

2. CHARACTERIZATION OF WATERSHED

East Canyon Reservoir watershed is located in north-central Utah approximately 20 miles east of Salt Lake City, Utah and 15 miles north of Park City, Utah (Figure 2.1). The watershed drains 145 square miles that includes Park City, Utah and several major ski resorts at its headwaters and a portion of Snyderville Basin from the Morgan–Summit county line to the headwaters of East Canyon Creek (SBWRD 2005). The watershed covers an elevation range from 5,600 feet (1,707 m) at the reservoir to over 10,000 feet (3,049 m) near Park City. Its principal drainage, East Canyon Creek begins just north of I-80 at the confluence of Kimball Creek from the south and an unnamed creek from the north. From there it flows northeast and north to the reservoir (Judd 1999; SBWRD 2005).

The State of Utah has designated the beneficial uses of the reservoir and creek as domestic drinking water with prior treatment (1C), primary contact recreation (swimming) (2A), secondary contact recreation (2B), cold water game fish and the associated food chain (3A), and agricultural water supply (4). The cold water game fish designated use (3A) was identified as partially supported on the State of Utah 1998 303(d) list (UDEQ 2000a). The 1992–1997 average total phosphorus concentration in the reservoir water column exceeded the state pollution indicator (0.025 mg/L) at 0.117 mg/L (Judd 1999). This led to the development of a TMDL for East Canyon Reservoir in 2000. Since 2000 the largest point source in the watershed, the East Canyon Water Reclamation Facility, has reduced nutrient loads to East Canyon Creek significantly. In addition, BMPs have been implemented to reduce nutrient runoff from nonpoint sources throughout the watershed, and water quality in the reservoir has improved.

The lands in the watershed are almost entirely privately owned. The reservoir shoreline is owned by the State of Utah with unrestricted public access to East Canyon State Park on the eastern side of the reservoir, and restricted vehicle access to the west side of the reservoir. The historical agricultural irrigation use of water has decreased in recent years with a corresponding increase in culinary water use due to increasing population growth, recreation use, and development in the watershed. Population in the study area is projected to increase from approximately 24,000 in 2001 to approximately 64,000 in 2030 and to 86,000 by the year 2050. If per-capita use rates were to continue as at present, this increased population would result in a municipal and industrial demand of approximately 25,000 acre-feet (34.5 cfs) per year in 2030 and 32,000 acre-feet (44 cfs) per year by 2050. However, assuming current water conservation goals are met, the projected demands would be approximately 23,000 acre-feet (32 cfs) per year in 2030 and 27,000 acre-feet (37 cfs) per year by 2050 (Bureau of Reclamation [BOR] 2006). The resident and tourist populations of the area have greatly increased since 1980 (Brooks et al. 1998) with growth rates increasing prior to and following the 2002 Winter Olympics in Park City.

The original TMDL was developed with a limited dataset and therefore was not able to attribute an internal load from reservoir sediments. A revised TMDL is currently under development for East Canyon Creek, incorporating a more detailed modeling of the nutrient spiraling in this tributary to East Canyon Reservoir. The original East Canyon Reservoir TMDL did not designate any additional implementation measures beyond those recommended in the East Canyon Creek TMDL. Therefore, the revised TMDL for East Canyon Reservoir is critical to determine if revised LAs in the East Canyon Creek TMDL are still protective of beneficial uses in East Canyon Reservoir. The incorporation of internal reservoir dynamics that govern phosphorus sedimentation and sediment nutrient release is critical to this reassessment. This requires the development of a reservoir model that accounts for internal processes and incorporates the more comprehensive dataset now available to the TMDL process.

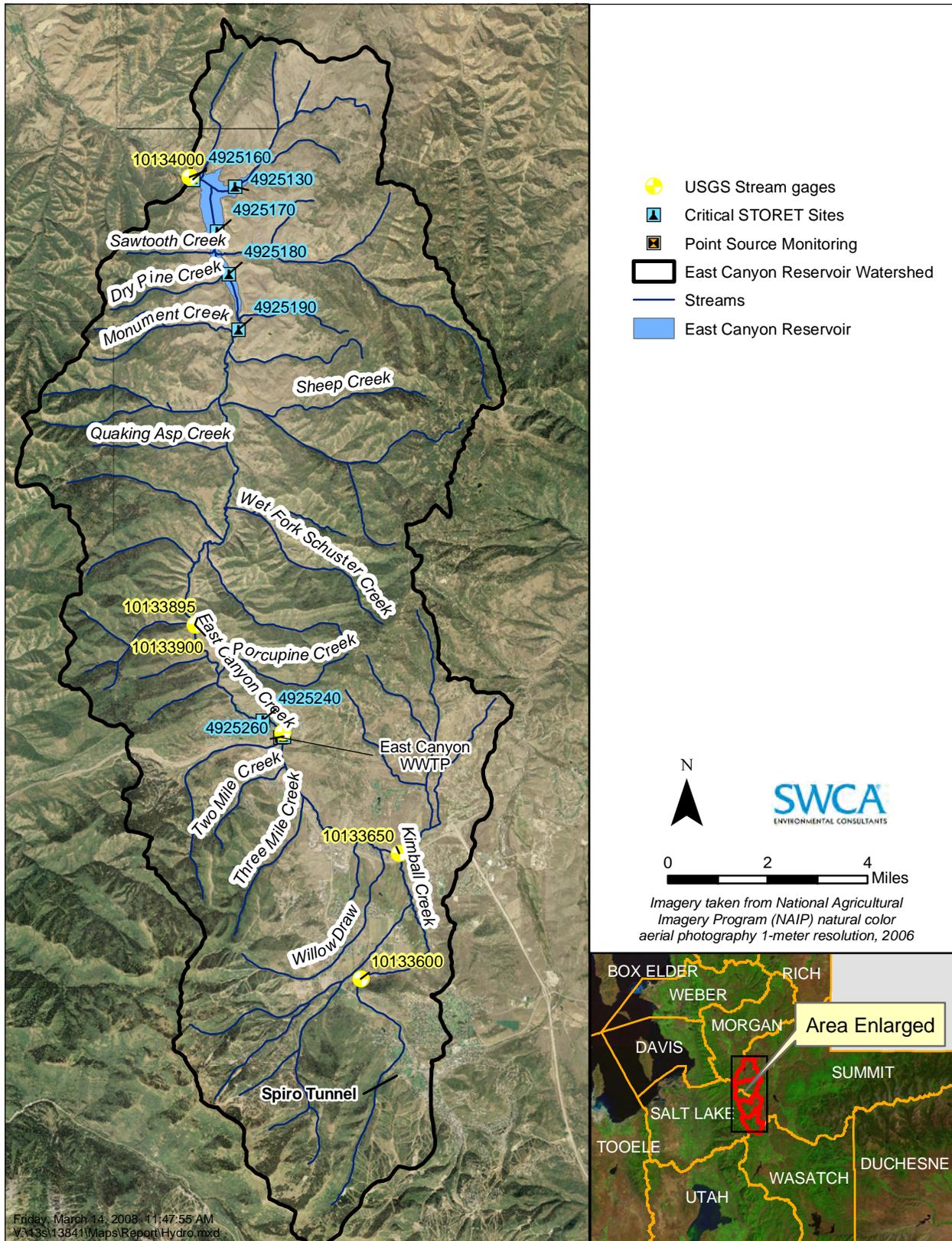


Figure 2.1. East Canyon Reservoir watershed boundary and hydrologic features map.

The only regulated point source in the watershed is Snyderville Basin's East Canyon Water Reclamation Facility (ECWRF). Nonpoint sources of pollutants include urban runoff, streambank erosion, agricultural land use, residential and commercial development, and stormwater. Additional phosphorus sources in the watershed consist of naturally occurring soil phosphate derived from the Phosphoria geologic formation in the southeastern and southwestern portions of the watershed, and phosphorus loading from reservoir sediments due to anoxic conditions.

2.1 PHYSICAL AND BIOLOGICAL CHARACTERISTICS

East Canyon Reservoir is an impoundment of East Canyon Creek, the latter of which drains 120 square miles of the eastern side of the Wasatch Range, including Park City and Snyderville Basin. East Canyon Reservoir is approximately 35 miles northeast of Salt Lake City and is one of six reservoirs in the Weber River Basin, which eventually drains to the Great Salt Lake. East Canyon Reservoir is approximately 3 miles (4.8 km) long and 2,000 feet (610 m) wide with a surface area of 681 acres (275 ha) at its full maximum depth of 195 feet (60 m) (BOR 2003). The minimum elevation of the reservoir is 5,577 feet (1,700 m).

The original dam was constructed in 1896, modified to increase storage capacity in 1900 and 1902, and then reconstructed in 1917 and 1966 to further increase the reservoir's water storage capacity to 28,800 acre-feet and 51,200 acre-feet, respectively (Judd 1999; BOR 2003). The reservoir's current active capacity is 48,100 acre-feet, with an additional 1,400 acre-feet of inactive storage and 1,690 acre-feet of dead storage (BOR 2003). The reservoir's drawdown volume is 23,268 acre-feet, with an average depth of 75 feet (23 m) and a maximum depth of 195 feet (59 m) (Judd 1999). The highest elevation in the watershed is at the southern end, with an average slope of 9% from 9,034 feet (2,753 m) near Park City to 5,690 feet (1,734 m) at the reservoir, and an average stream gradient of 4.2% (220 feet per mile) (Judd 1999). Slopes in the watershed range from 0 to greater than 100% (76.8 degrees; Figure 2.2). Most of the inflow to East Canyon Reservoir comes from East Canyon Creek (see Figure 2.1).

There has been a steady increase in residential, recreational, and commercial development in the upper portion of the East Canyon Reservoir watershed from Park City to Jeremy Ranch (BOR 2003). Runoff associated with construction sites and the associated increase in pollutant runoff from developed areas has contributed to water quality impairments identified in East Canyon Reservoir. The 1,210-acre (490-ha) Swaner Nature Preserve occurs in close proximity to most concentrated areas of development in the watershed north of Park City. The preserve contains portions of East Canyon Creek immediately north and south of I-80, and has likely reduced urban and agricultural impacts to water quality along this reach by capturing nutrients and sediments in riparian and wetland areas.

2.1.1 CLIMATE

The climate of the East Canyon Reservoir watershed study area is typical of semiarid central and northern mountainous regions of Utah. The majority of the land is at an elevation of 5,000 feet (1,525 m) or higher, where approximately 65% to 75% of the annual precipitation occurs in the winter months predominantly in the form of snow (Stonely 2004). Much of the water in the reservoir is derived from snowmelt runoff from high elevations and upstream reaches of tributaries.

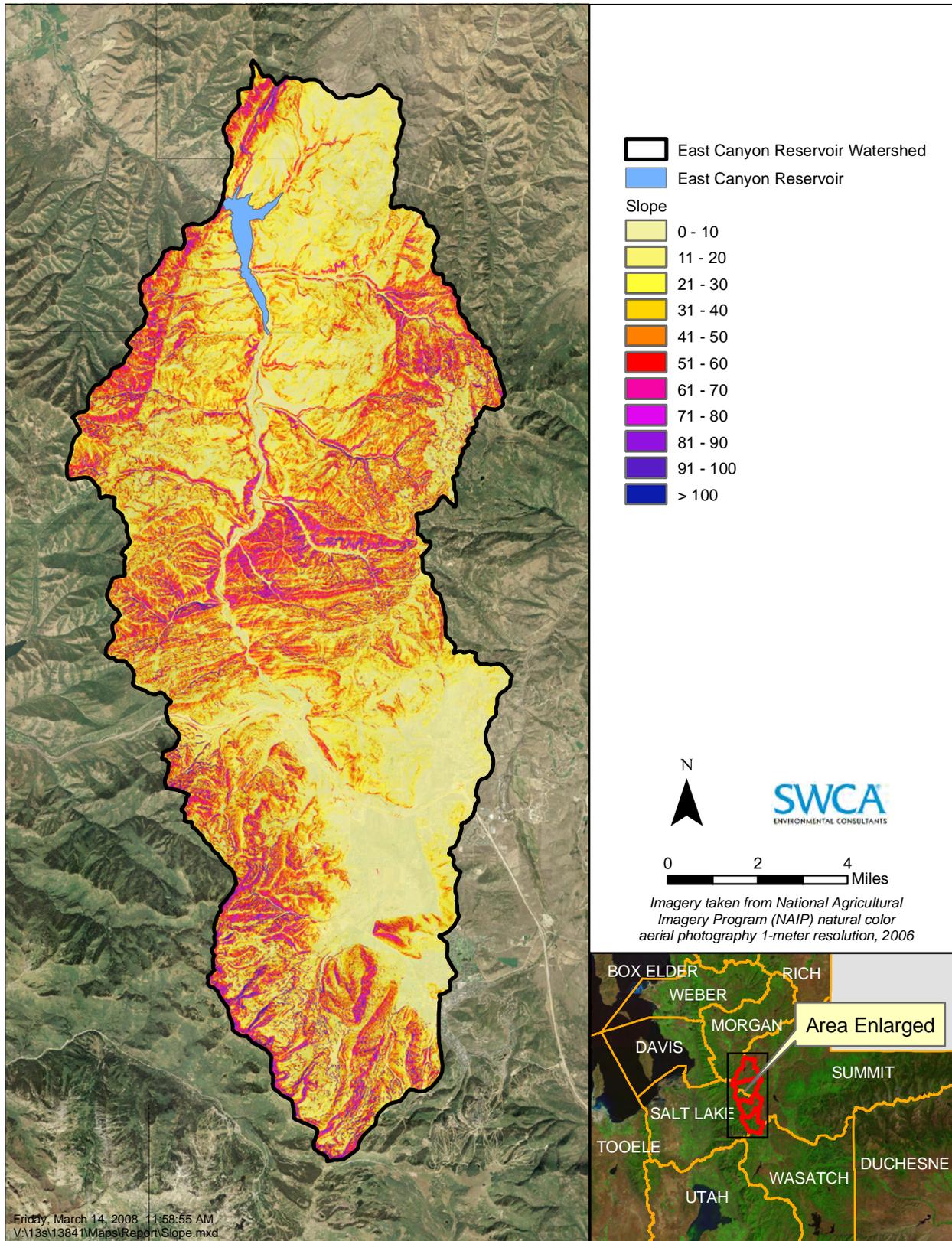


Figure 2.2. East Canyon Reservoir watershed slope map.

Climate data are not available from the reservoir directly. However, three climate sites maintained by the Western Regional Climate Center (WRCC) are available in or near the watershed boundaries: the Mountain Dell Dam Site, the Wanship Dam Site, and the Park City Fire Station 31 site.

The Mountain Dell Dam WRCC site is located at an elevation of 5,420 feet (1,652 m), approximately 8 linear miles southwest of the reservoir. Reported conditions at the site are assumed to accurately represent conditions at East Canyon Reservoir. The site has been in operation since July 1948 to the present, and data are available through June of 2007 (WRCC 2008). Average and extreme minimum and maximum temperatures recorded over the period of record for the Mountain Dell WRCC site are displayed in Table 2.1 and Figure 2.3. Average total monthly precipitation for this site is displayed in Table 2.2 and Figure 2.4.

Table 2.1. Mountain Dell Dam: Average Monthly Air Temperature Data Summary (1948–2007)

	Monthly Average			Extreme High (°F)		Extreme Low (°F)	
	Max (°F)	Min (°F)	Average (°F)				
Annual	61.5	32.3	46.9	102	July 1960	-30	Jan 1963
Winter	39.6	15.9	27.7	68	Feb 1963	-30	Jan 1963
Spring	59.1	30.8	44.9	92	May 2003	-14	Mar 1966
Summer	84.4	49.1	66.8	102	July 1960	21	Jun 1966
Fall	62.9	33.4	48.2	95	Sept 1959	-16	Nov 1955

Winter = December, January, and February; Spring = March, April, and May; Summer = June, July, and August;

Fall = September, October, and November.

Source: WRCC 2008.

Table 2.2. Mountain Dell Dam: Average Monthly Precipitation Data Summary (1948–2007)

	Average (inches)	High (inches)		Low (inches)	
Annual	23.81	38.51	1983	14.86	1976
Winter	6.58	14.42	1965	2.50	1990
Spring	7.59	13.14	1957	3.67	1969
Summer	3.50	9.10	1984	0.64	1972
Fall	6.13	13.75	1982	1.22	1952

Winter = December, January, and February; Spring = March, April, and May; Summer = June, July, and August; Fall = September, October, and November.

Source: WRCC 2008.

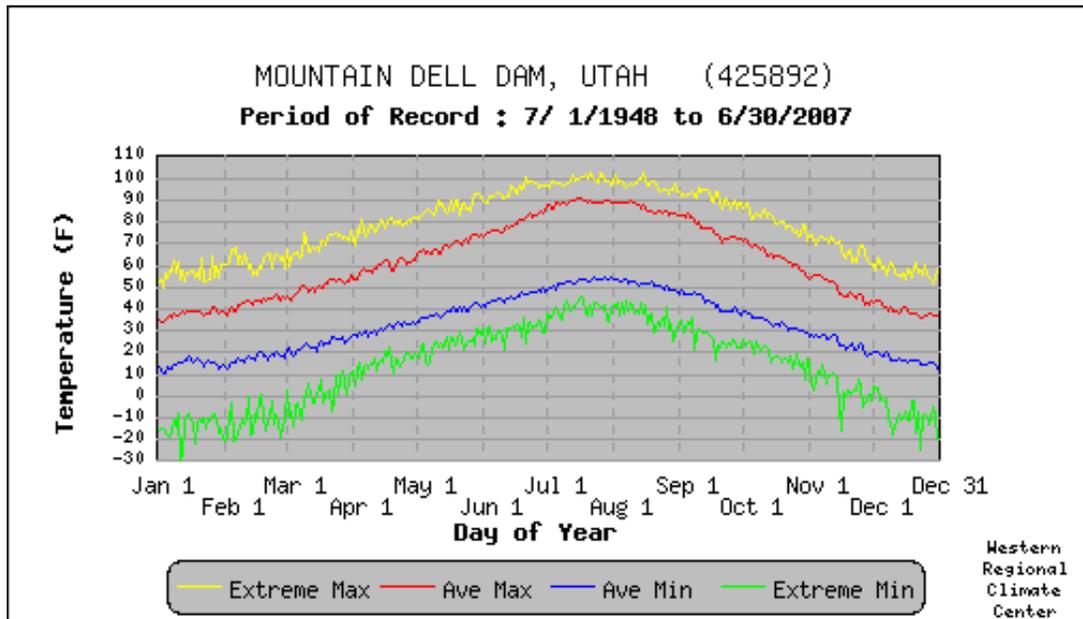


Figure 2.3. Average monthly air temperature conditions at the Mountain Dell Dam meteorological site, Utah (Source: WRCC 2008).

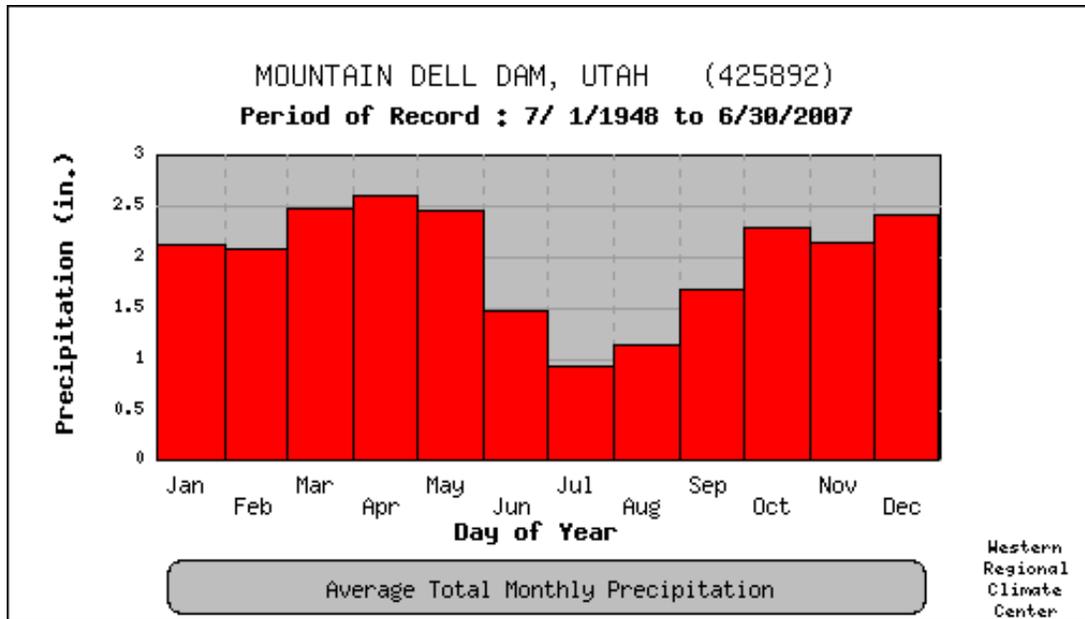


Figure 2.4. Average monthly total precipitation at the Mountain Dell Dam meteorological site, Utah (Source: WRCC 2008).

The Wanship Dam WRCC site is located at an elevation of 5,940 feet (1,810 m), approximately 10 linear miles southeast of the reservoir; it is representative of the topography and elevation of much of the watershed. The site has been in operation since August 1955 to the present, and data are available through June 2007 (WRCC 2008). Average and extreme minimum and maximum temperatures recorded over the period of record for the Wanship Dam WRCC site are displayed in Table 2.3 and Figure 2.5. Average total monthly precipitation for the Wanship Dam Site is displayed in Table 2.4 and Figure 2.6.

Table 2.3. Wanship Dam: Average Monthly Air Temperature Data Summary (1957–2007)

	Monthly Average			Extreme High (°F)		Extreme Low (°F)	
	Max (°F)	Min (°F)	Average (°F)				
Annual	60.3	28.7	44.5	101	Jul 2002	-37	Feb 1982
Winter	38.0	13.2	25.6	66	Feb 1963	-37	Feb 1982
Spring	58.0	28.5	43.2	94	May 2003	-25	Mar 1964
Summer	83.2	44.4	63.8	101	Jul 2002	21	Jun 1966
Fall	62.1	28.8	45.4	93	Sep 1990	-21	Nov 1984

Winter = December, January, and February; Spring = March, April, and May; Summer = June, July, and August; Fall = September, October, and November.

Source: WRCC 2008.

Table 2.4. Wanship Dam: Average Monthly Precipitation Data Summary (1957–2007)

	Average (inches)	High (inches)		Low (inches)	
		Year	Year	Year	Year
Annual	16.15	23.29	1982	9.61	1976
Winter	3.53	8.23	1965	1.29	1961
Spring	4.97	8.80	1995	1.61	1969
Summer	3.15	7.06	1983	0.80	1988
Fall	4.50	9.65	1982	1.14	1999

Winter = December, January, and February; Spring = March, April, and May; Summer = June, July, and August; Fall = September, October, and November.

Source: WRCC 2008.

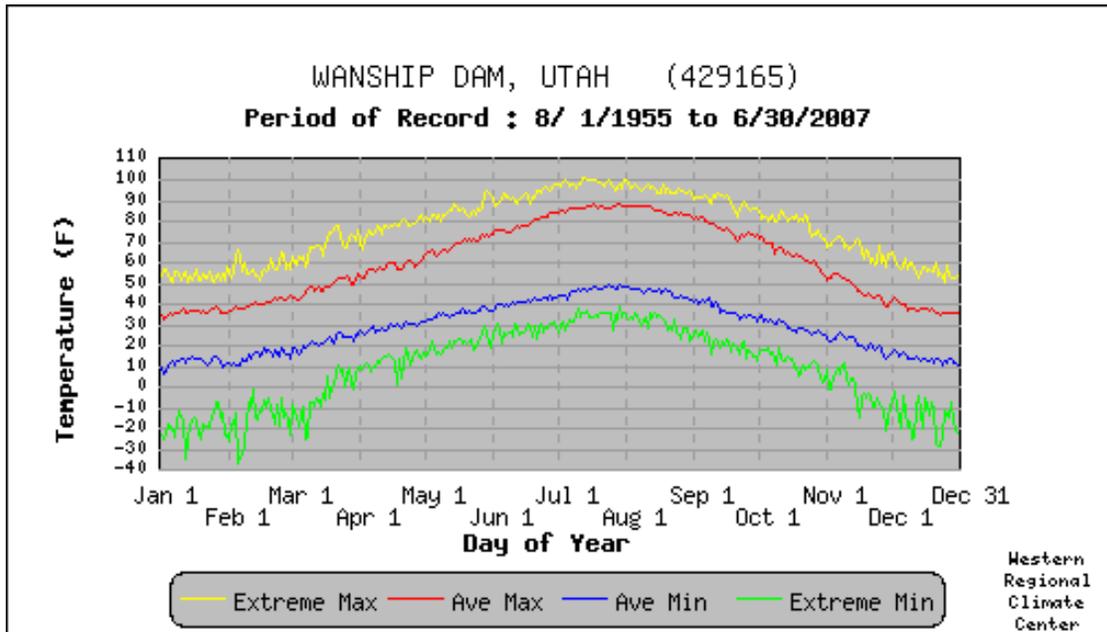


Figure 2.5. Average monthly air temperature conditions at the Wanship Dam meteorological site, Utah (Source: WRCC 2008).

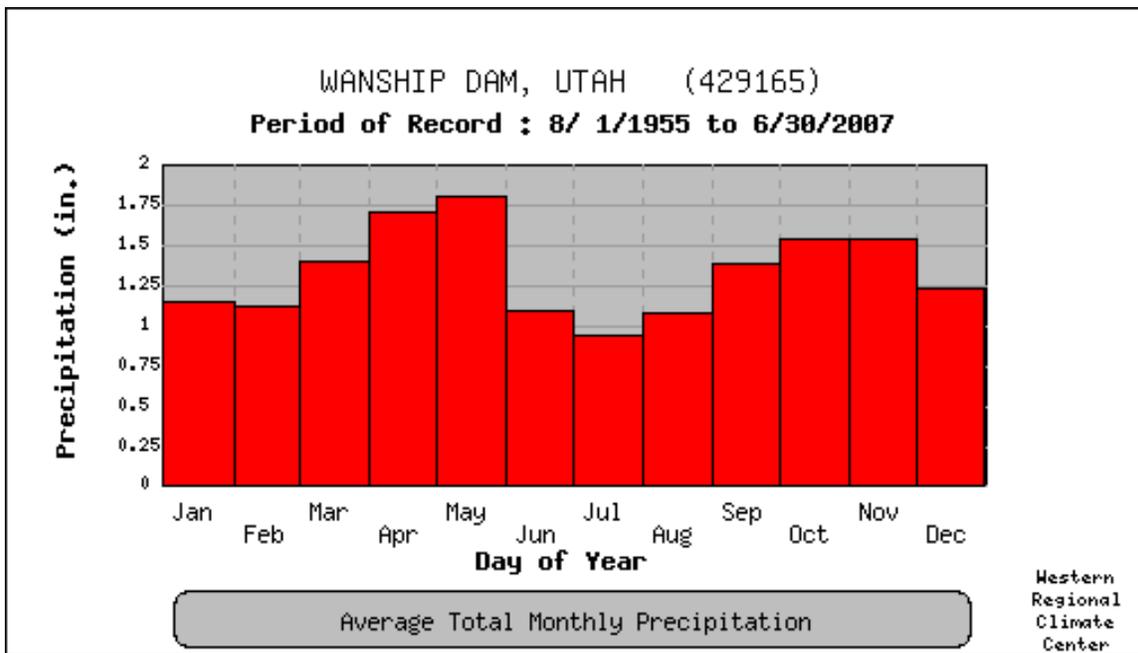


Figure 2.6. Average monthly total precipitation at the Wanship Dam meteorological site, Utah (Source: WRCC 2008).

The Park City Fire Station 31 WRCC site is located at an elevation of approximately 7,000 feet (2,133 m), approximately 15 linear miles south-southeast of the reservoir; it is representative of higher elevation areas in the southern portion of the watershed. The site has been in operation since September 1992 to the present, and data are available through June 2007 (WRCC 2008). Average and extreme minimum and maximum temperatures recorded over the period of record for the Park City Fire Station 31 WRCC site are displayed in Table 2.5 and Figure 2.7. Average total monthly precipitation for the Park City Fire Station 31 WRCC site is displayed in Table 2.6 and Figure 2.8.

Table 2.5. Park City Fire Station 31: Average Monthly Air Temperature Data Summary (1992–2007)

	Monthly Average			Extreme High (°F)		Extreme Low (°F)	
	Max (°F)	Min (°F)	Average (°F)				
Annual	57.0	29.2	43.0	99	Jul 2001	-19	Jan 2007
Winter	35.5	13.6	24.5	57	Dec 1995	-19	Jan 2007
Spring	55.2	28.2	41.6	89	May 2002	-13	Mar 2007
Summer	79.5	45.5	62.5	99	Jul 2001	21	Jun 2002
Fall	57.7	29.5	43.6	87	Sep 2000	-13	Nov 2006

Winter = December, January, and February; Spring = March, April, and May; Summer = June, July, and August; Fall = September, October, and November.

Source: WRCC 2008.

Table 2.6. Park City Fire Station 31: Average Monthly Precipitation Data Summary (1992–2007)

	Average (inches)	High (inches)		Low (inches)	
Annual	20.69	24.41	2005	18.03	2001
Winter	5.59	9.00	1993	3.18	2003
Spring	5.74	7.79	1995	3.08	2007
Summer	3.61	6.85	1998	2.31	2000
Fall	5.74	9.79	2004	1.55	1999

Winter = December, January, and February; Spring = March, April, and May; Summer = June, July, and August; Fall = September, October, and November.

Source: WRCC 2008.

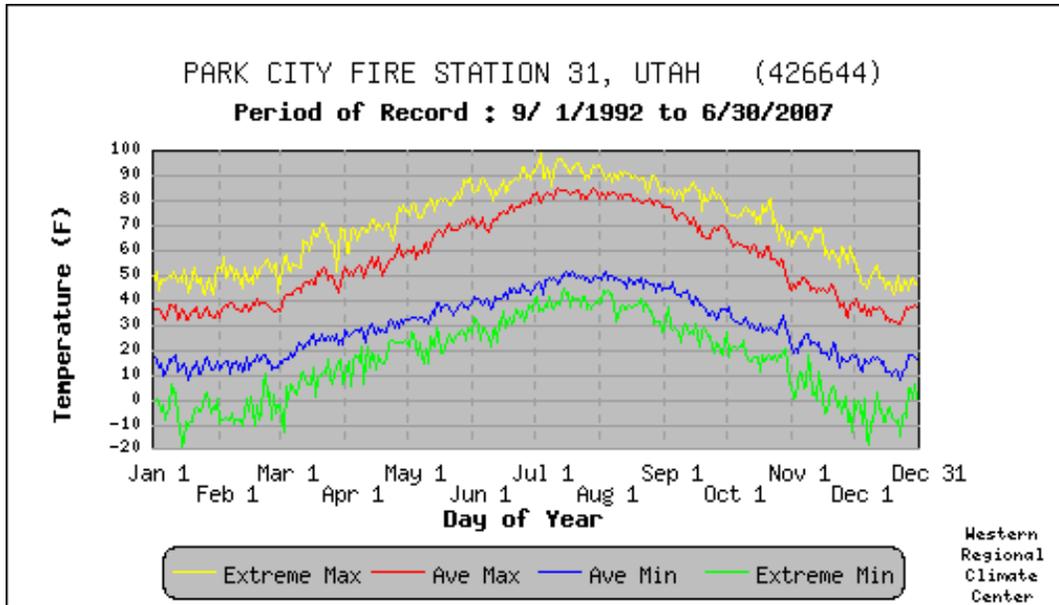


Figure 2.7. Average monthly air temperature conditions at the Park City Fire Station 31 meteorological site, Utah (Source: WRCC 2008).

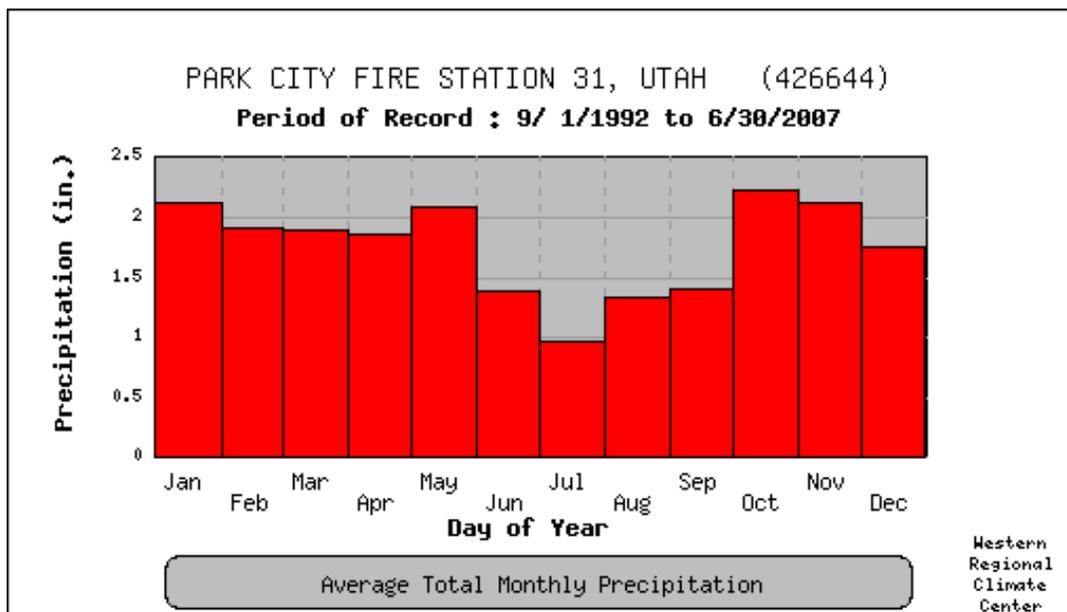


Figure 2.8. Average monthly total precipitation at the Park City Fire Station 31 meteorological site, Utah (Source: WRCC 2008).

Despite their difference in elevation, the observed temperatures and precipitation for the Mountain Dell Dam, Wanship Dam, and Park City Fire Station 31 WRCC sites are relatively similar (Table 2.7). Average precipitation ranges from 16.2 to 23.8 inches across the watershed and average annual temperature ranges from 43°F to 46.9°F.

Table 2.7. Climate Summaries for the East Canyon Reservoir Watershed

Climate Station	Average Annual Precipitation (inches)	Record High (inches)	Record Low (inches)	Average Annual Temperature (°F)	Extreme High (°F)	Extreme Low (°F)
Mountain Dell Dam	23.8	38.5	14.9	46.9	102	-30
Wanship Dam	16.2	23.3	9.6	44.5	101	-37
Park City Fire Station 31	20.7	24.4	18.0	43.0	99	-19

Source: WRCC 2008.

High-elevation meteorological data are available from the Parley's Summit SNOTEL (snow telemetry) site located on the extreme eastern edge of the watershed, about 8.6 linear miles from the reservoir. The SNOTEL site elevation is approximately 7,500 feet (2,286 m) and is assumed to be characteristic of climate conditions in the higher elevations in the watershed. Station data indicate that in the past 20 years, the average annual precipitation is 31.5 inches (80 cm) with a minimum of 22.2 inches (56.4 cm) recorded in 1988 and maximum of 45.3 inches (115 cm) falling in 1995 (National Resources Conservation Service 2008). Mean monthly high temperatures at the SNOTEL station from 1987–2007 ranged from 24.9 °F (-4 °C) in December to 64° F (17.8 °C) in July.

2.1.2 HYDROLOGY

Watershed hydrology includes both surface water and groundwater characterization in relationship to natural precipitation patterns and management. The hydrology of the East Canyon Reservoir watershed has been modified due to historic diversion of streams for mining activities, more recent diversion for irrigation and culinary use, and the impoundment of water in the reservoir itself (Brooks et al. 1998, Judd 1999). There are three other large reservoirs in the area: Echo Reservoir, Rockport Reservoir, and the Jordanelle Reservoir, but there are no impoundments in the Snyderville Basin (SBWRD 2005). In the East Canyon Reservoir watershed, there are several small lakes at high elevation and numerous ponds in the Park City area (see Figure 2.1).

2.1.2.1 Surface Water Hydrology

Most of the inflow to East Canyon Reservoir comes from East Canyon Creek, which drains 80% of the 145 square mile watershed (Judd 1999; SBWRD 2005). High elevation snow and spring runoff from snowmelt provide most of the water in East Canyon Creek, with the highest flows occurring in April and May (BOR 2003). Mean annual precipitation in the East Canyon drainage is 26 to 37 inches (66–94 cm) per year, 73% of which occurs as snow from October to April, with East Canyon Creek flows increasing from approximately 10,859 acre-feet per year (15 cfs) to 253,387 acre-feet per year (350 cfs) during spring runoff between March and May (Judd 1999). East Canyon Creek's headwaters are McLeod Creek near Thaynes Canyon, which receives a major portion of its perennial flow from the Spiro Tunnel and Sullivan Springs near Park City (SBWRD 2005). Groundwater discharge near Park Meadows and Snyderville and small perennial and ephemeral streams contribute to McLeod Creek before it becomes

Kimball Creek, just south of I-80. Kimball Creek joins an unnamed creek from the North to become East Canyon Creek. East Canyon Creek flows west and north from the confluence and receives additional water from Kimball Junction, Threemile Creek, Twomile Creek, Porcupine Creek, the Snyderville Basin WWTP (Judd 1999; SBWRD 2005), and numerous other small drainages along the creek. East Canyon Creek then flows through the Jeremy Ranch Golf Course and residential development before it travels approximately 12 miles (19 km) (ECRFC 2002) through rangelands confined within a narrow canyon before entering East Canyon Reservoir (BOR 2003).

Many of the original stream channels in the watershed have been altered by mining, agriculture and development. Red Pine Creek and Willow Draw no longer flow into McLeod Creek, having been diverted into channels or into the valley. Additionally, a large portion of McLeod Creek is diverted to the West Grade Canal and water is discharged at several other pumping points along McLeod Creek, Kimball Creek and East Canyon Creek (SBWRD 2005). Treated municipal wastewater from the ECWRF averages 3,478 acre-feet (4.8 cfs), which represents a significant portion of discharge into East Canyon Creek, particularly during the summer (SBWRD 2005). From 1939 to 2006, the average annual flow into East Canyon Reservoir from East Canyon Creek was 41,377 acre-feet per year (57.1 cfs) according to U.S. Geological Survey (USGS) flow records for 10134500 (Table 2.8).

Table 2.8. East Canyon Watershed Average Flow and Drainage Area

Gaging Station	Name	Period of Record	Average flow (cfs)	Elevation (feet)	Drainage Area (square miles)
10133600	McLeod Creek near Park City	1994–2006	14.4	6,590	8.8
10133650	East Canyon Creek below the I-80 Rest Stop	2004–2006	23.6	6,360	41.1
10133800	East Canyon Creek near Jeremy Ranch	2002–2006	32.9	6,240	57.2
10133900	East Canyon Creek near Park City, Utah	1982–1985	77.4	6,120	68.9
10133895	East Canyon Creek above Big Bear Hollow	1990–1996 1998–2001	36.0	6,120	75.0
10134500	East Canyon Creek near Morgan, Utah	1939–2006	57.1	5,460	145.0

Source: USGS NWISWeb 2008.

Recent East Canyon Reservoir water retention times vary between wet to dry years from 8 months to approximately 1.5 years, respectively. The average retention time from 2002 to 2007 was one year (Table 2.9). Retention times vary seasonally, with the lowest retention times in April during spring runoff and highest retention times in late summer and early fall. Outflow rates are determined by irrigation use and the associated water rights downstream of the reservoir.

Table 2.9. East Canyon Reservoir Inflow and Retention Times from 2001 to 2007

Water Year	Total cfs	Acre-feet per year	Average Storage Capacity (acre-feet)	Retention Time (years)
2001	23.4	16,987	*	*
2002	34.2	24,803	30,306	1.2
2003	25.0	18,091	29,475	1.6
2004	36.3	26,264	32,825	1.3
2005	65.9	47,751	38,969	0.8
2006	82.8	60,013	39,427	0.7
2007	35.7	25,848	37,175	1.4
Total Average Inflow	45.7	33,114	34,390	1.0

*2001 was not included because due to the 2001 water year starting October 1, 2000 for which data was not available.

Source: Reservoir daily storage record obtained from Beau Urionoa, BOR, by Greg Larson, SWCA, in February 2008.

2.1.2.2 Groundwater Hydrology

Groundwater in the upper East Canyon watershed collects in shallow unconsolidated deposits and consolidated fractured rock, and generally flows from high elevations in the southwestern portion of the watershed toward lower elevations in the northeast (Ashland et al. 2001; BOR 2003). The unconsolidated deposits are primarily alluvium, glacial till and glacial outwash, which are thin in most upland areas, generally in excess of 40 feet (12 m) thick in lowland areas and up to as much as 275 feet (220 m) thick in Parley's Park (Ashland et al. 2001). The unconsolidated material is heterogeneous with variable hydraulic conductivity values from 0.1 feet to 60 feet per day and is less productive than consolidated rock, where all public groundwater wells in the watershed are located (BOR 2003). Withdrawals from wells are greatest in late summer when water is needed for lawn and garden irrigation, but this represents a small portion of total groundwater discharge (BOR 2003). Groundwater seepage from wetlands or from excess irrigation may flow back to streams or aquifers; however base flow to streams during spring runoff is the largest component of groundwater discharge in the East Canyon watershed (Brooks et al. 1998; SBWRD 2005). Due to the limited storage capacity of the aquifer, there is a rapid decrease in groundwater baseflow following spring runoff (SBWRD 2005).

There are numerous springs in the East Canyon Reservoir watershed, with four large springs in the upper portion of the watershed discharging more than 200 acre-feet per year (0.276 cfs): Thirtiot Springs, Sullivan Springs, Spring Creek Springs, and Twomile Springs (SBWRD 2005). Flows from these springs vary seasonally from 72 to 13,755 acre-feet (0.1–19 cfs) and a portion of these waters are diverted for public water supply and irrigation with excess flowing into the East Canyon Creek watershed (SBWRD 2005).

Spiro Tunnel, located in Thaynes Canyon, extends several miles into the mountains above Park City to intersect a spring that would otherwise flow to the Big Cottonwood Canyon drainage. Spiro Tunnel currently provides 3,791 acre-feet of water to Park City (BOR 2006). A portion of water that flows through the Spiro Tunnel is diverted for municipal water supply, with the remainder diverted to the East Canyon Creek and Silver Creek watersheds. In 2004, discharge from the Spiro Tunnel into McLeod Creek ranged from 723 to 2,895 acre-feet per year (1.0 to 4.0 cfs), but varied with diversions to Silver

Creek (SBWRD 2005). A large portion of McLeod and Kimball Creeks, as well as White Pine Creek, Red Pine Creek and Willow Creek are seasonally diverted into the West Grade Canal west of Quarry Mountain for irrigation purposes (SBWRD 2005). The canal flows north then east to rejoin McLeod Creek, but there is generally no surface water remaining to flow back into the creek in the summer and during dry years (SBWRD 2005).

2.1.3 GEOLOGY AND SOILS

2.1.3.1 Geology

The East Canyon Reservoir watershed is located in north-central Utah in the topographically rugged area to the east of the Wasatch Range known as the Wasatch Hinterlands section of the Middle Rocky Mountains physiographic province (Stokes 1986). Rainfall in this area has contributed to the development of deep soil and dense vegetation cover with limited outcroppings of bedrock (Stokes 1986). An elongate crustal block bounded by faults, the East Canyon Graben, forms the valley where the reservoir is located. This valley is geologically complex, containing bedrock of varying composition (BOR 2003, Figure 2.9). The remainder of the East Canyon watershed is primarily composed of sedimentary rock and fine-grained alluvial deposits and glacial outwash (Olsen and Stamp 2000a) which produce high sediment loads in East Canyon Creek (Olsen and Stamp 2000a). Permian phosphatic shales (Park City Phosphoric Limestone Formation) occur in two distinct locations: the Threemile and Upper Spring Creek subbasins along the southern side of Threemile Canyon, and the Treasure Hollow and Willow Draw subbasins in the extreme southeastern corner of the watershed in Park City. A large proportion of these subbasins have been recently developed or are in active development, which has likely increased the erosion of phosphatic parent material and phosphorus loading in East Canyon Creek and East Canyon Reservoir (Olsen and Stamp 2000a).

2.1.3.2 Soils

Impacts to water quality from soils are due to streambank erosion and excess nutrients associated with runoff and sediments washed into the stream. As noted by the East Canyon Riparian and Fisheries Committee (ECRFC) (2002), erosion along East Canyon Creek occurs where riparian vegetation is sparse and there is direct disturbance to the streambank from livestock, recreation, or roadways. The soil groups that affect water quality in East Canyon Reservoir are generally the farmland soils near the streams, which are mostly of the Broadhead and Henefer groups characterized by deep topsoil, moderate permeability, and low erosion hazard (Judd 1999) (Figure 2.10). The surface soils in the watershed are not naturally high in phosphorus, with the exception of soils derived from the Park City Phosphoric Limestone Formation, as described in Section 2.1.3.1 above (Figure 2.9). As noted above, there has been recent development in the subbasins where the Phosphoria formation occurs in the watershed, which has likely caused the erosion of phosphatic soils and increased phosphorus loading in East Canyon Creek (Olsen and Stamp 2000a).

Soil data for the East Canyon Reservoir watershed were collected from the U.S. Department of Agriculture (USDA) Soil Conservation Service (NRCS 2007). The dominant soil types in the East Canyon Reservoir watershed are detailed in Table 2.10. The soils vary greatly in texture throughout the watershed (Table 2.11 and Figure 2.11) but generally have low erodibility factors ranging from 0.10 to 0.37 (NRCS 2007).

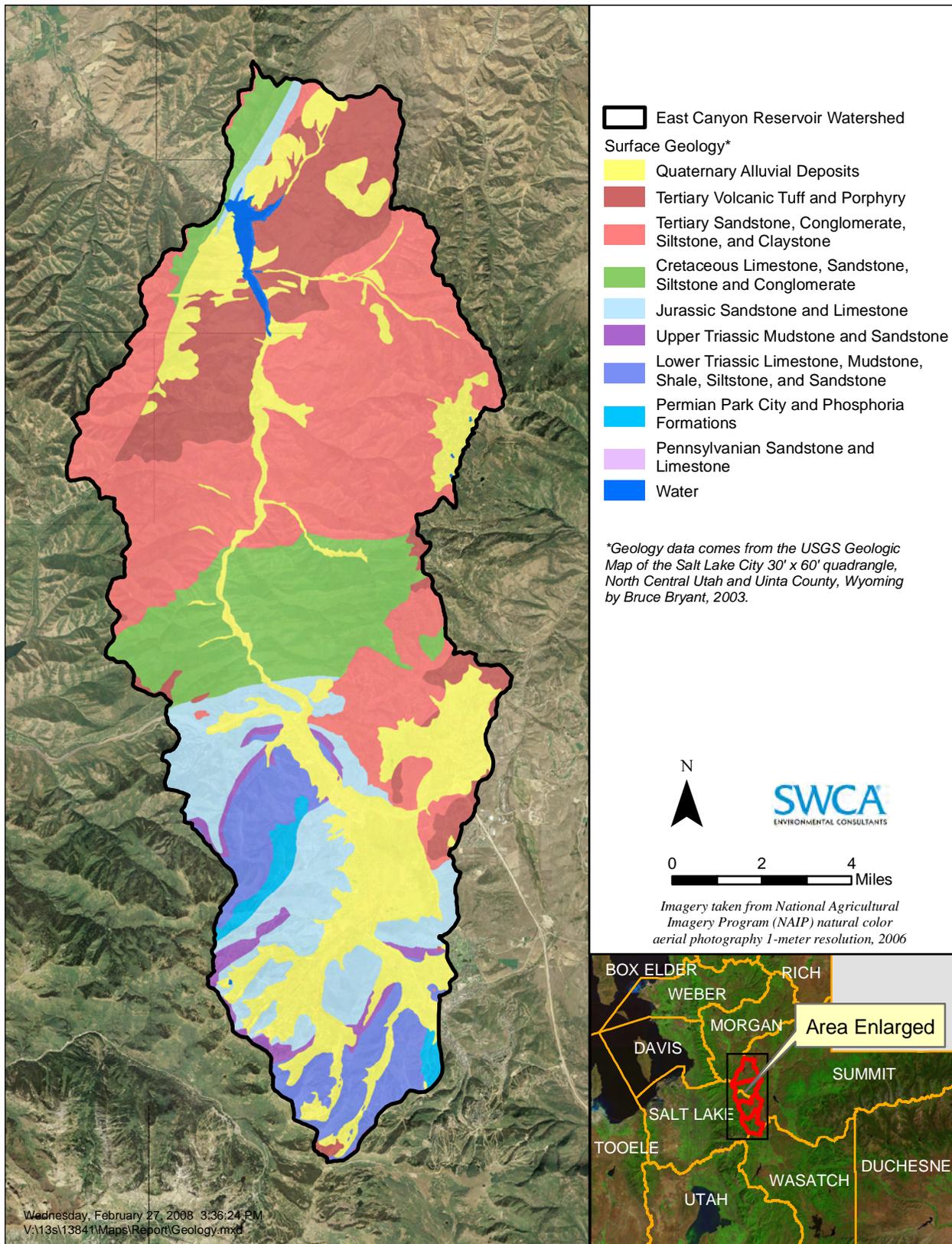


Figure 2.9. East Canyon Reservoir watershed geology map.

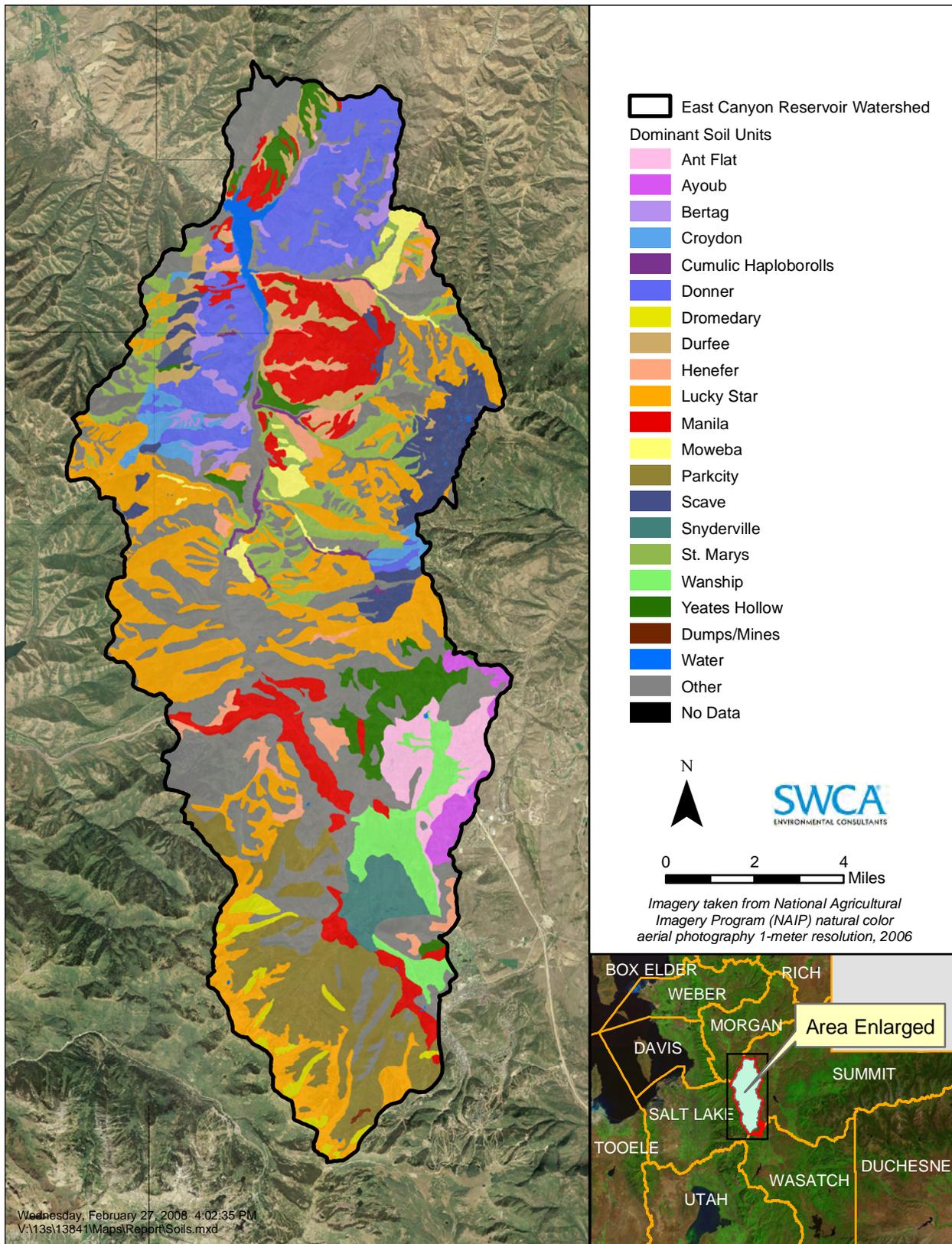


Figure 2.10. East Canyon Reservoir watershed soil classifications.

Table 2.10. Soil Types and Characteristics in the East Canyon Reservoir Watershed

Soil Name	Soil Texture	Estimated Soil Erodibility (K Factor)	Percent of East Canyon Reservoir Watershed
Lucky Star	Gravelly loam/silt loam	0.15/0.28	18.4%
Agassiz	Very cobbly loam	0.10	9.7%
Park City	Gravelly loam	0.10	8.2%
Donner	Cobbly loam	0.15	8.1%
Manila	Loam	0.24	7.5%
St. Mary's	Cobbly loam	0.15	4.8%
Scave	Loam	0.24	3.6%
Yeates Hollow	Cobbly loam/very stony loam	0.05/0.15	3.4%
Schuster	Loam	0.24	3.3%
Wanship	Loam	0.17	2.8%
Henefer	Loam	0.32	2.8%
Ant Flat	Loam	0.28	2.4%
Durfee	Stony loam	0.10	2.3%
Hades	Loam	0.24	1.9%
Fewkes	Gravelly loam	0.15	1.8%
Snyderville	Gravelly loam	0.15	1.6%
Bertag	Cobbly loam	0.20	1.5%
Moweba	Gravelly loam	0.10	1.4%
Croydon	Loam	0.24	1.3%
Ayoub	Cobbly loam	0.15	1.2%
Dromedary	Gravelly loam	0.17	1.1%
Hoskin	Cobbly loam	0.17	1.0%
Other Soils	NA	NA	10.0%

Source. NRCS 2007.

Table 2.11. Soil Texture in the East Canyon Reservoir Watershed

Texture	Acres	Percent
Gravelly loam	25,795.0	28.1%
Loam	24,043.2	26.2%
Cobbly loam	16,122.9	17.5%
Very cobbly loam	10,192.4	11.1%
Silt loam	5,974.6	6.5%
Gravelly fine sandy loam	3,054.5	3.3%
Very stony loam	2,415.8	2.6%
Stony loam	2,149.9	2.3%
Silty clay	1,039.5	1.1%
Water	714.3	0.8%
Variable	221.4	0.2%
Cobbly clay loam	76.4	0.1%
Other	56.1	0.1%
Extremely stony loam	42.5	<0.1%
Rock	37.5	<0.1%
Total	91,936	100%

Source: NRCS 2007.

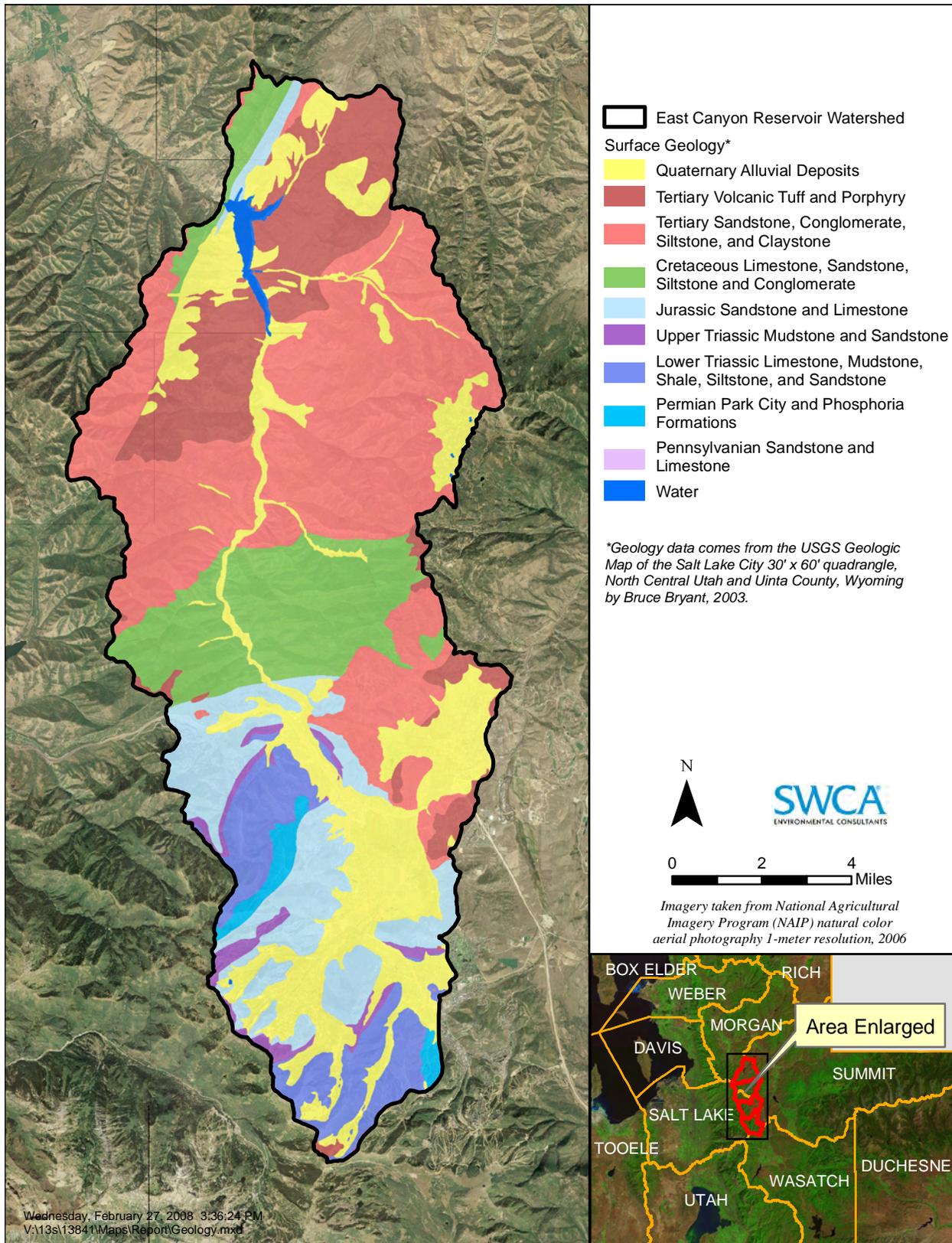


Figure 2.11. East Canyon Reservoir watershed soil textures.

2.1.3.3 Stream Geomorphology

In August 2001, the ECRFC (2002) conducted an inventory of the East Canyon Creek stream channel and riparian corridor using the Stream Visual Assessment Protocol (SVAP) developed by the USDA NRCS National Water and Climate Center (1998). A Stream Erosion Condition Inventory (SECI) developed by the Idaho NRCS was conducted simultaneously with the SVAP. The SECI rated the following criteria in each reach: bank erosion evidence, bank stability condition, bank cover/vegetation, lateral channel stability, channel bottom stability, and in-channel deposition in each reach. The survey included 40 miles (64 km) of East Canyon Creek from Park City to the creek's confluence with the Weber River downstream from East Canyon Reservoir. The stream was divided into 26 reaches based on geographic location, types and amounts of vegetation, impacts, and stream type. Approximately 24 miles (39 km), or 13 reaches of East Canyon Creek from East Canyon Reservoir to Old Ranch Road in Park City are included in the East Canyon Reservoir watershed.

The SVAP rates the overall condition of each stream reach based on average ranking of 14 categories; these rankings are poor (0–6.0), fair (6.1–7.4), good (7.5–8.9), and excellent (9.0–10.4) (NRCS 1998a). The 14 resource categories were combined to assess four general resource conditions for each reach: riparian habitat, fisheries habitat, excess nutrients, and channel function. Combined average ratings for the 13 reaches of East Canyon Creek within the watershed are presented here. The combined average rating for riparian habitat of 5.8 (poor) was based on SVAP rankings of the riparian zone, which averaged 6.9 (fair) in stream reaches in agricultural and grazing land from the mouth of East Canyon Creek above the reservoir to the ECWRF, and 4.7 (poor) in the upper part of the watershed below Old Ranch Road in Park City. The combined average rating for fisheries habitat of 5.1 (poor) was based on SVAP rankings of canopy cover, invertebrate habitat, macroinvertebrates, fish cover, fish barriers, pools, and bank stability. Fisheries habitat rankings averaged 5.27 (poor) in stream reaches through agricultural and grazing land from the reservoir to the ECWRF, and 4.9 (poor) in the upper part of the watershed. The combined average rating for excess nutrients of 5.3 (poor) was based on SVAP rankings for nutrient enrichment, animal waste, and water appearance. Excess nutrient rankings averaged 4.4 (poor) in stream reaches in agricultural and grazing land from the reservoir to the ECWRF, probably due to sewage effluent combined with other factors, and 6.3 (fair) from the ECWRF to Old Ranch Road. The combined average rating for channel function of 6.7 (fair) was based on SVAP rankings for channel condition, hydrologic alteration, and bank stability. Channel function rankings averaged 6.1 (fair) for stream reaches from the reservoir to the ECWRF, and 7.5 (good) from the ECWRF to Old Ranch Road (ECRFC 2002).

According to the SVAP, the most common impairments to channel stability were low riparian vegetation cover, road banks, recreation and livestock access to the stream, excess nutrients from the ECWRF prior to treatment upgrades to remove nutrients, or local development. The condition of East Canyon Creek was variable, with areas of low erosion and good riparian habitat immediately above the reservoir and in one of the uppermost reaches of the creek south of I-80 (Swaner Nature Preserve). The reaches through Jeremy Ranch golf course and the uppermost reach near Old Ranch Road in Park City also had low levels of erosion but riparian habitat was poor due to livestock access in small ranchettes and groomed turf up to the waterway. Several reaches just above the reservoir and below the ECWRF exhibited high rates of bank erosion, but had good riparian habitat with large amounts of woody vegetation. Within these reaches, erosion was noted to be largely due to road banks and livestock access. Reaches with high rates of erosion and poor riparian habitat occur above the reservoir, with areas near the State Park impacted by a primitive camping area, and by land clearing and continuous grazing activities further upstream. More than half of the stream reaches surveyed had excessive nutrient inputs, most occurring downstream from the ECWRF with additional nonpoint sources from sediment and animal waste. The reach just above the reservoir was significantly impacted, potentially due to camping in close proximity to or in the riparian area. One reach in the uppermost portion of the watershed was impacted by excess nutrient inputs from nonpoint sources in Park City (ECRFC 2002). Stream reaches north and parallel to I-80 are mostly in

Swaner Nature Preserve, but are also bordered by residential developments to the north, which may affect water quality and streambank stability.

2.1.4 PLANTS, ANIMALS, AND FISHERIES

The health, diversity, and distribution of vegetation, wildlife, and fish in a watershed can be both an influence on and an indicator of habitat and water quality status. The characteristics of these three categories are often a reflection of the level of use, management, and short-term climate conditions.

2.1.4.1 Riparian Plant Community

The riparian community of the East Canyon watershed is mostly comprised of willow species (*Salix* spp.), currant (*Ribes*), hawthorn (*Crataegus*), and river birch (*Betula nigra*). Herbaceous species include meadow foxtail (*Alopecurus arundinaceus*) (ECRFC 2002), sedges (*Carex* spp.), rushes (*Juncus* spp.), spike rush (*Eleocharis* spp.), and other graminoids (BOR 2003). Riparian areas constitute less than 3% of the watershed, but are ecologically important for maintaining plant diversity and wildlife habitats, bank stabilization, and capture and uptake of nonpoint source pollutants along waterways (Figure 2.12). Riparian areas in the upper portion of the watershed along private ranchettes, the Jeremy Ranch golf course, and I-80 are narrow and do not contain a lot of woody vegetation (ECRFC 2002). Throughout the watershed, the riparian vegetation is limited or absent with actively eroding banks where livestock have access to the riparian zone (ECRFC 2002). Approximately 45 acres of riparian vegetation occur along the shoreline of the reservoir, but the habitat is limited due to seasonal water level fluctuations (BOR 2003). Riparian vegetation may also be limited by seasonal variability in water flow in East Canyon Creek.

2.1.4.2 Dominant Upland Plant Community

East Canyon Reservoir lies on the eastern edge of the Intermountain Semi-Desert and Desert Province and the western edge of the Southern Rocky Mountain Steppe Province (BOR 2003). The climate is relatively dry in the watershed compared to higher elevation areas at the headwaters of East Canyon Creek closer to the Wasatch Front (Judd 1999). Gambel oak (*Quercus gambelii*) and bigtooth maple (*Acer grandidentatum*) associations dominate hillsides across 26.3% of the watershed (see Figure 2.12). Sagebrush (*Artemisia tridentata*) steppe occupies 29.4% of the watershed and is common around the reservoir and at lower elevations. Coniferous trees such as white fir (*Abies concolor*), subalpine fir (*A. lasiocarpa*), Douglas fir (*Pseudotsuga menziesii*), Engelmann spruce (*Picea engelmannii*), blue spruce (*P. pungens*), and limber pine (*Pinus flexilis*) are dominant on 27.9% of the watershed on north-facing slopes at elevations above approximately 6,000 feet (1,829 m). Alpine tundra zones occur on less than 4% of the watershed and are found above the tree line (Judd 1999). Invasive weeds, specifically cheatgrass, are known to occur in the project area.

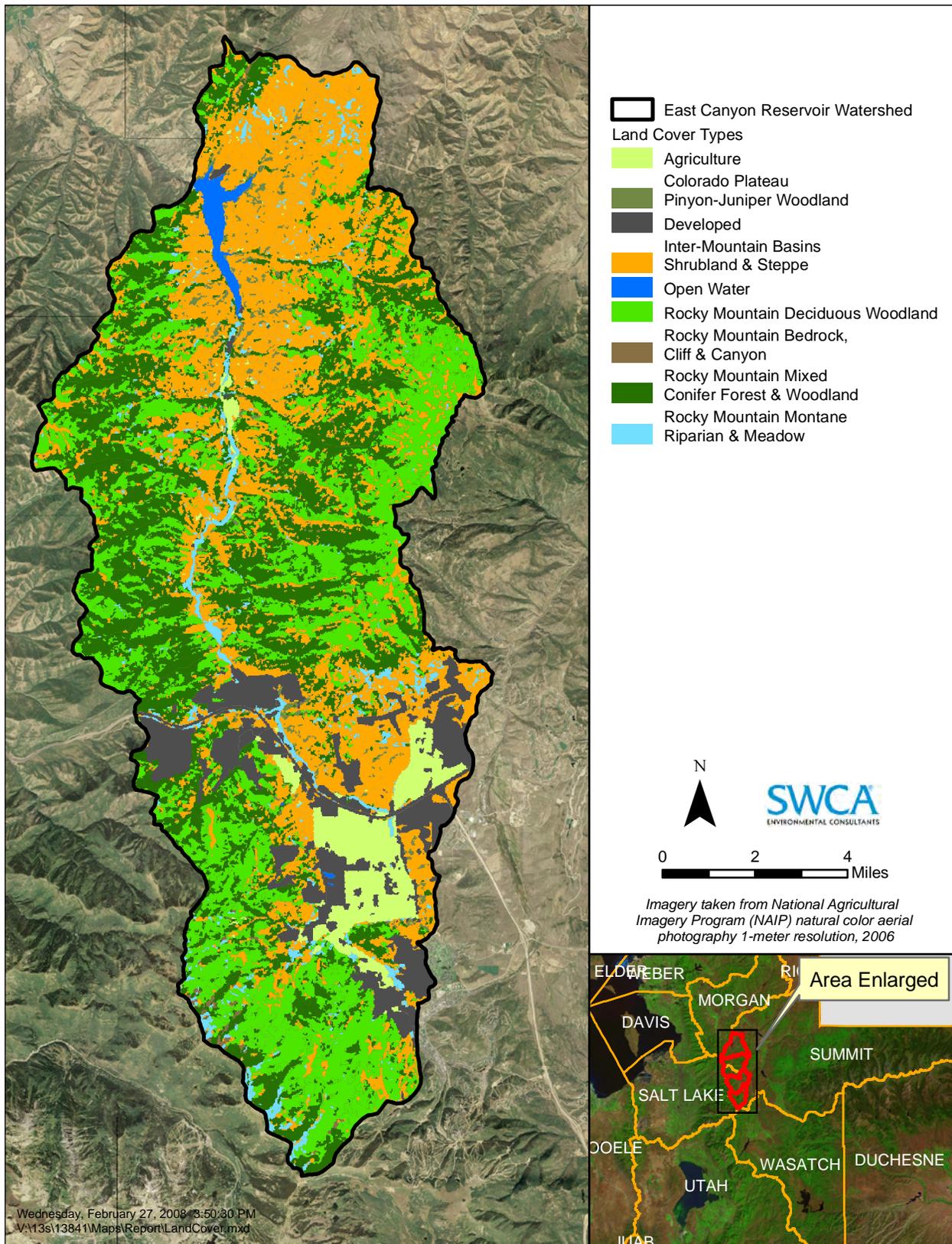


Figure 2.12. East Canyon Reservoir watershed vegetation and land cover.

2.1.4.3 Wildlife

Wildlife in and around East Canyon Reservoir are generally adversely affected by habitat degradation due to recreational activities, trespassing livestock, and water management (BOR 2003). However, some species, such as shorebirds, benefit during seasonal low water levels by increased habitat and prey availability. Overall shoreline habitat is limited by seasonal fluctuations in water levels and scouring of the shoreline that limits the development of riparian vegetation (BOR 2003).

Big game species in the watershed include mule deer, elk and moose. Mountain lions and bobcats are also known to occur in the area (BOR 2003). Beaver activity and dams have been noted along riparian areas in the watershed (ECRFC 2002). Common mammals in the area include yellow-bellied marmot, gophers, coyotes, porcupines, striped skunks, and raccoons. Common waterfowl and shorebird species in and around the reservoir likely include mallard, gadwall, northern pintail, teal, redhead, Canada goose, sandhill crane, killdeer, great blue heron, Clark's grebe, western grebe, gulls, and plovers (BOR 2003). It is likely that some of these species use riparian habitats along East Canyon Creek as well, and bald eagles are known to use riparian areas along the creek as wintering range (Stonely 2004). The upland areas surrounding the reservoir provide abundant small prey for raptors such as red-tailed hawks, Swainson's hawks, golden eagles, and American kestrels (BOR 2003).

2.1.4.4 Fisheries

Historically, East Canyon Reservoir and East Canyon Creek were high-quality trout fisheries and popular angling destinations in northern Utah. Until fairly recently, East Canyon Reservoir provided over 50,000 angling hours and 92 pounds per acre of rainbow trout, but water quality and habitat conditions have continuously degraded over the past 25 years (BOR 2003). The upstream portion of East Canyon Creek historically supported a reproducing population of kokanee salmon, which is no longer present due to degraded water quality (BOR 2003). The reservoir is managed as a cold water fishery, and the DWR stocks East Canyon Reservoir with approximately 300,000 fingerling rainbow trout annually. The reservoir has not been chemically treated to eliminate rough fish competition and so sustains both stocked and self-sustaining fish populations (Judd 1999). Fish species known to occur in the reservoir include black crappie, brown trout, Bonneville and Colorado River cutthroat trout, kokanee salmon, rainbow trout, tiger trout, Utah chub, speckled dace, fathead minnow, redbelt shiner, smallmouth bass, and cutbows (cutthroat trout × rainbow trout hybrids) (BOR 2003; Nadolski and Schaugaard 2008). East Canyon Creek is currently managed as a wild brown trout fishery with limited numbers of cutthroat and rainbow trout from upstream and the reservoir, respectively (BOR 2003). The Bonneville cutthroat trout, a Utah Sensitive Species, historically occurred in East Canyon Creek but is no longer believed to be present due to decreased flows, increased nutrient input, and degradation to water and habitat quality (BOR 2003).

Reservoir water quality has been impacted by agricultural and recreational land-use practices, and by upland development and highway construction in the area. In the 1990s the cold water fishery was impacted by blue-green algal blooms and depleted DO levels in the hypolimnion during the winters and summers of some years (Judd 1999; BOR 2003). Oxygen levels on the bottom of the reservoir are still depleted during summer months. This represents a dramatic change from the information presented in the "East Canyon Reservoir-Water Quality Assessment" (Merritt et al. 1980) where DO at the bottom of the reservoir was shown to rarely drop below 4 mg/L even in summer months. Sport fish species are seasonally stressed by high water temperatures and low oxygen conditions in the reservoir, and may become more susceptible to parasites, such as the rainbow trout parasitic anchorworm (*Lernaea*). These conditions compromise the overall health and survival of affected fish. Fingerling rainbow trout stocked in the spring have not survived recent summers and the UDWiR is evaluating the feasibility of establishing a warm water fishery in the reservoir (BOR 2003).

Today East Canyon Reservoir is managed as a basic-yield trout fishery and is maintained by stocking sub-catchable rainbow trout and catchable tiger trout. Recent monitoring of the fishery indicates that the abundance and diversity of fish species netted is low throughout East Canyon Reservoir. Rainbow trout compose 94% of the total fish biomass, and tiger trout compose the remaining 6%. A diversity of age and size classes was not present in 2007 for rainbow trout in East Canyon Reservoir, with a noticeable absence of smaller fish. This is most likely due to poor survival over the winter of 2006–2007 (Nadolski and Schaugaard 2008). Compared to 2005 data, size structure of rainbow trout in East Canyon Reservoir has become unbalanced and is now dominated by fish greater than 280 mm in length (Nadolski and Schaugaard 2008). Survival of tiger trout in the reservoir is generally poor and may be attributable to water quality and the presence of the anchorworm (Nadolski and Schaugaard 2008).

2.1.4.5 Special Designations

Federally listed wildlife species known to occur in the watershed include experimental population of the endangered black-footed ferret, the threatened Canada lynx, and a candidate for listing, the yellow-billed cuckoo (UDWiR 2008). Other species on the *Utah Sensitive Species List* include the bobolink, bald eagle, ferruginous hawk, greater sage-grouse, sharp-tailed grouse, Lewis's woodpecker, long-billed curlew, northern goshawk, three-toed woodpecker, grasshopper sparrow, Columbia spotted frog, western toad, and smooth greensnake (Table 2.12). Utah sensitive fish species known to occur in the watershed include the Bonneville cutthroat trout, Colorado River cutthroat trout, bluehead sucker, and leatherside chub. No threatened, endangered or sensitive plants are located in the project area.

Table 2.12. Utah Sensitive Species in Morgan and Summit Counties

Morgan County		
Common Name	Scientific Name	State Status*
Bald Eagle	<i>Haliaeetus leucocephalus</i>	S-ESA
Bluehead Sucker	<i>Catostomus discobolus</i>	CS
Bobolink	<i>Dolichonyx oryzivorus</i>	SPC
Bonneville Cutthroat Trout	<i>Oncorhynchus clarkii utah</i>	CS
Deseret Mountainsnail	<i>Oreohelix peripherica</i>	SPC
Ferruginous Hawk	<i>Buteo regalis</i>	SPC
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	SPC
Gray Wolf	<i>Canis lupus</i>	S-ESA
Greater Sage-Grouse	<i>Centrocercus urophasianus</i>	SPC
Lewis's Woodpecker	<i>Melanerpes lewis</i>	SPC
Lyrate Mountainsnail	<i>Oreohelix haydeni</i>	SPC
Northern Goshawk	<i>Accipiter gentilis</i>	CS
Sharp-tailed Grouse	<i>Tympanuchus phasianellus</i>	SPC
Western Pearlshell	<i>Margaritifera falcata</i>	SPC
Western Toad	<i>Bufo boreas</i>	SPC
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	S-ESA

Table 2.12. Utah Sensitive Species in Morgan and Summit Counties

Summit County		
Common Name	Scientific Name	State Status*
Bald Eagle	<i>Haliaeetus leucocephalus</i>	S-ESA
Bluehead Sucker	<i>Catostomus discobolus</i>	CS
Bobolink	<i>Dolichonyx oryzivorus</i>	SPC
Bonneville Cutthroat Trout	<i>Oncorhynchus clarkii utah</i>	CS
Brown (Grizzly) Bear	<i>Ursus arctos</i>	S-ESA
Canada Lynx	<i>Lynx canadensis</i>	S-ESA
Colorado River Cutthroat Trout	<i>Oncorhynchus clarkii pleuriticus</i>	CS
Columbia Spotted Frog	<i>Rana luteiventris</i>	CS
Deseret Mountainsnail	<i>Oreohelix peripherica</i>	SPC
Ferruginous Hawk	<i>Buteo regalis</i>	SPC
Greater Sage-Grouse	<i>Centrocercus urophasianus</i>	SPC
Leatherside Chub	<i>Gila copei</i>	SPC
Lewis's Woodpecker	<i>Melanerpes lewis</i>	SPC
Long-billed Curlew	<i>Numenius americanus</i>	SPC
Northern Goshawk	<i>Accipiter gentilis</i>	CS
Smooth Greensnake	<i>Opheodrys vernalis</i>	SPC
Three-toed Woodpecker	<i>Picoides tridactylus</i>	SPC
Western Pearlshell	<i>Margaritifera falcata</i>	SPC
Western Toad	<i>Bufo boreas</i>	SPC

Source: UDWiR 2007. Utah Conservation Data Center

Disclaimer: This list was compiled using known species occurrences and species observations from the Utah Natural Heritage Program's Biodiversity Tracking and Conservation System (BIOTICS); other species of special concern likely occur in counties in Utah. This list includes both current and historic records.

S-ESA = Federally listed or candidate species under the Endangered Species Act.

CS = Species receiving special management under a Conservation Agreement in order to preclude need for federal listing.

SPC = Wildlife species of concern.

2.2 CULTURAL CHARACTERISTICS

2.2.1 LAND USE AND OWNERSHIP

The watershed is predominantly forest (62%) and shrub/scrub (31%) habitat, the majority of which is privately owned (96%) (Table 2.13 and Figure 2.13). The second largest landowner is the United States Forest Service with jurisdiction over 2% of the land (Table 2.14). The privately owned land is used for residential and commercial development, ski resorts, and agricultural purposes. Agricultural operations include croplands and grazing for cattle and sheep. However, only 6% of the land in the watershed boundary is considered developed or agricultural (see Table 2.13 and Figure 2.14). The steep mountain slopes and forested land cover limit the amount of private development that can occur in the area.

Development is concentrated along Interstate 80 which connects the Snyderville Basin to Salt Lake City to the west and Evanston, Wyoming to the north.

Table 2.13. Land Use in the East Canyon Creek Watershed

	Area (acres)	Percentage of Total Land
Deciduous Forest	44,258.1	48%
Shrub/Scrub	28,121.1	31%
Evergreen Forest	12,628.1	14%
Developed Uses	4,228.8	
Pasture/Hay	993.6	1%
Open Water	599.4	1%
Mixed Forest	464.7	1%
Cultivated Crops	368.5	<1%
Woody Wetlands	228.6	<1%
Barren Land (Rock/Sand/Clay)	36.8	<1%
Grassland/Herbaceous	8.4	<1%
Total	91,936	100%

Source: USGS 2007

Table 2.14. Land Ownership in the East Canyon Creek Watershed

	Area (acres)	Percentage of Total Land
Private	88,130	96%
U.S. Forest Service	1,761	2%
State Parks and Recreation	747	1%
Water	650	1%
State Trust Lands	549	1%
State Wildlife Resources	99	<1%
TOTAL	91,936	100%

Source: 1995 Utah GAP Analysis project, Remote Sensing and GIS Laboratories, Department of Geography and Earth Resources, Utah State University, Logan.

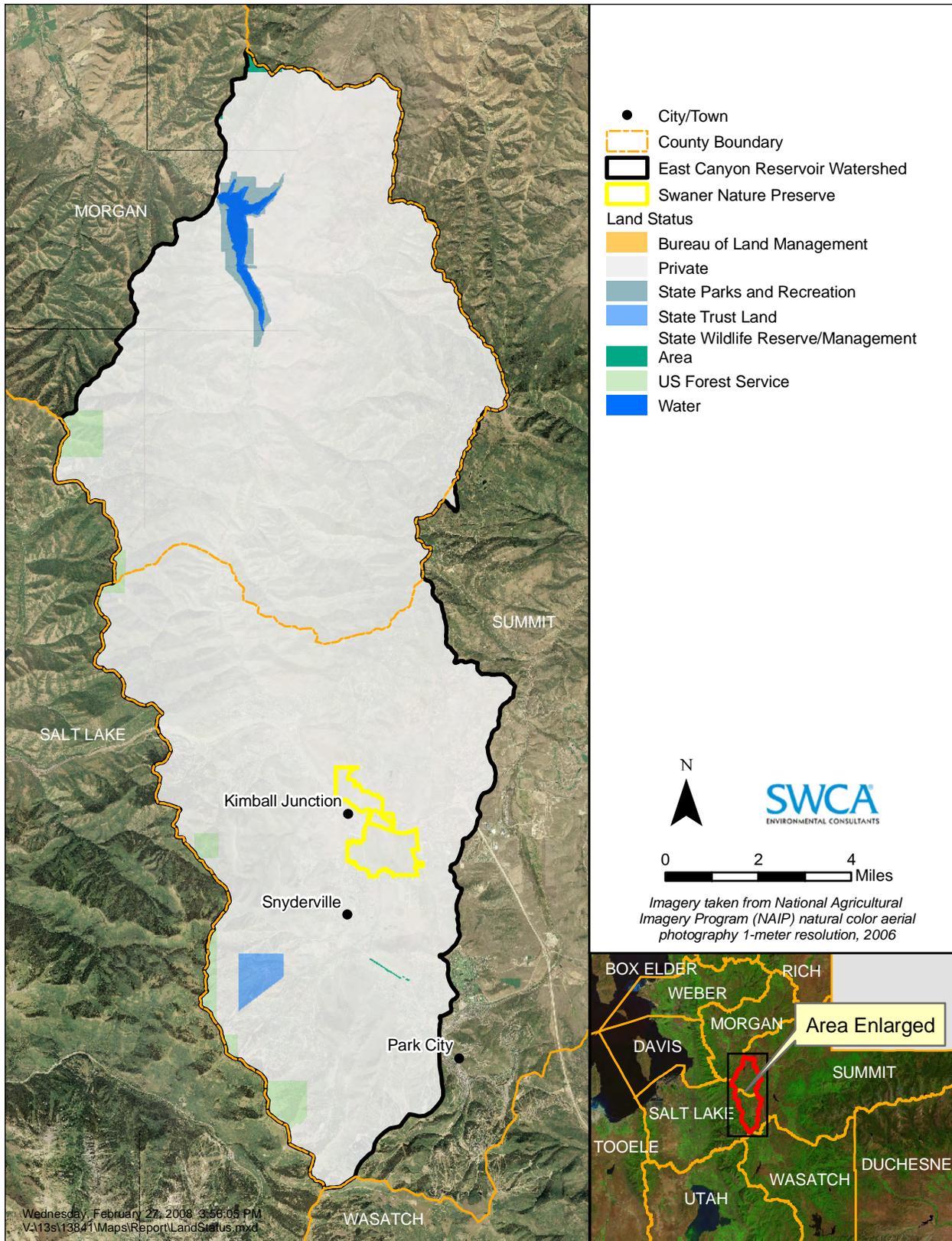


Figure 2.13. East Canyon Reservoir watershed land ownership.

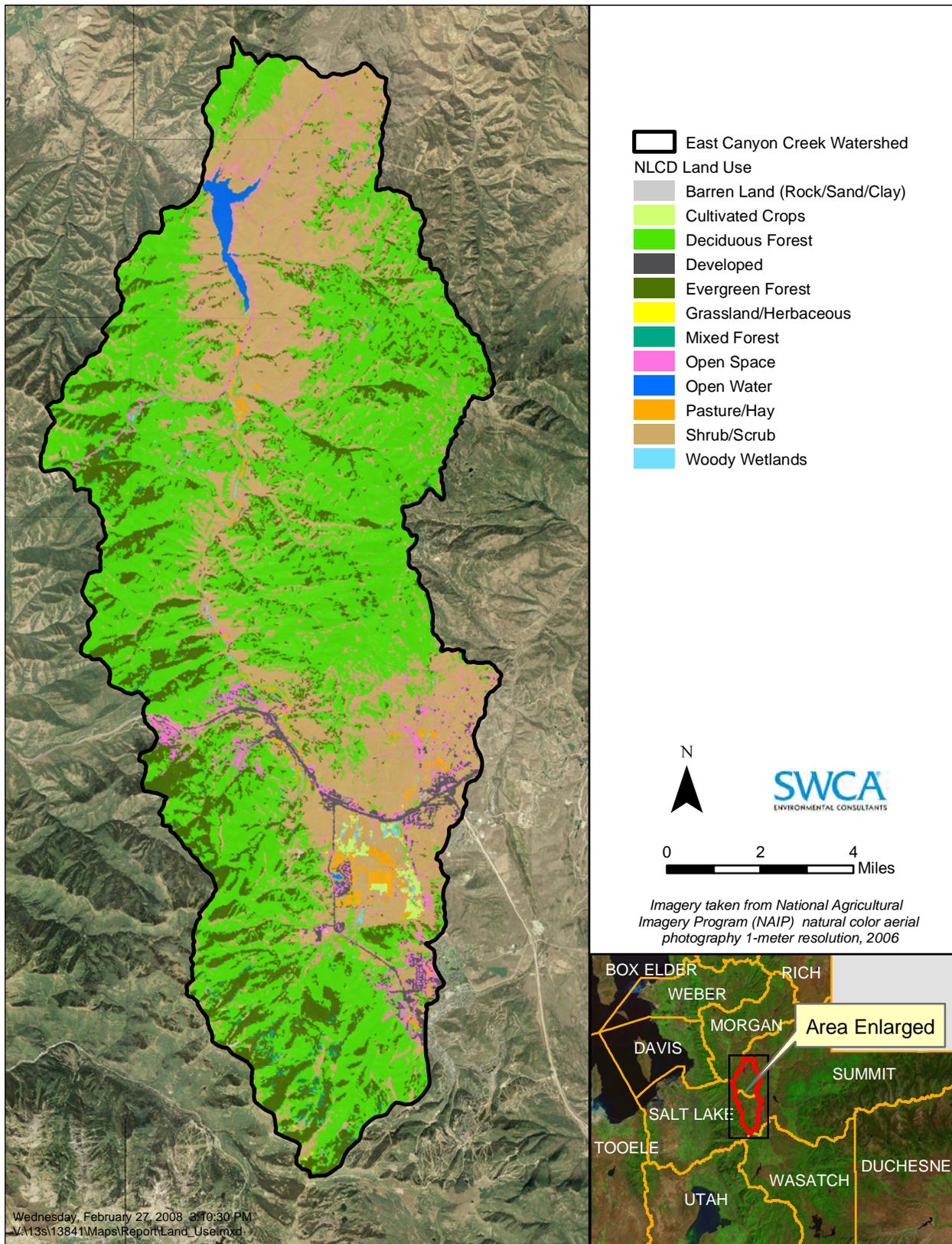


Figure 2.14. East Canyon Reservoir watershed land use.

2.2.2 POPULATION

The East Canyon Reservoir watershed lies in Summit and Morgan counties. Both of these counties have experienced considerable growth in the past decade; however, population growth in Summit County has been remarkable. Although the statewide population growth average from 1990 to 2000 was 29.6%, Summit County's population grew 91.6%. Park City has nearly doubled since 1990 from 4,468 residents to 7,497 in 2005. According to the Utah Governor's Office of Planning and Budget (GOPB), Morgan County's population increase was more consistent with the state average at a 29.0% increase (GOPB 2000). Populations in both counties are anticipated to increase exponentially in the coming decades. See Table 2.15 for population projections through 2050. The population center of the East Canyon Reservoir watershed lies in the Snyderville Basin. The Snyderville Basin includes the Park City and the unincorporated areas outside of the city limits. The population projections for Snyderville Basin are represented as the "Balance of Summit County" in Table 2.15. This number includes area residents living outside of incorporated cities and towns in Summit County.

Table 2.15. Population in East Canyon Reservoir Watershed

County/City	Population 2005	Estimated Population 2030	Estimated Population 2050
Summit County	36,417	85,660	132,681
Park City	7,497	16,312	n/a
Balance of Summit County	15,734	31,887	n/a
Morgan County	8,525	24,595	46,596
Total	68,173	158,454	179,277

Source: GOPB 2005; GOPB 2000a.

2.2.3 HISTORY AND ECONOMICS

Land use in the East Canyon Reservoir watershed has historical ties to the agricultural and mining industries. In the 1850s, European settlers began to colonize what is now considered Morgan and Summit counties (Hampshire 1998; Smith 1999). The high mountain valleys were ideal for agricultural practices. Numerous cattle, sheep, mink, and poultry farms were established by the turn of the century. Field crops produced in the area included barley, oats, alfalfa, and vegetables. Mining practices began in the 1870s upon the discovery of silver, coal, lead, and zinc in the Wasatch Mountains. Concentrated primarily in Summit County, the mining boom continued until the 1950s. Once the price of silver and other minerals began to drop and extraction was no longer deemed profitable, miners deserted the Park City area.

Although agricultural practices continued to be a way of life for residents in Morgan County in the mid-1900s, mining companies began to construct ski areas and golf courses on the previously mined lands in Summit County. In the 1960s the Park City area was reborn as a recreation destination. The development of three ski resorts, numerous golf courses, shopping, and luxury homes in the Snyderville Basin suggests that recreation and tourism has become a way of life for western Summit County. Today, recreation and tourism are undoubtedly the economic drivers in western Summit County. Eastern Summit County and Morgan County continue to maintain their agricultural roots but there are few residents in these counties who earn their living solely from agricultural production. Many residents are employed in the retail and trade sectors outside of the high mountain valleys. Because current economic conditions make farming and ranching a difficult way to earn a living, many landowners have begun to sell their land to residential developers (Smith 2007).

For nearly a decade the Snyderville Basin has been subject to tremendous growth pressure. Since the 2002 Winter Olympics the area has seen outstanding residential, commercial, and industrial development. The attractions of a year-round recreation destination have placed considerable strain on Snyderville Basin's infrastructure, water quality, and quantity. As illustrated in the land ownership map (Figure 2.13), the large amount of privately owned land (96%) in Morgan and Summit counties suggests that the area will be susceptible to development pressures for years to come.

2.2.4 RECREATIONAL USES OF EAST CANYON RESERVOIR

The recreational amenities of East Canyon Reservoir gained recognition in 1967 after the BOR completed the modern-day dam. Recreational facilities, managed by Utah Division of State Parks and Recreation, include a wide concrete boat ramp, modern restrooms with showers, sewage disposal, a 31-unit campground with a large overflow area, and fish cleaning stations. A concessionaire provides snacks and boat rentals. The fishery is stocked by the Utah Division of Wildlife Resources (Smith 1999). The reservoir is located approximately 35 miles northeast of Salt Lake City and accessible to motorists via Highway 65 and 66 which have connections to I-80 and I-84.

Recreational activities in the watershed area include cross-country skiing, fishing, boating, swimming, camping, picnicking, ice fishing, and water skiing. State park records indicate that the majority of recreational users are residents of nearby Salt Lake, Weber, Davis, Cache, Morgan, Tooele, and Summit counties.

Visitation to the East Canyon Reservoir State Park has fluctuated in recent years as indicated in Table 2.16. The average annual number of visitors is 85,423. Currently, visitation is measured by using a car counter and a visitor per car multiplier. It has been difficult for park managers to discern the specific type of usage per visitor. For example, although one user may come for a picnic in the day use area and go boating as well, another visitor may go boating and fishing. Park managers report the three most popular uses are boating, picnicking, and camping (personal communication between John Sullivan, East Canyon Reservoir State Park Manager, and Laura Vernon, SWCA, on February 14, 2008). Park visitation peaks during June, July, and August.

Table 2.16. East Canyon Reservoir State Park Visitation

Year	Number of Visitors
2002	105,737
2003	71,101
2004	57,371
2005	Unavailable
2006	94,807
2007	98,101

Source: personal communication between John Sullivan, East Canyon Reservoir State Park Manager, and Laura Vernon, SWCA, on February 14, 2008

East Canyon Resort is a privately owned 9,600-acre recreation-based resort that has been in operation since 1982. The property contains 32 town homes and an RV park that includes 84 hook-ups, restaurants, tennis courts, a mini-golf course, and hunting opportunities. East Canyon Resort is located southeast of the reservoir. It is generally assumed that patrons to East Canyon Resort also visit the reservoir.

2.2.4.1 Boating and Related Activities

Although previous reports suggest that fishing was once the most popular pastime at the reservoir, park managers today are suggesting that boating and water-sport activities are the most popular activities followed by picnicking and camping. On weekends the reservoir is crowded with boats, jet skis and other motor-powered watercraft. Boaters will often use the day-use areas for picnicking and camping areas for overnight stays. Swimming is also popular on the lake during the summer months. As noted above, peak months for swimming and boating are June, July, and August. In recent years park managers have reported that weekend park closures, during peak months, have been necessary as the parking lots have been at full capacity. In 2007 the East Canyon State Park was closed approximately 25 to 33 summer weekend days due to lack of parking. The number of closures in 2006 was considerably less at 6 to 10 days. The increase in closures from 2006 to 2007 could be a result of the closure of boat ramps at nearby lakes (Willard Bay and Deer Creek) (personal communication between John Sullivan, East Canyon Reservoir State Park Manager, and Laura Vernon, SWCA, on February 14, 2008). Weekdays are reported to be far less crowded with a larger percentage of the population fishing in comparison to other activities on the weekends.

As noted above, fishing was once a very popular pastime on the reservoir but has declined in previous decades. The decline could be attributed to the rise in popularity of motorized water sports, which undoubtedly makes fishing a challenge. Declining water quality and subsequent reduction in fish populations may also be attributed to the decrease in anglers. In previous years the reservoir was stocked with 300,000 rainbow trout for recreational fishing. East Canon Reservoir also had an annual run of kokanee salmon and healthy populations of cutthroat and brown trout. Today kokanee salmon no longer exist in East Canyon Reservoir, trout populations have been significantly reduced, and fish are stocked in the reservoir during the fall because of summer die-off (Nadolski and Schaugaard 2008)

There are no reports of park closures due to *Escherichia coli* or other potentially harmful bacteria. In warm summer months algal blooms may appear in the reservoir, and although visitors have commented on the presence of these blooms, they do not appear to deter swimmers and other users from their activities.

2.2.4.2 Hunting and Wildlife Observation

East Canyon Wildlife Management Area is located in the watershed, north of the reservoir, and was acquired in 1985 as an important big-game winter range. The area is managed by the Utah Division of Wildlife Resources and is used primarily for deer hunting. Neotropical migratory birds can be observed along riparian corridors. Hikers visiting the area also enjoy the scenery of Red Rock Canyon (UDWiR 2002).

The East Canyon Resort offers deer hunting on their nearby property. In 2005, 352 deer hunting applications were received by the resort. An annual harvest of approximately 50 buck occurs on the private property (Austin 2006).

2.2.4.3 Camping

The state park offers 15 tent sites and 31 recreational vehicle sites. Other than the recreational vehicle campsites offered at East Canyon Resort, there are no other campgrounds in the area and little public land is available for dispersed camping.

2.2.5 PUBLIC INVOLVEMENT

Throughout the TMDL process, local experience and participation were invaluable in identifying water quality issues and developing reduction strategies at the local scale. Because of the potential influence of the TMDL process on the local community and the dependence of any implementation plan on local participation, public involvement is viewed as critical to the entire TMDL process.

The East Canyon Watershed Committee attends quarterly meetings to discuss water resource issues in the basin. Feedback is welcomed from members of the committee and the public at large. Numerous members of the committee have contributed data, documents, and valuable input to the TMDL process. The watershed advisory group comprises local representatives from all major sectors of the local community as follows:

- Utah Department of Agriculture and Food
- Snyderville Basin Water Reclamation District
- Morgan County Health Department
- Weber Basin Water Conservancy District
- UDEQ/Division of Water Quality
- Utah Department of Natural Resources/Division of Wildlife Resources
- Kamas Valley Conservation District
- BOR
- Mountainland Association of Governments
- BIO-WEST Consulting
- Stantec Consulting
- Swaner Nature Preserve
- Citizens at large
- Environmental interests
- Sporting or recreational interests
- Agricultural interests
- Timber interests

Committee members are encouraged to work directly with their respective interest groups to provide direction to UDEQ in developing and implementing a watershed management plan. They may also help identify funding needs and sources of support for specific projects that may be implemented. The watershed advisory group is encouraged to assist in setting priorities for spending restoration funds and in periodically reviewing progress toward water quality improvement goals.

SWCA, in cooperation with the UDWQ and the East Canyon Watershed Committee, presented the findings of the TMDL at a public meeting on July 9, 2008 at the Sheldon Richins Building in Park City. A 30-day public comment period from October 15 to December 1, 2008 was advertised in local newspapers (*The Salt Lake Tribune*, *Deseret News*, and *Park Record*) and on the UDWQ website. No written comments were received during the 30-day comment period.