# South Platte Headwaters Wildfire/Watershed Assessment

## Prioritization of watershed-based risks to water supplies

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**This report was prepared by;**

JW Associates Inc.

PO Box 3759

Breckenridge, Colorado 80424

**For more information contact;**

Brad Piehl

970.406.0085 or

bpiehl@jw-associates.org

**Additional information on the South Platte Headwaters Watershed Assessment is available at:**

http://www.jw-associates.org/Projects/SPH_Home/SPH_Home.html

**On the cover - a posterized photograph of the Mosquito Range taken near Fairplay**

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# South Platte Headwaters Wildfire/Watershed Assessment

## Prioritization of watershed-based hazards to water supplies

## INTRODUCTION

This watershed assessment is designed to identify and prioritize sixth-level watersheds based upon their hazards of generating flooding, debris flows and increased sediment yields following wildfires that could have impacts on water supplies. It is intended to expand upon current wildfire hazard reduction efforts by including water supply watersheds as a community value. The watershed assessment follows a procedure prescribed by the Front Range Watershed Protection Data Refinement Work Group (2009).

Following the prioritization of watersheds and identification of Zones of Concern, some basic information was mapped within the Zones of Concern to complete an initial screening of potential opportunities for watershed protection. The results of the identification of potential opportunities is presented in the Next Steps section of this report.

Another goal of this assessment is to gather the key water supply stakeholders to communicate the suggested process, listen to any suggested changes, and build collaborative support for the assessment process. Four stakeholder meetings have created a diverse group of stakeholders (Appendix A) that have been engaged in the process.

## WATERSHED DESCRIPTION

The South Platte Headwaters watershed is the beginning of the South Platte River that joins the North Platte in Nebraska form the Platte River that drains into the Missouri River. As its name suggests, portions of this watershed are located at the continental divide next to several other high elevation watersheds including the Blue River (tributary to the Colorado River) and South Platte Headwaters. The South Platte River flows into the Upper South Platte watershed, downstream from the South Platte headwaters, and joins with the North Fork South Platte River before flowing out onto the high plains near Denver.

Several water providers have water collection and transmission systems in the South Platte Headwaters watershed. These systems store and transmit water from this watershed and from other diversions in the Blue River and Arkansas Headwaters watersheds. This watershed assessment is designed to assess hazards to water supply.

*View of Mosquito Range near Fairplay*

For this assessment the South Platte Headwaters watershed is approximately 1,026,099 acres in area and is composed of one fourth-level[1] (eight-digit) watershed (HUC 10190001). The South Platte Headwaters watershed contains six fifth-level watersheds and 42 sixth-level watersheds (Figure 1 and Table 1), which are the analysis units for this watershed assessment (Front Range Watershed Protection Data Refinement Work Group 2009). The South Platte Headwaters watershed and its fifth-level and sixth-level watersheds are shown on Figure 2 and the sixth-level watersheds are listed in Table 1.

[1] The watersheds that were used are part of the existing national network of delineated watersheds. Hydrologic Unit Codes (HUCs) are nested watersheds and are designated numerically by levels (Federal Geographic Data Committee 2004). Sixth-level HUCs or watersheds, use the 11th and 12th digits in the HUC code. Fifth-level HUCs use the ninth and 10th digits in the HUC code.

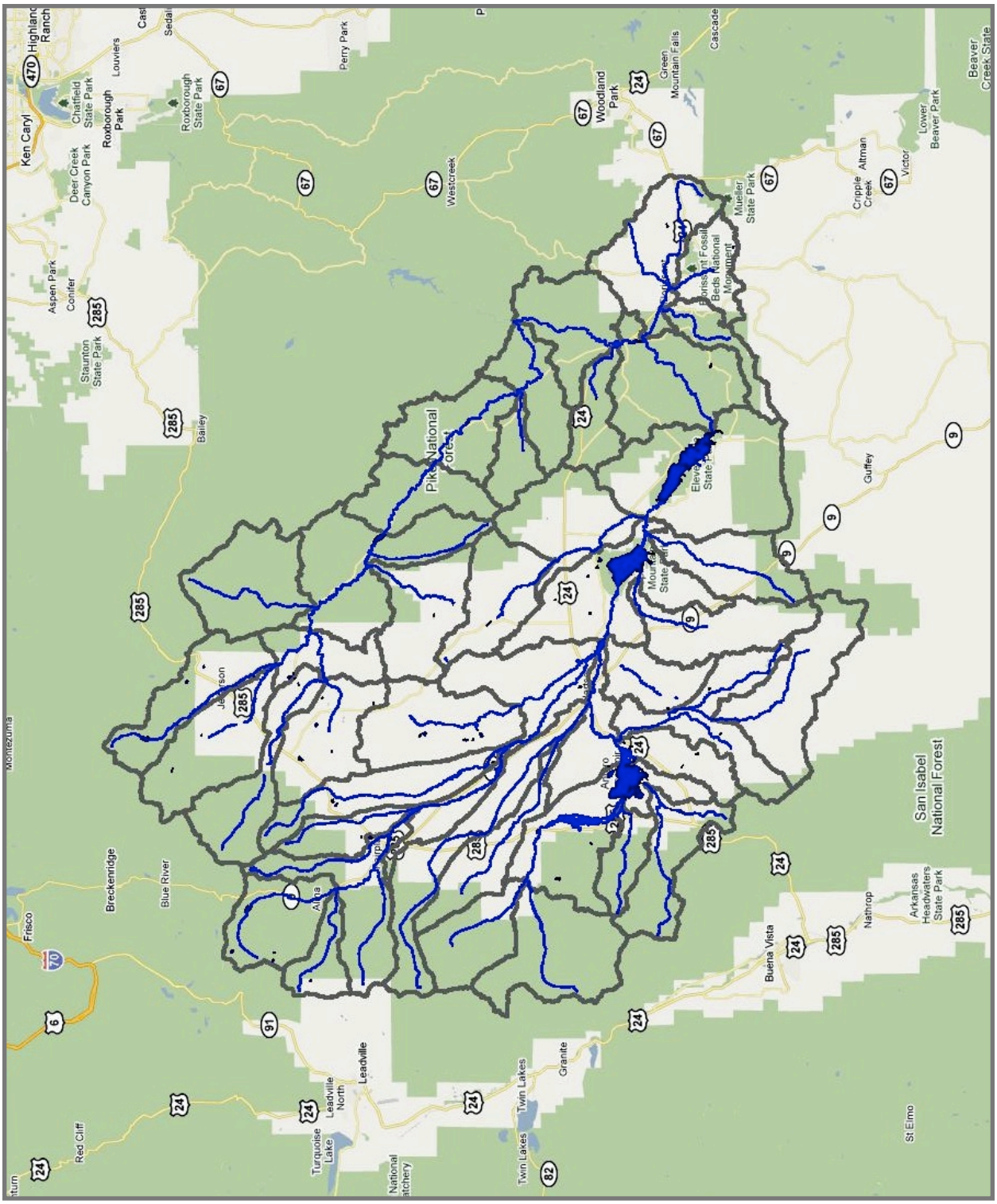


**Figure 1. South Platte Headwaters Watershed Analysis Area[2]**

[2] The sixth-level watersheds can be seen in this figure outlined in gray lines.

## Table 1. Fifth-level and Sixth-level Watersheds in South Platte Headwaters

| Fifth-level Watershed | Sixth-level Watershed | Watershed Area (acres) | Hydrologic Unit Code (HUC) |
|---|---|---|---|
| MIddle Fork South Platte River HUC 1019000101 | Mosquito Creek | 10,358 | 101900010101 |
| | Headwaters Middle Fork South Platte River | 22,096 | 101900010102 |
| | Crooked Creek | 11,537 | 101900010103 |
| | Beaver Creek-Middle Fork South Platte River | 27,293 | 101900010104 |
| | Trout Creek | 23,554 | 101900010105 |
| | Middle Fork South Platte River | 9,699 | 101900010106 |
| | The Basin | 30,555 | 101900010107 |
| | Outlet Middle Fork South Platte River | 25,521 | 101900010108 |
| South Fork South Platte River HUC 1019000102 | Twelve Mile Creek | 19,554 | 101900010201 |
| | Headwaters South Fork South Platte River | 32,585 | 101900010202 |
| | Spring Creek | 10,355 | 101900010203 |
| | Salt Creek | 21,823 | 101900010204 |
| | Antero Reservoir | 35,888 | 101900010205 |
| | Headwaters Agate Creek | 32,374 | 101900010206 |
| | Outlet Agate Creek | 26,242 | 101900010207 |
| | High Creek | 19,214 | 101900010208 |
| | Fourmile Creek | 30,780 | 101900010209 |
| | South Fork South Platte River | 28,150 | 101900010210 |
| Elevenmile Reservoir-South Platte River HUC 1019000103 | Spinney Mountain | 14,668 | 101900010301 |
| | Buffalo Gulch | 24,770 | 101900010302 |
| | Three Mile Creek | 21,367 | 101900010303 |
| | Headwaters Chase Gulch | 22,754 | 101900010304 |
| | Outlet Chase Gulch | 26,775 | 101900010305 |
| | Spinney Mountain Reservoir | 37,400 | 101900010306 |
| | Elevenmile Reservoir | 52,370 | 101900010307 |
| Headwaters Tarryall Creek HUC 1019000104 | Park Gulch | 24,166 | 101900010401 |
| | Headwaters Tarryall Creek | 24,177 | 101900010402 |
| | Jefferson Creek | 24,184 | 101900010403 |
| | Michigan Creek | 29,135 | 101900010404 |
| | Michigan Creek-Tarryall Creek | 14,064 | 101900010405 |

**Table 1. Fifth-level and Sixth-level Watersheds in South Platte Headwaters**

| Fifth-level Watershed | Sixth-level Watershed | Watershed Area (acres) | Hydrologic Unit Code (HUC) |
|---|---|---|---|
| Ruby Gulch-Tarryall Creek | Rock Creek | 29,141 | 101900010501 |
| HUC 1019000105 | Ruby Gulch | 25,513 | 101900010502 |
| | Lower Tarryall | 39,338 | 101900010503 |
| | Allen Creek-Tarryall Creek | 20,311 | 101900010504 |
| | Marksbury Gulch | 10,364 | 101900010505 |
| | Webber Park-Tarryall Creek | 24,339 | 101900010506 |
| | Outlet Tarryall Creek | 18,442 | 101900010507 |
| Elevenmile Canyon- | Grape Creek | 13,667 | 101900010601 |
| South Platte River | Fish Creek | 10,816 | 101900010602 |
| HUC 1019000106 | Twin Creek | 29,370 | 101900010603 |
| | Pulver Gulch | 12,772 | 101900010604 |
| | Elevenmile Canyon | 33,869 | 101900010605 |
| | Lower Lake George | 24,659 | 101900010606 |
| **Total Area** | | **1,026,009** | |

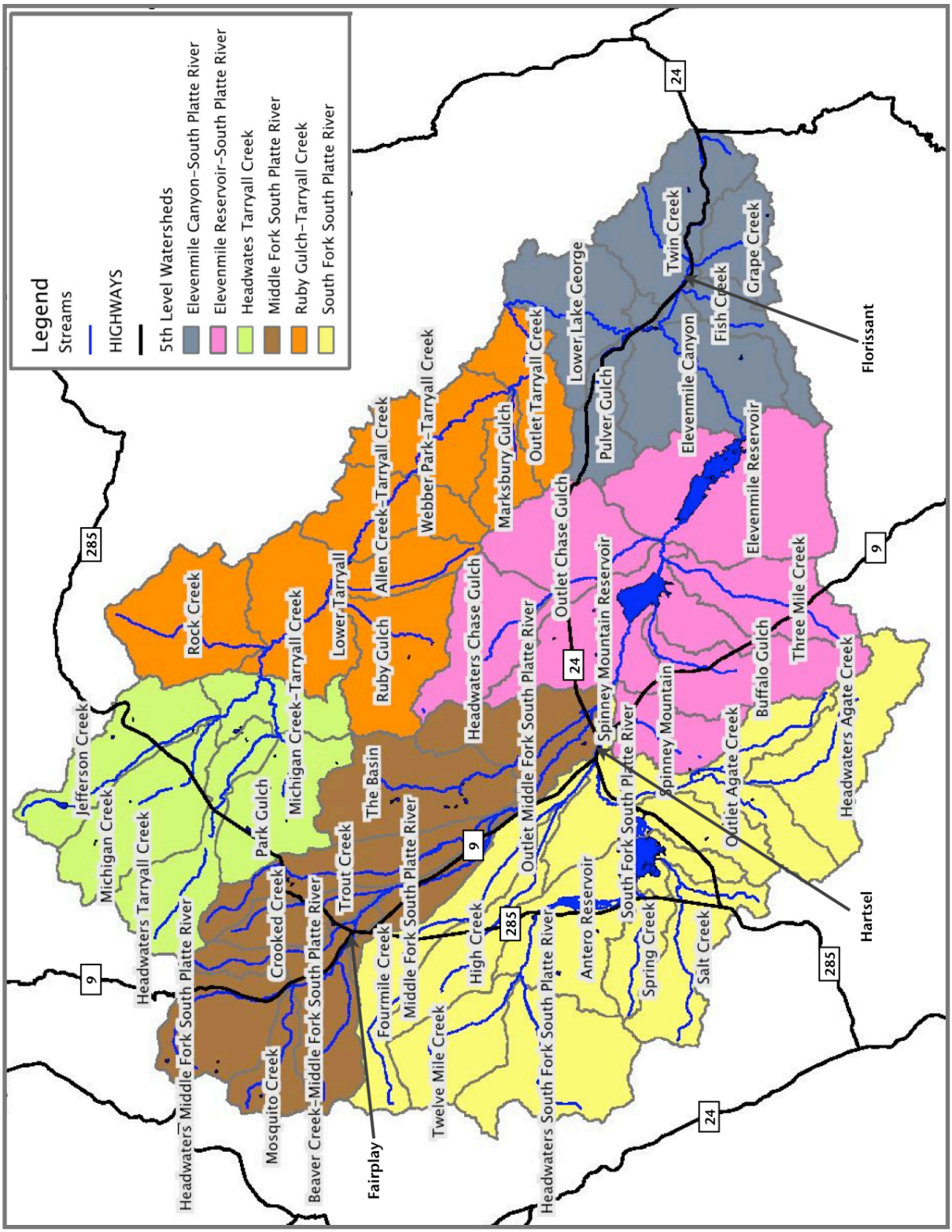


**Figure 2. South Platte Headwaters Fifth-level and Sixth-level Watersheds[3]**

[3] The sixth-level watersheds are labeled and divided by gray lines in Figure 2. The fifth-level watersheds are colored and identified in the legend. These watersheds correspond to Table 1.

## WATERSHED ASSESSMENT

The potential of a watershed to deliver sediments following wildfire depends on forest and soil conditions, the physical configuration of the watersheds, and the sequence and magnitude of rain falling on the burned area. High-severity fires can cause changes in watershed conditions that are capable of dramatically altering runoff and erosion processes in watersheds. Water and sediment yields may increase as more of the forest floor is affected by fire.

The South Platte Headwaters Watershed Assessment considers four components that are integral in evaluating hazardous watershed conditions: wildfire hazard, flooding or debris flow hazard, soil erodibility and water uses. This section of the report presents the watershed assessment analysis that results in prioritization of sixth-level watersheds. It also discusses the technical approach for each component and the process used to assemble the watershed ranking.

The categories used in the prioritization are numbered one though five, with one being the lowest ranking and five being the highest. The categories are used in this analysis for the purpose of comparing watersheds to each other within the South Platte Headwaters Watershed. Comparisons with other watershed assessments are not valid because this approach prioritizes watersheds by comparing them to the other sixth-level watersheds only in this watershed assessment area.

The South Platte Headwaters Watershed Assessment was developed through a stakeholder review process. The stakeholder group included representatives from water providers; federal, state and local land management agencies; counties; towns and other interested groups (Appendix A). Four stakeholder meetings were conducted to get the groups involved in the process, provide some local expertise to check and adjust the draft results and to understand how the assessment can be useful to the various stakeholder organizations.

# Component 1 - Wildfire Hazard

The forest conditions that are of concern for the South Platte Headwaters Watershed Assessment are the wildfire hazard based on existing forest conditions. The wildfire hazard (Flame Length) was determined using the Fire Behavior Assessment Tool (FBAT) (http://www.fire.org) which is an interface between ArcMap and FlamMap. The input spatial data were collected from LANDFIRE project (http://www.landfire.gov/) and updated for bark beetle mortality conditions using USDA Forest Service, Rocky Mountain Region Aerial Detection Survey Data (http://www.fs.fed.us/r2/resources/fhm/aerialsurvey/).

The flame length results were divided into five categories of wildfire hazard ranging from lowest (Category 0) to highest (Category 4). The flame length categories that were used are;

Flame Length Category 0 - 0 meters

Flame Length Category 1 - 1 to 10 meters

Flame Length Category 2 - 11 to 25 meters

Flame Length Category 3 - 26 to 40 meters

Flame Length Category 4 - >40 meters

The results (Appendix B) were categorized by sixth-level watershed into five categories that are used throughout the analysis using the following formula.

**Wildfire Hazard Ranking** = (Percentage in Category 3 + Percentage in Category 4 * 2)

The results were then categorized into five categories that are used throughout the analysis. The categorization procedure is the one prescribed by the Front Range Watershed Protection Data Refinement Work Group (2009). The calculation of ranking for each sixth-level watershed is completed as follows:

1. Use the wildfire hazard based on the percentage of each sixth-level watershed in the highest category.
2. Scale the results so that they fall within five equal categories.
3. Round the scaled result to the nearest whole number (retain the actual number for use in the Composite Hazard Ranking).
4. Create a map of the results using the following scheme:

    Category 1 – Lowest

    Category 2

    Category 3

    Category 4

    Category 5 – Highest

The categorized wildfire hazard by sixth-level watershed was mapped (Figure 3). The map shows that the highest hazards are in the following sixth-level watersheds; Headwaters South Fork South Platte River, Headwaters Tarryall Creek, Rock Creek, Allen Creek-Tarryall Creek, Grape Creek, and Lower Lake George.

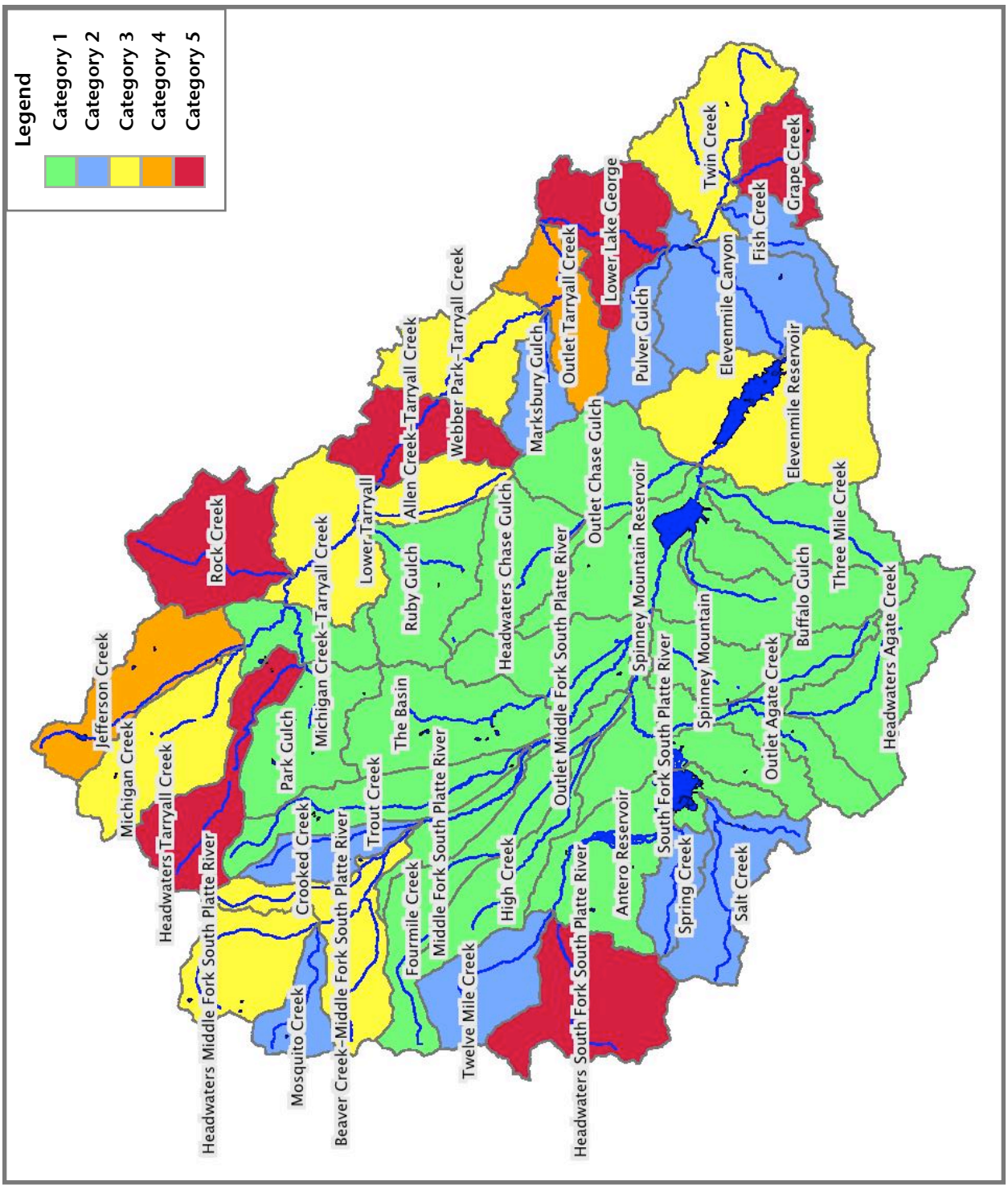


**Figure 3. South Platte Headwaters Watershed Wildfire Hazard Ranking**

# Component 2 - Flooding or Debris Flow Hazard

A combination of ruggedness and road density (miles of road per square mile of watershed area) was used to assess the flooding or debris flow hazard portion of the analysis. The two components, ruggedness and road density, are described below.

## Ruggedness

Watershed steepness or ruggedness is an indicator of the relative sensitivity to debris flows following wildfires (Cannon and Reneau 2000). The more rugged the watershed, the higher its sensitivity to generating debris flows following wildfire (Melton 1957). The Melton ruggedness factor is basically a slope index.

Melton (1957) defines ruggedness, R, as;

$$R = H_b A_b^{-0.5}$$

Where $A_b$ is basin area (square feet) and $H_b$ is basin height (feet) measured from the point of highest elevation along the watershed divide to the outlet.

Figure 4 displays the categorized ruggedness for the South Platte Headwaters Watershed. The map generally shows that the middle of the watershed (South Park) is quite flat. The most rugged area is the watersheds coming down the Mosquito Range on the western end of the assessment area. The tabular results are presented in Appendix B. The map (Figure 4) shows that the most rugged sixth-level watersheds are; Spring Creek, Salt Creek, Mosquito Creek, Crooked Creek, Headwaters Middle Fork South Platte River, and Beaver Creek-Middle Fork South Platte River. There are also eight watersheds rated in the next highest category (Category 4).

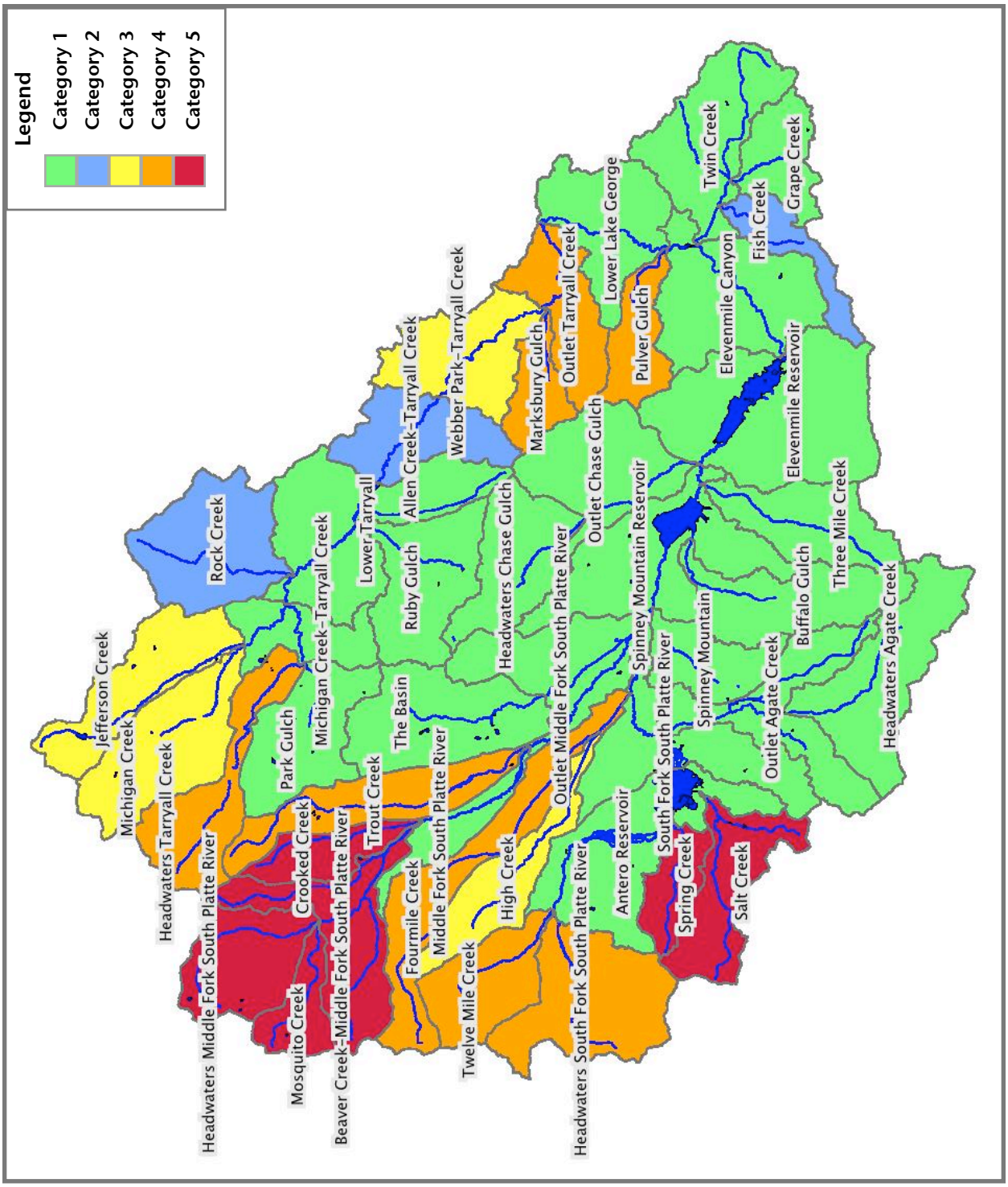


**Figure 4. South Platte Headwaters Watershed Ruggedness Ranking**

## Road Density

Roads can convert subsurface runoff to surface runoff and then route the surface runoff to stream channels, increasing peakflows (Megan and Kidd 1972, Ice 1985, and Swanson et al. 1987). Therefore, watersheds with higher road densities have a higher sensitivity to increases in peak flows following wildfires. Road density in miles of road per square mile of watershed area was used as an indicator of flooding hazard. Roads data need to be consistent within the entire watershed to allow for appropriate comparisons during prioritization. Therefore, the U.S. Census Bureau's Tiger database was used as a consistent roads data layer.

The road density ranking was adjusted to account for watersheds in certain areas that were heavily skewing the results. The roads that are of interest in this analysis are those roads that would increase the risk of flooding following wildfires in forested areas. The Tiger roads data was compared with conditions on the ground. This was done by looking at vegetation type mapping to eliminate roads in developed areas. Then digital images including Google Earth were used to look for roads that were not in the roads data and identify roads that were in subdivisions and towns. Road density in Beaver Creek-Middle Fork South Platte River, Middle Fork South Platte River, Outlet Middle Fork South Platte River, Headwaters Agate Creek, Outlet Agate Creek, High Creek, Fourmile Creek, South Fork South Platte River, Spinney Mountain, Buffalo Gulch, Headwaters Chase Gulch, Outlet Chase Gulch, Spinney Mountain Reservoir, Michigan Creek, Michigan Creek-Tarryall Creek, Ruby Gulch, Lower Tarryall, and Twin Creek were all adjusted using this method. The road lengths in those watersheds were reduced based upon an estimate of the percentage of roads within the forested area.

Figure 5 displays the categorized road density for the South Platte Headwaters Watershed and tabular results are presented in Appendix B. It displays some expected differences in road density throughout the watershed.  Figure 5 shows that the highest rankings are in the Twin Creek, and Grape Creek watersheds.

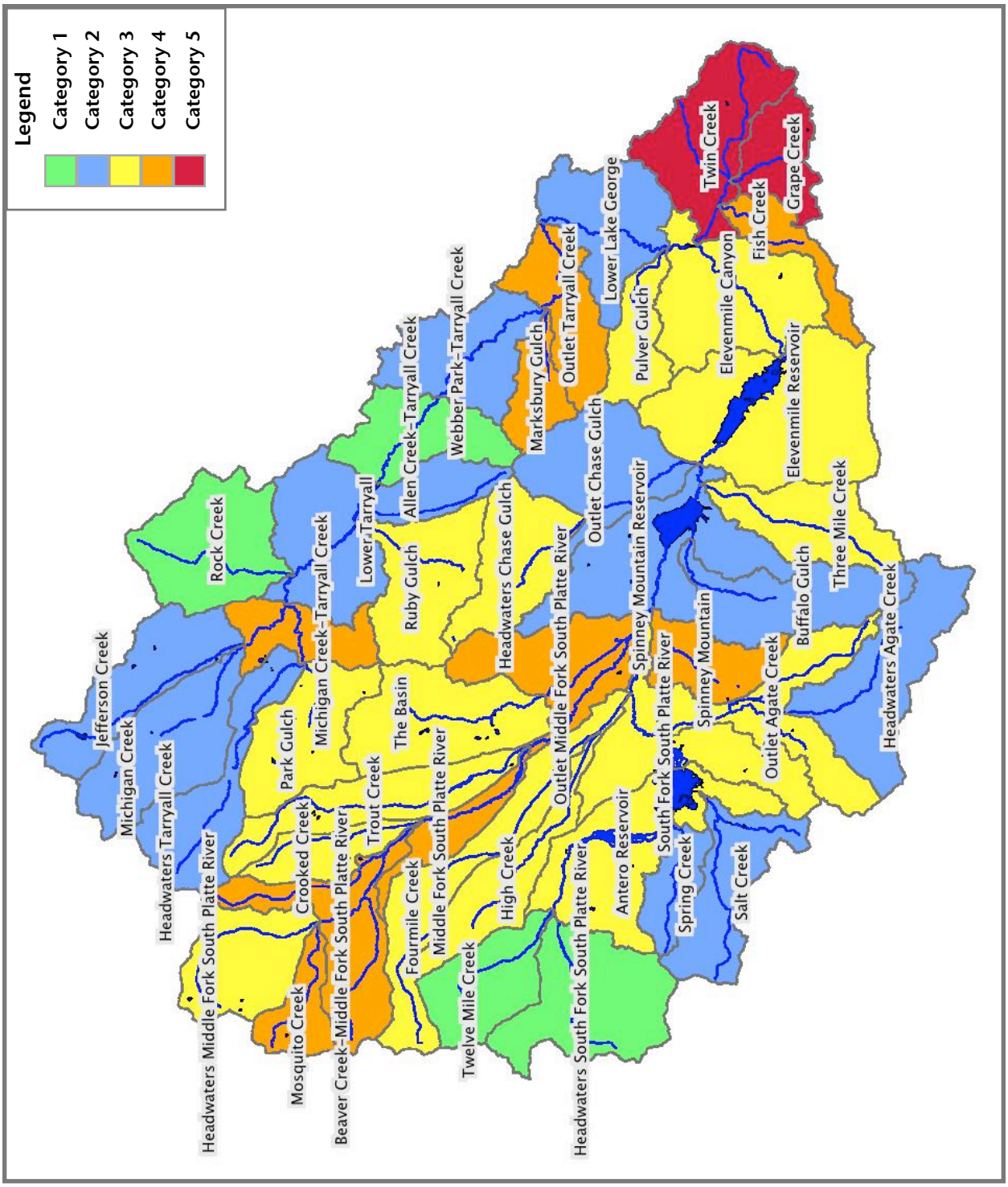


**Figure 5. South Platte Headwaters Watershed Road Density Ranking**

## Flooding or Debris Flow Hazard Ranking

The Flooding or Debris Flow Hazard is the combination of ruggedness and road density. The procedure from the Front Range Watershed Work Group (2009) assigned ruggedness a higher value than road density in this ranking. While ruggedness is the most important factor, an increase in road density will magnify the effects of ruggedness on the flooding/debris flow hazard. Accordingly, the analysis for flooding or debris flow hazard for the South Platte Headwaters Watershed used the following formula. The results of this calculation were then re-categorized into five hazard rankings.

**Flooding or Debris Flow Hazard Ranking** = (Road Density Ranking + Ruggedness Ranking * 2)[4]

Figure 6 shows that areas of the watershed with high road densities and high ruggedness rank high in this combined factor. The best way to look at this map is to look at a single watershed on the ruggedness and road density maps, noting the rankings on each. Then look at this map and see how they result in the final ranking for this component. The tabular results are presented in Appendix B. The highest ranked sixth-level watersheds are Mosquito Creek, Beaver Creek-Middle Fork South Platte River, Salt Creek, Crooked Creek, Headwaters Middle Fork South Platte River, and Spring Creek.

[4] The results of this calculation were then re-categorized into five hazard rankings.

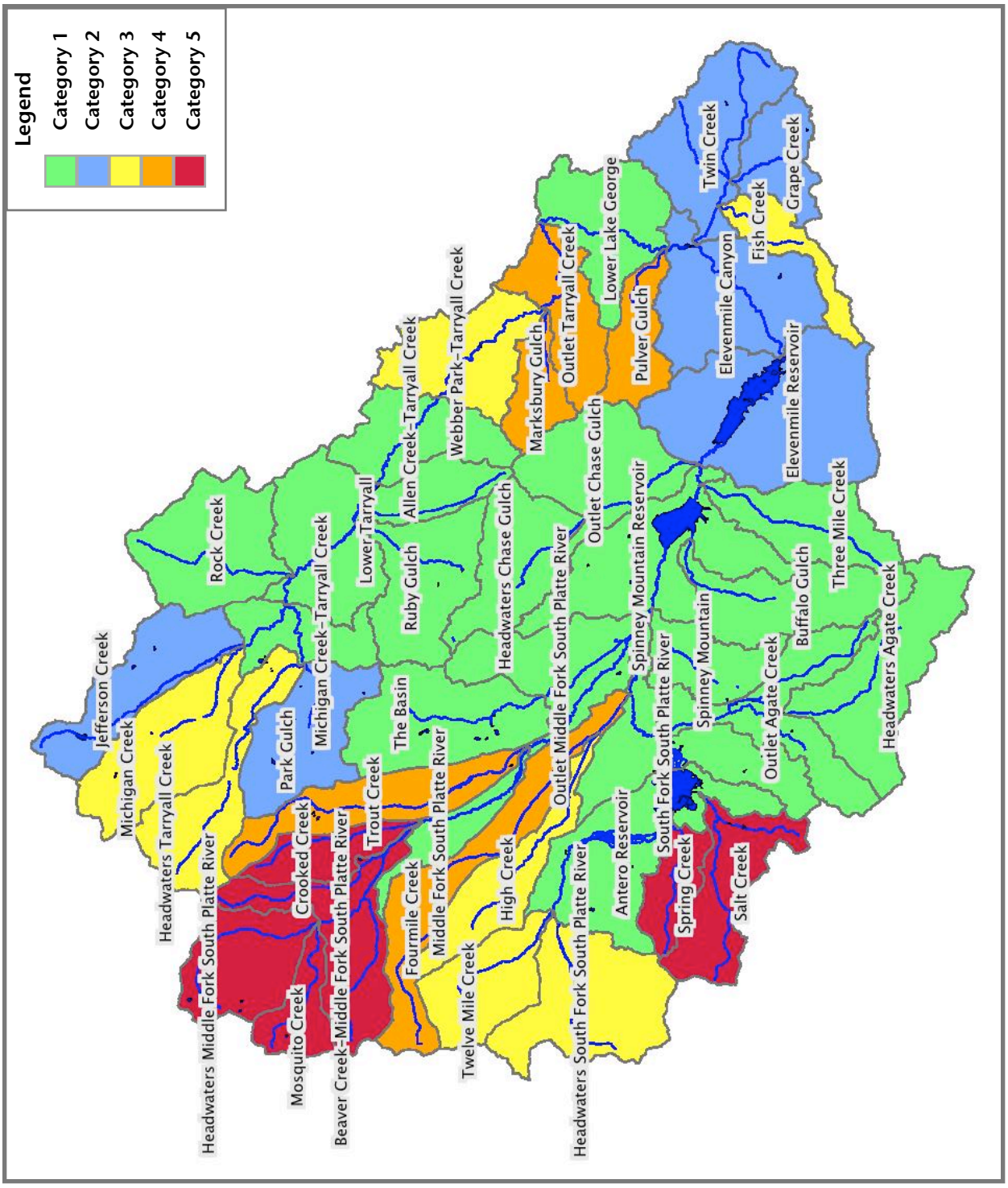


**Figure 6. South Platte Headwaters Watershed Flooding/Debris Flow Hazard Ranking**

## Component 3 - Soil Erodibility

High-severity fires can cause changes in watershed components that can dramatically change runoff and erosion processes in watersheds. Water and sediment yields may increase as more of the forest floor is consumed (Wells et al. 1979, Robichaud and Waldrop 1994, Soto et al. 1994, Neary et al. 2005, and Moody et al. 2008) and soil properties are altered by soil heating (Hungerford et al. 1991).

Two soils data sets were evaluated for use in this analysis. They were the U.S. Department of Agriculture - Natural Resources Conservation Service (NRCS) STATSGO and SSURGO soils data. STATSGO data are relatively coarse soils data, created at a scale of 1:250,000 and are available for the entire watershed assessment area. SSURGO soils data do not cover all the watershed assessment area, though efforts by the NRCS currently are under way to produce an updated soils data layer. The SSURGO data is available at a scale that generally ranges from 1:12,000 to 1:63,360. The STATSGO data were used in this analysis and provide a consistent soils data layer that can be used in the absence of more site-specific data.

The soil erodibility analysis used a combination of two standard erodibility indicators: the inherent susceptibility of soil to erosion (K factor) and land slope derived from Unites States Geological Survey (USGS) 30-meter digital elevation models. The K factor data from the STATSGO spatial database was combined with a slope grid using NRCS (USDA NRCS 1997) slope-soil relationships (Table 2) to create a classification grid divided into slight, moderate, severe and very severe erosion hazard ratings.

**Table 2. NRCS Criteria for Determining Potential Soil Erodibility**

| Percent Slope | K Factor <0.1 | K Factor 0.1 to 0.19 | K Factor 0.2 to 0.32 | K Factor >0.32 |
|---|---|---|---|---|
| 0-14 | Slight | Slight | Slight | Moderate |
| 15-34 | Slight | Slight | Moderate | Severe |
| 35-50 | Slight | Moderate | Severe | Very Severe |
| >50 | Moderate | Severe | Very Severe | Very Severe |

The potential soil erodibility rankings were increased in areas of granitic soils based upon the procedure used in the Upper South Platte test case in the Front Range Watershed Work Group (2009). Rankings were increased by up to one category if there was a large percentage of granitic derived soils. Many of the watersheds in the South Platte Headwaters have substantial areas of granitic derived soils.

The soil erodibility values for Mosquito Creek, and Headwaters Middle Fork South Platte River were skewing the categorization because of their high soil erodibility values and were manually given a score slightly more than the next highest score. Middle Fork South Platte River, The Basin, Outlet Middle Fork South Platte River, Headwaters Agate Creek, Outlet Agate Creek, South Fork South Platte River, Spinney Mountain, Buffalo Gulch, Three Mile Creek, Headwaters Chase Gulch, Spinney Mountain Reservoir, Park Gulch, Michigan Creek-Tarryall Creek, Ruby Gulch, Grape Creek, Fish Creek, Twin Creek, and Elevenmile Canyon were all skewing the categorization because of their low soil erodibility values and were manually given a score slightly lower than the next lowest score (Appendix B).

The resulting potential soil erodibility risk rankings are shown on Figure 7 and the tabular results are presented in Appendix B. The map shows areas of high soil erodibility in the watershed assessment area. The highest ranked sixth-level watersheds are Mosquito Creek, Headwaters Middle Fork South Platte River, Headwaters Tarryall Creek, and Webber Park-Tarryall Creek.

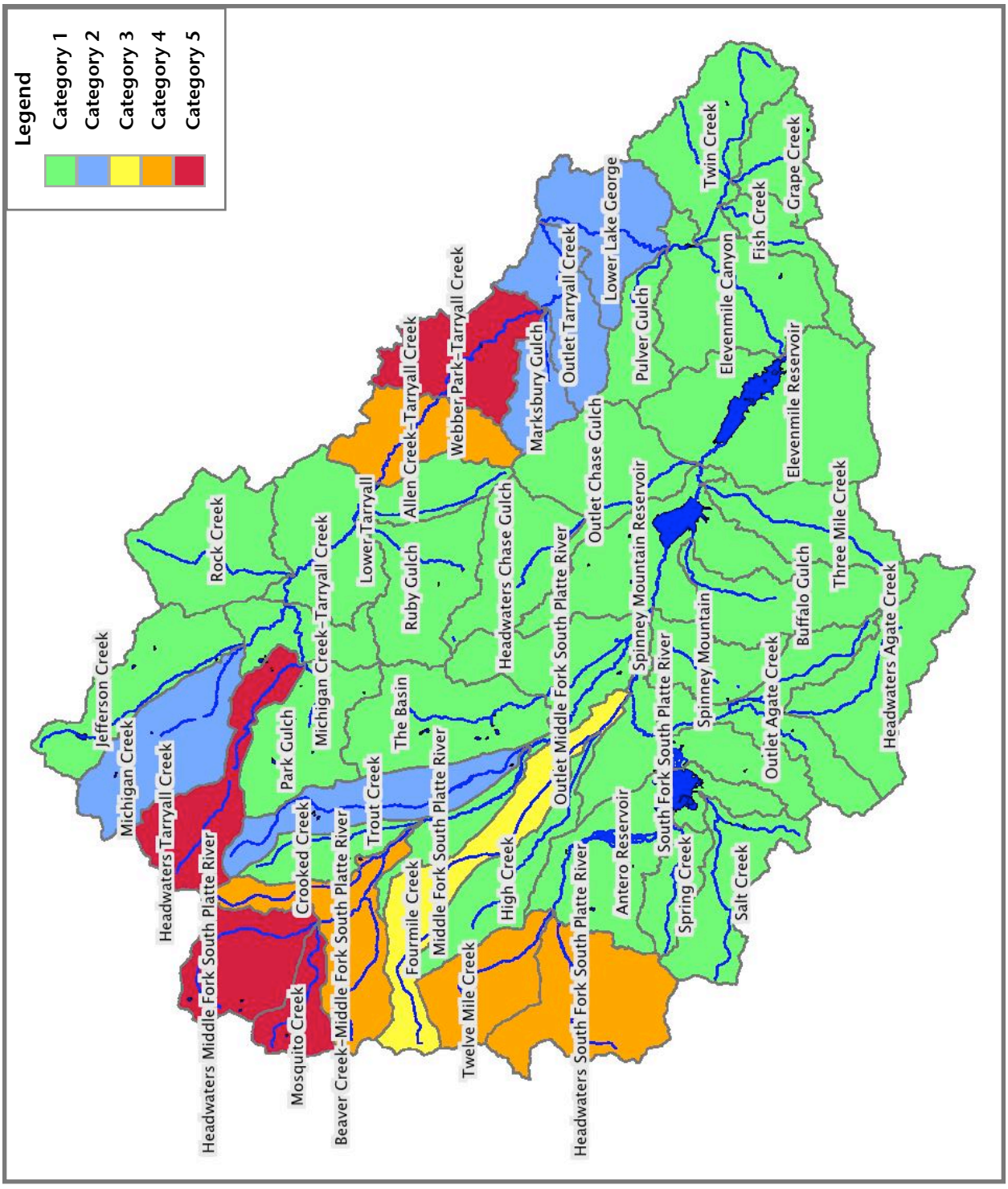


**Figure 7. South Platte Headwaters Watershed Potential Soil Erodibility Hazard Ranking**

## Composite Hazard Ranking

The Composite Hazard Ranking combines the first three components (Wildfire Hazard, Flooding/Debris Flow Hazard and Soil Erodibility) by numerically combining their rankings for each sixth-level watershed and then re-categorizing the results. The Composite Hazard Ranking map is useful in comparing relative watershed hazards based solely on environmental factors. The categorization procedure is the one prescribed by the Front Range Watershed Protection Data Refinement Work Group (2009).

Figure 8 shows the Composite Hazard Ranking for the South Platte Headwaters Watershed. The tabular results that display the rankings for Wildfire Hazard, Flooding/Debris Flow Hazard and Soil Erodibility, as well as the composite rankings are presented in Appendix B. The highest ranked sixth-level watersheds are Mosquito Creek, Headwaters Middle Fork South Platte River, Beaver Creek-Middle Fork South Platte River, Headwaters South Fork South Platte River, Headwaters Tarryall Creek, and Webber Park-Tarryall Creek. Additionally, there are three watersheds in Category 4.

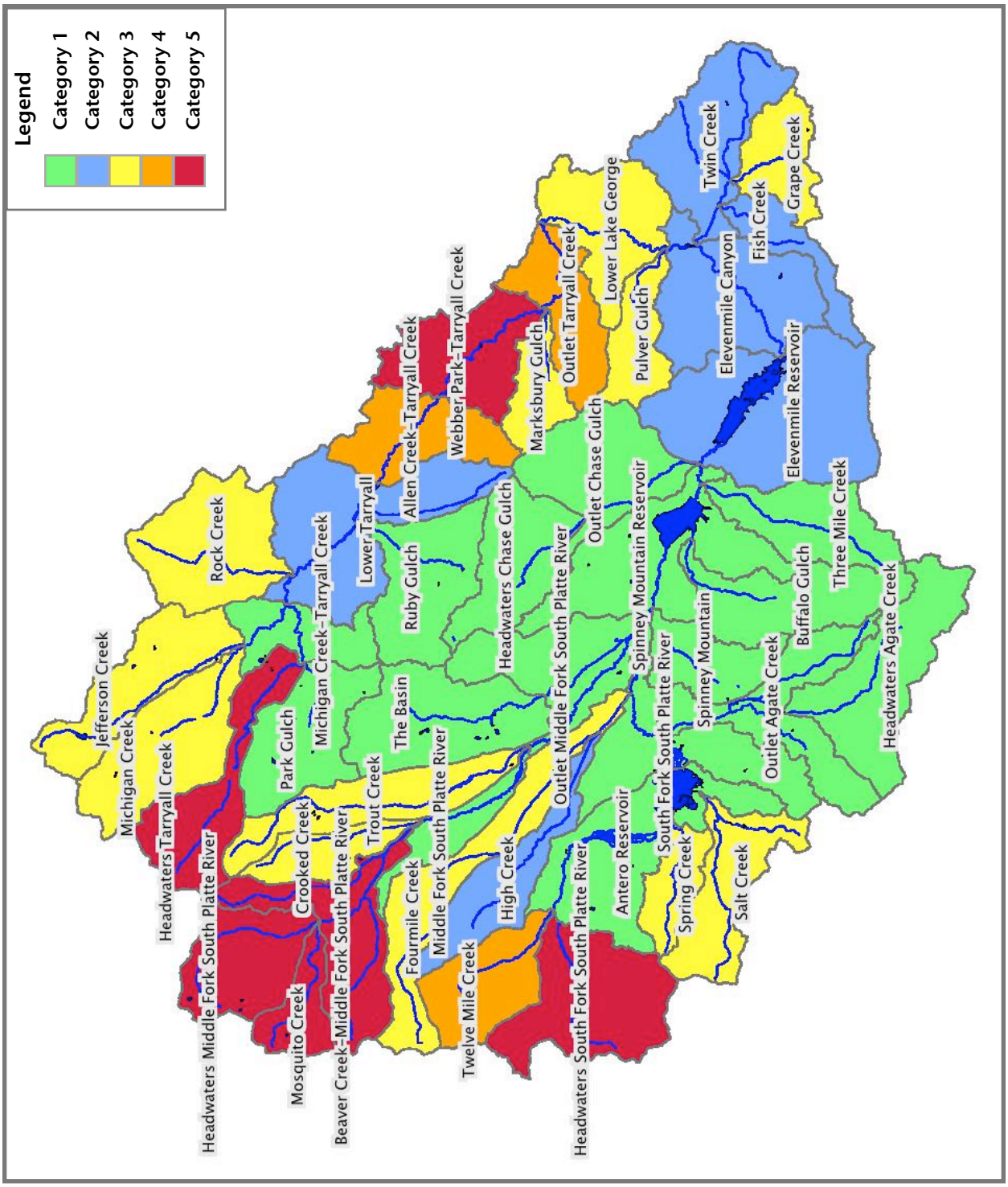


**Figure 8. South Platte Headwaters Watershed Composite Hazard Ranking**

## Component 4 - Water Supply Ranking

Surface water intakes, diversions, conveyance structures, storage reservoirs and streams are all susceptible to the effects of wildfires. The suggested approach from the procedure prescribed by the Front Range Watershed Protection Data Refinement Work Group (2009) is to first rank watersheds based upon the presence of water nodes.

Surface drinking water supply collection points from the Source Water Assessment and Protection (SWAP) Program (see http://www.cdphe.state.co.us/wq/sw/swaphom.html for basic information on the SWAP Program) were used to identify which sixth-level watersheds contain critical components of the public water supply infrastructure in Colorado. For this assessment, water nodes were defined as coordinate points corresponding to surface water intakes, upstream diversion points and classified drinking water reservoirs.

Water supply locations may not be identified in the state's database for some drinking water supply reservoirs that do not have associated direct surface water intakes. Also, some water supply reservoirs may not be identified in the SWAP database. The Water Supply map (Figure 9) was modified following the second stakeholder meeting to include several water supply sources.

## Final Priority

Those watersheds that have a water supply feature (diversion, reservoir or other) were given higher priority in the ranking scheme by increasing their priorities from the Composite Hazard map by one category. Those results were then re-categorized into five categories. Adjustments to the Final Priority were made due to the large percentage of red and orange watersheds. The distribution of the results for each analysis category were examined. While some of the hazard rankings were not evenly distributed, many of those analyses were reviewed and some were adjusted through the stakeholder review process. Therefore, the only adjustments to hazard ranking distributions were made to the Final Priority ranking.

The final priority rankings are shown on the Final Priority map (Figure 10). The sixth-level watersheds that ranked highest on the Final Priority map are Mosquito Creek, Headwaters Middle Fork South Platte River, Beaver Creek-Middle Fork South Platte River, and Headwaters Tarryall Creek.

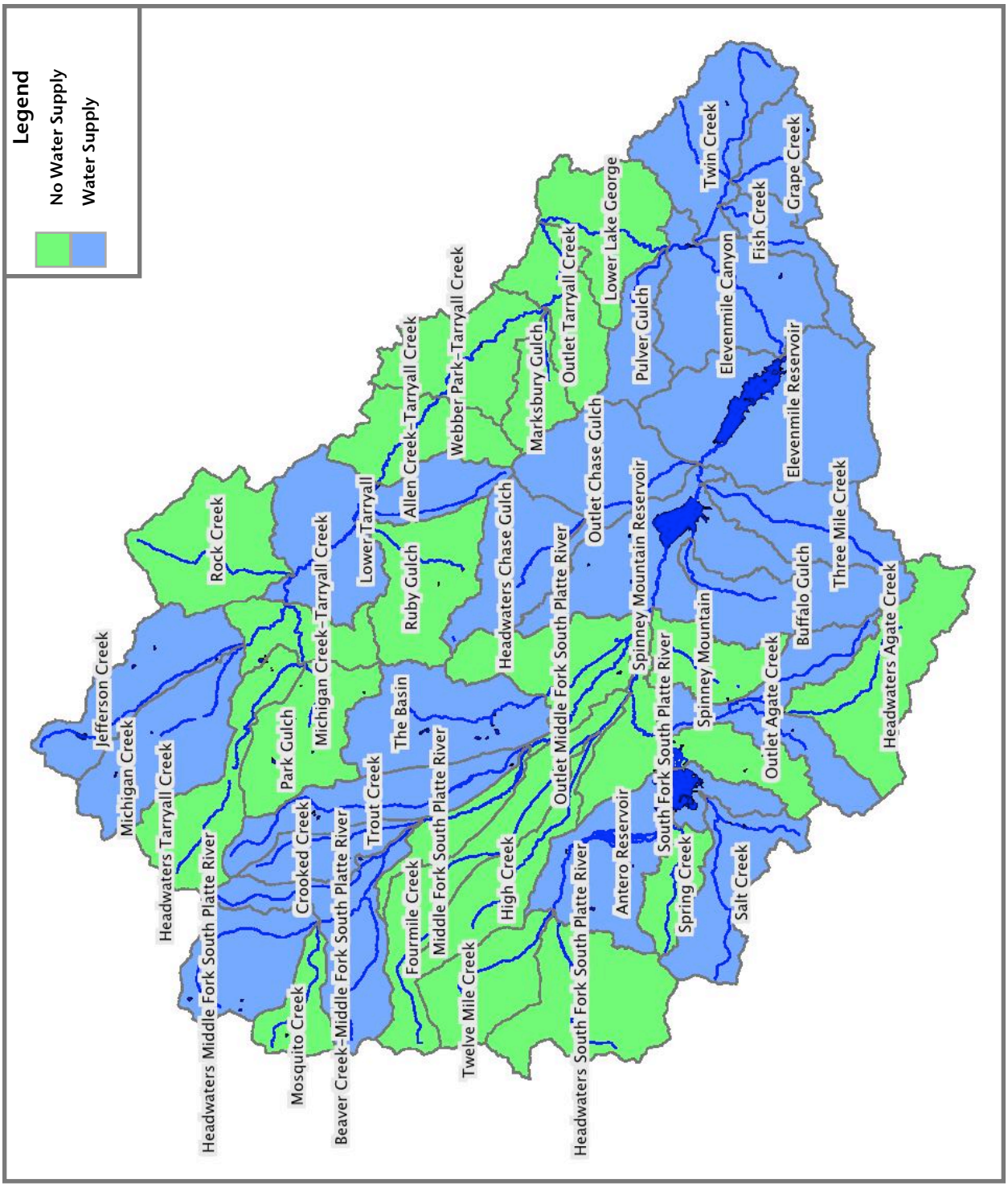


**Figure 9. South Platte Headwaters Watershed Water Supply**

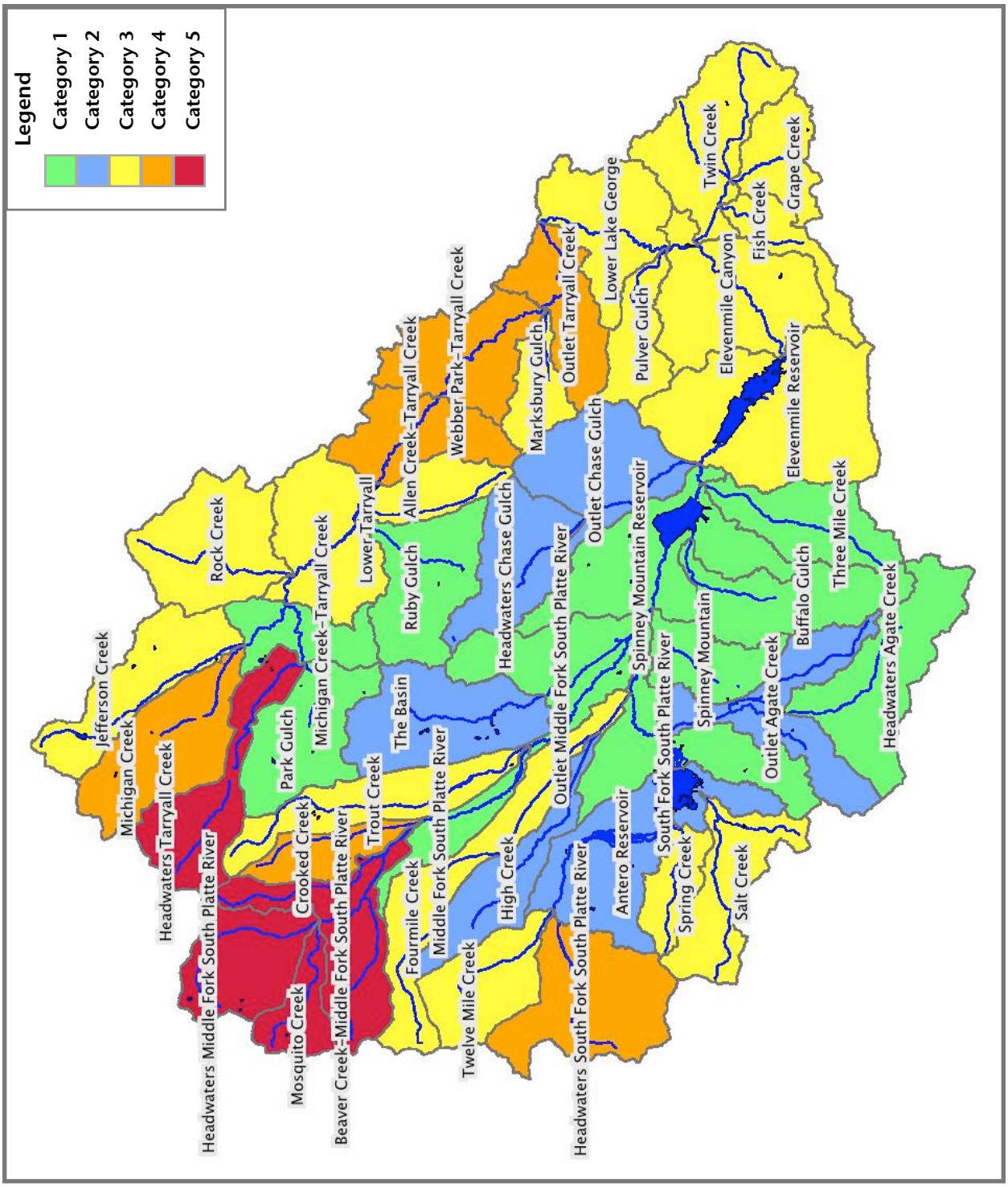


**Figure 10. South Platte Headwaters Watershed Final Priority**

# Zones of Concern

The Work Group identified an important risk factor for water uses related to transport of debris and sediment from upstream source water areas. The source water areas (i.e. watershed areas) above important surface water intakes, upstream diversion points and drinking water supply reservoirs have a higher potential for contributing significant sediment or debris. These areas, called Zones of Concern (ZoC), can be used by stakeholders to further define project areas that focus on watershed protection actions.

There were several methods suggested by the Front Range Watershed Protection Data Refinement Work Group (2009) to define ZoC. The South Platte Headwaters Watershed Stakeholders initially agreed to use the five-mile upstream distance. This approach is based on Colorado State Statute 31-15-707 which allows municipal water providers to enact an ordinance to protect their water intakes within five miles upstream of their intakes. This municipal statute that has been in place since the late 1800's and has been tested in court several times and upheld.

Many of the ZoC stopped at the watershed divide before they reached the five mile upstream distance. There were several important diversions and reservoirs that are positioned lower in the watershed. During the third stakeholder meeting, the group suggested that the ZoC be extended to 11 miles upstream for Antero and James Tingle Reservoirs. These ZoC were added as separate areas covering from five to 11 miles upstream.

Ten ZoC within five miles upstream of diversions and reservoirs were delineated in the South Platte Headwaters Watershed (Figure 11 and Table 3) totaling more than 156,000 acres. Three of the ZoC were extended to 11 miles upstream increasing the area to more than 210,000 acres. The ZoC were overlaid on the Final Priority map (Figure 10). More detailed maps of the ZoC are presented in the *Opportunities & Constraints* section below. The water supply agencies for each ZoC have also been identified in Table 3. Some of the ZoC overlap with others, or in other areas, the ZoC are close to overlapping upstream ZoC. In those situations, ZoC can be combined or viewed as one, combining several stakeholders into a larger ZoC.

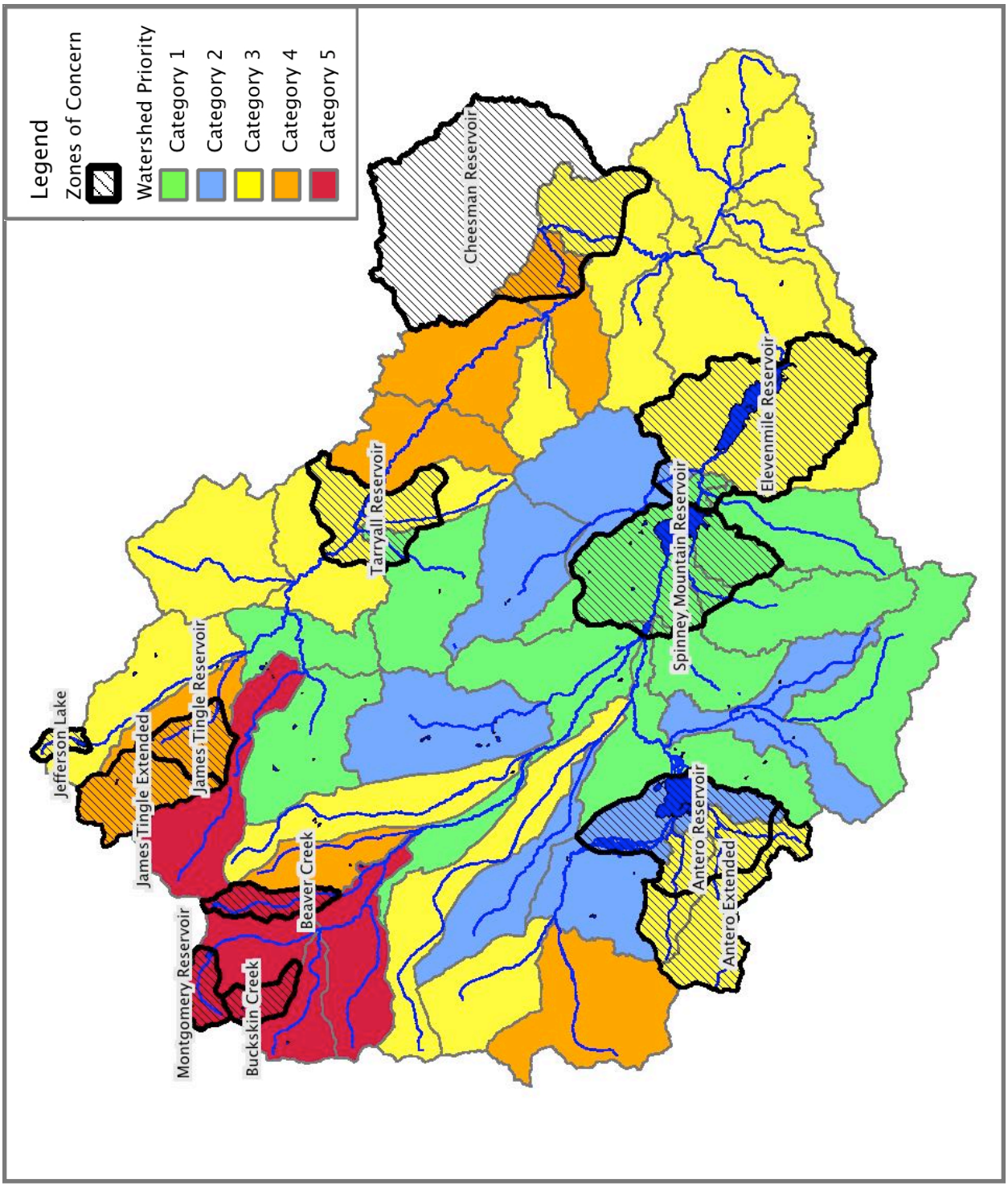


**Figure 11. South Platte Headwaters Watershed ZoC[5]**

[5] The *Opportunities & Constraints* section below displays and identifies each ZoC at a better scale than Figure 11.

## Table 3. South Platte Headwaters Watershed Zones of Concern[6]

| Name | 0-5 Mile Area | 5-11 Mile Area | Total ZoC Area | Water Supply Agencies |
|---|---|---|---|---|
| Antero Reservoir | 27,667 | 21,645 | 49,312 | Denver Water |
| Beaver Creek | 6,022 | 0 | 6,022 | Town of Fairplay |
| Buckskin Creek | 4,774 | 0 | 4,774 | Town of Alma |
| Cheesman Lake | 0 | 19,731 | 19,731 | Denver Water |
| Elevenmile Reservoir | 49,990 | 0 | 49,990 | Denver Water |
| James Tingle Reservoir | 8,371 | 12,947 | 21,318 | Center of Colorado Conservancy District |
| Jefferson Lake | 2,125 | 0 | 2,125 | City of Aurora |
| Montgomery Reservoir | 5,050 | 0 | 5,050 | Colorado Springs Utilities |
| Spinney Mountain Reservoir | 34,739 | 0 | 34,739 | City of Aurora /Denver Water |
| Tarryall Reservoir | 17,824 | 0 | 17,824 | Colorado Division of Wildlife |
| Totals | 156,562 | 54,323 | 210,885 | |

[6] The areas of the ZoC are in acres. The Cheesman Reservoir ZoC is only the portion within the South Platte Headwaters. The total for the Cheesman Reservoir ZoC is about 80,013 acres including the area in the Upper South Platte Watershed.

# RECOMMENDATIONS

This watershed assessment is a process that sets priorities, identifies stakeholders and Zones of Concern (ZoC). The next steps that are taken by stakeholders using the information presented in this report are essential to address the hazards identified through this process. Some potential opportunities are presented in the next section of this report. These recommendations are presented first to guide the reader through the *Opportunities & Constraints* section.

## Hazard Reduction Strategies

Although there are other strategies that can be pursued, the reduction of wildfire severity is the main goal for minimizing adverse hydrologic responses following intense wildfires. Wildfire severity is the effect that the fire has on the ground. Vegetative forest treatments can be effective in reducing the threat of crown fire (Graham et al. 1999). Treatments that reduce density and change the composition of stands would reduce the probability of crown fire, decrease severity, and enhance fire-suppression effectiveness and safety (Oucalt and Wade 1999, and Pollet and Omi 2002). In forested stands that have developed without regular disturbance, combinations of mechanical harvest/thinning and prescribed fire are the most effective technique for altering the fuels matrix (Graham et al. 2004).

There are portions of watersheds that may not be available for vegetation treatments because they are economically or administratively inaccessible. Examples of economic inaccessibility include areas that are far from existing roads where it would be very costly to build new roads to provide access, or areas that are so steep that removal of logs by helicopter may be the only option. During follow-up planning efforts the costs of specific project alternatives should be carefully evaluated in light of fire probabilities and the potential costs of no action. An example of administrative inaccessibility would be areas designated by the US Forest Service as wilderness.

There are some prudent measures that can be taken in situations where critical watersheds are economically or administratively inaccessible including;

1. Managing wildland fires in certain places as a management tool that would allow wildfire to reduce wildland fuels under defined circumstances. The conditions would be monitored frequently to ensure that the fire stays within that management prescription or suppression efforts would be required.
2. Reduction of wildfire severity in surrounding areas within those watersheds to reduce the potential extent of high severity burn.
3. Pre-permitting sediment control structures downstream from high hazard watersheds. Following the Hayman Fire in 2002, Denver Water installed a sediment control structure in Turkey Creek above Cheesman Reservoir. It took more than one year to get all approvals and permits in place to construct that structure. The highest sediment yield from wildfires is usually in the first 2-3 years. Stakeholders can do much of the permitting work ahead of time, including planning with the appropriate government agencies and conceptual design.

4. Communicating with state and local leaders and other interested groups about the hazards that these watersheds pose. There may be other resources at risk below these watersheds that can be protected, such as; houses in floodplains, important fisheries or riparian areas, and areas of mining tailings that could be a water quality risk if they are transported downstream.

## Stakeholder Group Organization

The ZoC are natural project areas for stakeholders to start the next planning steps. In some cases several ZoC may be lumped together to form larger project areas. Stakeholder groups will, by definition, include the water providers and/or municipalities that own water rights and operate in those watersheds, but should also include the following;

1. U.S. Forest Service - South Park Ranger District of the Pike National Forest.
2. Colorado State Forest Service - Salida District
3. Park and Teller Counties
4. Coalition for the Upper South Platte
5. Park County Water Preservation Coalition
6. Home owner associations
7. Other interested groups such as power companies

Stakeholders should review the *Opportunities & Constraints* section below to determine what watersheds/ZoC should be their priority. Some additional planning will be required to initiate watershed protection/hazard reduction projects within those ZoC. The discussion below presents some of the options.

There is a new planning process that is focused on watershed issues called Critical Community Watershed Wildfire Protection Plans (CWP)$^2$. The CWP$^2$ process (see http://www.jw-associates.org/Projects/Front_Range/Front_Range.html) is similar to the Community Wildfire Protection Plan (CWPP) process but expands to include watershed issues. Some existing CWPPs may cover portions of the watersheds/ZoC of interest. It may be more efficient to revise an existing CWPP by incorporating the watershed components from this assessment than to complete the CWP$^2$ process. Specific treatment areas and priorities identified in existing plans also should be reviewed for their contribution to the watershed protection efforts and incorporated into the expanded plan. Other efforts, such as source water protection plans, may also gain some efficiency and consistency by incorporating the results of this assessment.

National Environmental Policy Act (NEPA) planning efforts on federal lands may be able to be modified to incorporate watershed priorities. The NEPA analysis and decision-making process may also benefit from the technical support provided by this watershed assessment. Other existing land and vegetation management plans, fuels treatment plans, source water protection plans, watershed restoration plans or prescribed fire or fire-use plans may exist that cover portions of the critical watersheds.

This section of the watershed assessment presents the first step in identifying opportunities and constraints within the ZoC. This analysis is intended to identify potential opportunities that will aid the stakeholders in deciding whether to pursue watershed protection/hazard reduction efforts, the overall scope that those efforts might involve and identification of the key partners for those projects. This section is organized by general descriptions of the opportunities and constraints first and then presentation of potential opportunities for each ZoC that are shown on Figure 12.

## General Opportunities & Constraints

The opportunities and constraints described below were applied to the ZoC as a series of filters and identifiers of potential opportunities.

### Ownership

Land ownership patterns can be quite complicated depending upon where in Colorado the Watershed Assessment was conducted.  Major ownership classifications are Federal, State, Local Government and Private. Federal Lands include the National Forest System (NFS) Lands, Bureau of Land Management, National Park Service, Department of Defense, and potentially other agencies and departments. State lands are typically those owned or managed by the State Land Board, the Division of Wildlife, or State Parks. However, there are other agencies or institutions, such as state universities, that also may own significant acreage.

Local Government lands typically include county, city or town-owned properties. County-owned lands are often managed as open space or park lands. City-owned lands are also often owned and managed for open space or parks, but also for watershed protection or other purposes.

Private land is basically a category that can include a myriad of other types of ownerships including special district lands, company or corporate-owned lands, privately owned properties and more. Privately owned parcels can be present in extremely complex patterns, particularly where they are composed of old mining claims.

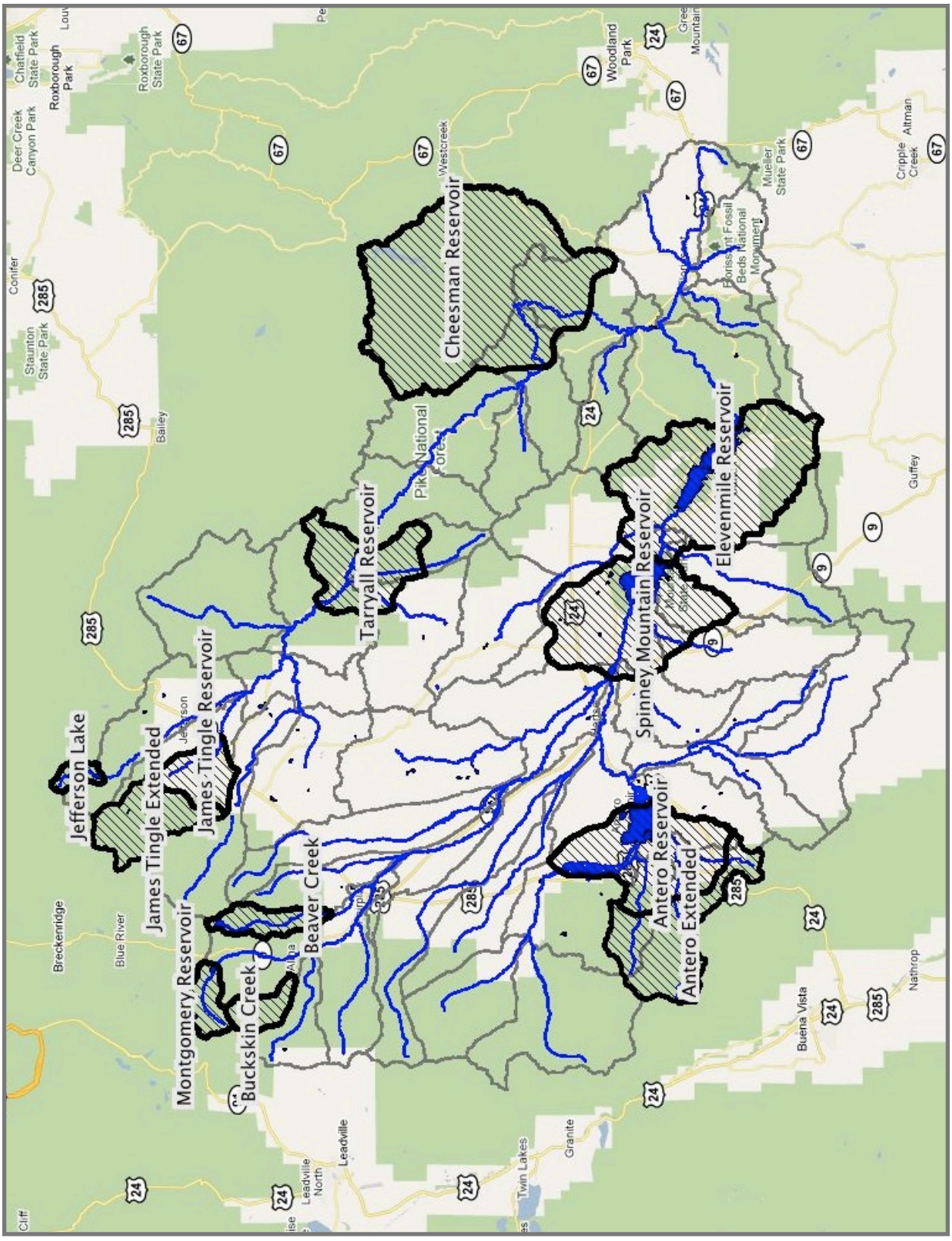


**Figure 12. South Platte Headwaters ZoC Base Map**

## Access

Access to and within a watershed or Zone of Concern is a key factor in determining opportunities for mitigating wildfire hazards or the ability to install, operate and maintain erosion and sediment control structures following wildfires. The analysis often is limited by the data available in determining what roads exist within any given area. Normally, data layers available for the analysis usually show major roads and access routes, but often fail to include small, local roads and trails, particularly on non-federal lands. Such roads are very important for accessing backcountry areas for conducting mitigation activities. Experience has shown that old roads used for mining or logging that can be temporarily re-opened to conduct project work may not be shown on any maps. Another option is temporary roads that can be constructed and closed following treatment, but they add costs to projects and current policies on many federal lands make even use of temporary roads difficult.

When conducting traditional logging and thinning operations where products are removed from the forest, areas within ¼-mile of roads can be accessed. If products do not have to be removed to meet fuel loading requirements and alternate treatment methods such as "mastication" or mulching can be used, areas within ½-mile of roads can typically be considered.

## Slopes

Land slope can be a major constraint when considering where and what treatments may be conducted to reduce wildfire hazards. Slope constraints are related directly to the typical harvesting or treatment systems and equipment employed and available within Colorado. Land management agency policies may also constrain the slopes upon which treatments may be conducted.

Slopes of 30 percent or less are the easiest to treat and the most traditional threshold for treatment given typical harvesting systems and equipment availability. Technological, power and other improvements now allow equipment to operate on slopes of 40 percent or perhaps even steeper ground. Experimental work conducted by the Colorado State Forest Service on Denver Water's lands in the Upper South Platte showed that tracked mastication equipment could work on slopes of up to 55 percent without causing erosion and resultant water quality issues.

Quite recently in Colorado there have been a several cable logging and even a few helicopter logging operations conducted. Slope is typically not an absolute constraint with these types of operations, but other factors such as the shape of the hillside (convex vs. concave), whether the project can be treated from above or below and others determine actual project feasibility.

The stakeholders decided to use a 40 percent slope as the upper limit of mechanical treatments. Potential opportunities were identified as greater on shallower slopes (less than 40 percent slope).

## Wilderness Areas

Operations in designated wilderness areas are highly restricted by law and agency policies. Often the only treatments possible can be to plan for use of natural fire to reduce wildfire hazards.

## Roadless Areas

Operations in designated roadless areas are restricted primarily by agency policies. Regulations allow construction of temporary roads, and their closure upon project completion, for the purpose of conducting harvests and wildfire hazard reduction treatments. Agency policy has caused treatments to focus on areas other than roadless whenever possible.

Colorado is one of two states that are attempting to develop rules for treatments within roadless areas. The Colorado Roadless Areas are currently under review by the US Secretary of Agriculture, but are operating under their proposed rules. This situation has resulted in roadless areas being divided into 2001 Roadless Rule (Federal) and Colorado Roadless Areas. Due to current legal actions, 2001 Roadless Rule areas are basically off limits to forest management. However, they should not be viewed as off limits to long-term watershed protection efforts.

The Colorado Roadless Areas have been reviewed and adjusted for actual conditions and therefore are likely more precise than the 2001 Roadless Rule areas. As currently proposed, treatments within Colorado Roadless Areas may be possible adjacent to at risk communities and for reducing wildfire hazards within watersheds. Areas within ½-mile of communities, and in some circumstances up to 1.5-miles from communities, may be treated to reduce wildfire hazards. Areas within watersheds may be treated if the USFS Regional Forester determines a significant risk of wildfire exists. All decisions about specific projects within roadless areas will be made by the USFS Regional Forester.

## Vegetation

Vegetation is what fuels a wildfire. The vegetation type and its arrangement, size, density, and moisture content; the slope of ground and the aspect it is found on; whether it is dead or alive; the weather and season of the year, and more all dictate if and how intensely fuels will burn.

The Colorado State Forest Service is developing a series of documents related to watersheds and their protection. The first document, tentatively titled, "*A Comprehensive Strategy for the Management and protection of Colorado's Watersheds*," will have a series of companion documents entitled, "*Management and Protection Techniques for Colorado's Watersheds*." The first companion document discusses management of ponderosa and lodgepole pines and uses numerous photographs to illustrate what these treatments might look like.

In general, ponderosa pine should most often be managed using forest restoration management techniques. Dense, homogenous stands of ponderosa pine can be thinned to a much more open state, and openings created and maintained across the landscape. This type of management makes a much more resilient

ecosystem, one that reduces wildfire intensities is better able to absorb and recover from the impacts of wildfire (Colorado State Forest Service 2007).

In Colorado, lodgepole pine is also found in dense, continuous stands. Because lodgepole grows differently than ponderosa pine and has a different ecology, it is difficult, within a short time period, to thin it sufficiently to develop diversity significant enough to reduce wildfire hazards. This much needed diversity must be developed by creating diversity at the stand and landscape levels by clearcutting, patch cutting, creating permanent openings, converting areas to aspen. Once management has begun for watershed protection, in some situations it may be advisable to utilize less traditional management techniques for long-term management (Colorado State Forest Service 2009).

The stakeholders decided to use mixed conifer and ponderosa pine for vegetation targets at lower elevations, and lodgepole pine and mixed conifer at higher elevations as targets for vegetation treatments to reduce wildfire severity.

## Beaver Creek, Buckskin Creek & Montgomery Reservoir ZoC

The maps and analysis for the Beaver Creek, Buckskin Creek & Montgomery Reservoir ZoC are combined. Figure 13 shows the general location of the Beaver Creek, Buckskin Creek & Montgomery Reservoir ZoC. Note that the ZoC are shown here in pink with crosshatching, but in the remaining figures the outlines appear as bold black lines with no crosshatching.

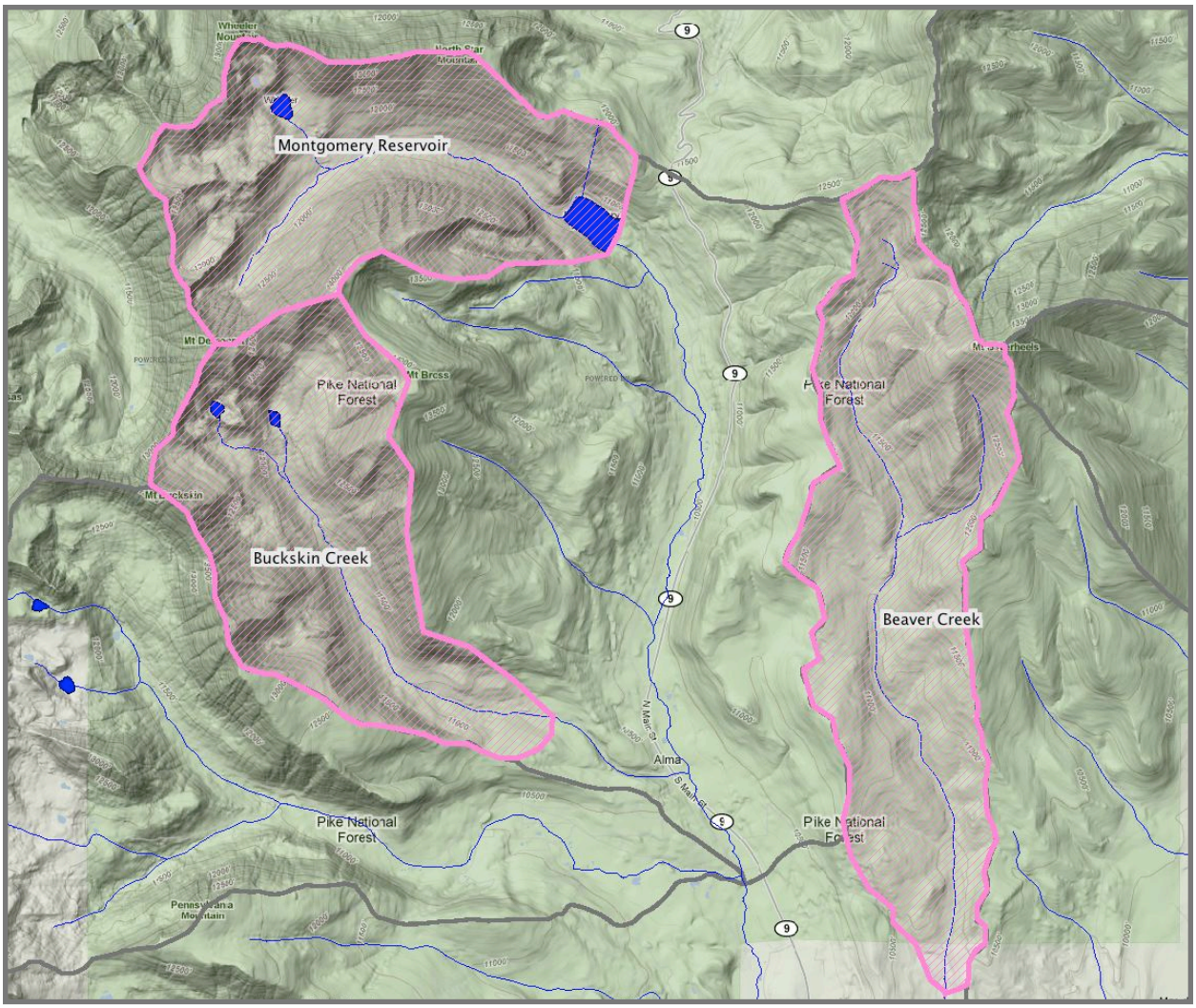


**Figure 13. Beaver Creek, Buckskin Creek & Montgomery Reservoir ZoC Location**

## Beaver Creek Ownership

Land ownership is mostly NFS lands in the upper watershed. There are two large pieces of private land in lower watershed (Figure 14).

## Buckskin Creek Ownership

Land ownership is mostly NFS lands in the upper ZoC. Primarily private lands in the lower watershed, intermingled with NFS lands (Figure 14).

## Montgomery Reservoir Ownership

Land ownership is primarily NFS lands in the ZoC, with mixed ownership immediately below the reservoir (Figure 14).

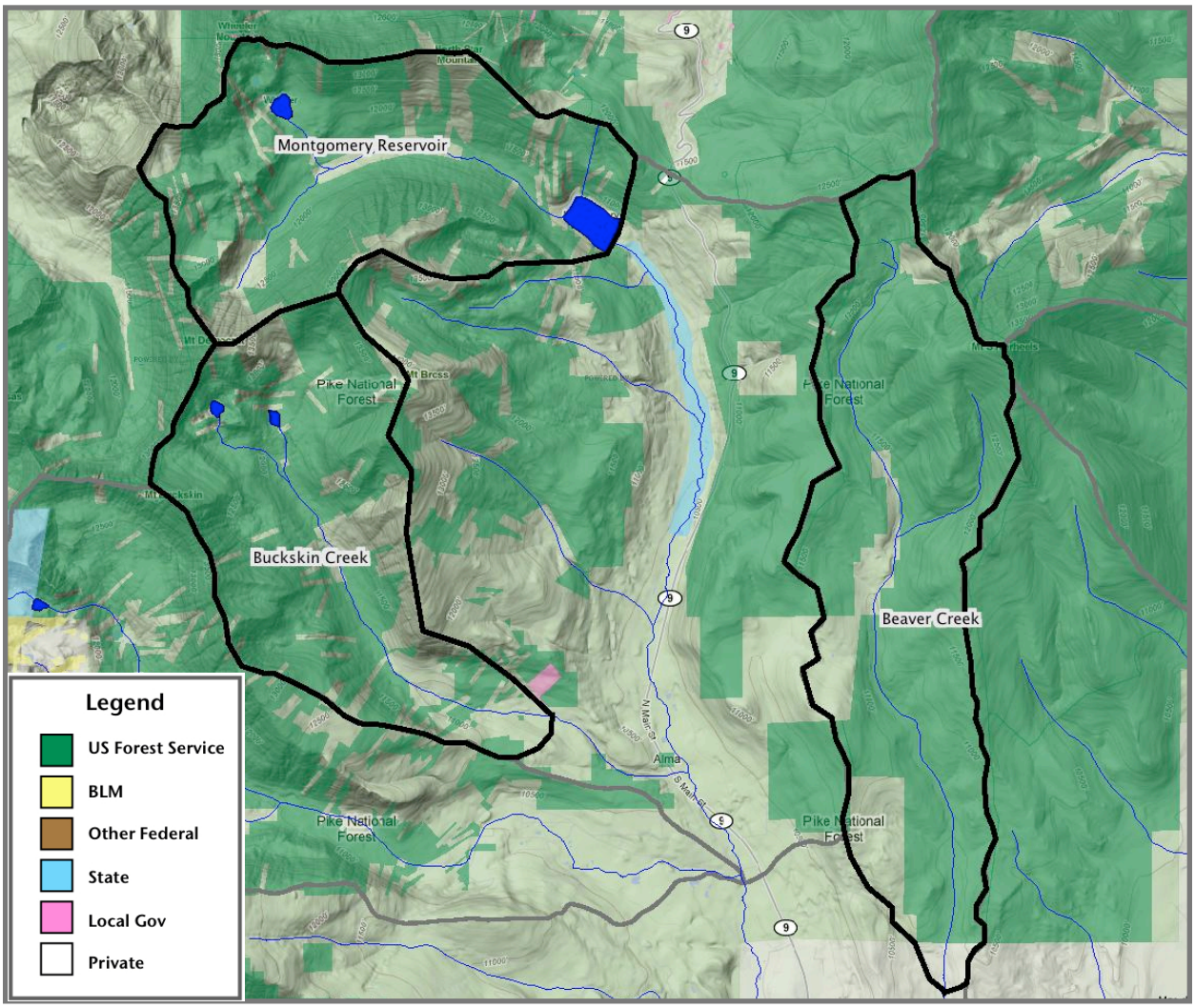


**Figure 14. Beaver Creek, Buckskin Creek & Montgomery Reservoir ZoC Ownership**

## Beaver Creek Watershed Priority

Beaver Creek-Middle Fork South Platte River is Red (Category 5) overall. Flooding/Debris Flow is Red and Soil Erodibility is Orange (Figure 15).

## Buckskin Creek Watershed Priority

Headwaters Middle Fork South Platte River is Red (Category 5) overall. Flooding/Debris Flow and Soil Erodibility is Red (Figure 15).

## Montgomery Reservoir Watershed Priority

Headwaters Middle Fork South Platte River is Red (Category 5) overall. Flooding/Debris Flow and Soil Erodibility is Red (Figure 15).

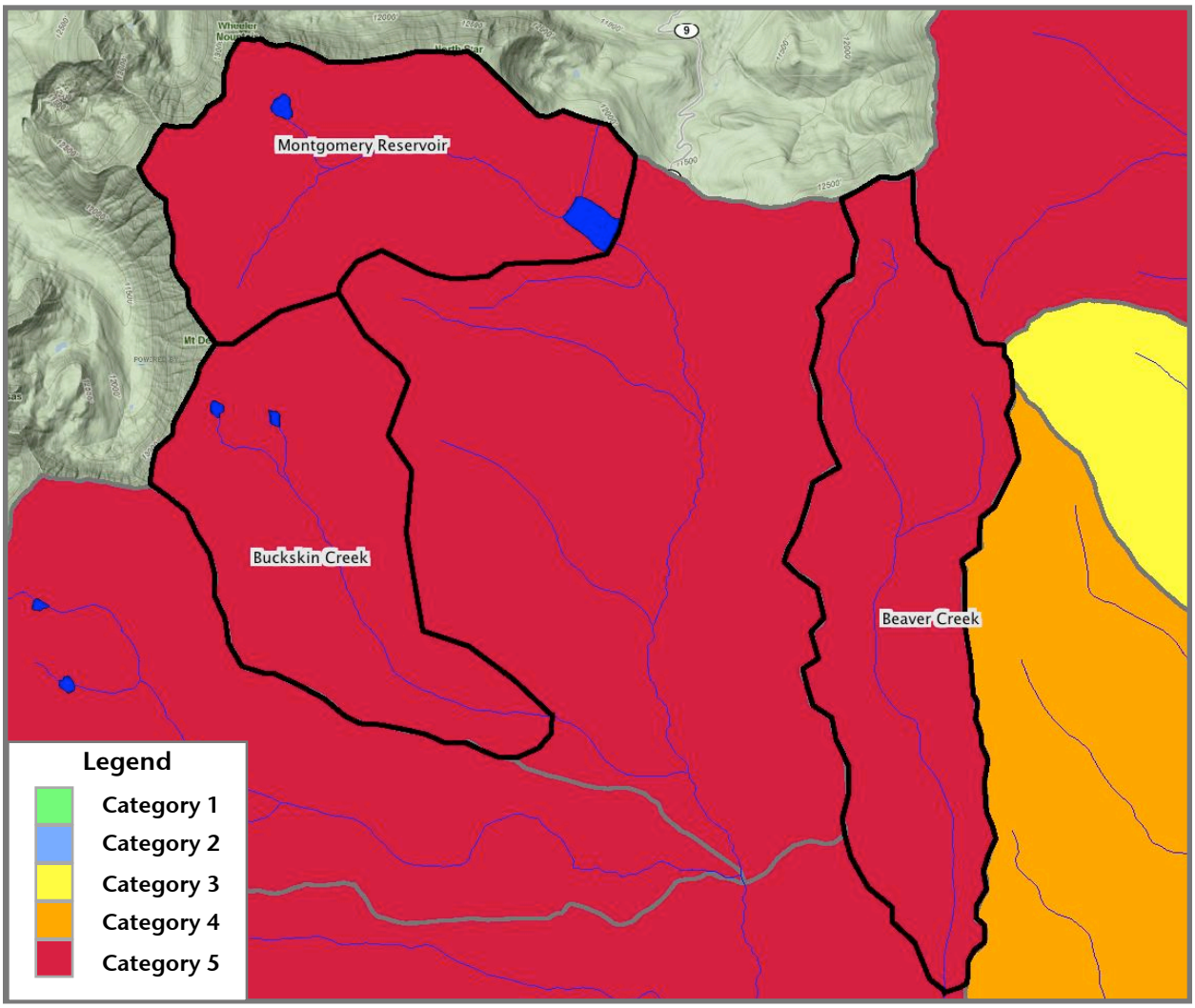


**Figure 15. Beaver Creek, Buckskin Creek & Montgomery Reservoir ZoC Watershed Priority**

## Beaver Creek Slopes

There are some large areas of steep slopes high in watershed, but lower half has shallower slopes (Figure 16).

## Buckskin Creek Slopes

Steep slopes are found over most of the ZoC except near the streams (Figure 16).

## Montgomery Reservoir Slopes

Steep slopes are found over most of the ZoC except near the streams (Figure 16).

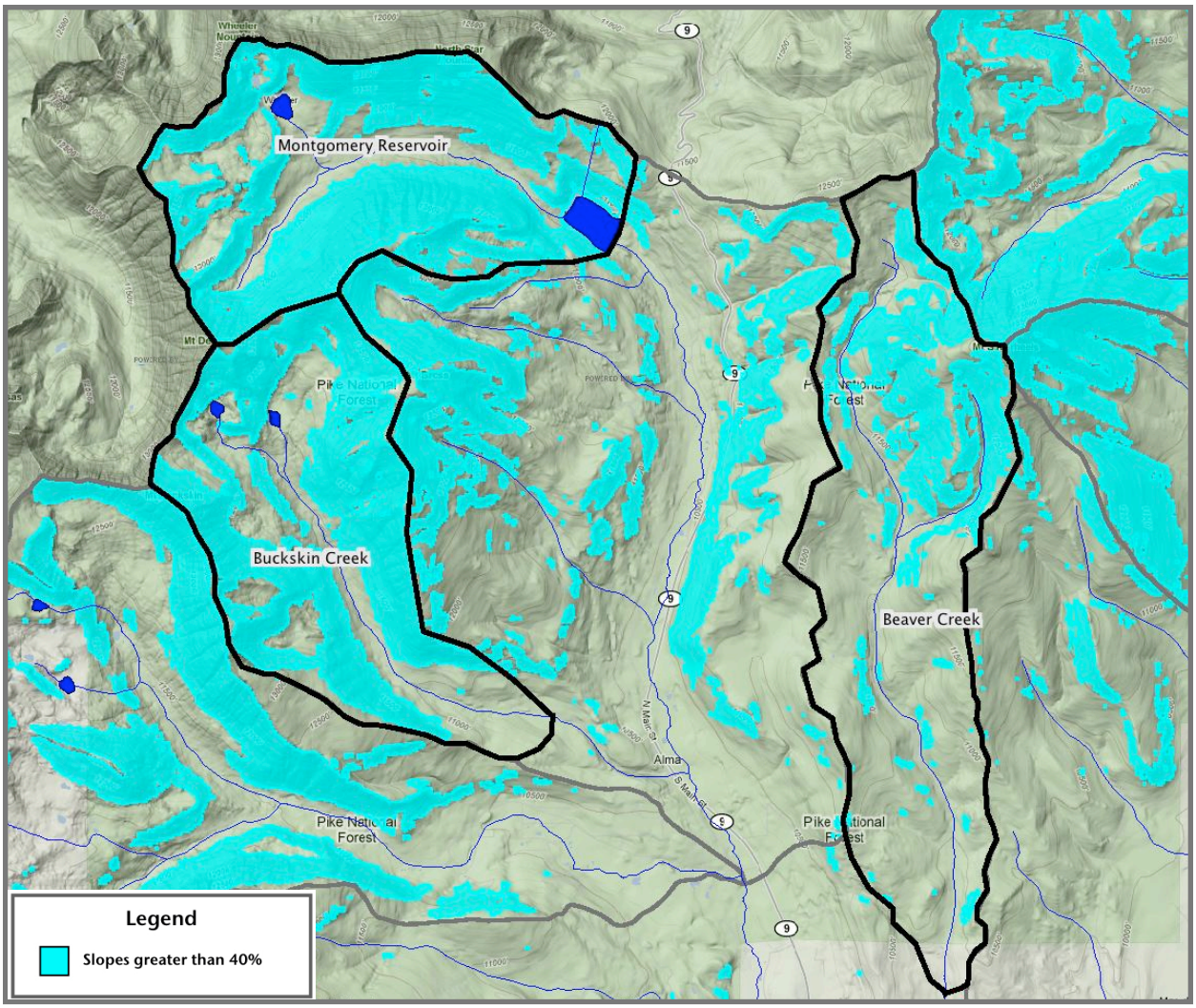


**Figure 16. Beaver Creek, Buckskin Creek & Montgomery Reservoir ZoC Slope**

## Beaver Creek Special Management Areas

No wilderness areas are present. There are two Roadless Areas (Hoosier Ridge and Silverheels) present in the higher elevations/northern portion of watershed (Figure 17).

## Buckskin Creek Special Management Areas

There are no wilderness or roadless areas (Figure 17).

## Montgomery Reservoir Management Areas

There are no wilderness or roadless areas (Figure 17).

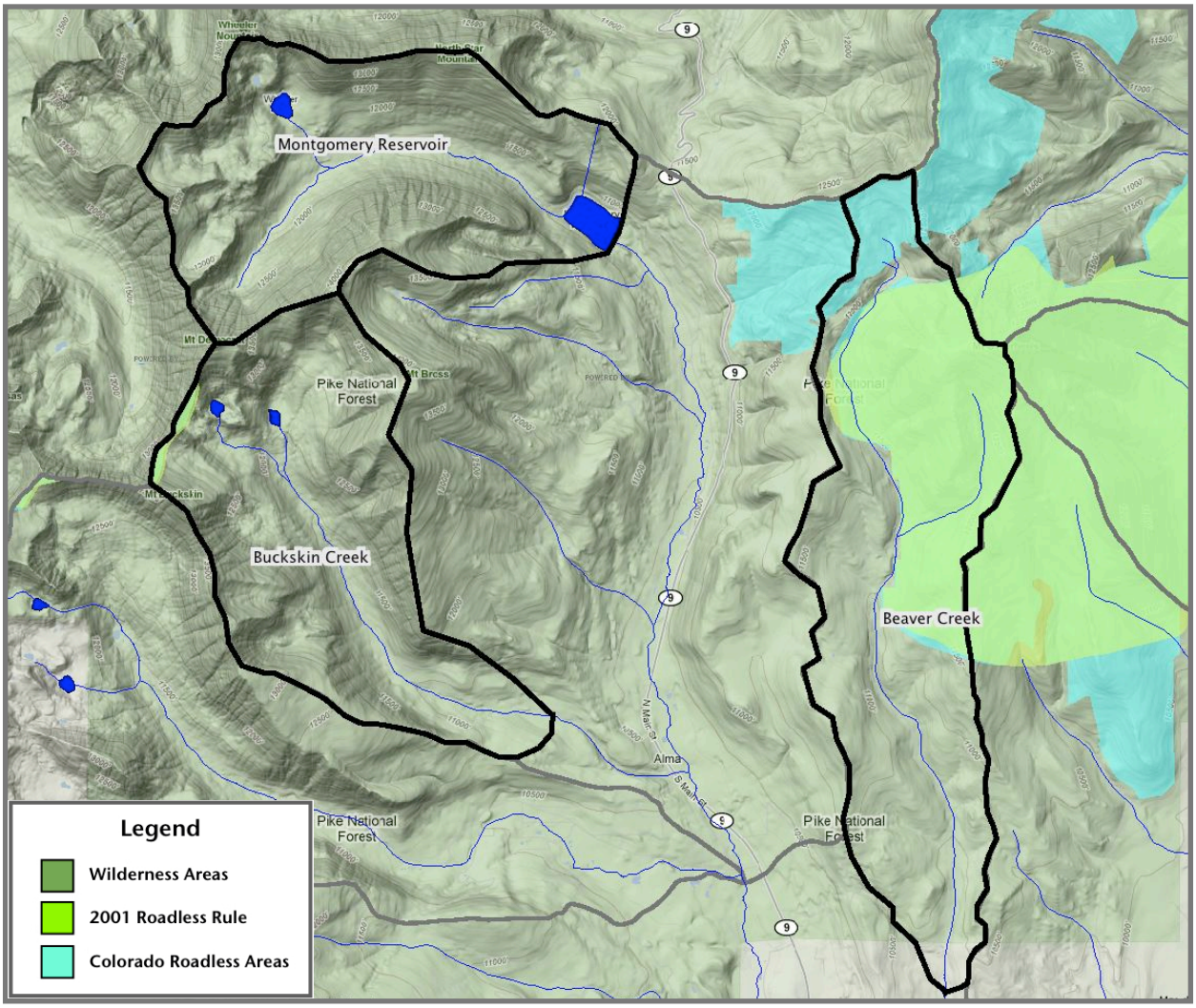


**Figure 17. Beaver Creek, Buckskin Creek & Montgomery Reservoir ZoC Special Areas**

## Beaver Creek Vegetation

Lower elevations are forested with a mosaic of lodgepole pine, aspen and mixed conifer. Middle elevations are mostly spruce-fir. Highest elevations are alpine and above treeline (Figure 18).

## Buckskin Creek Vegetation

Lower elevations are forested mostly with spruce-fir. Some small areas of lodgepole pine are found at the lowest elevations. Much of the watershed is alpine and above treeline (Figure 18).

## Montgomery Reservoir Vegetation

The lower elevations are forested mostly with spruce-fir. There are some areas of shrublands found in the lowest elevations. Much of the watershed is alpine and above treeline.(Figure 18).

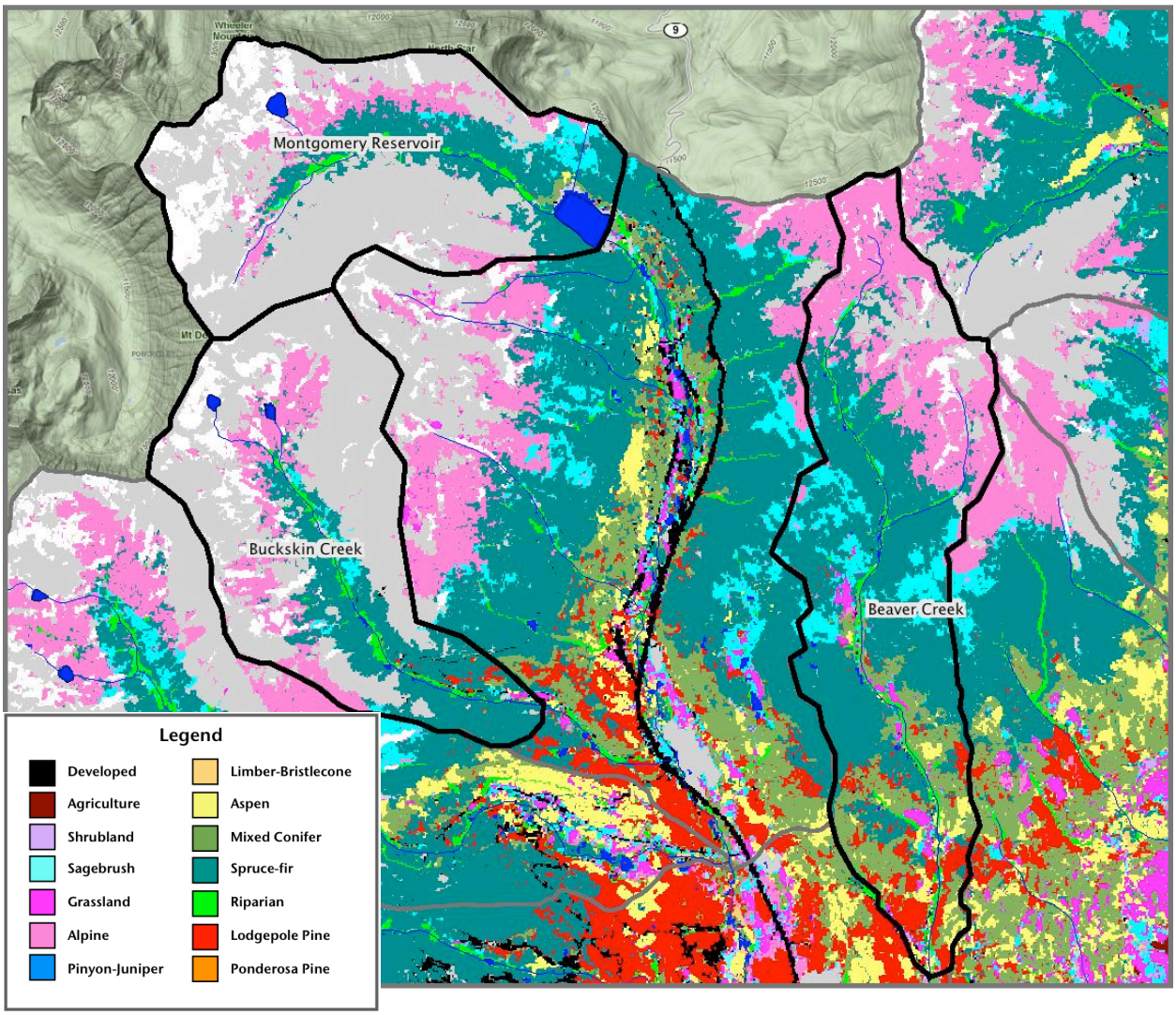


**Figure 18. Beaver Creek, Buckskin Creek & Montgomery Reservoir ZoC Vegetation**

## Beaver Creek Opportunities

There are roads and jeep trail access in the lower portions of the ZoC, with only limited roads in the upper watershed (Figure 19). There are management opportunities in the lodgepole pine and mixed conifer forest types in the lower portion of the watershed. These areas are on both private and NFS lands with existing road access. Slopes are conducive for both stand-level thinning activities and the development of fuelbreaks. Treatments could favor or develop a greater aspen component of the forest which would provide more of a "natural fuelbreak" and lower wildfire hazards and intensities. It appears that there is a major power distribution line within this watershed. This could provide opportunity to partner with power companies in activities that would protect the watershed and their power lines.

Stakeholders include: Town of Fairplay, US Forest Service, private landowners, Park County and Colorado State Forest Service.

## Buckskin Creek Opportunities

There is reasonable road access in lower ZoC. Road access is available along the drainage bottom to Kite Lake in the upper ZoC (Figure 19). There are some management opportunities in the lowest elevations of the watershed where there is better road access and more favorable slopes. This area has a mix of ownerships and use of the Good Neighbor and the Wyden Amendment Authorities is possible. Higher in the ZoC there is some management opportunities for areas along the road corridor where more shallow slopes exist (Figure 19).

Stakeholders include: Town of Alma, US Forest Service, private landowners, Park County and Colorado State Forest Service.

## Montgomery Reservoir Opportunities

Road access is available to the reservoir, with a jeep trail above the reservoir. However, most of the watershed is not roaded. There are few management opportunities in this watershed due to steep slopes and lack of road access (Figure 19). Immediately around and just above the reservoir there may be some opportunity for conducting hand work and limited mechanical treatments to reduce surface and forested fuels. The primary opportunity may be below the reservoir, outside of the ZoC, where thinning and fuelbreak treatments could be conducted to reduce the opportunity for fires to move up-slope/up-canyon into the ZoC. There may be opportunities to use the Good Neighbor and Wyden Amendment Authorities around the subdivisions below the reservoir.

Stakeholders include: Colorado Springs Utilities, US Forest Service, private landowners, Park County and Colorado State Forest Service.

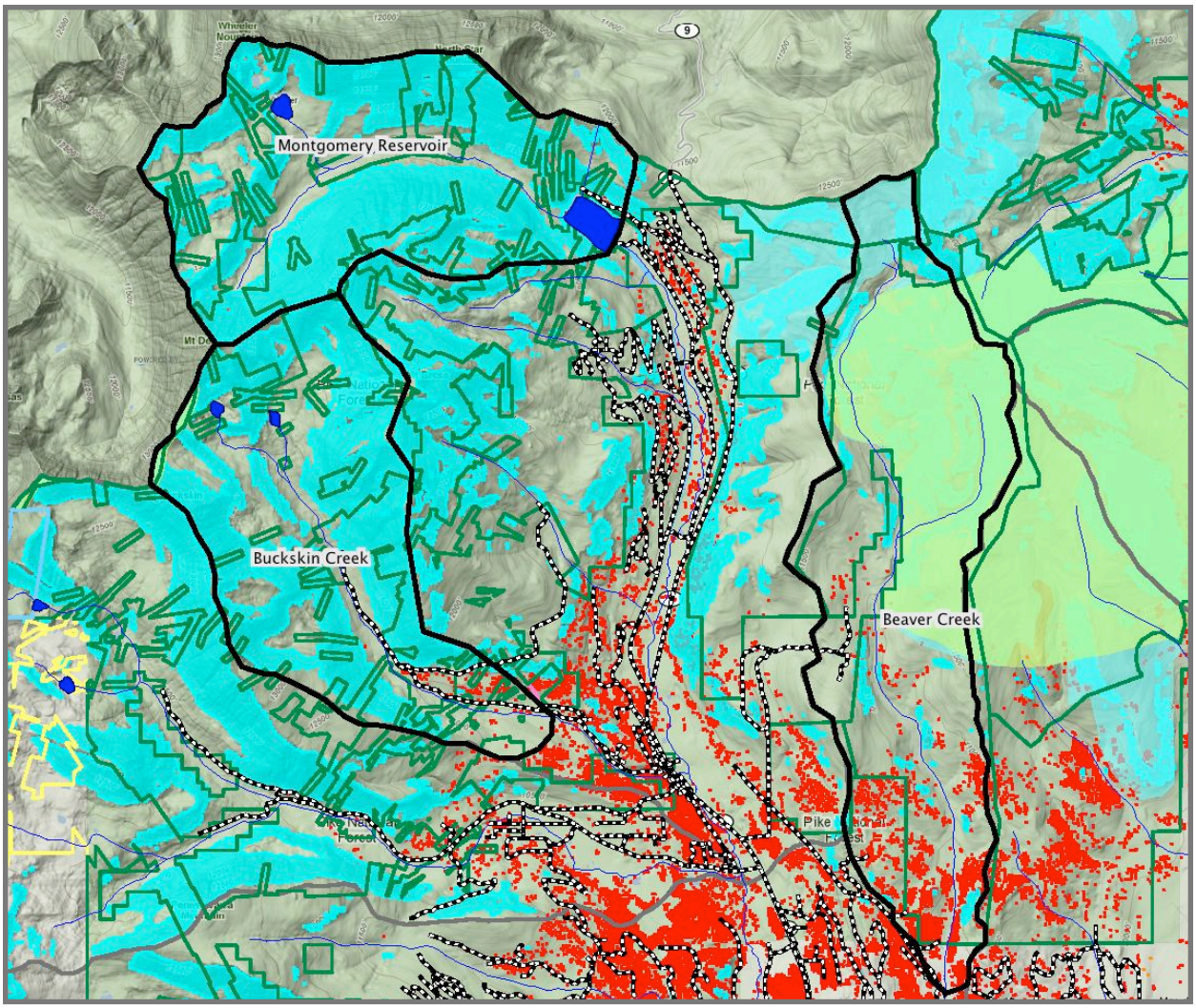


**Figure 19. Beaver Creek, Buckskin Creek & Montgomery Reservoir ZoC Opportunities**

# Antero Reservoir ZoC

Figure 20 shows the general location of the Antero Reservoir ZoC. Note that the ZoC are shown here in pink with crosshatching, but in the remaining figures the outlines appear as bold black lines with no crosshatching.

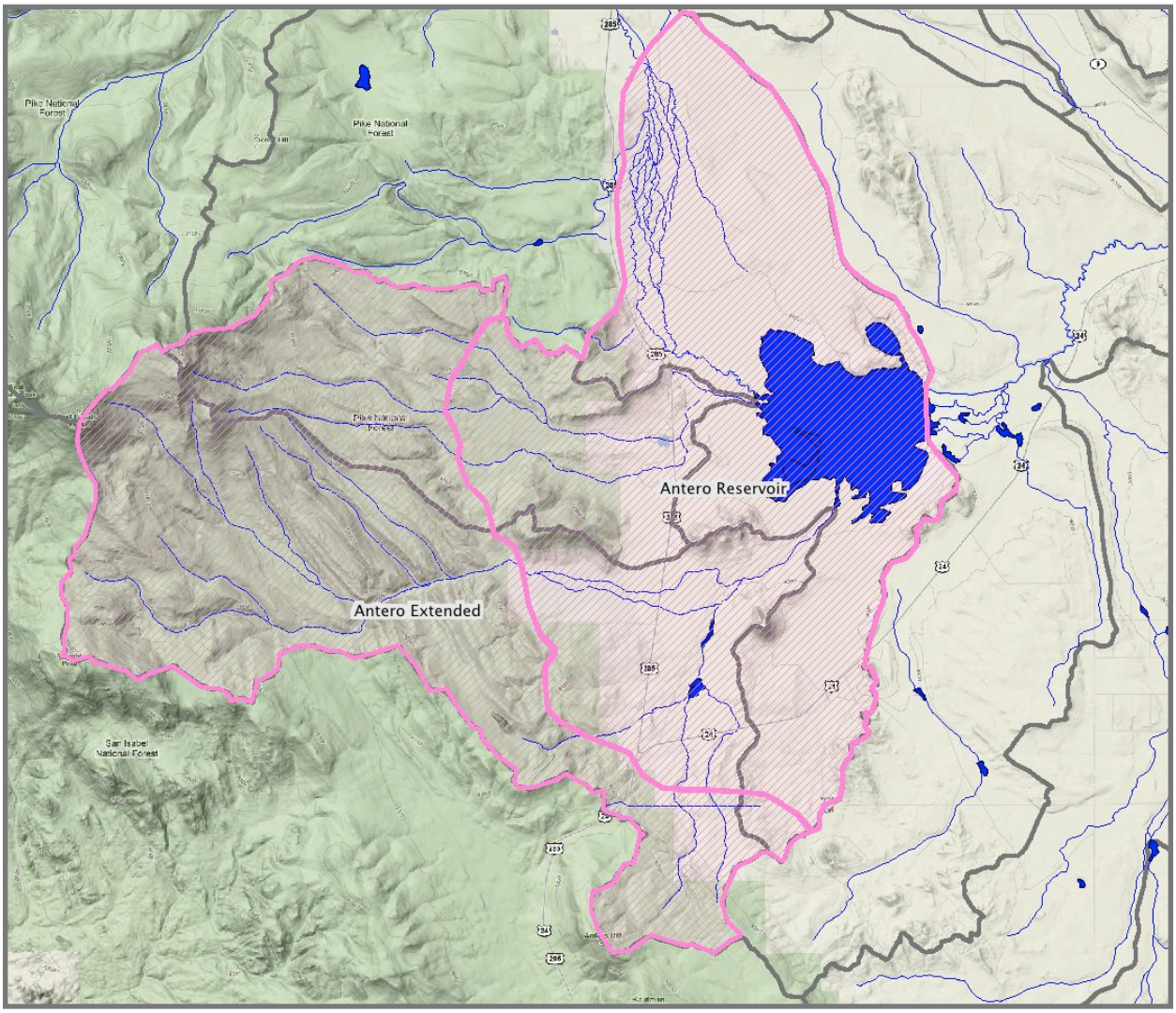


**Figure 20. Antero Reservoir ZoC Location**

## Antero Reservoir Ownership

Land ownership is mostly NFS lands in the extended ZoC. There are some scattered BLM lands, and two large areas owned by the State Board of Land Commissioners and Denver Water, along with other private lands in the lower ZoC (Figure 21).

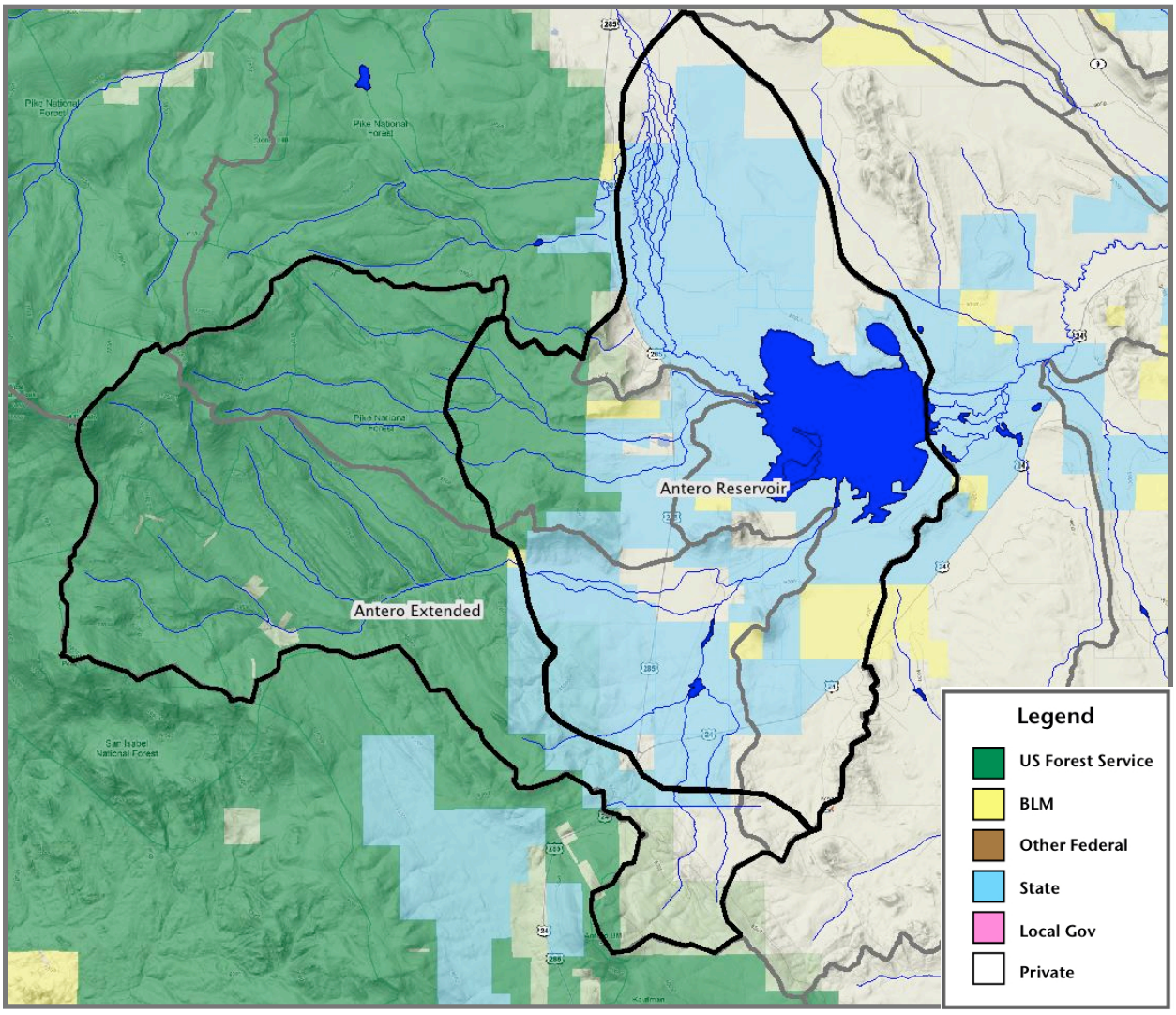


**Figure 21. Antero Reservoir ZoC Ownership**

## Antero Reservoir Watershed Priority

Salt Creek and Spring Creek watersheds are Yellow (Category 3) overall. They are both rated Red in the Flooding/Debris Flow category (Figure 22).

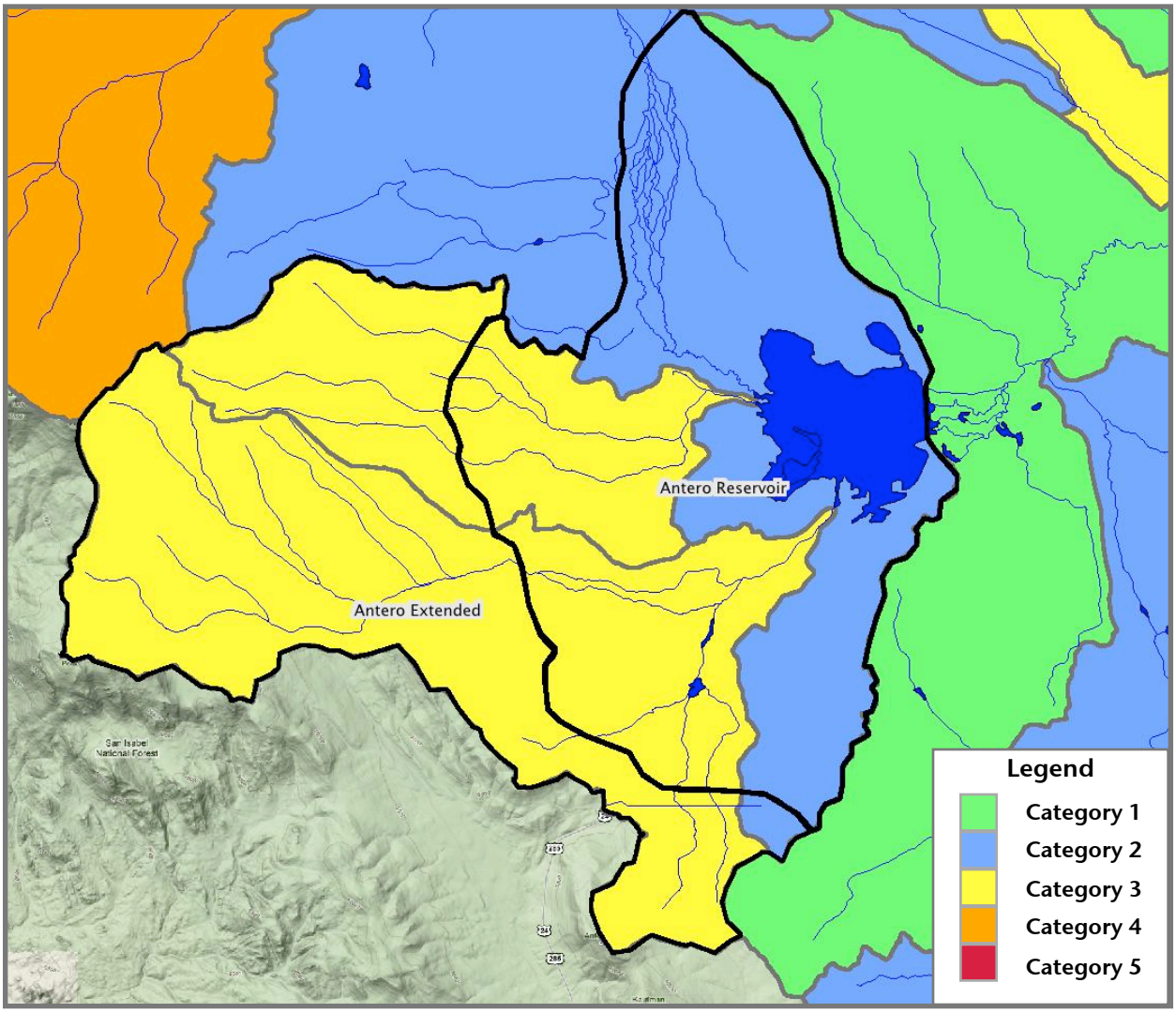


**Figure 22. Antero Reservoir ZoC Watershed Priority**

## Antero Reservoir Slopes

Most of the watershed (both the main and extended ZoC) has relatively shallow slopes. Primarily steep slopes are found at higher elevations in the extended ZoC (Figure 23).

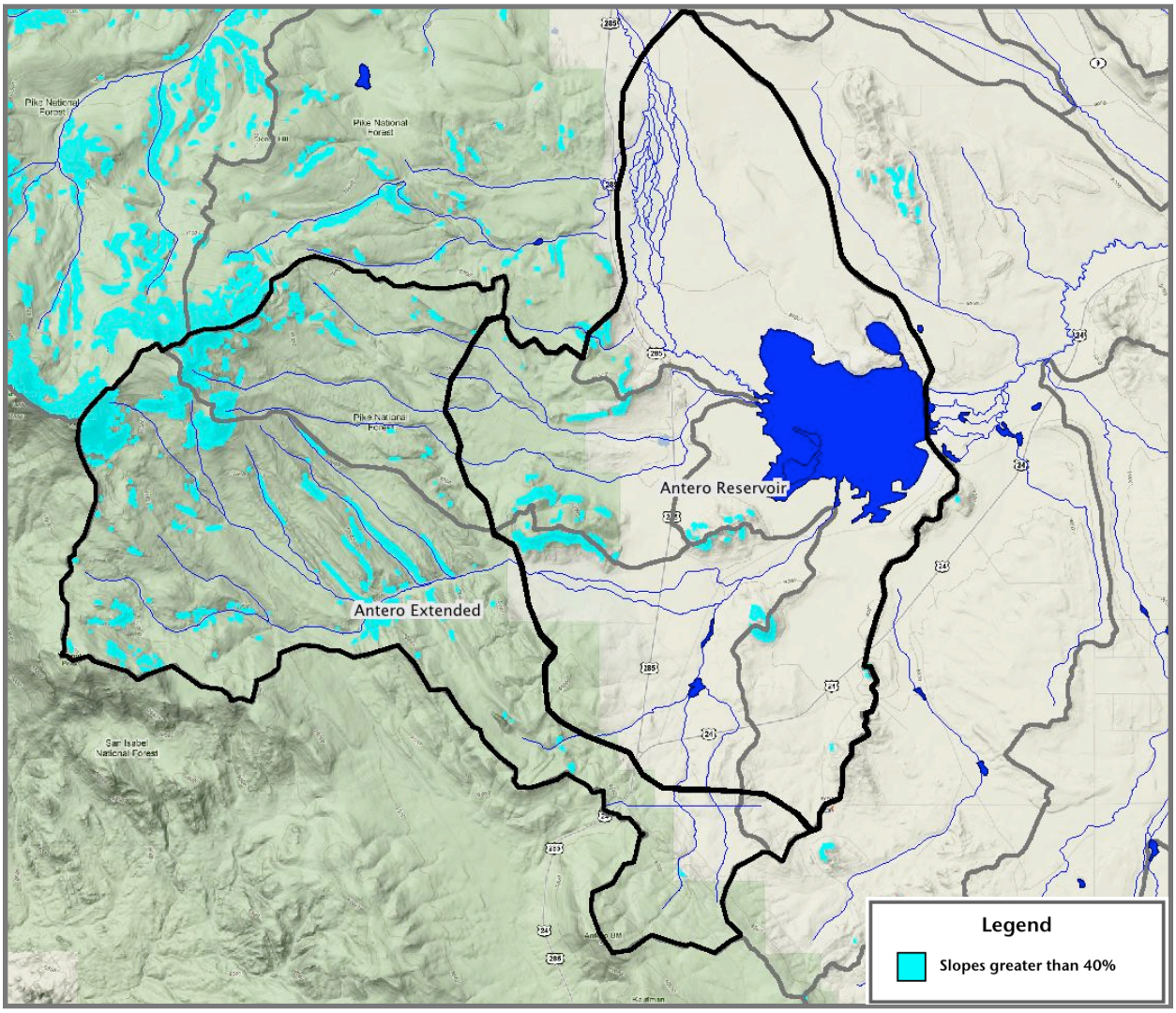


**Figure 23. Antero Reservoir ZoC Slope**

## Antero Reservoir Special Management Areas

High in the extended ZoC is the Buffalo Peaks Wilderness Area. The Buffalo Peaks South Roadless Area is below the wilderness and covers much of the Salt Creek and Spring Creek watersheds (Figure 24). The Colorado Roadless Areas extent well beyond the 2001 Roadless Rule (Federal) areas.

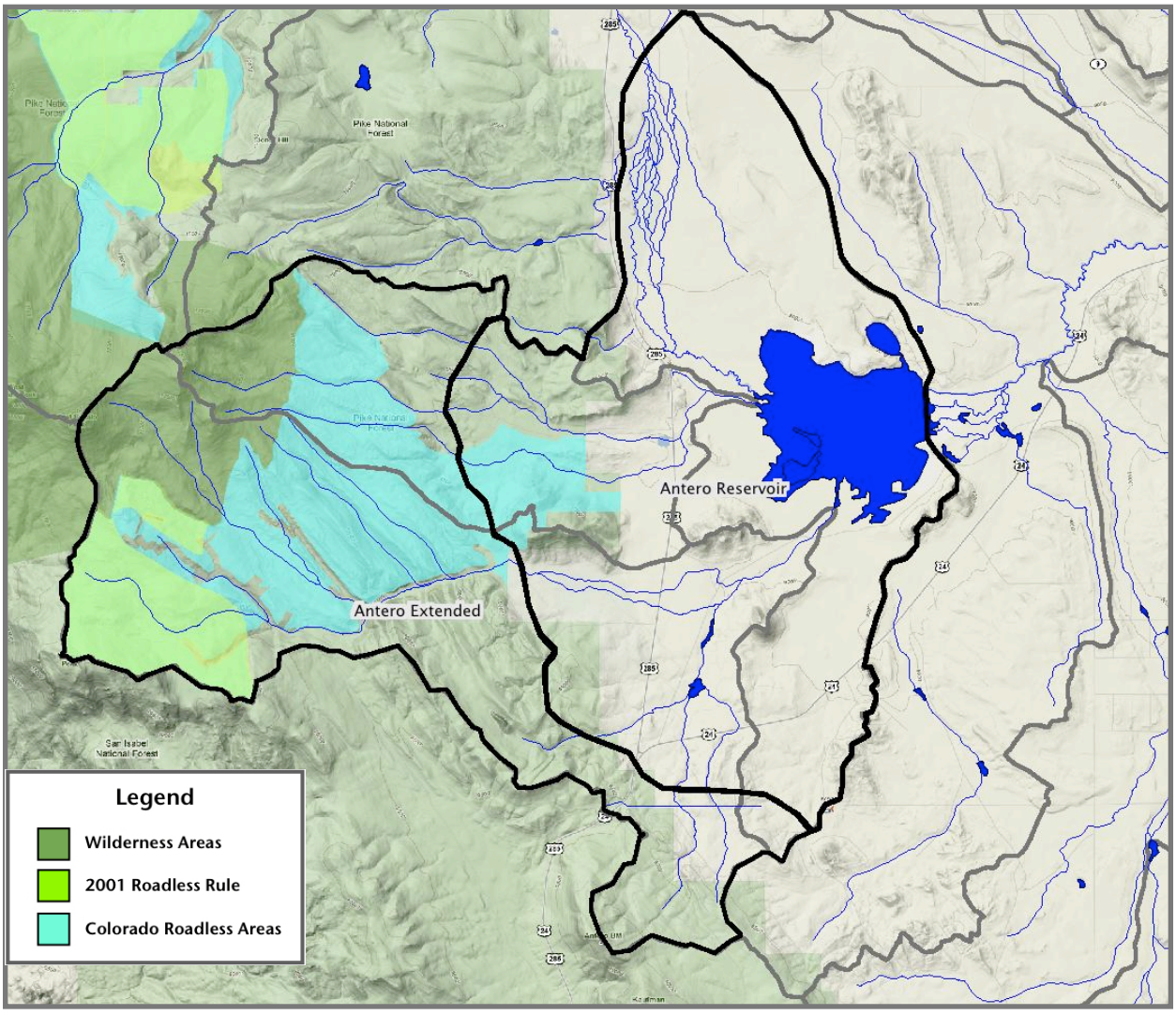


**Figure 24. Antero Reservoir ZoC Special Areas**

## Antero Reservoir Vegetation

The lower elevations are sagebrush with some pasture or other cultivated acres. The ZoC transitions quickly from these areas, through a band of ponderosa pine and up through some mixed conifer, and aspen. Highest elevations are alpine and above treeline.  Just a few small areas of lodgepole pine are present (Figure 25).

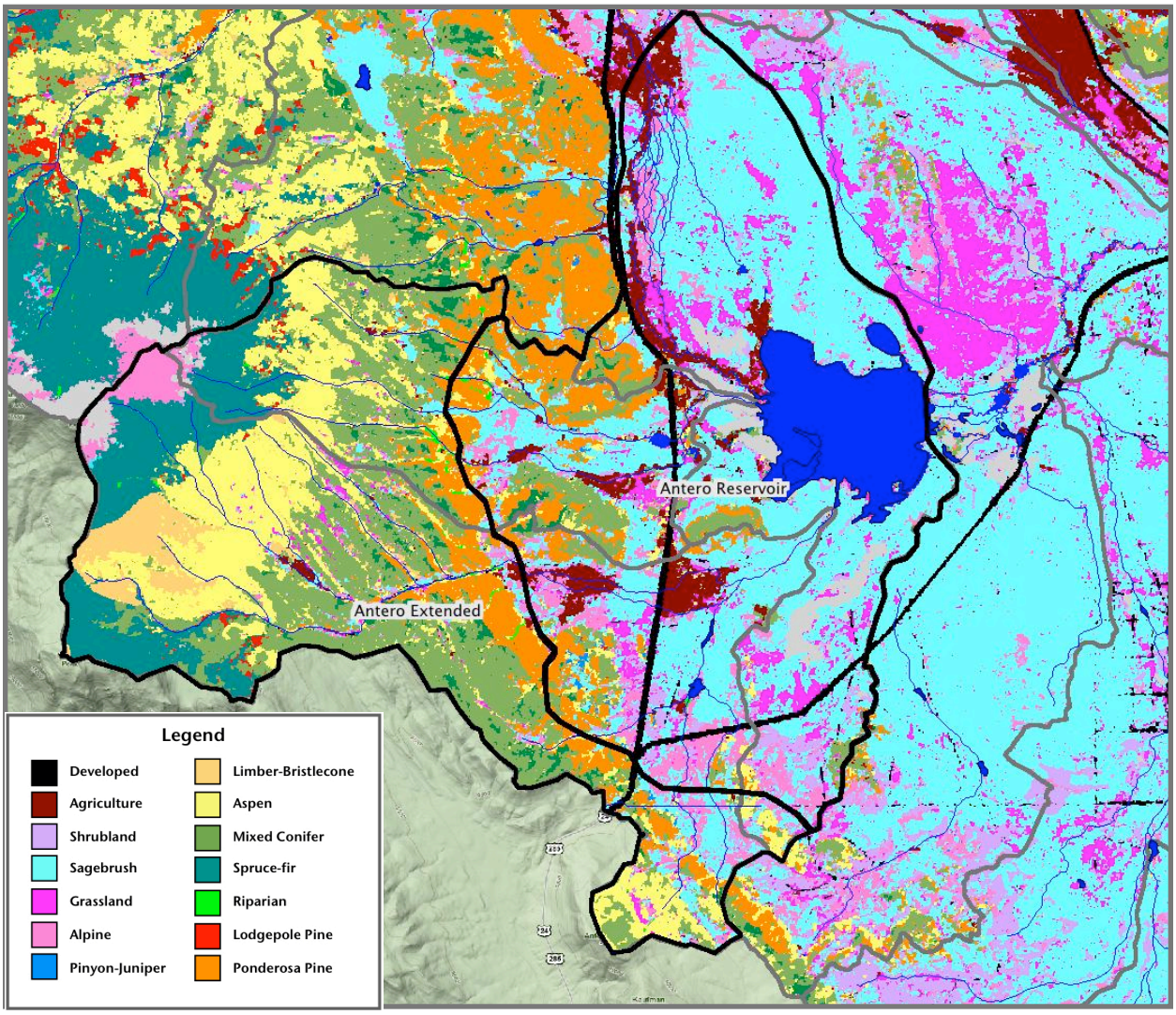


**Figure 25. Antero Reservoir ZoC Vegetation**

## Antero Reservoir Opportunities

There is some existing road access in the lower watershed. But just a few roads higher in the extended ZoC (Figure 26). There are good management opportunities in the forested areas below the roadless areas where access is available. These areas appear to be on shallower slopes and are found on NFS, State and other private lands. Treatments can vary widely including stand-level thinnings and regeneration cuts, mastication, fuelbreaks, and use of prescribed fire.

Treatments are possible in portions of the roadless areas if conducted for fire hazard mitigation for community of watershed protection purposes. Other portions of the roadless areas and all the wilderness areas should have fire use plans prepared and implemented.

It appears from aerial photos that some treatments have occurred on NFS lands in various locations. Treatments have also occurred on several private and state land parcels. The Colorado State Forest Service has management authority over many of the State Land Board lands as well as the Denver Water lands.

Stakeholders include: Denver Water, US Forest Service, private landowners, State of Colorado and Colorado State Forest Service.

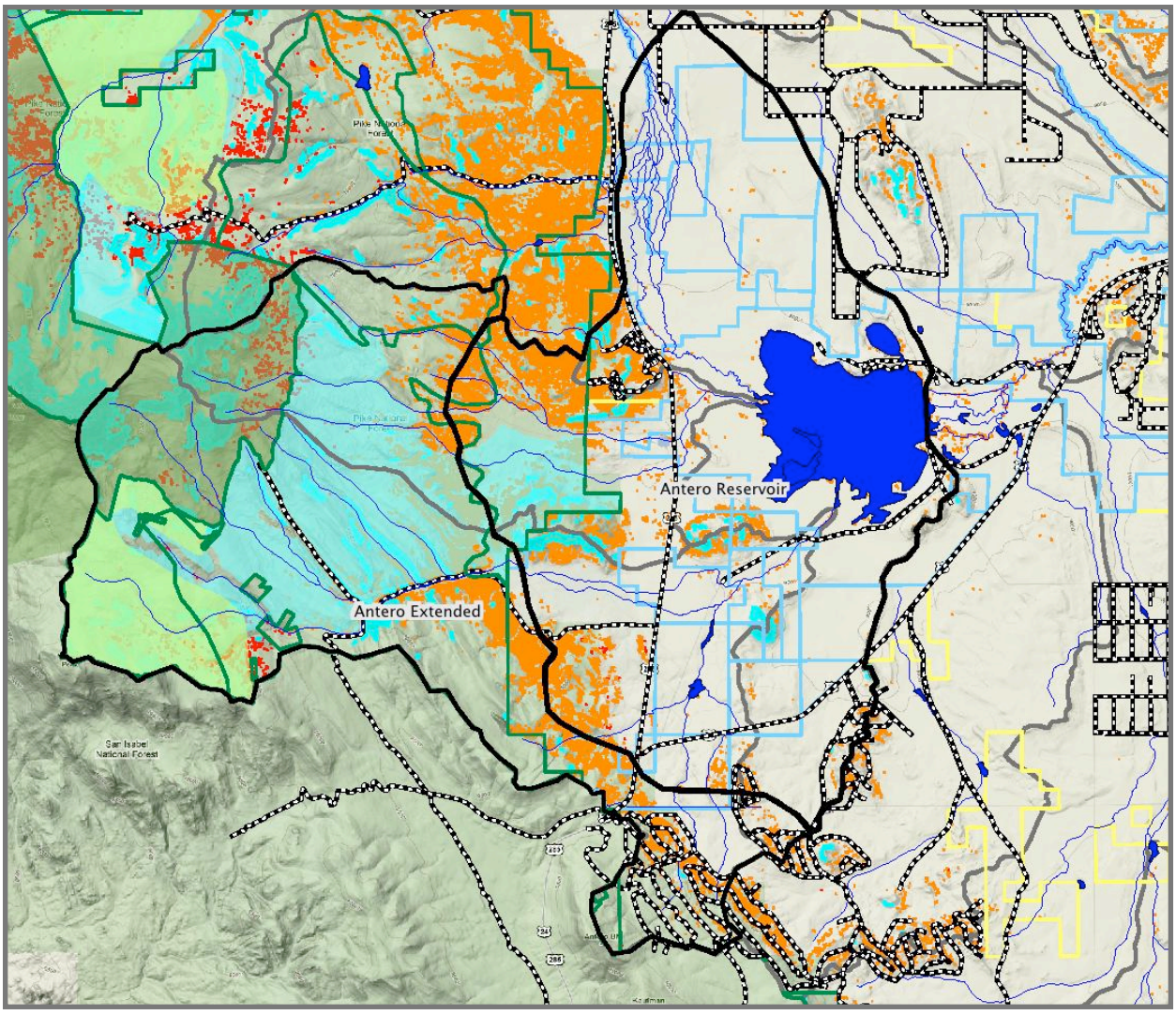


**Figure 26. Antero Reservoir ZoC Opportunities**

## Elevenmile & Spinney Mountain Reservoirs ZoC

The maps and analysis for the Elevenmile Reservoir and Spinney Mountain Reservoir ZoC are combined. Figure 27 shows the general location of the Elevenmile Reservoir and Spinney Mountain Reservoir ZoC. Note that the ZoC are shown here in pink with crosshatching, but in the remaining figures the outlines appear as bold black lines with no crosshatching.

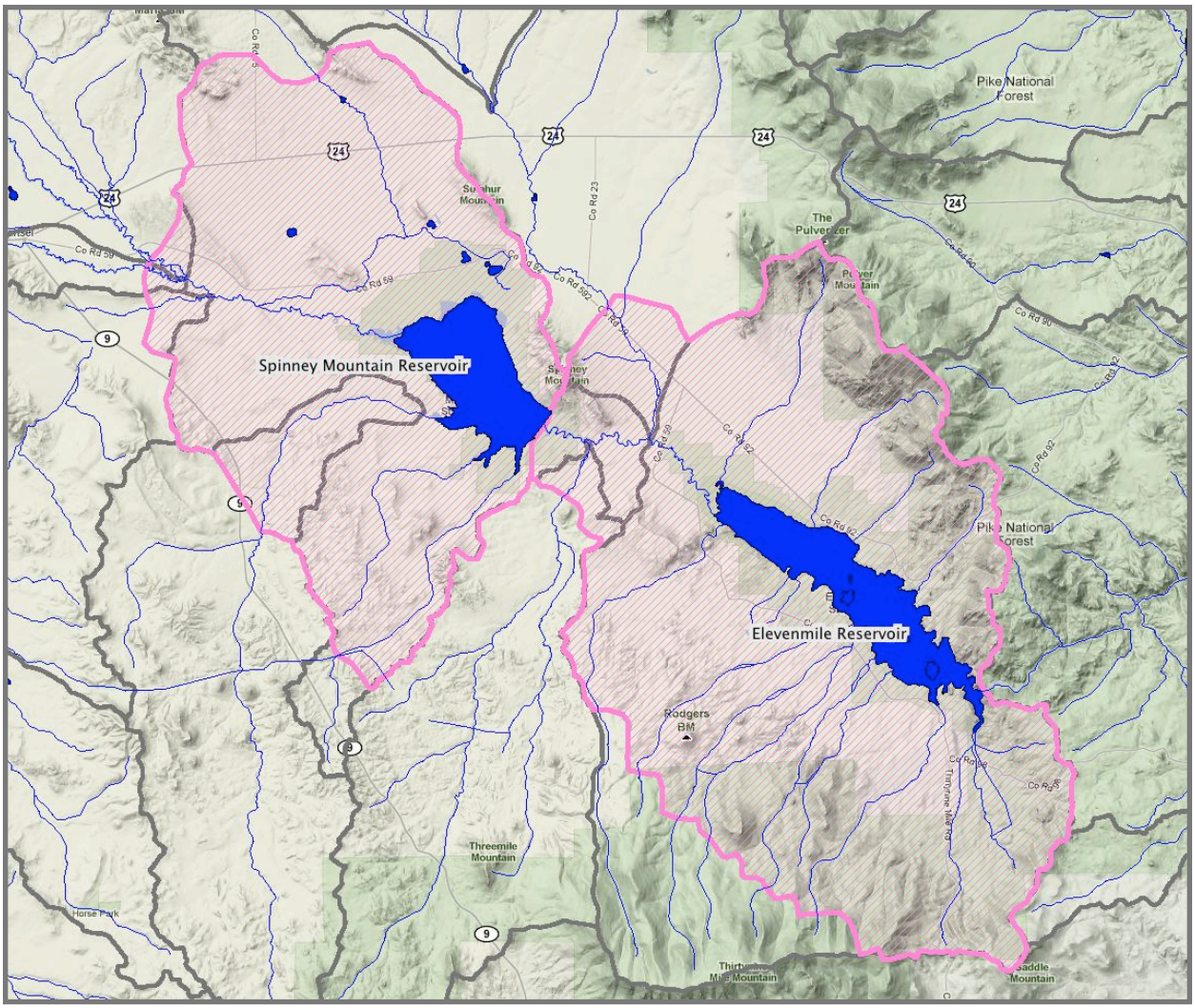


**Figure 27. Spinney Mountain and Elevenmile Reservoirs ZoC Location**

## Elevenmile Reservoir Ownership

Land ownership is a mixture of BLM, State, Denver Water and private in the lower elevations of the ZoC. The higher elevations are mostly NFS Lands (Figure 28).

## Spinney Mountain Reservoir Ownership

Land ownership is a mixture of BLM, State, and private (Figure 28).

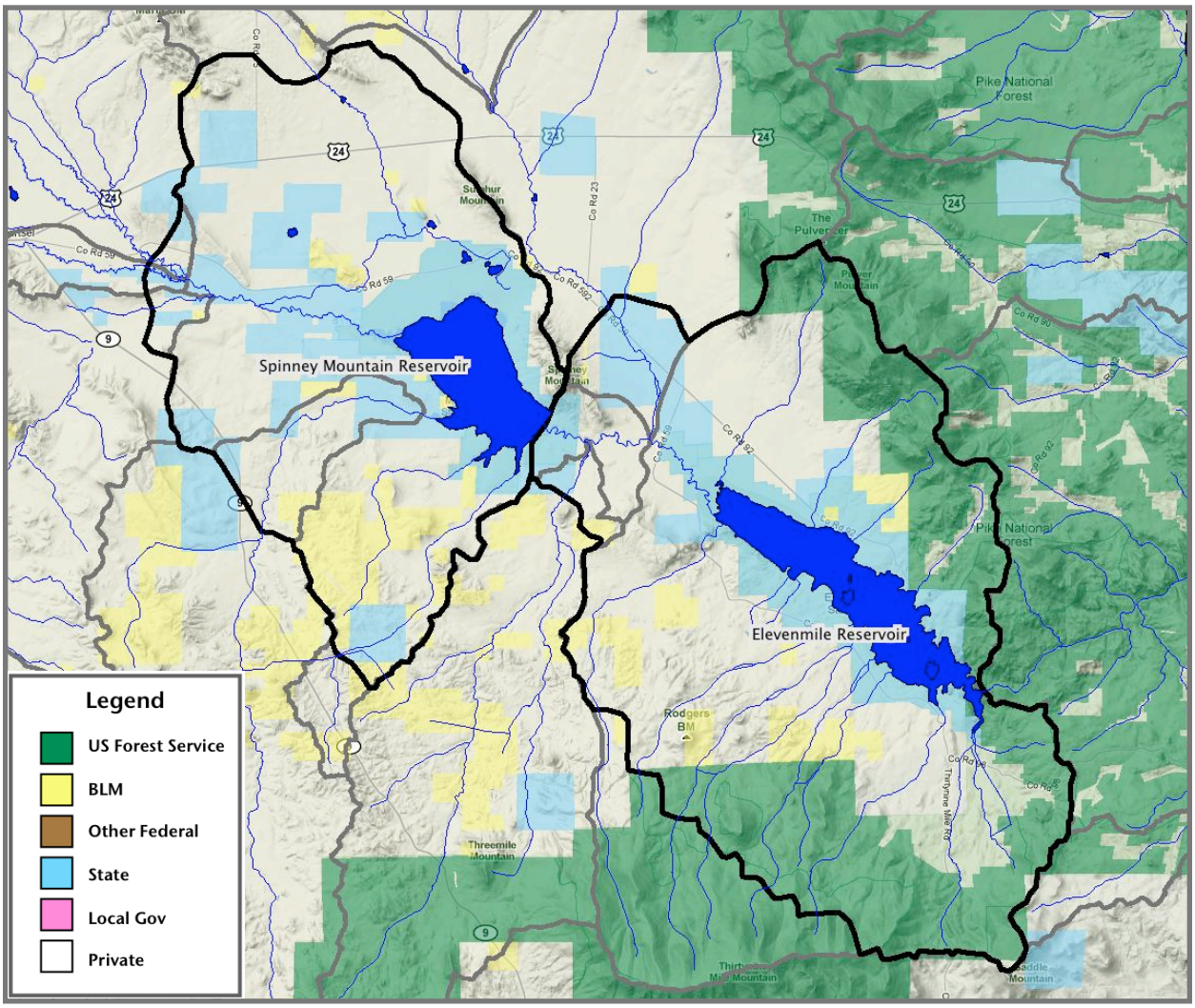


**Figure 28. Spinney Mountain and Elevenmile Reservoirs ZoC Ownership**

## Elevenmile Reservoir Watershed Priority

The Elevenmile Reservoir watershed is rated as Yellow (Category 3) overall (Figure 29).

## Spinney Mountain Reservoir Watershed Priority

The Spinney Mountain Reservoir watershed is rated as Green (Category 1) overall (Figure 29).

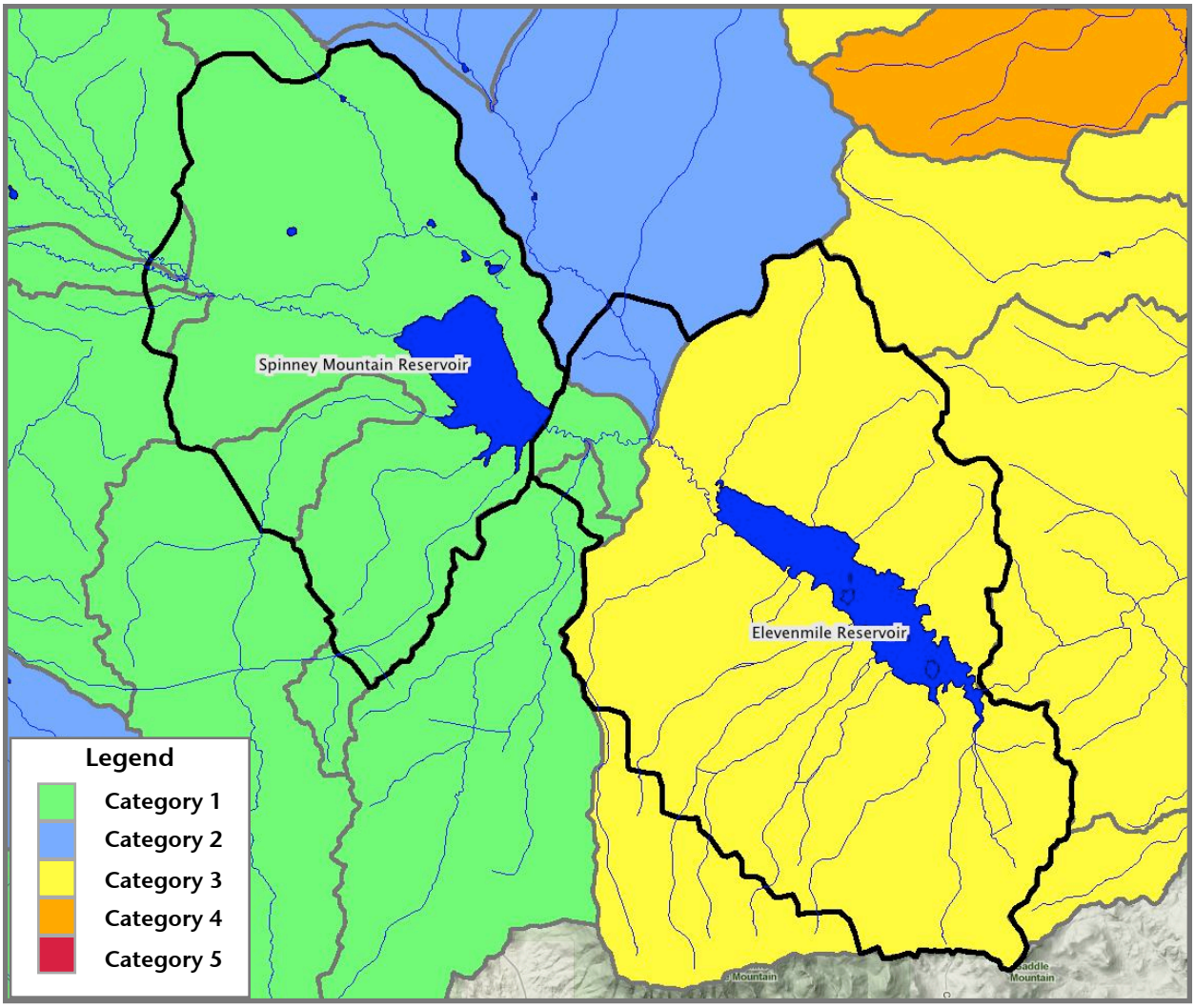


**Figure 29. Spinney Mountain and Elevenmile Reservoirs ZoC Watershed Priority**

## Elevenmile Reservoir Slopes

There are some areas of steep slopes mainly north and east of the reservoir (Figure 30). Smaller areas of steep slopes are present south of the reservoir. The steep slopes are at the higher elevations.

## Spinney Mountain Reservoir Slopes

There are very few areas of steep slopes that limit management operations (Figure 30).

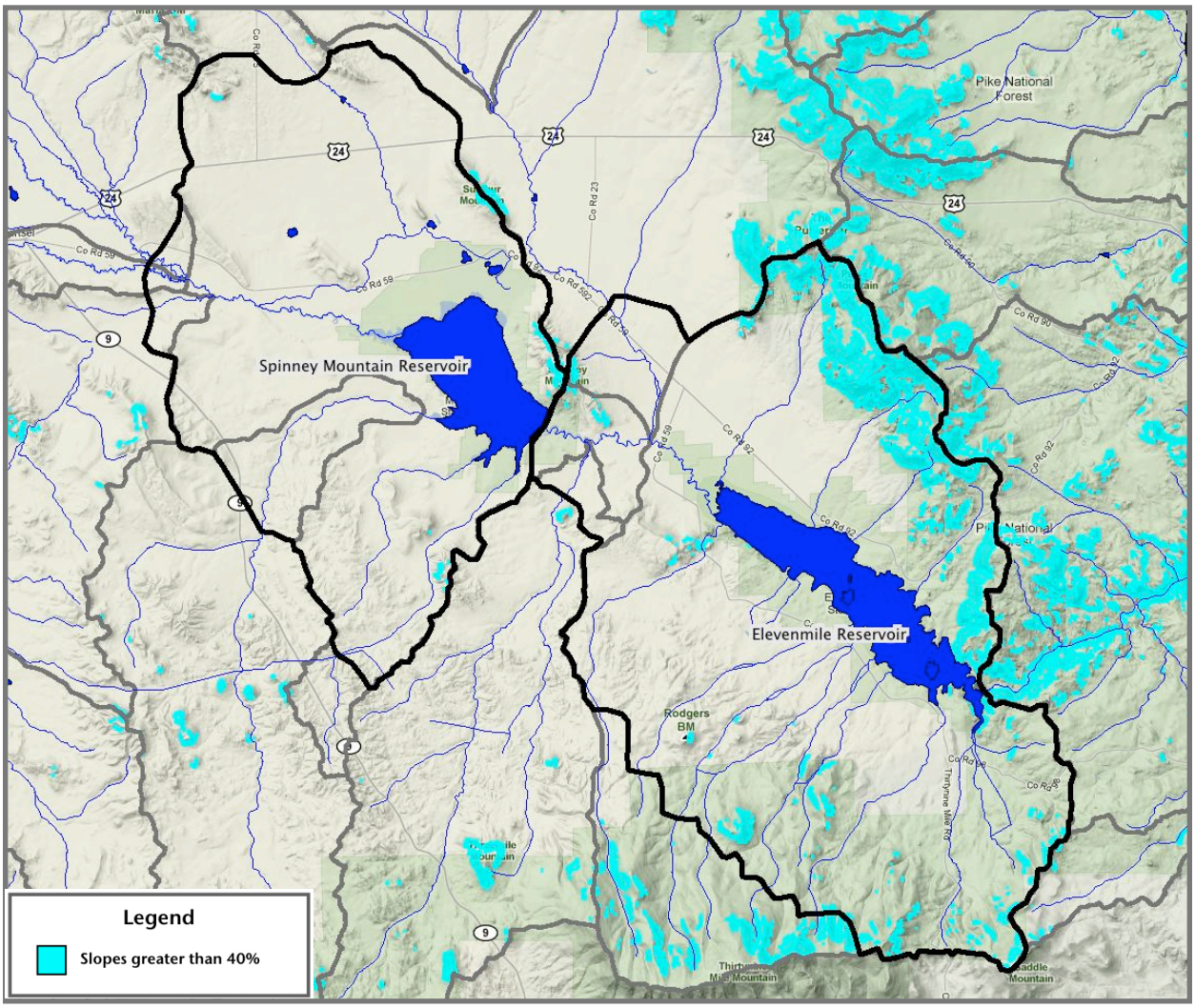


**Figure 30. Spinney Mountain and Elevenmile Reservoirs ZoC Slope**

## Elevenmile Reservoir Special Management Areas

There are no wilderness areas. There are two roadless areas, Puma Hills to the north and Thirty-nine Mile Mountain to the south of the reservoir (Figure 31). The Colorado Roadless Areas extend slightly beyond the 2001 Roadless Rule (Federal) areas.

## Spinney Mountain Reservoir Special Management Areas

There are no wilderness or roadless areas (Figure 31).

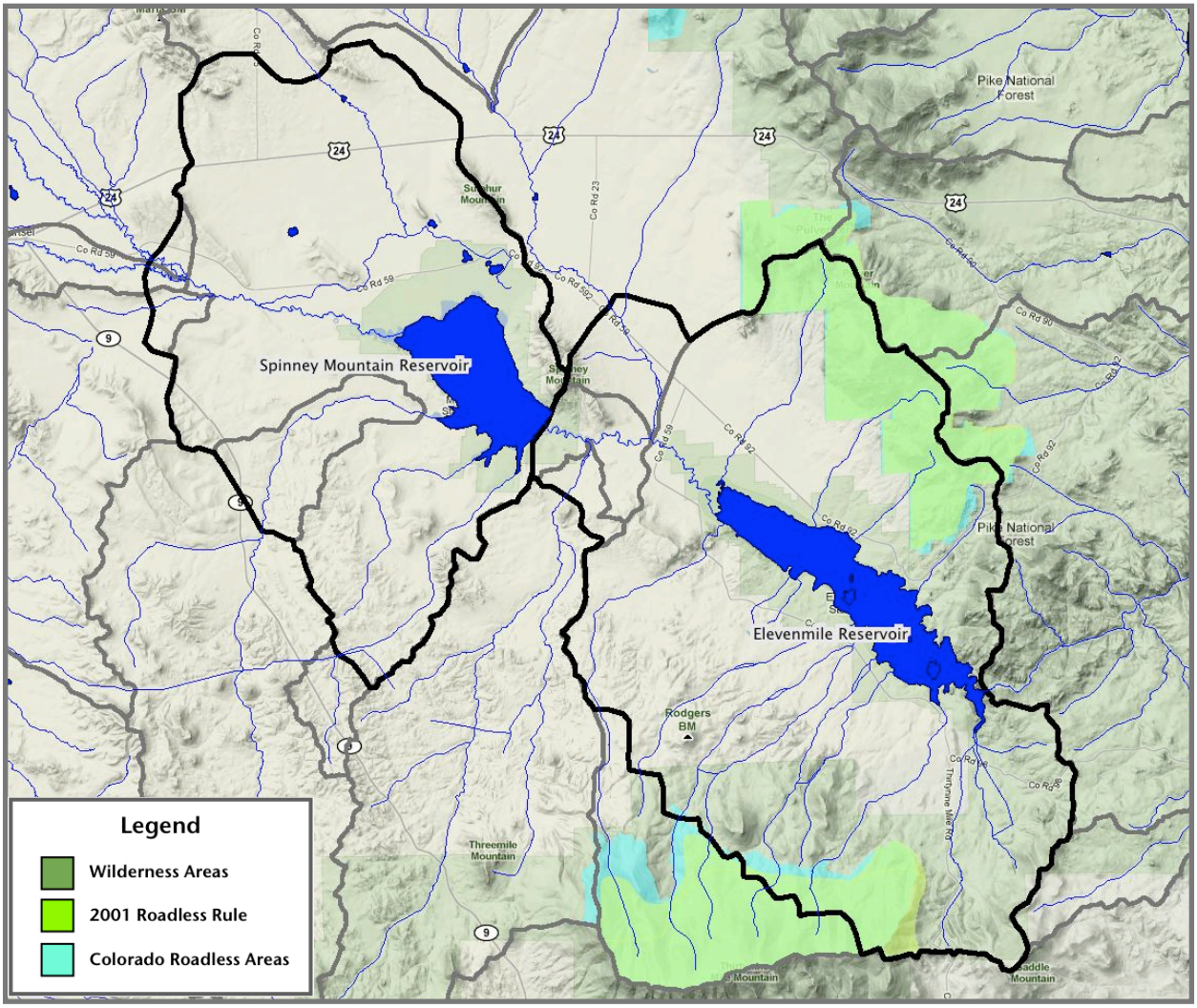


**Figure 31. Spinney Mountain and Elevenmile Reservoirs ZoC Special Areas**

## Elevenmile Reservoir Vegetation

Vegetation is mostly grasslands and sagebrush surrounding the reservoir and other areas low in the watershed (Figure 32). Where grazed, these areas typically will only carry fire under the most extreme conditions. Where areas have not been grazed, fires will carry more consistently, especially in drainage bottoms or other areas where moisture is more available to the grasses. North of the reservoir contains some ponderosa pine transitioning to mixed conifer and spruce/fir at higher elevations. South of the reservoir contains ponderosa pine transitioning to mixed conifer, aspen and spruce-fir at higher elevations.

## Spinney Mountain Reservoir Vegetation

Vegetation is almost entirely short grass and sagebrush (Figure 32).

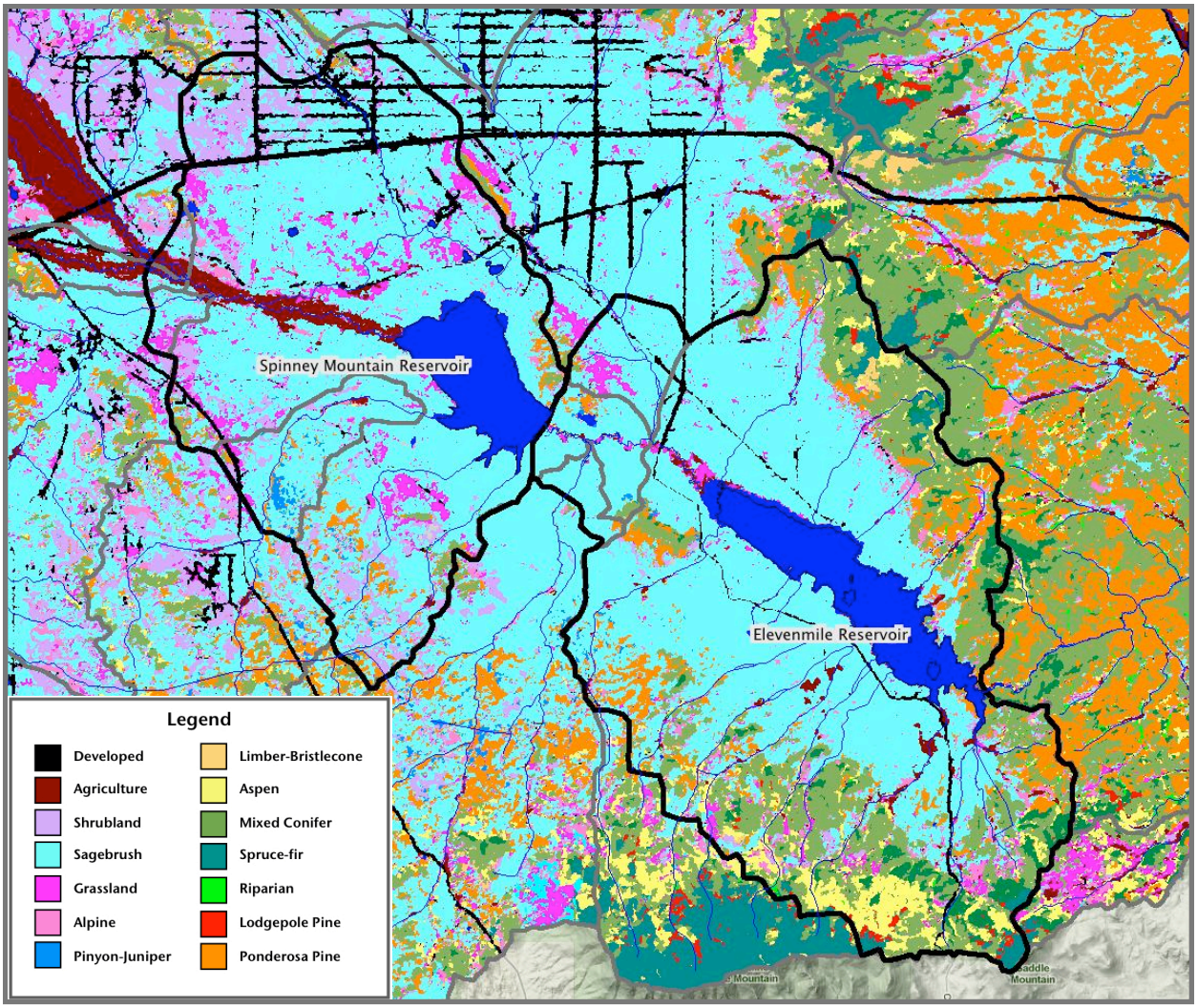


**Figure 32. Spinney Mountain and Elevenmile Reservoirs ZoC Vegetation**

## Elevenmile Reservoir Opportunities

There are existing county, ranch and BLM roads that provide access in the lower portions of the watershed. There are some US Forest Service roads at higher elevations, but many higher elevation areas have no existing road access (Figure 33).

There are some opportunities in ponderosa pine and mixed conifer that are below the roadless areas on both the north and south sides of the reservoir. Some of these areas have some existing road access and slopes less than 40 percent. The land ownership is mixed; NFS, BLM, Denver Water and private lands.

Denver Water owns the land immediately around Elevenmile Reservoir, and it is leased to Colorado State Parks for recreational use. The Colorado State Forest Service provides vegetation management assistance to both Denver Water and State Parks. A fuels management plan has been prepared for Elevenmile and implementation began during 2009 with some forest thinning and prescribed fire activities conducted. Mixed ownerships provide opportunity for cross-boundary treatments and utilization of the Good Neighbor and Wyden Amendment Authorities.

Stakeholders include: Denver Water, US Forest Service, private landowners, State of Colorado, Park County and Colorado State Forest Service.

## Spinney Mountain Reservoir Opportunities

There are some primary roads, subdivision and ranching access roads throughout the ZoC (Figure 33). There are few management opportunities, and no critical fuels management needs, due to the lack of forested vegetation and the lowest watershed priority ranking. Many of the lands in this area will not carry fire consistently if they have been grazed. Un-grazed areas could benefit from periodic use of prescribed fire. On a small scale, grass and shrublands can be managed through periodic mowing.

Stakeholders include: City of Aurora, US Forest Service, private landowners, State of Colorado, Park County and Colorado State Forest Service.

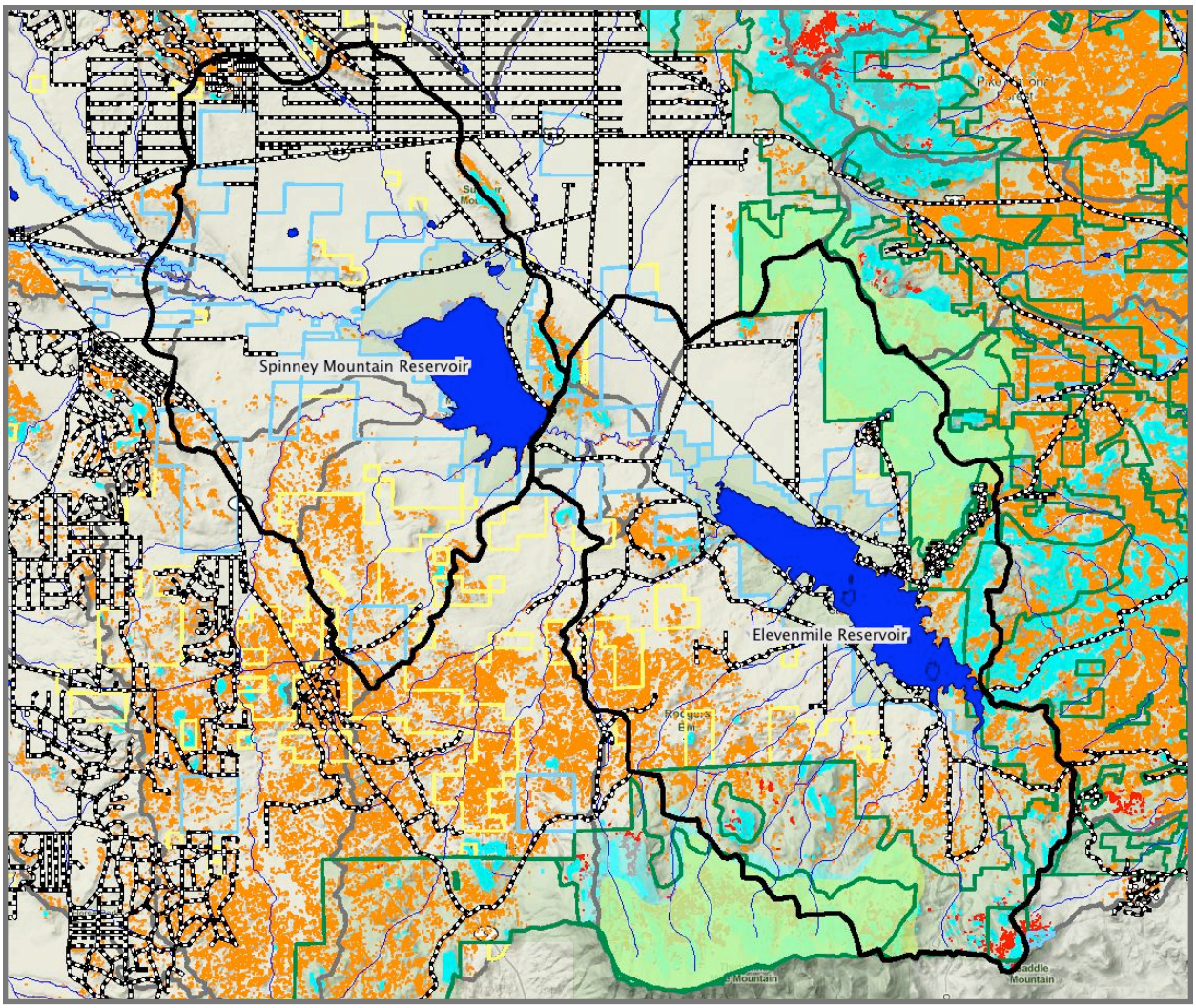


**Figure 33. Spinney Mountain and Elevenmile Reservoirs ZoC Opportunities**

# James Tingle Reservoir ZoC

Figure 34 shows the general location of the James Tingle Reservoir ZoC. Note that the ZoC are shown here in pink with crosshatching, but in the remaining figures the outlines appear as bold black lines with no crosshatching.

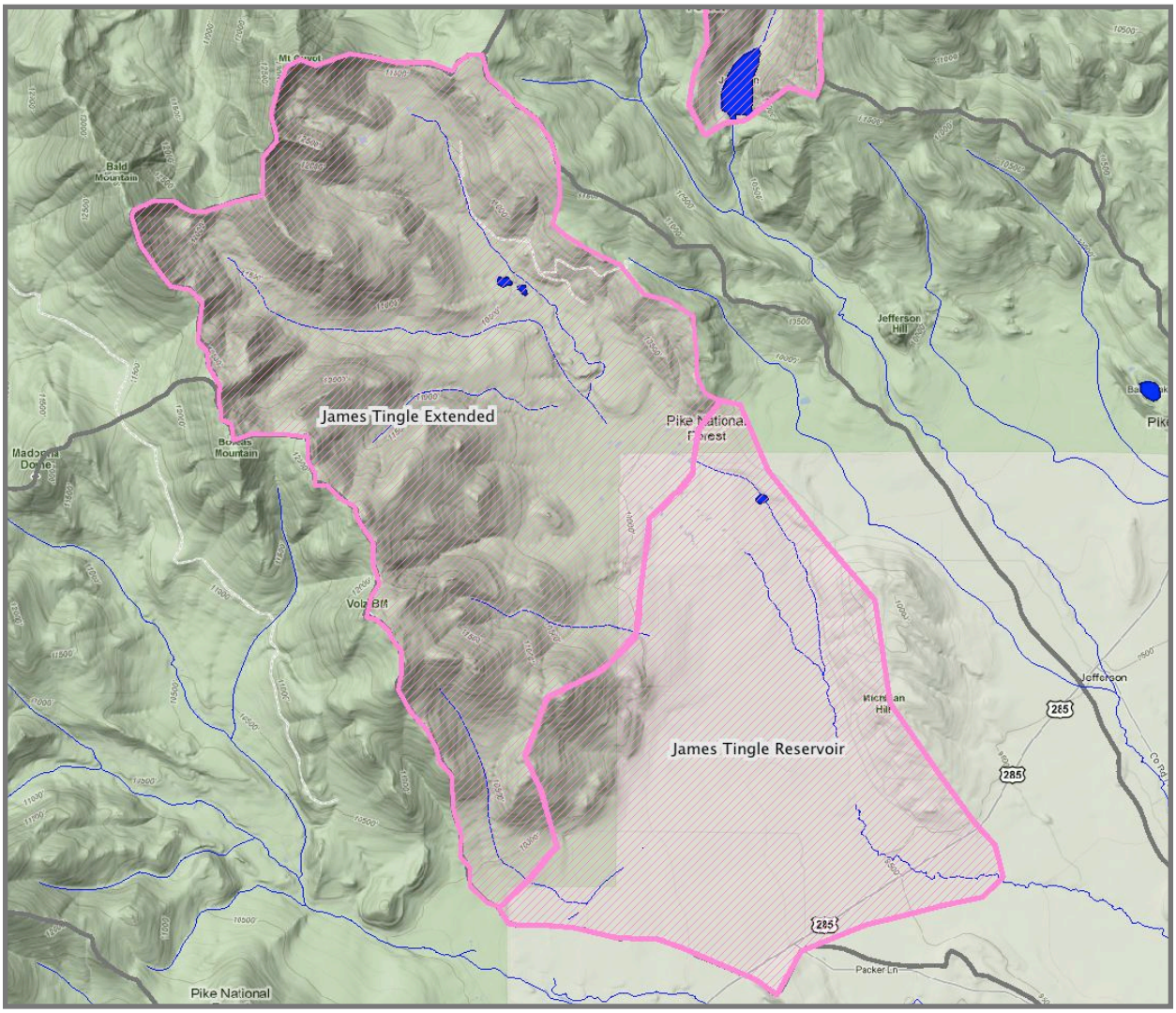


**Figure 34. James Tingle Reservoir ZoC Location**

## James Tingle Reservoir Ownership

Land ownership is mostly private lands within the 5-mile ZoC and mostly NFS lands in the extended ZoC (Figure 35).

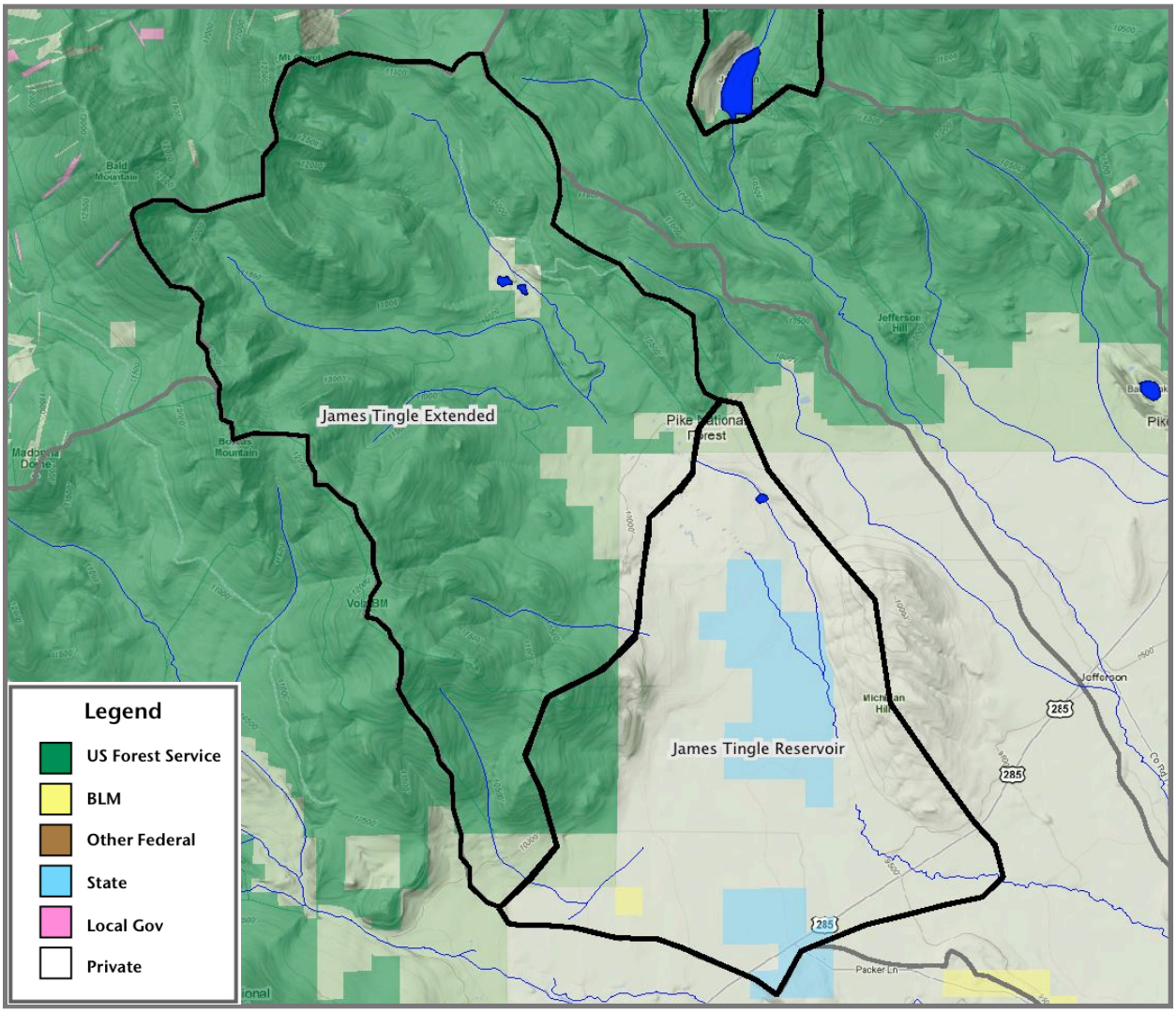


**Figure 35. James Tingle Reservoir ZoC Ownership**

## James Tingle Reservoir Watershed Priority

The Michigan Creek watershed is ranked Orange (Category 4) overall. Wildfire Hazard and Flooding/Debris Flow are ranked Yellow (Figure 36).

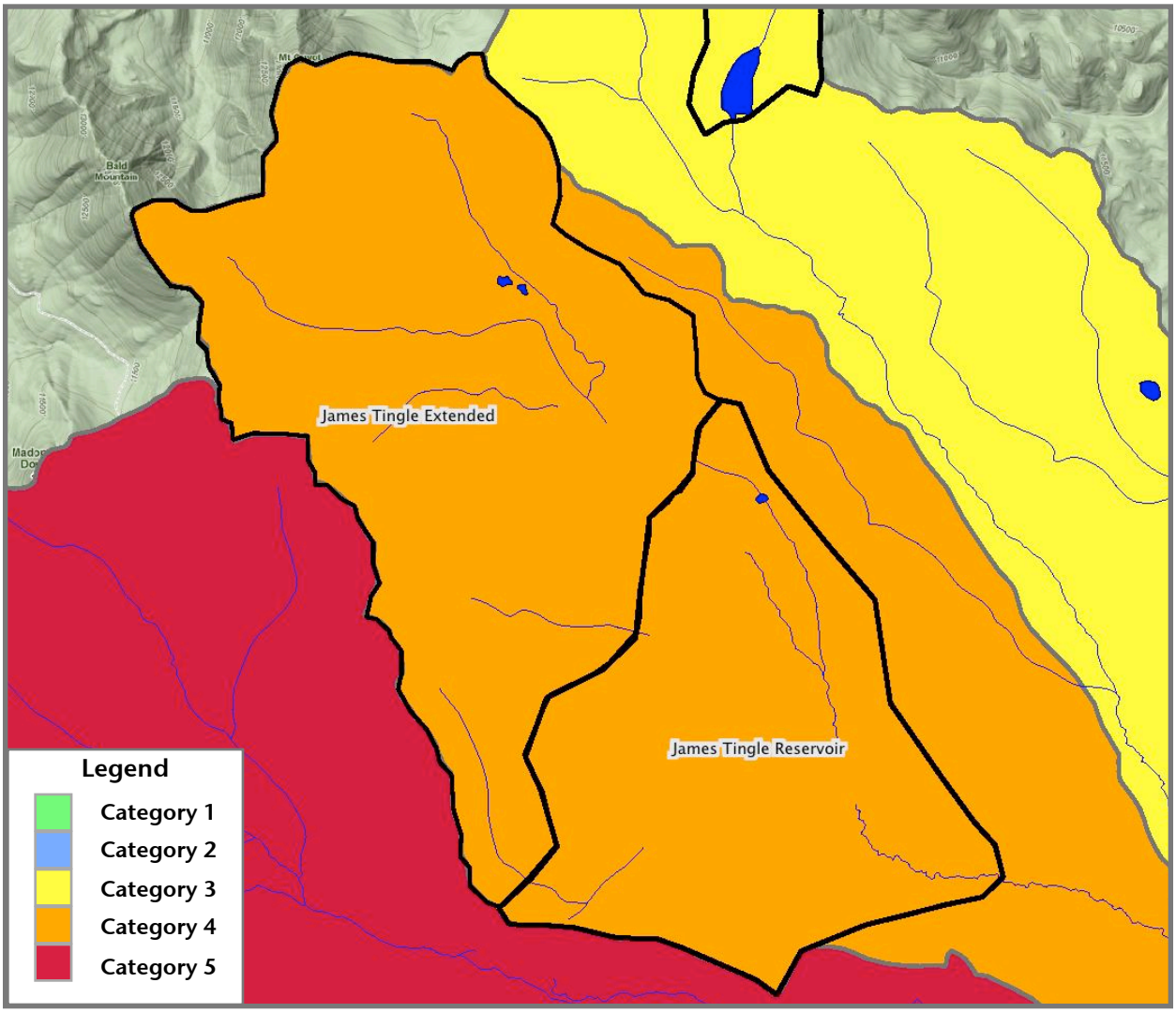


**Figure 36. James Tingle Reservoir ZoC Watershed Priority**

## James Tingle Reservoir Slopes

The areas of steep slopes are higher in the extended ZoC (Figure 37). The remainder of the ZoC is relatively shallow.

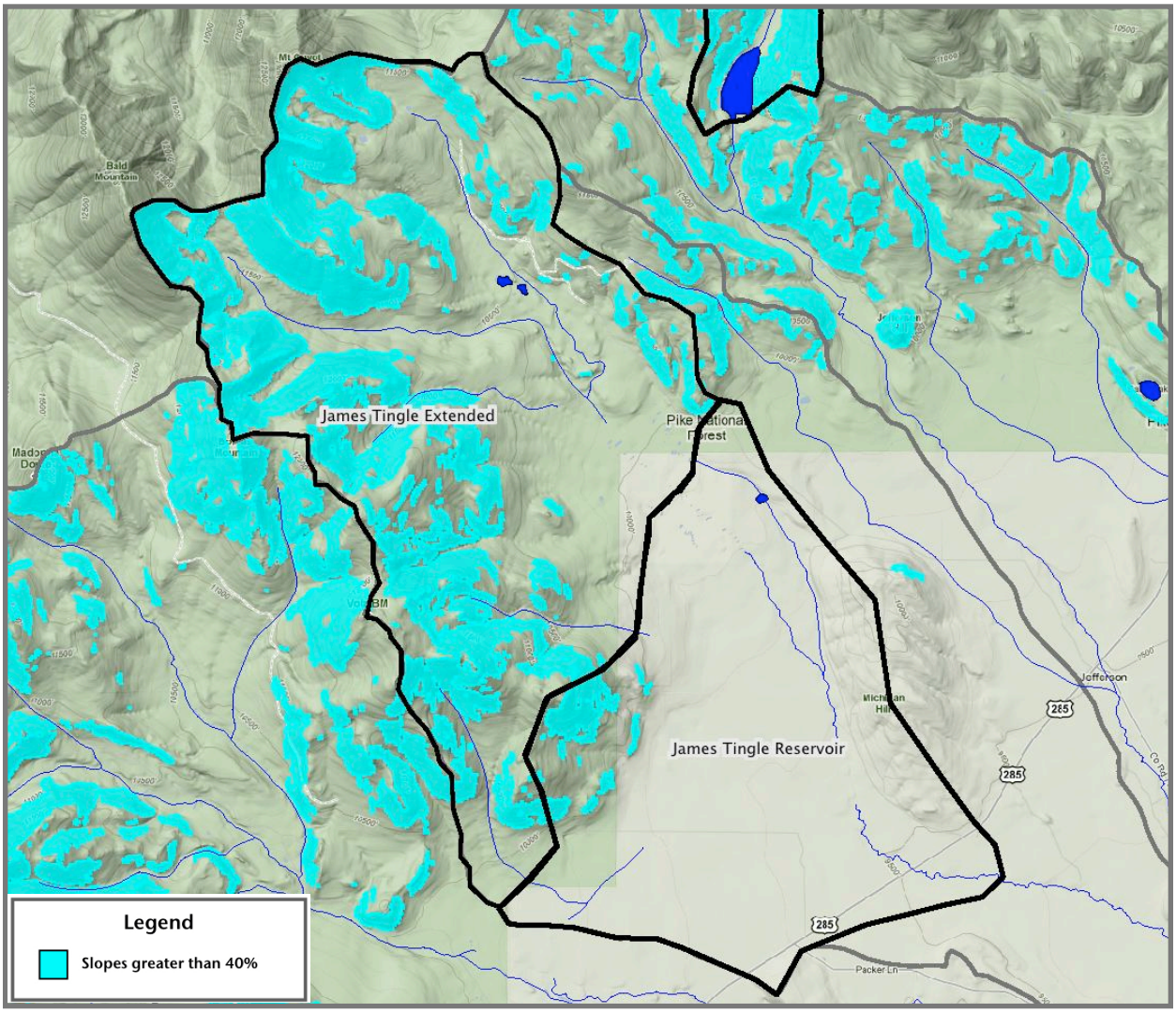


**Figure 37. James Tingle Reservoir ZoC Slope**

## James Tingle Reservoir Special Management Areas

There are no wilderness areas. There are Roadless Areas in the extended ZoC. The Boreas Roadless Area covers a large area in the western portion of the extended ZoC (Figure 38). The Jefferson Roadless Area covering a smaller area in the Northeastern corner of the extended ZoC. A large portion of the Boreas Roadless Area is Colorado Roadless Area only.

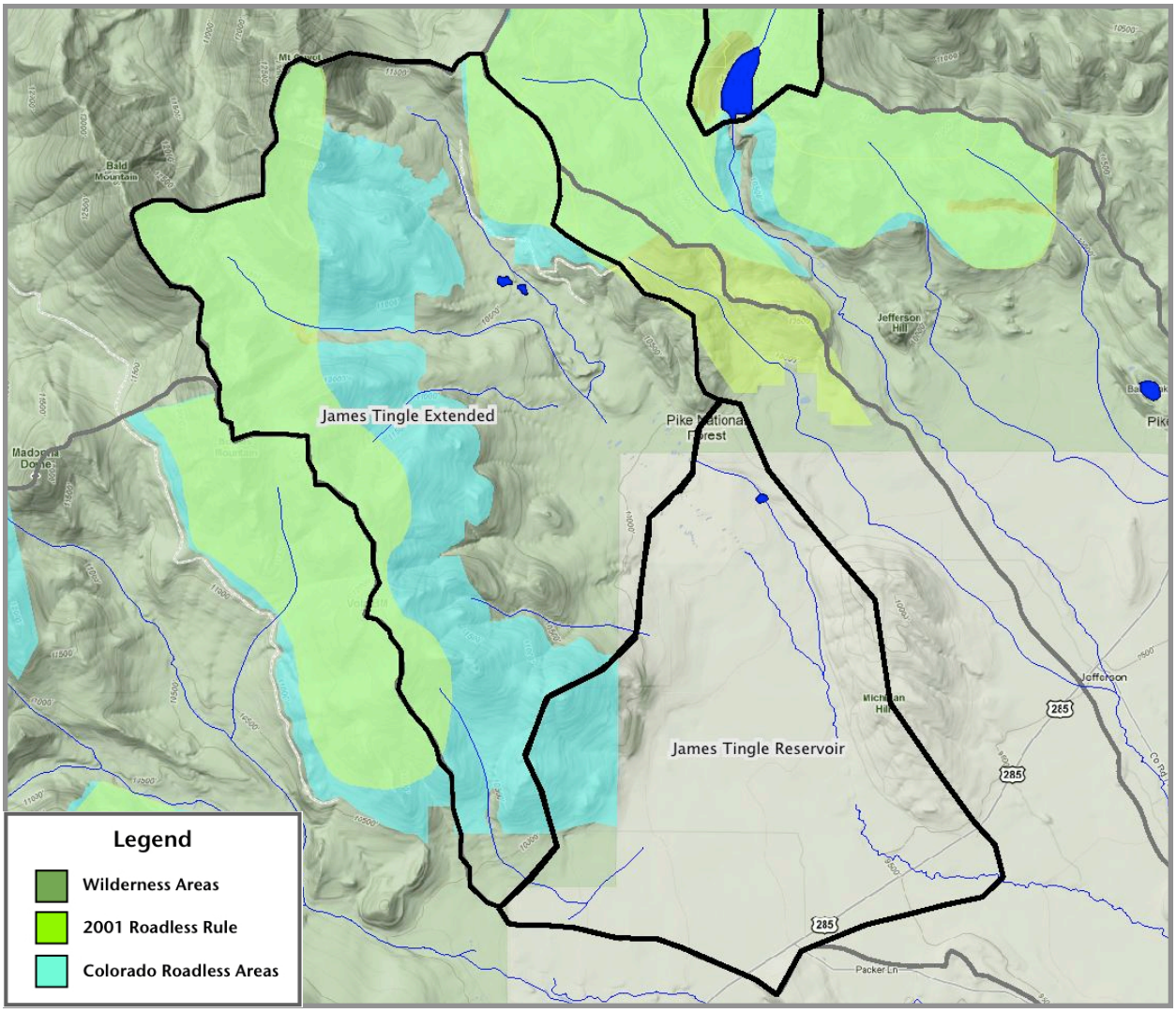


**Figure 38. James Tingle Reservoir ZoC Special Areas**

## James Tingle Reservoir Vegetation

The 5-mile ZoC is mostly grasslands and shrublands Figure 39). The extended ZoC is mostly forested. The ZoC transitions from grasslands and shrublands at the lower elevations to aspen, lodgepole and spruce-fir, and then to alpine at the highest elevations. Grasslands and shrublands in this area are likely to be of minor concern from a wildfire hazard standpoint.

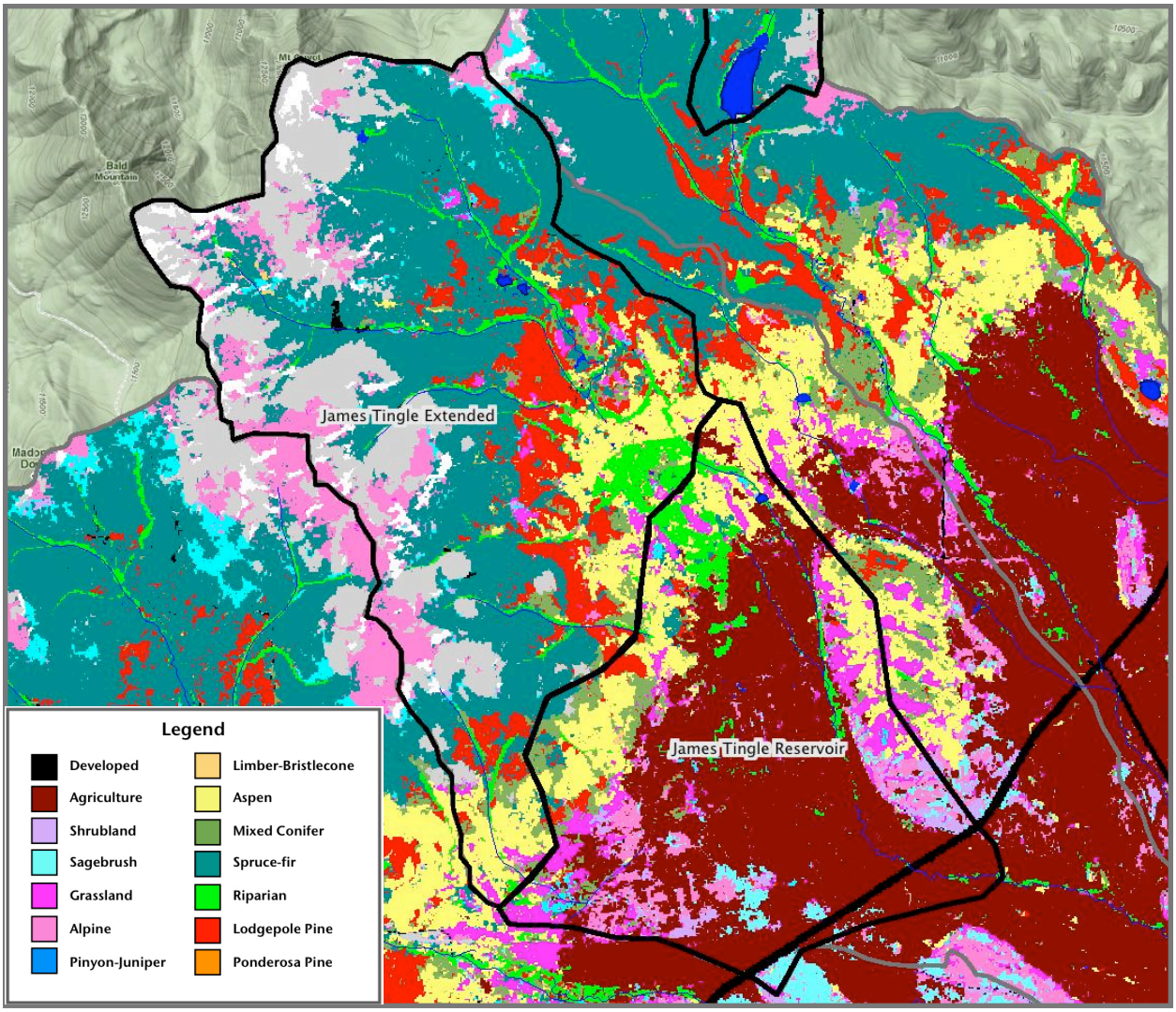


**Figure 39. James Tingle Reservoir ZoC Vegetation**

## James Tingle Reservoir Opportunities

There are management and fuel hazard reduction opportunities in lodgepole pine and spruce outside of Roadless Areas on slopes less than 40 percent, on all ownerships with good road access. Some vegetation management has been completed on NFS lands. If localized areas of shrublands are problematic, hazards can be mitigated relatively easily. The alpine areas are generally of little wildfire hazard concern. It appears that within the extended ZoC considerable thinning and harvesting have occurred on the NFS lands outside of roadless areas. Thinned and regenerated areas may be due for another entry to further thin, or to complete non-commercial thinnings. Mountain pine beetles are beginning to appear in scattered locations in lodgepole pine. There is an area of lodgepole in the north end of the subdivision where thinning could occur.

In areas of aspen, removal of encroaching conifers would help maintain aspen. Aspen is generally a good species to favor from a wildfire hazard standpoint. Some aspen stands in this area are old and suffering from Sudden Aspen Decline (SAD). These areas should be considered for regeneration to maintain this vegetation type (Figure 40).

Treatment area within the Roadless Areas would need a fuels treatment plan specifically addressing watershed protection and would require approval from the USFS Regional Forester. There are Roadless Areas where conditions are favorable for management. Treatment plans for these locations should be designed to develop greater stand and landscape diversity.

Stakeholders include: Center of Colorado Conservancy District, US Forest Service, private landowners, Park County and Colorado State Forest Service.

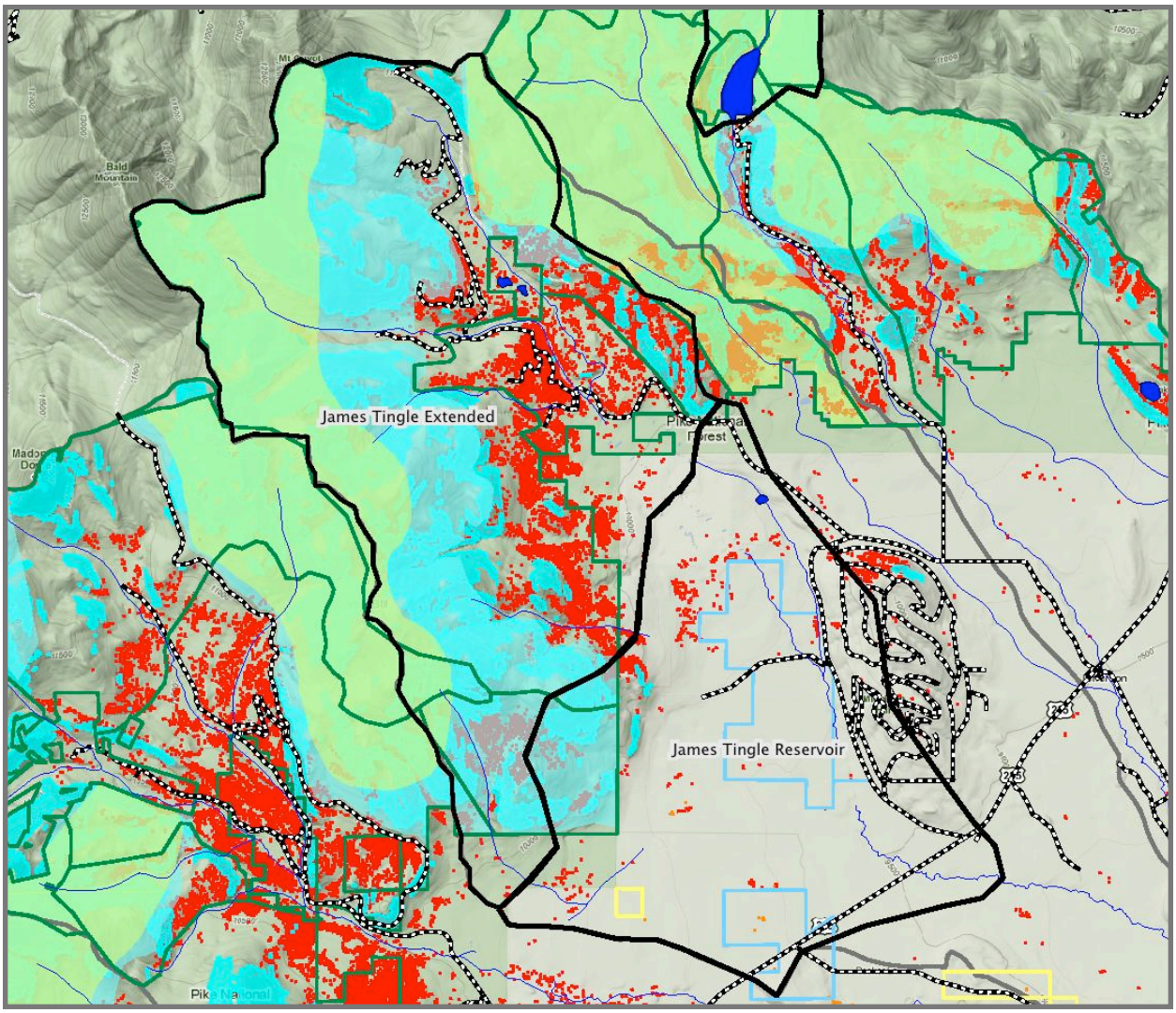


**Figure 40. James Tingle Reservoir ZoC Opportunities**

# Jefferson Lake ZoC

Figure 41 shows the general location of the Jefferson Lake ZoC. Note that the ZoC are shown here in pink with crosshatching, but in the remaining figures the outlines appear as bold black lines with no crosshatching.

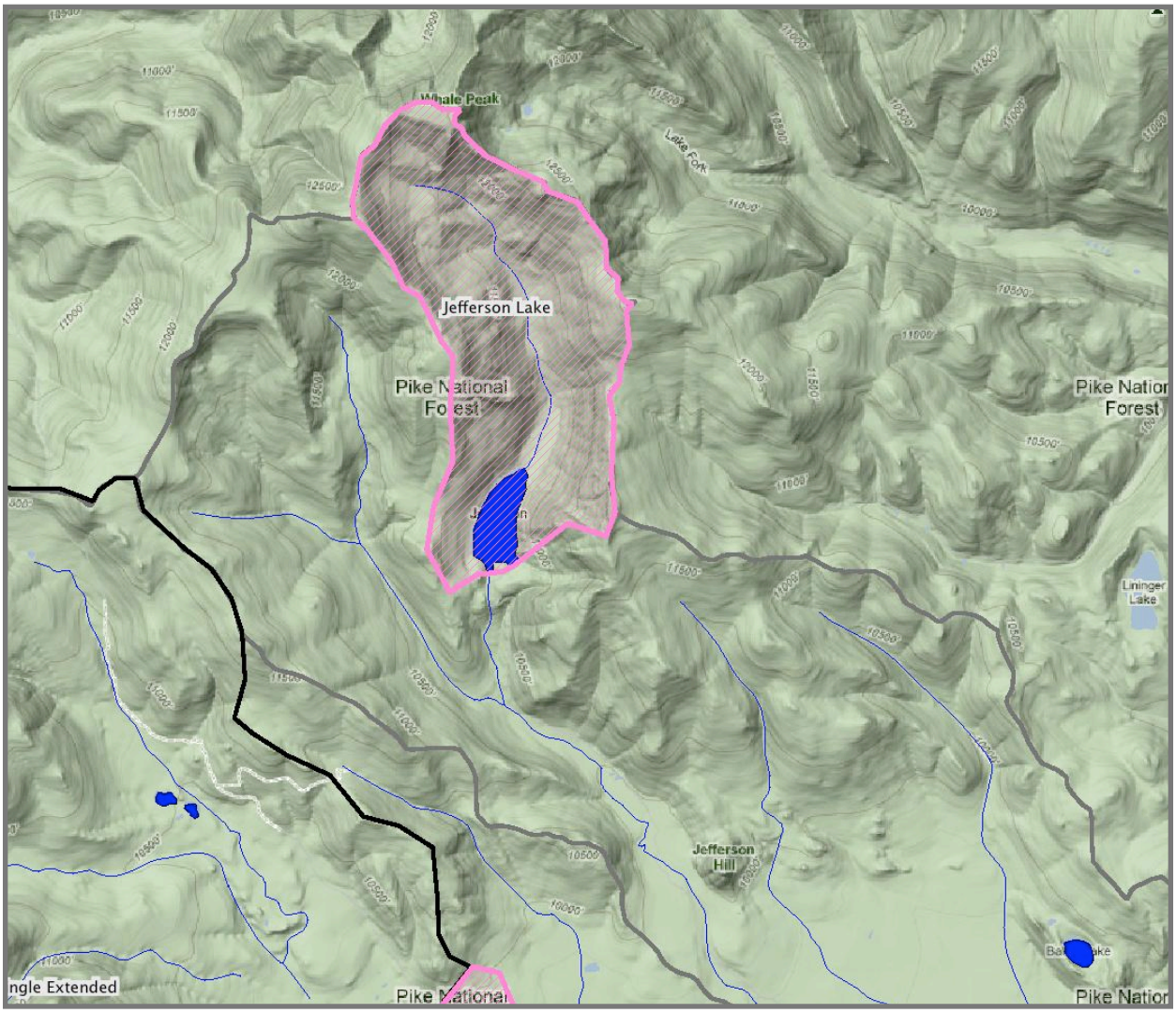


**Figure 41. Jefferson Lake ZoC Location**

## Jefferson Lake Ownership

Land ownership is all NFS lands (Figure 42).

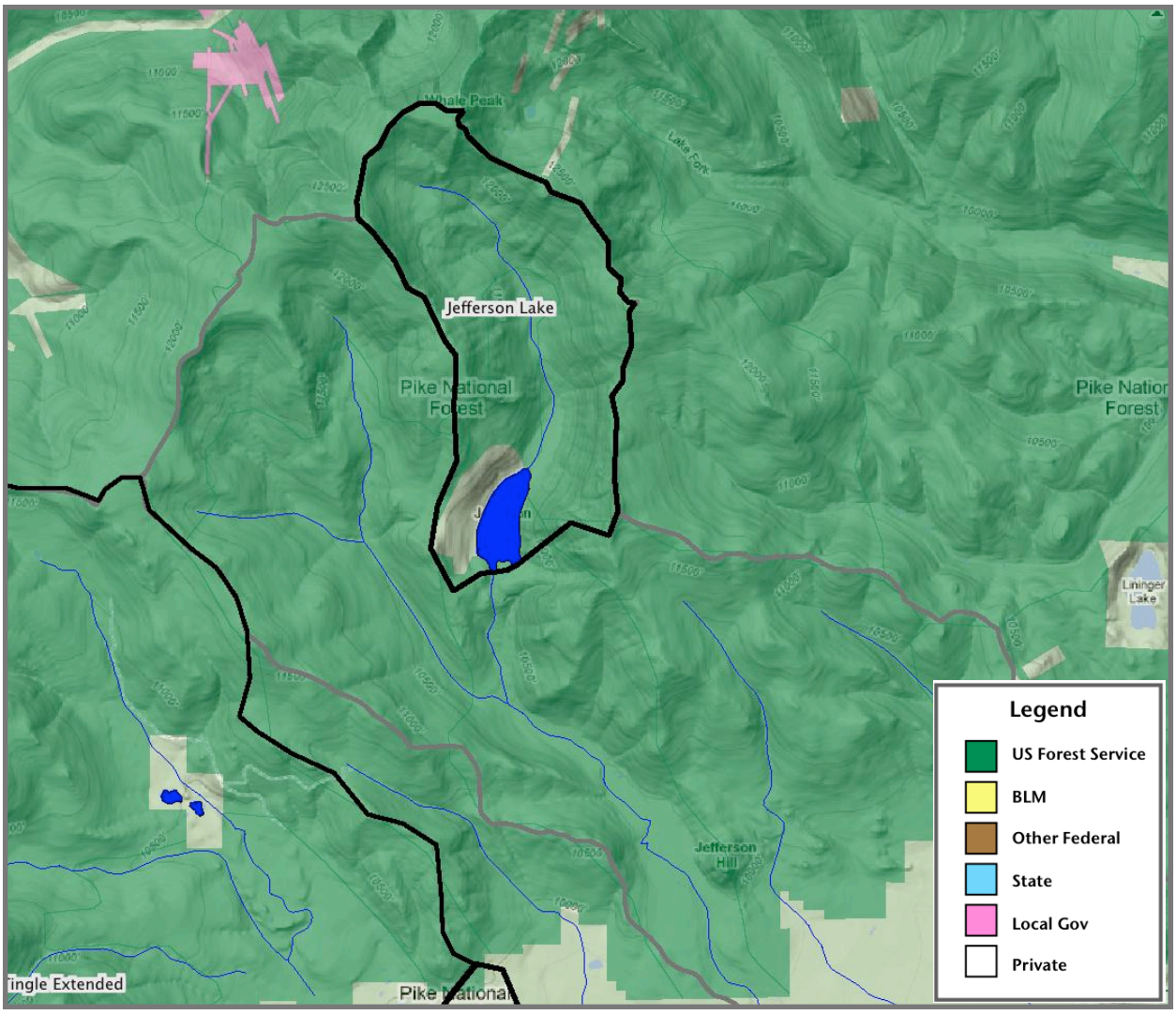


**Figure 42. Jefferson Lake ZoC Ownership**

## Jefferson Lake Watershed Priority

The Jefferson Creek watershed is ranked Yellow (Category 3) overall. Wildfire Hazard is ranked Orange. The primary risk of wildfire in this area is from human-caused events (Figure 43).

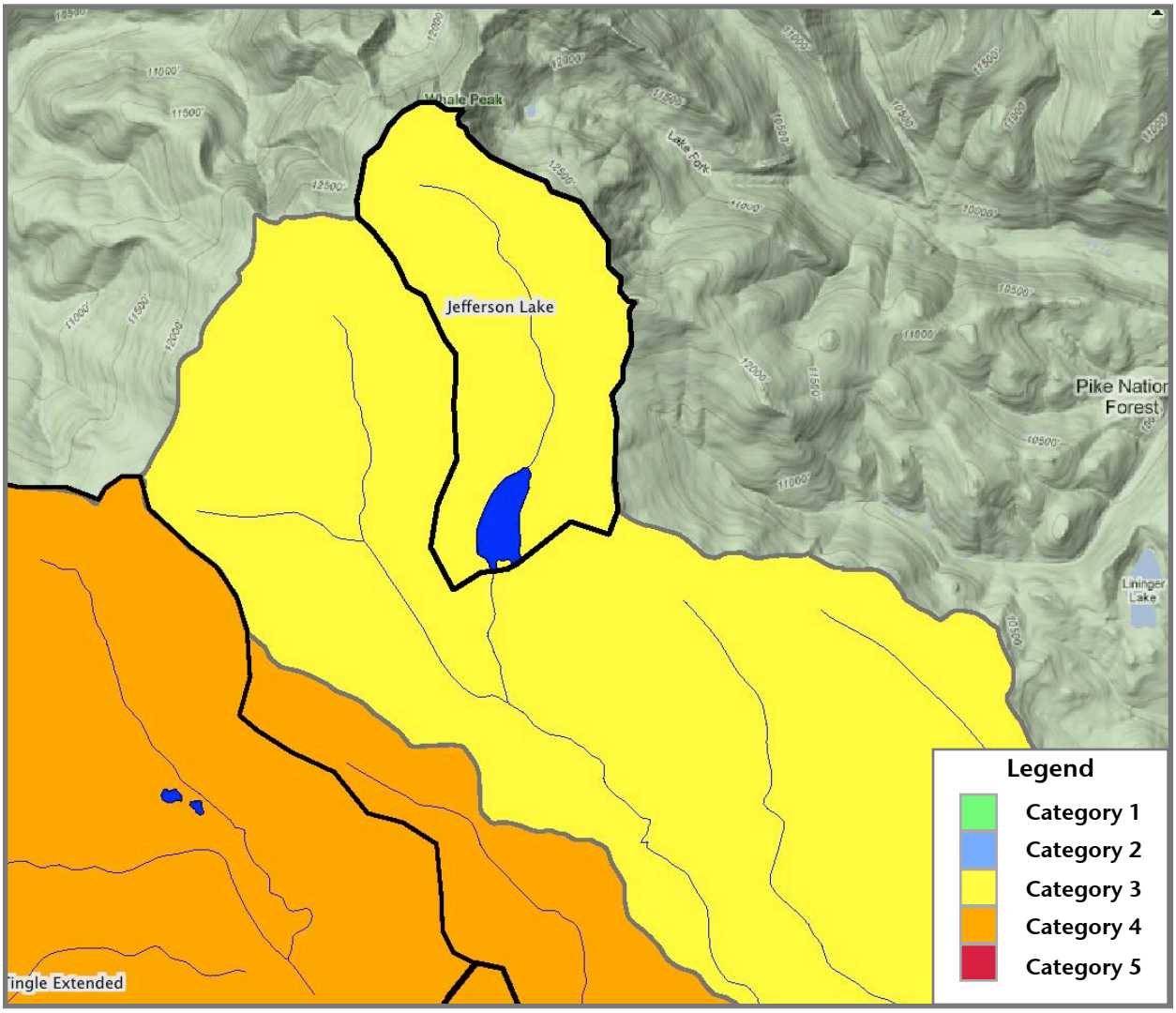


**Figure 43. Jefferson Lake ZoC Watershed Priority**

## Jefferson Lake Slopes

There are very steep slopes above the lake. The campground area south of the lake and the ridgeline west of the lake are operable (Figure 44).

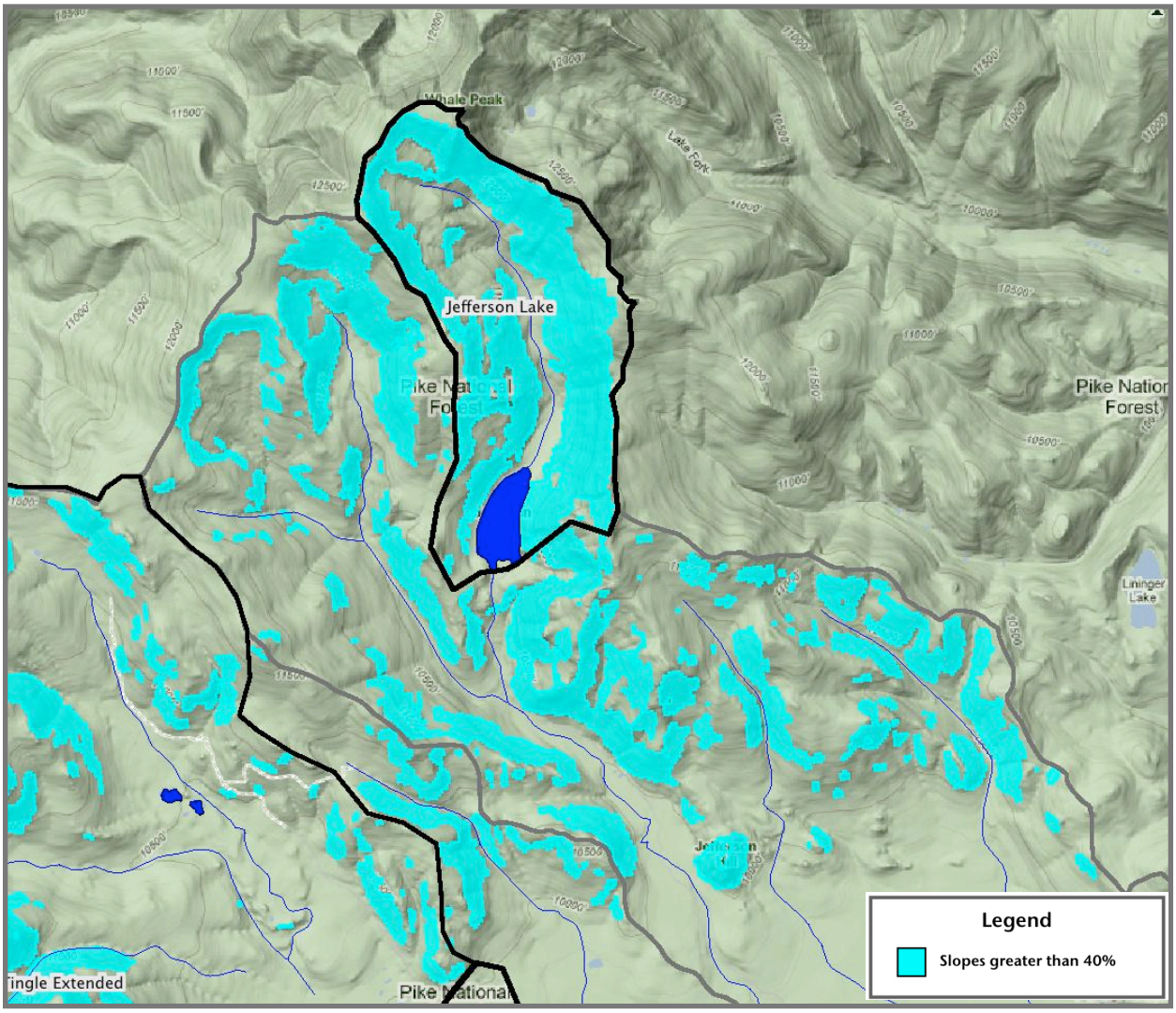


**Figure 44. Jefferson Lake ZoC Slope**

## Jefferson Lake Special Management Areas

There are no wilderness areas. The entire ZoC is in the Jefferson Roadless Area (Figure 45). The small area immediately to the west of the lake that is not identified as roadless appears to be a mapping error.

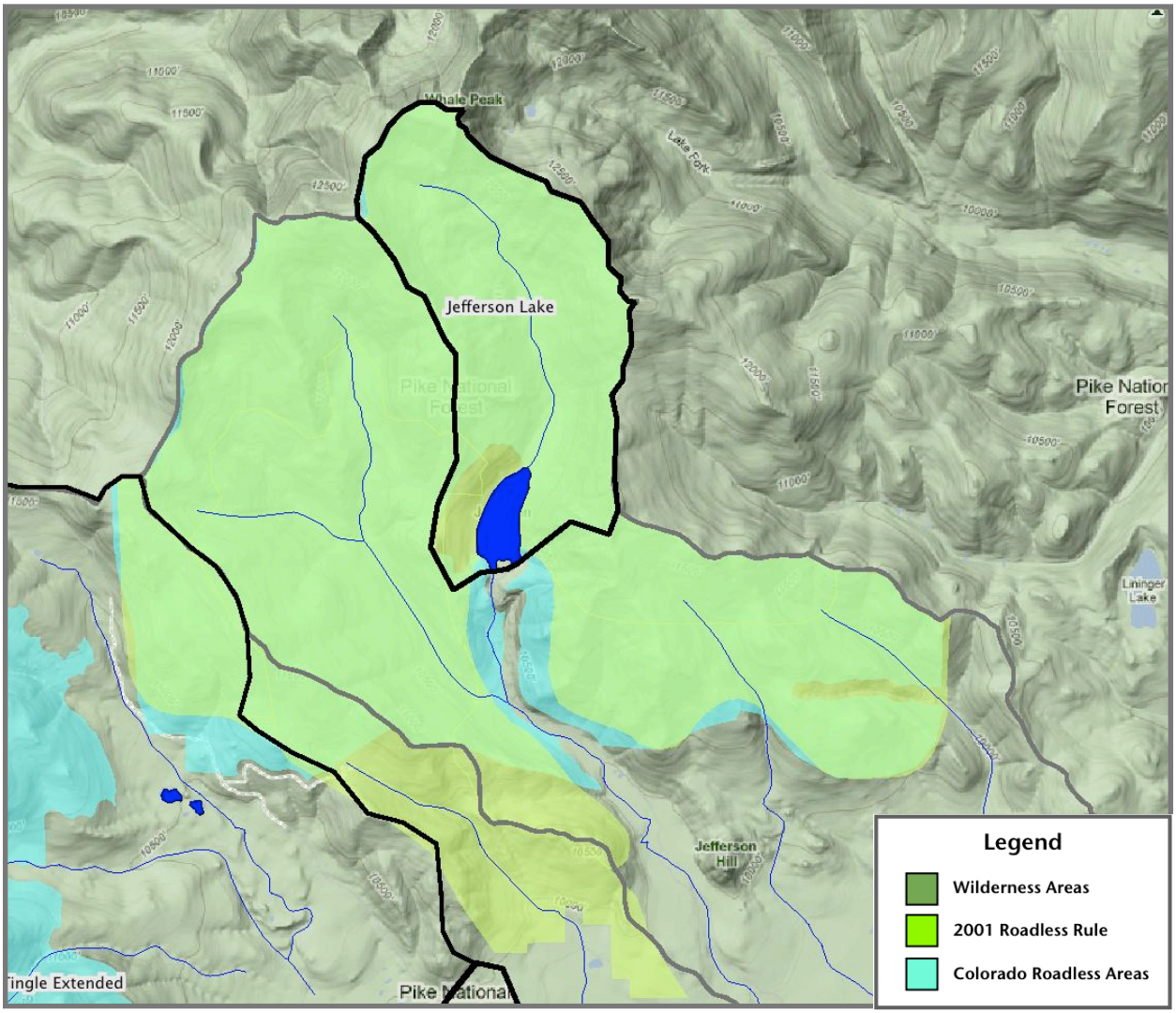


**Figure 45. Jefferson Lake ZoC Special Areas**

## Jefferson Lake Vegetation

Forested areas are mostly spruce-fir, with one small area of lodgepole pine immediately northwest of the lake. The spruce-fir transitions to alpine or rock and snow at the higher elevations. Some lodgepole pine areas are found south of the lake, with considerable aspen to the east of the access road (Figure 46).

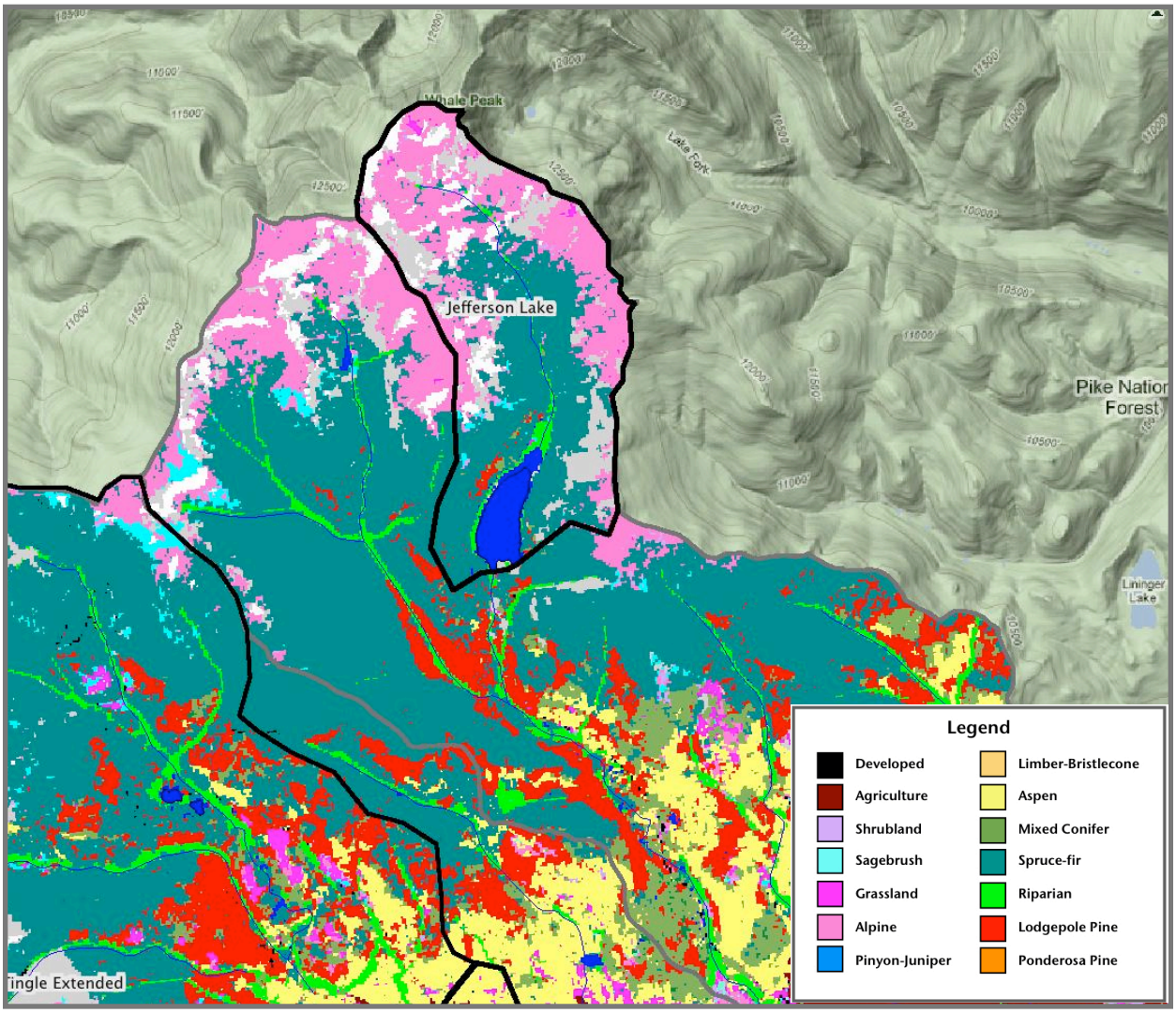


**Figure 46. Jefferson Lake ZoC Vegetation**

## Jefferson Lake Opportunities

Steep slopes occur in most of the forested areas. The area above the lake offers few opportunities for fuelbreaks or other vegetation management except for along the ridgeline west of the Lake (Figure 47). Thinning the areas around the campground and linking it to a fuelbreak along the ridgeline to the west of the Lake would help protect the area from fires approaching the area from the south/southwest. Though there is no existing road access to this area, other than the one road to the campground and lake, traditional logging equipment could potentially be used to develop this fuelbreak and forwarders used to remove harvested material from the treatment area.

The extent of shoreline usage by fishermen should be investigated. If areas of concentrated use are present it may be beneficial to conduct primarily handwork along the shoreline to reduce surface fuels in these areas. Because of the risk of human-caused fire events, consider also the value of thinning in and around the numerous campgrounds and along the access road below the ZoC to further reduce the risk of wildfires moving up-valley and into the basin around and above the Lake. These areas south and below the ZoC have many areas of lodgepole pine.

Stakeholders include: City of Aurora and US Forest Service.

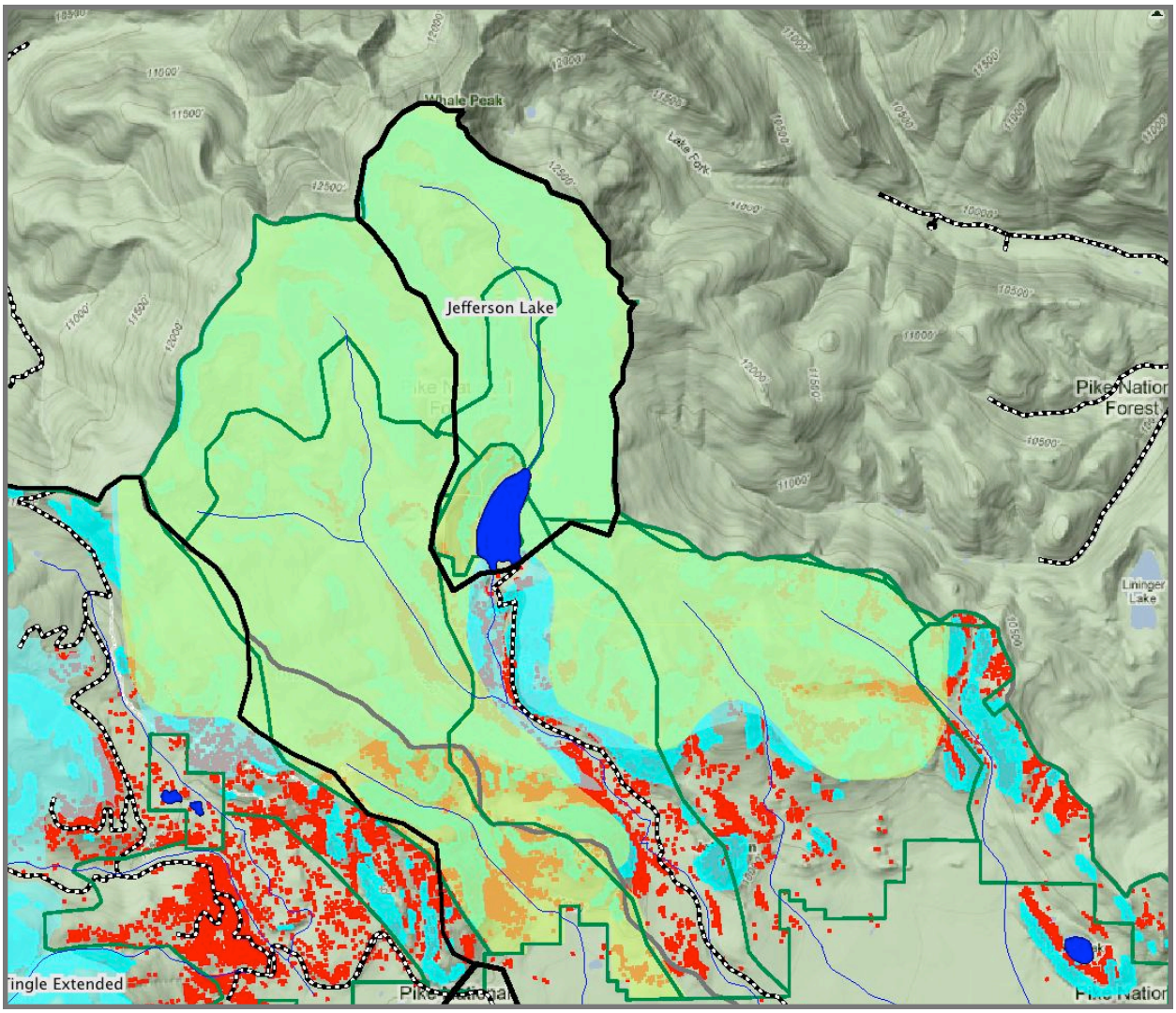


**Figure 47. Jefferson Lake ZoC Opportunities**

# Tarryall Reservoir ZoC

Figure 48 shows the general location of the Tarryall Reservoir ZoC. Note that the ZoC are shown here in pink with crosshatching, but in the remaining figures the outlines appear as bold black lines with no crosshatching.

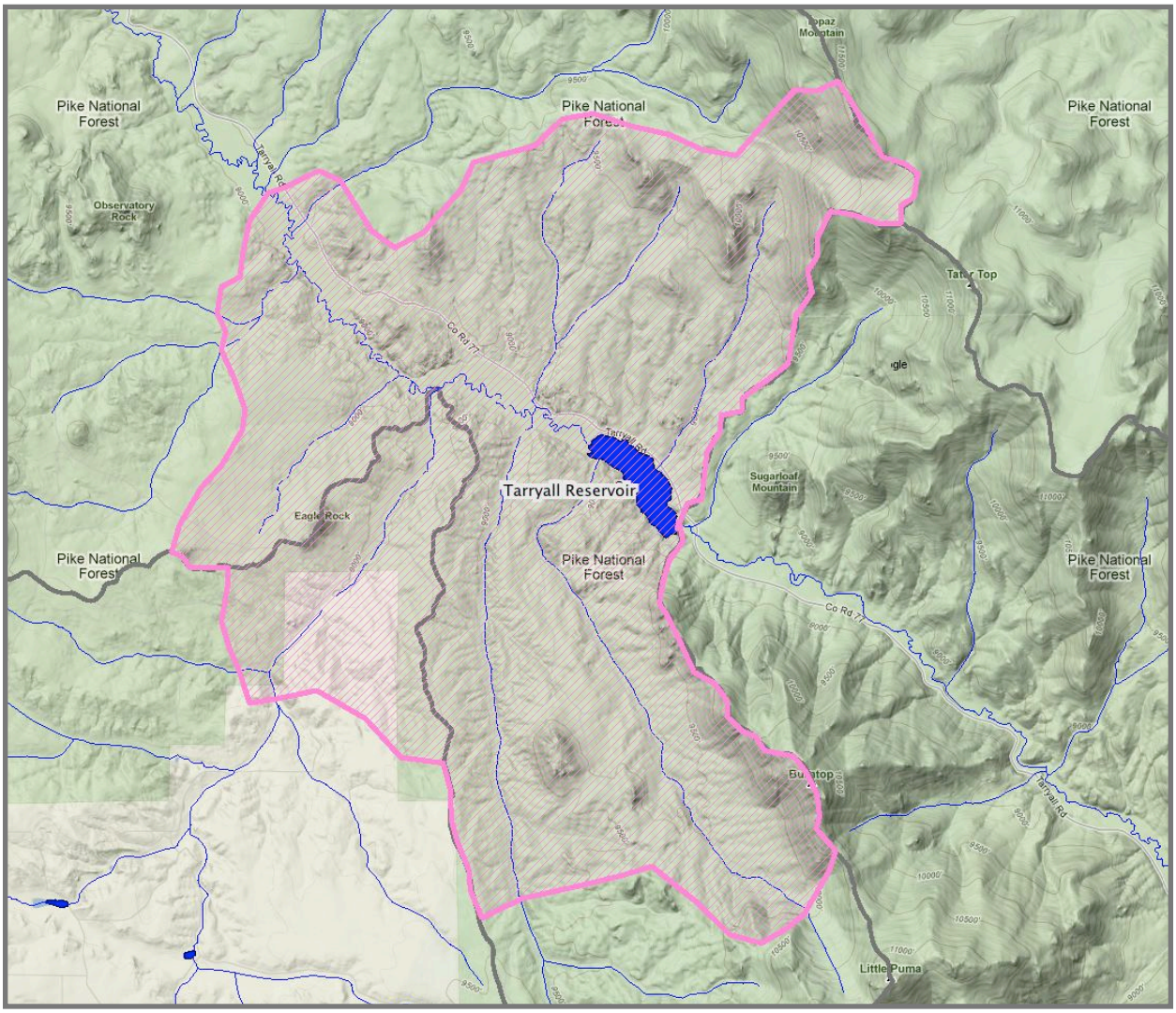


**Figure 48. Tarryall Reservoir ZoC Location**

## Tarryall Reservoir Ownership

The majority of the lands are NFS Lands. There are private lands along the river, a large private parcel north of the reservoir, and two large parcels south of the reservoir. Areas immediately around the reservoir and a small parcel approximately two miles above the reservoir are managed by the by the Division of Wildlife as a State Wildlife Area (Figure 49).

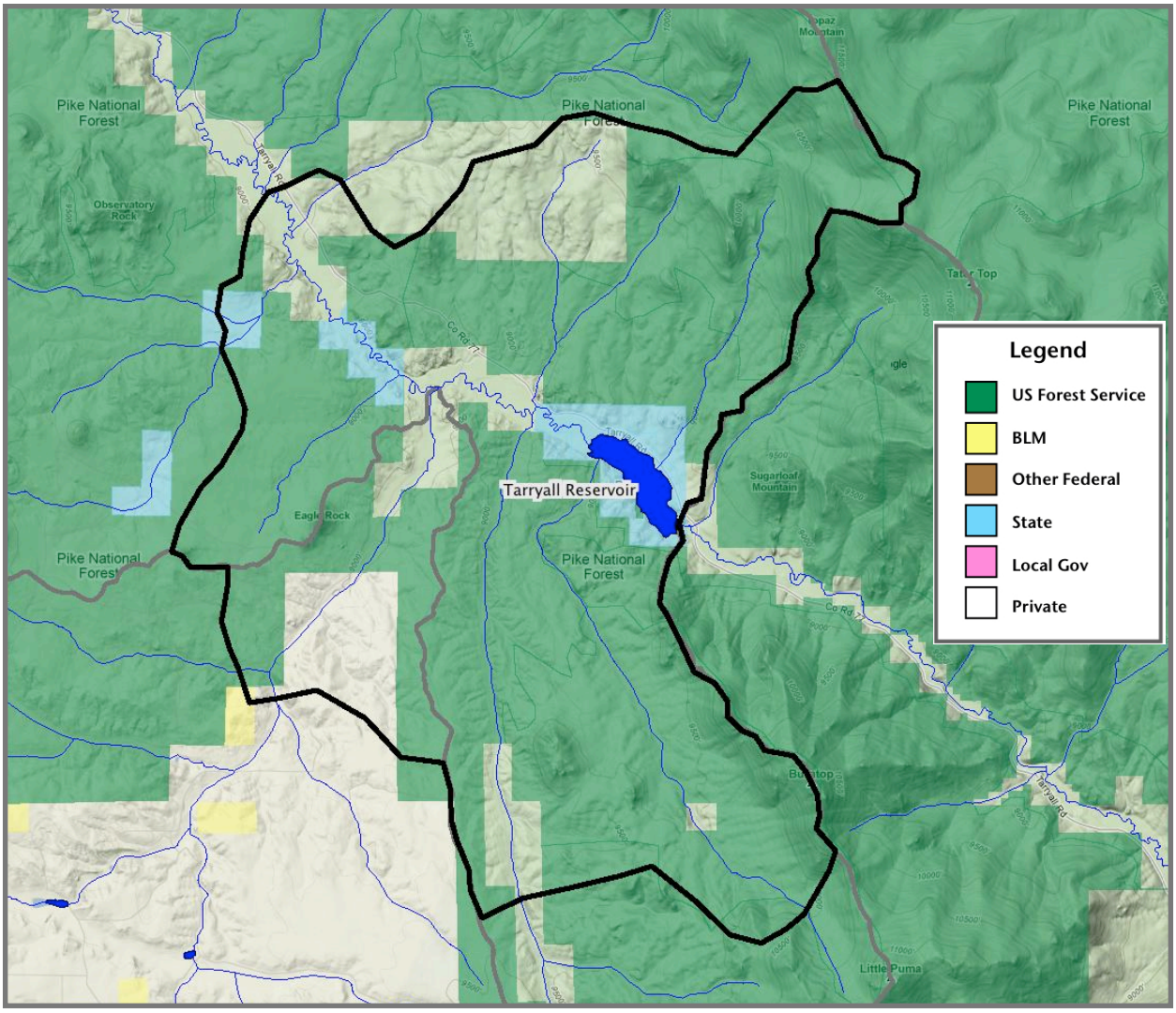


**Figure 49. Tarryall Reservoir ZoC Ownership**

## Tarryall Reservoir Watershed Priority

The Lower Tarryall watershed is rated as Yellow (Category 3) overall and the Ruby Gulch watershed is rated as Green overall (Figure 50).

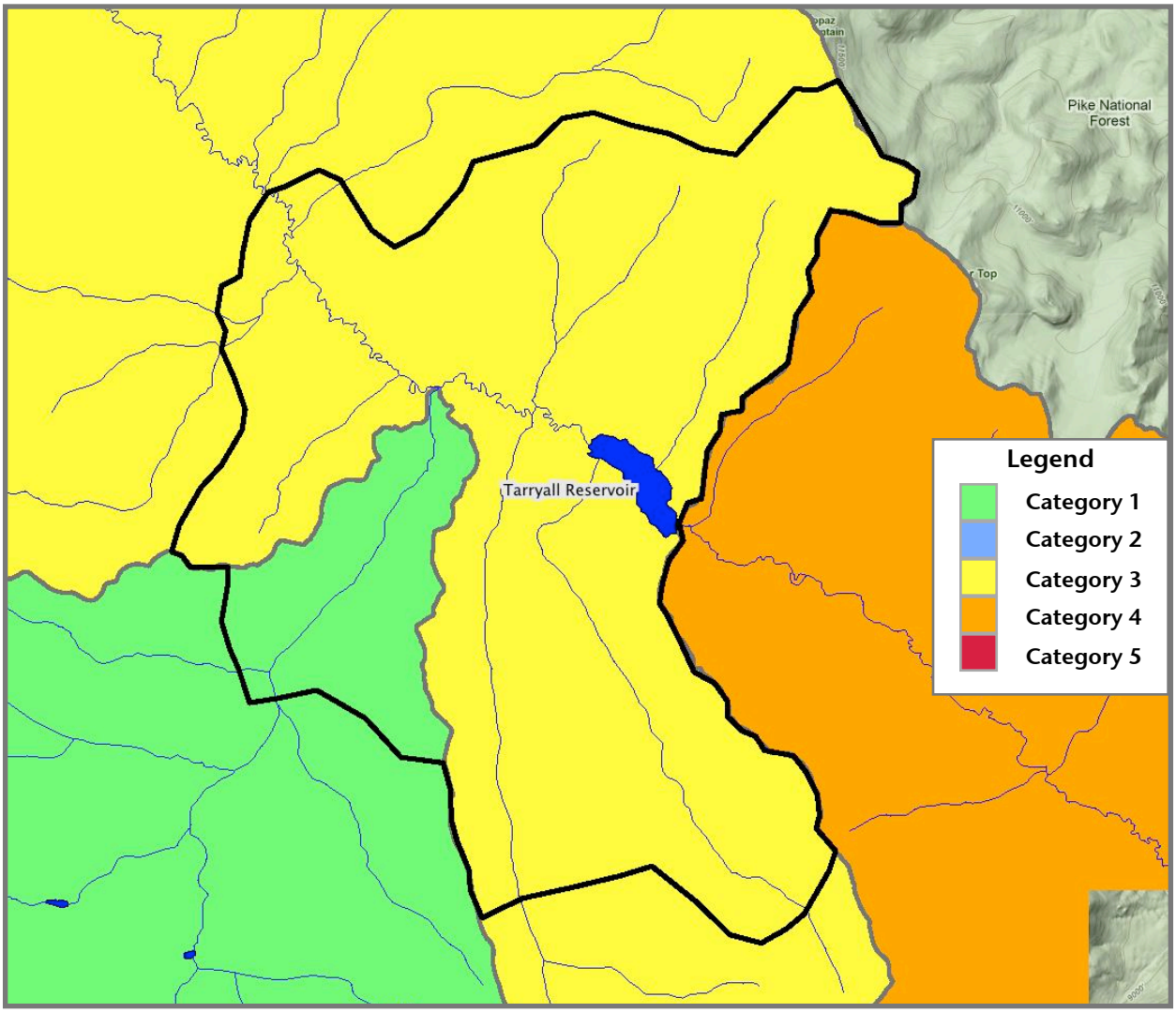


**Figure 50. Tarryall Reservoir ZoC Watershed Priority**

## Tarryall Reservoir Slopes

Most of the ZoC has operable slopes with some areas of steep slopes found along the eastern border of the ZoC (Figure 51).

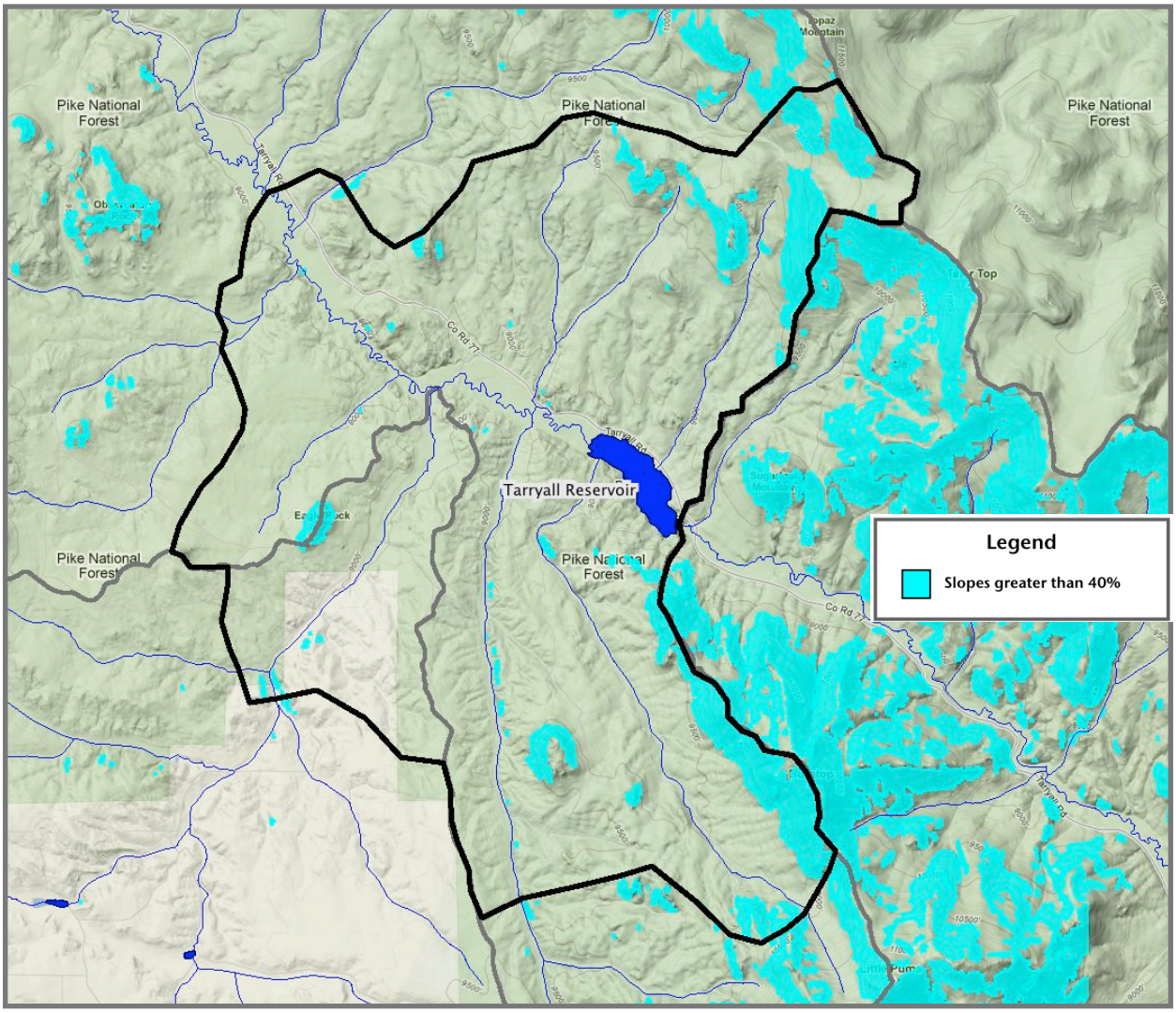


**Figure 51. Tarryall Reservoir ZoC Slope**

## Tarryall Reservoir Special Management Areas

There are no wilderness areas, but there are two roadless areas. The Farnum Roadless Area is in the southeast portion of the ZoC, east of Packer Gulch. The Lost Creek West Roadless Area occupies a small portion of the ZoC in the northeast. Overall they are a small part of the ZoC (Figure 52).

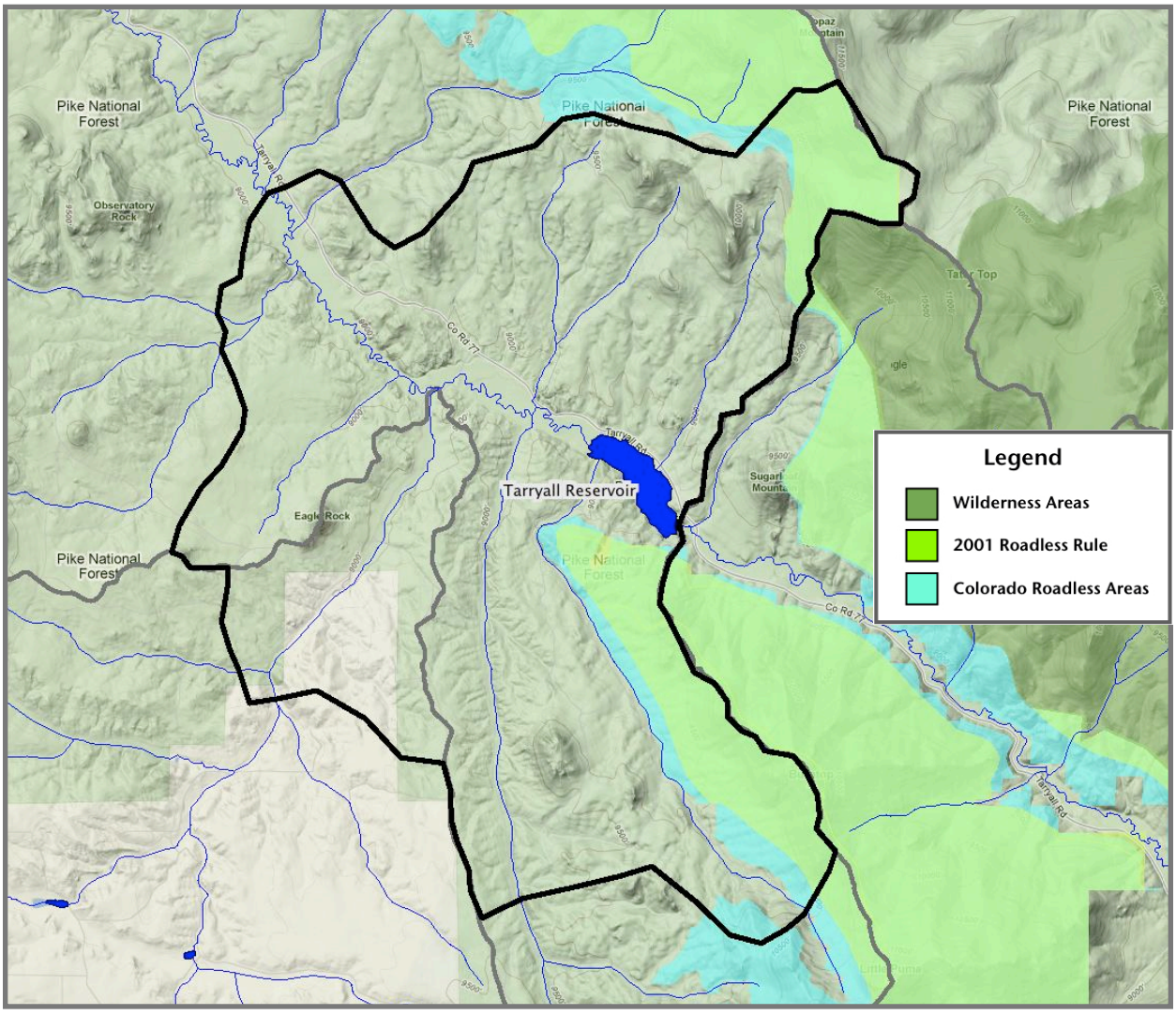


**Figure 52. Tarryall Reservoir ZoC Special Areas**

## Tarryall Reservoir Vegetation

Vegetation is mostly sagebrush and grasslands, with some areas of ponderosa pine and mixed conifer at higher elevations. Forested areas appear to be elevation and aspect-determined. There are some small areas of lodgepole pine in the two roadless areas (Figure 53).

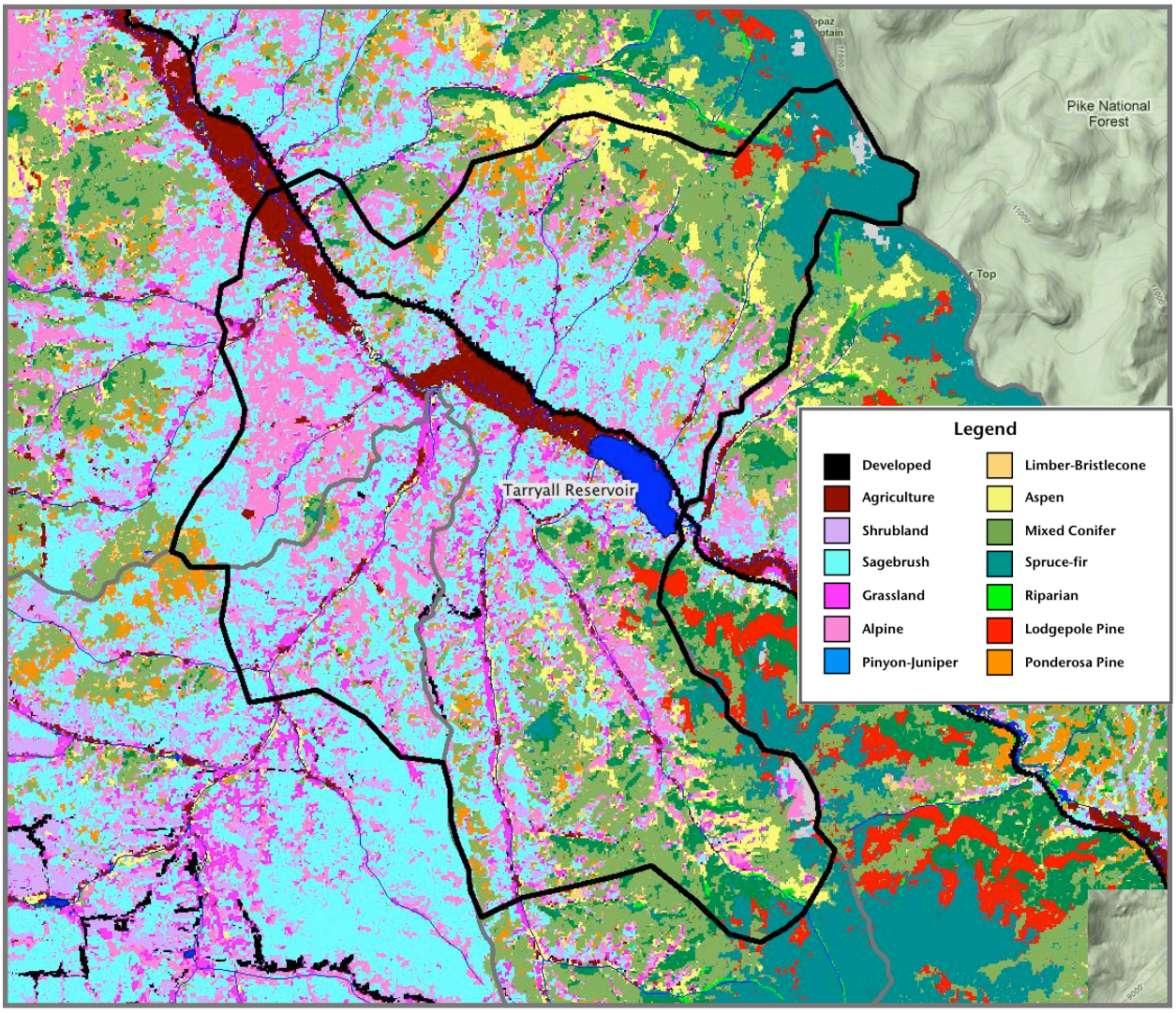


**Figure 53. Tarryall Reservoir ZoC Vegetation**

## Tarryall Reservoir Opportunities

Grassland and sagebrush areas can be managed by grazing or with prescribed fire; or, on a small scale, by periodic mowing. The largest areas of ponderosa pine are on private lands north of the reservoir and along Turner Gulch south of the reservoir, where access is available (Figure 54). It appears that some thinning and regeneration harvests have occurred on NFS lands south of the reservoir. The Division of Wildlife should be contacted about managing their properties and possibly partnering on treatments on other private lands.

Stakeholders include: State of Colorado Division of Wildlife, US Forest Service, private landowners, Park County and Colorado State Forest Service.

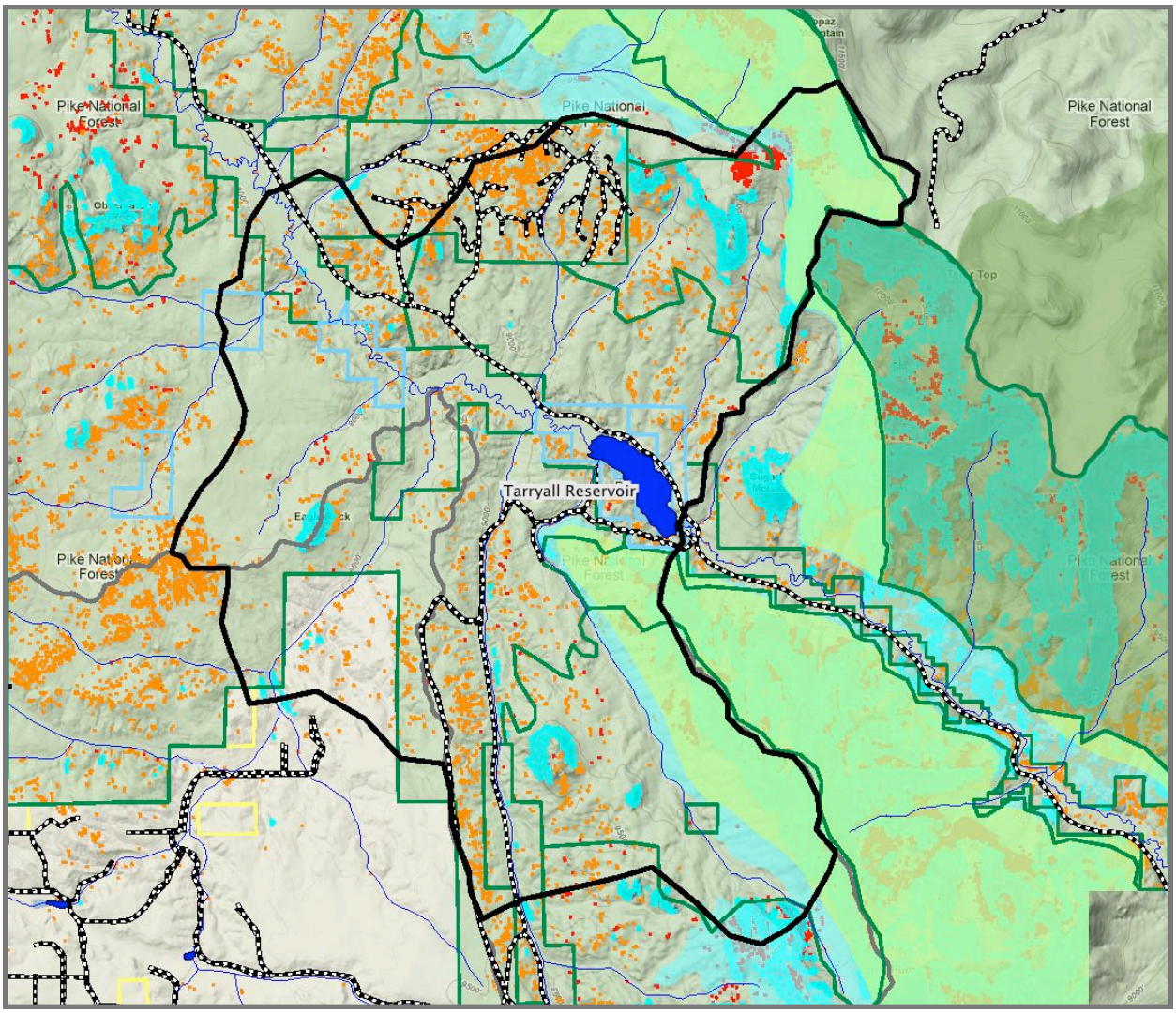


**Figure 54. Tarryall Reservoir ZoC Opportunities**

## Cheesman Reservoir ZoC

Figure 55 shows the general location of the Cheesman Reservoir ZoC. The lower portion of the Cheesman Reservoir ZoC is located in the Upper South Platte Watershed which has been evaluated in the watershed assessment for that watershed. Note that the ZoC are shown here in pink with crosshatching, but in the remaining figures the outlines appear as bold black lines with no crosshatching.

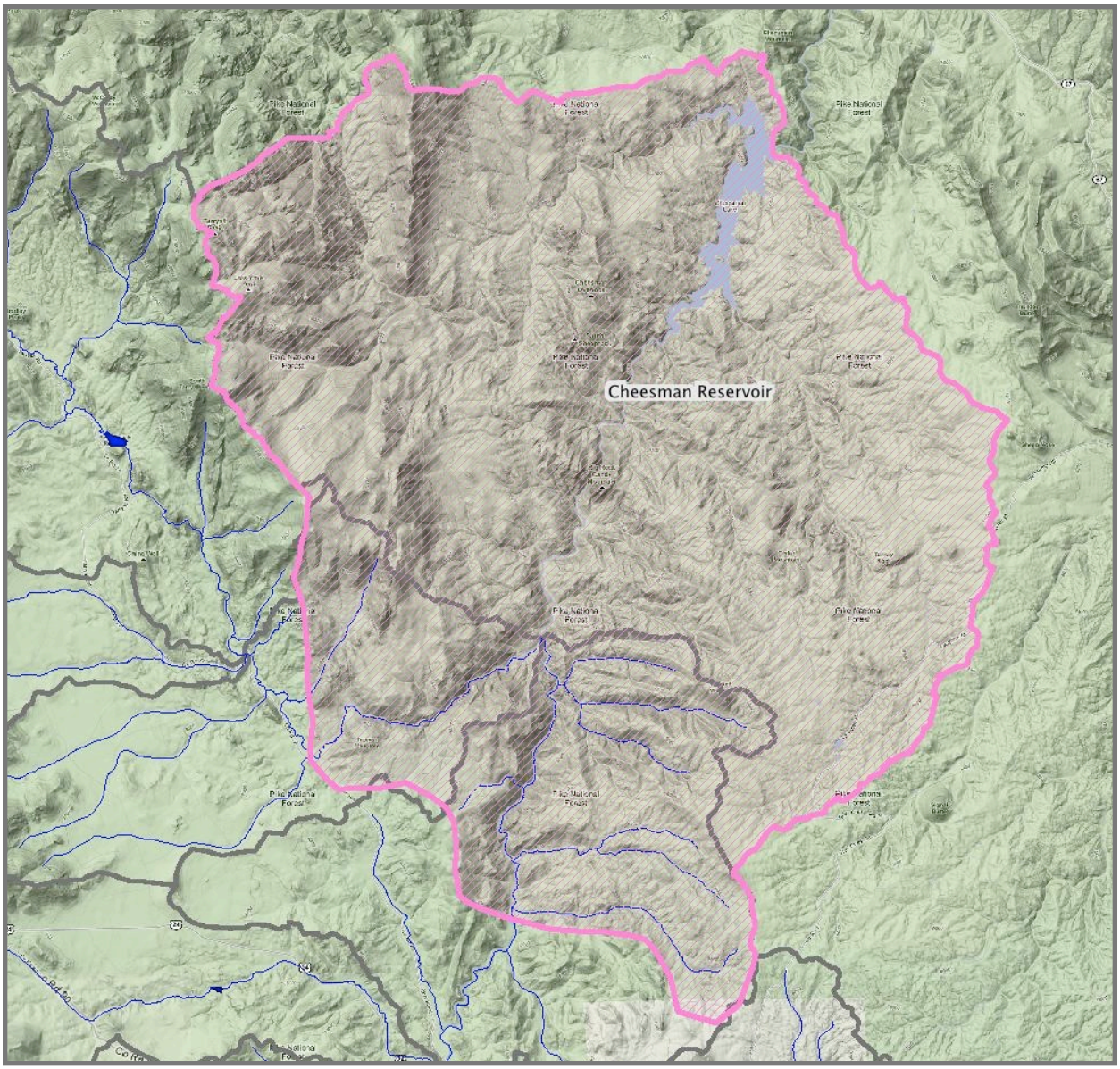


**Figure 55. Cheesman Reservoir ZoC Location**

## Cheesman Reservoir Ownership

Ownership is mostly NFS Lands. Private lands are present as small, scattered in-holdings (Figure 56). The area surrounding Cheesman Reservoir is owned by Denver Water.

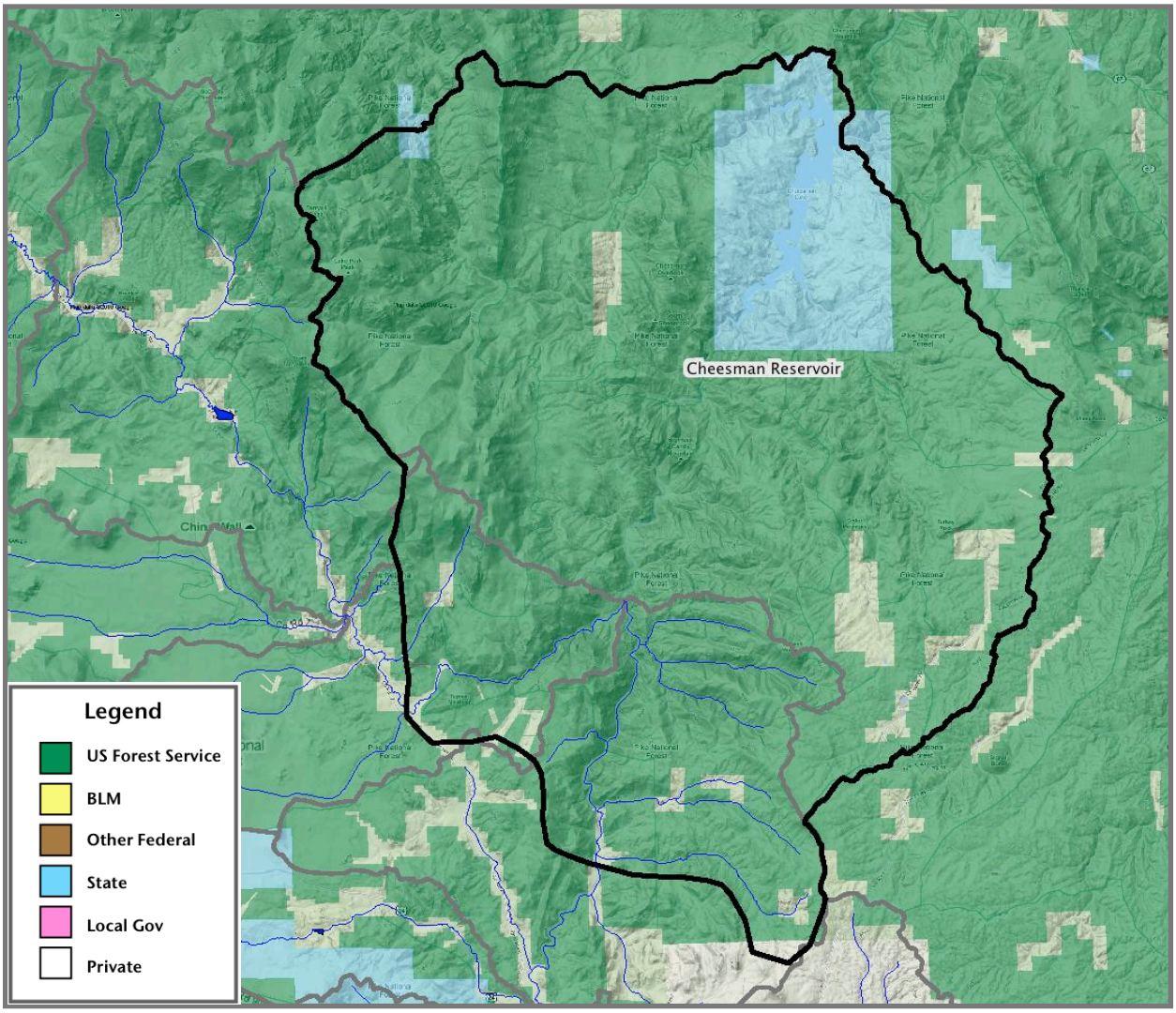


**Figure 56. Cheesman Reservoir ZoC Ownership**

## Cheesman Reservoir Watershed Priority

The Outlet Tarryall Creek watershed is rated as Orange (Category 4) overall and the Lower Lake George watershed is rated as Yellow (Category 3) overall. The Outlet Tarryall Creek watershed is rated Red (Category 5) for Soil Erodibility and Lower Lake George rated Red (Category 5) for Wildfire Hazard (Figure 57).

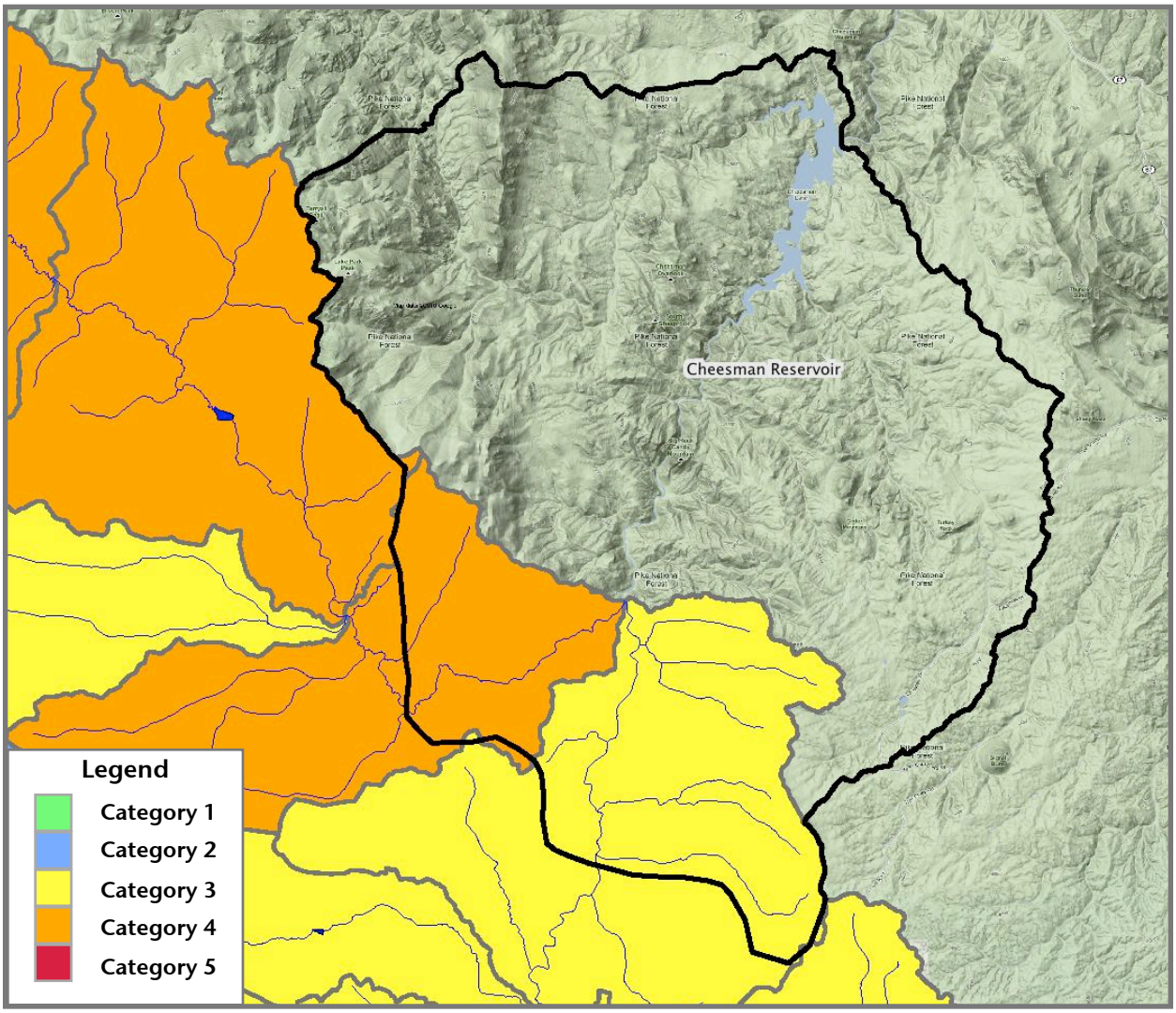


**Figure 57. Cheesman Reservoir ZoC Watershed Priority**

## Cheesman Reservoir Slopes

There are some large areas of steep slopes that define some of the canyon areas next to the main stream channels (Figure 58).

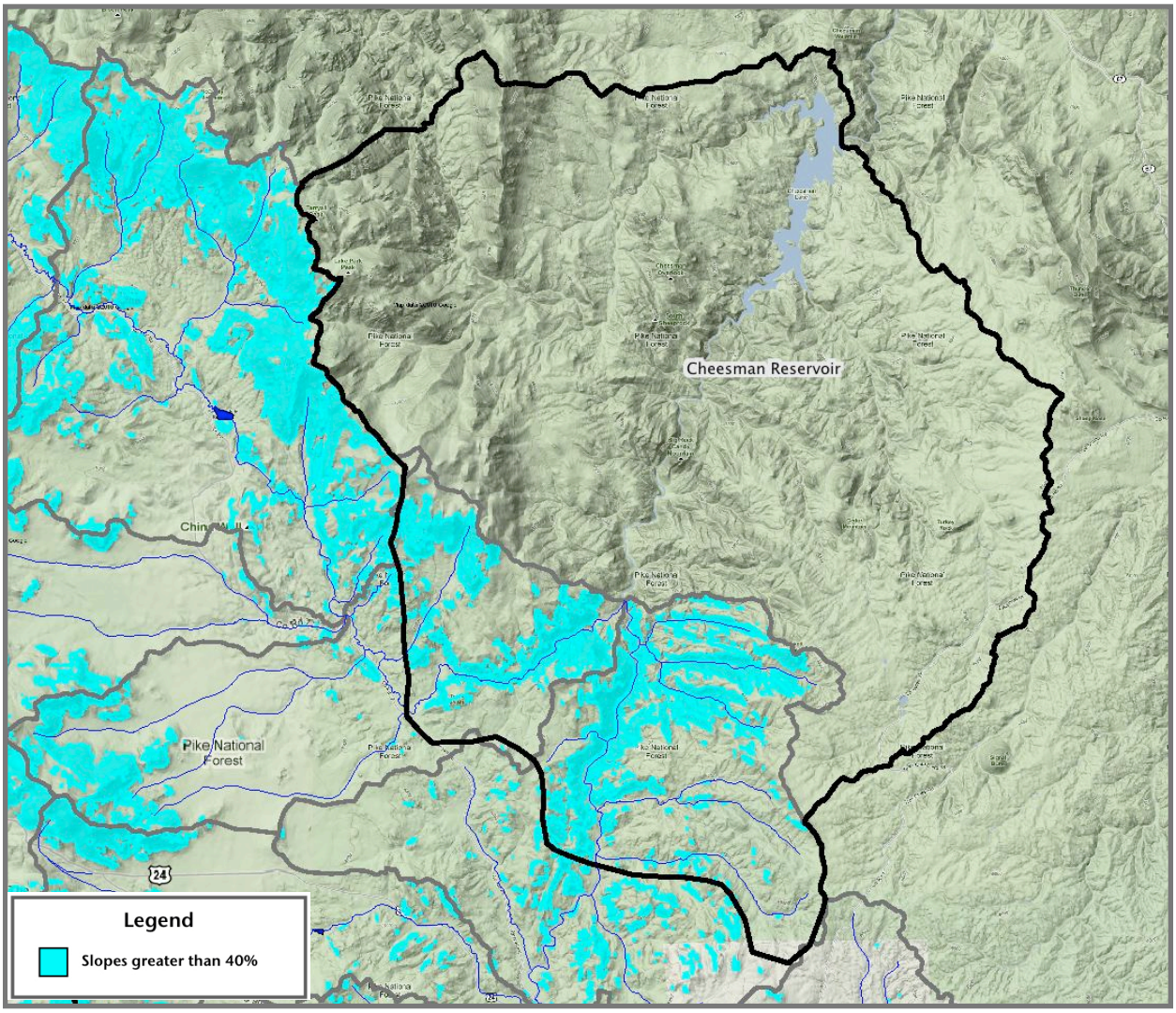


**Figure 58. Cheesman Reservoir ZoC Slope**

## Cheesman Reservoir Special Management Areas

There is a portion of the Lost Creek Wilderness Area on the west end of the ZoC (Figure 59. The Lost Creek South Roadless Area extends just south of the wilderness area. Overall they are a small part of the ZoC.

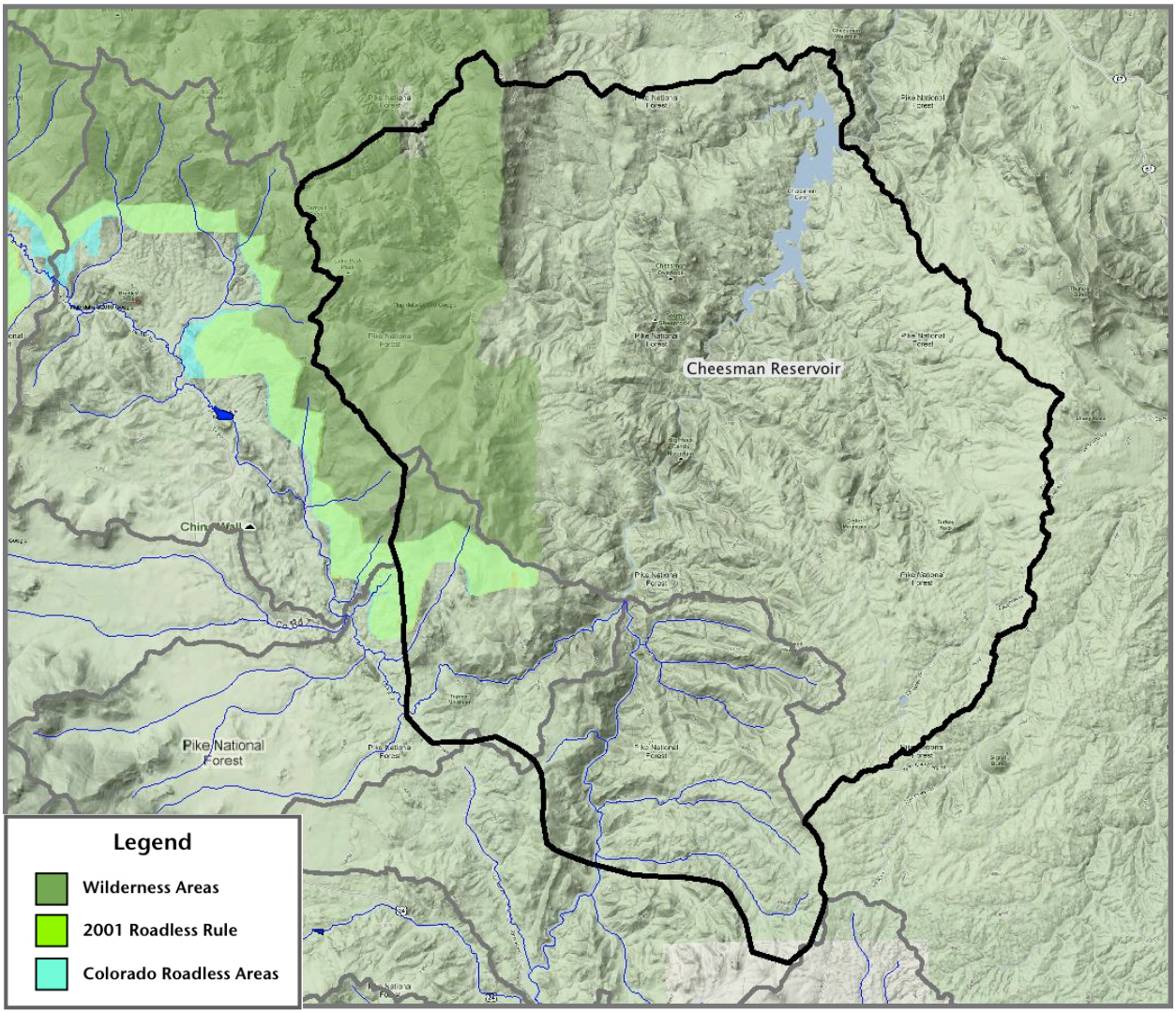


**Figure 59. Cheesman Reservoir ZoC Special Areas**

## Cheesman Reservoir Vegetation

Vegetation is mostly mixed conifer with some areas of ponderosa pine and aspen (Figure 60). Much of the mixed conifer type would, under a natural fire regime, be mostly ponderosa pine. Due to fire exclusion, Douglas-fir has invaded the ponderosa stands and is the primary driver of wildfire and fuel hazards. Much of the ZoC burned during the 2002 Hayman Fire. Only parts of the southwest and extreme southern portions of the ZoC escaped the fire. Depending upon location, the fire burned with low to severe severity, with most of the burned area within the ZoC experiencing low to moderate intensity. As a result, live forest densities over most of the ZoC are much lower, with extensive areas having few and even no live trees. Such areas now having a thriving grass and shrub component. The burned areas have experienced extensive snag-fall and in some areas this has resulted in large accumulations of heavy surface fuels that could further damage soils if they experience re-burning.

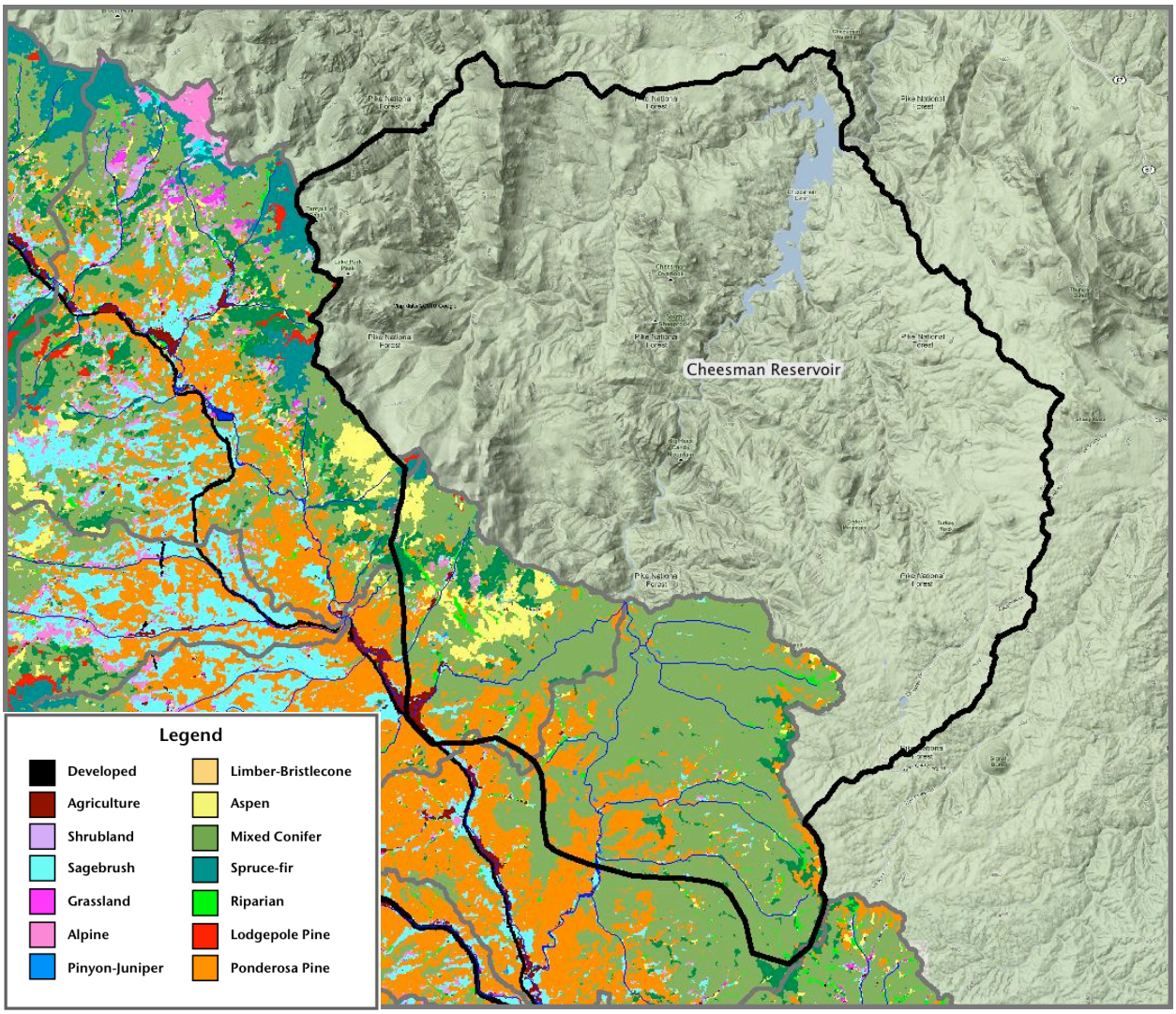


**Figure 60. Cheesman Reservoir ZoC Vegetation**

## Cheesman Reservoir Opportunities

There are opportunities in ponderosa pine and mixed conifer forests that are outside the wilderness and roadless areas (Figure 61). Some of these areas have slopes less than 40 percent. The land ownership is NFS lands mixed with scattered private lands. Road access is limited in some of these areas. These ponderosa and mixed conifer forests respond well to thinning that favors ponderosa pine over Douglas-fir and other species. Mastication has been used very efficiently in treatments on nearby ownerships. Use of prescribed fire following treatments is recommended.

Mastication, or machine piling followed by pile burning, should be considered in areas with heavy fuel accumulations following snag-fall. A major powerline passes through the ZoC in burned and un-burned areas. The controlling power company may be a partner on treatments that protect this corridor.

Forest conditions in much of the ZoC have been "re-set" due to the Hayman Fire, and will take many years to re-establish normal forest densities. There is a tendency to ignore these burned areas; however they should be monitored over the long-term and not be allowed to return to hazardous conditions. If managed starting while the stands are young, and maintained periodically over time, treatments can be much less expensive, especially if prescribed fire is used.

Stakeholders include: Denver Water, US Forest Service, private landowners, Park County and Colorado State Forest Service.

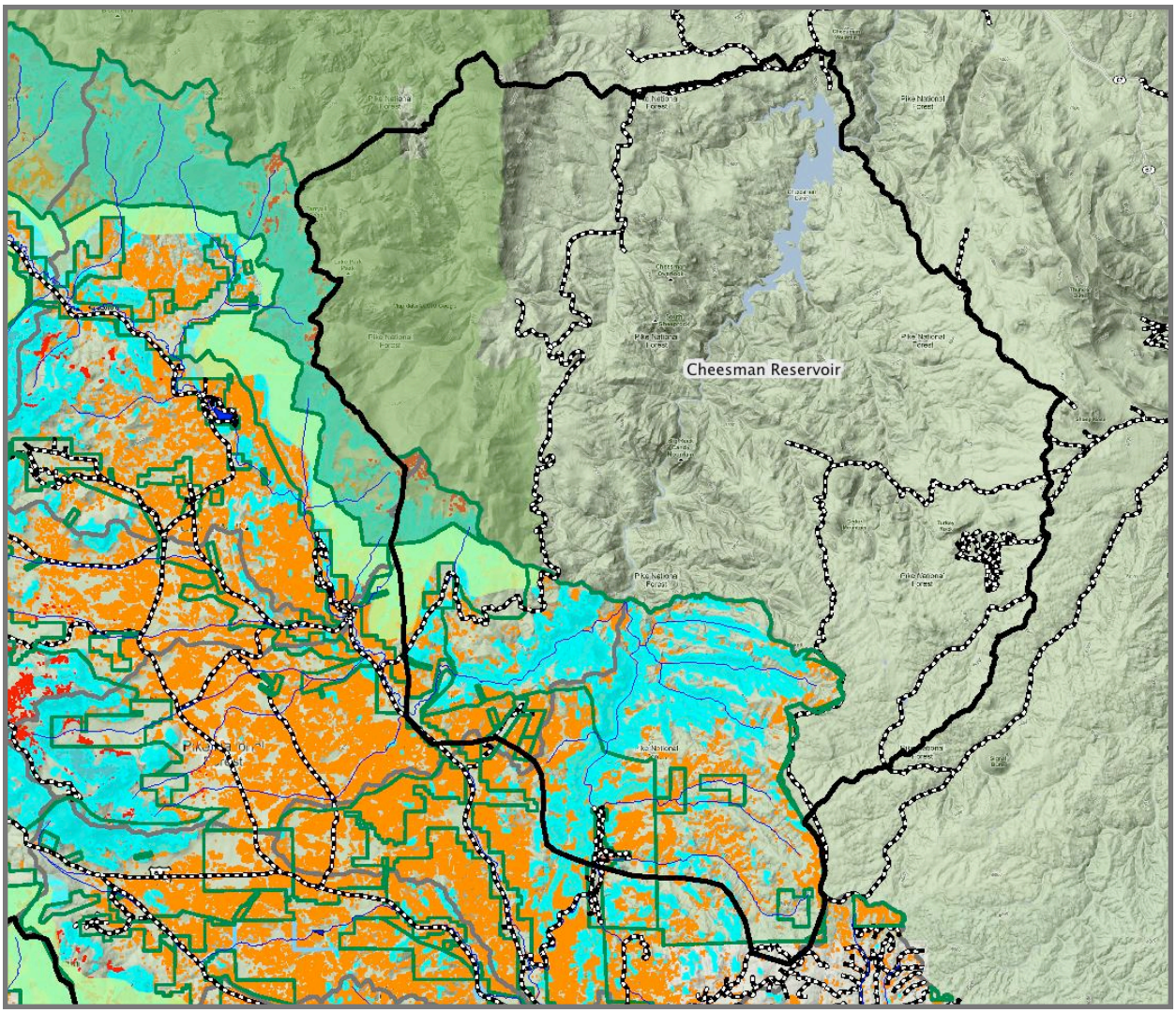


**Figure 61. Cheesman Reservoir ZoC Opportunities**

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## APPENDIX A

# LIST OF SOUTH PLATTE HEADWATERS WATERSHED STAKEHOLDERS

## Table A-1. South Platte Headwaters Watershed Stakeholders List

### South Platte Headwaters Watershed Stakeholders

| Organization | Last | First | Phone | email |
|---|---|---|---|---|
| Centennial WSD | McLoud | Rick | 303.791.0430 | rmcloud@highlandsranch.org |
| Center of Colorado Conservancy District | Drucker | Dan | 303.838.0302 | djdrucker@mailstation.com |
| City of Aurora | McHugh | Mike | 303.739.7006 | mmchugh@auroragov.org |
| Coalition for the Upper South Platte | Ekarius | Carol | 719-837-2737 | carol@uppersouthplatte.org |
| Colorado Department of Health and Environment | Duggan | John | 303.692.3534 | john.duggan@state.co.us |
| Colorado Springs Utilities | Howell | Eric | 719.668.4554 | ehowell@csu.org |
| Colorado State Forest Service | Schlosberg | Andy | 719.687.2921 | andy.schlosberg@colostate.edu |
| Denver Water | Kennedy | Don | 303.628.6528 | don.Kennedy@denverwater.org |
| Fairplay Water Works | Goble | Jeff | 719.836.2255 | |
| Northwest Fire Protection District | Roach | Brian | 719.836.1414 | broach@nwfpd.net |
| Park County | Tighe | John | 719.836.4210 | jtighe@parkco.us |
| Park County | Eisenman | Tom | | teisenman@parkco.us |
| Park County Water Preservation Coalition | James | Lynda | 303.838.2178 | lyndajames@earthlink.net |
| Teller County Commissioner | Ignatius | Jim | 719.689.2988 | |
| Town of Alma | Radtke | NIck | 719.836.2712 | almawater@townofalma.com |
| Town of Fairplay | Boyce | Fred | | townoffairplay@yahoo.com |
| Upper South Platte Conservancy District | Wissel | Dave | | dwissel@parkco.us |
| US Forest Service | Sexton | Kris | 719.836.3857 | ksexton@fs.fed.us |

APPENDIX B

# DETAILED SOUTH PLATTE HEADWATERS WATERSHED ASSESSMENT RESULTS

## Table B-1. South Platte Headwaters Watershed Wildfire Hazard Ranking

| Sixth-level Watershed Name | Watershed Area (acres) | Wildfire Hazard Calculation | Wildfire Rank |
|---|---|---|---|
| Headwaters South Fork South Platte River | 32,585 | 31.1% | *5.5* |
| Allen Creek-Tarryall Creek | 20,311 | 31.0% | *5.5* |
| Rock Creek | 29,141 | 30.9% | *5.5* |
| Lower Lake George | 24,659 | 30.6% | *5.4* |
| Headwaters Tarryall Creek | 24,177 | 26.8% | *4.7* |
| Grape Creek | 13,667 | 26.0% | *4.6* |
| Outlet Tarryall Creek | 18,442 | 23.0% | *4.1* |
| Jefferson Creek | 24,184 | 20.5% | *3.6* |
| Webber Park-Tarryall Creek | 24,339 | 19.3% | *3.4* |
| Headwaters Middle Fork South Platte River | 22,096 | 16.8% | *3.0* |
| Michigan Creek | 29,135 | 16.2% | *2.9* |
| Beaver Creek-Middle Fork South Platte River | 27,293 | 16.2% | *2.9* |
| Elevenmile Reservoir | 52,370 | 15.1% | *2.7* |
| Lower Tarryall | 39,338 | 14.9% | *2.7* |
| Twin Creek | 29,370 | 14.3% | *2.6* |
| Spring Creek | 10,355 | 13.7% | *2.5* |
| Twelve Mile Creek | 19,554 | 13.4% | *2.4* |
| Mosquito Creek | 10,358 | 13.3% | *2.4* |
| Marksbury Gulch | 10,364 | 11.4% | *2.1* |
| Crooked Creek | 11,537 | 11.4% | *2.1* |
| Elevenmile Canyon | 33,869 | 10.3% | *1.9* |
| Pulver Gulch | 12,772 | 8.9% | *1.6* |
| Salt Creek | 21,823 | 8.8% | *1.6* |
| Fish Creek | 10,816 | 8.7% | *1.6* |
| Antero Reservoir | 35,888 | 7.1% | *1.3* |
| Fourmile Creek | 30,780 | 6.9% | *1.3* |
| High Creek | 19,214 | 6.6% | *1.2* |
| Outlet Chase Gulch | 26,775 | 6.4% | *1.2* |
| Headwaters Chase Gulch | 22,754 | 2.9% | *0.6* |
| Trout Creek | 23,554 | 2.9% | *0.6* |
| Three Mile Creek | 21,367 | 2.7% | *0.5* |
| Middle Fork South Platte River | 9,699 | 2.5% | *0.5* |
| The Basin | 30,555 | 2.5% | *0.5* |
| Outlet Middle Fork South Platte River | 25,521 | 2.5% | *0.5* |
| Headwaters Agate Creek | 32,374 | 2.5% | *0.5* |
| Outlet Agate Creek | 26,242 | 2.5% | *0.5* |
| South Fork South Platte River | 28,150 | 2.5% | *0.5* |
| Spinney Mountain | 14,668 | 2.5% | *0.5* |
| Buffalo Gulch | 24,770 | 2.5% | *0.5* |
| Spinney Mountain Reservoir | 37,400 | 2.5% | *0.5* |
| Park Gulch | 24,166 | 2.5% | *0.5* |
| Michigan Creek-Tarryall Creek | 14,064 | 2.5% | *0.5* |
| Ruby Gulch | 25,513 | 2.5% | *0.5* |

## Table B-2. South Platte Headwaters Watershed Ruggedness Ranking[1]

| Sixth-level Watershed Name | Maximum Elevation | Minimum Elevation | Difference Elevation | Ruggedness | Rank |
|---|---|---|---|---|---|
| Spring Creek | 12,628 | 8,951 | 3,677 | 0.1731 | *5.5* |
| Salt Creek | 13,284 | 8,958 | 4,326 | 0.1719 | *5.4* |
| Mosquito Creek | 13,796 | 10,211 | 3,585 | 0.1688 | *5.3* |
| Crooked Creek | 13,333 | 9,587 | 3,746 | 0.1671 | *5.2* |
| Headwaters Middle Fork South Platte River | 14,238 | 10,207 | 4,031 | 0.1591 | *4.8* |
| Beaver Creek-Middle Fork South Platte River | 14,035 | 9,574 | 4,461 | 0.1584 | *4.8* |
| Twelve Mile Creek | 13,714 | 9,433 | 4,280 | 0.1467 | *4.2* |
| Trout Creek | 13,802 | 9,125 | 4,677 | 0.1460 | *4.1* |
| Pulver Gulch | 11,326 | 7,915 | 3,411 | 0.1446 | *4.0* |
| Outlet Tarryall Creek | 11,316 | 7,236 | 4,080 | 0.1440 | *4.0* |
| Marksbury Gulch | 11,286 | 8,272 | 3,014 | 0.1419 | *3.9* |
| Fourmile Creek | 14,022 | 8,892 | 5,130 | 0.1401 | *3.8* |
| Headwaters Tarryall Creek | 13,809 | 9,273 | 4,536 | 0.1398 | *3.8* |
| Headwaters South Fork South Platte River | 13,576 | 9,437 | 4,139 | 0.1346 | *3.5* |
| High Creek | 12,703 | 9,013 | 3,690 | 0.1275 | *3.2* |
| Michigan Creek | 13,605 | 9,259 | 4,346 | 0.1220 | *2.9* |
| Webber Park-Tarryall Creek | 12,156 | 8,266 | 3,890 | 0.1195 | *2.8* |
| Jefferson Creek | 13,035 | 9,259 | 3,775 | 0.1163 | *2.6* |
| Fish Creek | 10,512 | 8,066 | 2,447 | 0.1127 | *2.4* |
| Allen Creek-Tarryall Creek | 11,792 | 8,643 | 3,149 | 0.1059 | *2.1* |
| Rock Creek | 12,405 | 9,033 | 3,372 | 0.0946 | *1.5* |
| Elevenmile Canyon | 10,722 | 7,911 | 2,811 | 0.0896 | *1.2* |
| Elevenmile Reservoir | 11,546 | 8,541 | 3,004 | 0.0890 | *1.2* |
| Lower Tarryall | 11,749 | 8,846 | 2,903 | 0.0859 | *1.1* |
| Park Gulch | 12,047 | 9,273 | 2,775 | 0.0855 | *1.0* |
| Antero Reservoir | 12,287 | 8,938 | 3,349 | 0.0847 | *1.0* |
| Lower Lake George | 9,499 | 7,236 | 2,263 | 0.0846 | *1.0* |
| Outlet Chase Gulch | 11,355 | 8,584 | 2,772 | 0.0812 | *0.8* |
| Headwaters Chase Gulch | 11,267 | 8,800 | 2,467 | 0.0783 | *0.7* |
| Three Mile Creek | 10,942 | 8,600 | 2,342 | 0.0768 | *0.6* |
| Middle Fork South Platte River | 10,526 | 9,122 | 1,404 | 0.0750 | *0.5* |
| The Basin | 10,552 | 8,977 | 1,574 | 0.0750 | *0.5* |
| Outlet Middle Fork South Platte River | 9,974 | 8,771 | 1,204 | 0.0750 | *0.5* |
| Headwaters Agate Creek | 10,644 | 9,063 | 1,581 | 0.0750 | *0.5* |
| Outlet Agate Creek | 10,755 | 8,918 | 1,837 | 0.0750 | *0.5* |
| South Fork South Platte River | 9,820 | 8,771 | 1,050 | 0.0750 | *0.5* |
| Spinney Mountain | 9,817 | 8,758 | 1,059 | 0.0750 | *0.5* |
| Buffalo Gulch | 10,539 | 8,705 | 1,834 | 0.0750 | *0.5* |
| Spinney Mountain Reservoir | 9,843 | 8,584 | 1,260 | 0.0750 | *0.5* |
| Michigan Creek-Tarryall Creek | 10,378 | 9,095 | 1,282 | 0.0750 | *0.5* |
| Ruby Gulch | 10,289 | 8,905 | 1,384 | 0.0750 | *0.5* |
| Grape Creek | 9,617 | 8,151 | 1,466 | 0.0750 | *0.5* |
| Twin Creek | 9,830 | 7,951 | 1,879 | 0.0750 | *0.5* |

[1] Ruggedness is based on Melton (1957)

## Table B-3. South Platte Headwaters Watershed Road Density Ranking[2]

| Sixth-level Watershed Name | Roads (miles) | Roads Adjusted (miles) | Watershed Area (sq. mi.) | Road density (miles per sq. mi.) | Rank |
|---|---|---|---|---|---|
| Twin Creek | 176.6 | 132.5 | 45.89 | 2.89 | *5.5* |
| Grape Creek | 53.7 | 53.7 | 21.35 | 2.51 | *4.7* |
| Beaver Creek-Middle Fork South Platte River | 128.6 | 96.4 | 42.65 | 2.26 | *4.2* |
| Middle Fork South Platte River | 44.1 | 33.1 | 15.15 | 2.18 | *4.1* |
| Marksbury Gulch | 35.3 | 35.3 | 16.19 | 2.18 | *4.1* |
| Fish Creek | 35.7 | 35.7 | 16.90 | 2.11 | *3.9* |
| Outlet Tarryall Creek | 60.4 | 60.4 | 28.82 | 2.10 | *3.9* |
| Mosquito Creek | 33.6 | 33.6 | 16.18 | 2.07 | *3.8* |
| Michigan Creek-Tarryall Creek | 86.5 | 43.3 | 21.98 | 1.97 | *3.6* |
| Outlet Middle Fork South Platte River | 103.8 | 77.8 | 39.88 | 1.95 | *3.6* |
| Spinney Mountain | 89.1 | 44.5 | 22.92 | 1.94 | *3.6* |
| Elevenmile Canyon | 99.4 | 99.4 | 52.92 | 1.88 | *3.5* |
| Ruby Gulch | 149.3 | 74.6 | 39.86 | 1.87 | *3.4* |
| Pulver Gulch | 36.8 | 36.8 | 19.96 | 1.85 | *3.4* |
| The Basin | 88.0 | 88.0 | 47.74 | 1.84 | *3.4* |
| Headwaters Middle Fork South Platte River | 62.8 | 62.8 | 34.53 | 1.82 | *3.3* |
| Park Gulch | 64.0 | 64.0 | 37.76 | 1.70 | *3.1* |
| Antero Reservoir | 92.4 | 92.4 | 56.08 | 1.65 | *3.0* |
| Fourmile Creek | 104.4 | 78.3 | 48.09 | 1.63 | *2.9* |
| Outlet Agate Creek | 132.3 | 66.2 | 41.00 | 1.61 | *2.9* |
| Headwaters Chase Gulch | 113.9 | 56.9 | 35.55 | 1.60 | *2.9* |
| High Creek | 61.8 | 46.3 | 30.02 | 1.54 | *2.8* |
| Elevenmile Reservoir | 124.4 | 124.4 | 81.83 | 1.52 | *2.7* |
| Trout Creek | 55.6 | 55.6 | 36.80 | 1.51 | *2.7* |
| Crooked Creek | 26.3 | 26.3 | 18.03 | 1.46 | *2.6* |
| South Fork South Platte River | 125.6 | 62.8 | 43.98 | 1.43 | *2.5* |
| Three Mile Creek | 47.5 | 47.5 | 33.39 | 1.42 | *2.5* |
| Lower Tarryall | 115.3 | 86.4 | 61.47 | 1.41 | *2.5* |
| Outlet Chase Gulch | 116.4 | 58.2 | 41.84 | 1.39 | *2.5* |
| Salt Creek | 46.5 | 46.5 | 34.10 | 1.36 | *2.4* |
| Lower Lake George | 49.9 | 49.9 | 38.53 | 1.30 | *2.3* |
| Buffalo Gulch | 97.1 | 48.5 | 38.70 | 1.25 | *2.2* |
| Headwaters Tarryall Creek | 45.6 | 45.6 | 37.78 | 1.21 | *2.1* |
| Webber Park-Tarryall Creek | 44.9 | 44.9 | 38.03 | 1.18 | *2.0* |
| Spinney Mountain Reservoir | 133.3 | 66.7 | 58.44 | 1.14 | *2.0* |
| Michigan Creek | 66.8 | 50.1 | 45.52 | 1.10 | *1.9* |
| Headwaters Agate Creek | 108.8 | 54.4 | 50.58 | 1.07 | *1.8* |
| Spring Creek | 16.0 | 16.0 | 16.18 | 0.99 | *1.6* |
| Jefferson Creek | 35.7 | 35.7 | 37.79 | 0.94 | *1.6* |
| Rock Creek | 37.3 | 37.3 | 45.53 | 0.82 | *1.3* |
| Twelve Mile Creek | 24.6 | 24.6 | 30.55 | 0.81 | *1.3* |
| Headwaters South Fork South Platte River | 22.8 | 22.8 | 50.91 | 0.45 | *0.5* |
| Allen Creek-Tarryall Creek | 13.5 | 13.5 | 31.74 | 0.43 | *0.5* |

[2] The road density rank was adjusted based upon the procedure discussed in the report (p. 13) for several watersheds.

## Table B-4. South Platte Headwaters Watershed Flooding/Debris Flow Hazard Ranking[3]

| Sixth-level Watershed Name | Ruggedness Ranking | Road Density Ranking | Combined Ranking | Rank |
|---|---|---|---|---|
| Mosquito Creek | 5.3 | 3.8 | 14.40 | 5.5 |
| Beaver Creek-Middle Fork South Platte River | 4.8 | 4.2 | 13.73 | 5.2 |
| Salt Creek | 5.4 | 2.4 | 13.28 | 5.0 |
| Crooked Creek | 5.2 | 2.6 | 12.99 | 4.9 |
| Headwaters Middle Fork South Platte River | 4.8 | 3.3 | 12.91 | 4.9 |
| Spring Creek | 5.5 | 1.6 | 12.64 | 4.7 |
| Outlet Tarryall Creek | 4.0 | 3.9 | 11.92 | 4.4 |
| Marksbury Gulch | 3.9 | 4.1 | 11.88 | 4.4 |
| Pulver Gulch | 4.0 | 3.4 | 11.48 | 4.2 |
| Trout Creek | 4.1 | 2.7 | 10.94 | 4.0 |
| Fourmile Creek | 3.8 | 2.9 | 10.58 | 3.8 |
| Headwaters Tarryall Creek | 3.8 | 2.1 | 9.69 | 3.5 |
| Twelve Mile Creek | 4.2 | 1.3 | 9.58 | 3.4 |
| High Creek | 3.2 | 2.8 | 9.13 | 3.2 |
| Fish Creek | 2.4 | 3.9 | 8.78 | 3.1 |
| Michigan Creek | 2.9 | 1.9 | 7.66 | 2.6 |
| Headwaters South Fork South Platte River | 3.5 | 0.5 | 7.61 | 2.6 |
| Webber Park-Tarryall Creek | 2.8 | 2.0 | 7.57 | 2.5 |
| Jefferson Creek | 2.6 | 1.6 | 6.76 | 2.2 |
| Twin Creek | 0.5 | 5.5 | 6.50 | 2.1 |
| Elevenmile Canyon | 1.2 | 3.5 | 5.94 | 1.8 |
| Grape Creek | 0.5 | 4.7 | 5.74 | 1.8 |
| Park Gulch | 1.0 | 3.1 | 5.15 | 1.5 |
| Elevenmile Reservoir | 1.2 | 2.7 | 5.15 | 1.5 |
| Middle Fork South Platte River | 0.5 | 4.1 | 5.07 | 1.5 |
| Antero Reservoir | 1.0 | 3.0 | 4.97 | 1.4 |
| Allen Creek-Tarryall Creek | 2.1 | 0.5 | 4.65 | 1.3 |
| Michigan Creek-Tarryall Creek | 0.5 | 3.6 | 4.63 | 1.3 |
| Lower Tarryall | 1.1 | 2.5 | 4.60 | 1.3 |
| Outlet Middle Fork South Platte River | 0.5 | 3.6 | 4.60 | 1.3 |
| Spinney Mountain | 0.5 | 3.6 | 4.58 | 1.3 |
| Ruby Gulch | 0.5 | 3.4 | 4.44 | 1.2 |
| The Basin | 0.5 | 3.4 | 4.38 | 1.2 |
| Rock Creek | 1.5 | 1.3 | 4.30 | 1.1 |
| Lower Lake George | 1.0 | 2.3 | 4.24 | 1.1 |
| Headwaters Chase Gulch | 0.7 | 2.9 | 4.23 | 1.1 |
| Outlet Chase Gulch | 0.8 | 2.5 | 4.09 | 1.0 |
| Outlet Agate Creek | 0.5 | 2.9 | 3.91 | 1.0 |
| Three Mile Creek | 0.6 | 2.5 | 3.71 | 0.9 |
| South Fork South Platte River | 0.5 | 2.5 | 3.54 | 0.8 |
| Buffalo Gulch | 0.5 | 2.2 | 3.18 | 0.7 |
| Spinney Mountain Reservoir | 0.5 | 2.0 | 2.95 | 0.6 |
| Headwaters Agate Creek | 0.5 | 1.8 | 2.82 | 0.5 |

[3] Combined Ranking is Ruggedness Ranking times 2 plus the Road Density Ranking

## Table B-5. South Platte Headwaters Watershed Soil Erodibility Ranking[4]

| Sixth-level Watershed Name | Severe & Very Severe (acres) | Severe & Very Severe (%) | Granitic Soils (%) | Geology Ranking | Soils Rating |
|---|---|---|---|---|---|
| Mosquito Creek | 3,557.6 | 17.0% | 24.1% | 0.3 | *5.5* |
| Webber Park-Tarryall Creek | 3,741.9 | 15.4% | 71.0% | 0.8 | *5.5* |
| Headwaters Middle Fork South Platte River | 7,651.8 | 17.0% | 18.9% | 0.2 | *5.4* |
| Headwaters Tarryall Creek | 4,018.4 | 16.6% | 27.5% | 0.3 | *5.4* |
| Allen Creek-Tarryall Creek | 2,630.7 | 13.0% | 30.6% | 0.3 | *4.4* |
| Twelve Mile Creek | 2,429.8 | 12.4% | 2.6% | 0.0 | *3.9* |
| Headwaters South Fork South Platte River | 3,604.3 | 11.1% | 38.2% | 0.4 | *3.9* |
| Beaver Creek-Middle Fork South Platte River | 3,127.7 | 11.5% | 10.0% | 0.1 | *3.7* |
| Fourmile Creek | 2,625.1 | 8.5% | 6.6% | 0.1 | *2.8* |
| Outlet Tarryall Creek | 1,085.3 | 5.9% | 51.2% | 0.6 | *2.4* |
| Michigan Creek | 1,872.3 | 6.4% | 20.1% | 0.2 | *2.3* |
| Lower Lake George | 928.7 | 3.8% | 80.4% | 0.9 | *2.1* |
| Trout Creek | 1,371.3 | 5.8% | 2.4% | 0.0 | *1.9* |
| Marksbury Gulch | 372.7 | 3.6% | 56.9% | 0.6 | *1.8* |
| Outlet Chase Gulch | 920.9 | 3.4% | 31.2% | 0.3 | *1.5* |
| Elevenmile Canyon | 121.9 | 1.2% | 91.5% | 1.0 | *1.4* |
| Rock Creek | 967.6 | 3.3% | 19.9% | 0.2 | *1.3* |
| Michigan Creek-Tarryall Creek | 160.3 | 1.2% | 81.0% | 0.9 | *1.3* |
| Pulver Gulch | 327.8 | 2.6% | 41.0% | 0.4 | *1.3* |
| Twin Creek | 202.4 | 1.2% | 80.3% | 0.9 | *1.3* |
| Fish Creek | 0.0 | 1.2% | 73.3% | 0.8 | *1.3* |
| Grape Creek | 16.2 | 1.2% | 71.1% | 0.8 | *1.2* |
| Lower Tarryall | 960.1 | 2.4% | 32.2% | 0.4 | *1.2* |
| Jefferson Creek | 638.5 | 2.6% | 20.7% | 0.2 | *1.1* |
| Headwaters Chase Gulch | 186.4 | 1.2% | 55.9% | 0.6 | *1.1* |
| Ruby Gulch | 135.0 | 1.2% | 49.1% | 0.5 | *1.0* |
| Elevenmile Reservoir | 1,075.9 | 2.1% | 24.1% | 0.3 | *1.0* |
| Salt Creek | 462.1 | 2.1% | 10.8% | 0.1 | *0.9* |
| High Creek | 423.7 | 2.2% | 0.0% | 0.0 | *0.8* |
| Crooked Creek | 198.4 | 1.7% | 4.4% | 0.0 | *0.7* |
| Spring Creek | 172.4 | 1.7% | 0.0% | 0.0 | *0.6* |
| Spinney Mountain | 24.2 | 1.2% | 12.5% | 0.1 | *0.6* |
| Park Gulch | 126.8 | 1.2% | 10.2% | 0.1 | *0.6* |
| Antero Reservoir | 496.8 | 1.4% | 0.0% | 0.0 | *0.6* |
| Outlet Agate Creek | 11.8 | 1.2% | 5.0% | 0.1 | *0.6* |
| Headwaters Agate Creek | 79.2 | 1.2% | 4.6% | 0.0 | *0.5* |
| The Basin | 151.2 | 1.2% | 4.5% | 0.0 | *0.5* |
| Buffalo Gulch | 50.5 | 1.2% | 3.8% | 0.0 | *0.5* |
| Spinney Mountain Reservoir | 39.1 | 1.2% | 2.2% | 0.0 | *0.5* |
| South Fork South Platte River | 16.2 | 1.2% | 2.1% | 0.0 | *0.5* |
| Three Mile Creek | 77.6 | 1.2% | 0.9% | 0.0 | *0.5* |
| Middle Fork South Platte River | 77.6 | 1.2% | 0.0% | 0.0 | *0.5* |
| Outlet Middle Fork South Platte River | 33.4 | 1.2% | 0.0% | 0.0 | *0.5* |

[4] Soil Erodibility Value is percentage of Severe plus 2 times the percentage of Very Severe.

## Table B-6. South Platte Headwaters Watershed Composite Hazard Ranking[5]

| Sixth-level Watershed Name | Wildfire Hazard Rank | Flooding/Debris Flow Rank | Soil Erodibility Rank | Composite Hazard Rank |
|---|---|---|---|---|
| Headwaters Tarryall Creek | 4.7 | 3.5 | 5.4 | 5.5 |
| Mosquito Creek | 2.4 | 5.5 | 5.5 | 5.4 |
| Headwaters Middle Fork South Platte River | 3.0 | 4.9 | 5.4 | 5.4 |
| Headwaters South Fork South Platte River | 5.5 | 2.6 | 3.9 | 4.8 |
| Beaver Creek-Middle Fork South Platte River | 2.9 | 5.2 | 3.7 | 4.7 |
| Webber Park-Tarryall Creek | 3.4 | 2.5 | 5.5 | 4.6 |
| Allen Creek-Tarryall Creek | 5.5 | 1.3 | 4.4 | 4.5 |
| Outlet Tarryall Creek | 4.1 | 4.4 | 2.4 | 4.4 |
| Twelve Mile Creek | 2.4 | 3.4 | 3.9 | 3.9 |
| Lower Lake George | 5.4 | 1.1 | 2.1 | 3.4 |
| Marksbury Gulch | 2.1 | 4.4 | 1.8 | 3.3 |
| Rock Creek | 5.5 | 1.1 | 1.3 | 3.1 |
| Fourmile Creek | 1.3 | 3.8 | 2.8 | 3.1 |
| Spring Creek | 2.5 | 4.7 | 0.6 | 3.1 |
| Michigan Creek | 2.9 | 2.6 | 2.3 | 3.1 |
| Crooked Creek | 2.1 | 4.9 | 0.7 | 3.0 |
| Grape Creek | 4.6 | 1.8 | 1.2 | 3.0 |
| Salt Creek | 1.6 | 5.0 | 0.9 | 3.0 |
| Pulver Gulch | 1.6 | 4.2 | 1.3 | 2.8 |
| Jefferson Creek | 3.6 | 2.2 | 1.1 | 2.8 |
| Trout Creek | 0.6 | 4.0 | 1.9 | 2.5 |
| Twin Creek | 2.6 | 2.1 | 1.3 | 2.3 |
| Fish Creek | 1.6 | 3.1 | 1.3 | 2.3 |
| High Creek | 1.2 | 3.2 | 0.8 | 2.0 |
| Elevenmile Reservoir | 2.7 | 1.5 | 1.0 | 2.0 |
| Elevenmile Canyon | 1.9 | 1.8 | 1.4 | 2.0 |
| Lower Tarryall | 2.7 | 1.3 | 1.2 | 2.0 |
| Outlet Chase Gulch | 1.2 | 1.0 | 1.5 | 1.4 |
| Antero Reservoir | 1.3 | 1.4 | 0.6 | 1.2 |
| Michigan Creek-Tarryall Creek | 0.5 | 1.3 | 1.3 | 1.2 |
| Headwaters Chase Gulch | 0.6 | 1.1 | 1.1 | 1.0 |
| Ruby Gulch | 0.5 | 1.2 | 1.0 | 1.0 |
| Park Gulch | 0.5 | 1.5 | 0.6 | 0.9 |
| Middle Fork South Platte River | 0.5 | 1.5 | 0.5 | 0.9 |
| Spinney Mountain | 0.5 | 1.3 | 0.6 | 0.8 |
| Outlet Middle Fork South Platte River | 0.5 | 1.3 | 0.5 | 0.8 |
| The Basin | 0.5 | 1.2 | 0.5 | 0.8 |
| Outlet Agate Creek | 0.5 | 1.0 | 0.6 | 0.7 |
| Three Mile Creek | 0.5 | 0.9 | 0.5 | 0.7 |
| South Fork South Platte River | 0.5 | 0.8 | 0.5 | 0.6 |
| Buffalo Gulch | 0.5 | 0.7 | 0.5 | 0.6 |
| Spinney Mountain Reservoir | 0.5 | 0.6 | 0.5 | 0.5 |
| Headwaters Agate Creek | 0.5 | 0.5 | 0.5 | 0.5 |

[5] The Composite Hazard Rank is the sum of the Wildfire Hazard Rank, Flooding/Debris Flow Rank, and Soil Erodibility Rank that is re-categorized into 5 categories.

## Table B-7. South Platte Headwaters Watershed Final Priority Ranking[6]

| Sixth-level Watershed Name | Wildfire Hazard | Flooding/ Debris Flow | Soil Erodibility | Composite | Node Ranking | Overall Ranking |
|---|---|---|---|---|---|---|
| Headwaters Middle Fork South Platte River | 3.0 | 4.9 | 5.5 | 5.4 | 1 | 5.5 |
| Beaver Creek-Middle Fork South Platte River | 2.9 | 5.2 | 3.7 | 4.7 | 1 | 5.0 |
| Headwaters Tarryall Creek | 4.7 | 3.5 | 5.4 | 5.5 | 0 | 4.8 |
| Mosquito Creek | 2.4 | 5.5 | 5.5 | 5.4 | 0 | 4.7 |
| Headwaters South Fork South Platte River | 5.5 | 2.6 | 3.6 | 4.8 | 0 | 4.2 |
| Webber Park-Tarryall Creek | 3.4 | 2.5 | 5.0 | 4.6 | 0 | 4.0 |
| Allen Creek-Tarryall Creek | 5.5 | 1.3 | 4.2 | 4.5 | 0 | 3.9 |
| Outlet Tarryall Creek | 4.1 | 4.4 | 2.0 | 4.4 | 0 | 3.8 |
| Michigan Creek | 2.9 | 2.6 | 2.2 | 3.1 | 1 | 3.5 |
| Crooked Creek | 2.1 | 4.9 | 0.7 | 3.0 | 1 | 3.5 |
| Grape Creek | 4.6 | 1.8 | 0.5 | 3.0 | 1 | 3.5 |
| Salt Creek | 1.6 | 5.0 | 0.8 | 3.0 | 1 | 3.5 |
| Twelve Mile Creek | 2.4 | 3.4 | 4.1 | 3.9 | 0 | 3.4 |
| Pulver Gulch | 1.6 | 4.2 | 0.9 | 2.8 | 1 | 3.3 |
| Jefferson Creek | 3.6 | 2.2 | 1.0 | 2.8 | 1 | 3.3 |
| Trout Creek | 0.6 | 4.0 | 2.0 | 2.5 | 1 | 3.1 |
| Lower Lake George | 5.4 | 1.1 | 1.3 | 3.4 | 0 | 3.0 |
| Twin Creek | 2.6 | 2.1 | 0.5 | 2.3 | 1 | 2.9 |
| Fish Creek | 1.6 | 3.1 | 0.5 | 2.3 | 1 | 2.9 |
| Marksbury Gulch | 2.1 | 4.4 | 1.3 | 3.3 | 0 | 2.9 |
| Rock Creek | 5.5 | 1.1 | 1.2 | 3.1 | 0 | 2.8 |
| Fourmile Creek | 1.3 | 3.8 | 2.8 | 3.1 | 0 | 2.7 |
| Spring Creek | 2.5 | 4.7 | 0.6 | 3.1 | 0 | 2.7 |
| Elevenmile Reservoir | 2.7 | 1.5 | 0.8 | 2.0 | 1 | 2.6 |
| Elevenmile Canyon | 1.9 | 1.8 | 0.5 | 2.0 | 1 | 2.6 |
| Lower Tarryall | 2.7 | 1.3 | 0.9 | 2.0 | 1 | 2.6 |
| Outlet Chase Gulch | 1.2 | 1.0 | 1.2 | 1.4 | 1 | 2.1 |
| Antero Reservoir | 1.3 | 1.4 | 0.6 | 1.2 | 1 | 2.0 |
| High Creek | 1.2 | 3.2 | 0.8 | 2.0 | 0 | 1.8 |
| Headwaters Chase Gulch | 0.6 | 1.1 | 0.5 | 1.0 | 1 | 1.8 |
| The Basin | 0.5 | 1.2 | 0.5 | 0.8 | 1 | 1.6 |
| Outlet Agate Creek | 0.5 | 1.0 | 0.5 | 0.7 | 1 | 1.5 |
| Three Mile Creek | 0.5 | 0.9 | 0.5 | 0.7 | 1 | 1.5 |
| Buffalo Gulch | 0.5 | 0.7 | 0.5 | 0.6 | 1 | 1.4 |
| Spinney Mountain Reservoir | 0.5 | 0.6 | 0.5 | 0.5 | 1 | 1.4 |
| Michigan Creek-Tarryall Creek | 0.5 | 1.3 | 0.5 | 1.2 | 0 | 1.1 |
| Ruby Gulch | 0.5 | 1.2 | 0.5 | 1.0 | 0 | 0.9 |
| Park Gulch | 0.5 | 1.5 | 0.5 | 0.9 | 0 | 0.9 |
| Middle Fork South Platte River | 0.5 | 1.5 | 0.5 | 0.9 | 0 | 0.8 |
| Spinney Mountain | 0.5 | 1.3 | 0.5 | 0.8 | 0 | 0.8 |
| Outlet Middle Fork South Platte River | 0.5 | 1.3 | 0.5 | 0.8 | 0 | 0.8 |
| South Fork South Platte River | 0.5 | 0.8 | 0.5 | 0.6 | 0 | 0.6 |
| Headwaters Agate Creek | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0.5 |

[6] The Final Numeric Rank is the sum of the Composite Hazard Rank and the Water Supply Rank.