**NPS problems in the watershed or other area of concern.**

**Section 319 Nonpoint Source Pollution Control Program**

**Information/Education/Training Project Final Report**

# Turkey Creek Watershed Case Study


**By Karen Berry**

**Colorado Geological Survey**

**Jefferson Conservation District**



The project was conducted in cooperation with the State of Colorado and the United States Environmental Protection Agency, Region 8.

Grant # WQC0200714

# Table of Contents

## List of Figures

# List of Tables

## Executive Summary

| Turkey Creek Watershed Case Study Funding and Expenditures | |
|---|---|
| **Grant Number** | **02FAA00714** |
| **Grant Source** | Colorado Department of Health and Environment |
| **Start Date** | **10/28/2001** |
| **Completion Date** | **3/31/2005** |

| Funding | | |
|---|---|---|
| **Cash** | **Grant** | **Match** |
| EPA | $39,000.00 | |
| Local Groups | | |
| State | | |
| **In-Kind** | | **Match** |
| Federal | | |
| State | | $26,455.34 |
| Local Groups | | $ 4,500.00 |
| **Total** | $39,000.00 | $30,955.34 |

| Expenditures | |
|---|---|
| EPA Funds | $39,000.00 |
| Other | $30,955.34 (in kind) |
| **Total** | $69,955.34 |

**Table 1 Summary of Funding and Expenditures**

## Summary of Accomplishments

**Construction Water Erosion Model:** Using data collected on soils, vegetation, and topography, CGS created a Best Management Practices tool that estimates and compares soil loss from different soil types, slope and practices. Land managers and construction professionals can use the tool to select the most effective Best Management Practices for a site. The tool describes the limitations of typical BMPs recommendations for reducing nonpoint source pollution from construction sites.

**Post Construction Water Erosion Model:** A river basin scale model was used to compare the impact of land management practices on water and sediment yields in the large, complex Turkey Creek Watershed with varying soils, land use, and management conditions over long periods of time. Tools developed from the model allow planners to assess the effects of growth and development and/or changes in management practices on water quality.

**Outreach:** The Jefferson Conservation District sponsored a regional workshop on using polymers as a Best Management Practice on construction sites. CGS conducted a technical transfer session, at an international construction industry conference, on using a watershed model to evaluate land-use and water quality in an urban mountain watershed.

Jefferson County hosted numerous open houses during development of comprehensive plans. During these collaborative planning meetings, community organizations, citizens, and local stakeholders viewed project maps showing where development may cause water-quality impacts. In this interactive environment, citizens formulated action strategies and goals for water quality improvement, many of which are now part of county land use plans. Similar meetings with other watershed stakeholders were held.

## Introduction

### Project Summary

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Lead Project Sponsor: Colorado Geological Survey, 1313 Sherman Street Room 715, Denver, CO 80203 (303) 866-2611

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| | |
|---|---|
| Hydrologic Unit Code: | COSPUS14 |
| High Priority Watershed: | Yes |

TMDL Development and/or Implementation: Yes

| Project Categories | | |
|---|---|---|
| **Type** | **Waterbody** | **Non Point Source** |
| **Information** | **Lakes** | **Agriculture** |
| **Education** | **Reservoirs** | **Urban** |
| | **Streams** | **Construction** |
| **General Project Location** | | |
| **39 degrees 30 minutes to 39 degrees 38 minutes** | | |
| **105 degrees 23 minutes to 105 degrees 12 minutes** | | |

## Description of Project Area

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The study area is the 47.2 square miles Turkey Creek watershed, in Jefferson County, southwest of Denver, Colo. The study area includes the urban areas of Conifer, Aspen Park, and Indian Hills. In the study area, there are about 4,900 single-family dwellings, industrial uses and major commercial centers. Residential densities range from low to high with the average about one dwelling unit per 6 acres.

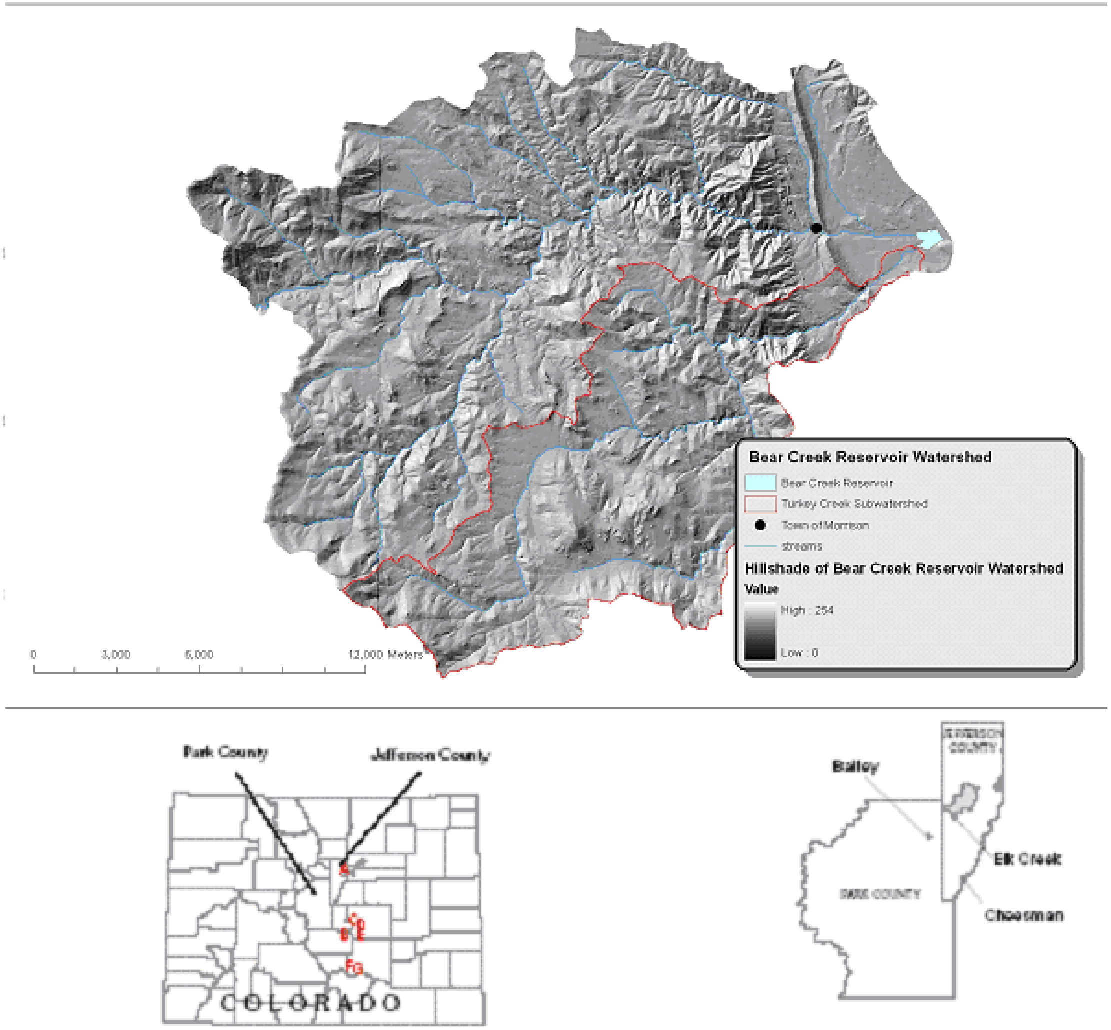


**Figure 1 Location of Project Area**

The watershed topography is steep and rocky with elevations ranging from about 10,500 ft in the southwestern part of the watershed to about 5,600 ft where Turkey Creek exits the mountainous canyon and flows into Bear Creek Reservoir (figure 2).

The Turkey Creek watershed covers about 25 percent of the total area tributary to the Bear Creek Reservoir (figure 1). Bear Creek Reservoir is classified to include the beneficial uses of recreation, aquatic life, and water supply.

Vegetation types mapped from remotely sensed images, and other sources, revels that the watershed is dominated by mixed conifer trees (Douglas fir, ponderosa, and lodgepole pine). Along drainages, mountain meadows, and lower elevations, shrubs such as bitterbrush, skunkbrush, and mountainmahogany can be found as well as native and introduced grasses and forbs (figure 2).

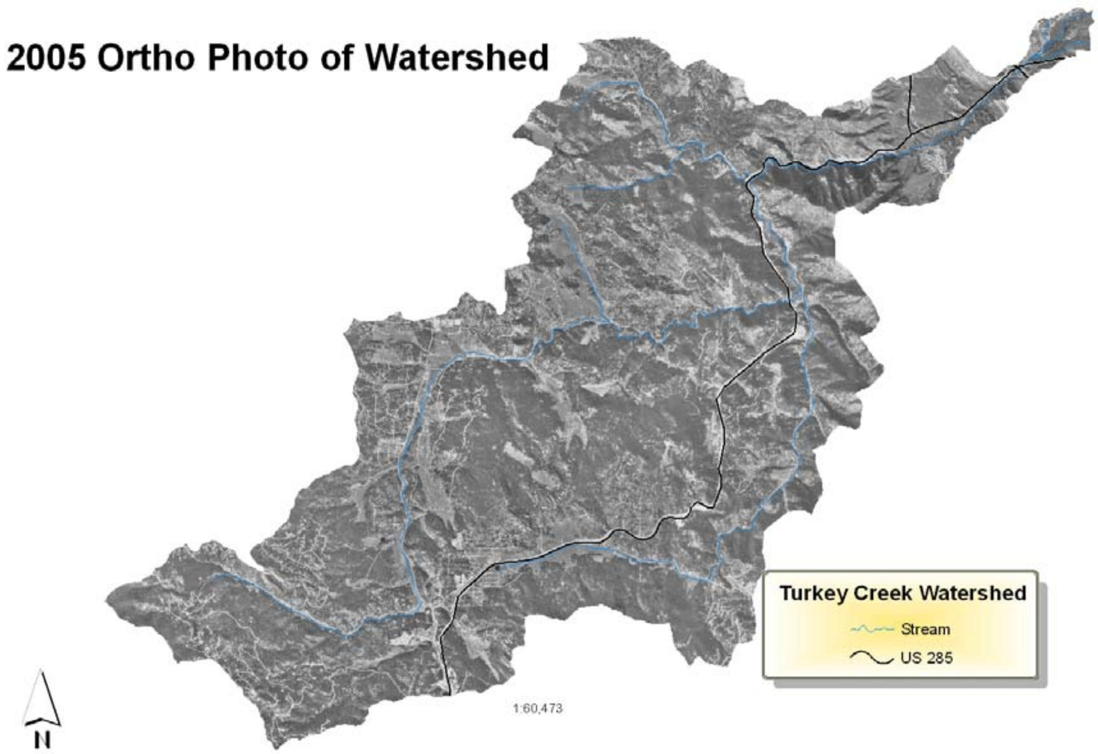


**Figure 2  2005 Ortho Photo of Project Area**

Rock outcrops and thin gravelly soils, derived from crystalline metamorphic and intrusive rock, can be found throughout the mountainous parts of the watershed. Soils, in the lower end of the watershed, derived from sedimentary rock, are thick and high in clay and silt.  A simplified geologic map of the project area is shown below in figure 3.

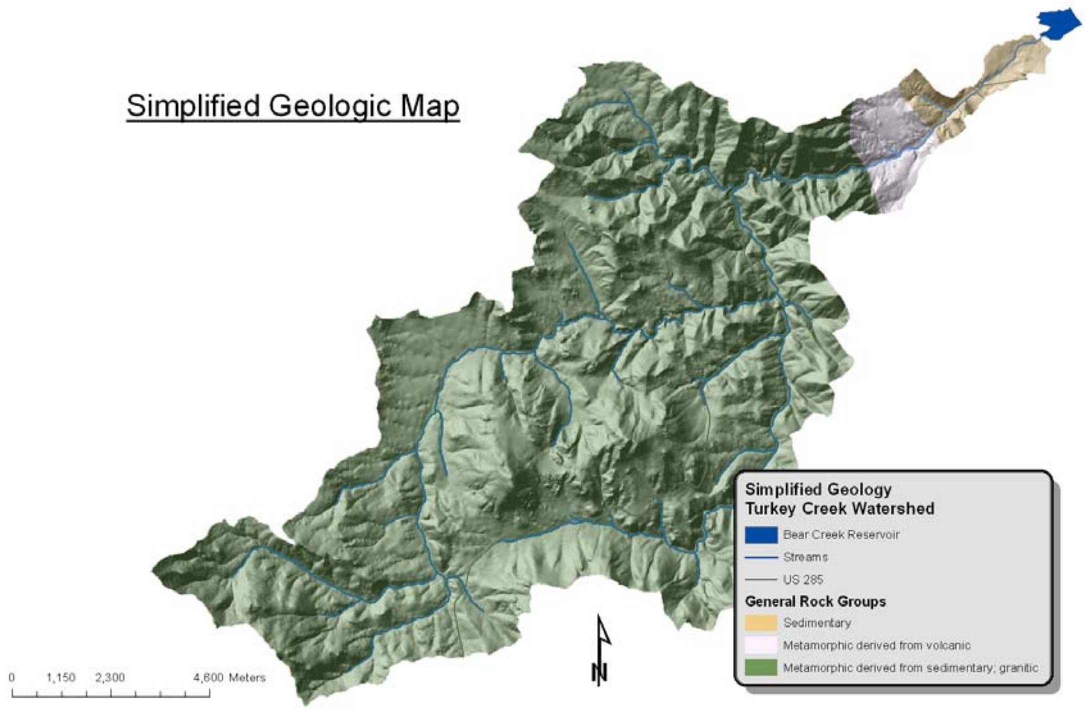


**Figure 3 Simplified Geologic Map**

## Water Quality Issues

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A 1990 Clean Lakes Study found that the ecological health of Bear Creek reservoir is at risk due to nutrient and sediment loading. At times, the reservoir does not meet beneficial use classifications due to excessive phosphorus and nitrogen loading, algal blooms, potential for fish kills and elevated concentrations of metals in fish. Phosphorus loading, from point and nonpoint sources, is a key water quality concern. The study also recommends reducing sediment loading into the reservoir.

Monitoring indicates that Turkey Creek is an important contributor to nutrient and sediment loading in the reservoir. Although the Turkey Creek sub watershed covers only a small portion (25%) of the Bear Creek Watershed, at times, it contributes over 40 percent of sediment and nutrient loads (fig. 3).

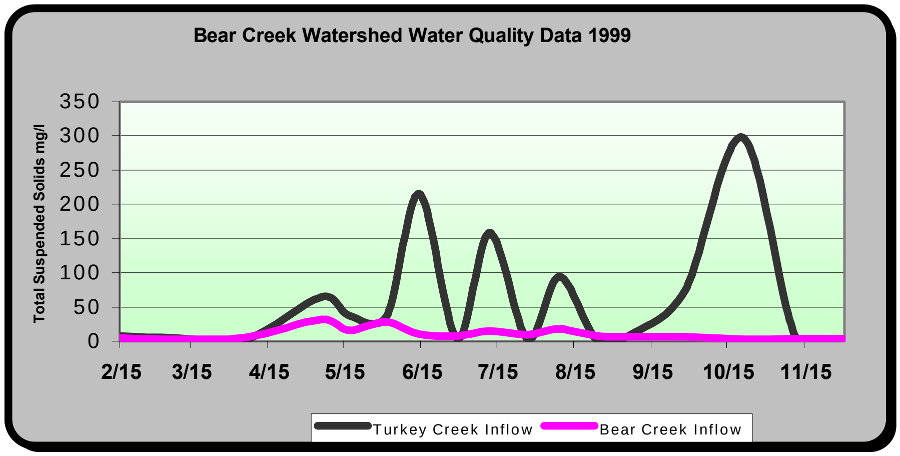


**Figure 4 Bear Creek and Turkey Creek Water Quality Data**

The primary source of sediment and nutrient loading is thought to be nonpoint sources from urban development (fig 5 and 6). The major land use in the Turkey Creek Watershed is residential development. The Bear Creek Watershed Association (BCWA) has identified residential development as the major cause of nonpoint source sediment loading (BCWA, 1996). Additional nonpoint sediment sources include road construction and stream bank erosion. Monitoring by the Bear Creek Watershed Association indicates that suspended solids from point sources accounts for less than one percent of the total load into the reservoir.

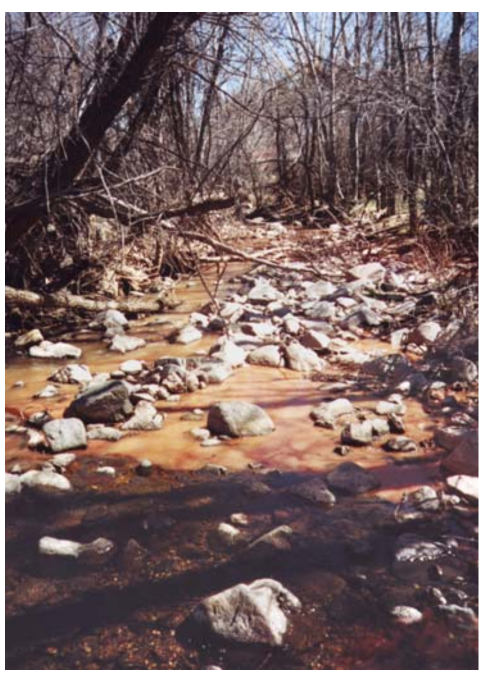

**Figure 5 Sediment-laden water in Turkey Creek from urban development.**

Water flows from foreground to background. Immediately downstream of urban development discharge water color changes from clear to brown from due to suspended solids. Photo by Karen Berry, 2000.

**Figure 6  Example of erosion from urban development.**

**Runoff and sediment flows from construction site flows directly to Turkey Creek.**

**Photo by Karen Berry, 2000.**

There are currently about 4600 homes in the Turkey Creek basin and an additional 3600 homes could be built using wells and individual septic systems. If public water and sewer services become widely available, an additional 12,000 homes could be built (Jefferson County, 2001).  Future development could significantly increase sediment and nutrient levels in the watershed.

## Project Goals, Objectives, and Activities

### Planned and Actual Milestones, Products and Completion Dates

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Although sediment is a major cause of nonpoint source pollution adversely affecting water quality in the Colorado, it is very expensive and impractical to monitor nonpoint source pollution in a large watershed. There is a demonstrated need to predict sediment and nutrient loading with a management tool. Using, a watershed scale model developed to predict the impact of land use and management on water and sediment, watershed runoff and sediment loading for estimated and compared for the Turkey Creek watershed.

The case study model would serve as an “Information and Education” tool for educating individuals, developers, and government officials on the effects of different land uses on the water quality of the watershed. Because the tool can identify areas that are prone to excessive sediment and nutrient loading, the tool can be used in watershed enhancement planning as well as evaluating the effects of individual development proposals.

Demonstrate how a watershed model can be used as a pollution prevention and watershed enhancement or management tool for federal, state, and local agencies. Produce maps and examples showing the factors and areas that contribute to nonpoint pollution because of varying land use, soils, and management using the Turkey Creek Watershed as a case study.

Project goals include:

- ✓ Calibrate and verify the model for the Turkey Creek Watershed. Develop specific model input and output files for specific slope, vegetation, soil, climate, drainage and land use conditions in the Turkey Creek Watershed;
- ✓ Raise public awareness of sediment as major nonpoint source pollutant and the specific factors that cause accelerated erosion and nonpoint source pollution in the Turkey Creek Watershed;
- ✓ Create a transferable water erosion prediction model that can be adapted for use in similar areas.

| Objectives & Tasks | Status | Output | Qty | Year 1 | | | | | | Year 2 | | | | | | Year 3 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 |
| **Objective 1** | | | | ***Each period is two months*** | | | | | | | | | | | | | | | | | |
| ***Model Input Tasks*** | Estimated | Input Parameters | | | | | | | | | | | | | | | | | | | |
| | *Actual* | *Input Parameters* | | | | | | | | | | | | | | | | | | | |
| | Estimated | Purchase DEM | 1 | | | | | | | | | | | | | | | | | | |
| | *Actual* | *Purchase DEM* | 4 | | | | | | | | | | | | | | | | | | |
| **Objective 2** | | | | | | | | | | | | | | | | | | | | | |
| ***Erosion Factor Tasks*** | Estimated | Soil Map | 1 | | | | | | | | | | | | | | | | | | |
| | *Actual* | *Soil Map* | 3 | | | | | | | | | | | | | | | | | | |
| | Estimated | Slope Map | 1 | | | | | | | | | | | | | | | | | | |
| | *Actual* | *Slope Map* | 3 | | | | | | | | | | | | | | | | | | |
| | Estimated | HEL Map | 1 | | | | | | | | | | | | | | | | | | |
| | *Actual* | *HEL Map* | 3 | | | | | | | | | | | | | | | | | | |
| | Estimated | HEL Land Use Map | 1 | | | | | | | | | | | | | | | | | | |
| | *Actual* | *HEL Land Use Map* | 1 | | | | | | | | | | | | | | | | | | |
| | Estimated | Land Use Map | 1 | | | | | | | | | | | | | | | | | | |
| | *Actual* | *Land Use Map* | 1 | | | | | | | | | | | | | | | | | | |
| | Estimated | WEPP input and output | 1 | | | | | | | | | | | | | | | | | | |
| | *Actual* | *WEPP input and output* | 3 | | | | | | | | | | | | | | | | | | |
| **Objective 3** | | | | | | | | | | | | | | | | | | | | | |
| ***Draft Report Tasks*** | Estimated | Report on Key Factors | 1 | | | | | | | | | | | | | | | | | | |
| | *Actual* | *Report on Key Factors* | | | | | | | | | | | | | | | | | | | |
| | Estimated | Model Users Guide | 1 | | | | | | | | | | | | | | | | | | |
| | *Actual* | *Model Users Guide* | 1 | | | | | | | | | | | | | | | | | | |
| | Estimated | Verify Model | | | | | | | | | | | | | | | | | | | |
| | *Actual* | *Verify Model* | | | | | | | | | | | | | | | | | | | |
| **Objective 4** | | | | | | | | | | | | | | | | | | | | | |
| ***Monitoring Plan Tasks*** | Estimated | Oversite Meetings | 4 | | | | | | | | | | | | | | | | | | |
| | *Actual* | *Oversite Meetings* | 0 | | | | | | | | | | | | | | | | | | |
| | Estimated | Final Report CD | 150 | | | | | | | | | | | | | | | | | | |
| | *Actual* | *Final Report on web* | 1 | | | | | | | | | | | | | | | | | | |
| | Estimated | Monitor Use | | | | | | | | | | | | | | | | | | | |
| | *Actual* | *Monitor Use* | | | | | | | | | | | | | | | | | | | |
| | Estimated | Customer Survey | 1 | | | | | | | | | | | | | | | | | | |
| | *Actual* | *Customer Interviews* | 6 | | | | | | | | | | | | | | | | | | |
| | Estimated | Semi-annual Report | 2 | | | | | | | | | | | | | | | | | | |
| | *Actual* | *Semi-annual Report* | | | | | | | | | | | | | | | | | | | |
| **Objective 5** | | | | | | | | | | | | | | | | | | | | | |
| ***Outreach Tasks*** | Estimated | Website | 1 | | | | | | | | | | | | | | | | | | |
| | *Actual* | *Website* | 1 | | | | | | | | | | | | | | | | | | |
| | Estimated | Technical transfer events | 1 | | | | | | | | | | | | | | | | | | |
| | *Actual* | *Technical transfer events* | 5 | | | | | | | | | | | | | | | | | | |

**Table 2 Planned and Actual Milestones**

## Objectives and Products

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**Objective 1: Gather model input parameters**

*Work with the Natural Resources Conservation Service, Jefferson County, and other local agencies to gather slope, soils, topography, vegetation and land use information for watershed.*

The model requires specific information about weather, soil, topography, vegetation and land management practices in the watershed. The physical processes associated with water and sediment movement, plant growth, and nutrient cycling, etc. are directly modeled using this input data.

***Topography***

A digital elevation model (DEM) was used to analyze topography and drainage patterns of the land-surface terrain and to define drainage area boundaries. Analysis using a fine-resolution (1-meter) DEM proved to be cumbersome and impractical. Computer processing time was excessive and erroneous drainage patterns occurred in areas with little topographic relief. Below is a generalized slope map derived from a 10-meter DEM. The watershed is steep, with approximately 55% of the area having slope gradients 40% or greater.

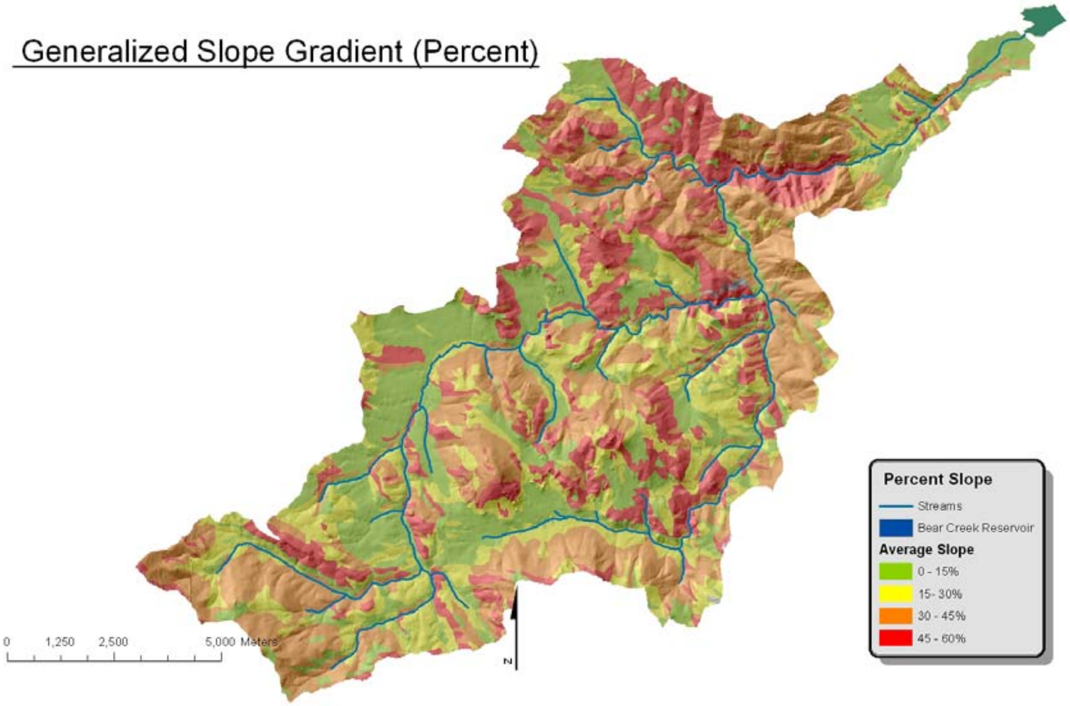


**Figure 7 Turkey Creek Watershed Slope Gradients**

### *Soils*

Movement of sediment and pollutants into watercourses is often caused by erosion. Soil erosion by water is the result of rain detaching and transporting vulnerable soil. Erosion is directly affected by the steepness and length of the slope. Greater slopes increase the runoff velocity and the movement of sediment carried in runoff.  Another important factor in soil erosion is soil types.

All soils are not created equal. A basic and important difference between soils is texture. This refers to the size particles in a soil. Soils of different textures pose different risks for the movement of erosion and contaminants.  Erosion reaches a peak for silty clay loam soils. Larger textured soils like sands are more difficult to erode, because of their large particles.  Clay soil is difficult to detach, but once suspended in runoff is not easily removed, and can be transported over long distances.   Soil properties were derived from the United States Department of Agriculture Soil Survey of the Golden Area, Colorado.  A generalized soil map for the watershed is shown in Figure 8. Table 3 shows the distribution of generalized soil types in the watershed. As noted in the description of the project area, soil types are closely related to the "parent material" or general rock types.

| Major Soil Types | Area of Watershed |
|---|---|
| Clay and Clay Loam | 5% |
| Sandy Loam | 15% |
| Loam | 2% |
| Loamy Sand | 43% |
| Rock Outcrop (no to thin soil cover) | 34% |

**Table 3 Distribution of Major Soil Types**

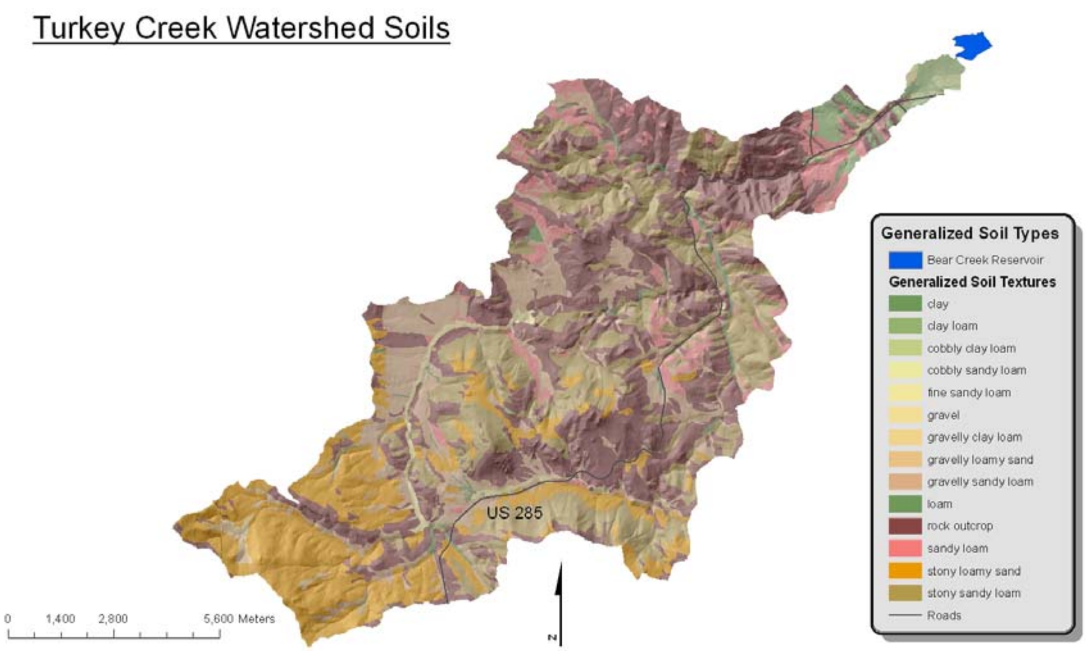


**Figure 8 Generalized Soil Map**

***Vegetation***

Vegetation plays a critical role in the amount of water, sediment, and pollutants that move through a watershed. The leaves and branches of vegetation intercept rainfall, reducing erosive energy and slowing the movement of rain water. Root growth and plant litter improve soil structure and enhance infiltration of rainfall, reducing surface runoff. Stems of trees and shrubs resist and slow out-of-bank stream flow and stream bank erosion.

Vegetation and plant debris slow surface runoff encouraging sediment and attached pollutants to settle before entering surface water. Root growth and plant residue improve soil structure which enhances infiltration of dissolved contaminants. Once in the soil, pollutants can be immobilized, transformed by soil microbes, or taken up by vegetation. Groundwater flowing through plant roots is also filtered by these processes.

Vegetation data, for modeling, was collected from the following sources:

- ✓ Jefferson County Mountain Area Research Project- Computer Aided Planning Program (CAPP)
- ✓ Natural Resources Conservation Service Soil Survey of the Golden Area
- ✓ Landsat ETM+ 30 meter remotely sensed image

For both the CAPP project and the soil survey, vegetation mapping was done using aerial photographs taken prior to 1980. Vegetation types were verified using remotely sensed images.

This information was used to update previous vegetation mapping. Below, a simplified vegetation map shows typical vegetation types in the watershed.

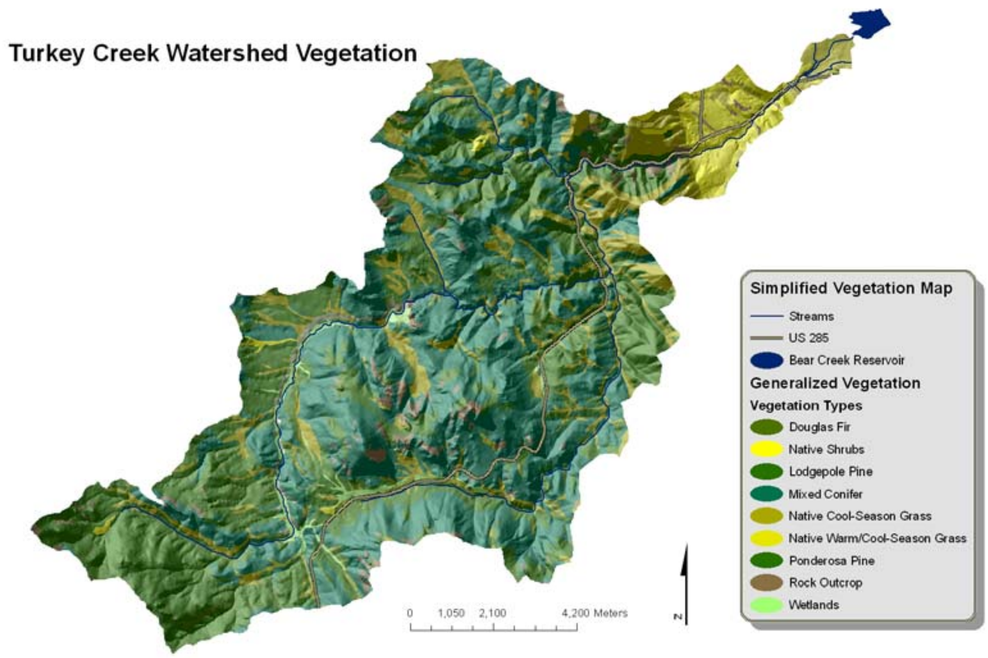


**Figure 9 Simplified Vegetation Map**

Excluding urban development, most of the land cover in the watershed is evergreen forest. Table 4 shows the percentage distribution of major vegetation types.

| Major Vegetation Types | % of Watershed* |
|---|---|
| Mixed Conifer | 36% |
| Lodgepole | 29% |
| Cool-Season Grasses | 15% |
| Ponderosa | 10% |
| Mixed Warm/Cool-Season Grasses | 4% |
| Rock Outcrops (little to no vegetation) | 3% |
| Native shrubs (evergreen & deciduous) | 2% |
| Sedges & Willows (wetlands) | 1% |
| Douglas Fir | >1% |
| * excluding urban and agricultural land uses | |

**Table 4 Distribution of Major Vegetation Types**

***Land Use***

Urbanization creates more impervious surfaces, thus increasing runoff and impairing water quality.  It alters the natural infiltration capability of the land and generates a host of pollutants, such as pet waste, pesticides and household hazardous wastes, thus causing an increase in storm water runoff volumes and pollutant loading. Storm water runoff washes over impervious areas, picking up pollutants along the way.  Continued urban growth will likely increase pollutant loads to Bear Creek Reservoir.

Studies reveal that the level of imperviousness in an area strongly correlates with decreased quality of nearby streams. Land use and the extent of impervious surfaces is a key variable in predicting pollutant loads and flooding. Information on existing and future land use, including land management practices, was collected from the following sources:

- ✓ Parcel information, Jefferson County Planning Department and Assessor; Landsat ETM+ 30 meter remotely sensed image, ortho photos from the Denver Regional Council of Governments and the Natural Resources Conservation Service;

- ✓ Zoning and Existing Land Use, Jefferson County Planning Department, ortho photos from the Denver Regional Council of Governments and the Natural Resources Conservation Service;

- ✓ Future Land Use, Jefferson County South Jeffco and Conifer Community Plans, Jefferson County Planning Department, and Denver Regional Council of Governments;

- ✓ Roads, Jefferson County Planning Department, Colorado Department of Transportation, and Landsat ETM+ 30 meter remotely sensed image, ortho photos from the Denver Regional Council of Governments and the Natural Resources Conservation Service;

- ✓ Land Management, Jefferson County Planning Department, Landsat ETM+ 30 meter remotely sensed image, and Natural Resources Conservation Service;

- ✓ Impervious Areas, Jefferson County Highways and Transportation, Landsat ETM+ 30 meter remotely sensed image, ortho photos from the Denver Regional Council of Governments and the Natural Resources Conservation Service;

Data from these sources was used to generate existing and future land use for the basin. Primarily using parcel, zoning and building permit data from the county planning department, the number of additional residential homes, commercial and industrial structures that could be constructed in the basin was estimated and used to determine future land use in the basin. For example, currently, in the basin, building permits can be issued on an additional ~3000 lots.

The SWAT model contains specific land use categories and information land-use information from the basin was arranged into these urban land types. The table and figure below, generally illustrate the percentage (area) of existing land-use types in the watershed.

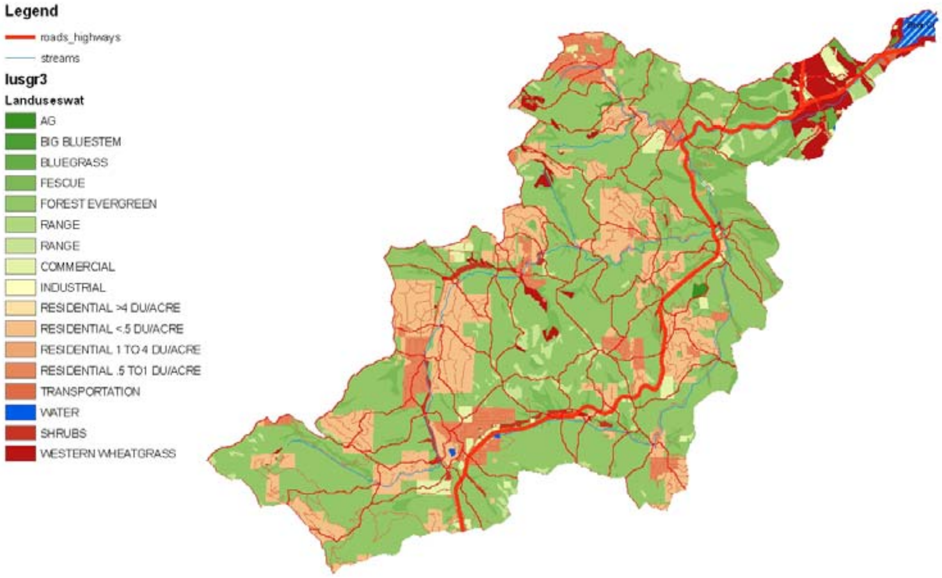


**Figure 10 Turkey Creek Basin Existing Land Use**

| Urban Land Use | % of Watershed (area) |
|---|---|
| **Agricultural** | **>1** |
| **Commercial** | **2** |
| **Industrial** | **>1** |
| **Residential > 4 du/acre** | **>1** |
| **Residential 1 to 4 du/acre** | **>1** |
| **Residential .5 to1 du/acre** | **5** |
| **Residential <.5 du/acre** | **16** |
| **Water (reservoirs)** | **1** |
| **Transportation** | **6** |
| ***Total*** | ***~29%*** |
| **du- dwelling unit** | |

**Table 5  Existing Urban Land Use**

### *Climate and Hydrology*

USGS Water-Resources Investigations Report 03–4034 (2003) describes hydrologic conditions and a hydrologic assessment of water resources in the Turkey Creek watershed including, evapotranspiration, surface water, ground water, and water quality. The report includes estimates of fracture porosity and a characterization of water-balance terms using a watershed precipitation-runoff model.

The extensive study includes historical climatologic data collected by study-area residents, contemporary data collected during the study from 1998 to 2001, and historical data from agencies such as the Colorado Climate Center, State Engineers Office (SEO), and the USGS. However, the USGS watershed assessment did not include flow routing, information on sediment yields, or how different land uses impacts runoff and sediment yields. The data and information, such as evapotranspiration measurements, collected by USGS was used extensively in the SWAT study and helped provide the framework for assessing the sensitivity of SWAT model inputs.

## **Objective 2: Determine land uses and key parameters that cause accelerated erosion and affect the water quality of the watershed. Create an assessment tool to determine water quality impacts from sediment**

Soil and water are inextricably bound together in the watershed: thus, soil quality is one of the factors that water quality. In Turkey Creek, soils vary in their ability to support land uses; store floodwaters; purify and renew water supplies; and absorb, buffer and transform chemicals and waste.

The term "soil quality" is as a measure of how well a soil performs the above functions. High-quality soils contribute to myriad benefits from the land —from healthy forestlands, grasslands, wetlands and backyard gardens to scenic landscapes and wildlife habitats in addition to limited but productive agricultural land.

In the watershed, high-quality soil means soils that have maximum ability to absorb rainfall and store water needed for plant growth, thus reducing the risk of flooding during storms and ensuring greater resilience to the effects of drought and erosion. When used for disposal of agricultural or municipal waste, such as septic system effluent, healthily functioning soils have a greater capacity to purify those wastes, resulting in better protection of ground and surface water.

High-quality soils are resistant to degradation have a greater potential to store carbon as soil organic matter. Sound stewardship of the watershed's soil resource helps maintain the functional capacity of soil—its "quality." Poor land-use and management practices, on the other hand, can initiate a cycle of soil quality degradation through erosion, compaction, and other forms of soil deterioration.

One of the major processes that cause a decline in soil quality is erosion by water and wind. These debilitating processes can alter natural hydrologic and sedimentation regimes that developed over thousands of years. Some land uses and management practices in the watershed cause erosion rates great enough to have adverse impacts on long-term soil productivity and overall soil quality.

### *Erosion and Vegetation Map*

Soil formation is a very slow process. Soils cannot renew their eroded surface while erosion continues to degrade the soil, and any erosion can greatly reduce soil quality and productivity. It can take hundreds, if not thousands, of years for the renewal of eroded soil, given the topography and climate of the watershed and Jefferson County. Both the watershed and county contain sensitive soils that are very thin with limited rooting depths, organic matter, and with steep slopes that are prone to erosion. Revegetation attempts on steep, thin soils with little organic matter often fail and can result in long-term erosion and sedimentation.

The key factors that determine how sensitive a soil is to disturbance include depth to bedrock, organic matter and permeability. A GIS model, GIS layers, and a PDF map showing sensitive soils were created for the watershed and for Jefferson County. The GIS layer was included, as a map, in updates of the Evergreen, Central, and North Plains Community (Master) Plans. Non point source, natural resource, sensitive soil and erosion prevention planning policies were given to Jefferson County and many of the suggested policies were included in the county land-use plans. A sensitive soil map for Jefferson County is shown below (figure 11) as well as a map from one of the county's community plans (figures 12 and 13). The community plan map shown below is not located in the Turkey Watershed. It is provided as an example of how the GIS model can easily transfers to other areas. The county will incorporate the countywide data into other master plans as they are updated.

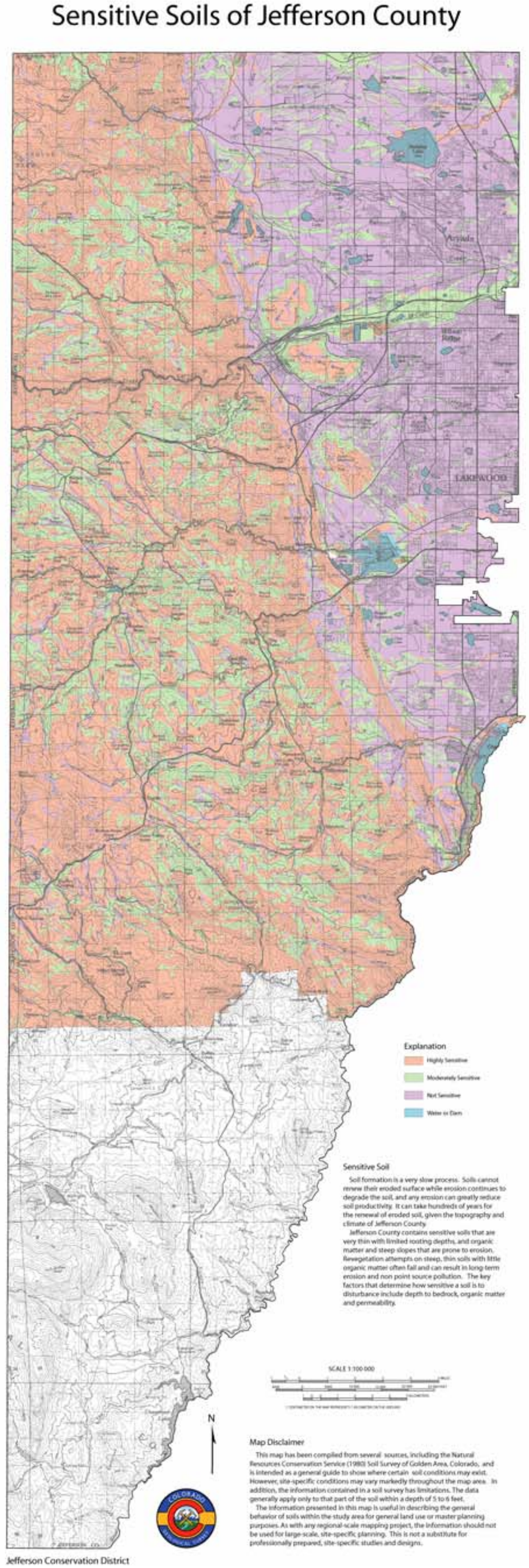


**Figure 11 Countywide Map of Sensitive Soil**

Central Plains Community Plan Map

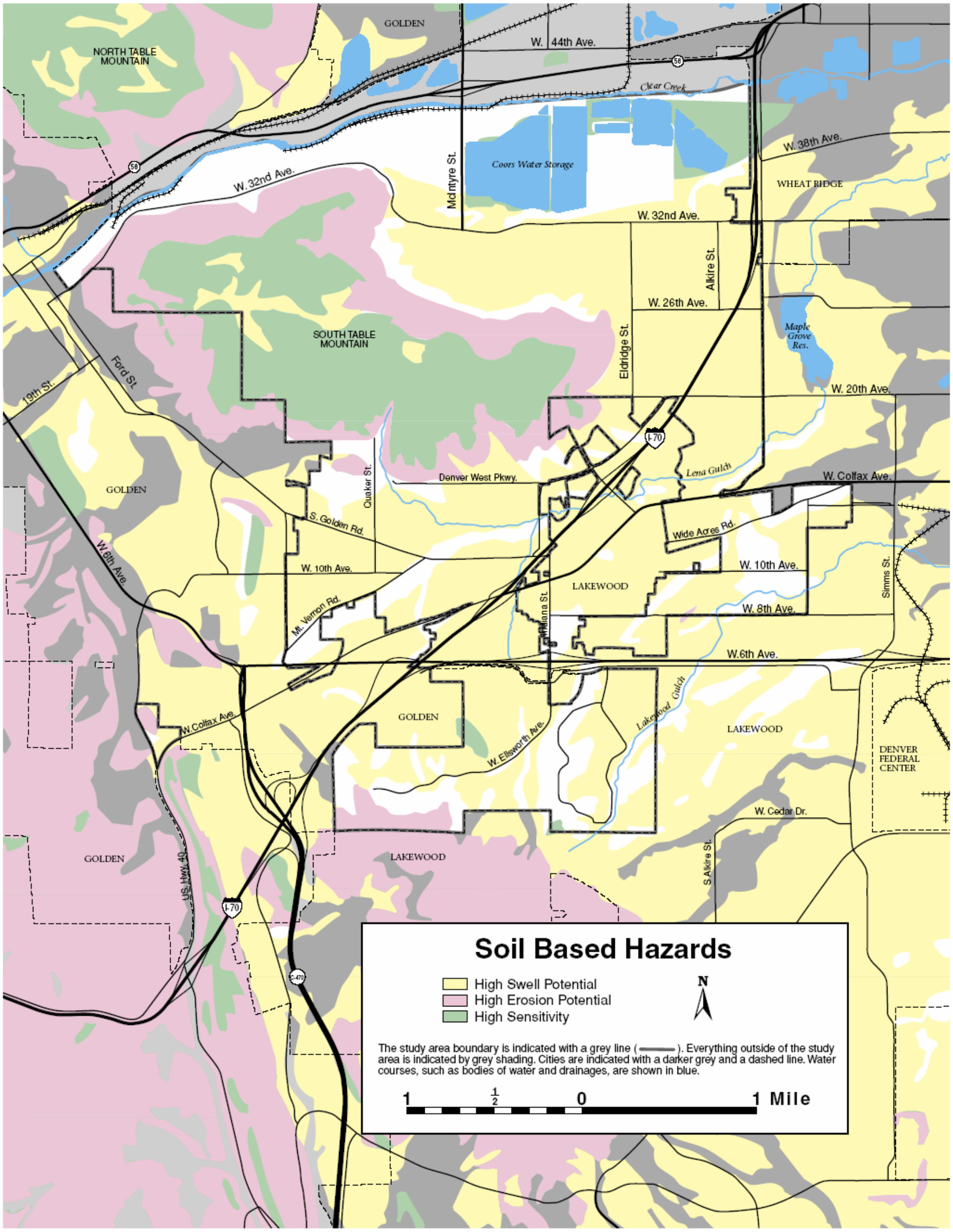


**Figure 12 Master Plan Map Showing Sensitive Soil**

### *Erosion and Soil Types*

Soil erodibility or K factor, represents both susceptibility of soil to erosion and the rate of runoff. For Jefferson County and the watershed, soils high in clay have a low erodibility because they resist detachment. However, small soil particles, such as clay and silt, are extremely difficult to remove from runoff and cause significant water quality problems. Coarse textured soils, such as sandy and gravelly soils, have low K values, because of low runoff even though these soils are easily detached. Medium textured soils, such as the silt loam soils, have moderate K values because they are moderately susceptible to detachment and they produce moderate runoff. Soils high in silt are highly erodible; they are easily detached and produce high rates of runoff.

Organic matter reduces erodibility because it reduces the susceptibility of the soil to detachment, and it increases infiltration, which reduce runoff and thus erosion. Soil structure affects both susceptibility to detachment and infiltration. Permeability of the soil profile affects K because it affects runoff. GIS layers showing soil erodibility (K factor) in relationship to soil texture were created for the watershed and for Jefferson County.

These layers are an interim product used in the development of a highly erodible soil layer. The highly erodible GIS model and resulting layer includes other factors, such as slope steepness and length, in determining overall erosion potential. A countywide map, based on the GIS model, showing areas that may be highly erodible is shown in Figure 14. Again, this data and resulting land-use policy has been incorporated into several of the county's comprehensive planning documents or sub area plans. The county will continue to incorporate the countywide data into other master plans as they are updated.

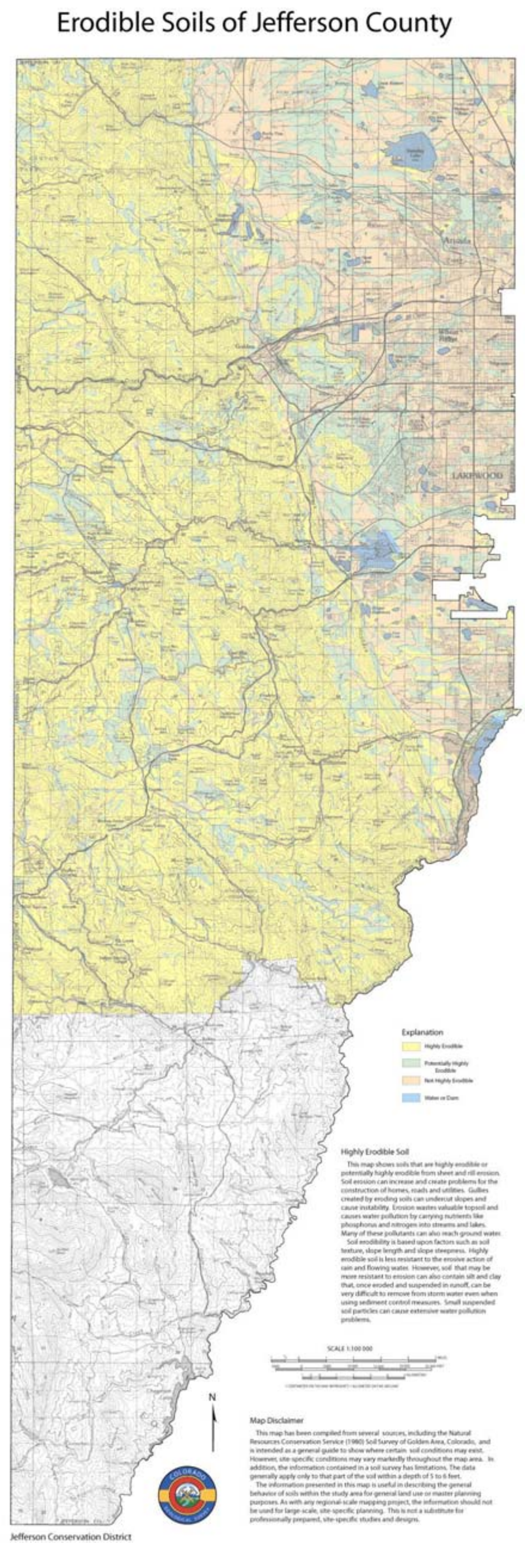


**Figure 13 Countywide Map of Highly Erodible Soil**

**Erosion and Land Use Changes**

The soil erodibility ratings generated for the previous maps are natural erodibility conditions in the top 4 to 6 inches of each soil layer and do not include the impacts of what happens to soil during urban development or other intensive land uses. During typical development activities; soil erodibility increases because subsoil is exposed, organic matter is removed, soil structure destroyed, and soil compaction reduces permeability. These changes vary, in complex ways, and are difficult to evaluate across a watershed. However, looking at an individual hillslope, one can evaluate how topographic and land use changes relate to erosion and sedimentation rates.

Using a hillslope erosion model, an easy to use database was created that shows average annual sediment yield for the major soil types in the watershed in relationship to slope gradient, slope length, and management practices. Land managers use the database to guide the selection of erosion and sediment control practices for a particular site or determine if an erosion and sediment control plan is adequate. Sections of the database are included in Appendix A.

In a typical application, the spreadsheet is used to estimate erosion rates for a set of erosion and sediment control alternatives. Topographic changes, erosion and sediment control practices can be compared and those with the lowest erosion rates selected.

**Objective 3: Verify and calibrate model. Identify key factors that result in accelerated erosion. How the model can be used for future watershed and pollution prevention planning.**

After discussions with land managers and local governments in the watershed, it became apparent that two different scenarios are of concern to decision makers: How does construction effects water quality and once developed, how does land-use relate to long-term water quality in streams and reservoirs.

The Revised Universal Soil Loss Equation was used to evaluate land management, soil and sediment yield for typical hillslope development scenarios.

### *Construction Related Nonpoint Source Pollution*

Using the hillside erosion model, average annual sediment yields were calculated and compared for differing soil types, slope gradient, slope length and best management practices. A comparison, for a prevalent soil type in the watershed, is shown in the table below. The table shows that soil loss varies greatly depending on topography, and management practices.

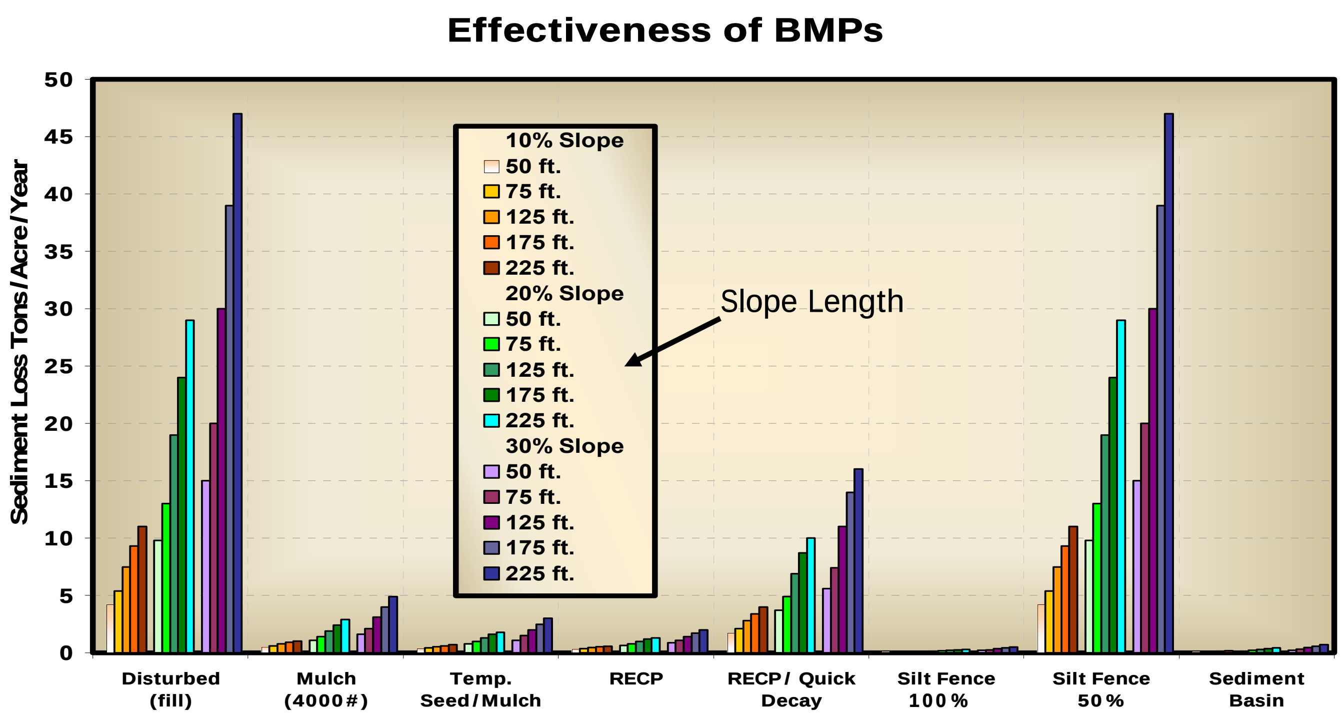


**Table 6 Effectiveness of Construction BMPs**

The comparison shows that many commonly used sediment control measures are not effective on steep slopes and shallow soil. For example, on first glance, silt fence (100%) appears to effectively reduce sedimentation. However, this assumes fence placement along contour and fully entrenched. Given the steep and rocky nature of the watershed, silt fence is almost never installed in this manner. When we look at silt fence (50%) that performs at half maximum trapping, as is common in the watershed, we find that it does little to control sedimentation.

As is commonly known, erosion control is more effective than sediment control. This is especially true in areas, like the Turkey Creek Watershed, with mountainous slopes and little soil. But regional and local storm drainage and nonpoint source pollution list sediment control measures, like silt fence, as acceptable BMPs.

To reduce construction-related nonpoint source pollution, storm water management and land use policies should reflect the following:

- ✓ Fit development to the terrain;
- ✓ Time grading and construction to minimize soil exposure;
- ✓ To the extent possible, retain existing vegetation;
- ✓ Vegetate and mulch bare soil; and
- ✓ Divert runoff away from denuded areas.

The county has included many of these suggestions in their comprehensive plans (see table 7), with an implementation strategy to update development codes to reflect policy. The Bear Creek Watershed Association and other partners in the watershed should work with the county on implementation of these policies.

| Jefferson County Community Plan Policies and Implementation Strategies | | |
|---|---|---|
| **Development Constraints** | **Development Review Policies** | **Implementation Strategies** |
| Highly Erodible or Sensitive Soil | The natural topography and existing vegetation should be protected before, during, and after development. Disturbed areas should be stabilized as quickly as possible to reduce fugitive dust and erosion potential. | The county should evaluate its zoning and development codes to ensure that natural topography and existing vegetation are protected and incorporated into site design to the maximum extent possible. |
| | Soil hazards should be mitigated or eliminated. | Prior to development, a study should be conducted to determine soil hazards and required mitigation. |
| Steep Slopes | Non-residential and multi-family development should not occur on slopes greater than 20%. | Prior to development, a slope analysis is conducted; development in steep areas is avoided to the extent feasible |
| | Single-family residential development should not occur on slopes greater than 30%. | Prior to development, a slope analysis is conducted; development in steep areas is avoided to the extent feasible. |
| Large Animals on Small Lots | Domestic livestock can have an adverse impact on water quality. Land use policy in regard to livestock should be based on both a general use standard and site specific data. | A study should be conducted to determine acreage and management practices required for large animals. The community should be involved in the process of identifying and adopting needed standards and regulations. |

Table 7 Jefferson County Community Plan Policies

***Post Construction Nonpoint Source Pollution***

**Overview of the Soil and Water Assessment Tool (SWAT)**

SWAT is a river basin scale model developed to describe the impact of land management practices on water, sediment, and nutrient yields in large, complex watersheds with varying soils, land use, and management conditions over long periods. SWAT is a public domain model supported by the USDA-ARS at the Grassland, Soil and Water Research Laboratory in Temple, Texas.

SWAT is used to simulate a system of multiple hydrologically connected watersheds. Each watershed is first divided into subbasins and then in hydrologic response units (HRU) based on the land use and soil distributions. The model is physically based and is used to study long-term impacts.

SWAT requires specific information about weather, soil properties, topography, vegetation, ground water, land use and land management practices occurring in the watershed. The physical processes associated with surface and ground water flow, sediment routing, and nutrient cycling are modeled by SWAT using this input data. The data collected includes the following GIS layers; model input files and associated metadata:

- Existing land use
- Potential future land use
- Vegetative Cover
- Impervious Area (connected and indirectly connected)
- Soil
- Slope
- Surface Hydrology
- Climate

**Watershed Results from Long- Term Simulation**

Using SWAT, A long-term simulation (30 years) was developed using the data described above. The three figures shown below look at the relationship of soil type, land use, land cover, and sediment yield for the average annual sediment yield resulting from the long-term simulation. Figure 15 is a graph that shows how land use and land cover relate to the average total sediment yield for the entire Turkey Creek Watershed.  This chart is a simple look at land use, land cover, and sediment yield independent of other factors such as slope and soil type. Moderate density housing (1 to 4 dwelling units per acre) and areas with perennial grass cover are the greatest contributors to sediment yield.

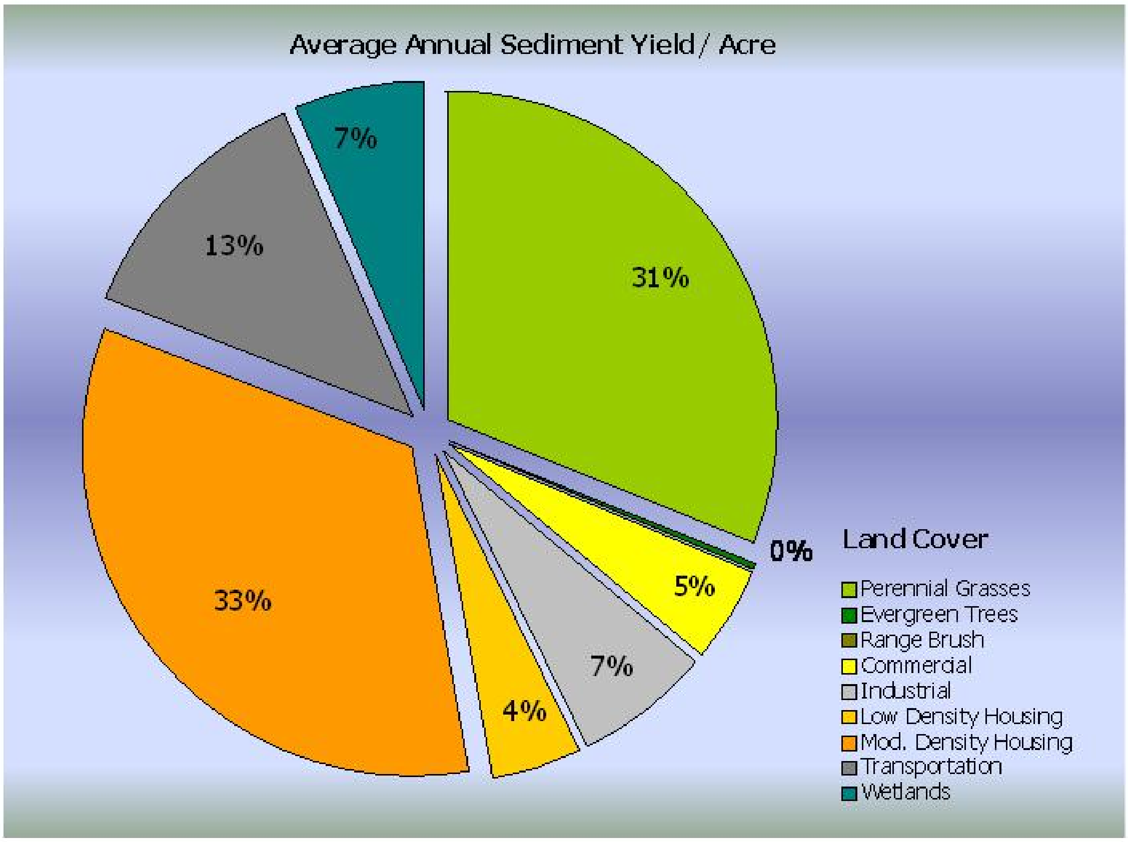


**Figure 14 Post Construction Land Use/Cover and Sediment Yield for Watershed**

In order to evaluate how soil type affects sediment yield, areas with the same land cover, but different soil types, were compared.  Figure 16 shows how various soil types contribute to average annual sediment yield for areas with perennial grass cover.  Figure 17 shows the same relationships, except for evergreen forest cover.

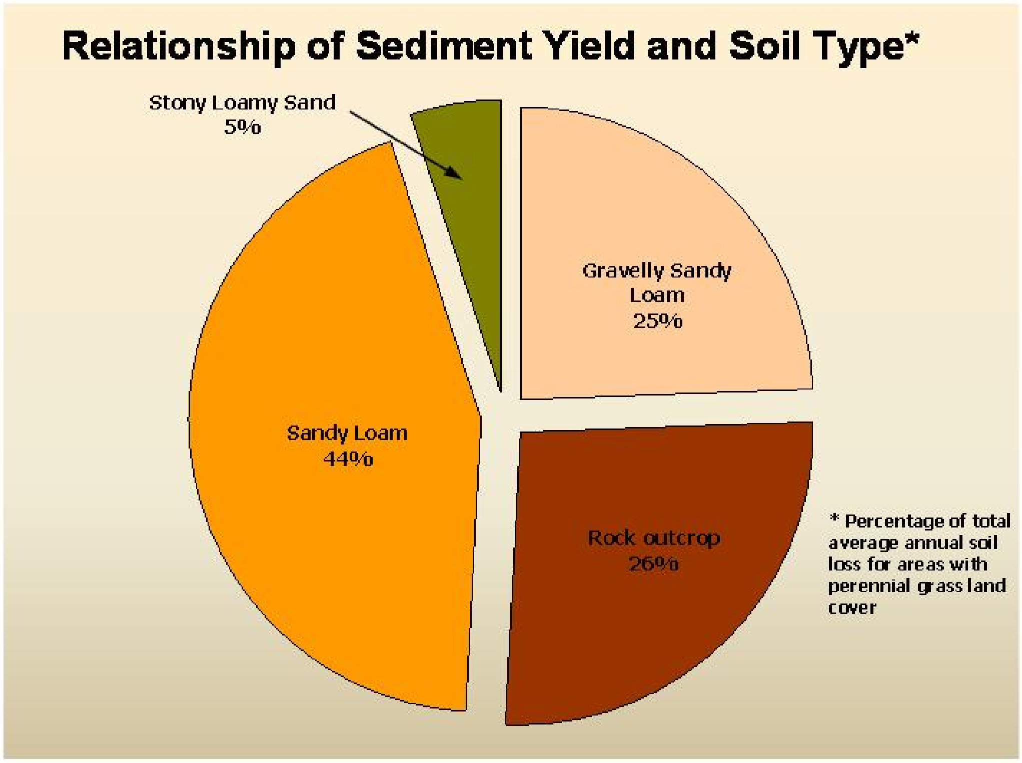


**Figure 15 Sediment Yield/ Soil Type/Perennial Grass Cover**

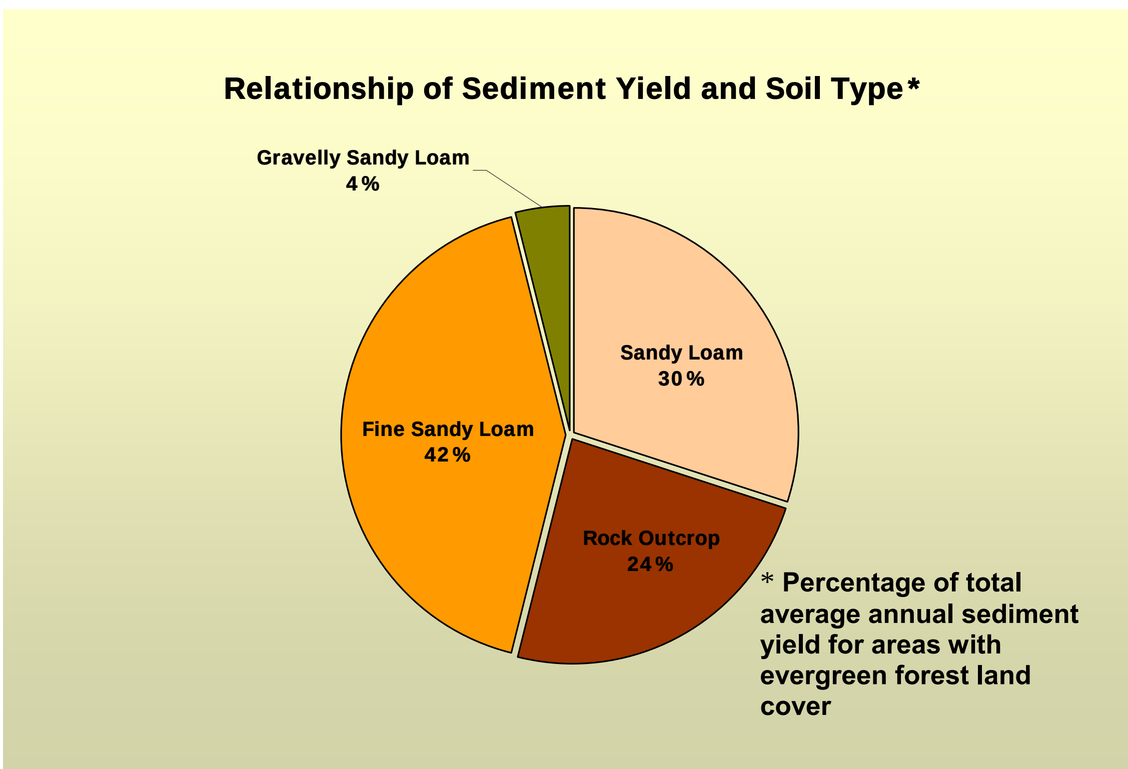


**Figure 16 Sediment Yield/Soil Type/ Evergreen Forest**

In general, the greatest runoff and sediment yield occurs in areas with urban development, especially higher density development. However, less developed areas, with erodible soil or native grass cover, also had higher sediment yields. When such areas are developed or overgrazed, accelerated erosion, sedimentation, and water quality impacts can result.

**Sub Basin Results from Long- Term Simulation**

| *Sub Basins Producing the Most Sediment** | | | | | | | |
|---|---|---|---|---|---|---|---|
| % of Total Sediment Yield in Watershed | | HRUs Producing the Most Sediment from Highest→Lowest | | | | | |
| | | HRU 1 | | HRU 2 | | HRU 3 | |
| *Subbasin* | *Sediment Yield* | *LULC* | *Soil* | *LULC* | *Soil* | *LULC* | *Soil* |
| 13 | Moderate | UTRN | CO078 | UTRN | CO138 | UTRN | CO125 |
| 15 | High | UCOM | CO057 | UCOM | CO141 | | |
| 16 | High | UCOM | CO141 | UCOM | CO057 | UTRN | CO057 |
| 19 | High | UCOM | CO056 | UCOM | CO155 | UTRN | CO067 |
| 62 | Moderate | UTRN | CO138 | UTRN | CO125 | UTRN | CO078 |
| 63 | Moderate | RNGB | CO005 | RNGB | CO009 | UTRN | CO151 |
| 68 | Mod. To High | FRSE | CO078 | FESC | CO123 | FESC | CO078 |
| 70 | Mod. To High | UTRN | CO005 | UTRN | CO002 | WWGR | CO080 |
| **11.2 inches of precipitation* | | | | | | | |

**Table 8 High Sediment Producing Sub Basins and HRUs**

| Land Use and Cover | SWAT Code |
|---|---|
| Residential-High Density | URHD |
| Range-Brush | RNGB |
| Water | WATR |
| Wetlands-Non-Forested | WETN |
| Commercial | UCOM |
| Southwestern US (Arid) Range | SWRN |
| Kentucky Bluegrass | BLUG |
| Forest-Evergreen | FRSE |
| Tall Fescue | FESC |
| Residential-Low Density | URLD |
| Agricultural Land-Generic | AGRL |
| Big Bluestem | BBLS |
| Industrial | UIDU |
| Transportation | UTRN |
| Western Wheatgrass | WWGR |
| Residential-Medium Density | URMD |
| Residential-Med/Low Density | URML |

**Table 9 Land Use and Cover Codes**

| Soil | Code | Soil Texture | Soil | Code | Soil Texture |
|---|---|---|---|---|---|
| CO | 178 | clay loam | CO | 78 | rock outcrop |
| CO | 173 | fine sandy loam | CO | 77 | stony loamy sand |
| CO | 171 | loam | CO | 76 | stony loamy sand |
| CO | 169 | cobbly sandy loam | CO | 75 | stony loamy sand |
| CO | 165 | loam | CO | 72 | sandy loam |
| CO | 162 | clay loam | CO | 71 | sandy loam |
| CO | 160 | clay loam | CO | 70 | sandy loam |
| CO | 157 | gravelly sandy loam | CO | 69 | gravelly sandy loam |
| CO | 156 | sandy loam | CO | 68 | gravelly sandy loam |
| CO | 155 | sandy loam | CO | 67 | gravelly sandy loam |
| CO | 153 | sandy loam | CO | 66 | gravelly sandy loam |
| CO | 152 | sandy loam | CO | 65 | rock outcrop |
| CO | 151 | gravel | CO | 65 | rock outcrop |
| CO | 150 | gravelly loamy sand | CO | 64 | rock outcrop |
| CO | 149 | gravelly clay loam | CO | 63 | clay |
| CO | 146 | fine sandy loam | CO | 61 | loam |
| CO | 144 | rock outcrop | CO | 60 | loam |
| CO | 141 | rock outcrop | CO | 59 | sandy loam |
| CO | 140 | rock outcrop | CO | 58 | sandy loam |
| CO | 139 | rock outcrop | CO | 57 | stony sandy loam |
| CO | 138 | rock outcrop | CO | 56 | stony sandy loam |
| CO | 131 | clay loam | CO | 55 | stony sandy loam |
| CO | 130 | clay loam | CO | 54 | stony sandy loam |
| CO | 129 | clay loam | CO | 41 | clay loam |
| CO | 128 | clay loam | CO | 37 | gravelly sandy loam |
| CO | 125 | stony sandy loam | CO | 29 | clay loam |
| CO | 124 | rock outcrop | CO | 26 | clay loam |
| CO | 123 | rock outcrop | CO | 23 | stony sandy loam |
| CO | 122 | stony sandy loam | CO | 22 | loam |
| CO | 111 | gravel | CO | 15 | sandy loam |
| CO | 106 | clay loam | CO | 14 | sandy loam |
| CO | 105 | clay loam | CO | 9 | rock outcrop |
| CO | 99 | clay loam | CO | 8 | sandy loam |
| CO | 92 | clay loam | CO | 5 | rock outcrop |
| CO | 91 | clay loam | CO | 4 | loam |
| CO | 87 | sandy loam | CO | 2 | loam |
| CO | 86 | sandy loam | | | |
| CO | 85 | sandy loam | | | |
| CO | 84 | sandy loam | | | |
| CO | 80 | cobbly clay loam | | | |

**Table 10 Soil Codes**

In addition, steep areas with very thin soils, derived from grus (decomposed granite) or colluvial material, are also prone to higher erosion rates and sediment yields. Due to limited soil and rooting depths in these areas, vegetation is difficult to establish and maintain and is highly sensitive to disturbance.

For example, some areas of rangeland appear to be prone to erosion and higher sediment yields. In these areas, it may prudent to look at managing the number and concentration of large animals. The BCWA and the Jefferson Conservation District may wish to participate in the county's task force that is addressing management of large animals. Drought and the loss of native grasses will likely increase sediment loading in the watershed. Land managers should closely look at land uses in these areas and consider methods to protect stressed native rangeland as well as revegetation of hard hit areas.

### *Maps of Sub Basin Sediment Yields*

Please follow the cross-reference links to:

Figure 17 Appendix B, Sub Basin Sediment Yield During a Dry Year

Figure 18 Appendix B, Sub Basin Sediment Yield During a Wet Year

Figure 19 Appendix B, Sub Basin Sediment Yield During an Average Year

Figure 20 Appendix B, Post Construction Sediment Yield and Soil Type

Figure 21 Appendix B, Post Construction Sediment Yield and Land Use/Cover

Figure 22 Appendix B, Sub Basin Sediment Yield and Major Land Use/Cover

### *Sensitivity of Construction and Post-Construction Models*

**Construction Model:** RUSLE2 is an erosion model designed to predict the longtime average annual soil loss carried by runoff from slopes in many management systems including construction sites. Widespread use has substantiated the usefulness and validity of RUSLE for this purpose.

Because of the unpredictable short-time fluctuations in the levels of influential variables, however, many soil-loss equations, including those in RUSLE2, are less accurate for the prediction of specific events than for the prediction of longtime averages. It is important to realize that the amount of research on effects of land disturbance from construction on RUSLE technology is not as extensive as that associated with other applications such as cropping.

In addition, RUSLE2 does not apply to concentrated flow areas where ephemeral gully erosion occurs or on undisturbed forested lands. The accuracy of RUSLE also varies depending on soil texture, slope length and steepness. Calculations on long, steep slopes tend to be less accurate and the margin of error under such conditions can be has high as 50 percent.

**Post Construction Model:**

***Water Balance Calibration***

To calibrate the water balance and stream flow one needs some understanding of the actual conditions occurring in the watershed. A USGS stream gage, with daily records, located near the watershed out let was used to calibrate the model. However, due to limited availability of daily stream flow data temporal calibration of the model was limited.

Calibration for water balance and stream flow was first done for average annual conditions. Once the model was calibrated for average annual conditions, monthly records were used to fine-tune the calibration. The average annual observed and simulated results were similar for average annual and monthly conditions.

***Sediment Calibration***

There are two sources of sediment in the SWAT model: loadings from HRUs/subbasins and channel degradation/deposition. The sediment contribution (loadings from HRUs/subbasins) should be compared to measured values.

Channel degradation will be significant during extreme storm events and in unstable subbasins. Unstable subbasins are those undergoing a significant change in land use patterns such as urbanization. Variables that affect channel degradation/deposition include:

1) The linear and exponential parameters used to calculate sediment reentrained in channel sediment routing. These variables affect sediment routing in the entire watershed.

2) The channel erodibility factor

3) The channel cover factor

Little information on daily sediment loading was available to calibrate the sediment contribution from subbasins. Limited site-specific information was collected on channel degradation and/or deposition. Loadings from the subbasins were then adjusted until reasonable values were generated given modeled and observed channel degradation/deposition.

## Model Sensitivity

As with all models, due to spatial variability and budget constraints, it is not possible to eliminate uncertainty. Some model parameters are not well understood or site-specific data is not available. Key SWAT input parameters were varied, over a wide range, to assess the relative impact of model inputs on model results. Model inputs were varied by 10% increments, within allowable ranges, and model outputs for runoff and sediment yield were compared.

Results were similar to those found in published literature and some examples are shown in the table below:

| Input Parameters | Model Results\Variation in Sediment Yield | Model Results\Variation in Runoff |
|---|---|---|
| SCS Curve Number (impervious area) | Very High | Very High |
| Soil Water Capacity | Very High | Very High |
| Channel Length | Moderate | Moderate |
| Depth of Soil Layer | Very High | Very High |

**Table 11 Model Sensitivity Analysis**

The results indicate that slight changes in soil depth or SCS curve number (impervious area) can greatly influence runoff and sediment rates. During urban development, the impacts of soil compaction, removal of organic matter and changes in soil thickness adversely impact soil and water quality and are not considered during calculation of development-related runoff and sediment yields.

Urbanization in the basin creates more impervious surfaces, thus increasing runoff and impairing water quality in urban watersheds. The extent of such impervious surfaces is a key factor in predicting pollutant loads and flooding. Continued urban growth will result in increased pollutant loads to Bear Creek from urban nonpoint sources unless action is taken to manage it.

The study reveals that the level of imperviousness, and the type of imperviousness, strongly correlates with decreased water quality. When impervious areas are disconnected from water courses, runoff allowed to infiltrate, overall runoff and water quality impacts from urban development are reduced.

Currently, the primary management tools for reducing urban nonpoint source pollutants are storm water best management practices that detain, retain, or treat pollutant-laden runoff.

Jefferson County and other local governments are developing and implementing a community-based planning process to determine which tools are the most feasible, effective, and acceptable in achieving pollutant reduction. Planning tools include increasing infiltration, reducing impervious surfaces, reducing directly connected impervious surfaces, implementing better site design, and incorporating natural hydrologic features to enhance storm water management.

Regulatory measures exist as well, including protection of sensitive natural features, such as floodplains, as well as regulations to ensure adequate erosion and sediment control during subdivision development. Regulatory tools are also used to address failing or inadequate septic systems that are potentially significant sources of pathogens and nutrients. Finally, education and increased public awareness encouraging informed decision-making complete the tool kit. An example of a brochure on increasing infiltration in a mountainous watershed is included in Figure 23 Example of Educational Brochure.

**Objective 4: Determine the effectiveness of the project by monitoring and assisting in the use of the model by federal, state, and local agencies.**

Nonpoint source planning tools, including a GIS model, GIS layers, maps, and associated land use policies created for the watershed are used Jefferson County. These tools are included in the Evergreen, Central, and North Plains Community (Master) Plans.

Development proposals, in each of the plan areas, are reviewed and a determination is made if the proposal is in conformance with the nonpoint source planning tools and policies. Approximately 350 land use applications have been reviewed and approved since inclusion of the tools and policies in each of the three community plans. While it is difficult to determine the effectiveness of the tools for each case, generally, as a result of using the tools, development proposals were improved to protect water quality in the following ways:

- ✓ Development or land use changed to fit the terrain;
- ✓ BMPs changed or added to prevent erosion and increase capture of sediment;
- ✓ Grading and construction timed to minimize soil exposure; and
- ✓ To the extent feasible, existing vegetation was retained.

Other local governments are now using similar tools in their planning process. For example, Douglas County is implementing nonpoint source planning tools when purchasing open space. The county feels that purchasing development rights, in areas with critical soil conditions, may help protect water quality in Cherry Creek Reservoir.

In Colorado, state agencies and conservation districts examine developments proposals for erosion, sedimentation, soil hazard, or water quality issues. The Colorado Geological Survey and the Jefferson Conservation District now review development proposals, in Jefferson county, using soil loss models and GIS soil layers. Both agencies submit recommendations for changes to land use, grading, and proposed erosion and sediment control measures to Jefferson

County. Generally, the county requires the changes be in place before approving new development.*

**Objective 5: Demonstrate through public outreach and transfer how Model can be used as a pollution prevention and watershed enhancement tool.**

Numerous meetings were held with local government officials, professional associations and watershed groups to discuss project results and the usefulness of planning tools. Final products were then tailored to meet the needs of local users and agencies. A summary of meeting results is listed below:

Jefferson County hosted numerous open houses during development of neighborhood plans. During these collaborative planning meetings, community organizations, citizens, and local stakeholders viewed project GIS layers and maps showing where development may cause water-quality impacts. In this interactive environment, citizens formulated action strategies and goals for water quality improvement, many of which are now part of neighborhood plans. Similar meetings with other watershed stakeholders were held.

Working closely with Jefferson County, local agencies, and citizen groups, CGS developed planning tools and policies that reduce the impact of development on water quality. CGS worked with the county storm water coordinator on community plan policies for the reduction of non-point source pollution.

Local government users expressed concerns on having the time and resources to run even simple erosion prediction models. As a result, typical construction conditions were modeled, using RUSLE, and those results were placed into simple spreadsheets. Developers, state, and local government planners use the spreadsheets to estimate erosion rates for a set of erosion and sediment control

* Personal communication, M. Schuster, Jefferson County Planning and Zoning, 2004

alternatives. Erosion and sediment control practices are ranked by erosion rates and the most effective practices are chosen. Many users stated that this type of information, in a simple spreadsheet, was useful and easy to use.

**Websites:** Project Products are available on the following websites:

Colorado Geological Survey http://www.geosurvey.state.co.us

- ✓ Models and GIS layers
- ✓ Project Reports
- ✓ PDF images of land-use planning maps

Jefferson County http://www.co.jefferson.co.us

- ✓ Evergreen Area Community Plan

  http://www.co.jefferson.co.us/planning/planning_T59_R17.htm

  - o Non-point source, water quality, and soil planning policies
  - o Maps of GIS layers

- ✓ Central Plains Community Plan

  http://www.co.jefferson.co.us/planning/planning_T59_R14.htm

  - o Non-point source, water quality, and soil planning policies
  - o Maps of GIS layers

- ✓ North Plains Area Community Plan

  http://www.co.jefferson.co.us/planning/planning_T59_R21.htm

  - o Non-point source, water quality, and soil planning policies
  - o Maps of GIS layers

- ✓ Bear Creek Watershed Association http://www.bearcreekwatershed.org/
    - o Maps of GIS layers

**Technical Transfer:** Other technical transfer and outreach activities include:

- ✓ Attended numerous community meetings, during development of community plans, to discuss natural resource planning and how land use and soil limitations, within the watershed and county, affects non-point source pollution. CGS worked with the county storm water coordinator on creation of water quality policies that were adopted in community plans.
- ✓ Abstract "Using SWAT to Evaluate Land Use and Sediment Yields in an Urban Mountain Watershed" published in the 2005 Proceedings of the International Erosion Control Association
- ✓ "Using SWAT to Evaluate Land Use and Sediment Yields in an Urban Mountain Watershed" presented at the 2005 International Erosion Control Association Conference.
- ✓ The Jefferson Conservation District sponsored a workshop titled "Effective Erosion and Sediment Control Through Polymer BMPs at 21st Century Smarter Growth Conference, April 2005. Workshop topics included soil quality, soil texture, and selection of BMPs in areas with sensitive soil. The workshop was attended by 18 local government planners, watershed managers, developers and conservation professionals.
- ✓ CGS presented model results to Bear Creek Watershed Association; as a result, the final products were modified to meet the needs of users.

**Long Term Results in Terms of Behavior Modification, Stream/Lake Quality or Watershed Protection Changes**

Please follow the cross-reference link to:

Objective 4: Determine the effectiveness of the project by monitoring and assisting in the use of the model by federal, state, and local agencies.

## Public Involvement and Coordination

Numerous meetings were held with local government officials, professional associations and watershed groups to discuss project results and the usefulness of planning tools. Final products were then tailored to meet the needs of local users and agencies. A summary of meeting results is listed below:

The Jefferson Conservation District sponsored a regional workshop on using polymers as a Best Management Practice on construction sites. CGS conducted a technical transfer session, at an international construction industry conference, on using a watershed model to evaluate land-use and water quality in an urban mountain watershed.

Jefferson County hosted numerous open houses during development of neighborhood plans. During these collaborative planning meetings, community organizations, citizens, and local stakeholders viewed project maps showing where development may cause water-quality impacts. In this interactive environment, citizens formulated action strategies and goals for water quality improvement, many of which are now part of neighborhood plans. Similar meetings with other watershed stakeholders were held.

## State Agencies

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Please follow the cross-reference link to:

Objective 4: Determine the effectiveness of the project by monitoring and assisting in the use of the model by federal, state, and local agencies.

## Federal Agencies

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Please follow the cross-reference link to:

Objective 4: Determine the effectiveness of the project by monitoring and assisting in the use of the model by federal, state, and local agencies.

## Local Governments, Industry, Environmental, and Other Groups

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Please follow the cross-reference link to:

Objective 4: Determine the effectiveness of the project by monitoring and assisting in the use of the model by federal, state, and local agencies.

## Public Participation

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Please follow the cross-reference links to:

- Summary of Accomplishments

- **Objective 5: Demonstrate through public outreach and transfer how Model can be used as a pollution prevention and watershed enhancement tool.**

## Other Sources of Funds

Other than EPA funds, the primary source of funds was in-kind contributions from the following organizations:

- Colorado Geological Survey
  - $26,455.34 in-kind
- Jefferson Conservation District
  - 70 hours in-kind @ 20 per hour $1400
- Jefferson County
  - Land use data in-kind $1800
  - 40 hours in-kind @ 20 per hour $800
- Bear Creek Watershed Association
  - 20 hours in-kind @ 20 per hour $400
- City of Lakewood
  - 5 hours in-kind @ 20 per hour $100

Please follow the cross reference link to the budget summary:

Table 1 Summary of Funding and Expenditures

As an “Information and Education” project, an important goal was to demonstrate how a watershed model can be used as a pollution prevention and management tool. The original plan was to use the WEPP watershed model. The Water Erosion Prediction Project (WEPP) is a physically and process-based continuous simulation erosion model. The model was developed to predict erosion effects from land use and management practices within small watersheds and hillsides. Using WEPP, in the large complex Turkey Creek watershed, requires dividing the basin into smaller sub-watersheds and modeling each sub-watershed separately.

Due to severe drought during the project, little stream flow and water quality data was available for small tributary channels making it difficult to model sub-watersheds independently. In addition, land managers expressed interest in the interaction between sub-watersheds. The WEPP model is not suited to evaluation of water quality in multiple hydrologically connected watersheds.

To capture the diversity of land use and soils that encompass the watershed, the Soil and Water Assessment Tool (SWAT) was used to model the Turkey Creek watershed. SWAT is a river basin scale model developed to quantify the impact of land management practices on water, sediment, and nutrient yields in large, complex watersheds with varying soils, land use, and management conditions over long periods.

However, SWAT is a complicated model that requires numerous inputs and specialized technical skills. Using SWAT to model individual hillslopes is not practical and the Revised Universal Soil Loss Equation was used to evaluate land management, soil and sediment yield for typical development scenarios such as the construction of roads.

Please follow the cross reference links to:

- Table 6 Effectiveness of Construction BMPs
- Table 7 Jefferson County Community Plan Policies
- Table 8 High Sediment Producing Sub Basins and HRUs
- Table 12: Appendix A, Soil Loss From Fill SlopesTable 13: Appendix A, Soil Loss From Cut Slopes
- Table 14: Appendix A, Soils and Management Practices Used in Construction Erosion Model
- Figure 8 Generalized Soil Map
- **Error! Reference source not found.**
- Figure 10 Turkey Creek Basin Existing Land Use
- Figure 11 Countywide Map of Sensitive Soil
- Figure 12 Master Plan Map Showing Sensitive Soil
- **Error! Reference source not found.**
- Figure 17 Appendix B, Sub Basin Sediment Yield During a Dry Year
- Figure 18 Appendix B, Sub Basin Sediment Yield During a Wet Year
- Figure 19 Appendix B, Sub Basin Sediment Yield During an Average Year

- Figure 20 Appendix B, Post Construction Sediment Yield and Soil Type
- Figure 21 Appendix B, Post Construction Sediment Yield and Land Use/Cover
- Figure 22 Appendix B, Sub Basin Sediment Yield and Major Land Use/Cover

## Future Activity Recommendations

- Jefferson County, in association with other land managers, should continue to implement the strategies outlined in land use plans and in Table 7 Jefferson County Community Plan Policies.
- Additional sediment monitoring will assist in determining the impacts of urbanization in the watershed and development of site-specific mitigation policies, tools, and techniques.
- The BCWA should work closely with the county in developing policies for management of large animals in native grass areas.
- Extensive road systems in low to moderately low density residential developments contribute to higher than average sediment yields in some areas. Jefferson County and the BCWA should develop policies and programs that encourage the clustering of homes and reduced road networks.

## References

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# Appendix A

## Soil Loss From Typical Fill Slopes

**Table 12: Appendix A, Soil Loss From Fill Slopes**

| *Soil/ Slope/Length | Disturbed (fill) | Mulch (4000#) | Temp. Seed/Mulch | RECP | RECP/ Quick Decay | Silt Fence | Silt Fence 50% | Sediment Basin |
|---|---|---|---|---|---|---|---|---|
| **Silt Loam 10% Slope** | | | **Sediment loss in tons per acre per year** | | | | | |
| 50 ft. | 12.0 | 1.0 | 0.7 | 0.6 | 4.3 | 1.5 | 12.0 | 0.8 |
| 125 ft. | 22.0 | 1.7 | 1.0 | 0.9 | 7.5 | 4.4 | 21.0 | 1.4 |
| 175 ft. | 27.0 | 2.0 | 1.2 | 1.1 | 9.2 | 6.3 | 27.0 | 1.7 |
| 225 ft. | 32.0 | 2.4 | 1.3 | 1.2 | 11.0 | 10.0 | 31.0 | 2.0 |
| **Silt loam 20% Slope** | | | | | | | | |
| 75 ft. | 39.0 | 3.0 | 1.8 | 1.6 | 13.0 | 6.5 | 39.0 | 2.5 |
| 125 ft. | 56.0 | 4.3 | 2.5 | 2.1 | 19.0 | 11.0 | 56.0 | 3.6 |
| 175 ft. | 72.0 | 5.5 | 3.0 | 2.4 | 24.0 | 18.0 | 71.0 | 4.6 |
| 225 ft. | 87.0 | 6.6 | 3.4 | 2.8 | 28.0 | 27.0 | 87.0 | 5.6 |
| **Silt Loam 30% Slope** | | | | | | | | |
| 75 ft. | 60.0 | 4.8 | 2.8 | 2.3 | 20.0 | 9.6 | 60.0 | 3.9 |
| 125 ft. | 89.0 | 7.1 | 3.8 | 3.0 | 29.0 | 18.0 | 89.0 | 5.8 |
| 175 ft. | 120.0 | 9.3 | 4.7 | 3.6 | 37.0 | 27.0 | 120.0 | 7.5 |
| 225 ft. | 140.0 | 11.0 | 5.6 | 4.2 | 45.0 | 32.0 | 140.0 | 9.1 |
| **Clay Loam 10% Slope** | | | | | | | | |
| 50 ft. | 10.0 | 2.0 | 0.8 | 0.7 | 4.1 | 0.2 | 10.0 | 0.9 |
| 125 ft. | 17.0 | 2.9 | 1.1 | 0.9 | 6.2 | 0.2 | 17.0 | 1.4 |
| 175 ft. | 20.0 | 3.4 | 1.2 | 1.0 | 7.3 | 0.2 | 20.0 | 1.6 |
| 225 ft. | 23.0 | 3.8 | 1.3 | 1.1 | 8.2 | 0.2 | 23.0 | 1.9 |

| *Soil/ Slope/Length | Disturbed (fill) | Mulch (4000#) | Temp. Seed/Mulch | RECP | RECP/ Quick Decay | Silt Fence | Silt Fence 50% | Sediment Basin |
|---|---|---|---|---|---|---|---|---|
| **Clay loam 20% Slope** | | | | | | | | |
| 50 ft. | 25.0 | 4.6 | 1.8 | 1.4 | 9.4 | 0.4 | 25.0 | 2.0 |
| 75 ft. | 32.0 | 5.7 | 2.2 | 1.7 | 12.0 | 0.4 | 32.0 | 2.6 |
| 125 ft. | 44.0 | 7.5 | 2.7 | 2.0 | 16.0 | 0.5 | 44.0 | 3.6 |
| 175 ft. | 54.0 | 9.1 | 3.1 | 2.3 | 19.0 | 0.6 | 54.0 | 4.4 |
| 225 ft. | 63.0 | 10.0 | 3.4 | 2.5 | 22.0 | 0.6 | 63.0 | 5.1 |
| **Clay Loam 30% Slope** | | | | | | | | |
| 50 ft. | 38.0 | 6.9 | 2.7 | 2.1 | 14.0 | 0.5 | 38.0 | 3.1 |
| 75 ft. | 50.0 | 8.9 | 3.3 | 2.4 | 18.0 | 0.6 | 50.0 | 4.7 |
| 125 ft. | 70.0 | 12.0 | 4.2 | 3.0 | 24.0 | 0.8 | 70.0 | 5.7 |
| 175 ft. | 88.0 | 15.0 | 5.0 | 3.5 | 30.0 | 0.9 | 88.0 | 7.1 |
| 225 ft. | 100.0 | 18.0 | 5.6 | 3.9 | 35.0 | 1.0 | 100.0 | 8.4 |
| **Sandy Loam 10% Slope** | | | | | | | | |
| 50 ft. | 8.7 | 0.8 | 0.6 | 0.5 | 3.3 | 0.1 | 8.7 | 0.3 |
| 75 ft. | 10.0 | 1.1 | 0.7 | 0.7 | 4.0 | 0.2 | 10.0 | 0.3 |
| 125 ft. | 14.0 | 1.4 | 0.9 | 0.9 | 5.3 | 0.2 | 14.0 | 0.4 |
| 175 ft. | 17.0 | 1.7 | 1.0 | 1.0 | 6.4 | 0.2 | 17.0 | 0.5 |
| 225 ft. | 20.0 | 1.9 | 1.1 | 1.1 | 7.3 | 0.2 | 20.0 | 0.6 |
| **Sandy Loam 20% Slope** | | | | | | | | |
| 50 ft. | 21.0 | 1.8 | 1.4 | 1.0 | 7.5 | 0.3 | 21.0 | 0.6 |
| 75 ft. | 28.0 | 2.3 | 1.7 | 1.3 | 9.7 | 0.4 | 28.0 | 0.8 |
| 125 ft. | 39.0 | 3.2 | 2.2 | 1.6 | 13.0 | 0.5 | 39.0 | 1.1 |
| 175 ft. | 49.0 | 4.0 | 2.6 | 1.9 | 17.0 | 0.5 | 49.0 | 1.4 |
| 225 ft. | 59.0 | 4.7 | 2.9 | 2.1 | 20.0 | 0.6 | 59.0 | 1.7 |
| **Sandy Loam 30% Slope** | | | | | | | | |
| 50 ft. | 32.0 | 2.8 | 2.0 | 1.5 | 11.0 | 0.5 | 32.0 | 0.9 |
| 75 ft. | 38.0 | 4.2 | 2.5 | 2.2 | 15.0 | 0.6 | 38.0 | 1.1 |
| 125 ft. | 56.0 | 6.0 | 3.4 | 2.8 | 20.0 | 0.8 | 56.0 | 1.6 |
| 175 ft. | 71.0 | 7.6 | 4.0 | 3.3 | 25.0 | 0.9 | 71.0 | 2.0 |
| 225 ft. | 85.0 | 9.0 | 4.7 | 3.8 | 30.0 | 1.0 | 85.0 | 2.4 |

| *Soil/ Slope/Length | Disturbed (fill) | Mulch (4000#) | Temp. Seed/Mulch | RECP | RECP/ Quick Decay | Silt Fence | Silt Fence 50% | Sediment Basin |
|---|---|---|---|---|---|---|---|---|
| **Sandy Loam - 10% Slope - 8% Rock Cover** | | | | | | | | |
| 50 ft. | 6.9 | 0.8 | 0.6 | 0.5 | 2.8 | 0.1 | 6.9 | 0.2 |
| 75 ft. | 8.8 | 1.0 | 0.7 | 0.6 | 3.5 | 0.1 | 8.8 | 0.3 |
| 125 ft. | 12.0 | 1.3 | 0.9 | 0.8 | 4.6 | 0.1 | 12.0 | 0.3 |
| 175 ft. | 15.0 | 1.5 | 1.0 | 0.9 | 5.5 | 0.2 | 15.0 | 0.4 |
| 225 ft. | 17.0 | 1.7 | 1.1 | 0.9 | 6.3 | 0.2 | 17.0 | 0.5 |
| **Sandy Loam - 20% Slope - 8% Rock Cover** | | | | | | | | |
| 50 ft. | 15.0 | 1.7 | 1.2 | 1.0 | 5.7 | 0.2 | 15.0 | 0.4 |
| 75 ft. | 19.0 | 2.1 | 1.5 | 1.2 | 7.4 | 0.3 | 19.0 | 0.6 |
| 125 ft. | 30.0 | 2.5 | 2.0 | 1.5 | 13.0 | 0.4 | 30.0 | 0.9 |
| 175 ft. | 38.0 | 3.9 | 2.6 | 1.9 | 14.0 | 0.4 | 38.0 | 1.1 |
| 225 ft. | 46.0 | 4.6 | 2.9 | 2.2 | 16.0 | 0.5 | 46.0 | 1.3 |
| **Sandy Loam - 30% Slope - 8% Rock Cover** | | | | | | | | |
| 50 ft. | 22.0 | 4.5 | 1.8 | 1.4 | 8.5 | 0.3 | 22.0 | 0.6 |
| 75 ft. | 30.0 | 6.0 | 2.3 | 1.7 | 11.0 | 0.5 | 30.0 | 0.9 |
| 125 ft. | 44.0 | 8.7 | 3.1 | 2.2 | 16.0 | 0.5 | 44.0 | 1.2 |
| 175 ft. | 57.0 | 11.0 | 3.8 | 2.6 | 20.0 | 0.8 | 57.0 | 1.5 |
| 225 ft. | 67.0 | 13.0 | 4.4 | 3.0 | 24.0 | 0.7 | 67.0 | 1.9 |
| **Sandy Loam - 10% Slope - 13% Rock Cover** | | | | | | | | |
| 50 ft. | 5.5 | 0.8 | 0.6 | 0.5 | 2.4 | 0.1 | 5.5 | 0.2 |
| 75 ft. | 7.1 | 0.9 | 0.7 | 0.6 | 2.9 | 0.1 | 7.1 | 0.2 |
| 125 ft. | 9.6 | 1.2 | 0.8 | 0.7 | 3.9 | 0.1 | 9.6 | 0.3 |
| 175 ft. | 12.0 | 1.4 | 0.9 | 0.8 | 4.7 | 0.1 | 12.0 | 0.3 |
| 225 ft. | 14.0 | 1.5 | 1.0 | 0.9 | 5.3 | 0.1 | 14.0 | 0.4 |
| **Sandy Loam - 20% Slope - 13% Rock Cover** | | | | | | | | |
| 50 ft. | 13.0 | 1.7 | 1.3 | 1.0 | 5.3 | 0.2 | 13.0 | 0.4 |
| 75 ft. | 17.0 | 2.1 | 1.5 | 1.2 | 6.8 | 0.2 | 17.0 | 0.5 |
| 125 ft. | 24.0 | 2.9 | 2.0 | 1.6 | 9.4 | 0.3 | 24.0 | 0.7 |
| 175 ft. | 30.0 | 3.6 | 2.4 | 1.8 | 12.0 | 0.3 | 30.0 | 0.9 |
| 225 ft. | 36.0 | 4.2 | 2.7 | 2.1 | 14.0 | 0.4 | 36.0 | 1.0 |

| *Soil/ Slope/Length | Disturbed (fill) | Mulch (4000#) | Temp. Seed/Mulch | RECP | RECP/ Quick Decay | Silt Fence | Silt Fence 50% | Sediment Basin |
|---|---|---|---|---|---|---|---|---|
| **Sandy Loam - 30% Slope - 13% Rock Cover** | | | | | | | | |
| 50 ft. | 20.0 | 2.5 | 1.9 | 1.5 | 7.8 | 0.3 | 20.0 | 0.6 |
| 75 ft. | 26.0 | 3.3 | 2.3 | 1.8 | 10.0 | 0.3 | 26.0 | 0.8 |
| 125 ft. | 38.0 | 4.7 | 3.1 | 2.3 | 14.0 | 0.4 | 38.0 | 1.1 |
| 175 ft. | 49.0 | 6.0 | 3.8 | 2.7 | 18.0 | 0.5 | 49.0 | 1.4 |
| 225 ft. | 58.0 | 7.2 | 4.4 | 3.1 | 22.0 | 0.6 | 58.0 | 1.7 |
| **Loam - 10% Slope - Slow Permeability** | | | | | | | | |
| 50 ft. | 13.0 | 2.4 | 1.0 | 0.8 | 5.0 | 0.2 | 13.0 | 0.6 |
| 75 ft. | 17.0 | 2.9 | 1.1 | 0.9 | 6.2 | 0.2 | 17.0 | 0.8 |
| 125 ft. | 23.0 | 3.7 | 1.4 | 1.1 | 8.1 | 0.3 | 23.0 | 1.1 |
| 175 ft. | 27.0 | 4.4 | 1.5 | 1.2 | 9.7 | 0.3 | 27.0 | 1.3 |
| 225 ft. | 32.0 | 5.0 | 1.7 | 1.4 | 11.0 | 0.3 | 32.0 | 1.5 |
| **Loam - 20% Slope - Slow Permeability** | | | | | | | | |
| 50 ft. | 32.0 | 5.4 | 2.1 | 1.7 | 11.0 | 0.5 | 32.0 | 1.5 |
| 75 ft. | 42.0 | 7.0 | 2.6 | 2.0 | 15.0 | 0.5 | 42.0 | 2.0 |
| 125 ft. | 59.0 | 9.6 | 3.3 | 2.5 | 20.0 | 0.7 | 59.0 | 2.9 |
| 175 ft. | 74.0 | 12.0 | 3.9 | 2.9 | 25.0 | 0.8 | 74.0 | 3.6 |
| 225 ft. | 87.0 | 14.0 | 4.5 | 3.2 | 29.0 | 0.9 | 87.0 | 4.2 |
| **Loam- 30% Slope - Slow Permeability** | | | | | | | | |
| 50 ft. | 49.0 | 8.2 | 3.2 | 2.3 | 17.0 | 0.7 | 49.0 | 2.4 |
| 75 ft. | 65.0 | 11.0 | 4.0 | 2.8 | 23.0 | 0.8 | 65.0 | 3.2 |
| 125 ft. | 94.0 | 16.0 | 5.3 | 3.6 | 32.0 | 1.1 | 94.0 | 4.6 |
| 175 ft. | 120.0 | 20.0 | 6.4 | 4.3 | 40.0 | 1.3 | 120.0 | 5.8 |
| 225 ft. | 140.0 | 24.0 | 7.3 | 4.8 | 47.0 | 1.4 | 140.0 | 6.9 |
| **Loam - 10% Slope - Mod Permeability** | | | | | | | | |
| 50 ft. | 12.0 | 1.5 | 0.9 | 0.7 | 4.5 | 0.2 | 12.0 | 0.6 |
| 75 ft. | 15.0 | 1.6 | 1.0 | 0.8 | 5.5 | 0.2 | 15.0 | 0.7 |
| 125 ft. | 20.0 | 1.7 | 1.2 | 1.0 | 7.2 | 0.2 | 20.0 | 1.0 |
| 175 ft. | 24.0 | 2.0 | 1.4 | 1.1 | 8.6 | 0.3 | 24.0 | 1.2 |
| 225 ft. | 28.0 | 2.2 | 1.5 | 1.2 | 9.8 | 0.3 | 28.0 | 1.4 |

| *Soil/ Slope/Length | Disturbed (fill) | Mulch (4000#) | Temp. Seed/Mulch | RECP | RECP/ Quick Decay | Silt Fence | Silt Fence 50% | Sediment Basin |
|---|---|---|---|---|---|---|---|---|
| **Loam - 20% Slope - Mod Permeability** | | | | | | | | |
| 50 ft. | 28.0 | 2.6 | 1.9 | 1.5 | 10.0 | 0.4 | 28.0 | 1.4 |
| 75 ft. | 37.0 | 3.2 | 2.3 | 1.7 | 13.0 | 0.5 | 37.0 | 1.8 |
| 125 ft. | 52.0 | 4.4 | 3.0 | 2.2 | 18.0 | 0.6 | 52.0 | 2.5 |
| 175 ft. | 66.0 | 5.3 | 3.5 | 2.5 | 22.0 | 0.7 | 66.0 | 3.2 |
| 225 ft. | 78.0 | 6.2 | 4.0 | 2.8 | 26.0 | 0.8 | 78.0 | 3.8 |
| **Loam - 30% Slope - Mod Permeability** | | | | | | | | |
| 50 ft. | 43.0 | 3.9 | 2.8 | 2.1 | 15.0 | 0.6 | 43.0 | 2.1 |
| 75 ft. | 58.0 | 5.0 | 3.5 | 2.5 | 20.0 | 0.7 | 58.0 | 2.8 |
| 125 ft. | 83.0 | 7.1 | 4.7 | 3.2 | 28.0 | 1.0 | 83.0 | 4.0 |
| 175 ft. | 110.0 | 8.9 | 5.7 | 3.8 | 35.0 | 1.1 | 110.0 | 5.1 |
| 225 ft. | 130.0 | 11.0 | 6.5 | 4.3 | 42.0 | 1.3 | 130.0 | 6.1 |
| **Loamy Sand - 10% Slope - 8% Rock Cover** | | | | | | | | |
| 50 ft. | 4.2 | 0.5 | 0.4 | 0.3 | 1.7 | 0.1 | 4.2 | 0.1 |
| 75 ft. | 5.4 | 0.6 | 0.4 | 0.4 | 2.1 | 0.1 | 5.4 | 0.1 |
| 125 ft. | 7.5 | 0.8 | 0.5 | 0.5 | 2.8 | 0.1 | 7.5 | 0.1 |
| 175 ft. | 9.3 | 0.9 | 0.6 | 0.5 | 3.4 | 0.1 | 9.3 | 0.1 |
| 225 ft. | 11.0 | 1.0 | 0.7 | 0.6 | 4.0 | 0.1 | 11.0 | 0.2 |
| **Loamy Sand - 20% Slope - 8% Rock Cover** | | | | | | | | |
| 50 ft. | 9.8 | 1.1 | 0.8 | 0.6 | 3.7 | 0.1 | 9.8 | 0.2 |
| 75 ft. | 13.0 | 1.4 | 1.0 | 0.8 | 4.9 | 0.2 | 13.0 | 0.2 |
| 125 ft. | 19.0 | 1.9 | 1.3 | 1.0 | 6.9 | 0.2 | 19.0 | 0.3 |
| 175 ft. | 24.0 | 2.4 | 1.6 | 1.2 | 8.7 | 0.3 | 24.0 | 0.4 |
| 225 ft. | 29.0 | 2.9 | 1.8 | 1.3 | 10.0 | 0.3 | 29.0 | 0.4 |
| **Loamy Sand - 30% Slope - 8% Rock Cover** | | | | | | | | |
| 50 ft. | 15.0 | 1.6 | 1.1 | 0.9 | 5.6 | 0.2 | 15.0 | 0.2 |
| 75 ft. | 20.0 | 2.1 | 1.5 | 1.1 | 7.4 | 0.3 | 20.0 | 0.3 |
| 125 ft. | 30.0 | 3.1 | 2.0 | 1.4 | 11.0 | 0.4 | 30.0 | 0.5 |
| 175 ft. | 39.0 | 4.0 | 2.5 | 1.7 | 14.0 | 0.4 | 39.0 | 0.6 |
| 225 ft. | 47.0 | 4.9 | 3.0 | 2.0 | 16.0 | 0.5 | 47.0 | 0.7 |

| *Soil/ Slope/Length | Disturbed (fill) | Mulch (4000#) | Temp. Seed/Mulch | RECP | RECP/ Quick Decay | Silt Fence | Silt Fence 50% | Sediment Basin |
|---|---|---|---|---|---|---|---|---|
| **Loamy Sand - 10% Slope - 20% Rock Cover** | | | | | | | | |
| 50 ft. | 2.6 | 0.4 | 0.3 | 0.3 | 1.2 | 0.0 | 2.6 | 0.0 |
| 75 ft. | 3.4 | 0.5 | 0.4 | 0.3 | 1.5 | 0.0 | 3.4 | 0.1 |
| 125 ft. | 4.7 | 0.7 | 0.5 | 0.4 | 2.0 | 0.1 | 4.7 | 0.1 |
| 175 ft. | 5.8 | 0.8 | 0.6 | 0.5 | 2.4 | 0.1 | 5.8 | 0.1 |
| 225 ft. | 6.8 | 0.9 | 0.6 | 0.5 | 2.8 | 0.1 | 6.8 | 0.1 |
| **Loamy Sand - 20% Slope - 20% Rock Cover** | | | | | | | | |
| 50 ft. | 6.0 | 0.9 | 0.7 | 0.6 | 2.6 | 0.1 | 6.0 | 0.1 |
| 75 ft. | 8.0 | 1.2 | 0.9 | 0.7 | 3.4 | 0.1 | 8.0 | 0.1 |
| 125 ft. | 12.0 | 1.7 | 1.1 | 0.9 | 4.8 | 0.1 | 12.0 | 0.2 |
| 175 ft. | 15.0 | 2.1 | 1.4 | 1.1 | 6.0 | 0.2 | 15.0 | 0.2 |
| 225 ft. | 18.0 | 2.5 | 1.6 | 1.2 | 7.1 | 0.2 | 18.0 | 0.3 |
| **Loamy Sand - 30% Slope - 20% Rock Cover** | | | | | | | | |
| 50 ft. | 9.0 | 1.4 | 1.0 | 0.8 | 3.8 | 0.1 | 9.0 | 0.1 |
| 75 ft. | 12.0 | 1.9 | 1.3 | 1.0 | 5.1 | 0.2 | 12.0 | 0.2 |
| 125 ft. | 18.0 | 2.7 | 1.8 | 1.3 | 7.3 | 0.2 | 18.0 | 0.3 |
| 175 ft. | 25.0 | 3.7 | 2.3 | 1.7 | 9.7 | 0.3 | 25.0 | 0.4 |
| 225 ft. | 30.0 | 4.5 | 2.6 | 1.9 | 12.0 | 0.3 | 30.0 | 0.4 |

**Table 13: Appendix A, Soil Loss From Cut Slopes**

| *Soil/ Slope/Length | Disturbed (cut) | Mulch (4000#) | Temp. Seed/Mulch | RECP | RECP/ Quick Decay | Silt Fence | Silt Fence 50% | Sediment Basin |
|---|---|---|---|---|---|---|---|---|
| **Silt Loam 10% Slope** | | | | **Sediment loss in tons per acre per year** | | | | |
| 50 ft. | 6.6 | 0.3 | 0.3 | 0.2 | 1.1 | 0.2 | 6.6 | 0.4 |
| 75 ft. | 7.8 | 0.3 | 0.3 | 0.2 | 1.2 | 0.2 | 7.8 | 0.5 |
| 125 ft. | 9.7 | 0.4 | 0.4 | 0.3 | 1.4 | 0.3 | 9.7 | 0.6 |
| 175 ft. | 11.0 | 0.4 | 0.4 | 0.3 | 1.5 | 0.3 | 11.0 | 0.7 |
| 225 ft. | 12.0 | 0.5 | 0.4 | 0.3 | 1.6 | 0.4 | 12.0 | 0.8 |
| **Silt loam 20% Slope** | | | | | | | | |
| 50 ft. | 15.0 | 0.7 | 0.6 | 0.5 | 2.6 | 0.5 | 15.0 | 1.0 |
| 75 ft. | 20.0 | 0.8 | 0.7 | 0.5 | 2.9 | 0.6 | 20.0 | 1.3 |
| 125 ft. | 25.0 | 1.0 | 0.9 | 0.6 | 3.5 | 0.8 | 25.0 | 1.6 |
| 175 ft. | 30.0 | 1.1 | 1.0 | 0.6 | 3.9 | 0.9 | 30.0 | 2.0 |
| 225 ft. | 35.0 | 1.3 | 1.1 | 0.6 | 4.3 | 1.0 | 35.0 | 2.2 |
| **Silt Loam 30% Slope** | | | | | | | | |
| 50 ft. | 24.0 | 1.0 | 0.9 | 0.6 | 3.8 | 0.7 | 24.0 | 1.6 |
| 75 ft. | 31.0 | 1.2 | 1.1 | 0.7 | 4.5 | 0.9 | 31.0 | 2.0 |
| 125 ft. | 41.0 | 1.6 | 1.3 | 0.8 | 5.5 | 1.2 | 41.0 | 2.6 |
| 175 ft. | 49.0 | 1.9 | 1.5 | 0.9 | 6.3 | 1.5 | 49.0 | 3.2 |
| 225 ft. | 57.0 | 2.2 | 1.7 | 0.9 | 6.9 | 1.7 | 57.0 | 3.7 |
| **Clay Loam 10% Slope** | | | | | | | | |
| 50 ft. | 4.1 | 0.2 | 0.2 | 0.2 | 0.7 | 0.1 | 4.1 | 0.3 |
| 75 ft. | 4.6 | 0.3 | 0.2 | 0.2 | 0.8 | 0.1 | 4.6 | 0.4 |
| 125 ft. | 5.4 | 0.3 | 0.3 | 0.2 | 0.8 | 0.2 | 5.4 | 0.4 |
| 175 ft. | 5.9 | 0.3 | 0.3 | 0.2 | 0.9 | 0.2 | 5.9 | 0.5 |
| 225 ft. | 6.4 | 0.3 | 0.3 | 0.2 | 0.9 | 0.2 | 6.4 | 0.5 |

| *Soil/ Slope/Length | Disturbed (cut) | Mulch (4000#) | Temp. Seed/Mulch | RECP | RECP/ Quick Decay | Silt Fence | Silt Fence 50% | Sediment Basin |
|---|---|---|---|---|---|---|---|---|
| **Clay loam 20% Slope** | | | | | | | | |
| 50 ft. | 9.9 | 0.5 | 0.5 | 0.4 | 1.7 | 0.3 | 9.9 | 0.8 |
| 75 ft. | 12.0 | 0.6 | 0.5 | 0.4 | 1.8 | 0.4 | 12.0 | 0.9 |
| 125 ft. | 14.0 | 0.7 | 0.6 | 0.4 | 2.1 | 0.4 | 14.0 | 1.1 |
| 175 ft. | 16.0 | 0.8 | 0.7 | 0.4 | 2.2 | 0.5 | 16.0 | 1.3 |
| 225 ft. | 18.0 | 0.9 | 0.7 | 0.5 | 2.4 | 0.5 | 18.0 | 1.5 |
| **Clay Loam 30% Slope** | | | | | | | | |
| 50 ft. | 15.0 | 0.8 | 0.7 | 0.5 | 2.5 | 0.5 | 15.0 | 1.2 |
| 75 ft. | 18.0 | 0.9 | 0.8 | 0.6 | 2.8 | 0.6 | 18.0 | 1.5 |
| 125 ft. | 23.0 | 1.1 | 0.9 | 0.6 | 3.2 | 0.7 | 23.0 | 1.8 |
| 175 ft. | 26.0 | 1.3 | 1.0 | 0.6 | 3.5 | 0.8 | 26.0 | 2.1 |
| 225 ft. | 29.0 | 1.4 | 1.1 | 0.7 | 3.8 | 0.9 | 29.0 | 2.4 |
| **Sandy Loam 10% Slope** | | | | | | | | |
| 50 ft. | 4.7 | 0.2 | 0.2 | 0.2 | 0.8 | 0.1 | 4.7 | 0.1 |
| 75 ft. | 5.5 | 0.3 | 0.2 | 0.2 | 0.9 | 0.2 | 5.5 | 0.2 |
| 125 ft. | 6.6 | 0.3 | 0.3 | 0.2 | 1.0 | 0.2 | 6.6 | 0.2 |
| 175 ft. | 7.4 | 0.3 | 0.3 | 0.2 | 1.1 | 0.2 | 7.4 | 0.2 |
| 225 ft. | 8.2 | 0.4 | 0.3 | 0.2 | 1.1 | 0.3 | 8.2 | 0.2 |
| **Sandy Loam 20% Slope** | | | | | | | | |
| 50 ft. | 11.0 | 0.5 | 0.5 | 0.4 | 1.9 | 0.3 | 11.0 | 0.3 |
| 75 ft. | 14.0 | 0.6 | 0.6 | 0.4 | 2.1 | 0.4 | 14.0 | 0.4 |
| 125 ft. | 17.0 | 0.7 | 0.6 | 0.4 | 2.4 | 0.5 | 17.0 | 0.5 |
| 175 ft. | 20.0 | 0.8 | 0.7 | 0.5 | 2.7 | 0.6 | 20.0 | 0.6 |
| 225 ft. | 23.0 | 0.9 | 0.8 | 0.5 | 2.9 | 0.7 | 23.0 | 0.7 |
| **Sandy Loam 30% Slope** | | | | | | | | |
| 50 ft. | 17.0 | 0.8 | 0.7 | 0.5 | 2.8 | 0.5 | 17.0 | 0.4 |
| 75 ft. | 21.0 | 1.0 | 0.8 | 0.6 | 3.2 | 0.7 | 21.0 | 0.6 |
| 125 ft. | 28.0 | 1.2 | 1.0 | 0.6 | 3.8 | 0.8 | 28.0 | 0.8 |
| 175 ft. | 33.0 | 1.4 | 1.1 | 0.7 | 4.3 | 1.0 | 33.0 | 0.9 |
| 225 ft. | 37.0 | 1.6 | 1.2 | 0.7 | 4.7 | 1.1 | 37.0 | 1.1 |

| *Soil/ Slope/Length | Disturbed (cut) | Mulch (4000#) | Temp. Seed/Mulch | RECP | RECP/ Quick Decay | Silt Fence | Silt Fence 50% | Sediment Basin |
|---|---|---|---|---|---|---|---|---|
| **Sandy Loam - 10% Slope - 8% Rock Cover** | | | | | | | | |
| 50 ft. | 3.3 | 0.2 | 0.2 | 0.2 | 0.6 | 0.1 | 3.3 | 0.1 |
| 75 ft. | 3.8 | 0.2 | 0.2 | 0.2 | 0.6 | 0.1 | 3.8 | 0.1 |
| 125 ft. | 4.6 | 0.3 | 0.2 | 0.2 | 0.7 | 0.1 | 4.6 | 0.1 |
| 175 ft. | 5.2 | 0.3 | 0.3 | 0.2 | 0.7 | 0.2 | 5.2 | 0.2 |
| 225 ft. | 5.7 | 0.3 | 0.3 | 0.2 | 0.8 | 0.2 | 5.7 | 0.2 |
| **Sandy Loam - 20% Slope - 8% Rock Cover** | | | | | | | | |
| 50 ft. | 7.8 | 0.5 | 0.4 | 0.3 | 1.3 | 0.2 | 7.8 | 0.2 |
| 75 ft. | 9.4 | 0.5 | 0.5 | 0.4 | 1.4 | 0.3 | 9.4 | 0.3 |
| 125 ft. | 12.0 | 0.6 | 0.6 | 0.4 | 1.6 | 0.4 | 12.0 | 0.3 |
| 175 ft. | 14.0 | 0.7 | 0.6 | 0.4 | 1.8 | 0.4 | 14.0 | 0.4 |
| 225 ft. | 16.0 | 0.8 | 0.7 | 0.4 | 2.0 | 0.5 | 16.0 | 0.4 |
| **Sandy Loam - 30% Slope - 8% Rock Cover** | | | | | | | | |
| 50 ft. | 12.0 | 0.7 | 0.6 | 0.5 | 1.9 | 0.4 | 12.0 | 0.3 |
| 75 ft. | 15.0 | 0.8 | 0.7 | 0.5 | 2.2 | 0.4 | 15.0 | 0.4 |
| 125 ft. | 19.0 | 1.0 | 0.9 | 0.6 | 2.6 | 0.6 | 19.0 | 0.5 |
| 175 ft. | 22.0 | 1.2 | 1.0 | 0.6 | 2.9 | 0.7 | 22.0 | 0.6 |
| 225 ft. | 25.0 | 1.4 | 1.1 | 0.7 | 3.1 | 0.8 | 25.0 | 0.7 |
| **Sandy Loam - 10% Slope - 13% Rock Cover** | | | | | | | | |
| 50 ft. | 2.8 | 0.2 | 0.2 | 0.2 | 0.5 | 0.1 | 2.8 | 0.1 |
| 75 ft. | 3.2 | 0.2 | 0.2 | 0.2 | 0.5 | 0.1 | 3.2 | 0.1 |
| 125 ft. | 3.9 | 0.3 | 0.2 | 0.2 | 0.6 | 0.1 | 3.9 | 0.1 |
| 175 ft. | 4.4 | 0.3 | 0.3 | 0.2 | 0.6 | 0.1 | 4.4 | 0.1 |
| 225 ft. | 4.8 | 0.3 | 0.3 | 0.2 | 0.7 | 0.2 | 4.8 | 0.1 |
| **Sandy Loam - 20% Slope - 13% Rock Cover** | | | | | | | | |
| 50 ft. | 6.5 | 0.5 | 0.4 | 0.3 | 1.1 | 0.2 | 6.5 | 0.2 |
| 75 ft. | 7.8 | 0.5 | 0.5 | 0.4 | 1.2 | 0.2 | 7.8 | 0.2 |
| 125 ft. | 9.9 | 0.6 | 0.6 | 0.4 | 1.4 | 0.3 | 9.9 | 0.3 |
| 175 ft. | 12.0 | 0.7 | 0.6 | 0.4 | 1.5 | 0.4 | 12.0 | 0.3 |
| 225 ft. | 13.0 | 0.8 | 0.7 | 0.4 | 1.6 | 0.4 | 13.0 | 0.4 |

| *Soil/ Slope/Length | Disturbed (cut) | Mulch (4000#) | Temp. Seed/Mulch | RECP | RECP/ Quick Decay | Silt Fence | Silt Fence 50% | Sediment Basin |
|---|---|---|---|---|---|---|---|---|
| **Sandy Loam - 30% Slope - 13% Rock Cover** | | | | | | | | |
| 50 ft. | 9.8 | 0.7 | 0.6 | 0.5 | 1.6 | 0.3 | 9.8 | 0.3 |
| 75 ft. | 12.0 | 0.8 | 0.7 | 0.5 | 1.8 | 0.4 | 12.0 | 0.3 |
| 125 ft. | 16.0 | 1.0 | 0.9 | 0.6 | 2.1 | 0.5 | 16.0 | 0.5 |
| 175 ft. | 19.0 | 1.2 | 1.0 | 0.6 | 2.4 | 0.6 | 19.0 | 0.5 |
| 225 ft. | 21.0 | 1.3 | 1.1 | 0.6 | 2.6 | 0.6 | 21.0 | 0.6 |
| **Loam - 10% Slope - Slow Permeability** | | | | | | | | |
| 50 ft. | 6.1 | 0.3 | 0.3 | 0.2 | 1.0 | 0.2 | 6.1 | 0.3 |
| 75 ft. | 7.1 | 0.4 | 0.3 | 0.3 | 1.1 | 0.2 | 7.1 | 0.3 |
| 125 ft. | 8.4 | 0.4 | 0.4 | 0.3 | 1.3 | 0.3 | 8.4 | 0.4 |
| 175 ft. | 9.5 | 0.4 | 0.4 | 0.3 | 1.4 | 0.3 | 9.5 | 0.5 |
| 225 ft. | 10.0 | 0.5 | 0.4 | 0.3 | 1.4 | 0.3 | 10.0 | 0.5 |
| **Loam - 20% Slope - Slow Permeability** | | | | | | | | |
| 50 ft. | 15.0 | 0.7 | 0.7 | 0.5 | 2.4 | 0.5 | 15.0 | 0.7 |
| 75 ft. | 18.0 | 0.8 | 0.7 | 0.5 | 2.7 | 0.5 | 18.0 | 0.9 |
| 125 ft. | 22.0 | 1.0 | 0.8 | 0.6 | 3.1 | 0.7 | 22.0 | 1.1 |
| 175 ft. | 26.0 | 1.1 | 0.9 | 0.6 | 3.5 | 0.8 | 26.0 | 1.2 |
| 225 ft. | 29.0 | 1.2 | 1.0 | 0.6 | 3.7 | 0.9 | 29.0 | 1.4 |
| **Loam- 30% Slope - Slow Permeability** | | | | | | | | |
| 50 ft. | 23.0 | 1.1 | 1.0 | 0.7 | 3.7 | 0.7 | 23.0 | 1.1 |
| 75 ft. | 28.0 | 1.3 | 1.1 | 0.8 | 4.2 | 0.8 | 28.0 | 1.3 |
| 125 ft. | 35.0 | 1.6 | 1.3 | 0.8 | 4.9 | 1.1 | 35.0 | 1.7 |
| 175 ft. | 42.0 | 1.9 | 1.5 | 0.9 | 5.5 | 1.3 | 42.0 | 2.0 |
| 225 ft. | 47.0 | 2.1 | 1.6 | 0.9 | 6.0 | 1.4 | 47.0 | 2.3 |
| **Loam - 10% Slope - Mod Permeability** | | | | | | | | |
| 50 ft. | 5.5 | 0.3 | 0.3 | 0.2 | 0.9 | 0.2 | 5.5 | 0.3 |
| 75 ft. | 6.3 | 0.3 | 0.3 | 0.2 | 1.0 | 0.2 | 6.3 | 0.3 |
| 125 ft. | 7.5 | 0.4 | 0.3 | 0.2 | 1.1 | 0.2 | 7.5 | 0.4 |
| 175 ft. | 8.4 | 0.4 | 0.3 | 0.3 | 1.2 | 0.3 | 8.4 | 0.4 |
| 225 ft. | 9.2 | 0.4 | 0.4 | 0.3 | 1.3 | 0.3 | 9.2 | 0.5 |

| *Soil/ Slope/Length | Disturbed (cut) | Mulch (4000#) | Temp. Seed/Mulch | RECP | RECP/ Quick Decay | Silt Fence | Silt Fence 50% | Sediment Basin |
|---|---|---|---|---|---|---|---|---|
| **Loam - 20% Slope - Mod Permeability** | | | | | | | | |
| 50 ft. | 13.0 | 0.7 | 0.6 | 0.4 | 2.2 | 0.4 | 13.0 | 0.6 |
| 75 ft. | 16.0 | 0.7 | 0.7 | 0.5 | 2.4 | 0.5 | 16.0 | 0.8 |
| 125 ft. | 20.0 | 0.9 | 0.8 | 0.5 | 2.8 | 0.6 | 20.0 | 1.0 |
| 175 ft. | 23.0 | 1.0 | 0.8 | 0.5 | 3.1 | 0.7 | 23.0 | 1.1 |
| 225 ft. | 25.0 | 1.1 | 0.9 | 0.6 | 3.3 | 0.8 | 25.0 | 1.2 |
| **Loam - 30% Slope - Mod Permeability** | | | | | | | | |
| 50 ft. | 20.0 | 1.0 | 0.9 | 0.6 | 3.3 | 0.6 | 20.0 | 1.0 |
| 75 ft. | 25.0 | 1.1 | 1.0 | 0.7 | 3.7 | 0.7 | 25.0 | 1.2 |
| 125 ft. | 32.0 | 1.4 | 1.2 | 0.7 | 4.4 | 1.0 | 32.0 | 1.5 |
| 175 ft. | 37.0 | 1.7 | 1.3 | 0.8 | 4.9 | 1.1 | 37.0 | 1.8 |
| 225 ft. | 42.0 | 1.9 | 1.4 | 0.8 | 5.3 | 1.3 | 42.0 | 2.0 |
| **Loamy Sand - 10% Slope - 8% Rock Cover** | | | | | | | | |
| 50 ft. | 1.8 | 0.1 | 0.1 | 0.1 | 0.3 | 0.1 | 1.8 | 0.0 |
| 75 ft. | 2.2 | 0.1 | 0.1 | 0.1 | 0.3 | 0.1 | 2.2 | 0.0 |
| 125 ft. | 2.7 | 0.1 | 0.1 | 0.1 | 0.4 | 0.1 | 2.7 | 0.0 |
| 175 ft. | 3.0 | 0.2 | 0.1 | 0.1 | 0.4 | 0.1 | 3.0 | 0.1 |
| 225 ft. | 3.4 | 0.2 | 0.2 | 0.1 | 0.4 | 0.1 | 3.4 | 0.1 |
| **Loamy Sand - 20% Slope - 8% Rock Cover** | | | | | | | | |
| 50 ft. | 4.3 | 0.3 | 0.2 | 0.2 | 0.7 | 0.1 | 4.3 | 0.1 |
| 75 ft. | 5.3 | 0.3 | 0.3 | 0.2 | 0.8 | 0.2 | 5.3 | 0.1 |
| 125 ft. | 6.8 | 0.4 | 0.3 | 0.2 | 0.9 | 0.2 | 6.8 | 0.1 |
| 175 ft. | 8.1 | 0.4 | 0.3 | 0.2 | 1.0 | 0.3 | 8.1 | 0.1 |
| 225 ft. | 9.2 | 0.4 | 0.4 | 0.2 | 1.1 | 0.3 | 9.2 | 0.1 |
| **Loamy Sand - 30% Slope - 8% Rock Cover** | | | | | | | | |
| 50 ft. | 6.6 | 0.4 | 0.3 | 0.2 | 1.0 | 0.2 | 6.6 | 0.1 |
| 75 ft. | 8.2 | 0.4 | 0.4 | 0.3 | 1.2 | 0.3 | 8.2 | 0.1 |
| 125 ft. | 11.0 | 0.6 | 0.5 | 0.3 | 1.5 | 0.3 | 11.0 | 0.2 |
| 175 ft. | 13.0 | 0.7 | 0.6 | 0.3 | 1.7 | 0.4 | 13.0 | 0.2 |
| 225 ft. | 15.0 | 0.8 | 0.6 | 0.4 | 1.8 | 0.5 | 15.0 | 0.2 |
| **Loamy Sand - 10% Slope - 20% Rock Cover** | | | | | | | | |

| *Soil/ Slope/Length | Disturbed (cut) | Mulch (4000#) | Temp. Seed/Mulch | RECP | RECP/ Quick Decay | Silt Fence | Silt Fence 50% | Sediment Basin |
|---|---|---|---|---|---|---|---|---|
| 50 ft. | 1.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.0 | 12.2 | 0.0 |
| 75 ft. | 1.4 | 0.1 | 0.1 | 0.1 | 0.2 | 0.0 | 1.4 | 0.0 |
| 125 ft. | 1.8 | 0.1 | 0.1 | 0.1 | 0.3 | 0.1 | 1.8 | 0.0 |
| 175 ft. | 2.0 | 0.1 | 0.1 | 0.1 | 0.3 | 0.1 | 2.0 | 0.0 |
| 225 ft. | 2.2 | 0.2 | 0.1 | 0.1 | 0.3 | 0.1 | 2.2 | 0.0 |
| **Loamy Sand - 20% Slope - 20% Rock Cover** | | | | | | | | |
| 50 ft. | 2.8 | 0.2 | 0.2 | 0.2 | 0.5 | 0.1 | 2.8 | 0.0 |
| 75 ft. | 3.4 | 0.3 | 0.2 | 0.2 | 0.5 | 0.1 | 3.4 | 0.1 |
| 125 ft. | 4.4 | 0.3 | 0.3 | 0.2 | 0.6 | 0.1 | 4.4 | 0.1 |
| 175 ft. | 5.2 | 0.4 | 0.3 | 0.2 | 0.7 | 0.2 | 5.2 | 0.1 |
| 225 ft. | 5.9 | 0.4 | 0.4 | 0.2 | 0.7 | 0.2 | 5.9 | 0.1 |
| **Loamy Sand - 30% Slope - 20% Rock Cover** | | | | | | | | |
| 50 ft. | 4.2 | 0.3 | 0.3 | 0.2 | 0.7 | 0.1 | 4.2 | 0.1 |
| 75 ft. | 5.2 | 0.4 | 0.4 | 0.3 | 0.8 | 0.2 | 5.2 | 0.1 |
| 125 ft. | 6.9 | 0.5 | 0.4 | 0.3 | 0.9 | 0.2 | 6.9 | 0.1 |
| 175 ft. | 8.3 | 0.6 | 0.5 | 0.3 | 1.0 | 0.3 | 8.3 | 0.1 |
| 225 ft. | 9.5 | 0.7 | 0.6 | 0.4 | 1.1 | 0.3 | 9.5 | 0.1 |

*See tables below for soil and BMP characteristics

| Soil Textures Used in Hillside Erosion Model | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil Texture | Particle Size (mm) ,% | | | Hydrologic Class | Rock Cover % | Organic Matter % | Perm | Detached Particle Information | | | | | RUSLE2 K |
| | Clay (<.002) | Silt (.002-.05) | Sand (.05-2) | | | | | Clay % | Silt % | Sand % | Small Agg% | Large Agg% | |
| Silt loam | 20 | 60 | 20 | C | 0 | 0.5 | slow | 5.2 | 24 | 6.6 | 36 | 28 | 0.49 |
| Clay loam | 33 | 33 | 33 | C | 0 | 0.5 | slow | 8.6 | 3.1 | 4.5 | 30 | 53 | 0.28 |
| Sandy Loam | 10 | 25 | 65 | B | 0 | 0.5 | mod | 2.6 | 7 | 38 | 18 | 34 | 0.31 |
| Sandy Loam | 10 | 25 | 65 | D | 8 | 0.5 | mod | 2.6 | 7 | 38 | 18 | 34 | 0.31 |
| Sandy Loam | 10 | 25 | 65 | D | 13 | 0.5 | mod | 2.6 | 7 | 38 | 18 | 34 | 0.31 |
| Loamy Sand | 6 | 12 | 82 | D | 8 | 0.5 | mod to rapid | 1.5 | 1.4 | 61 | 11 | 26 | 0.18 |
| Loamy Sand | 6 | 12 | 82 | D | 20 | 0.5 | mod to rapid | 1.5 | 1.4 | 61 | 11 | 26 | 0.18 |
| Loam | 18 | 41 | 41 | C | 0 | 0.5 | slow | 4.7 | 8.6 | 15 | 32 | 39 | 0.45 |
| Loam | 18 | 41 | 41 | B | 0 | 0.5 | mod | 4.7 | 8.6 | 15 | 32 | 39 | 0.4 |

| Management Practices Used in Hillside Erosion Model | | | | | | | |
|---|---|---|---|---|---|---|---|
| Management | Vegetation | Lb/Acre | Max. Canopy Cover % | Cover % | Decomp. Half-life in Days | Veg. Retardance Class | Description |
| Mulch | native hay | 4000 | | 93 | 58 | | Apply native hay mulch |
| Broadcast Seed & Mulch | temp. (oats) | 2100 | 74 | 91 | 87 | Mod. Low | Broadcast seed temp. vegetation, apply straw mulch (2000 lbs/acre) |
| RECP | roll material | 4000 | | 99 | 100 | | Apply generic erosion control blanket |
| RECP | roll material quick decay | 4000 | | 99 | 10 | | Apply generic quick decay erosion control blanket |
| Silt fence full retardance | | | | | | Extreme | Represents a silt fence that performs at maximum trapping* |
| Silt fence half retardance | | | | | | None | Represents a silt fence that performs at half maximum trapping |
| Sediment basin | | | | | | | Small well designed, constructed, & maintained sediment basin ** |

* Silt fence installed fully on contour and fully entrenched along entire length and properly staked

**Overland flow path drains directly into a simple, optimally performing sediment basin typical of those used on construction sites

**Table 14: Appendix A, Soils and Management Practices Used in Construction Erosion Model**

## Appendix B

### Sub Basin Sediment Yield

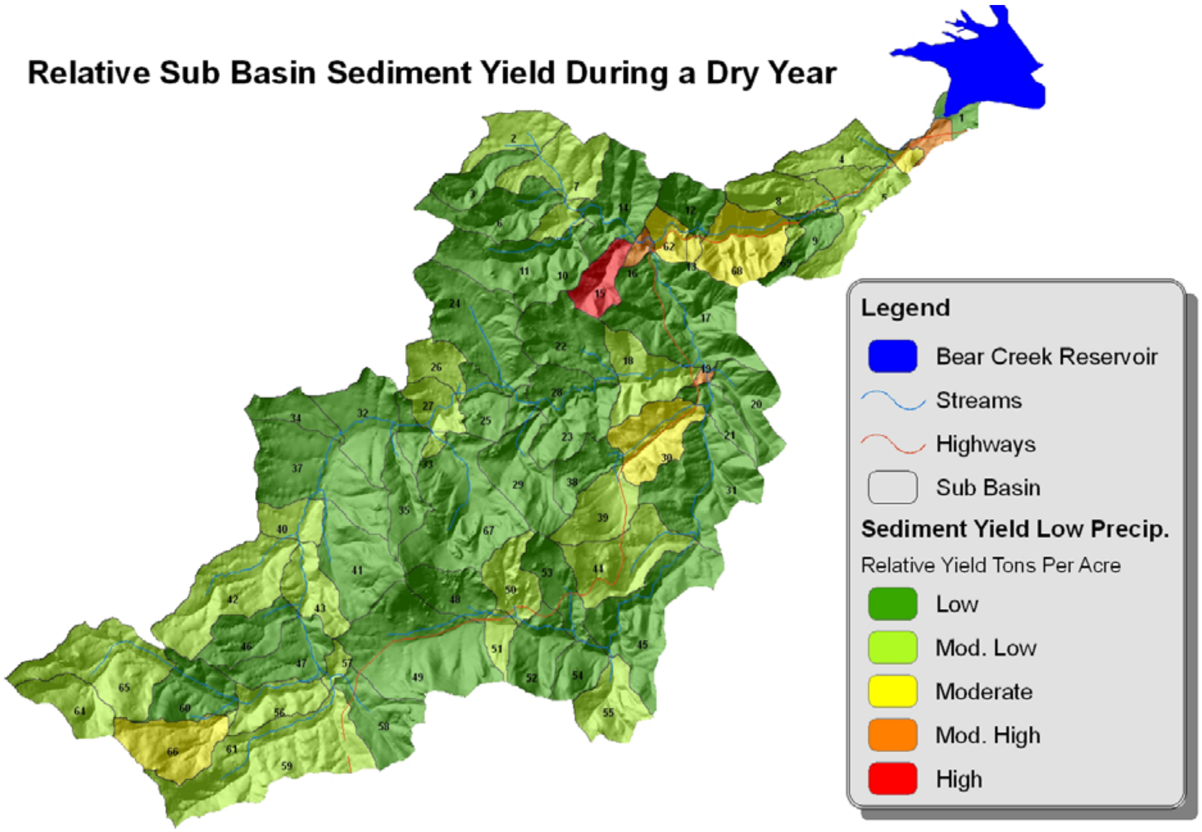



**Figure 17 Appendix B, Sub Basin Sediment Yield During a Dry Year**

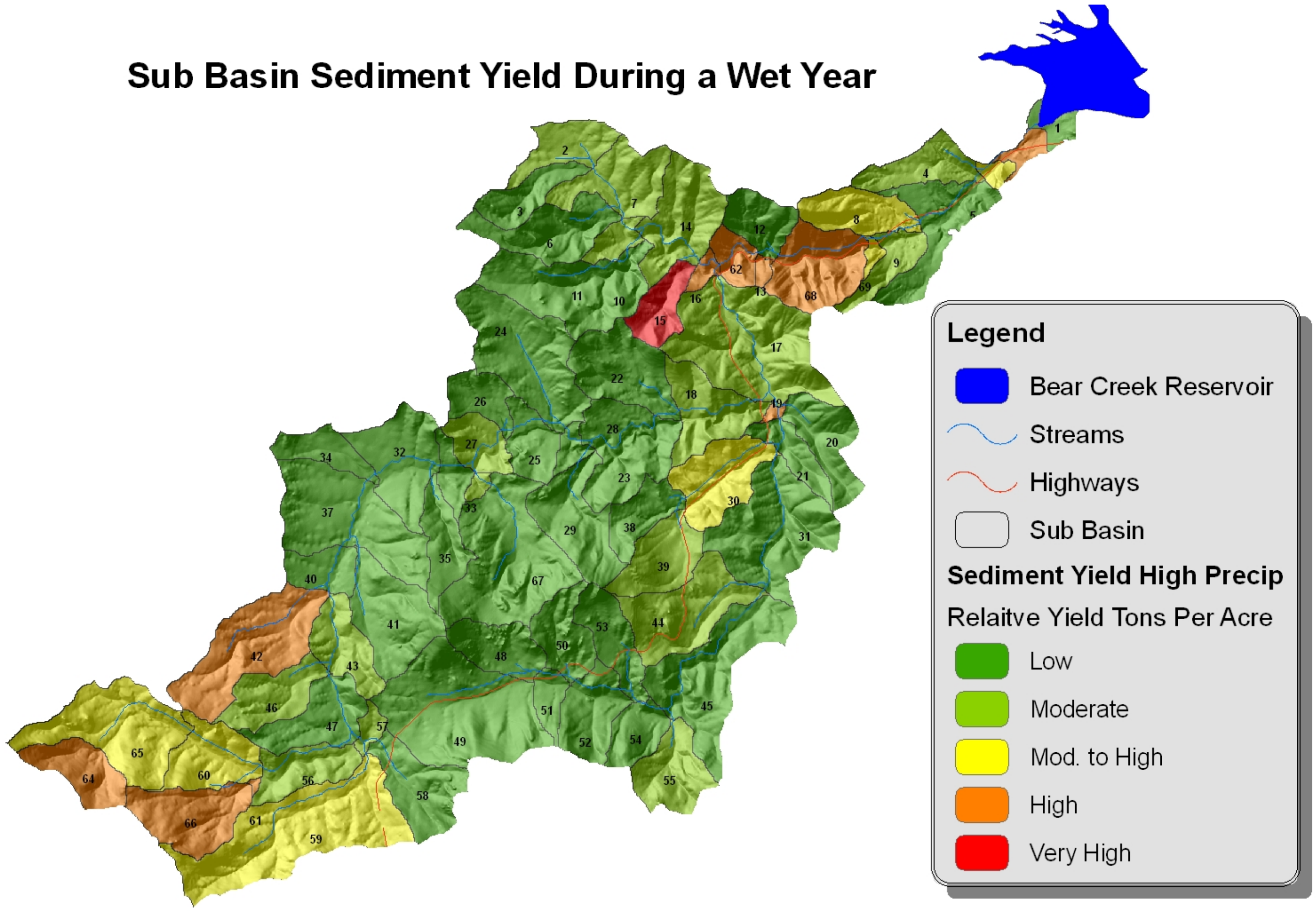



**Figure 18 Appendix B, Sub Basin Sediment Yield During a Wet Year**

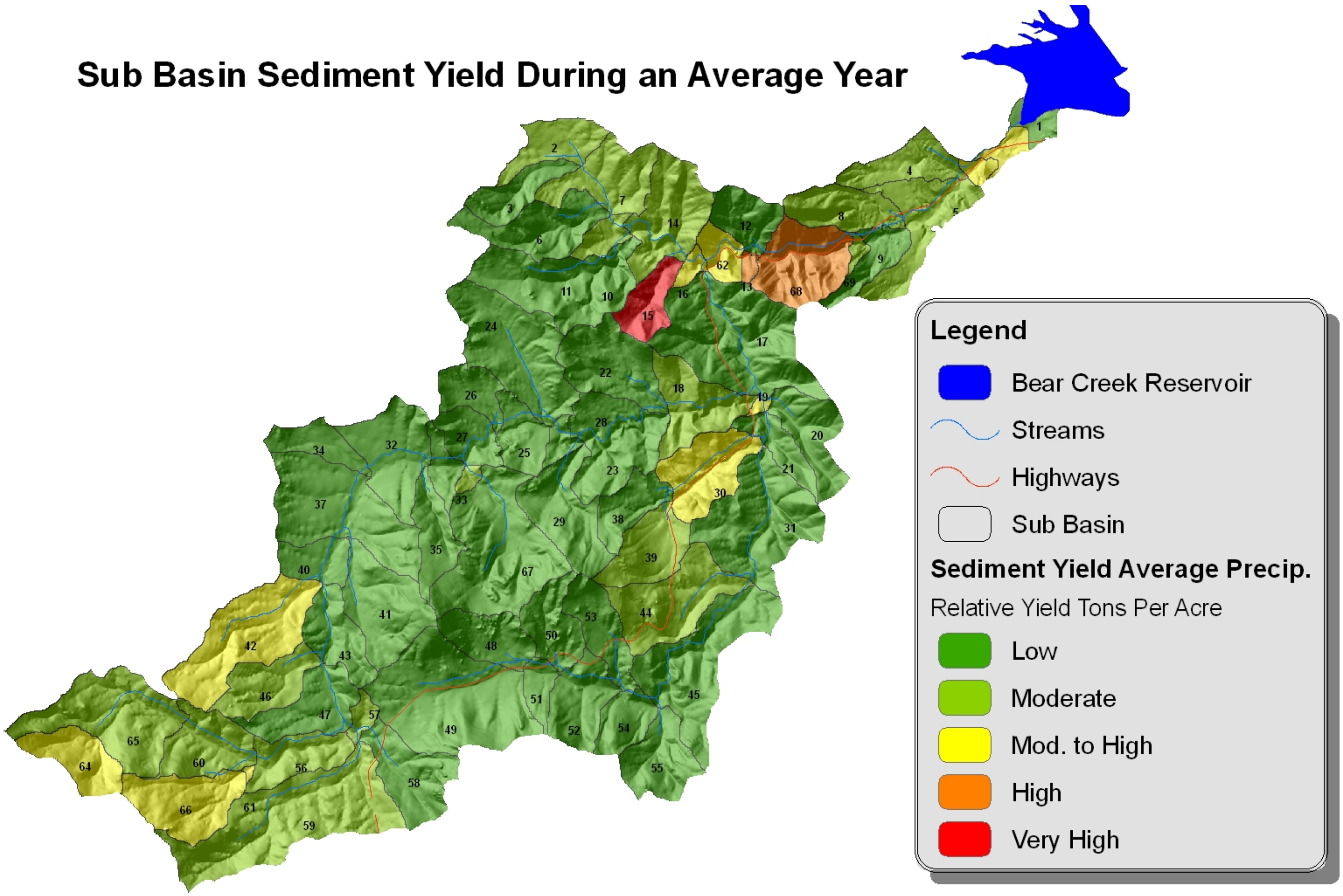



**Figure 19 Appendix B, Sub Basin Sediment Yield During an Average Year**

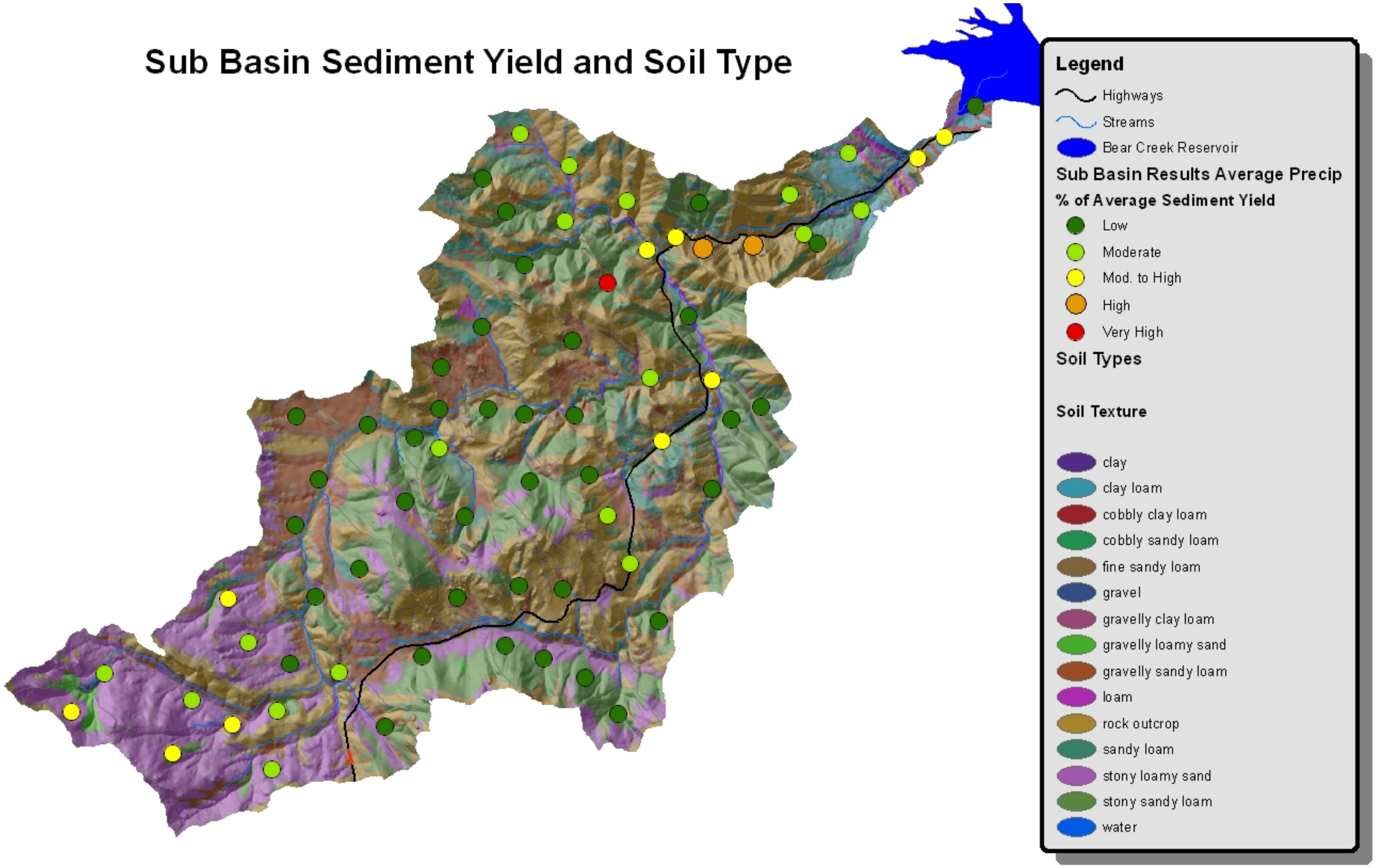



**Figure 20 Appendix B, Post Construction Sediment Yield and Soil Type**

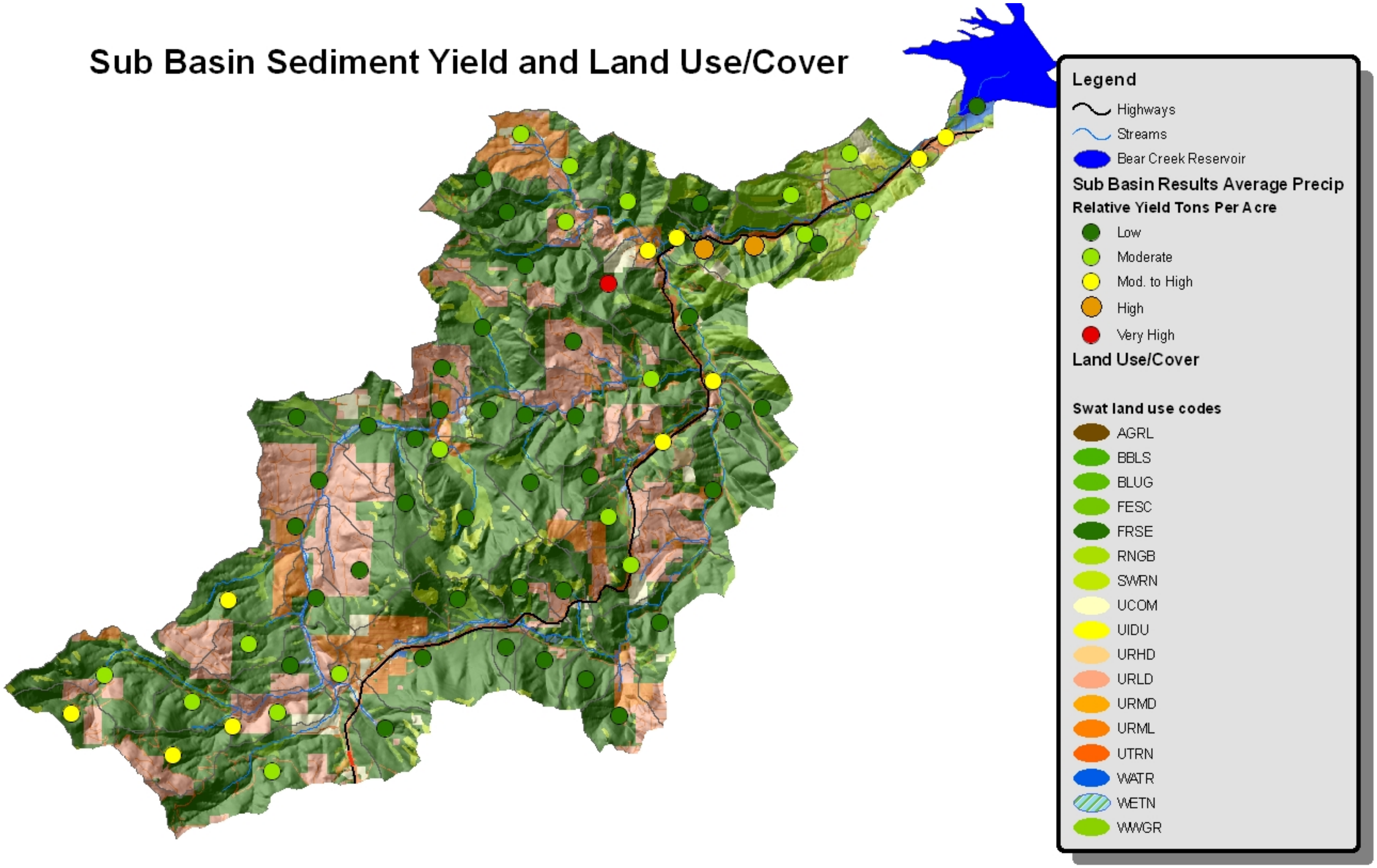



**Figure 21 Appendix B, Post Construction Sediment Yield and Land Use/Cover**

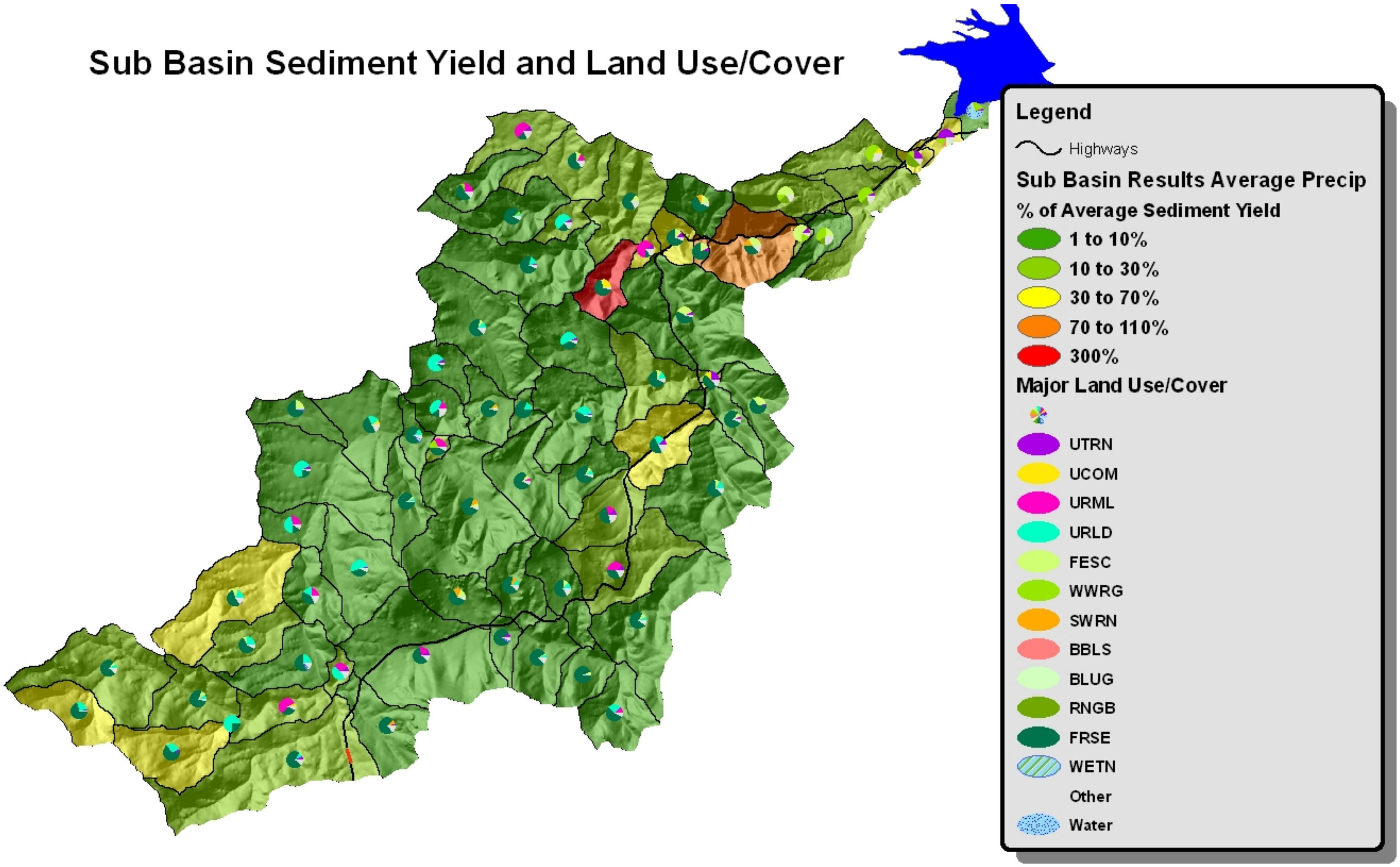
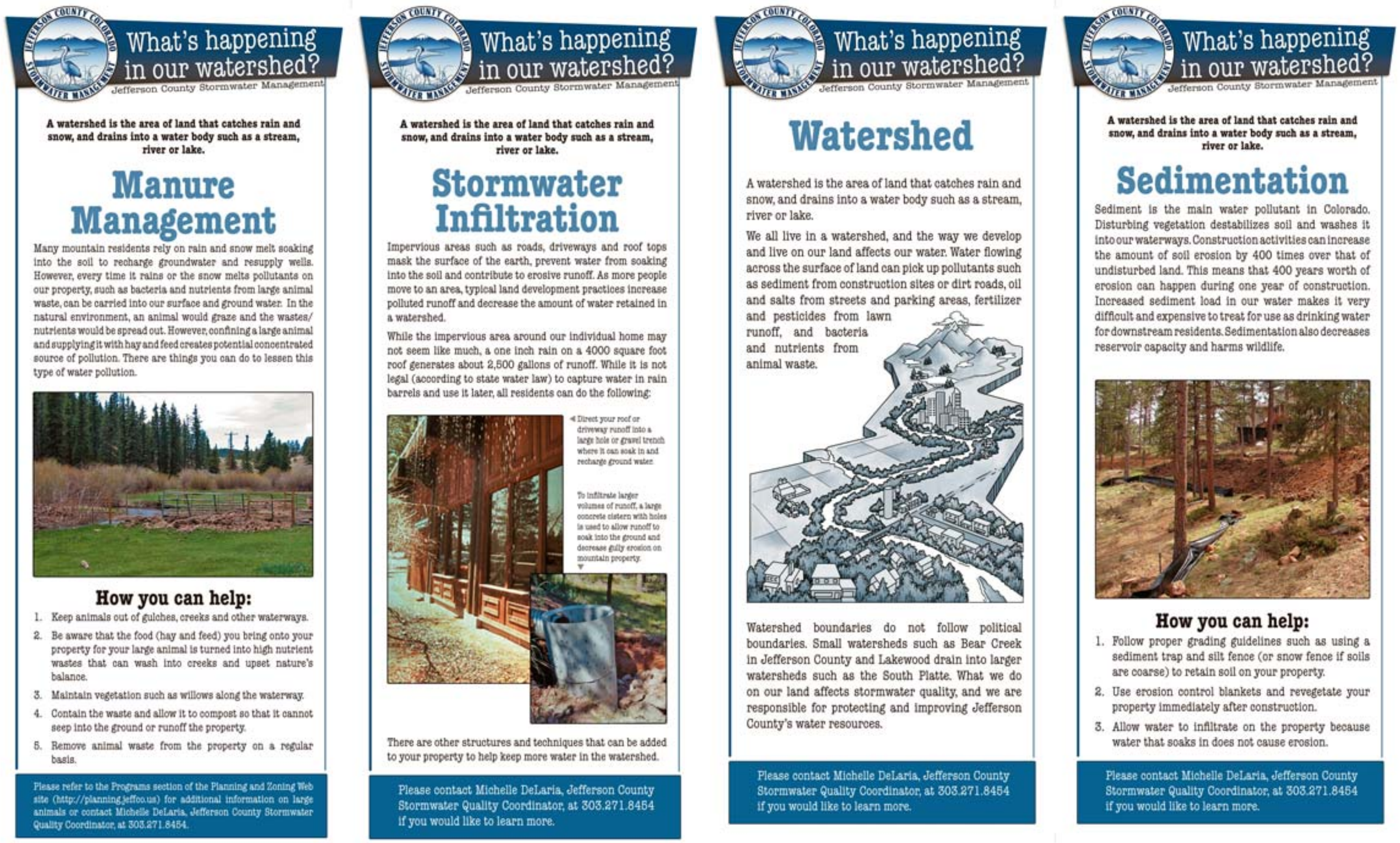



**Figure 22 Appendix B, Sub Basin Sediment Yield and Major Land Use/Cover**

## Appendix C

### Educational Materials



What's happening in our watershed?
Jefferson County Stormwater Management

**A watershed is the area of land that catches rain and snow, and drains into a water body such as a stream, river or lake.**

# Manure Management

Many mountain residents rely on rain and snow melt soaking into the soil to recharge groundwater and resupply wells. However, every time it rains or the snow melts pollutants on our property, such as bacteria and nutrients from large animal waste, can be carried into our surface and ground water. In the natural environment, an animal would graze and the wastes/nutrients would be spread out. However, confining a large animal and supplying it with hay and feed creates potential concentrated source of pollution. There are things you can do to lessen this type of water pollution.

## How you can help:

1. Keep animals out of gulches, creeks and other waterways.
2. Be aware that the food (hay and feed) you bring onto your property for your large animal is turned into high nutrient wastes that can wash into creeks and upset nature's balance.
3. Maintain vegetation such as willows along the waterway.
4. Contain the waste and allow it to compost so that it cannot seep into the ground or runoff the property.
5. Remove animal waste from the property on a regular basis.

Please refer to the Programs section of the Planning and Zoning Web site (http://planning.jeffco.us) for additional information on large animals or contact Michelle DeLaria, Jefferson County Stormwater Quality Coordinator, at 303.271.8454.

What's happening in our watershed?
Jefferson County Stormwater Management

**A watershed is the area of land that catches rain and snow, and drains into a water body such as a stream, river or lake.**

# Stormwater Infiltration

Impervious areas such as roads, driveways and roof tops mask the surface of the earth, prevent water from soaking into the soil and contribute to erosive runoff. As more people move to an area, typical land development practices increase polluted runoff and decrease the amount of water retained in a watershed.

While the impervious area around our individual home may not seem like much, a one inch rain on a 4000 square foot roof generates about 2,500 gallons of runoff. While it is not legal (according to state water law) to capture water in rain barrels and use it later, all residents can do the following:

◄ Direct your roof or driveway runoff into a large hole or gravel trench where it can soak in and recharge ground water.

To infiltrate larger volumes of runoff, a large concrete cistern with holes is used to allow runoff to soak into the ground and decrease gully erosion on mountain property. ▼

There are other structures and techniques that can be added to your property to help keep more water in the watershed.

Please contact Michelle DeLaria, Jefferson County Stormwater Quality Coordinator, at 303.271.8454 if you would like to learn more.

What's happening in our watershed?
Jefferson County Stormwater Management

# Watershed

A watershed is the area of land that catches rain and snow, and drains into a water body such as a stream, river or lake.

We all live in a watershed, and the way we develop and live on our land affects our water. Water flowing across the surface of land can pick up pollutants such as sediment from construction sites or dirt roads, oil and salts from streets and parking areas, fertilizer and pesticides from lawn runoff, and bacteria and nutrients from animal waste.

Watershed boundaries do not follow political boundaries. Small watersheds such as Bear Creek in Jefferson County and Lakewood drain into larger watersheds such as the South Platte. What we do on our land affects stormwater quality, and we are responsible for protecting and improving Jefferson County's water resources.

Please contact Michelle DeLaria, Jefferson County Stormwater Quality Coordinator, at 303.271.8454 if you would like to learn more.

What's happening in our watershed?
Jefferson County Stormwater Management

**A watershed is the area of land that catches rain and snow, and drains into a water body such as a stream, river or lake.**

# Sedimentation

Sediment is the main water pollutant in Colorado. Disturbing vegetation destabilizes soil and washes it into our waterways. Construction activities can increase the amount of soil erosion by 400 times over that of undisturbed land. This means that 400 years worth of erosion can happen during one year of construction. Increased sediment load in our water makes it very difficult and expensive to treat for use as drinking water for downstream residents. Sedimentation also decreases reservoir capacity and harms wildlife.

## How you can help:

1. Follow proper grading guidelines such as using a sediment trap and silt fence (or snow fence if soils are coarse) to retain soil on your property.
2. Use erosion control blankets and revegetate your property immediately after construction.
3. Allow water to infiltrate on the property because water that soaks in does not cause erosion.

Please contact Michelle DeLaria, Jefferson County Stormwater Quality Coordinator, at 303.271.8454 if you would like to learn more.

**Figure 23 Example of Educational Brochure**