water use factor of 0.93 acre-feet (AF) per acre based on actual data from several ski areas in the Colorado River Basin.

SWSI identified several specific issues conceptually, but did not quantify demands except for identifying the number of pre-1972 lots in Park County. The Identified Projects and Processes (IPPs) for the study area primarily identify the need for additional augmentation water.

Due to the broader view of the South Platte River Basin used in SWSI, information for the UMC region was not able to provide information with a level of detail that is important for local water users. In SWSI, groundwater recharge estimates were made only for aquifers identified as major aquifers. Groundwater in the UMC region is derived from a non-major, crystalline bedrock aquifer. Recharge from the crystalline bedrock aquifer was thus not included in the SWSI study. Additionally, population projections were made on a county-wide basis without consideration for variations in population growth and geological limitations within a county. For example, the portion of Jefferson County that is included in the UMC study region is extremely mountainous and relatively sparsely populated. The portion of the County that is in the Denver Metro area, however, has experienced significant growth and is characterized by a very different set of water needs.

2.3 Procedure for Estimating Demands

Demands were estimated using the sources outlined in Section 2.1 and spatially dividing the study area into three general categories: public land, surveyed water provider service areas, and private land outside of a water provider service area (i.e., self-supplied water users, typically by wells). Figure 2-1 is a map that shows the division of the study area into these categories.

Demands in the public lands were assumed to be zero and to not increase in the future (except for well data provided by Colorado State Parks, see Section 2.5). Demands for areas within a water provider service area were determined through a survey of multiple providers in the study area. Additional information about the surveyed water providers (SWP) was obtained from the State of Colorado's hydrologic database, HydroBase, as well as information provided by water commissioners and other DWR staff responsible for the study area. Demands for private land outside of SWP service areas were assumed to be self-supplied and were estimated using parcel and zoning geographic information system (GIS) datasets, population projections, and the DWR well permit database. Figure 2-2 shows a schematic of the demand estimation procedure.

Figure 2-2 Procedure for Estimating Water Demands in the UMC Study Area

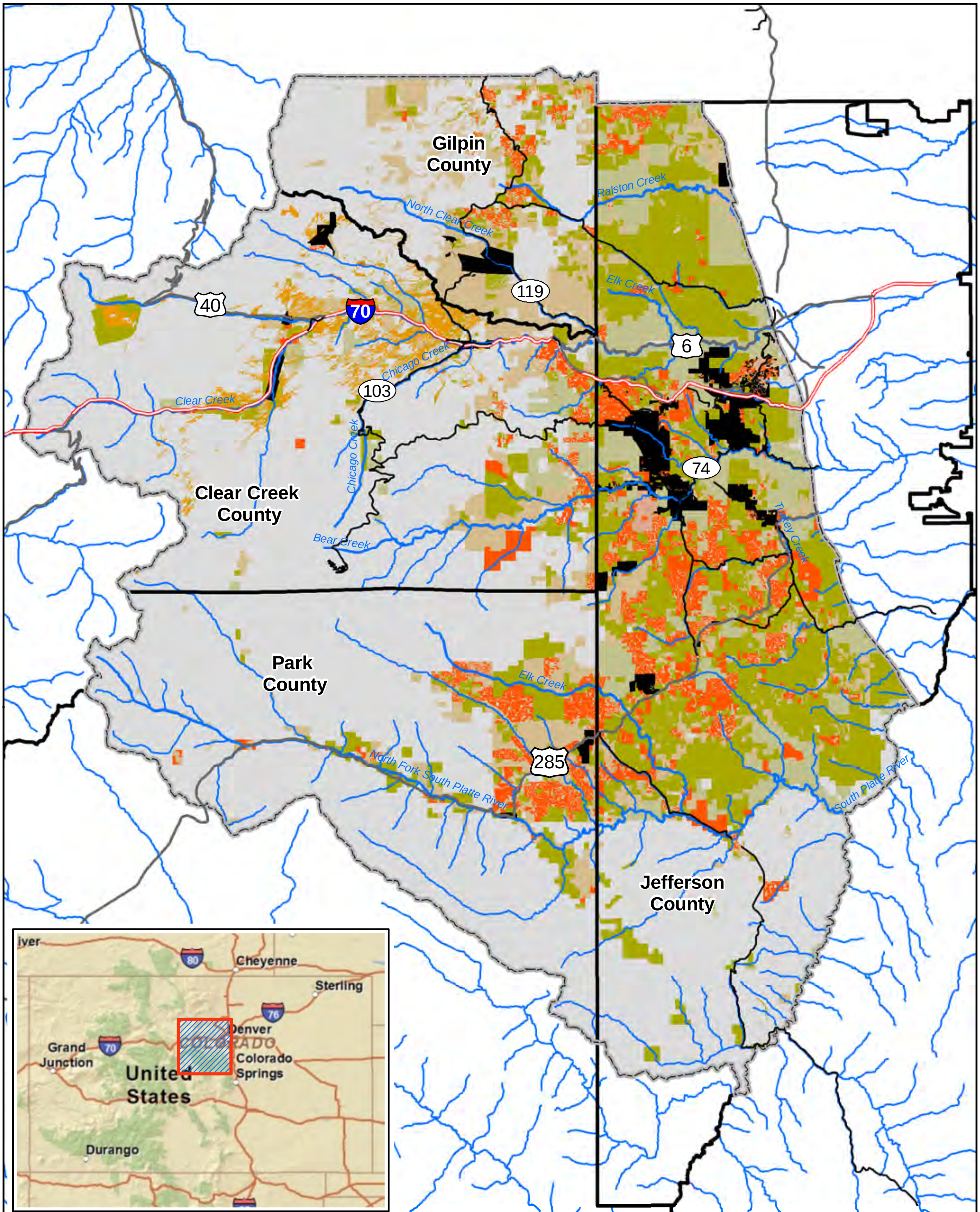

Figure 2.1 Current and Future Demands for UMC Study Area

UMC Water Needs Assessment
Water Supply Analysis

1 inch = 7 miles
0 3.5 7
Miles

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Roads
- Interstate/Limited Access
- U.S. Highways
- State/CO Highways
- Main Streams

- County Lines
- UMC Study Area
- Surveyed Water Provider Area
- Current Demands-Platted
- Current Demands-Unplatted*
- Future Demands-Unimproved Parcels

2.4 Population Projections

Population projections were estimated for this study based on current (2010) and future (2050) conditions. Projections were made to approximate future demands for the study area based on the relationship between current and future population. Officials from counties participating in the UMC study were contacted to obtain information on current and future populations and water demands. The information from the counties was utilized to the extent possible and was supplemented with data gathered from sources identified in the subsequent sections. The following sections also present the methodology for estimating population and results of the population and water demand analyses.

Population estimates in the UMC area were characterized as either (1) permanent resident population, (2) part-time weekend/vacation population, or (3) transient (temporary) population, which includes recreational and tourism demands. All population projections were rounded to the nearest ten persons.

2.4.1 Permanent Resident Population

The permanent resident population is defined as the population that lives full-time in a particular location. County-wide population estimates are appropriate for Clear Creek and Gilpin counties. Jefferson and Park counties have significant population outside of the study area, so additional analysis was required to develop estimates for portion of these counties within the study area.

2.4.1.1 Data Sources

Estimates of the permanent resident population in each county were developed using a combination of data obtained from the U.S. Census Bureau, the Colorado State Demography Office (SDO), a draft study conducted by CDM and Harvey Economics on behalf of the CWCB (2010) and the individual participant counties.

U.S. Census Bureau's Census 2000 data (www.census.gov, accessed December 2009) consisted of three datasets:

1. Population by county for Colorado
2. Jefferson County population by census tract
3. Park County population by census tract

Colorado population forecasts by county for the years 2000-2035 were downloaded from the SDO website (www.dola.state.co.us/dlg/demog/index.html). The datasets were developed in October 2009 and represent the most recent available population forecast data. Colorado population forecasts by county for the years 2035-2050 were obtained from new data developed by Harvey Economics in March 2010 as part of an update for the June 2009 CWCB study (CWCB 2010). Population forecasts for 2050 are based on low, middle, and high growth scenarios.

Clear Creek County

Clear Creek County is located entirely within the UMC study area. Current and future permanent population estimates were calculated directly from SDO and CWCB data. Permanent population for Clear Creek County is presented in Section 2.4.1.3.

Gilpin County

Current and future permanent population estimates were provided by Gilpin County staff. The County also provided water demand estimates that are discussed in further detail in subsequent sections. Upon review, minor revisions were made to the Gilpin County dataset for consistency across all UMC data. Permanent population for Gilpin County is presented in Section 2.4.1.3.

Jefferson County

The Jefferson County website (co.jefferson.co.us/planning/planning_T59_R37.htm, accessed December 2009) provides demographic data. The populated areas that fall within the UMC study area are generally not located in incorporated towns or cities, but considered a part of unincorporated community plan areas. Six community plan areas are at least partially included in the UMC study area as shown in Figure 2-3. One or more census tract is associated with each area, so the census tract most closely associated with each area is also shown in Table 2-1. This information was provided by the additional demographic information factsheets on the Jefferson County website. Permanent population for Jefferson County within the study area is presented in Section 2.4.1.3.

The 2000 census tract data was compared to data downloaded directly from the U.S. Census Bureau for verification. Because census tracts 98.08, 120.34, and 120.35 are only partially located within the study area boundaries, Jefferson County personnel provided population data that was used to determine the population only in the UMC area (Clark, 2010b).

Table 2-1 Community Plan Area with Associated Census Tracts

Community Plan Area	Census 2000 Tracts
North Mountains	98.08
Central Mountains	98.44, 98.45
Evergreen	98.46, 98.47, 98.48, 120.26, 120.30, 120.31
South Central Mountains/Indian Hills	120.27
Conifer/285 Corridor	120.32, 120.33, 120.36, 120.37, 120.58
South Jefferson County	120.34, 120.35

Park County

Park County is divided into five census tracts. As shown in Figure 2-4, the boundaries Census Tracts 1 and 2 closely correspond to the boundaries UMC study area (Deagan 2009). Thus, data from census these census tracts provided the basis for estimates of current and future population in the Park County study area. Permanent population for Park County within the study area is presented in Section 2.4.1.3.

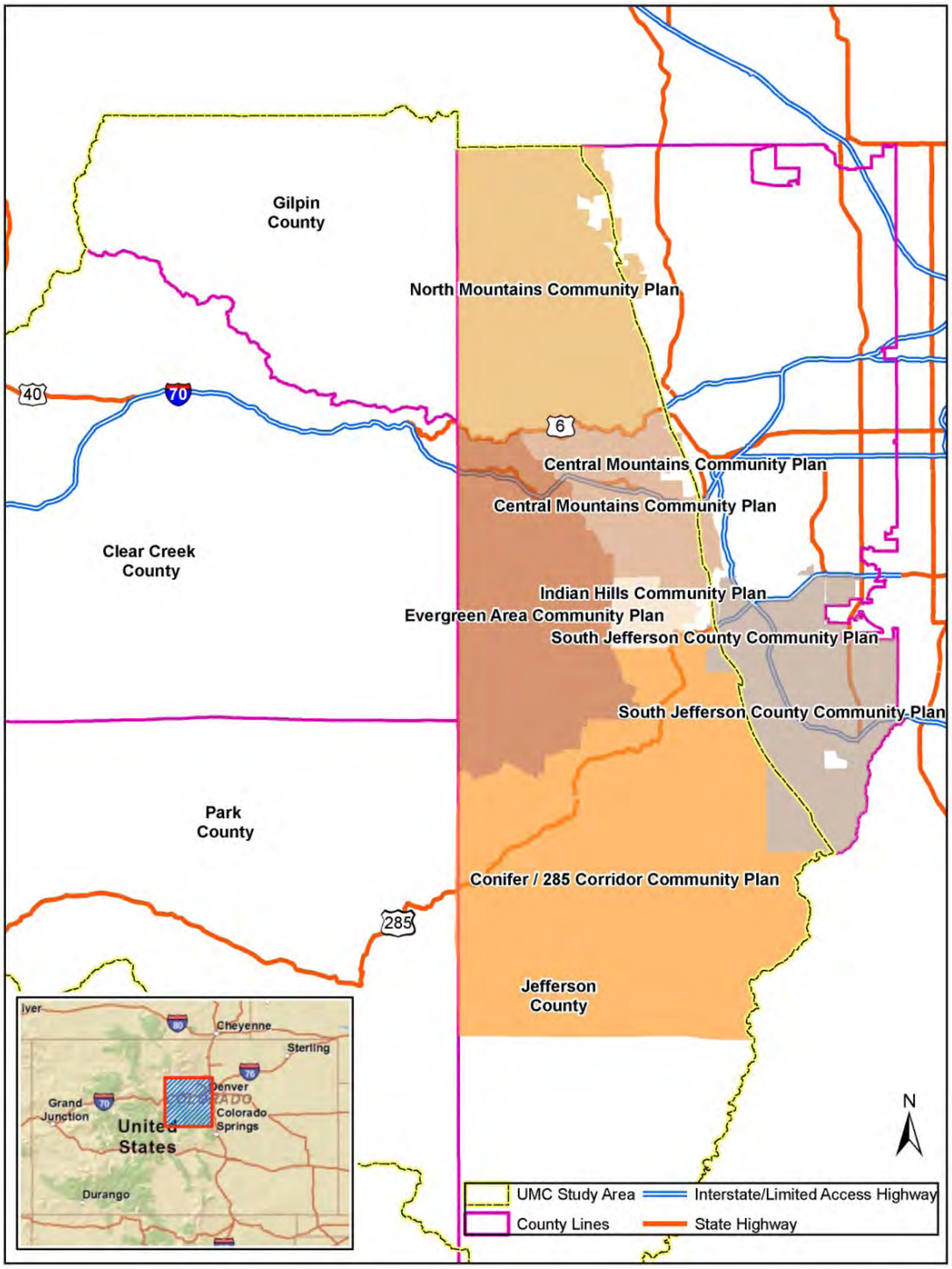

Figure 2-3 Jefferson County Census Tracts

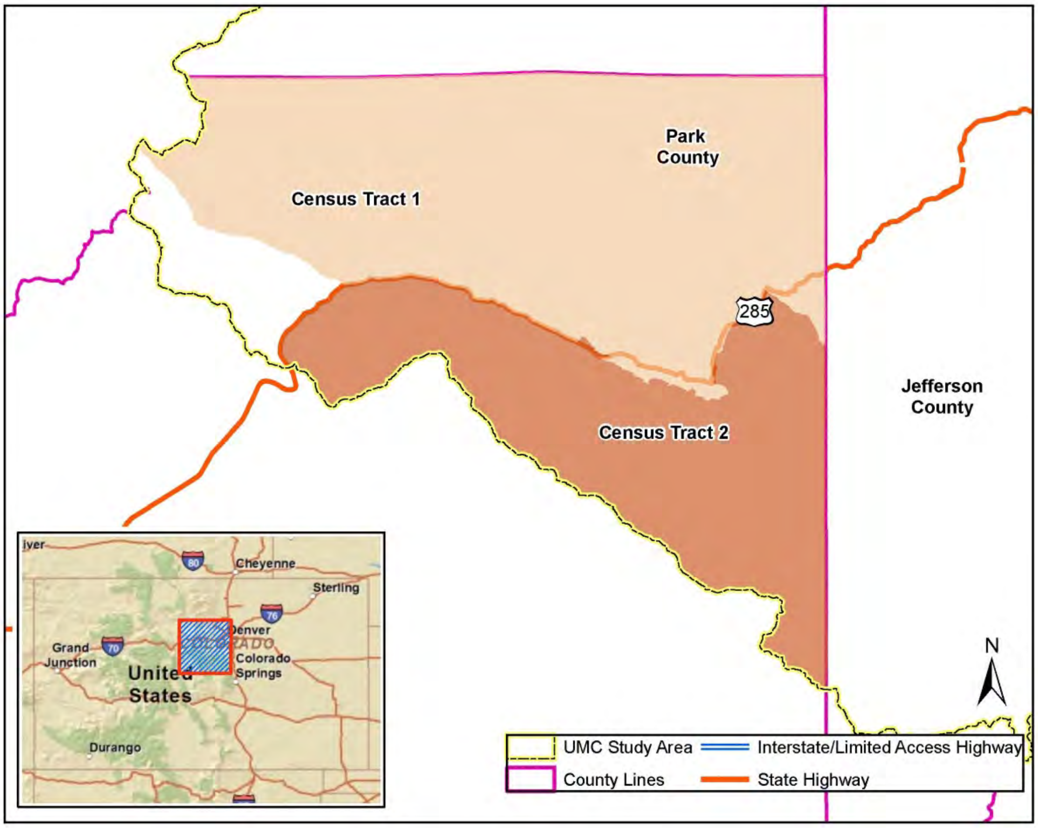

Figure 2-4 Park County Census Tracts

2.4.1.2 Permanent Population Forecasting Methods

Data Sources and Adjustments for Consistency

For all counties but Gilpin, the April 2000 population reported in the 2009 SDO population forecast dataset was slightly higher than the value reported in the Census 2000 data. Because the SDO values are more recent, the 2000 population values were assumed to be more accurate and served as the starting point for this analysis. Gilpin County projections were made based on county-provided data.

For Clear Creek County, the county-wide SDO values were used directly as the population estimate for the year 2000. SDO values are county-wide and thus cannot be directly applied to the portion of Jefferson and Park Counties within the study area. The census tract data was adjusted to align with SDO county-wide population. The adjustment factor was calculated as the percent difference between the 2000 Census data and the SDO data for the year 2000. The factor was applied to the Jefferson County and Park County tracts within the study area. This resulted in an additional 207 people from the 2000 Census for these counties.

Minor adjustments were made to the population data provided by Gilpin County to be consistent with other data sources. The dataset designated 2008 as the "current" year. Since other data sources defined the current year as 2010, it was assumed that the 2008 Gilpin values were also valid for 2010. This is a reasonable assumption as

Gilpin County has experienced low growth rates in recent years (Peterson 2010b). The projections provided by Gilpin County have a single population projection instead of a range of low, middle, and high growth estimates for the other three counties.

The county-wide average annual growth rate used by Gilpin County for their population estimates is 1.56 percent. This growth rate was used to project populations to 2050.

Permanent Population Forecast Calculations
Using the SDO countywide population forecast data, average annual population growth rates were computed for the period 2000 to 2010 and for 2010 to 2035. The first set of population growth rates were applied to the year 2000 populations to forecast existing or current conditions populations for the year 2010. Population forecasts for Clear Creek County were done on a countywide basis. Forecasts for Jefferson County and Park County were computed for each census tract; each census tract was assumed to grow at the countywide rate. The second set of average annual growth rates were applied to the 2010 current conditions populations to forecast 2035 populations, the end of the SDO forecast period.

Using the Harvey Economics data, average annual population growth rates were computed for the 2035 to 2050 period, with low, middle, and high growth scenarios to 2050. These growth rates were then applied to the previously computed 2035 population forecasts to generate a range (low, middle, and high) of population forecasts for 2050. Study area populations for Jefferson County and Park County were computed by summing the individual census tract populations. The population growth rates used for this study are shown in Table 2-2.

Table 2-2 County Permanent Population Growth Rates

	Average Annual Percent Change in Population				
County	**2000-2010[1]**	**2010-2035[2]**	**2035-2050[3] Low**	**2035-2050[3] Middle**	**2035-2050[3] High**
Clear Creek	0.11 percent	1.81 percent	0.60 percent	1.44 percent	2.20 percent
Gilpin	N/A	1.70 percent	0.44 percent	2.82 percent	4.34 percent
Jefferson	0.44 percent	0.89 percent	0.58 percent	0.97 percent	1.58 percent
Park	1.82 percent	3.28 percent	0.34 percent	0.79 percent	1.15 percent

1 Census and SDO data for 2000 (SDO, 2009)
2 SDO Projections through 2035 (SDO,2009)
3 Harvey Economics (CWCB, 2009)

2.4.1.3 Permanent Population Forecasting Results

Current and forecasted population estimates for permanent population in the UMC study area are shown in Table 2-3. Results on and census tract-basis (Clear Creek, Jefferson, and Park Counties) and municipal basis (Gilpin County) are provided in Appendix A. Future population estimates were rounded to the nearest ten persons.

Population estimates for Gilpin County were calculated by County officials and provided by Gilpin County.

Table 2-3 Current and Future Permanent Population Estimates for the UMC Study Area

County	Current Permanent (2010) Population	Future Permanent (2050) Population Low	Future Permanent (2050) Population Middle	Future Permanent (2050) Population High
Clear Creek	9,490	16,240	18,400	20,560
Gilpin*	5,300	10,060	10,060	10,060
Jefferson	55,640	75,700	80,150	87,710
Park	11,220	26,420	28,250	29,780
Total	**81,650**	**128,420**	**136,860**	**148,110**

**County Provided Data*

2.4.2 Part-Time Resident Population

Part-time residents are defined as the population that occupies vacation or seasonal homes for only a portion of the year and are not included in the permanent population totals in Table 2-3. Part-time populations for the UMC area were quantified to the extent possible based on data provided by the counties. County-wide projections are presented in Table 2-4. Future population estimates were calculated with a 1 percent annual growth rate and rounded to the nearest 10 persons. The rate was used by Gilpin County to estimate future part-time populations, and was applied to the entire study area to maintain consistency.

Clear Creek County

Based on parcel data provided by Clear Creek County, 1,323 residential properties (e.g., single-family dwellings, condominiums, and mobile homes) with owner addresses outside of the county were identified. Clear Creek County planners estimated that approximately one-third of these structures are vacation homes (Steele 2010a). Part-time population was computed using the census value of 2.3 persons per household.

Gilpin County

Gilpin County currently contains 639 part-time residential units with a 70 percent occupancy rate and an average 2.3 persons per household. The County provided the current and future part-time residential population estimates based on a 1 percent annual growth rate.

Jefferson County

In surveys of water providers, Jefferson County mountain area SWPs reported low part-time home occupancies ranging from 1 – 5 percent. Due to the low number of part-time residences, Jefferson County planning staff recommended that all homes in Jefferson County should be assumed to be full-time residences. Thus, there is no part-time population associated with Jefferson County.

CDM

Park County

In October 2009, 23.3 percent of the homes in Park County 2000 census tracts 1 and 2 were seasonally occupied (Deagan 2009). Assuming the same people per household value (2.5 persons per household) for both permanent and part-time populations, the part-time population (Table 2-3) represents 23.3 percent of the combined permanent and part-time population.

Seasonal occupancy rates in the census tracts corresponding to the Park County study area have historically varied. Rates were 34.1 percent in 1990, 16.3 percent in 2000, and 23.3 percent in October 2009 (Deagan 2009). The lack of an identifiable trend over the 20-year period precludes forecasting the future part-time residential population for Park County based on county-specific data. Thus, to be consistent with the forecast procedure used in Gilpin and Clear Creek Counties, a 1 percent growth rate was assumed for part-time population.

Table 2-4 Part-Time Population Projections by County

County	Current (2010) Part-Time Population	Future (2050) Permanent Part-Time Population
Clear Creek	1,010	1,500
Gilpin*	1,028	1,530
Jefferson	--	--
Park	3,410	5,080
Total	**5,450**	**8,110**

**County Provided Data*

2.4.3 Non-Residential (Transient) Population

The non-residential, or transient, population of the study area is defined as the population that only temporarily places demands on water supply systems. There are numerous reasons for non-residential use of water systems including patrons visiting the Central City/Black Hawk gaming district, ski resort users, and vehicle passengers stopping at the tourist and/or service facilities along I-70. Demand from this type of population is already incorporated in several surveyed water providers and is evident from the high per-capita use rates for communities bordering I-70 (Section 2.2; SWSI 2009).

Clear Creek County

The non-residential population of Clear Creek County was estimated using vehicle count data from the Colorado Department of Transportation (CDOT) (www.coloradodot.info/travel). In 2009, the average daily number of vehicles passing through the Eisenhower/Johnson Tunnels was 32,152 (combined eastbound and westbound). Even if only a fraction of the occupants of these vehicles stop to utilize services or visit tourist attractions, it is apparent that Clear Creek County could have a sizeable non-residential population drawing on its water systems. High per-capita use rates in communities in the I-70 corridor (e.g. Georgetown, Idaho Springs, Empire) suggest that the transient population contributes significantly to the total water use in the county. Potential water demands associated with this transient population are discussed further in Section 2.7.

Ski area visitor statistics for Clear Creek County provide further insight to the transient population. Based on data available from Colorado Ski County USA, Echo Mountain averaged 24,013 skier visits during ski seasons from 2006 to 2009. For the ski seasons from 1999 to 2009, Loveland averaged 242,795 visits. With the assumption that ski season occurs from November 15 through April 15 (151 days), Echo Mountain and Loveland receive approximately 159 and 1,608 daily visits, respectively. Considering that Clear Creek County has 9,490 permanent residents, the number of skiers equate to approximately 19 percent of the permanent population. This high transient population likely impacts daily water demands for the County significantly and may provide additional explanation for the high per capita water use determined in the initial SWSI study for Clear Creek County.

Gilpin County

Data provided by Gilpin County reports estimates of non-residential water demands, but does not include non-residential population estimates. Thus, transient populations presented in this section for Gilpin County are for information purposes only and were not used to calculated demands (see Section 2.6.2.3).

Transient population estimates are available for Central City and Blackhawk, the two main tourist areas in Gilpin County. Dale Lauer, the Water Coordinator for the City of Black Hawk, estimated the total daily service population for Black Hawk as 15,134 persons. This is consistent with the service population of 15,167 reported in the U.S. Environmental Protection Agency (EPA) Safe Drinking Water Information System (SDWIS) database. Transient population was determined by subtracting the full and part-time population from the service population. The estimated transient population of Black Hawk and Central City is 14,750 and 2,600, respectively. Transient populations in Gilpin County are very high relative to resident populations, and are consistent with casino statistics reported by the Colorado Department of Revenue, Division of Gaming (2009).

Transient usage of unincorporated Gilpin County is assumed to be limited to outdoor activities such as camping and hiking, which have very low, and primarily seasonal, water demands.

Jefferson County

U.S. Interstate 70 passes through a corridor of the Jefferson County study area that is primarily residential, including the communities of Lookout Mountain, Genesee, Evergreen, and El Rancho. Due to the lack of services at most interchanges, limited tourist attractions, and the close proximity to the Denver metropolitan area, it is believed that a transient population passing through the area would not contribute significantly to water consumption not already included in SWP demands.

Similarly, U.S. Highway 285 passes through a different corridor of the Jefferson County study area. The corridor includes the residential communities of Indian Hills, Conifer, Aspen Park as and Tiny Town Historical Park. However, the primary draw for transient visitors is access to outdoor activities such as camping, hiking, mountain biking, and fishing. Demands associated with these activities are likely captured in the demands for commercial SWPs such as the Conifer Metropolitan District and the Aspen Park Metropolitan District (see Section 2.7). Thus, the transient population is assumed to be engaged in activities that do not significantly impact water demands in the area not already included in the SWP demands.

Park County

From Jefferson County, U.S. Highway 285 continues into the Park County study area to Kenosha Pass. A majority of commercial establishments along the highway in Park County are within a SWP boundary. The majority of transient demands in Park County are captured in water provider use rates, and thus do not require population information.

2.5 Demands from Public Land

Demands for public lands were assumed to be zero, unless otherwise provided. The Jefferson County Open Space program provided well permit information that contained well production data. As shown in Table 2-5, well production can range from 8 to 40 AFY. However, legal pumping limits for domestic and residential wells are 1 and 0.33 AFY, respectively. These values were assumed to be valid for public wells and used to estimate annual demands for public land. Thus, annual demands for open space land in Jefferson County are approximately 10 AFY.

Table 2-5 Public Land Well Production and Estimated Demand

Park Name	Well Type	Demand (AFY)
Beaver Ranch	Commercial	1
Flying J Ranch well	Commercial	1
Pine Valley Ranch - hand pump-Picnic	Commercial/drinking water	1
Reynolds Ranch - hand pump-Campground	Commercial/Drinking water	1
Alderfer Three Sisters - residence well	Domestic	1
Elk Meadow - caretaker residence well	Domestic	1
Reynolds Ranch - caretaker residence well	Domestic	1
White Ranch - caretaker residence well	Domestic	1
Pine Valley Ranch - well-Residence	Household use only	0.33
White Ranch - hand pump-Sawmill	Other/ Drinking water	1
White Ranch - hand pump-Sourdough Springs	Other/ Drinking water	1
TOTAL		**10**

2.6 Demands from Surveyed Water Providers

Several water providers in the study area representing a cross-section of uses in the UMC study area, such as cities and towns, water districts, subdivisions, mobile home parks, schools, commercial entities, restaurants, summer camps, and ski areas, were contacted by phone and email to collect data and other information on current and future water demands in the region. These entities are referred to as SWP and represent a large portion of the population in the study area that is served by a central water provider. Water providers that serve a population greater than 300 were selected for the initial survey. Additional providers were selected based on client-provided criteria and did not necessarily meet the service population criteria of 300 persons. All demand projections were rounded to the nearest ten persons. Demands for areas that are served by providers not included in the survey are quantified with self-supplied demands analysis (Section 2.8).

2.6.1 SWP Survey Methodology

The SWPs were identified from the EPA SDWIS database through a screening process that included only providers within the study area. The process also identified the source of water (surface water or groundwater), type of system (community SWP or commercial enterprise), and service population reported by the EPA. SWPs were then classified as one of the following three types. Data is summarized in subsequent sections based on these classifications.

- **Community Public Water System**. Serve at least 25 year-round residents and include water utilities, mobile home parks, apartment buildings, and nursing homes (EPA, 2010).

- **Non-transient, Non-Community Public Water System**. Community providers Non-transient, non-community providers supply water to at least 25 of the same persons for six months or more per year. Examples include schools, office buildings, and factories (EPA, 2010).

- **Transient, Non-community Public Water Systems**. Serves at least 25 persons, but not necessarily the same persons, for at least 60 days per year. Examples include restaurants, camps and campgrounds, motels and hotels, and bottled water companies (EPA, 2010).

In November 2009, CDM drafted a cover letter and survey to solicit information from UMC SWPs about current and future water demands and other useful water system parameters relevant for the purposes of this study. These documents are included in Appendix B. Surveys were submitted to 34 SWPs in December 2009 (Table 2-6) and all providers were contacted by phone prior to delivery of the survey.

Table 2-6 lists the water providers surveyed and indicates the level of response from each. Although the City of Georgetown and Camp IDRAHAJE did not return surveys, service population and water demand data was obtained during a subsequent phone interview. To supplement returned surveys and make estimates for those entities not returning a survey, additional information was gathered from the EPA SDWIS database and the Colorado's Decision Support Systems (CDSS) HydroBase to supplement survey responses. Officials from the Division 1 Engineer's office and Water Commissioners from several Water Districts in the study area also provided valuable data and helped identify primary diversion structures for providers.

Table 2-6 SWPs in UMC Study Area

#	Water System Name[1]	County	Water System Type	Primary Water Source Type	Daily Service Population[2]	Returned Survey
1	Burger King – Downieville	Clear Creek	Transient Non-Community	Groundwater	503	X
2	Echo Mountain Ski Park	Clear Creek	Transient Non-Community	Groundwater	725	
3	Empire, Town of	Clear Creek	Community	Surface Water	500	X
4	Georgetown, Town of	Clear Creek	Community	Surface Water	1,439	X[6]
5	Loveland Basin Ski Area	Clear Creek	Non-Transient Non-Community	Surface Water	2,042	
6	Loveland Valley Ski Area	Clear Creek	Transient Non-Community	Surface Water	2,016	
7	St. Mary's Glacier WSD	Clear Creek	Community	Groundwater	1,000	
8	Black Hawk, City of	Gilpin	Community	Surface Water	15,167	X
9	Central City, City of	Gilpin	Community	Surface Water	3,565	
10	Gilpin County School	Gilpin	Non-Transient Non-Community	Groundwater	500	
11	Aspen Park MD	Jefferson	Non-Transient Non-Community	Groundwater	1,100	X
12	Blue Mountain WD	Jefferson	Community	Groundwater	300	X
13	Brook Forest WD	Jefferson	Community	Groundwater	900	
14	Conifer MD	Jefferson	Non-Transient Non-Community	Groundwater	1,250	X
15	Dukes MHP	Jefferson	Community	Groundwater	400	
16	Evergreen MD[3]	Jefferson	Community	Surface Water	13,500	X
17	Forest Hills MD	Jefferson	Community	Groundwater	400	
18	Genesee WSD	Jefferson	Community	Surface Water	4,100	X
19	Geneva Glen Camp	Jefferson	Transient Non-Community	Groundwater	310	
20	Homestead WC	Jefferson	Community	Surface Water[4]	700	X
21	Idledale WSD	Jefferson	Community	Groundwater	350	
22	Indian Hills WD	Jefferson	Community	Groundwater[5]	1,300	
23	Jefferson County Schools – Conifer HS	Jefferson	Non-Transient Non-Community	Surface Water	2,350	X
24	Jefferson County Schools – Elk Creek ES	Jefferson	Non-Transient Non-Community	Surface Water	600	X
25	Jefferson County Schools – Marshdale ES	Jefferson	Non-Transient Non-Community	Groundwater	920	X
26	Lookout Mountain WD	Jefferson	Community	Surface Water	1,499	
27	Mountain WSD	Jefferson	Community	Groundwater	900	X
28	Mt. Vernon County Club	Jefferson	Community	Groundwater	572	X
29	Bailey WSD	Park	Community	Surface Water	390	
30	Camp ID RA HA JE	Park	Transient Non-Community	Groundwater	617	X[6]

Table 2-6 SWPs in UMC Study Area, continued

#	Water System Name[1]	County	Water System Type	Primary Water Source Type	Daily Service Population[2]	Returned Survey
31	Deer Creek Christian Camp	Park	Transient Non-Community	Groundwater	135	
32	Platte Canyon Schools – Deer Creek ES	Park	Non-Transient Non-Community	Groundwater	601	X
33	Platte Canyon Schools – Platte Canyon HS/Fitzsimmons MS	Park	Non-Transient Non-Community	Groundwater	551	X
34	Will-O-Wisp MD	Park	Community	Groundwater	300	

1 Water system name abbreviations:
MD Metropolitan District
WD Water District
WSD Water & Sanitation District
WC Water Company
MHP Mobile Home Park
ES Elementary School
HS High School
MS Middle School
2 Service populations in this table are the values reported in the EPA SDWIS database, used for provider screening. Survey responses may differ.
3 Evergreen MD also includes:
El Rancho MD
Kittredge Sanitation & Water District
Upper Bear Creek WSD
West Jefferson County MD
4 EPA SDWIS database identifies Homestead WC primary water source type as surface water, but survey response indicates only well supplies.
5 EPA SDWIS database identifies Indian Hills WD primary water source type as "groundwater under influence of surface water."
6 Camp ID RA HA JE and Georgetown did not return survey, but provided information about service population and demands over the phone.

CDM

2.6.2 Water Provider Survey Results

Data from the survey results, County officials, and SDWIS and CDSS databases was then compiled to develop estimates of current (2010) and future (2050) service area populations and demands for the SWPs.

The per capita demands presented in this section differ from SWSI estimates for Gilpin, Jefferson, and Park Counties due to differences in data collection. Estimates for Gilpin County include demands from casinos, not just residential. Jefferson and Park Counties include large population areas outside of the UMC area that were not included in this study. Clear Creek County demands are higher than other counties due to elevated daily demands in Idaho Springs that were also applied to Empire, Georgetown, and St. Mary's Glacier WSD. These areas have higher commercial and transient use that increase the per capita water demand. Information for Idaho Springs was provided by CWCB updates to SWSI (CWCB 2010).

2.6.2.1 Community Water Providers

A county-wide summary of the 2010 demands for community SWPs are presented in Table 2-7. Current population information was returned with survey data. The per capita water demand was calculated by dividing the total daily demand provided in the survey by the total population served by the SWP.

Table 2-7 Summary of Current Demands for Community SWPs

County	Current (2010) Population in SWP Areas	Current (2010) Demand in SWP Areas [AFY]	Per capita Water Demand in SWP Areas [gpcd]
Clear Creek	4,340	1,089	224
Gilpin*	1,379	70	--
Jefferson	25,402	2,388	84
Park	690	55	71
Total	**31,811**	**3,603**	**--**

**Provided by County as combination of part- and full- time residential demands*

Future demand estimates were made either by applying the county-wide population growth rate (Table 2-2), or an adjusted growth rate based on provider-identified criteria such as a limited number of remaining taps. The 2050 water demand forecasts for each provider for the low, middle, and high growth scenarios are presented in Appendix A. A county-wide summary of this information calculated to the nearest 10 AF is presented in Table 2-8.

Table 2-8 Summary of Future Demands for Community SWPs

County	Future (2050) Demand in SWP Areas Low [AFY]	Future (2050) Demand in SWP Areas Middle [AFY]	Future (2050) Demand in SWP Areas High [AFY]
Clear Creek	1,790	2,010	2,240
Gilpin*	360	360	360
Jefferson	2,510	2,760	3,010
Park	130	140	150
Total	**4,790**	**5,270**	**5,760**

**Provided by County as combination of part- and fill- time residential demands*

2.6.2.2 Non-Transient, Non-Community SWPs

Seven non-transient, non-community SWPs responded to the water demand survey. This included six schools. Future demand estimates were made by applying the county-wide population growth rate (Table 2-2). A county-wide summary is presented in Table 2-9.

Table 2-9 Current and Future Demands for Non-transient, Non-community SWPs

County	Current (2010) Demand in SWP Area [AFY]	Future (2050) Demand in SWP Area Low [AFY]	Future (2050) Demand in SWP Area Middle [AFY]	Future (2050) Demand in SWP Area High [AFY]
Clear Creek	--	--	--	--
Gilpin*	1.9	3.1	4.5	5.6
Jefferson	12.0	16.3	17.2	18.9
Park	3.8	8.9	9.5	10.0
Total	**17.7**	**28.3**	**31.2**	**34.4**

**Survey Responses received from Gilpin County school*

2.6.2.3 Commercial SWPs

Surveys were also provided to commercial providers (transient, non-community providers by EPA definition), including commercial entities, casinos, three summer camps, and two ski areas in the UMC study area. However, several commercial providers did not respond and are therefore not included in the demand estimates. Current and future demands for the commercial SWPs are included in Appendix A and a county-wide summary is provided in Table 2-10.

Table 2-10 Current and Future Demands for Surveyed Commercial SWPs

County	Current (2010) Demand-Commercial SWPs [AFY]	Future (2050) Demand - Commercial SWPs Low [AFY]	Future (2050) Demand-Commercial SWPs Middle [AFY]	Future (2050) Demand in SWP Areas-Commercial SWPs High [AFY]
Clear Creek	2.2	2.2	2.2	2.2
Gilpin*	311.2	981.7	981.7	981.7
Jefferson	36.8	41.3	41.3	41.3
Park	--	--	--	--
Total	**350.3**	**1025.2**	**1025.2**	**1025.2**

**Provided by County as non-residential, gaming and non-gaming demands*

The only Commercial SWP in Clear Creek County is the Downieville Burger King. Future construction of restaurants and/or commercial services may impact water demands. Water rights would be required in order to have an individual water supply or water permit.

Additional commercial demand associated with the Clear Creek County transient population is best demonstrated by example as shown in Table 2-11.

Table 2-11 Example of Transient Demand Calculation

Service Station on I-70, not connected to a community water system		
Users	3 percent of I-70 Traffic	vehicles
I-70 Traffic (Eisenhower Tunnel)	x 32,152	vehicles
Average Vehicles at Service Station/Day	964.56	vehicles
Average Vehicle Occupancy (Clear Creek County)	x 1.98	persons/vehicle
Service Station Daily Customers	1,910	persons
1.5 gallon water/Customer	x 1.50	gallons
Daily Water Demand	2,865	gallons/day
Annual Water Demand	**3.21**	**AF/year**

A demand of 3.21 AFY is relatively minor in the context of the overall study area demand. Moreover, if similar facilities are connected to community water systems to other larger communities in the county such as Idaho Springs, Empire, or Georgetown, the transient demands are most likely captured in the community demand.

Recall from Section 2.3 that ski areas generate high transient demands. Echo Creek and Loveland Ski Area visitors alone equate to about 20 percent of the permanent population in Clear Creek County during the winter months. This high transient population may impact daily demands significantly at the ski areas. Data for water use at the ski areas was not available (see Table 2-6).

The future demand for the Conifer Metropolitan District, a commercial SWP in Jefferson County, was reported as 750,000 gpd, or 840 AFY. This demand is very high relative to current use of 24.48 AFY, but was confirmed by the District engineer who noted that the current demand was associated with the existing commercial use. A District report indicated that a 350,000 gpd wastewater plant is planned for some point after 2025. The District engineer indicated that future water supply would be brought in by future users (personal communication, 2010). Due to the uncertainty of the future growth and that future users will bring in other water supplies, for the purposes of this study, the future demand is assumed to be equal to the current demands.

Table 2-12 Summary of Current and Future Demands for Surveyed SWPs

County	Current (2010) SWP Demand [AFY]	Future (2050) SWP Demand Low [AFY]	Future (2050) SWP Demand Middle [AFY]	Future (2050) SWP Demand High [AFY]
Clear Creek	1,091	1,790	2,010	2,240
Gilpin	384	1,340	1,350	1,350
Jefferson	2,437	2,570	2,820	3,070
Park	59	140	150	160
Total	**3,912**	**5,700**	**6,180**	**6,660**

2.7 Recreation and Tourism Demands

Recreation and tourism may significantly impact water demands in the UMC study area, especially in Clear Creek and Gilpin Counties. These counties contain many tourist attractions, campgrounds, ski/outdoor centers, and casinos. This is particularly true in Clear Creek County, with the Argo Mine, hot springs, and other attractions in Idaho Springs. The County also contains the visitor's center/rest stop and Georgetown Loop Railroad in Georgetown; services available to travelers in Downieville (e.g., Burger King, Starbucks, and Conoco Truck Stop); the Loveland Valley and Loveland Basin Ski Areas surrounding the Eisenhower Tunnel; and the Echo Mountain Ski and Snowboard Park near Squaw Pass. Likewise, Gilpin County has significant recreational water demand, with 24 casinos and hundreds of accompanying hotel rooms in the Black Hawk and Central City gaming districts.

Future recreation and tourism demands were estimated based on development plans provided through interviews with UMC officials. The results of the interviews are summarized below by county.

- Clear Creek Whitewater Park (Clear Creek County). Currently under construction by Clear Creek County Open Space Commission (OSC). Located near Lawson (Rollenhagen 2010).

- Eclipse Snow Park (Clear Creek County). Currently undergoing development review. Formerly the St. Mary's Glacier Ski Area. Secured water rights with St. Mary's Water & Sanitation to supply up to 30,000 gallons per month (1.1 AFY if year-round). Snowmaking capabilities are not required, but may be necessary for any future park expansions (Steele 2010a and 2010b).

- Echo Mountain Park (Clear Creek County). No known plans to expand park, no separate residential or commercial growth with continued operation is expected in the vicinity (Steele 2010a).

- Loveland Ski Area (Clear Creek County). No plans for future development. Additional development would require land use approval from the U.S. Forest Service (USFS) (Steele 2010a and 2010b).

- Gilpin County. No known plans for future recreational development that would create additional water demands outside of the casino/gaming districts (Petersen 2010). The County provided information on the estimated demands in the gaming district that are presented in Table 2-13.

- Jefferson County. No known plans for future recreational development that would create additional water demands (Clark 2010a).

- Park County. No known plans for future recreational development that would create additional water demands (Deagan 2010).

Additional information for summer camp areas was estimated based on data provided by Camp IDRAHAJE. These responses in combination with the interview results were used to estimate current and future recreational demands (Table 2-13). Demands for individual recreational facilities are included in Appendix A, Table A-7.

Table 2-13 Current and Future Recreational Demands based on County Information and Provider Survey Responses

County	Current (2010) Demand [AF]	Future (2050) Demand [AF]
Clear Creek	88	88
Gilpin*	310	978
Jefferson	2.2	2.2
Park	4.8	4.8
Total	**405**	**1,073**

**Accounted for in commercial SWP demands (Table 2-10)*

2.8 Self-Supplied Demands

Self-supplied wells (or other sources such as trucked water) meet a significant portion of the demands outside of SWP areas. Demands outside of SWP areas were estimated through an analysis of parcel data based on zone category. These demands include smaller water providers that were not surveyed for this study. Zoning categories define the land use type (Section 2.8.1) and demand estimates were developed using land use type and the Colorado Department of Water Resources well permit database. Demands for self-supplied areas were estimated by analyzing the parcel data outside of SWP boundaries. All demand projections were rounded to the nearest ten AFY. Table 2-14 provides a summary of all parcels in the UMC study area and identifies public land acreage. Table 2-15 shows all parcels outside of SWP areas, current demands were calculated for private, improved parcels (Section 2.8.4.1). Future demands accounted for 2010 conditions as well as demands associated with parcels available for development (Section 2.8.4.2).

2.8.1 Parcel Geodatabase Development

To perform demand estimates using parcels, GIS land parcel datasets provided by each county were combined into a single dataset. The datasets included public land, mining claims; land within and outside of SWP boundaries.

The spatial coverage of the GIS datasets left several gaps, such as public land and right-of-ways. GIS datasets provided by the Colorado State Parks and the Colorado Ownership Management and Protection program were used to identify public lands in the study area where there were gaps in the parcels coverage (e.g. USFS, State Parks, County Parks and Open Space, etc.). Information provided by each county's staff was used to determine the land use and existing level of development of each parcel in the initial County parcel dataset and classified using the following attributes:

- Public or private land. Indicates parcel ownership as private, local, state, or federal.
- In or out of SWP service area. Indicates if a parcel is located within a SWP area.
- Improved or unimproved. Indicates if parcel is currently improved or is unimproved. Improved parcels are assumed to be developed, whereas unimproved parcels are developable for future growth.

Table 2-14 Study Area Parcels

County	AG	COMM	CD	IND	LU	MIN	PD	RES	UNZ	Private Land	Public Land Area (ac)
Clear Creek											
SWP Count	0	17	5	0	0	220	4	1,245	73	1,564	
SWP Area (ac)	0	81	4	0	0	234	2	584	34	939	
Outside SWP Count	99	246	125	5	474	8,057	109	5,054	64	14,233	
Outside SWP Area (ac)	1,569	452	7,658	49	4,920	24,247	995	24,330	129	64,348	188,328
Gilpin											
SWP Count	0	0	0	0	0	0	0	4	0	4	
SWP Area (ac)	0	0	0	0	0	0	0	86	0	86	
Outside SWP Count	24	50	0	0	0	0	0	5,102	1	5,177	
Outside SWP Area (ac)	55	48	0	0	0	0	0	44,280	5	44,388	51,478
Jefferson											
SWP Count	1,060	382	110	10	0	0	3,259	5,523	19	10,363	
SWP Area (ac)	5,098	575	120	14	0	0	2,931	4,139	114	12,991	
Outside SWP Count	9,877	73	149	3	0	0	375	7,712	85	18,274	
Outside SWP Area (ac)	192,298	235	980	405	0	0	3,315	15,451	1,144	213,829	93,301
Park											
SWP Count	0	8	0	0	0	0	486	189	0	683	
SWP Area (ac)	0	5	0	0	0	0	234	304	0	543	
Outside SWP Count	128	21	6	0	0	11	67	5,854	24	6,111	
Outside SWP Area (ac)	15,714	24	841	0	0	144	96	24,887	289	41,996	166,643
Total SWP Count	1,060	407	115	10	0	220	3,749	6,961	92	12,614	
Total SWP Area (ac)	5,098	660	124	14	0	234	3,167	5,112	147	14,558	
Total Outside SWP Count	10,128	390	280	8	474	8,068	551	23,722	174	43,795	
Total Outside SWP Area (ac)	209,635	760	9,480	453	4,920	24,391	4,406	108,949	1,567	364,560	499,750

AG agriculture, COMM commercial, CD conservation district, IND industry,
LU limited use, MIN mining, PD planned development, RES residential, UNZ unzoned

Table 2-15 Private Parcels outside of SWP Area

County	AG	COMM	CD	IND	LU	MIN	PD	RES	UNZ	Total
Clear Creek										
Improved Count	78	212	121	3	371	739	94	3,877	61	5,556
Improved Area (ac)	378	299	7,263	13	1,420	5,085	944	14,033	112	29,546
Unimproved Count	21	34	4	2	103	7,318	15	1,177	3	8,677
Unimproved Area (ac)	1,191	154	395	36	3,500	19,162	51	10,297	17	34,801
Gilpin										
Improved Count	18	27	0	0	0	0	0	2,540	0	2,585
Improved Area (ac)	34	27	0	0	0	0	0	11,688	0	11,748
Unimproved Count	6	23	0	0	0	0	0	2,562	1	2,592
Unimproved Area (ac)	21	21	0	0	0	0	0	32,592	5	32,639
Jefferson										
Improved Count	7,920	62	120	3	0	0	274	5,811	63	14,253
Improved Area (ac)	168,653	227	854	405	0	0	2,925	13,603	1,079	187,745
Unimproved Count	1,957	11	29	0	0	0	101	1,901	22	4,021
Unimproved Area (ac)	23,645	9	126	0	0	0	391	1,848	65	26,084
Park										
Improved Count	76	9	1	0	0	0	48	4,326	12	4,472
Improved Area (ac)	6,966	13	1	0	0	0	24	17,435	87	24,525
Unimproved Count	52	12	5	0	0	11	19	1,528	12	1,639
Unimproved Area (ac)	8,748	12	841	0	0	144	72	7,452	202	17,471
Total Improved Count	8,092	310	242	6	371	739	416	16,554	136	26,866
Total Improved Area (ac)	176,030	565	8,118	418	1,420	5,085	3,892	56,759	1,278	253,565
Total Unimproved Count	2,036	80	38	2	103	7,329	135	7,168	38	16,929
Total Unimproved Area (ac)	33,605	195	1,362	36	3,500	19,306	514	52,190	289	110,995

AG agriculture, COMM commercial, CD conservation district, IND industry,
LU limited use, MIN mining, PD planned development, RES residential, UNZ unzoned

- Zoning category. Zone category based on zoning code provided by the county. See Section 2.8.2.
- Platted or unplatted. Indicates if parcel is platted or unplatted.
- Number and types of wells. Indicates the number and use type of groundwater wells located on a parcel. See Section 2.8.3.1.

2.8.2 Parcel Zoning Categories

The zoning codes provided by each county varied significantly. County staff members were contacted to help clarify zoning codes and categorize into broader zoning categories that could be applied across the study area. The zoning codes were generalized into eight zoning categories: residential, commercial, industrial, mining, limited use, agricultural, unzoned, and planned development, as shown in Figure 2-5.

Agricultural zones include any improved agricultural land use, including rural residential. In Jefferson County, most parcels within the UMC study area that are zoned as 'agricultural' are large-lot residential. Limited use zones include federal lands, natural resources and conservation districts. A number of parcels zoned for planned development (PD) were identified in Clear Creek, Jefferson, and Park Counties. The meaning of PD varies by county and county officials were contacted to determine the type of development in these areas. A majority of PD parcels in Clear Creek and Jefferson County have already been developed, whereas most Park County PD parcels are currently unimproved.

Clear Creek County PD Parcels

There are 109 PD parcels in Clear Creek County outside of SWP areas. These parcels include areas rezoned based on an Official Development Plan (ODP) and are primarily designated for commercial or industrial uses, such as telecommunications facilities (e.g. cell phone towers). ODPs outline permitted uses and structures allowed. If water is required, applicants must provide a legal water supply. A majority of the PD zoned properties in Clear Creek County have been developed according to their specific development plan (Rollenhagen 2010; Steele 2010a).

Jefferson County PD Parcels

The UMC study area portion of Jefferson County includes approximately 375 PD parcels outside of SWP areas. PD parcels in Jefferson County are many times for single family residential or commercial development. For PD parcels to be used for commercial development, a Site Development Plan (SDP) is required. Once the SDP is complete, a building permit must be obtained within one year. The future use for vacant PD parcels, can be inferred from assigned tax classes (Clark 2010b).

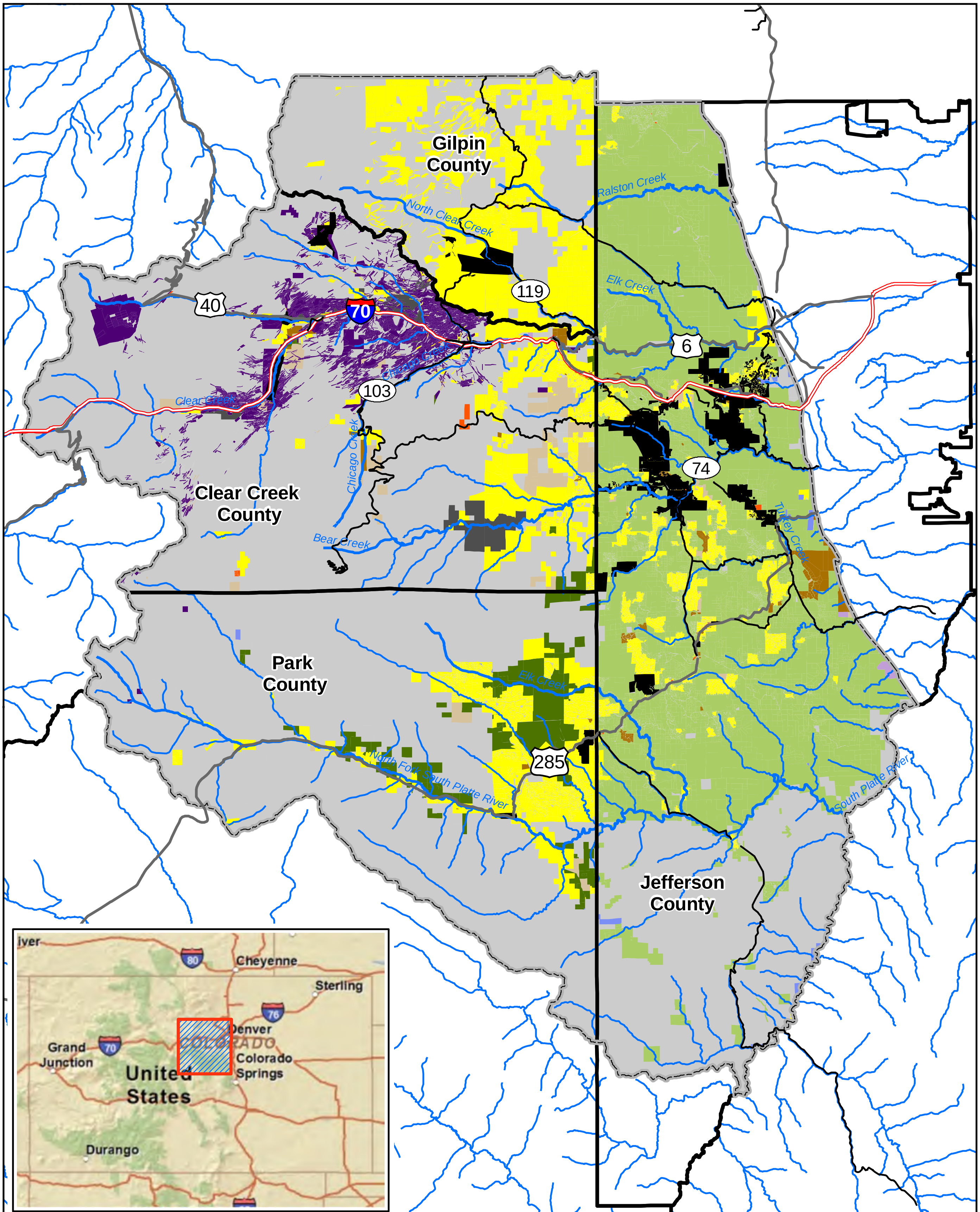

Figure 2.5 Zone Categories for Private Parcels

UMC Water Needs Assessment
Water Supply Analysis

1 inch = 7 miles

0 3.5 7 Miles

N

Roads
- Interstate/Limited Access
- U.S. Highways
- State/CO Highways
- Main Streams
- County Lines
- UMC Study Area
- Surveyed Water Provider Area

Park and Public Lands

Private Land

ZoningCat
- Ag/Large-Lot Residential
- Agriculture
- Commercial
- Conservation District
- Industrial
- Limited Use
- Mining
- Planned Development
- Residential
- Unzoned

Park County PD Parcels

Park County contains 67 PD parcels outside of SWP areas, a majority of which have not yet been developed. The Park County Land Use Regulations define a PD zone as an area of land that may developed as a number of dwelling units, commercial, educational, recreational, or light industrial uses. PD parcels must include a plan that does not correspond in lot size, or type of use, density, lot coverage, open space, or other restriction to the existing land use regulations in Park County.

2.8.3 Parcel Analysis

Demand estimates were conducted only for private parcels located outside of SWP areas. Recall that demands for public lands were assumed to be zero, unless otherwise provided (Section 2.5). As shown in Table 2-15, the UMC study area contains approximately 43,790 private parcels outside of SWP boundaries. Approximately 26,970 are considered improved (developed) and 16,940 are considered unimproved.

2.8.3.1 Parcel Analysis Validation Well Data

The Colorado DWR's well permit database was used to compare the parcel count to the number and types of wells. The database included listings for wells with state-issued paperwork, such as permit applications or water rights filings. Some of these wells have not yet been drilled or commenced pumping operations. The well permit database was screened to identify active wells located within the UMC study area. Entries with yield values, depth values, static water levels, construction dates, or other similar information in the database were assumed to be active wells. As shown in Figure 2-6, approximately 26,800 active wells were identified within the UMC study area and were designated one of the following uses:

- Commercial (425 wells). Water used for motels, restaurants, office buildings, ski resorts, water parks, and other commercial facilities and institutions such as greenhouses, feed lots, and dairy operations (DWR 2010).

- Industrial (2 wells). Water used for industrial purposes, such as fabrication, processing, washing, in-plant conveyance, and cooling, and includes such industries as steel, chemicals, paper, and petroleum refining (DWR 2010).

- Municipal (150 wells). Water withdrawn by public and private water suppliers and delivered to users or groups of users. Municipal water suppliers provide water for a variety of uses, such as domestic, commercial, industrial, thermoelectric power, and public water use (DWR 2010).

- Domestic (9,140 wells). Issued on tracts of land of 35 acres or more where the proposed well will be the only well on the tract, or on tracts of land of less than 35 acres in limited areas of the state if minimal impact on surface water rights. May serve up to three single-family dwellings, irrigate one acre or less of lawn and garden, and provide water for the individual's domestic animals and livestock (DWR 2008)

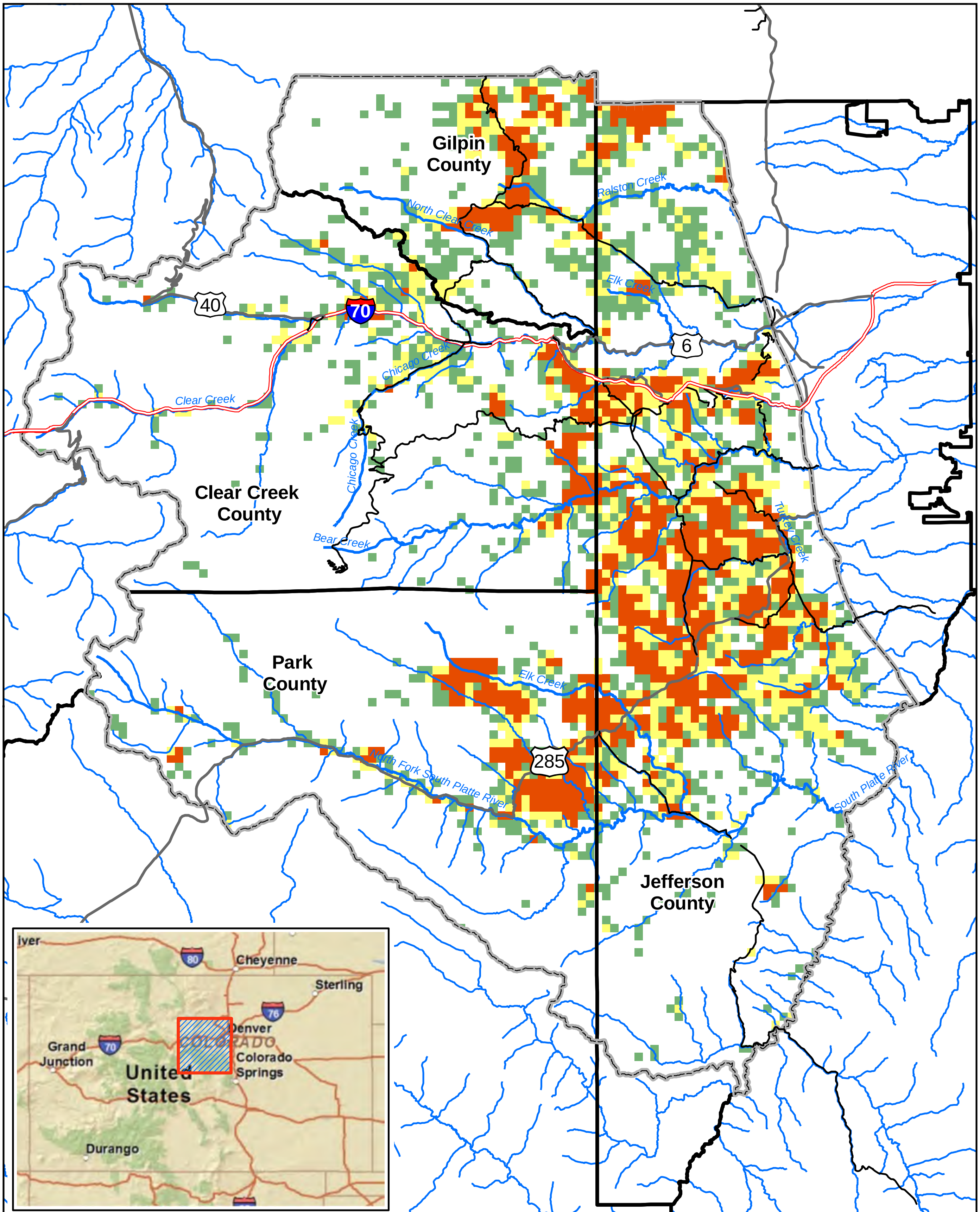

Figure 2.6 Domestic/HUO Well Density

UMC Water Needs Assessment
Water Supply Analysis

1 inch = 7 miles

0 3.5 7 Miles

N

Roads

- Interstate/Limited Access
- U.S. Highways
- State/CO Highways
- Main Streams

- UMC Study Area
- County Lines

Well Density

- 1 - 2 wells/100 acres
- 3 - 8 wells/100 acres
- 9 - 91 wells/100 acres

- Household Use Only (14,330 wells). Water for household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets; no outside uses are allowed. For parcels less than 35 acres, only a single family dwelling is permitted, multi-family dwellings are considered commercial use. For parcels over 35 acres, up to 3 dwelling can be developed (DWR 2010).

- Fire (1 well). Water used for fire protection (DWR 2010).

- Other (75 wells). Water used for purpose other than defined by beneficial use definitions. Wells designated for monitoring purposes.

- Stock (77 wells). Water used for non commercial livestock watering. Includes domesticated animals allowed by the county zoning ordinances (DWR 2010).

Domestic and HUO wells were the focus of the well analysis because they account for 97.5 percent of all wells in the UMC study area outside of the SWP boundaries. Of the active wells in the database, about 22,600 domestic and HUO wells are located outside of SWP areas as shown in Table 2-16. This correlates well with the 22,780 private, improved parcels use not served by a SWP with a residential and agricultural land use (Section 2.8.3, Table 2-15) and indicates that parcels outside of a SWP area are primarily self-supplied by wells. Thus, demands associated with well use can be used to represent parcel demands.

Table 2-16 Active wells located in the UMC Study Area

Location	All Beneficial Uses	Commercial	Domestic	Fire	HUO	Industrial	Irrigation	Municipal	Other	Stock	Total
Clear Creek County											
SWP	0	4	5	0	21	1	0	3	1	0	35
Outside SWP	0	69	942	0	1,820	1	4	0	10	3	2,849
Gilpin County											
SWP	0	1	1	0	4	0	0	1	0	0	7
Outside SWP	0	41	930	0	1,611	0	2	8	8	5	2,605
Jefferson County											
SWP	1	49	481	0	289	0	14	66	12	1	913
Outside SWP	1	187	5,440	1	7,237	0	13	57	36	23	12,995
Park County											
SWP	0	2	32	0	8	0	0	6	0	0	48
Outside SWP	0	72	1,305	0	3,341	0	5	9	8	8	4,748
Total SWP	***1***	***56***	***519***	***0***	***322***	***1***	***14***	***76***	***13***	***1***	***1,003***
Total Outside SWP	***1***	***369***	***8,617***	***1***	***14,009***	***1***	***24***	***74***	***62***	***39***	***23,197***

2.8.3.2 Well Pumping Rates

Demands for the wells outside of SWP areas were estimated based on well counts (Table 2-14) and usage rates as described below.

- Domestic (DOM) Well Usage Rate (used only for current well demand): 0.6 AFY
- Household Use Only (HUO) Well Usage Rate: 0.25 AFY
- All other well types Usage Rate: 0.33 AFY

The legal pumping limit for a domestic well is approximately 1 AFY if a full acre of lawn and garden are irrigated. It is believed that few users pump at this rate, and a lower rate of 0.6 AFY was chosen. The legal HUO pumping limit is 0.33 AFY. However, this rate was established in the 1970's when the number of persons per household was higher. Also, the pumping limit must represent both full and part time populations. Thus, lower pumping rate of 0.25 AFY was used for this study. For the purposes of this study, all other well types (except monitoring wells) were assumed to have a pumping rate of 0.33 AFY.

The number of Domestic wells and HUO wells were used to develop a weighted current demand for each improved residential parcel outside the SWP boundaries. As shown in Table 2-17, average weighted residential demands ranged from 0.35-0.40 AFY for counties in the UMC area. The UMC average, weighted demand was 0.38 AFY and was used for subsequent demand analysis for residential and agricultural parcels.

Table 2-17 Calculation of Average, Weighted Demand for UMC Wells outside of SWP area

County	Household Wells (#) outside SWP Area	Domestic Wells (#) outside SWP Area	All other Well Types	Total Wells	Demand per Residential Parcel (AFY)
Clear Creek	1,820	942	87	2,849	0.37
Gilpin	1,611	930	64	2,605	0.38
Jefferson	7,237	5,440	318	12,995	0.40
Park	3,341	1,305	102	4,748	0.35
UMC Study Area	***14,009***	***8,617***	**571**	***23,197***	**0.38**

2.8.4 Demands Outside SWP Area

Current (2010) and future (2050) parcel demands were calculated using the well demand for the information presented in Table 2-17. Recall that these demands are for public parcels outside of SWP areas and that these demands must be met with groundwater supply.

2.8.4.1 Current (2010) Demands Outside SWP Area

Current demands were calculated for private, improved parcels based on well demands discussed in Section 2.8.3.2 for Clear Creek, Jefferson, and Park Counties. Gilpin County provided data for current demands in unincorporated areas. Current demands are shown in Table 2-18. Demands for residential parcels were computed by multiplying the number of improved residential parcels outside of the SWP boundaries by the weighted average demand of 0.38 AFY. All non-residential parcels outside the SWP boundaries were multiplied by the assumed average demand of 0.33 AFY, except parcels zoned as conservation district, limited use or unzoned. Demands in Gilpin County outside of the SWP boundaries were provided directly by county staff.

Table 2-18 Current Demands for Parcels outside of SWP area

County	Residential/Agriculture		All Others[2]		Total Demand
	Parcel Count	Demand (AFY)	Parcel Count	Demand (AFY)	
Clear Creek	3,877	1,470	1,126	370	1,840
Gilpin[1]	--	--	--	--	417
Jefferson	13,731	5,220	339	110	5,330
Park[3]	4,326	1,640	85	30	1,670
Total	**21,934**	**8,330**	**1,550**	**510**	**9,257**

[1] Provided by County as demands in Unincorporated Gilpin
[2] No demands for parcels zoned as conservation district, limited use, or unzoned

2.8.4.2 Future (2050) Demands Outside SWP Area

Future demands in Clear Creek, Jefferson, and Park Counties associated with residential development were estimated based on permanent and part-time population forecasts (Tables 2-3 and 2-4), county census person per household data (Section 2.4.2). Future demands for Gilpin County were provided by county staff, and thus not calculated as part of the following procedure.

- Step 1. Estimated increase in population outside of SWP areas for 2050 growth scenarios. Calculated by subtracting SWP service population from total county population. Total population includes both part-time and permanent population numbers.

- Step 2. Determined number of houses required for future population estimates from Step 1 according to census person per household data.

- Step 3. Estimated demand for future housing under the assumption that all future full-time residential wells will be permitted HUO (0.25 AFY pumping limit. Total 2050 demands for full-time residential (domestic and HUO) wells must account for 2010 demands.

The land requirement for future development was also estimated based on minimum lot size information during this procedure and was compared to the amount of developable land in the UMC study area. This serves as an indication of how Counties may meet the needs of future development.

Person per household values range from 2.4 persons per household for Clear Creek County to 2.5 persons per household for Jefferson and Park Counties. Table 2-19 presents the total population for the Clear Creek, Jefferson, and Park Counties for current (2010) and future (2050) conditions calculated according to Step 1. Table 2-19 also shows the estimated number of houses required to meet population needs, this value was calculated based on the person per household values for each county (Step 2). Recall that Gilpin County provided a single 2050 future growth projection rather than low-medium-high scenarios for areas outside of SWP

Table 2-19 Future Population and Housing Needs outside of SWP areas in Clear Creek, Jefferson, and Park Counties

County	2010 Population outside SWP	Future (2050) Conditions Low		Future (2050) Conditions Medium		Future (2050) Conditions High	
		Incremental Population outside SWP	Additional Housing Need	Incremental Population outside SWP	Additional Housing Need	Incremental Population outside SWP	Additional Housing Need
Clear Creek	7,561	5,360	2,230	6,930	2,890	8,470	3,530
Gilpin*	4,949	160	70	160	70	160	70
Jefferson	30,719	18,700	7,480	20,590	8,240	25,590	10,240
Park	13,940	15,920	6,370	17,630	7,050	19,040	7,620
Total	57,169	40,140	16,150	45,310	18,250	53,260	21,460

**Population data provided by County*

A minimum lot size of 1 acre is required to accommodate an on-site well and septic system leach field. County officials were contacted to determine the minimum allowable lot sizes for the future subdivision of private land that is currently developable. Unimproved platted parcels and all unplatted parcels were considered land available for development. Improved, unplatted parcels with buildings were accounted for by multiplying the acreage by the minimum lot size and subtracting from the total improved, unplatted area for each county. Please note that the development potential (i.e. the amount of land with site characteristics appropriate for development) was not evaluated as part of this regional study. This information was used to calculate the land required to meet future growth in the UMC study area (Step 3) as shown in Table 2-20.

Table 2-20 Future Land Requirements (acres) in Clear Creek, Jefferson, and Park Counties

County	Minimum Lot Size (ac)	Land Available (ac)	Future (2050) Conditions Low	Future (2050) Conditions Medium	Future (2050) Conditions High
Clear Creek	*5*	*37,390*	11,150	14,450	17,650
Gilpin*	*20*	*32,660*	1,400	1,400	1,400
Jefferson	*10*	*141,100*	74,800	82,400	102,400
Park	*8*	*27,570*	50,960	56,400	60,960
Total	--	*238,720*	*138,310*	*154,650*	*182,410*

**Population data provided by County*

The land required for future conditions in Park County exceeds the amount of land available. The land requirements for all other counties can be met with available land (Current unplatted, improved and unimproved parcels). To meet land requirement needs in Park County for the future, high scenario, the County will likely need to change their minimum lot size or curb development as it exceeds available land. The needs in all Counties may require central water and sanitary sewer providers for new well development.

Demands calculated based on the housing requirements (Table 2-17) and HUO pumping limits are presented in Table 2-21 for Clear Creek, Jefferson, and Park Counties. Please note that future demand calculations were based only on HUO wells because DOM wells are no longer being permitted with new development. Gilpin County demands were provided by County staff. Self-supplied wells will likely not meet high demands. This portion of the UMC study area will likely require a centralized water provider to meet water supply needs.

Table 2-21 Demands (AFY) outside of SWP areas for UMC region

County	Future (2050) Conditions Low	Future (2050) Conditions Medium	Future (2050) Conditions High
Clear Creek	2,398	2,563	2,723
Gilpin*	960	960	960
Jefferson	7,200	7,390	7,890
Park	3,263	3,433	3,575
Total	**13,820**	**14,345**	**15,147**

**Provided by County as future demands in Unincorporated Gilpin*

2.9 Summary of Demands for UMC Study Area

Demands for the UMC study area based on the supply required by public land, areas served by SWP, and self-supplied private land are summarized in Table 2-22.

Table 2-22 Summary of Demands in UMC Study Area

County	Demand Type	Current (2010) Demands [AFY]	Future (2050) Demands [AFY] Low	Future (2050) Demands [AFY] Medium	Future (2050) Demands [AFY] High
Clear Creek	Public Land	--	--	--	--
	SWP Area	1,179	1,878	2,098	2,328
	Self-Supplied Private Land	1,840	2,398	2,563	2,723
	Total	*3,019*	*4,276*	*4,661*	*5,051*
Gilpin	Public Land	--	--	--	--
	SWP Area	384	1,340	1,350	1,350
	Self-Supplied Private Land	417	960	960	960
	Total	*801*	*2,300*	*2,310*	*2,310*
Jefferson	Public Land	10	10	10	10
	SWP Area	2,439	2,572	2,822	3,072
	Self-Supplied Private Land	5,330	7,200	7,390	7,890
	Total	*7,779*	*9,782*	*10,222*	*10,972*
Park	Public Land	--	--	--	--
	SWP Area	64	145	155	165
	Self-Supplied Private Land	1,670	3,263	3,433	3,575
	Total	*1,734*	*3,407*	*3,587*	*3,740*
Total	***Public Land***	***10***	***10***	***10***	***10***
	SWP Area	***4,066***	***5,935***	***6,425***	***6,915***
	Self-Supplied Private Land	***9,257***	***13,820***	***14,345***	***15,147***
UMC Area Total		**13,333**	**19,765**	**20,780**	**22,072**

CDM

Section 3
Draft - UMC Recharge Estimates

3.1 Introduction

The assessment of water availability in the UMC area requires estimates of groundwater recharge to predict sustainable levels of groundwater development. It should be noted that even though recharge occurs to the aquifer zone, recovery of this water by wells is dependent on many factors, especially in areas such as the Study Area where the well depth and degree of fracturing intersected by a well controls the well production. This section describes the geologic framework in the UMC study area, summarizes findings from the earlier studies that are used as the basis for estimating recharge and presents average recharge estimates for the UMC area. Application of this analysis to determination of sustainable groundwater development is provided in Section 4.

3.1.1 UMC Study Area Geology

The geology in the UMC study area is characterized by a complex assemblage of metamorphic and intrusive bedrock units. This area has been extensively deformed and faulted over geologic time, which has impacted the properties of these bedrock units. Unconsolidated alluvial, colluvial and glacial deposits comprise the surficial deposits in portions of the area. Previous studies (Bossong et al. 2003) included a detailed geologic and hydrologic characterization of the Turkey Creek watershed, which is located within the UMC Study Area (Figure 3-1). Geologic characterization of other portions of the study area is available on geologic maps (Tweto 1979 and Kellog et al. 2008). The detailed work documented in the Turkey Creek study (Bossong et al. 2003) was extended to the UMC study area using similar classification methods, since the Turkey Creek watershed geology is similar to the remainder of the area.

The Turkey Creek Study grouped bedrock units into four general aquifer classifications for purposes of estimating water budget components, which included metamorphic, intrusive, Pike's Peak granite, and highly fractured bedrock zones. The highly fractured areas include fracture zones, faults, and shear zones. The bedrock within the study area is typically fractured, but is more intensively broken within and adjacent to these major zones. The unfractured intrusive and metamorphic rocks are virtually impermeable unless they are fractured. The geologic classifications were made based on lithologic similarity, structural history, and geologic setting. The same classification system was applied to the surficial geology in the UMC study area in order to delineate aquifer types throughout the study area. Existing geologic mapping was compiled from the most detailed sources available for the study area. This included the geologic map of the Denver west quadrangle (30 feet by 60 feet) for North-Central Colorado that provided data for Gilpin County and portions of Clear Creek and Jefferson Counties (Kellog et al. 2008). Geologic data for remainder of the UMC study area was incorporated from the 1:500,000 USGS geologic map (Tweto 1979). The Denver west quadrangle map was given preference for areas of overlap. At mapping boundaries between the maps, care was taken to match aquifer type delineations to ensure topological accuracy.

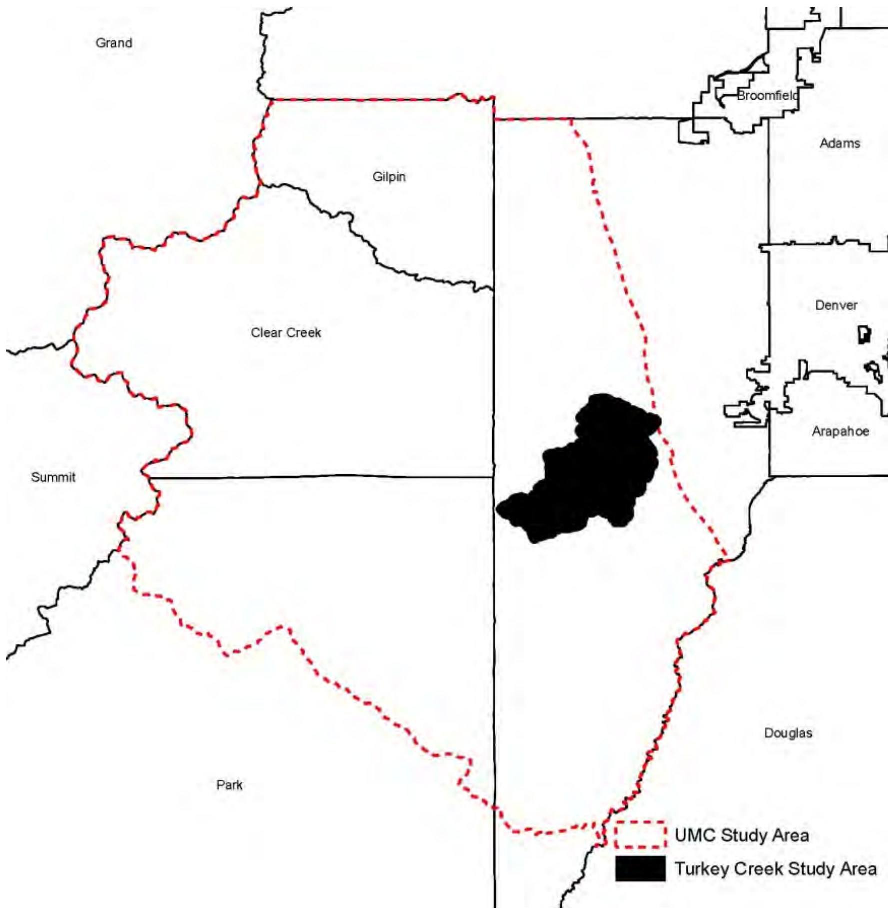

Figure 3-1 Turkey Creek Study Area

Bedrock geologic units were classified into the same four categories that were developed for the Turkey Creek Study. Turkey Creek does not contain significant amounts of alluvium, so Bossong (2003) did not incorporate this unit into the analysis. The UMC study area, however, contains significant unconsolidated upland and valley bottom alluvial or glacial deposits. The unconsolidated materials were included in the current analysis as a separate classification. Valley fill alluvium occurs adjacent to streams that are typically gaining flow from groundwater. Recharge does occur in these valley bottom alluvial areas, however, due to the relatively high permeability of these deposits, and their interconnection with the surface water system, this recharge does not contribute to the bedrock aquifer system. Groundwater development in the valley bottom alluvial system is more related to streamflow, rather than local recharge from precipitation. Upland alluvial and unconsolidated deposits do provide a recharge pathway that can contribute to the underlying bedrock aquifers.

Through replicating the Turkey Creek Study methods, and adding the alluvial classification, five aquifer types were delineated in the UMC study (Figure 3-2). Table 3-1 summarizes the individual mapping units from the original source, along with the aquifer classification unit to which each was assigned. The aquifer classifications are defined below:

- Metamorphic Group. Metamorphosed and foliated gneisses and schists
- Intrusive Group. Large scale intrusive quartz monzonites found in plutons (e.g. the Silver Plume Quartz Monzonite)
- Pike's Peak Group. Large scale intrusive Pikes Peak granite batholith
- Highly Fractured Group. Major fault, fracture and shear zones that cut through all rock types and includes other mapped structural brecciated zones. These zones include a 200 meter buffer zone centered on the mapped feature.

Alluvial Group

- Upland Subgroup. Glacial and alluvial deposits within the topographically upland portions of the study area. These units significantly contribute to recharge in underlying bedrock zones.
- Valley Fill Subgroup. Glacial and alluvial deposits within the topographically lower portions of the study area along significant streams. This zone does not contribute significantly to bedrock recharge, since it occurs in areas of discharge to the streams.

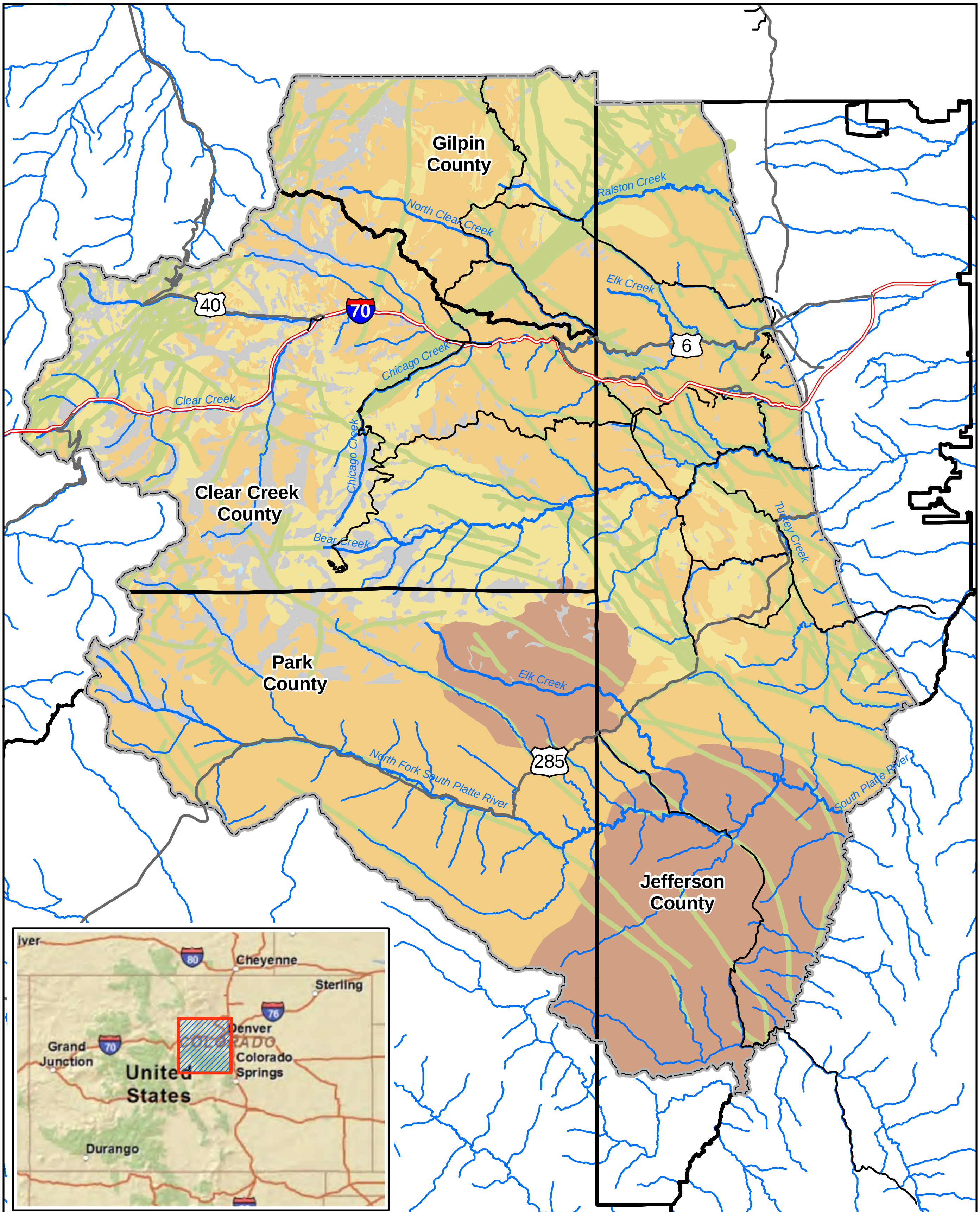

Figure 3.2 UMC Study Area Aquifer Classification

UMC Water Needs Assessment
Water Supply Analysis

1 inch = 7 miles
0 4 8 Miles

N

Roads
Interstate/Limited Access
U.S. Highways
State/CO Highways
Main Streams

County Lines
UMC Study Area

Aquifer Classification
Alluvium
Highly Fractured
Intrusive
Metamorphic
Pikes Peak
Water Body

Table 3-1 Individual Surficial Rock Types (from Source Maps) Assigned to Aquifer Groups

Aquifer Group	Source Map	Surficial Geologic Unit from Original Source Map
Alluvium (Upland Deposits)	Tweto, 1979	Quaternary, glacial drift (Qd)
	Kellog, et.al., 2008	Collivum (Qc), Landslide Deposits (Qls), Talus deposits (Qt), Rock-glacier deposits (Qrg), Mass-movement and glacial deposits (Qmg), Till of Pinedale age (Qtp), Till of Bull Lake age (Qtp), Till of Pinedale and till of Bull Lake age, undivided (Qti)
Alluvium (Valley Fill Deposits)	Tweto, 1979	N/A
	Kellog, et.al., 2008	Artificial fill deposits (af), Post-Piney Creek alluvium and Pinery Creek Alluvium, undivided (Qa), Valley-floor alluvium (Qva), Broadway Alluvium (Qb), Young stream-terrace alluvium (Qg1), Louviers Alluvium (Qlv), Slocum Alluvium (Qs), Alluvium and colluvium, undivided (Qac), Fan deposits (Qf)
Highly Fractured Zone	Tweto, 1979	Major mapped faults
	Kellog, et.al., 2008	Major mapped faults, shear and structural Breccia Zones
Intrusive Zone	Tweto, 1979	Granitic rock (Yg) and Granitic Rock (Xg)
	Kellog, et.al., 2008	Intrusive breccia (PEKix), Porphyries of the alkalic group (PEKpa), Older felsic to intermediate porphyries of alkali-calcic group (PEKpc), Younger felsic to intermediate porphyries of alkali-calcic group (PEpc), Rhyolite porphyry (PErp), Gabbro (Xgb), Boulder Creek Granodiorite (XgdB), Mafic granodiorite, quartz diorite, hornblende diorite, and hornblendite (Xgh), Monzogranite of Elephant Butte (Xgr), Younger diorite and hornblendite (Yd), Peraluminous monzogranite (Yg), Younger gabbro (Ygb), Granodiorite and monzogranite (Ygd), Granodiorite of Mount Evans batholith (YgdM), Silver Plume Granite (YgSP), Granodiorite and monzogranite of unknown age (YXgd), Twin Spruce Monzogranite (YXgT), Pegmatite and aplite (YXp)
Metamorphic Zone	Tweto, 1979	Biotite gneiss (Xb), Early Proterozoic felsic gneiss (Xfh)
	Kellog, et.al., 2008	Biotite gneiss (Xb), Cordierite-biotite gneiss (Xbc), Biotite gneiss, hornblende gneiss, and calc-silicate gneiss (Xbhc), Porphyroblastic quartz-biotite-muscovite schist of White Ranch (Xbp), Calc-silicate gneiss (Xc), Quartz-feldspar gneiss (Xf), Hornblende-plagioclase gneiss and amphibolite (Xh), Hornblende gneiss and calc-silicate gneiss (Xhc), Mixed layered gneiss (Xlg), Muscovite-quartz schist (Xqs), Sheared rocks of the Idaho Springs-Ralston shear zone (YXcr)
Pike's Peak Zone	Tweto, 1979	Rocks of the Pikes Peak Batholith (Yp)
	Kellog, et.al., 2008	Middle Proterozoic granite (Ygp), Pike's Peak granite, Fine grained porphyritic phase of the Pike's Peak Granite (YgPp)

3.1.2 UMC Study Area Precipitation

The monthly average precipitation over the analysis period of water years 1949 to 1999 at the Cheesman dam station is shown on Figure 3-3. The highest precipitation occurs in July and August, coinciding with periods of high evapotranspiration rates. The precipitation at the Cheesman station ranged from 10.31 to 24.14 inches, with an average of 16.49 inches at this station during the water year 1949 to 1999 period.

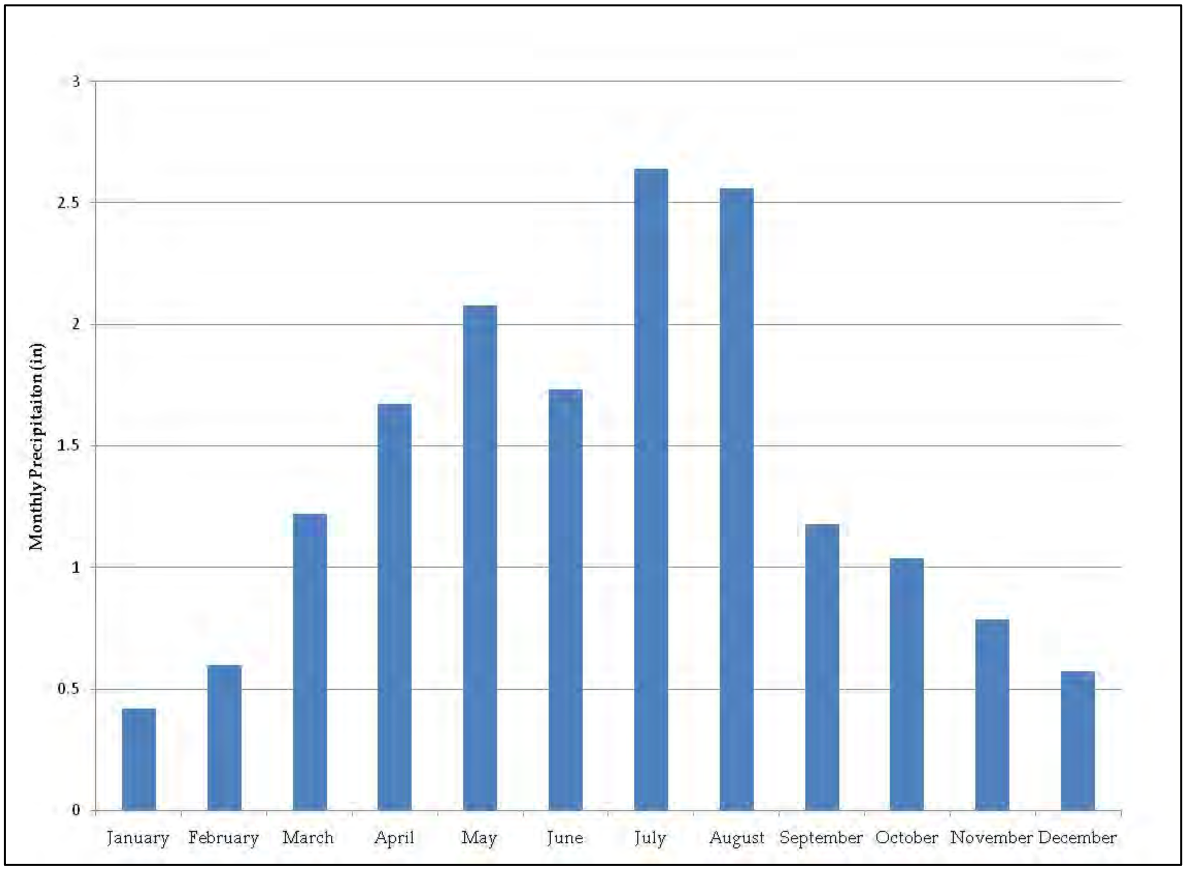

Figure 3-3 Average Monthly Precipitation at Cheesman Dam from 1949 to 1999

Precipitation typically accumulates as snowfall during the fall and winter periods when evapotranspiration is low, and significant recharge occurs as the snowpack melts in the spring. Figure 3-4 illustrates this distribution of recharge (BFI, base flow infiltration), based on the calibrated model simulations reported in Bossong (2003). Average precipitation, evapotranspiration and recharge over the 33 month period of the study are shown, indicating that most of the recharge occurs during the snowmelt periods. For this reason, fall and winter precipitation is the most important for evaluation of recharge, since precipitation during the growing season is largely consumed by evapotranspiration, based on the Turkey Creek studies. Recharge may also occur during other seasons during higher rainfall events that are sufficient to replenish soil moisture within the root zone of plants and infiltrate to deeper intervals. Figure 3-5 shows the proportion of fall and winter precipitation during the

1949 to 1999 analysis period. This plot approximates a normal distribution. The 95 percent confidence limits on the mean value of the proportion of fall and winter precipitation ranges from 25 to 30 percent of the total annual precipitation, with a mean value of 27.5 percent.

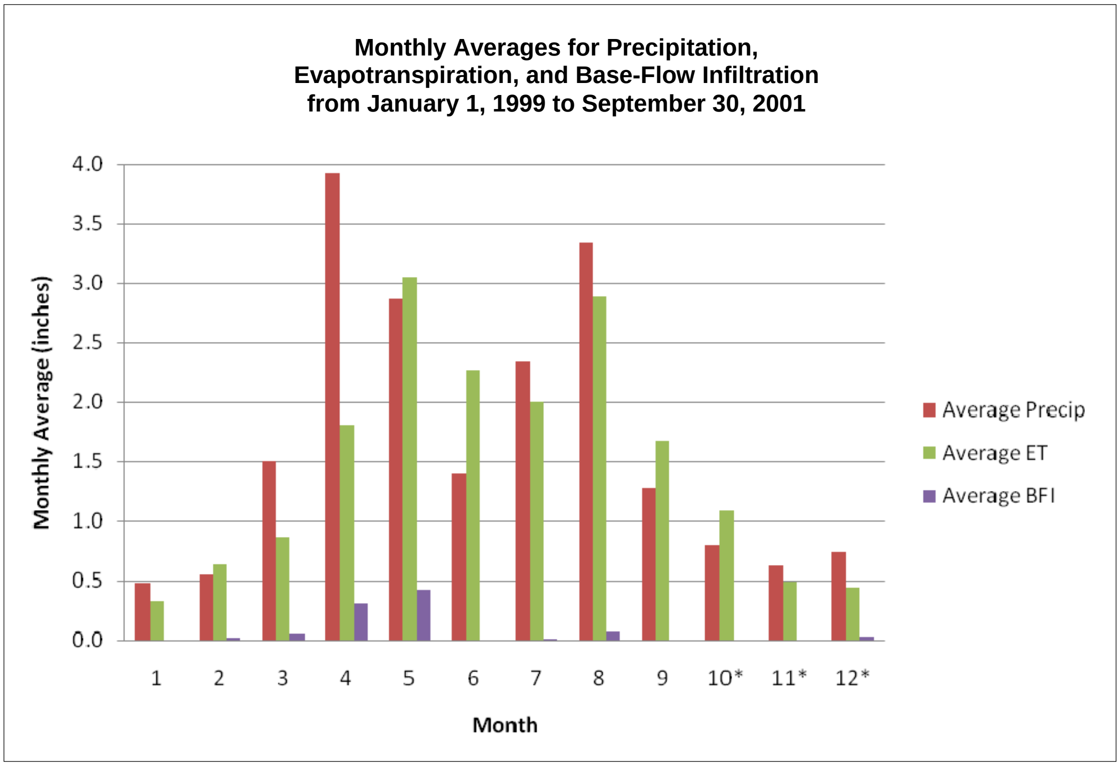

Figure 3-4 Comparison of Turkey Creek Precipitation, Evapotranspiration, and Recharge

*Only for years 1999-2000

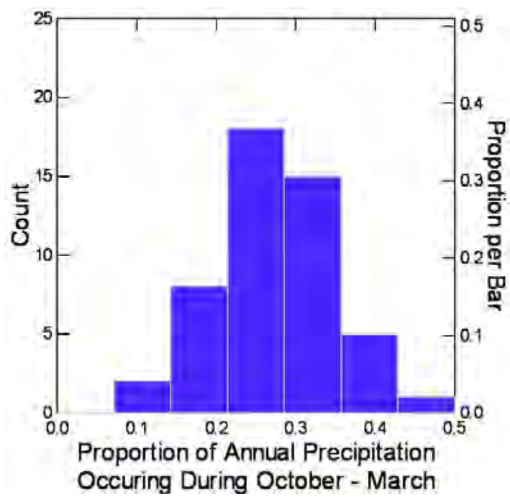

Figure 3-5 Proportion of Total Precipitation during the Fall and Winter

There are limited meteorological monitoring stations within the study area with long-term, daily records. Average annual precipitation has been interpreted through the study area, based on the available stations and orographic factors. Since annual average precipitation data are available throughout the study area, the average annual precipitation was used for estimation of recharge quantities, by applying the percentage of annual precipitation that occurs during the fall and winter months. Contours of these average annualprecipitation rates are shown on Figure 3-6.

The average annual precipitation in the study area ranges from 15 to 43 inches, with the fall and winter precipitation ranging from 4.1 to 11.8 inches, based on the average 27.5 percent factor from the Cheesman station. The high precipitation occurs along the high elevation divide, where most of this occurs as snow during the winter. The percentage of fall and winter precipitation is greater at these high elevations; however, little private land that may be developed is present at these elevations, so the underestimate of the fall and winter precipitation does not significantly impact this study.

3.1.3 Previous Studies on Recharge in UMC Study Area

The evaluation of recharge for this study uses the extensive work documented in the Turkey Creek area (Figure 3-2) that was conducted by the USGS and cooperators (Bossong, 2003), the Colorado School of Mines, and the Colorado Geological Survey.

3.1.3.1 Turkey Creek Study

The Turkey Creek study (Bossong, 2003) described hydrologic conditions and estimated water resources in the basin. This program included geologic characterization, hydrologic and climatological monitoring and synthesis of these data into a water budget model. The geologic work included mapping of surficial rock types, compilation of well logs and assessment of the degree of fracturing in order to determine the hydrologic characteristics of each geologic category. The hydrologic characterization grouped the bedrock units into four classes; 1) Metamorphic rocks, 2) Intrusive rocks, 3) Highly fractured zones, and 4) Pikes Peak granite. Very little alluvial fill material was present in the Turkey Creek study area, so it was not characterized.

The major elements necessary to characterize water budgets for the basin were monitored during the 1999 to 2001 period of the Turkey Creek study to provide basin specific information. Climatological and streamflow gauging data from existing stations were utilized in the investigation, along with new data collection for rainfall, temperature, and evapotranspiration over several years. Rainfall was monitored at 15 sites, supplemented by snow monitoring at several other locations. Temperature monitoring was conducted at four locations in the basin. Detailed evapotranspiration and associated physical data were collected at two locations. Streamflow was monitored periodically at more than 25 locations within the basin to supplement the continuous monitoring at selected locations. Fifteen wells were monitored on a monthly basis, while a single period measurement of water levels at 131 wells was conducted to develop a potentiometric surface map.

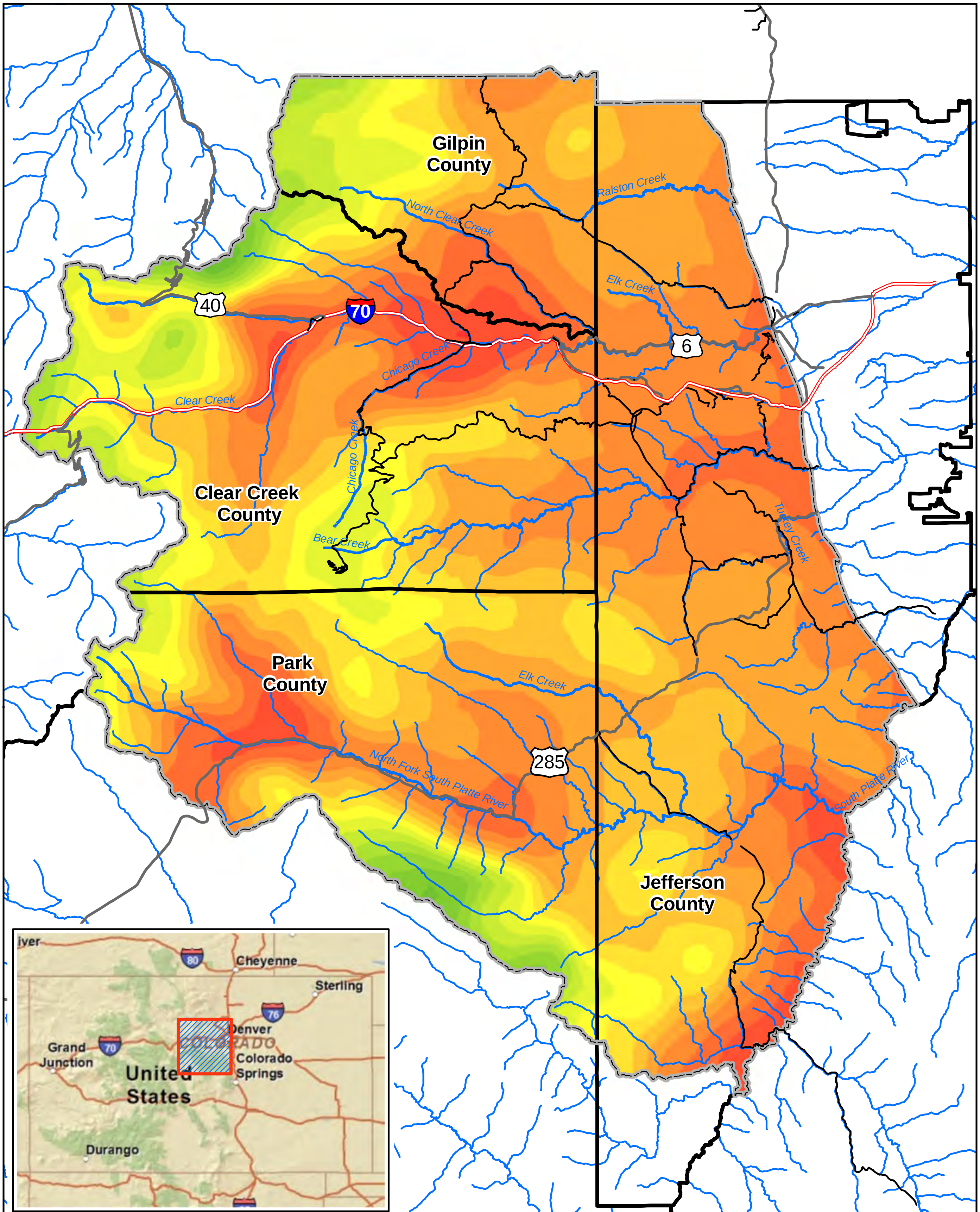

Figure 3.6 Average Annual Precipitation

UMC Water Needs Assessment
Water Supply Analysis

1 inch = 7 miles
0 4 8 Miles

N

Roads

- Interstate/Limited Access
- U.S. Highways
- State/CO Highways
- Main Streams
- UMC Study Area
- County Lines

Average Annual Precipitation (in)

15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43

These data were used to support development of a runoff model for the basin to quantify the major elements of the water balance. This model was developed using the Precipitation-Runoff Modeling System, which represents physical processes active in the basin and allows variation in the spatial distribution of parameters. Site data were used to develop hydrologic response units (HRUs) based on the geology, soils, slope, aspect and other characteristics. The model uses precipitation as the source of water, which is partitioned into losses from evapotranspiration, changes in storage in the basin soils and groundwater reservoir and runoff leaving the basin. Accounting is performed on sub-units within the basin to allow characterization of areas that have similar hydrologic characteristics. The model was calibrated to data collected over the three year duration of the study, and then used to simulate a 50 year period. The calibration period is impacted by the extensive groundwater use in the basin, and may underestimate the native recharge quantity due to this use. The runoff modeling indicated that infiltration of precipitation below the root zone was significant; however, a large portion of this infiltrating water discharges relatively rapidly to streams from what was termed the interflow reservoir. The remainder of the infiltrating recharge replenishes the base flow reservoir, or the deeper groundwater reservoir. The base flow reservoir supports longer duration discharge to streams, and in the Turkey Creek basin, typically retained some storage from year to year. The study found that the water in the baseflow reservoir in intrusive and metamorphic rock was released more rapidly than that in the highly fractured and Pikes Peak materials. The deep groundwater reservoir is below local stream base level and is not typically depleted by local stream discharge. The deep groundwater reservoir eventually discharges to regional streams. The baseflow and deep groundwater reservoirs can support development of groundwater supplies, at the cost of decreasing streamflow, however, since the dominant lithologies in the study area are also the ones that drain within a few months of recharge events, not all of this baseflow reservoir recharge is available to support groundwater development, which occurs year around.

3.1.3.2 Colorado School of Mines

The Colorado School of Mines has also conducted research in the Turkey Creek basin, specifically assessing consumptive use and return flows from produced groundwater (Stannard, et. al. 2010). Individual groundwater wells are used by most homes that are not within organized utility districts in the study area. Only a portion of the water produced from these wells is consumed, since most is returned to the subsurface in on-site septic tank and leach field systems. During the 1999 to 2001 study period, water levels were observed to be declining within the basin. The reason for the observed decline was not determined in the study. A study by Poeter (Poeter, et. al., unknown date) included a detailed water balance, and estimated that 75 percent of the average recharge in the Turkey Creek watershed is being pumped, with most of this returning to groundwater.

A Colorado School of Mines thesis by VanderBeek (VanderBeek, G. A., 2009) assessed recharge rates and the water budget in the Turkey Creek watershed. This study concluded that the recharge rates estimated by Bossong et. al. (2003) overestimated the quantity of recharge in the basin. VanderBeek noted that significant uncertainty remained on the recharge quantities. The recharge rates, based on calibrating a groundwater model, were estimated to range from 0.1 to 2.25 inches per year. This study also found that considering slope and aspect ratio of the land surface improved the model calibration.

The consumptive use of water that is pumped for individual households using on site wells operating under a household use only permit, with on-site disposal has been investigated in the Front Range area. The State Engineer estimated that 87.7 percent of the water pumped for household use only wells with on-site disposal was returned to the aquifer (Vanslyke and Simpson, 1974). Research conducted by Paul (Paul, 2007) while at the Colorado School of Mines quantified the water budget at an individual household in the Turkey Creek watershed over a several year period. This work included monitoring of well pumping, discharge to the on-site leach field, and evapotranspiration on the leach field. This work found that 84.4 percent of the pumped water was returned to groundwater. The most recent analysis (Stannard, et. al., 2010) refined estimates of consumptive use of water wells, considering a more detailed analysis of evapotranspiration over leach fields. This study found that the consumptive use amounted to 19.6 percent of the water pumped, with the remainder returning to groundwater. The sites used in the study included some outdoor use of well water that was not quantified, so this loss percentage may overestimate losses for indoor use only wells.

3.1.3.3 Colorado Geologic Survey

The Colorado Geologic Survey (Topper, 2009) conducted an evaluation of recharge potential in Clear Creek County. This investigation developed a classification system for native recharge potential based on the geology, slope, soil classification and precipitation. The highest groundwater recharge potential was associated the relatively flat areas associated with the alluvium in valley areas. Areas of intense faulting and fracturing were also classified as areas of significant potential recharge. Bedrock zones outside of the fractured and faulted areas had the lowest potential recharge.

3.2 Recharge Estimate

In order to estimate the sustainable groundwater availability, the results of the Turkey Creek study (Bossong, 2003) were used to develop methods to estimate groundwater recharge that is potentially available to wells. This investigation has a large site-specific data set and a well calibrated model that considers both surface water and groundwater. The Turkey Creek study area is representative of conditions that are present throughout the current larger study area, with a similar range in climatological, geologic and topographic conditions. The objective of the methodology development was to define a relatively simple approach that utilizes available data for the study area that builds on the relationships that were developed for the Turkey Creek study.

3.2.1 Methodology

The methodology for estimating recharge relies on relationships developed from the calibrated watershed model developed for the Turkey Creek basin (see Section 3.1.3). Available geologic mapping at a variety of scales was compiled and each geologic unit classified into one of the four hydrogeologic groups, plus alluvium, as shown in Figure 3-2 (Section 3.1.2). Estimation of the average annual recharge under native conditions for each of the demand areas uses the annual precipitation, geologic class and the contributing recharge area to the demand location.

Assessing the proportion of recharge that is available for sustainable development should consider the return flows from on-site septic systems, which will recycle a significant proportion of groundwater that is pumped. The most recent studies indicate that about 80.4 percent of the pumped water returns to groundwater through the on-site disposal systems. The net recharge from these systems, after considering discharge to streams from the interflow reservoir, results in approximately 52 percent of the pumped water reaching the baseflow and deep groundwater reservoirs.

3.2.1.1 UMC Study Area Water Budget

The conceptual model defining the water budget components is summarized on Figure 3-7, which is a simplified representation of the system developed for the Turkey Creek watershed. This conceptual model describes the movement of water originating from precipitation through different compartments.

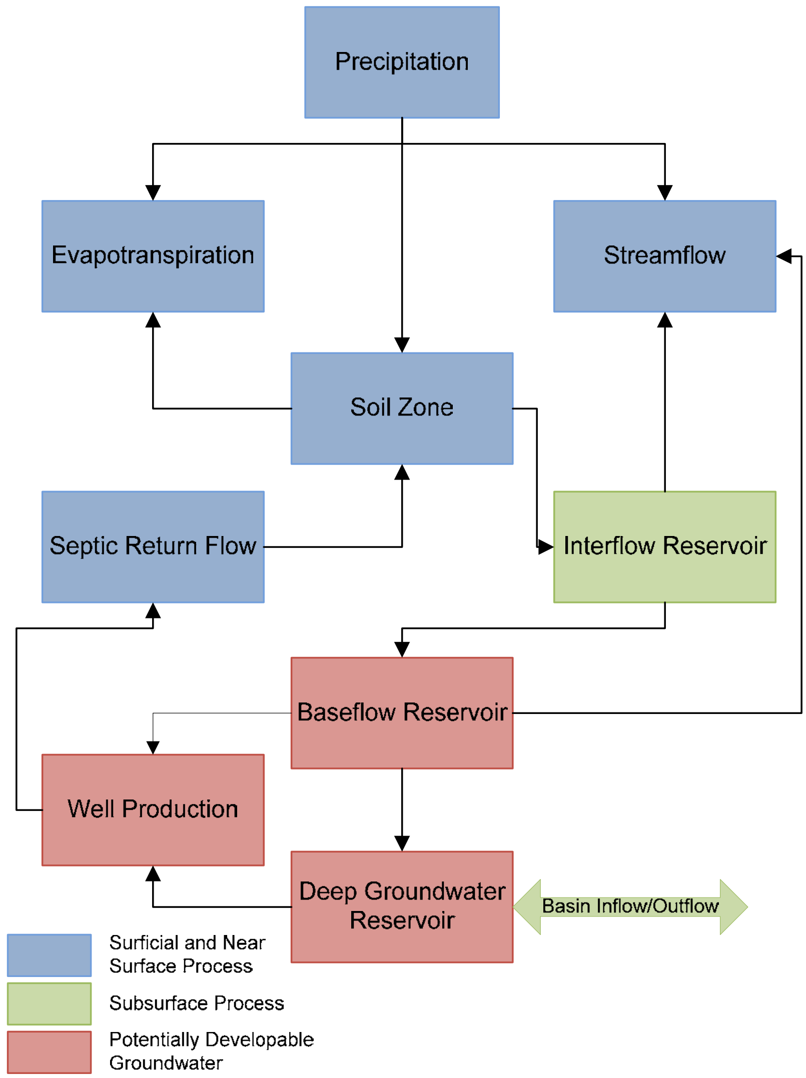

Figure 3-7 Site Water Budget Conceptual Model

The majority of the precipitation is lost to evapotranspiration, with the remainder either infiltrating or running off to streams. Precipitation that does not immediately run off enters the soil, where it is either evapotranspired or infiltrated to deeper zones. A portion of the infiltrating water discharges to the surface water system from interflow and baseflow reservoirs. The interflow reservoir contains water only for short periods after infiltration events, and does not provide a reliable source of water to wells. The baseflow reservoir contains water through most of the year, and may have carryover storage of 0.1 to 0.2 inches over the watershed for average years in the Turkey Creek watershed (Bossong 2003). The baseflow reservoir releases water most rapidly after recharge events in the spring, with flows declining gradually after this period. Groundwater in the baseflow reservoir discharges more rapidly in the metamorphic and intrusive areas, and is retained longer in the highly fractured and Pikes Peak zones. A portion of the water in the base flow reservoir percolates to the deeper groundwater system. The deep groundwater system is typically below local stream level and is less connected with the surface water system. Water from this deeper groundwater reservoir eventually discharges to the surface water system. In portions of the study area near regional streams that represent base level discharge areas, no recharge will occur to the deeper groundwater system, unless water levels in the aquifer decline below the stream base level. Figure 3-8 is a schematic representation of the relationship of the baseflow and deep groundwater reservoirs. The groundwater table typically is a subdued reflection of the surface topography, where water levels are highest beneath hills, with a gradient toward streams. When water levels are above the local stream level, a gradient will exist that drives flow toward the stream where it supports the baseflow discharge. Deeper bedrock zones that are below this stream base level but a portion of this water will eventually discharge to larger regional streams. If water levels in the aquifer decline below the stream base level, then flow to the stream will be cut off in that area, and water would be produced from storage within the aquifer, plus whatever recharge percolates to this deep zone.

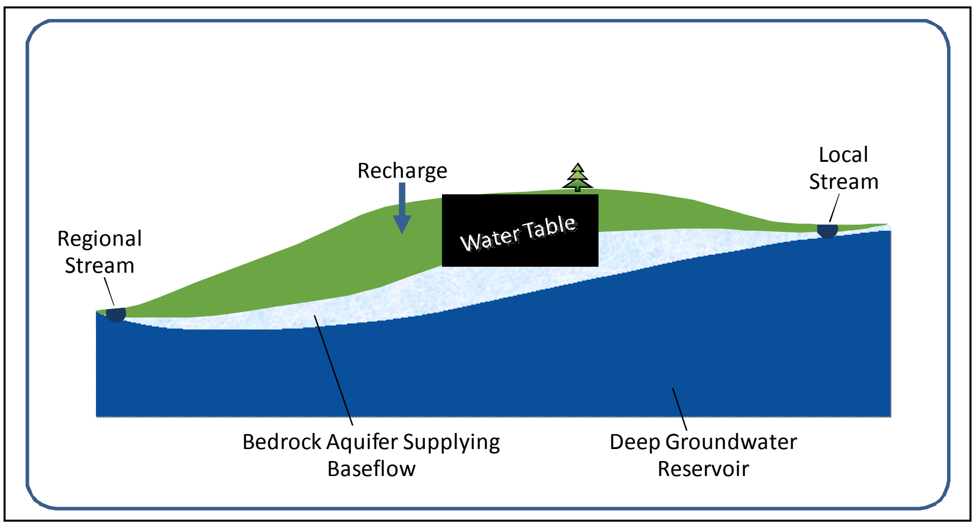

Figure 3-8 Schematic Representation of Baseflow and Deep Groundwater Reservoirs

The baseflow reservoir is potentially available to support groundwater development as it can support well production for at least part of the year. The Turkey Creek studies (Bossong,et.al, 2003), concluded that recharge in the dominant rock types (intrusive and metamorphic zones) discharged within several months of a recharge event. This means that not all water in this zone is available to support year around groundwater development. Wells in the study area are typically completed in the physical interval that represent the baseflow reservoir, thus will obtain some of their production from this interval. In addition, the drawdowns that these wells induce during times when little water is present in this zone will increase the quantity of water that will move into the deep groundwater interval, since the gradient available to support flow toward streams will be decreased. Groundwater that is pumped from the baseflow reservoir and deeper zones is returned to the subsurface as seepage from on-site septic systems, where it moves through the system in a manner similar to infiltrating precipitation. As noted from available studies, the estimated quantity of return flow from on-site disposal systems amounts to 80.4 percent of the groundwater that is pumped. This return flow from on-site disposal system then partitions between the interflow, baseflow and deep reservoirs, similar to precipitation, the net result of which is that about 52 percent of the pumped water returns to the baseflow and deep reservoirs.

3.2.1.2 Fate of Precipitation in UMC Study Area

The results of the Turkey Creek study (Bossong, 2003) provide a basis for assessing the fate of precipitation. Figure 3-9 shows the annual average partitioning of precipitation between evapotranspiration, surface water and groundwater components, based on the calibrated model simulations for the 1949 to 1999 period from the Turkey Creek study across all rock types.

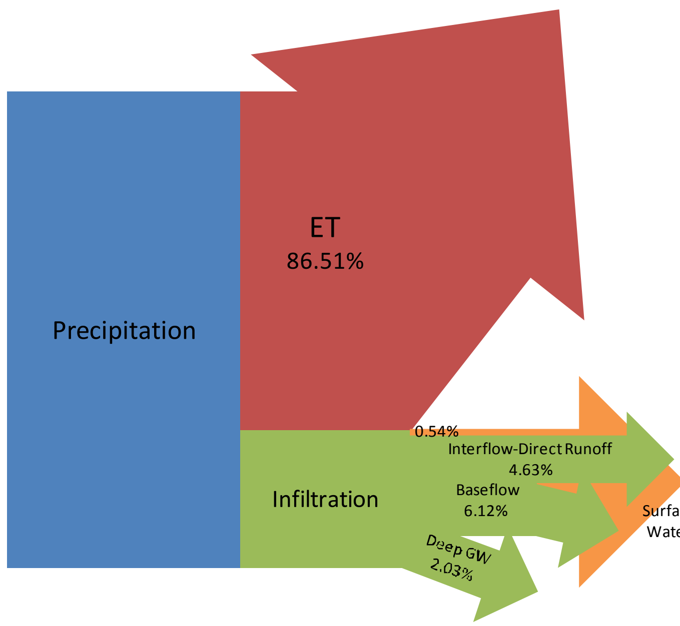

Figure 3-9 Precipitation Partitioning based on Turkey Creek Study

Most precipitation is consumed as evapotranspiration (86.5 percent), with about 0.5 percent running off directly to surface water. The rest infiltrates below the root zone, where it is no longer available to support evapotranspiration. This infiltrating water is further partitioned into flow in the interflow zone, where 4.6 percent of precipitation discharges to surface water relatively rapidly from the interflow zone, and is not available to support groundwater development. The baseflow reservoir discharges to the surface water system more slowly, has seasonal carryover of storage in some rock types and is partially available to support groundwater development in the bedrock system. This component of flow amounts to about 6.1 percent of precipitation. The remaining 2 percent of infiltration recharges deeper groundwater reservoirs that do not discharge to local streams. When the system is in equilibrium, all of the infiltration components (interflow, baseflow and deep groundwater) will eventually discharge to the surface water system, unless removed by wells. Similar partitioning of infiltrating water from on-site disposal systems occurs, with approximately 52 percent of the pumped water entering the baseflow of deep groundwater reservoirs. With increasing development of the groundwater resource, a new equilibrium condition will develop, as drawdown in the aquifers will decrease hydraulic gradients toward streams, decreasing the discharge from the baseflow reservoir zone.

3.2.1.3 Precipitation and Baseflow Correlation

Mathematical Correlation

To estimate recharge to the baseflow and deeper bedrock zones that can support groundwater development, simulation results from the Turkey Creek study were used to develop regression equations relating fall and winter precipitation to recharge. This approach was specific to the metamorphic, intrusive, highly fractured, and Pike's Peak groups. Recharge for the alluvium geologic class was estimated to be the same as the Pikes Peak granite, which has the highest infiltration rates. The permeability of the alluvial material is significantly higher than any of the other classes, and the alluvial materials typically have a lower surface slope. These factors combine to result in relatively high infiltration rates. The use of the same infiltration rate as the Pikes Peak group regression will provide a conservative underestimate of the recharge that occurs. Since the alluvial deposits are typically near streams, much of the recharge will discharge to the stream relatively rapidly, so this is not considered recharge that is available to the bedrock aquifers.

The results of the Turkey Creek study indicate that most precipitation that occurs during the growing season is consumed by evapotranspiration. Precipitation exceeds evapotranspiration during the fall and winter, when snow accumulates. As this snow melts in the spring, significant recharge occurs. Recharge will also occur in response to rainfall amounts during the growing season that exceed soil moisture and evapotranspiration demands.

The maximum available groundwater in the basin includes the baseflow discharge to streams from the baseflow reservoir, and deep reservoir recharge. Realistically, not all of this water is available for recovery by wells, since full consumption of this water would result in complete depletion of streamflow, and a significant percentage of this baseflow discharges within a few months of the recharge event in the spring snowmelt. Discharge rates also vary during the year, with baseflows highest after the spring recharge and declining over the remainder of the year. Available precipitation data for the study area consists of average annual quantities, due to the limited number of monitoring stations.

The long term simulations in Turkey Creek utilized the precipitation records from the Cheesman Dam gage to quantify the site water budget. Precipitation data from the Georgetown and Berthoud Pass stations was also examined. The Cheesman and Georgetown seasonal distributions are very similar, however, the station at Berthoud

Pass, on the continental divide, shows significantly higher precipitation during the fall and winter months. The Cheesman precipitation records were used to develop regression equations relating the baseflow discharge and deep reservoir recharge calculated in the Turkey Creek model to annual precipitation.

Spatial Correlation
Precipitation and baseflow was spatially correlated by merging average annual precipitation spatial data with the aquifer classification dataset (Figure 3-3). This provided a master geospatial dataset of the UMC area with average annual precipitation values for areas contributing to recharge. Recharge quantities are calculated by applying the regression equations to this combined dataset that includes both the aquifer classification and precipitation.

3.2.2 Regression Analysis

A series of regression equations were developed relating fall and winter precipitation totals to the modeled recharge that was simulated for the baseflow discharge and deep reservoir compartments in the Turkey Creek study, for each of the four geologic classes. Monthly precipitation data were available for this area, allowing the direct determination of precipitation during the fall and winter period. The Turkey Creek simulation results incorporate more detailed data on slope, aspect, vegetation and other factors that control recharge, however, the range of conditions is similar to those encountered in the developable portions of the study area. The regression approach was selected for application in the current study area, since data are available to make these estimates. Application of the more complex methods similar to the Turkey Creek study is not appropriate, since sufficient detailed data are not available for the entire study area.

3.2.2.1 Regression Equations for Geologic Classes

The regression equations developed for application to this study used information from the long-term simulations in the Turkey Creek study, correlating the fall and winter precipitation with the model estimated baseflow discharge from the baseflow reservoir and recharge to the deep groundwater reservoir. This quantity represents the maximum quantity of groundwater that would be developable, if all streamflow were depleted. In particular, the baseflow discharge component is depleted in areas distant from regional streams typically within a few months of recharge events. These correlations were conducted on a water year basis, utilizing data provided in Table 31 of the Turkey Creek study (Bossong, 2003). Figures 3-10, 3-11, 3-12 and 3-13 provide scatter plots of annual precipitation versus the sum of model calculated baseflow discharge and deep groundwater reservoir recharge, along with the regression line describing the relationship.

These regressions are statistically significant; however, a high degree of scatter occurs around the regression line, indicating random variability. Use of average conditions and the regression relationships is an appropriate method for this regional planning evaluations, however the process must consider that half the years will be below this average.

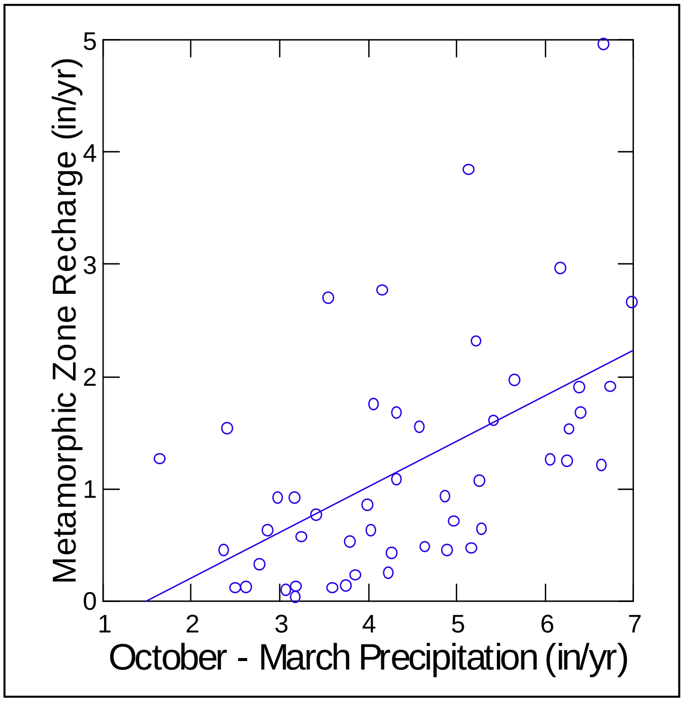

Figure 3-10 Relationship between Winter Precipitation and Metamorphic Zone Recharge

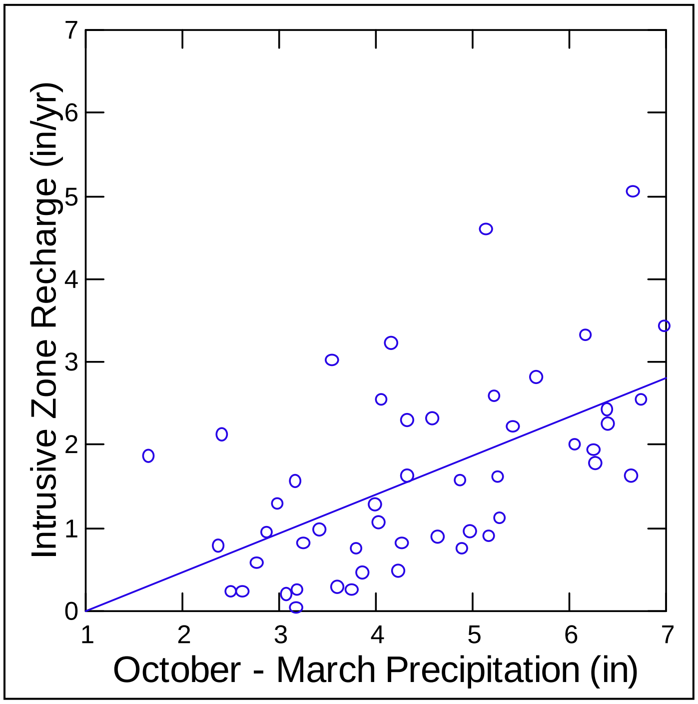

Figure 3-11 Relationship between Winter Precipitation and Intrusive Zone Recharge

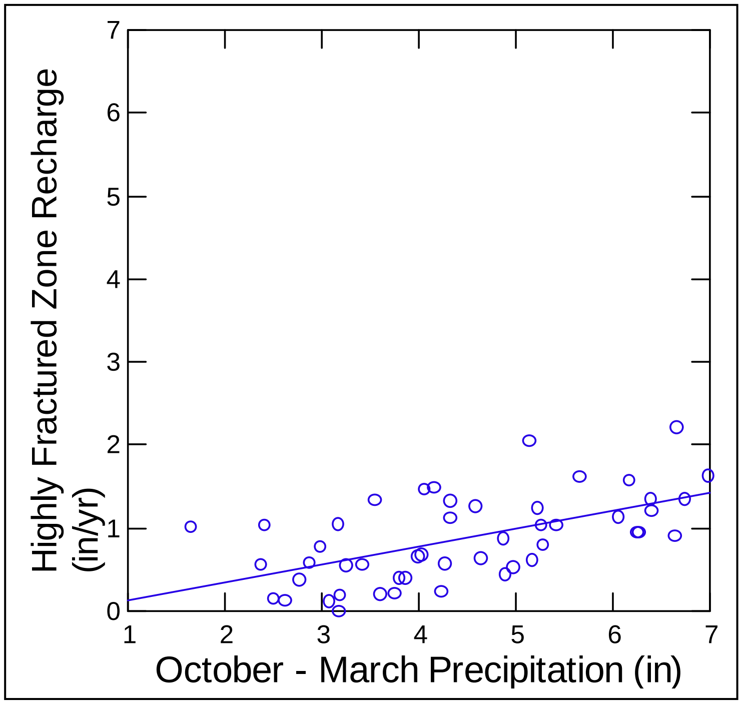

Figure 3-12 Relationship between Winter Precipitation and Highly Fractured Zone Recharge

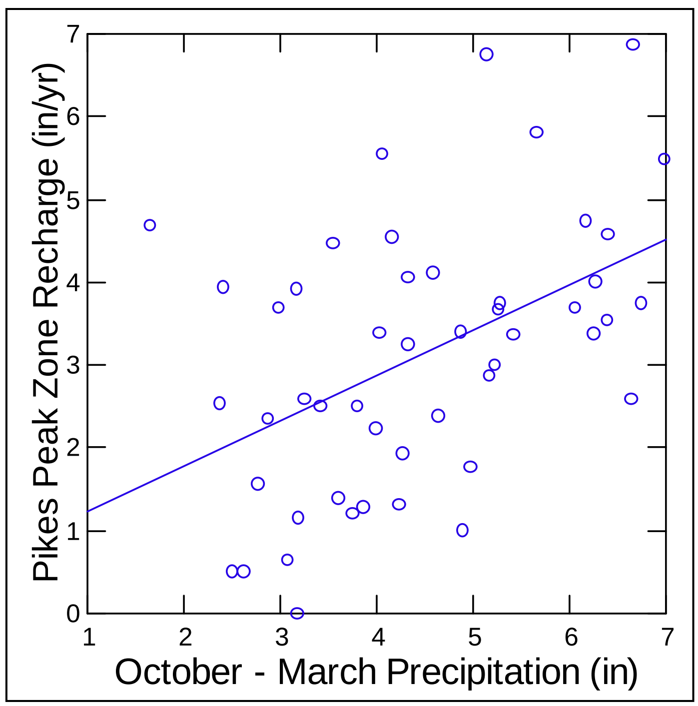

Figure 3-13 Relationship between Winter Precipitation and Pike's Peak Zone Recharge

3.2.2.2 Recharge Quantification for Geologic Classes

In order to provide a relative comparison of recharge quantities between the four bedrock categories, the regression equations were used with the average annual precipitation from the Turkey Creek area (16.5 inches). The following recharge quantities were determined using the regression equations:

- Metamorphic zone – 1.24 in. (7.5 percent of annual)
- Igneous intrusive zone – 1.76 in. (10.0 percent of annual)
- Highly fractured zone – 0.89 in. (5.4 percent of annual)
- Pikes peak granite zone – 3.17 in. (19.2 percent of annual)

These individual zone recharge estimates are comparable to the total Turkey Creek basin recharge partitioning as shown on Figure 3-9 (Section 3.2.1.3), where 8.15 percent of annual precipitation supports baseflow discharge and deep groundwater reservoirs recharge based on the mix of zones in the Turkey Creek area. Table 3-2 provides the correlation coefficient and the regression equation relating average annual precipitation and the recharge quantity selected to represent each of the recharge zones. These regression equations account for the average proportion of annual precipitation that occurs during the fall and winter season that was used in developing the original regressions.

Pikes Peak Recharge

The results for the Pikes Peak granite are anomalously higher than the recharge from other zones, which may be partially due to its limited occurrence within the Turkey Creek area. The Pikes Peak granite also tends to develop a thick weathered zone that may allow infiltration of recharge below the root zone relatively rapidly, resulting in greater recharge. Since recharge calculated for this zone is higher than is reasonable for the entire study area, the regresssion developed for other intrusive rocks is utilized for estimating recharge.

Fault Zone Recharge

The fault zone results are anomalously low, compared to what would be expected, based on the conclusions in the unpublished Clear Creek study (Topper, 2010, personal communication). The fault zones are also limited in aerial extent in Turkey Creek, and also are located in the Silver Plume granite, which may have a lower degree of fracturing. For purposes of estimating recharge, areas that are classified as fractured or faulted will utilize the regression equations for the corresponding rock type.

Alluvial Recharge

As noted earlier, alluvial deposits that occur in major drainages are not considered to recharge the bedrock, since they occur in discharge areas that are in close hydraulic communication with the surface water system. Alluvial and unconsolidated deposits that occur in small upland drainages will utilize the regression equations for the projected rock type that underlies the material.

3.3 Groundwater Recharge in UMC Study Area

Groundwater recharge was calculated with the regression analysis and spatial relationship between average annual precipitation and aquifer classifications. Equations from Table 3-2 were applied first to the Clear Creek watershed in order to compare the recharge calculations with the baseflow measurements from Clear Creek at the City of Golden (Gauge 06719505). Total groundwater recharge was then calculated for privately owned lands outside of organized public utilities within the UMC study.

Table 3-2 Regression Summary for Recharge Estimation

Geologic Classification	Correlation Coefficient	Regression Equation (in/yr)
Metamorphic Zone	0.54	-0.602+0.1114*annual precipitation
Intrusive Zone	0.56	-0.464+0.129*annual precipitation
Fault Zone	--	Use equation for geologic zone
Pikes Peak Zone	--	Use equation for intrusive zone
Upland alluvial/unconsolidated	--	Use equation for underlying geologic zone
Major valley alluvium	--	No bedrock recharge assumed – discharge area

3.3.1 Clear Creek Recharge Estimate

As shown in Figure 3-14, the Clear Creek watershed is centrally located in the UMC study area. Average annual baseflow was estimated based on flows measured at the City of Golden from October through March on Clear Creek, correcting for trans-basin transfers, diversions upstream of the gage and for wastewater discharges from Idaho Springs, Georgetown, Central City and Blackhawk. Consumptive use of groundwater in the basin was estimated at about 250 AFY based on the number of permitted wells and added to the baseflow estimate. A conservativly low estimate of recharge that occurs on the approximately 6,400 acres of valley bottom alluvium was also made and included in the estimate. Assuming 3 inches of recharge, this amounts to about 1,600 AFY. The October through March period represents primarily groundwater discharge and is a reasonable proxy for the quantity of groundwater discharging from the basin. This does not account for higher baseflow discharge that occurs following the spring recharge, which will make this number conservatively low. Portions of the Clear Creek watershed also extend to the continential divide at high elevation, where the proportion of fall and winter precipitation is higher than in other portions of the study area, which also makes this estimate of baseflow conservertively low. If the groundwater is at or near steady-state, which is likely, then this should also approximate the groundwater recharge in the basin. The average annual baseflow for Clear Creek, based on this analysis is approximately 41,000 AFY. This baseflow component remains relatively consistent from year to year over the period of record, indicating that a large groundwater reservoir is present that damps out variability due to drought years.

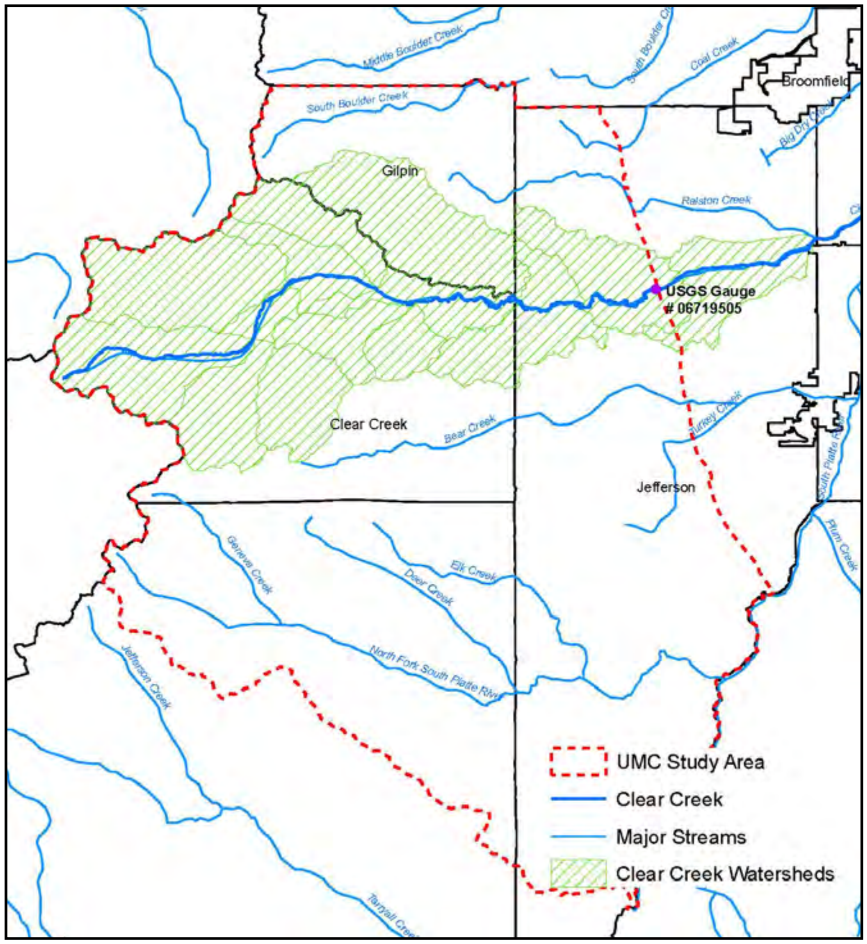

Figure 3-14 Clear Creek Watershed located in the UMC Study Area

The regression based methodology was used to estimate the baseflow discharge plus deep groundwater recharge components for the Clear Creek watershed for comparison. The estimated average recharge using the regression methods was 50,480 AFY (2.3 inches/year over basin), which is 23.1 percent higher than the estimate based on gaging records. This agreement is reasonable, considering that the baseflow discharge that occurs shortly after the spring recharge is not included in the gaging based estimate.

3.3.2 UMC Study Area Recharge Estimate

The regression method was used to estimate the annual average recharge for current and potentially developable lands in the study area, that are not currently within the boundaries of organized water supply utilities. Table 3-3 summarizes the estimated recharge quantity by county.

This quantity of recharge is not the quantity that may be available for development. As noted in prior sections, a significant portion of the recharge includes baseflow discharges that occur within a few months of recharge events. Section 4 addresses factors impacting the sustainable quantity of recharge that is available for development.

Table 3-3 Recharge Estimate for Private Lands

County	Area (AC)	Total Recharge (AFY)	Average Recharge Rate (in/yr)
Clear Creek	71,275	11,948	2.01
Gilpin	28,697	4,578	1.91
Jefferson	218,287	35,536	1.95
Park	42,524	8,152	2.30
Total	**360,783**	**60,214**	**2.00**

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Section 4
Long Term Aquifer Sustainability

4.1 Introduction

One of the objectives of this study is to assess the long term sustainability of the water supply in the crystalline bedrock aquifer system in the study area. This requires consideration of the balance between average recharge, current and future water demands. As discussed in Section 2, demands for the study area were divided into (1) demands met by a water provider and (2) demands met by self-supplied wells. Based on feedback from water providers surveyed, it is assumed that surveyed water providers (SWPs) will be able to meet their future demand. Thus, the long term aquifer sustainability was assessed for parcels outside of SWP service areas. Demands for residential parcels outside of SWP areas were assumed to be supplied by private wells.

4.1.1 Definition of Sustainability

For the purposes of this study, aquifer sustainability is defined as the ability to use the crystalline bedrock aquifers to meet current and future needs without (1) mining of the aquifers and (2) without significant degradation of the quality of the groundwater.

Demands in excess of recharge are indicative of aquifer mining. Demand and recharge balance analyses are based on annual, average recharge conditions. Water planners should consider that half the time, recharge quantities will be lower than average conditions, and that demand may exceed recharge during these periods. This carryover storage in the aquifer system helps attenuate the impact of low recharge years. Groundwater quality can be negatively impacted by pumping, when the percentage of water that is pumped to supply individual households is returned to the aquifer system by infiltration from on-site septic systems. Studies by the USGS within the current study area (Miller and Ortiz, 2007, and Bossong, et. al., 2003) have shown impacts on groundwater quality from on-site disposal systems in some locations.

4.2 Limitations for Well Development

Individual households outside of organized utility districts rely on wells drilled predominantly into crystalline bedrock aquifers. Successful well development is dependent on adequate depth and the quantity of fracturing that is intersected by the well. The proximity of the well location to streams is also important, since water level fluctuations are typically lower in these areas. Water levels in areas more distant from regional streams will experience inter-annual fluctuation, and water levels can drop significantly in drought years. If an individual well does not tap into fracture zones that are below the zone of fluctuating water levels, their supply is at risk, even though water budget analysis indicates sufficient recharge and storage is available to meet demands.

Parcels served by wells also typically have an on-site septic system with a leach field that returns a significant percentage of the pumped water back to the subsurface. As outlined in Section 3, the net return of water to the base flow and deep groundwater system is about 52 percent, after accounting for consumptive use and rapid losses to surface water. The quality of aquifer water can be adversely impacted if the ratio of recharge from septic returns is too high when compared to natural recharge. The analysis presented in this section will incorporate a range of ratios between septic returns and native recharge.

4.3 Baseflow and Drought Susceptibility

Available data from the Clear Creek drainage was assessed to evaluate the impact of drought years on baseflow discharges. Baseflow is typically balanced with recharge to groundwater in a major regional stream, such as Clear Creek. Figure 4.1 provides annualized baseflow discharge, after corrections to account for transbasin imports, diversions and other flows unrelated to groundwater. Since the baseflow estimation period is much later than recharge, this represents the groundwater draining from the deep groundwater reservoir.

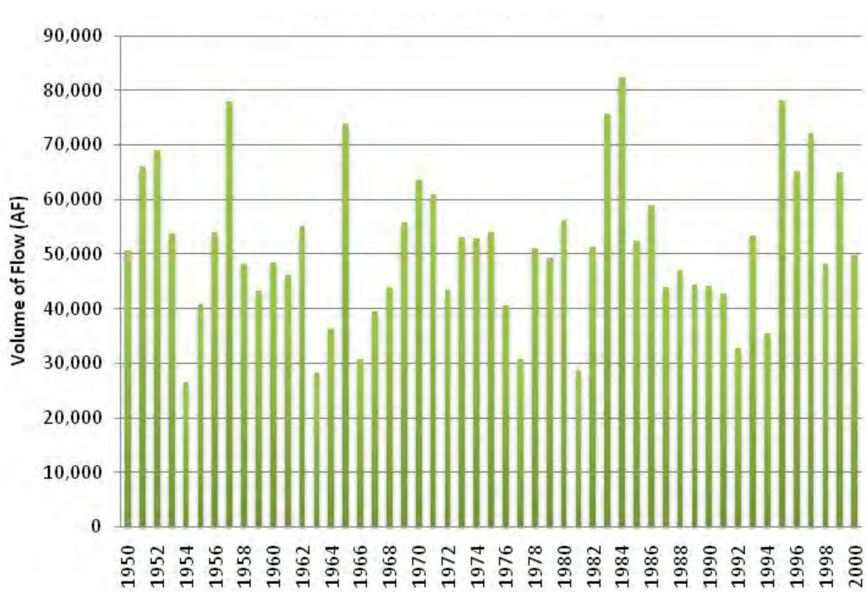

Figure 4.1 Variation of Winter Streamflow at USGS Gage near Lawson, Colorado on Clear Creek from 1950 to 2000

Even in drought years, such as 1954 and 1963, the volume of baseflow doesn't fall below 30,000 AF, indicating that there is significant baseflow discharge from the aquifer and that carryover storage is present in the aquifer. Please note that in areas near baseflow streams, the deeper portions of the aquifer are fully saturated, and so there is no storage below the stream elevation. Thus, all recharge contributes to this baseflow. Areas near regional streams have larger quantities of groundwater available over the year since recharge from upgradient areas flows toward these streams. Since the areas adjacent to these regional streams are at base level and areas more distant from the stream have water table elevations that are higher, significant storage is available that will provide flow toward the streams for a significant period, even in times when recharge is low. In areas more distant from these regional streams, the baseflow component of recharge is more rapidly depleted after recharge events and is less available to support year round demand.

Wells developed in close proximity to streams with significant baseflow will likely maintain water supplies during drought, since water remains in storage within the aquifer. Wells located farther from baseflow streams will be more susceptible to supply fluctuation during periods of low recharge, since water levels will decline more rapidly in these areas, compared to locations near baseflow streams. Figure 4.2 shows a classification system relating risk of groundwater declines during low recharge periods. This figure shows buffer zones around regional streams that indicate relative susceptibility to impacts from low recharge years. The green band lies within one mile of a regional stream, and has the greatest potential for producing groundwater from both the deep groundwater reservoir and ability to capture more of the baseflow reservoir component of recharge. The yellow and green zones lay 2 and 3 miles respectively from these streams and have a lesser ability to capture the baseflow reservoir component of recharge.

This classification system was used to estimate the relative proportion of the baseflow reservoir recharge component that is developable. The deep reservoir component of recharge is available in all three of the zones. The yellow zone, located between one and two miles from regional streams, is estimated to have half the baseflow reservoir recharge component available for development, while the red zone is estimated to have only the deep reservoir recharge component available.

Recharge rates presented in Section 3.3.2 were adjusted to account for proximity to baseflow streams (green, yellow, and red zones) according to the above methodology. This adjusted recharge rate is considered the "potentially developable" recharge for sustainability analyses and is presented in Table 4-1, for the parcels that are candidates for development.

Table 4-1 Estimate of Potentially Developable Recharge

County	Potentially Developable Recharge (AFY)
Clear Creek	7,696
Gilpin	3,274
Jefferson	21,991
Park	5,115
Total	**38,076**

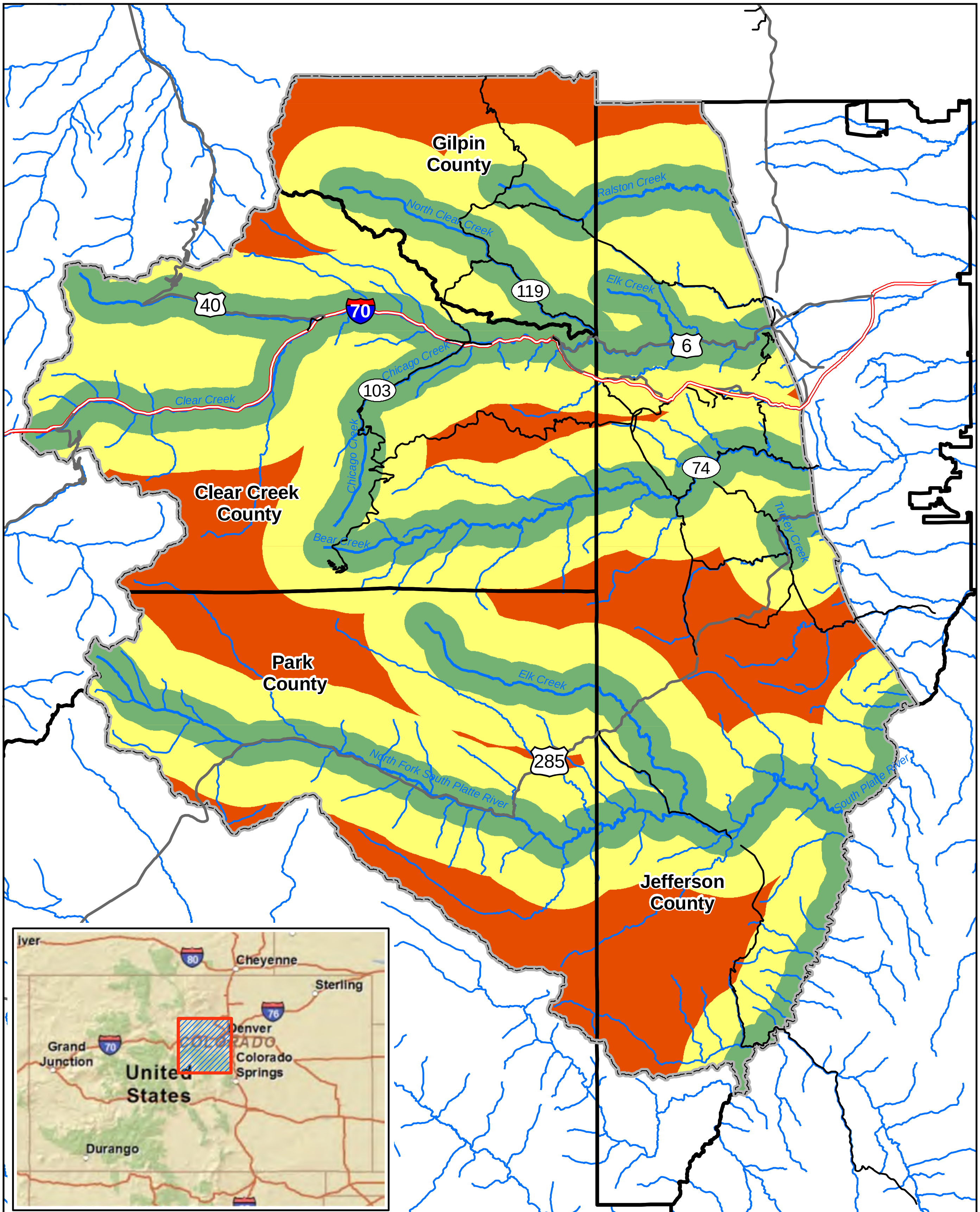

Figure 4.2 Proximity to Regional Streams

UMC Water Needs Assessment
Water Supply Analysis

1 inch = 7 miles
0 3.5 7 Miles

N

Roads

- Interstate/Limited Access
- U.S. Highways
- State/CO Highways
- Main Streams

- County Lines
- UMC Study Area
- < 1 mile from Regional Stream
- 1 to 3 miles from Regional Stream
- > 3 miles from Regional Stream

4.4 Sustainability of Aquifer Systems

Sustainable groundwater development must consider both the available recharge and the flows that are returned to the groundwater system from on-site septic systems. Water that passes through the septic tank and leach field system is degraded and needs to be diluted by native recharge in order to maintain acceptable quality for use. This section compares the native recharge, pumping and returns flows from on-site systems on individual parcels. This is conservative, since it does not consider potential additional water that may be recharge in upgradient areas that flows through the parcel. Two end points were considered when assessing the degree of dilution of leach field return flows, as follow.

- **Lower dilution case**. Consumptive use met by long term native recharge. This would occur when the consumptive use and other losses from pumped water is equal to the native recharge on the parcel. This would result in a dilution rate of 1:1, where approximately half of the pumped water on a parcel would consist of native recharge and half would be recycled water from on-site disposal systems, increasing the potential for degradation of groundwater quality. This does not consider that the recharge from the on-site disposal systems will enter the upper portion of the aquifer, while wells will typically be pumping from deeper portions of the aquifer. This results in greater mixing with water that is in storage. In areas of dense development, the beneficial impact of this mixing with water in storage diminishes as the on-site disposal component of recharge mixes deeper into the aquifer.

- **Higher dilution case**. This end point assumes that on-site pumping is limited to 33 percent of the native recharge occurring on the parcel. This results in a dilution ratio of about 4:1, limiting the impact of on-site disposal recharge on overall water quality. The mixing considerations noted above would result in further dilution of the on-site disposal recharge.

End points were quantified in this study with the calculation of the demand ratio, which is the ratio of pumping demand to recoverable native recharge. The demand ratio is an important indicator of how the quality of groundwater will be impacted by development. The study area was partitioned into cells with an area of 160 acres (0.5 mile grid spacing) to assess current and future demand ratios. This approach allows assessment of future scenarios where the specific buildout pattern is uncertain.

It should be noted that this analysis does not consider recharge on adjacent lands such as green belts and other undeveloped properties which may provide additional water to the system. Thus, results are somewhat conservative. Analyses are also based on average conditions, which mean that half the time, less recharge will be available. Development will result in lower water levels, which may open up additional storage that can allow salvage of additional recharge water that otherwise would discharge to the surface system.

4.4.1 Demand Ratio Analysis

UMC parcels outside of SWP areas were assigned a grid based on their centroid location. To calculate the demand ratio for each grid required (1) cumulative grid recharge and (2) cumulative grid demands.

Cumulative grid recharge was calculated using regressions presented in Section 3.3.2 and included a multiplier based on distance from regional streams (Section 4.3). Cumulative grid demand was also calculated for each grid cell by summing demands for all parcels within each grid. Current demands included any parcel currently developed, and incremental future demands include were calculated for all unplatted and unimproved (developable) parcels.

4.4.1.1 Additional Considerations for Future Development

In order to assess the demand ratios that would result from a range of future development densities, all developable lands were assumed to have lot sizes as specified in the following scenarios. This provides an indication of potential problem areas, without knowing precisely where such development occurs. The potential sustainability of future development in the UMC study area was assessed according to the following scenarios:

- **Minimum Lot Size (High Density).** Assumes that all developable parcels are developed using a lot site of 2 acres.

- **County Density (Current Lot Size).** Assumes that all of the developable parcels are developed at a lot size consistent with current county regulations. These lot sizes are 5 acres for Clear Creek County, 20 acres for Gilpin County, 10 acres for Jefferson County and 8 acres for Park County.

- **Maximum lot Size (Low Density).** Assumes that future development occurs with a lot size of 12 acres.

4.4.1.2 Using Demand Ratio to Guide Development

Demand ratios results, as shown in Figure 4-3 through 4-7, were classified into (1) low, (2) intermediate, and (3) high categories. A low demand ratio refers to the sustainable condition defined previously in which proper dilution factors are maintained, whereas a high demand ratio refers to the unsustainable condition in which proper dilution factors are not maintained. Intermediate demand ratio captures everything in between, and may represent areas that could transition to either condition depending on how future development occurs and water use practices.

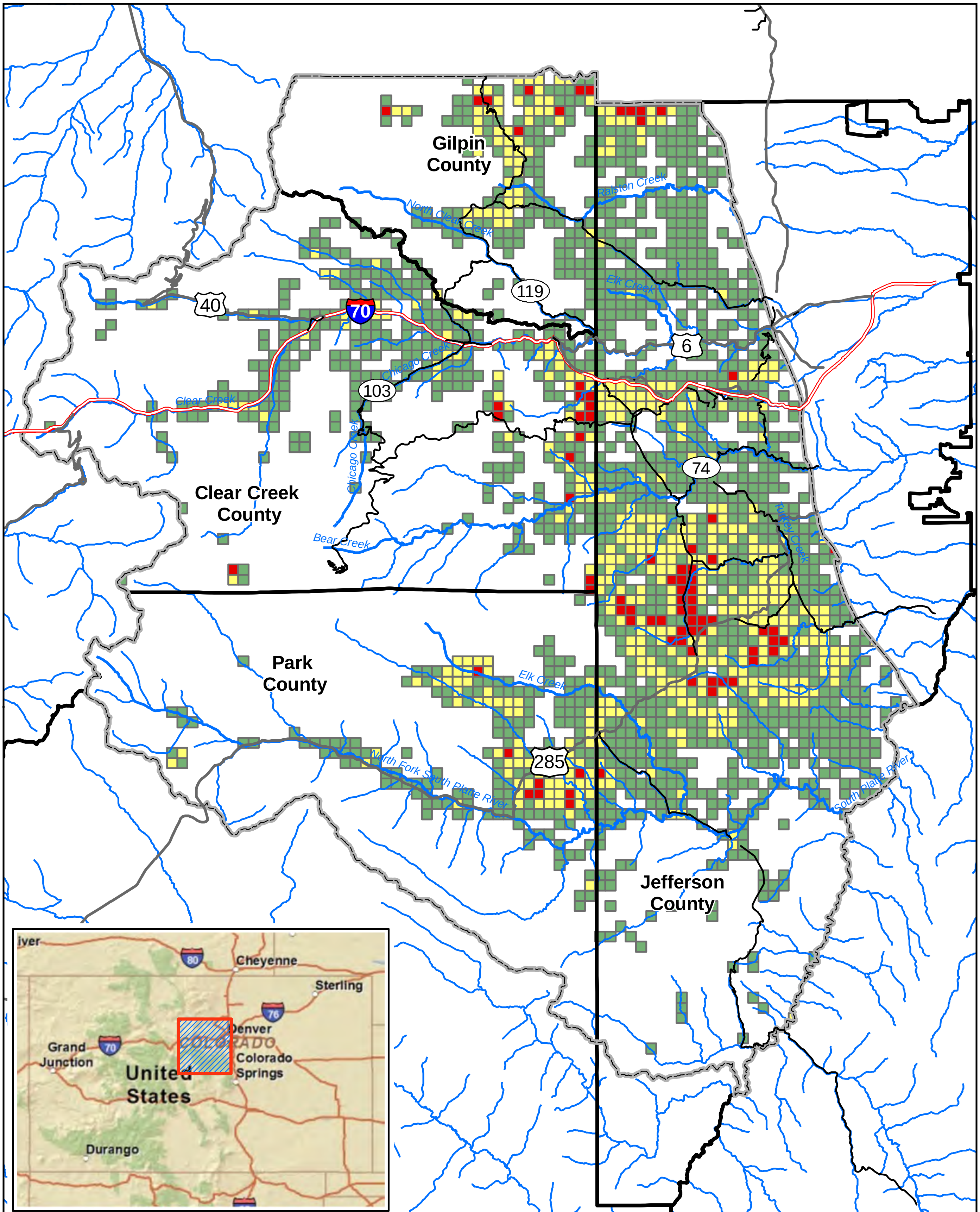

Figure 4.3 Current Conditions Demand Ratio

UMC Water Needs Assessment
Water Supply Analysis

1 inch = 7 miles

0 4 8 Miles

N

Roads
- Interstate/Limited Access
- U.S. Highways
- State/CO Highways
- Main Streams

- UMC Study Area
- County Lines

Current Demand Ratio
- Low Demand Ratio
- Intermediate Demand Ratio
- High Demand Ratio

4.4.2 Demand Ratio Results

4.4.2.1 Current Conditions

The result of the demand ratio analysis for current conditions is shown on Figure 4.3. A majority (71-percent) of the UMC study area outside of SWPs has a low demand ratio, while 24-percent and 4-percent have intermediate and high demand ratios, respectively. This shows that a majority of water users outside SWPs do not impact groundwater quality at current use rates. This is consistent with studies in the Turkey Creek watershed and Park County conducted by the USGS that indicated few areas experience significant groundwater quality degradation under current conditions. However, increases in water demand with continued development, may start to impact groundwater quality, especially if concentrated in regions that are yellow and red in current conditions scenario.

4.4.2.2 Future Conditions

Demand ratio results for future conditions are shown in Figure 4.4 to 4.6 and summarized in Table 4.2. Table 4.2 expresses the percentage the potentially developable areas that would be classified in the low, intermediate, and high demand ratio categories.

Table 4-2 Demand Ratio for Minimum County, and Maximum Lot Size Scenarios

Lot Size Scenario	Demand Ratio*		
	Low (% grids)	*Intermediate (% grids)*	*High (% grids)*
Minimum (High Density-2 ac; Figure 4.4)	67%	13%	20%
County (Current lot size; Figure 4.5)	76%	19%	5%
Maximum (Low Density-12 ac; Figure 4.6)	77%	19%	4%

**Ratio of cumulative parcel demand to grid recharge*

Ratios do not vary significantly between the county lot size (Figure 4.5) and maximum lot size (Figure 4.6) conditions. Thus, county lot size requirements may not degrade water quality if future development follows current lot size criteria. However, it is important to note that this analysis considers that every parcel in the county be developed under similar lot size criteria. Development will likely be concentrated in certain counties and areas. Conservative lot size criteria in regions of high development will be critical to maintain groundwater quality. For the case were a high density development (2 acre lot size) is assumed, the proportion of cells that exceed the target demand ratio increases dramatically, especially in Jefferson County.

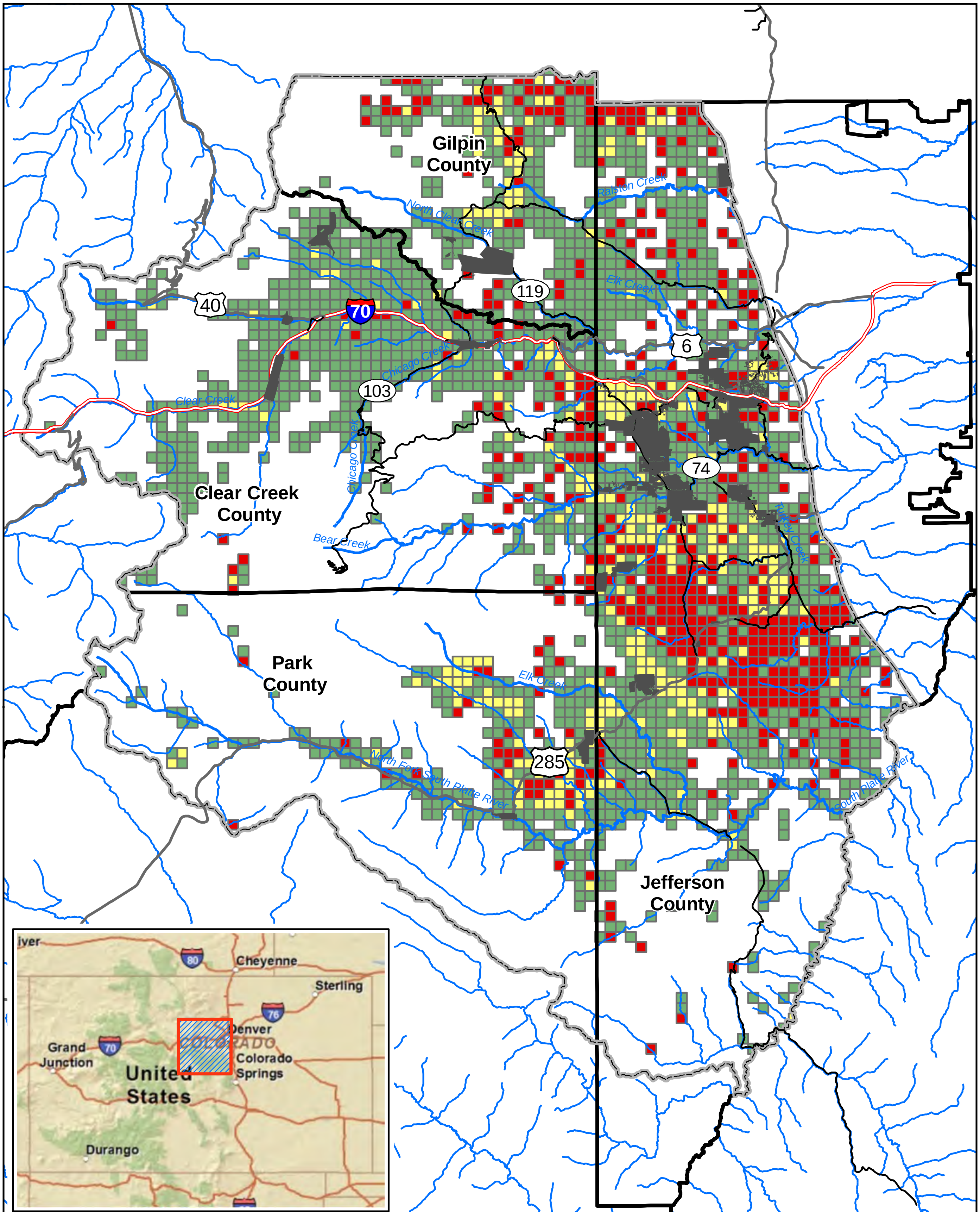

Figure 4.4 Future Conditions-Minimum Lot Size (High Density)

UMC Water Needs Assessment
Water Supply Analysis
1 inch = 7 miles

0 4 8 Miles

N

Roads

- Interstate/Limited Access
- U.S. Highways
- State/CO Highways
- Main Streams
- Surveyed Water Provider Area

- County Lines
- UMC Study Area

Future Demand Ratio-Min. Lot

- Low Demand Ratio
- Intermediate Demant Ratio
- High Demand Ratio

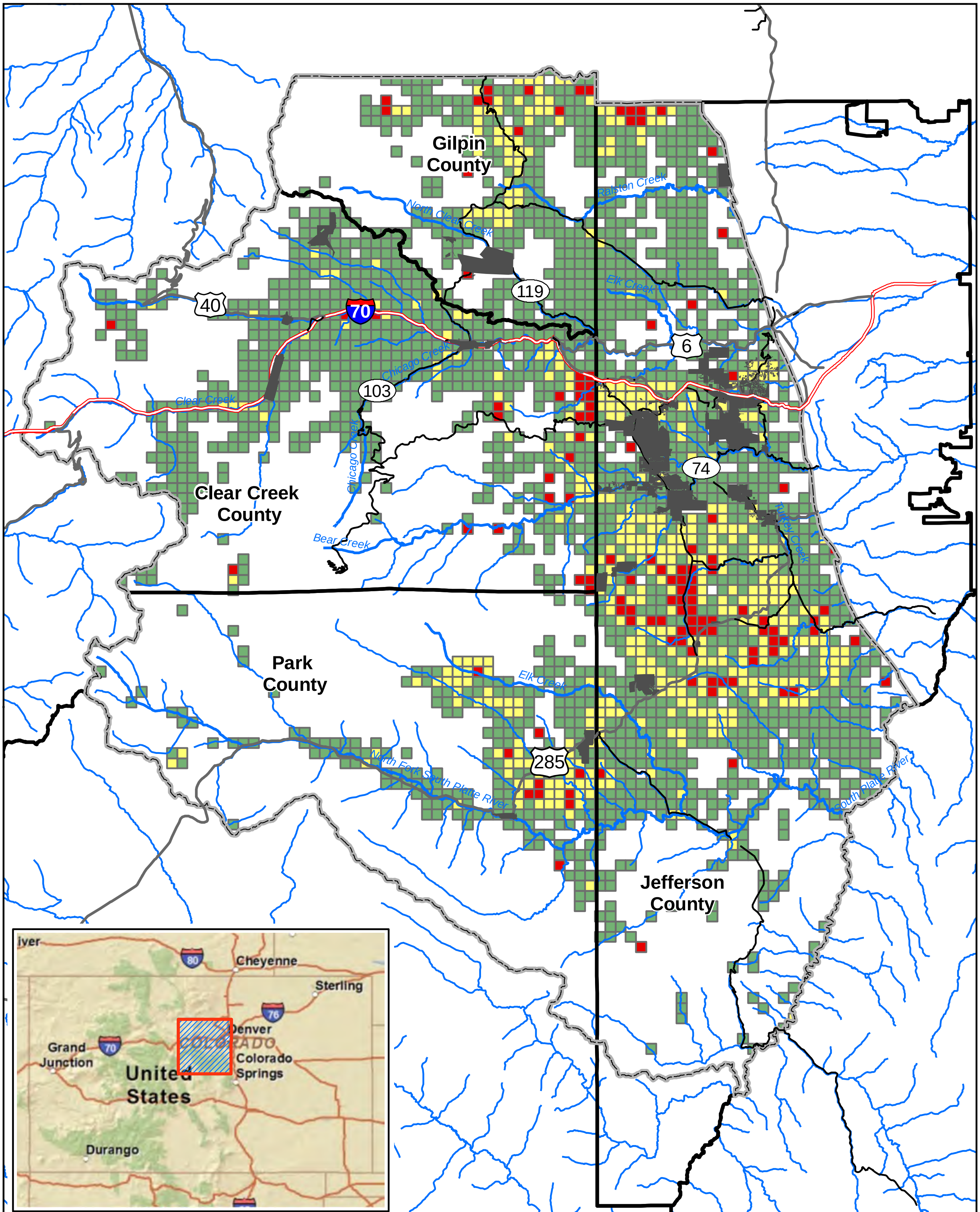

Figure 4.5 Future Conditions-County Lot Size

UMC Water Needs Assessment
Water Supply Analysis

1 inch = 7 miles

0 4 8
Miles

N

Roads

- Interstate/Limited Access
- U.S. Highways
- State/CO Highways
- Main Streams
- Surveyed Water Provider Area

- County Lines
- UMC Study Area

Future Demand Ratio-County Lot

- Low Demand Ratio
- Intermediate Demand Ratio
- High Demand Ratio

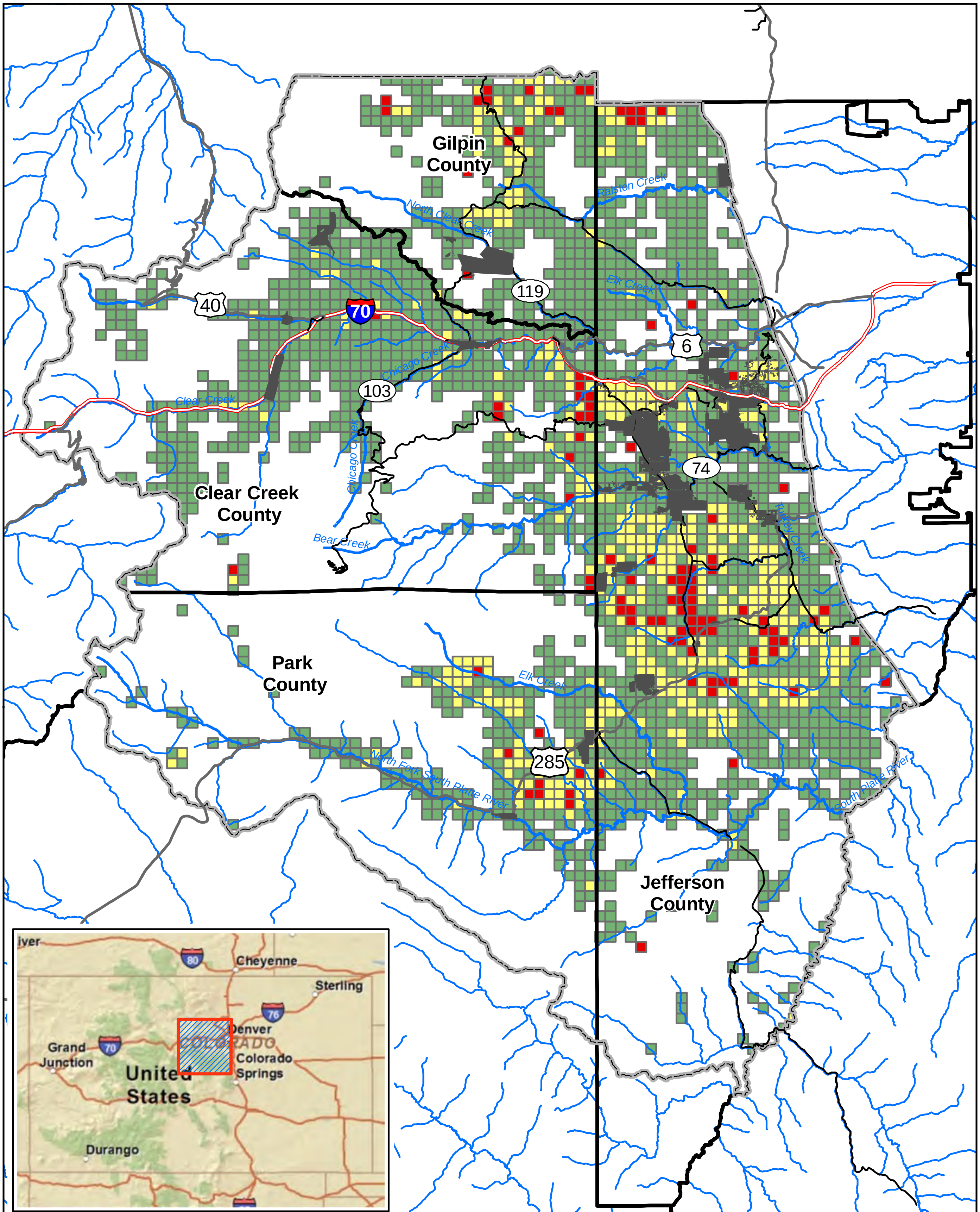

Figure 4.6 Future Conditions-Maximum Lot Size (Low Density)

UMC Water Needs Assessment
Water Supply Analysis

1 inch = 7 miles

0 4 8 Miles

N

Roads

- Interstate/Limited Access
- U.S. Highways
- State/CO Highways
- Main Streams
- Surveyed Water Provider Area

- County Lines
- UMC Study Area

Future Demand Ratio-Max. Lot

- Low Demand Ratio
- Intermediate Demand Ratio
- High Demand Ratio

4.5 Summary

Groundwater quality is the principal factor impacting sustainability of the groundwater resource in the crystalline bedrock aquifers in the study area. Adequate recharge is available to support the anticipated development population in 2050, however, the percentage of this recharge that is developed should be maintained at a level that results in adequate dilution of on-site disposal system recharge. Figures 4.4 through 4.6 are planning maps that provide classification of areas that have the greatest potential to impact groundwater quality under different lot size assumptions.

Section 5
Report Summary

This study was initiated to refine understanding of water demands and sustainable groundwater development potential in the mountainous areas of Clear Creek, Gilpin, Jefferson and Park counties within the South Platte watershed. The focus of the water availability study was areas served by groundwater from the crystalline bedrock aquifers that underlie the area.

As part of the study, population trends and future water demands were projected to 2050, including both resident and transient recreational requirements. The current permanent resident population of the UMC study is estimated at 81,650, with approximately 5,450 part time residents. The population of this area is projected to increase to approximately 128,000 to 148,000, with part time residents increasing to about 8,000 by 2050. A significant portion of the current and future water demand will fall outside of water provider areas and must be supplied by on-site wells producing from the crystalline bedrock aquifers. Demands outside of the service water provider areas are estimated to increase from 9,257 AFY (current), to 21,460 AFY in 2050.

The results of detailed studies conducted in the Turkey Creek watershed by the USGS and others were extended to the entire UMC study area to estimate recharge to the crystalline bedrock aquifers. Precipitation and snowmelt that infiltrates into the soil supports evapotranspiration and streamflow, in addition to recharging the deeper aquifer system. Much of the recharge subsequently discharges to streams shortly after a recharge event, and is thus not available to support reliable groundwater development, especially in areas more distant from regional streams. Water that is pumped for on-site water supply is discharged to on-site waste disposal system where some of this water infiltrates back to the deeper portions of the crystalline bedrock aquifer system. Estimates of native recharge to the privately held lands outside of water provider areas amounts to an annual average of about 60,000 AFY, of which only a portion would support sustainable groundwater development.

Analysis of regional stream baseflow, which is supported by discharge from the crystalline bedrock aquifer system, demonstrate that significant carryover storage is available during drought years. During drought years, if wells don't produce from the deepest portion of the aquifer, water levels may decline significantly and individual wells may not be able to produce sufficient water to meet on-site demands in areas distant from regional streams. Two aspects of sustainability were considered, (1) maintaining a balance between recharge on individual parcels and (2) maintaining water quality. A demand ratio representing the ratio of pumping demand to the native component of recharge, was assessed for both current and future conditions to understand sustainability. Since locations of future development are uncertain, the three alternative development densities were applied to all remaining developable lands in order to provide decision makers with information to assess sustainability issues.

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Section 6
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Appendix A
2010 Population and Demand Data for Surveyed Community Water Providers

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Table A-1. 2010 Population and Demand for Surveyed Community Water Providers

Water Provider Name	Current (2010) Population	Current (2010) Demand [AF]	Per Capita Demand [gpcd]	Data Sources
Clear Creek County				
Empire, Town of	400	109	243	Population and demand from survey.
Georgetown, Town of	1,100	212	172	Population projected from Census 2000, demand from HydroBase data.
Idaho Springs, City of[1]	1,840	614	298	Population and demand from 2009 CWCB study data.
St. Mary's Glacier Water & Sanitation District	1,000	154	137	Population from EPA, demand from HydroBase data.
Gilpin County				
Black Hawk, City of (full-time residential)	108	9.1	75	Population and demand from Gilpin County.
Black Hawk, City of (part-time residential)	308	6.5	19	Population and demand from Gilpin County.
Central City, City of (full-time residential)	551	46	75	Population and demand from Gilpin County.
Central City, City of (part-time residential)	411	8.6	19	Population and demand from Gilpin County.
Jefferson County				
Blue Mountain Water District	300	22	67	Population and demand from survey.
Brook Forest Water District	900	58	58	Population from EPA, demand from HydroBase data.
Dukes Mobile Home Park, LLC	400	16	35	Population from EPA, demand based on Treatment Tech data.
Evergreen Metropolitan District	14,397	1,412	88	Population and demand from survey.
Forest Hills Metropolitan District	400	37	83	Population from EPA, demand from HydroBase data
Genesee Water & Sanitation District	4,010	439	98	Population and demand from survey.
Homestead Water Company	900	47	47	Population and demand from survey.
Idledale Water & Sanitation District	350	15	38	Population from EPA, demand from HydroBase data.
Indian Hills Water District	1,100	45	37	Population calculated from 2007 water use data published in February 2008 Indian Hills community newsletter, demand from HydroBase data.
Lookout Mountain Water District	1,499	207	123	Population from EPA, demand from HydroBase data.
Mountain Water & Sanitation District	900	52	52	Population and demand from survey.
Mt. Vernon Country Club	246	38	139	Population and demand from survey.
Park County				
Bailey Water & Sanitation District	390	32	74	Population from EPA, demand from Water Commissioner.
Will-O-Wisp Metropolitan District	300	23	68	Population from EPA, demand from Water Commissioner.

1 Idaho Springs not specifically surveyed for UMC study, but relevant data available from CWCB (2009) study.

Table A-2. CDSS HydroBase Source Data for Current Community Water Provider Demands

Water Provider Name	WDID	Structure Name	Period of Record[2]	Average Annual Diversions [AF]
Brook Forest Water District	0902502	BROOK FOREST AUG	2000-2005	58
Forest Hills Metropolitan District	0902511	FOREST HILLS VENTURE AUG	2000-2005	37
Georgetown, Town of	0700681	GEORGETOWN DITCH[1]	2000-2008	212
Idledale Water & Sanitation District	0907582 0905783	IDLEDALE WELL 1A-34384-F IDLEDALE WELL 1B-34384-F	2000-2008	15
Indian Hills Water District	0905304 0905748	INDIAN HILLS W TC-8 INDIAN HILLS W 5	2006-2008	45
Lookout Mountain Water District	0700517	BEAVER BROOK RES 3A[1]	2000-2008	207
St. Mary's Water & Sanitation District	0702002	ST MARYS W&SD WL FLD	2007	154

1 Identified by District 7 Water Commissioner Gray Samenfink as the primary diversion structure for water provider (personal communications, 03/27/2010 and 03/29/2010).
2 HydroBase records are maintained on an administrative water year or irrigation year basis (November through October).

Table A-3. 2010 Population and Demands for Surveyed School Water Providers

Water Provider Name	Current (2010) Population	Current (2010) Demand [AF]	Per Capita Demand[1] [gpcd]	Data Sources
Gilpin County				
Gilpin County School	500	1.9	4.6	Population from EPA, demand calculated from gpcd.[2]
Jefferson County				
Conifer High School	1,900	10	6.3	Population and demand from survey.
Elk Creek Elementary School	340	0.5	1.8	Population and demand from survey.
Marshdale Elementary School	335	1.5	5.2	Population and demand from survey.
Park County				
Deer Creek Elementary School	500	1.3	3.0	Population and demand from survey.
Platte Canyon High School/Fitzsimmons Middle School	1,000	2.5	3.0	Population and demand from survey.

1 Per capita demands based on the assumption that schools are open September through May (273 days).
2 Per capita use for Gilpin County School based on weighted average per capita use of the other five surveyed schools.

Table A-4. 2050 Demand Forecasts for Surveyed Community Water Providers

Water Provider Name	2050 Demand LOW [AF]	2050 Demand MIDDLE[AF]	2050 Demand HIGH [AF]	Methodology
Clear Creek County				
Empire, Town of	109	111	113	245 active taps, 8 inactive. Low estimate assumes zero added taps, high estimate assumes 8 added taps.
Georgetown, Town of	363	411	459	Assumed to grow at Clear Creek County rates, constant per capita use.
Idaho Springs, City of	1,050	1,190	1,331	Assumed to grow at Clear Creek County rates, constant per capita use.
St. Mary's Glacier Water & Sanitation District	263	299	334	Assumed to grow at Clear Creek County rates, constant per capita use.
Gilpin County				
Black Hawk, City of (full-time residential)	14	14	14	Demand from Gilpin County, constant per capita use.
Black Hawk, City of (part-time residential)	10	10	10	Demand from Gilpin County, constant per capita use.
Central City, City of (full-time residential)	326	326	326	Demand from Gilpin County, constant per capita use.
Central City, City of (part-time residential)	13	13	13	Demand from Gilpin County, constant per capita use.
Jefferson County				
Blue Mountain Water District	24	24	25	108 active taps, 7-12 inactive. Low estimate assumes 7 added taps, high estimate assumes 12 added taps.
Brook Forest Water District	79	84	91	Assumed to grow at Jefferson County rates, constant per capita use.
Dukes Mobile Home Park, LLC	16	16	16	Assume fixed property boundaries, expansion unlikely.
Evergreen Metropolitan District	1,451	1,646	1,841	5,759 active taps, 162 inactive. Low estimate assumes 162 added taps, high estimate based on survey response, middle estimate is average of high and low.
Forest Hills Metropolitan District	37	38	38	145 existing residences. Low estimate assumes zero added taps, high estimate assumes 5 added taps, middle estimate is average of high and low.[1]
Genesee Water & Sanitation District	446	463	480	1,315 active taps, 21 inactive. Low estimate assumes 21 added taps, high estimate based on survey response, middle estimate is average of high and low.
Homestead Water Company	64	68	74	Assumed to grow at Jefferson County rates, constant per capita use. Survey response (66 AF) in range of estimates.
Idledale Water & Sanitation District	20	22	24	Assumed to grow at Jefferson County rates, constant per capita use.
Indian Hills Water District	61	65	71	Assumed to grow at Jefferson County rates, constant per capita use. [2]
Lookout Mountain Water District	207	216	225	According to website, 30-60 inactive taps. Low estimate assumes zero added taps, middle estimate assumes 30 added taps, high estimate assumes 60 added taps. [3]
Mountain Water & Sanitation District	71	75	82	Assumed to grow at Jefferson County rates, constant per capita use.
Mt. Vernon Country Club	38	41	44	105 active taps, 15 inactive. Low estimate assumes zero added taps, high estimate assumes 15 added taps. Middle estimate is average of high and low and is equal to survey response.

Table A-4. 2050 Demand Forecasts for Surveyed Community Water Providers

Water Provider Name	2050 Demand LOW [AF]	2050 Demand MIDDLE[AF]	2050 Demand HIGH [AF]	Methodology
Park County				
Bailey Water & Sanitation District	76	82	86	Assumed to grow at Park County rates, constant per capita use.
Will-O-Wisp Metropolitan District	53	57	60	Assumed to grow at Park County rates, constant per capita use.

1 A Jefferson County website (http://www.co.jefferson.co.us/placenames/search3.cfm?ps_oid=113771&search=) says "The plan for 150 units [in Forest Hills] was 90% built in 1998." A Forest Hills WWTP plan prepared by Leonard Rice Engineers for the Bear Creek Watershed Association (March 2010) says the District has 145 residential dwellings and is not anticipated to expand. Together, these two references suggest there may be 5 potential homes not yet built in Forest Hills.

2 November 2006 and December 2007 newsletters on the Indian Hills website (www.indianhillscolorado.com) indicate that two taps were to be available for sale in 2007 and again in 2008. However, there is no indication as to the upper limit of taps in the Indian Hills Water District, or whether this trend of tap sales would continue into the future.

3 Lookout Mountain forecasts based on assumption of 0.3 AF/tap, which is derived from average of nearby Evergreen MD and Genesee WSD.

Table A-5. 2050 Demand Forecasts for Surveyed School Water Providers

Water Provider Name	2050 Demand LOW [AF]	2050 Demand MIDDLE[AF]	2050 Demand HIGH [AF]	Methodology
Gilpin County				
Gilpin County School	3.1	4.5	5.6	Assumed to grow at Gilpin County rates, constant per capita use.
Jefferson County				
Conifer High School	14	14	16	Assumed to grow at Jefferson County rates, constant per capita use. [1]
Elk Creek Elementary School	0.7	0.7	0.8	Assumed to grow at Jefferson County rates, constant per capita use. [1]
Marshdale Elementary School	2.0	2.1	2.3	Assumed to grow at Jefferson County rates, constant per capita use. [1]
Park County				
Deer Creek Elementary School	3.0	3.2	3.3	Assumed to grow at Park County rates, constant per capita use.
Platte Canyon High School/Fitzsimmons Middle School	5.9	6.3	6.7	Assumed to grow at Park County rates, constant per capita use.

1 Survey responses for Jefferson County Schools assumed 10% total growth in demand from 2010 to 2050.

Table A-6. Current and Future Demands for Surveyed Commercial Water Providers

Water Provider Name	Current (2010) Demand [AF]	2050 Demand LOW [AF]	2050 Demand MIDDLE [AF]	2050 Demand HIGH [AF]
Clear Creek County				
Burger King – Downieville[1]	2.2	2.2	2.2	2.2
Gilpin County				
Black Hawk, City of (non-residential, non-gaming district) [2]	1.0	1.5	1.5	1.5
Central City, City of (non-residential, non-gaming district) [2]	1.0	1.5	1.5	1.5
Jefferson County				
Aspen Park Metropolitan District[3]	12	17	17	17
Conifer Metropolitan District[4]	24.48	24.48	24.48	24.48

1 Burger King current demand based on survey response of 2,000 gpd. Water demand for this individual Burger King not anticipated to increase, as restaurant has an occupancy limit dictated by fire codes.

2 Black Hawk and Central City non-residential, non-gaming demands based on data from Gilpin County, i.e., current = 905 gpd, 2050 = 1,347 gpd.

3 Aspen Park MD current demand based on survey response of 11,000 gpd. According to survey, Aspen Park MD future use limited to 15,000 gpd based on water rights.

4 Conifer MD current demand based on survey response (value also corresponds to combined limit of five wells decreed in Case No. 2001CW161). Conifer MD future demand assumed to be limited by existing water rights decree.

Table A-7. Current and Future Recreational Demands for Surveyed Water Providers

Recreational Demand	County	Current (2010) Demand Estimate [AF]	Future (2050) Demand Estimate LOW [AF]	Future (2050) Demand Estimate MIDDLE [AF]	Future (2050) Demand Estimate HIGH [AF]
Ski and snowboard areas					
Echo Mountain[1]	Clear Creek	25	25	25	25
Loveland[2]	Clear Creek	63	63	63	63
Summer camps					
Camp ID RA HA JE[3]	Park	3.9	3.9	3.9	3.9
Deer Creek Christian Camp[4]	Park	0.9	0.9	0.9	0.9
Geneva Glen Camp[4]	Jefferson	2.2	2.2	2.2	2.2
Gaming Districts					
Black Hawk[5]	Gilpin	254	802	802	802
Central City[5]	Gilpin	56	176	176	176

1 Echo Mountain current demand based on pumping data for WY 2007-2009, provided by DWR. Based on information from Clear Creek County, assume no future growth.

2 Loveland includes both Loveland Valley and Loveland Basin Ski Areas. Current demand based on diversions into 0704030 Golden Reservoir 1 West, 2004-2008, coded for snowmaking. Based on information from Clear Creek County, assume no future growth.

3 Camp ID RA HA JE current demand based on population and water use information provided by the camp's water system operator (personal communication, 02/12/2010). Camp is assumed to be open April through September (183 days). Assume no future growth.

4 Current demands for Deer Creek Christian Camp and Geneva Glen Camp based on per capita use calculated for Camp ID RA HE JE (12 gpcd) and service populations from EPA. Assume no future growth.

5 Current and future gaming district demands based on data provided by Gilpin County. Future demand assumes 2008 base year demand of 276,023 gpd for the combined Black Hawk/Central City gaming districts, followed by a one-year increase of 15% due to implementation of Amendment 50, followed by 41 years with 2.5% annual growth. Total use is split based on the 2008 gaming device ratio, 82% to Black Hawk, 18% to Central City.

Appendix B
UMC Provider Summary

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555 17th Street, Suite 1100
Denver, CO 80202
tel: 303-383-2300
fax: 303-308-3003

December 2, 2009

Subject: Upper Mountain Counties Water Provider Survey

Dear Water Service Provider:

Camp Dresser & McKee, Inc., (CDM), acting on behalf of and in coordination with the Upper Mountain Counties Water Needs Consortium, is evaluating the long-term sustainability of the aquifer systems utilized for water supply in the Upper Mountain Counties of the South Platte River Basin. The designated study area for the assessment is the mountainous part of Jefferson County, northeastern Park County, Clear Creek County, and Gilpin County. This study is made possible through a grant from the Interbasin Compact Committee (IBCC) South Platte and Metro Roundtables, with funding from the Colorado Water Conservation Board.

The purpose of the project—formally known as the Upper Mountain County Water Needs Assessment and Water Supply Analysis—is to provide a more accurate assessment of the water supply needs of the four-county study area, which is highly dependent upon groundwater in fractured and faulted bedrock aquifers. In addition, the project aims to update SWSI demand projections for all water providers in the study area. This analysis will help the four counties to have a better understanding of the impacts of growth related to the buildout of existing platted lots, many of which were created prior the 1972 Land Use Act. If all of these lots are improved and homes constructed on them, there may be issues with continued water supply viability.

Current and future water demands, water consumptive use, return flows from on-lot sewage disposal systems, and recharge from precipitation will be evaluated as part of this study. The results of the analyses will be used to help the counties to (1) identify areas of aquifer sustainability; (2) identify potential problem areas where there could be declines in aquifer levels or water quality; and (3) determine if they need to take action to reduce the potential problems in areas where they may occur.

Based on your location and population served, you have been identified as a key water provider within the project study area. To aid us in producing the most reliable and accurate assessment of the mountain aquifer systems, please provide as much information as possible in response to the inquiries on the attached survey.

Thank you for your time and assistance in providing valuable data and information to support this study. If you have any questions about the survey, please contact me via email at turnersm@cdm.com, or by phone at 303-383-2318.

Very truly yours,

Seth M. Turner, P.E.
Water Resources Engineer
Camp Dresser & McKee Inc.

Matt Bliss
Project Manager

Upper Mountain Counties – Aquifer Sustainability Study
Water Provider Survey

To aid us in producing the most reliable and accurate assessment of the mountain aquifer systems, please provide as much information as possible for the following inquiries.

1. Water provider contact information

Date						
Name						
Address	**Street or P.O. Box**					
	Suite					
	City, State ZIP					
Telephone		**Fax**				
Best Time to Call (mark with "X")		**Weekday**		**Weekend**		
		Morning		**Afternoon**		**Evening**
Email						
Contact Person(s)						

2. Service area information

Service Population				
Number of Metered Customers				
Number of Unmetered Customers				
Number of Taps	**Active**		**Inactive**	

3. What are the current and anticipated future demands on your water supply system, in acre-feet per year, gallons per day, or other appropriate units?

Description	Value	Units
Current (Year 2009)		
Future (Year 2050)		

4. If you know your future water demands in question (3), what are they based on?

	Study	
	Internal Estimates	
	Guess	
	State Population Projections	
	Other (please describe)	

5. For the demands provided in response to question (1), please specify the percentage distribution of deliveries to the following:

Customer Description	Current (Year 2009)	Future (Year 2050)
Permanent, full-time residences	%	%
Temporary residences (e.g., vacation/weekend homes)	%	%
Permanent, non-residential users (e.g., businesses, municipal buildings, parks, etc.)	%	%
Tourism and other recreational users	%	%

6. What percentage of your total water supply comes from groundwater sources (alluvial or bedrock), both currently and in the future?

Description	Type of Aquifer	Value	Units
Current (Year 2009)	Alluvial		
	Bedrock		
Future (Year 2050)	Alluvial		
	Bedrock		

7. Please provide a map(s) of your service area. GIS shapefiles are preferred, if available.

8. Does your District/Town have a water conservation plan that is in draft form or has been submitted to the Colorado Water Conservation Board's Office of Water Conservation? If so, are you willing to share the draft information?

9. Please provide on the attached "Community Wells" sheet a tabulation of wells your District/Town owns that are used to meet demands within your service area.

10. Are there any known private domestic or commercial wells within your service area that are not part of the community water supply? If yes, please provide details on the attached "Private Wells" sheet.

11. Are there any known concerns with the quality (e.g., high concentrations of metals or other pollutants) or quantity (e.g., low well yields) of your water supply source water? Please provide specific details, if applicable.

12. Are there any known concerns about the long term sustainability of the aquifers from which your wells pump water based on declining ground water levels under current or dry year conditions such as the recent drought of 2001 to 2005?

13. If your service area is fully built out by 2050, do you anticipate any long term sustainability issues for the aquifers from which your wells pump?

Water Provider Name					
Community wells owned/operated by District/Town					
#	Well Name	Location Description and/or Coordinates	Withdrawal/Pumping Rates		Well Permit Number/ID
			Value	Units	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Water Provider Name					
Private Domestic or Commercial Wells Located within District/Town Service Area					
#	Well Name	Location Description and/or Coordinates	Withdrawal/Pumping Rates		Well Permit Number/ID
			Value	Units	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

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Appendix C
UMC Parcel Data Summary

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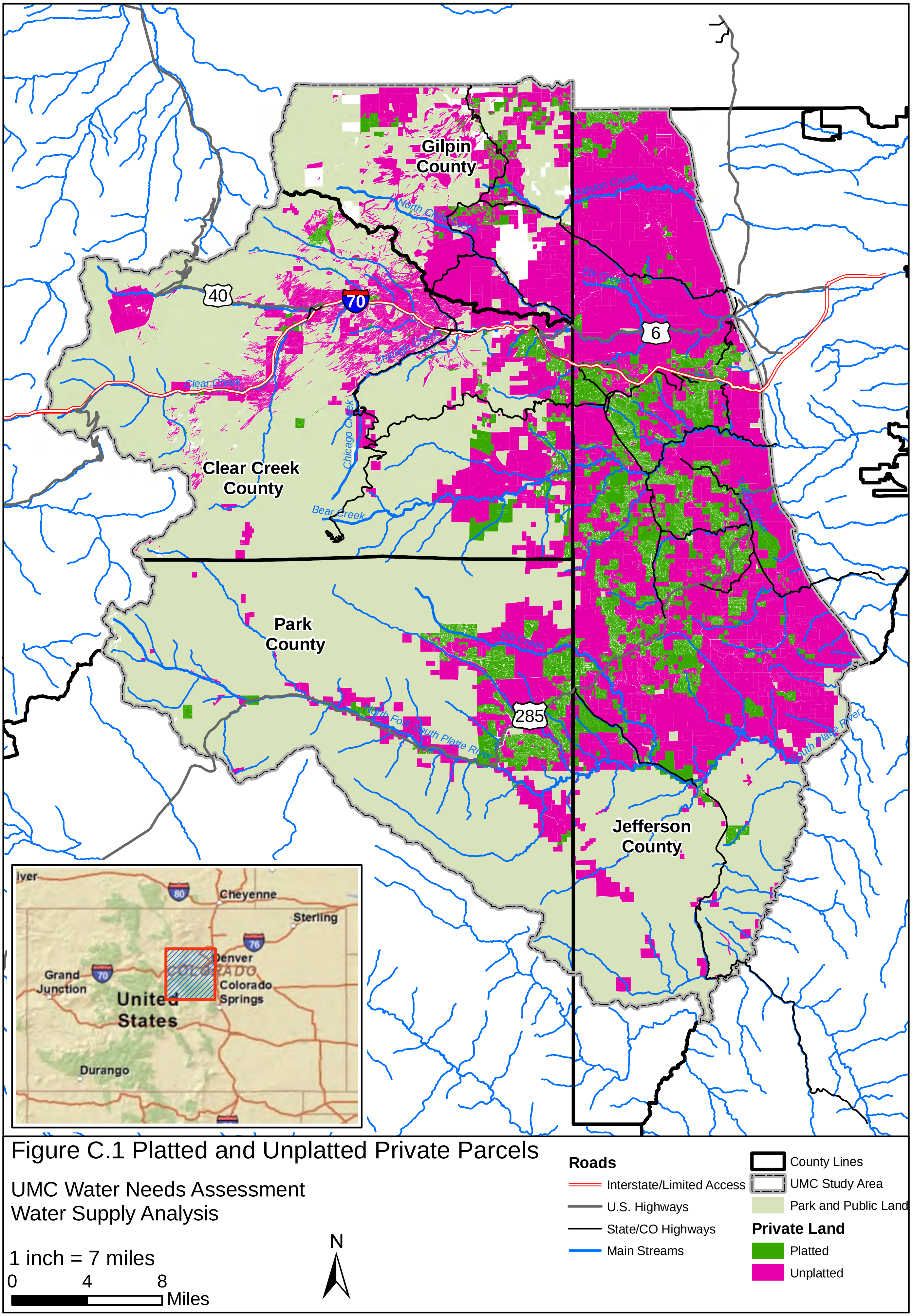

Figure C.1 Platted and Unplatted Private Parcels

UMC Water Needs Assessment
Water Supply Analysis

Table C.1 Acreage Summary for UMC Study Area

County	Private Area	Public Area	Total
Clear Creek			
SWP Area (ac)	939	188,330	253,620
Non-SWP Area (ac)	64,348		
Gilpin			
SWP Area (ac)	86	51,480	95,950
Non-SWP Area (ac)	44,388		
Jefferson			
SWP Area (ac)	12,991	93,300	320,120
Non-SWP Area (ac)	213,829		
Park			
SWP Area (ac)	543	166,640	209,180
Non-SWP Area (ac)	41,996		
Total SWP Area (ac)	14,558	499,750	878,870
Total Non-SWP Area (ac)	364,560		
Total	379,118		

Table C.2 Current Demands-Private Parcels outside SWP Area

County	AG	COMM	CD	IND	LU	MIN	PD	RES	UNZ	Total
Clear Creek										
Imp Count	78	212	121	3	371	739	94	3,877	61	5,556
Sum of Improved Area	378	299	7,263	13	1,420	5,085	944	14,033	112	29,546
Gilpin										
Imp Count	18	27	0	0	0	0	0	2,540	0	2,585
Sum of Improved Area	34	27	0	0	0	0	0	11,688	0	11,748
Jefferson										
Imp Count	7,920	62	120	3	0	0	274	5,811	63	14,253
Sum of Improved Area	168,653	227	854	405	0	0	2,925	13,603	1,079	187,745
Park										
Imp Count	76	9	1	0	0	0	48	4,326	12	4,472
Sum of Improved Area	6,966	13	1	0	0	0	24	17,435	87	24,525
Total Imp Count	8,092	310	242	6	371	739	416	16,554	136	26,866
Total Sum of Improved Area	176,030	565	8,118	418	1,420	5,085	3,892	56,759	1,278	253,565

Table C.3 Future Demands-Private, Improved Parcels

County	AG	COMM	CD	IND	LU	MIN	PD	RES	UNZ	Total
Clear Creek										
Sum of Platted area	88	85	38	2	28	127	73	6,235	7	6,682
Sum of Unplatted area	290	214	7,225	11	1,392	4,958	871	7,798	105	22,865
Gilpin										
Sum of Platted area	28	5	0	0	0	0	0	3,350	0	3,382
Sum of Unplatted area	6	22	0	0	0	0	0	8,338	0	8,366
Jefferson										
Sum of Platted area	21,409	61	341	3	0	0	1,405	11,453	125	34,797
Sum of Unplatted area	147,244	166	513	402	0	0	1,520	2,150	954	152,948
Park										
Sum of Platted area	62	8	0	0	0	0	20	9,969	6	10,065
Sum of Unplatted area	6,905	4	1	0	0	0	4	7,466	81	14,461
Total Sum of Platted area	21,586	158	379	5	28	127	1,497	31,007	138	54,926
Total Sum of Unplatted area	154,444	406	7,739	413	1,392	4,958	2,395	25,752	1,140	198,639

Table C.4 Future Demands-Private, Unimproved Parcels

County	AG	COMM	CD	IND	LU	MIN	PD	RES	UNZ	Total
Clear Creek										
Sum of Platted area	0	18	0	0	7	269	20	2,104	6	2,424
Sum of Unplatted area	1,191	136	395	36	3,493	18,893	31	8,193	11	32,377
Gilpin										
Sum of Platted area	11	6	0	0	0	0	0	2,993	0	3,009
Sum of Unplatted area	10	16	0	0	0	0	0	29,599	5	29,630
Jefferson										
Sum of Platted area	4,134	6	67	0	0	0	343	1,724	29	6,302
Sum of Unplatted area	19,511	3	60	0	0	0	48	125	35	19,782
Park										
Sum of Platted area	80	12	0	0	0	0	23	2,382	7	2,504
Sum of Unplatted area	8,668	0	841	0	0	144	49	5,070	195	14,967
Total Sum of Platted area	4,224	40	67	0	7	269	386	9,203	43	14,239
Total Sum of Unplatted area	29,381	155	1,295	36	3,493	19,037	128	42,986	246	96,756