# APPENDIX G – UPLAND SEDIMENT ASSESSMENT

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# G1.0 Introduction

The Redrock TMDL Planning Area (TPA) is located in Beaverhead County, with a small portion in Madison County. The Red Rock TPA encompasses the entire Red Rock River watershed, which flows northwest through the upper and Lower Red Rock Lakes and Lima Reservoir before joining into Clark Canyon Reservoir. The TPA coincides with the 10020001 fourth-code hydrologic unit code. This report provides an upland source assessment that will be used for TMDL development.

Upland sediment loading due to hillslope erosion was modeled using the Universal Soil Loss Equation (USLE) and sediment delivery to the stream was predicted using a sediment delivery ratio and accounting for estimated quality and width of riparian buffers. This model provided an assessment of existing sediment loading from upland sources and an assessment of potential sediment loading through the application of Best Management Practices (BMPs). The BMPs evaluated assumed modifications in upland management practices as well as improvements within the riparian buffer zone. When reviewing the results of the upland sediment load model, it is important to note that a significant portion of the sediment load is the “natural upland load” and not affected by the application of BMPs to the upland management practices.

The general form of the USLE has been widely used for erosion prediction in the U.S. and is presented in the National Engineering Handbook (1985) as:

(1) $A = RK(LS)CP$ (in tons per acre per year)

where soil loss (A) is a function of the rainfall erosivity index (R), soil erodibility factor (K), overland flow slope and length (LS), crop management factor (C), and conservation practice factor (P) (Wischmeier and Smith 1978, Renard et al. 1997). USLE was selected for the Red Rock TPA due to its relative simplicity and ease in parameterization and the fact that it has been integrated into a number of other erosion prediction models. These include: (1) the Agricultural Nonpoint Source Model (AGNPS), (2) Areal Nonpoint Source Watershed Environment Response Simulation Model (ANSWERS), (3) Erosion Productivity Impact Calculator (EPIC), (4) Generalized Watershed Loading Functions (GWLF), and (5) the Soil Water Assessment Tool (SWAT). A detailed description of the general USLE model parameters is presented below.

The **R-factor** is an index that characterizes the effect of raindrop impact and rate of runoff associated with a rainstorm. It is a summation of the individual storm products of the kinetic energy in rainfall (hundreds of ft-tons per acre per year) and the maximum 30-minute rainfall intensity (inches per hour). The total kinetic energy of a storm is obtained by multiplying the kinetic energy per inch of rainfall by the depth of rainfall during each intensity period.

The **K-factor** or soil erodibility factor indicates the susceptibility of soil to resist erosion. It is a measure of the average soil loss (tons per acre per hundreds of ft-tons per acre of rainfall intensity) from a particular soil in continuous fallow. The K-factor is based on experimental data from the standard SCS erosion plot that is 72.6 ft long with uniform slope of 9%.

The **LS-factor** is a function of the slope and overland flow length of the eroding slope or cell. For the purpose of computing the LS-factor, slope is defined as the average land surface gradient. The flow length refers to the distance between where overland flow originates and runoff reaches a defined channel or depositional zone. According to McCuen (1998), flow lengths are seldom greater than 400 ft or shorter than 20 ft. Therefore, any LS-Factor value exceeding 400 was set to 400. The LS factor is dimensionless. Therefore, the DEM in meters was used in the analysis and generated the same LS value as a DEM in feet would generate.

The **C-factor** or crop management factor is the ratio of the soil eroded from a specific type of cover to that from a clean-tilled fallow under identical slope and rainfall. It integrates a number of factors that affect erosion including vegetative cover, plant litter, soil surface, and land management. The original C-factor of the USLE was experimentally determined for agricultural crops and has since been modified to include rangeland and forested cover. It is now often referred to as the vegetation management factor (VM) for non-agricultural settings (Stone 2015)

The **P-factor** or conservation practice factor is a function of the interaction of the supporting land management practice and slope. It incorporates the use of erosion control practices such as strip-cropping, terracing and contouring, and is applicable only to agricultural lands. Values of the P-factor compare straight-row (up-slope down-slope) farming practices with that of certain agriculturally based conservation practices.

The result from multiplying all of these components in the USLE model is an estimate of erosion per year for each cell of the DEM. This analysis used a 10-meter DEM, and each cell represents 100 square meters. To determine how much each cell generated in tons per acre the DEM was multipled by 0.024, which is the conversion factor from 100 square meters to acres.

The USLE method is generally used to estimate run-off from fields and not at a watershed scale. However, at a watershed scale, sediment that is not close to the stream network is less likely to make it to the stream. Megahan and Ketcheson (1996) found that the amount of a sediment that makes it to the stream depends on travel distance. In order to correct for this, the result from the USLE equation was multipled by the sediment delivery ratio. This is described in **Section 5.4.9**.

# G2.0 Modeling Scenarios

Four management scenarios were evaluated for the Red Rock TPA. They include: (1) an existing conditions scenario that considers the current land cover, management practices, and riparian health in the watershed; (2) an upland BMP conditions scenario that considers improved grazing and cover management; (3) a riparian health BMP conditions scenario that considers improved riparian buffer zones; and (4) a riparian health BMP and upland BMP conditions scenario that considers improved riparian buffer zones and grazing and cover management.

## G2.1 Upland BMP Scenario

Sediment loading was estimated before and after upland BMPs by adjusting the c-value in the USLE equation according to **Section 5.4.11**. The c-value represents the amount loading from different types of cover and decreasing the c-value reflects the implementation of practices to decrease erosion such as cover crops, change in tillage, or revegetation. Land cover categories considered to be affected by human-caused activity and therefore receiving an adjustment of the c-value included developed lands, pasture/hay, grasslands/herbaceous, shrub/scrub, cultivated crops, and transitional (logging and timber harvest).

## G2.2 Riparian Buffer Scenario

Sediment was estimated before and after riparian zone improvements (width and/or quality) by adjusting the filtering capacity of the zone within 120 feet of the stream. Well vegetated riparian buffers have been shown to act as filters that help to remove sediment from overland flow. A coarse GIS framework was used to determine the width of the riparian buffer. The filtering ability of different widths was based on estimates from the literature for different land cover types. This reduction was applied to the amount of sediment entering the stream, and then modified to reflect potential increases in riparian buffer width and quality according to **Section 5.4.11**. Given the coarse resolution of the NLCD, these estimates are considered an approximation. Ground-truthing would be required to develop more precise estimates.

## G2.3 Upland BMP and Riparian Buffer combined scenario

The combined scenario was estimated by adjusting both the c-value to reflect reducted erosion from improved upland practices, and increased filtering ability by the riparian buffer due to an increase in quality and/or width.

# G3.0 Data Sources

Grid data of the **R-factor** was obtained from the Montana State Library. Also referred to as “Relative Effective Annual Precipitation”, this map was created by NRCS and is based on Parameter-elevation Regressions on Independent Slopes Model (PRISM) precipitation data. PRISM precipitation data is derived from weather station precipitation records, interpolated to a gridded landscape coverage by a method (developed by the Spatial Climate Analysis Service of Oregon State University) which accounts for the effects of elevation on precipitation patterns.

Polygon data of the **K-factor** were obtained from the NRCS General Soil Map (STATSGO) database and the NRCS Soil Survey Geographic (SSURGO) database.

The **LS-factor** was derived from 30m USGS digital elevation model (DEM) grid data, interpolated to a 10m pixel. This factor is calculated within the model.

The **c-factor** was estimated using the National Land Cover (NLCD) dataset and using c-factor interpretations provided by the NRCS with input from Montana Department of Environmental Quality (DEQ). C-factors are intended to be conservatively representative of conditions in the Red Rock TPA.

The **P-factor** was set to one, as per previous communication with the NRCS State Agronomist who suggested that this value is the most appropriate representation of current management practices in the larger Beaverhead watershed of which Red Rock TPA is a part.

The **sediment delivery ratio** was derived by the model for each grid cell based on the observed relationship between the distance from the delivery point to the stream and the percent of eroded sediment delivered to the stream. This relationship was established by Megehan and Ketcheson (1996).

The **riparian buffer filtering capacity** was based on estimated filtering capacities of riparian zones of different land covers, widths, and qualities and was based largely on a review of such data (Wenger et al. 1999)

# G4.0 Detailed Modeling Methods

An appropriate grid for each data source was created, giving full and appropriate consideration to proper stream network delineation, grid cell resolution, etc. GIS methods were used to estimate tons of loading per acre per year for each grid cell. The model also derived a sediment delivery ratio for each cell, and reduced the predicted sediment production by that factor to estimate sediment delivered to the stream network.

Specific parameterization of the USLE factors were preformed according to the following sections.

## G4.1 Sub-basins

The Red Rock TPA boundary and the sub-basin boundaries were defined using USGS Streamstats, by delinating from a point immediately downstream of impaired segments (**Figure G-1**). For the Big Sheep Creek segment, the contribution of sediment from the upper watershed which is not impaired was included in the estimate.

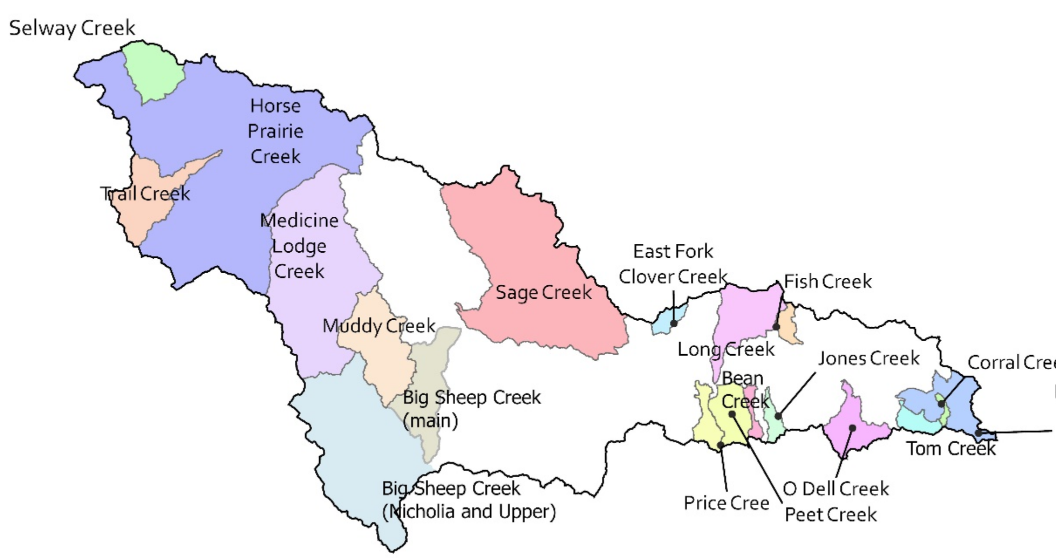


**Figure G-1. Sub-basin polygons for the Upland Sediment Analysis.**

## G4.2 Red Rock TPA DEM

The digital elevation model (DEM) for the Red Rock TPA is the foundation for developing the LS factor, for defining the extent of the bounds of the analysis area, and for delineating the area within the outer bounds of the analysis for which the USLE model is not valid (i.e. the concentrated flow channels of the stream network). The USGS 30m DEM (level 2) for the Red Rock TPA was used for these analyses (**Figure G-2**). The DEM was interpolated to a 10m analytic grid cell to render the delineated stream network more representative of the actual size of Red Rock TPA streams and to minimize resolution dependent stream network anomalies. The resulting interpolated 10m DEM was then subjected to standard hydrologic preprocessing, including the filling of sinks to create a positive drainage condition for all areas of the watershed.

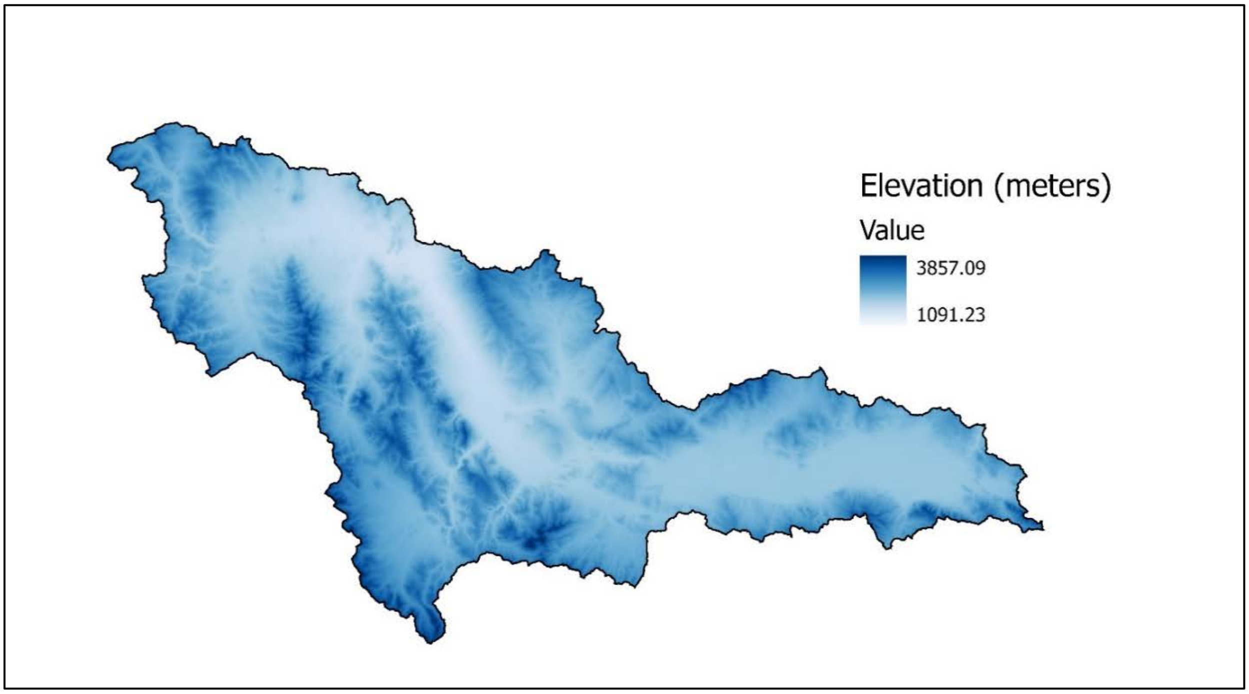


**Figure G-2. Digital Elevation Model (DEM) of the Red Rock TPA.**

## G4.3 Red Rock TPA Flow Network

The National Hydrography Dataset Streams layer was used as the streams layer in the analysis. The stream network for the watershed was derived from the 10m DEM, using hydrologic analysis methods in ArcPro 2.7 (**Figure G1-3**) to burn the NHD into the DEM. Before performing all operations, the NHD layer was converted to a 10-meter resolution raster and thinned.

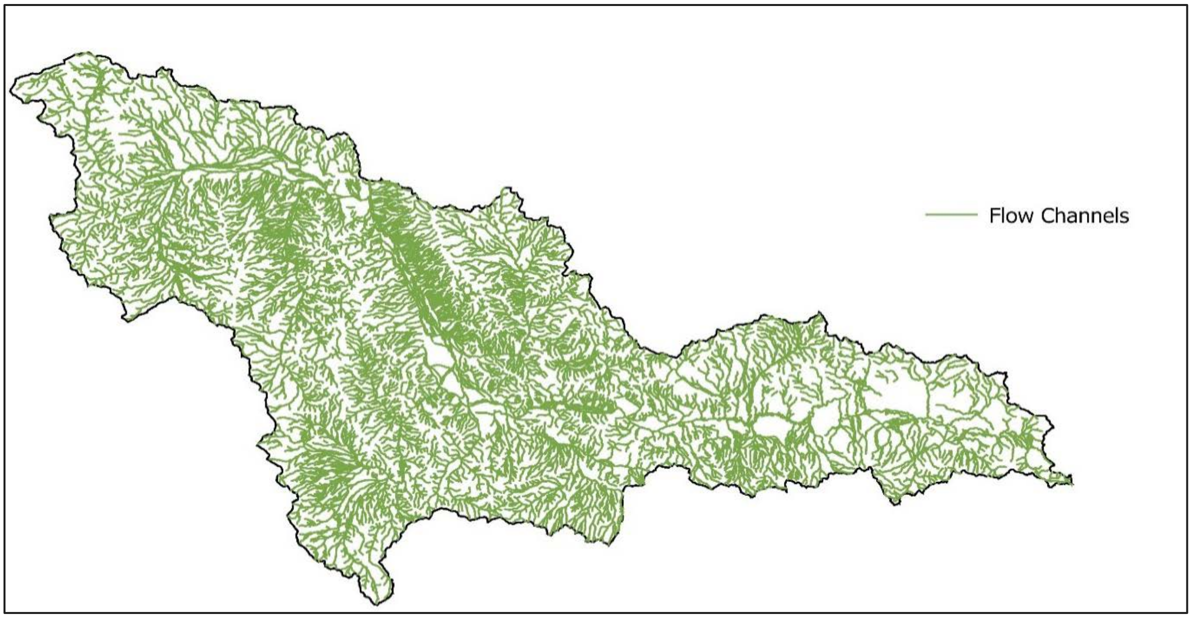


**Figure G-3. Flow network for the Red Rock TPA.**

## G4.4 R-Factor

The rainfall and runoff factor grid was obtained by the Montana State Library, at 4 km grid cell resolution. For the purposes of this analysis, the SCAS R-factor grid was resampled to a 10m analytic cell size and clipped to the extent of the Red Rock TPA, to match the project's standard grid definition (**Figure G-4**).


**Figure G-4. ULSE R-factor for the Red Rock TPA.**

## G4.5 K-Factor

The soil erodibility factor grid was compiled from the 1:250K STATSGO and SSURGO data, as published by the NRCS. (**Figure G-5**). The grid was converted to 1 10-meter resolution for the analysis.

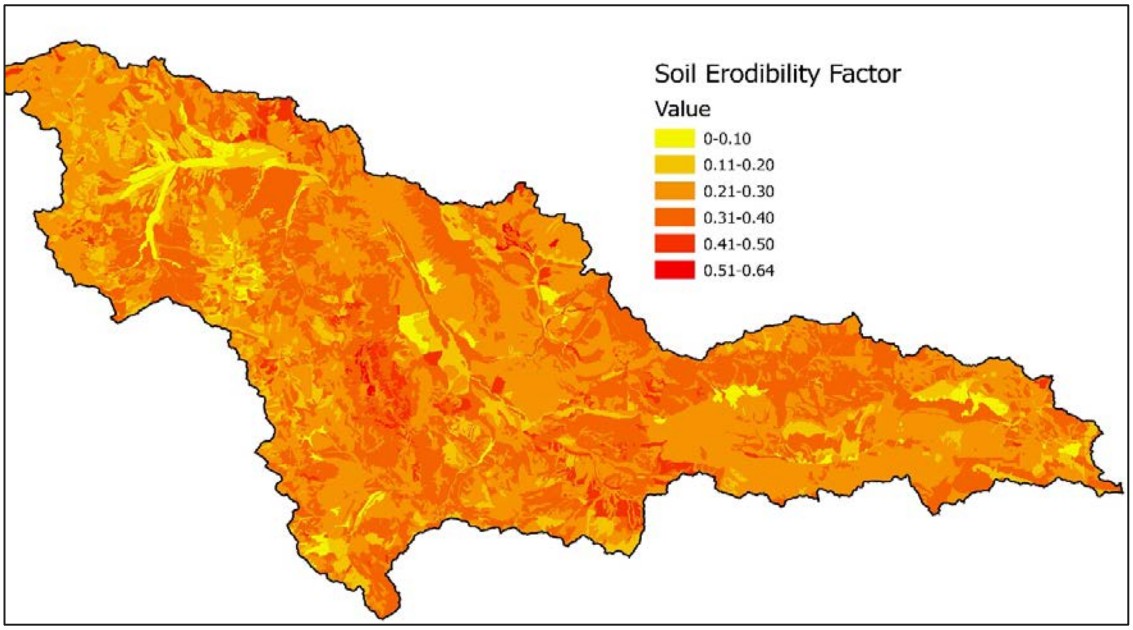


**Figure G-5. ULSE K-factor for the Red Rock TPA**

## G4.6 LS-FACTOR

The equation used for calculating the slope length and slope factor was that given in the updated definition of RUSLE, as published in USDA handbook #703:

$LS = Si (\lambda im+1 - \lambda i-1m+1) / (\lambda I - \lambda i-1) (72.6)m$

Where:

$\lambda i$ = length in feet from top of slope to lower end of the segment. This value was determined by applying GIS based surface analysis procedures to the Red Rock TPA DEM, and calculating total upslope length for each 10m grid cell (**Figure G-6**). In accordance with research that indicates that, in practice, the slope length rarely exceeds 400 ft, $\lambda$ was limited to the corresponding value in meters (~ 122 meters). Because the LS factor is dimensionless, it produced the same result to calculate LS factor in metric units of the DEM.

Si = slope steepness factor for the ith segment.
= $10.8 \sin \theta + 0.03$ for $\theta < 9\%$
= $16.8 \sin \theta - 0.50$ for $\theta > 9\%$

m = a variable slope-length exponent.
= $\beta / (1 + \beta)$

and

$\beta$ = ratio of rill to interrill erosion.
= $(\sin \theta / 0.0896) / [3.0 (\sin \theta)0.8 + 0.56]$

θ = slope angle as calculated by GIS based surface analysis procedures from the Red Rock TPA DEM.

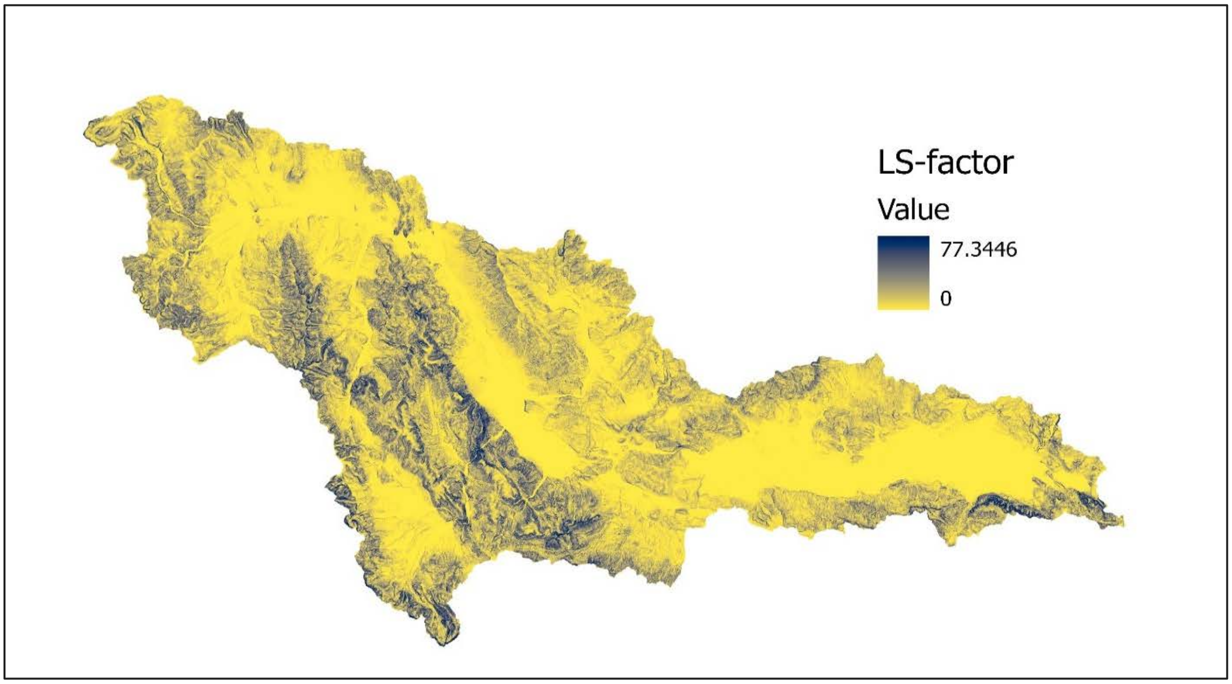


**Figure G-6. ULSE LS-factor for the Red Rock TPA**

## G4.7 C FACTOR

The 2001 National Land Cover Dataset (NLCD) was obtained from USGS for use in establishing USLE c-factors for the Red Rock TPA . C-factors for the current conditions scenario were based on values used in the Beaverhead Sediment TMDLS (Montana DEQ, 2020), which were developed in consultation with NRCS. The 2001 NLCD is the most current NLCD for the project area, and is a categorized 30 meter Landsat Thematic Mapper image shot in 2001. The NLCD image was reprojected to NAD83 UTM Coordinate System and resampled to the project standard 10m grid.

| NLCD Code | Description | C-Factor Existing Condition |
|---|---|---|
| 71 | Grasslands/Herbaceous | 0.020 |
| 52 | Shrub/Scrub | 0.020 |
| 42 | Evergreen Forest | 0.003 |
| 81 | Pasture/Hay | 0.020 |
| 82 | Cultivated Crops | 0.200 |
| 21 | Developed, Open Space | 0.003 |
| 22 | Developed, Low Intensity | 0.001 |
| 90 | Woody Wetlands | 0.013 |
| 23 | Developed, Medium Intensity | 0.001 |
| 31 | Barren Land | 0.001 |
| 95 | Emergent Herbaceous Wetlands | 0.003 |

| NLCD Code | Description | C-Factor Existing Condition |
|---|---|---|
| 24 | Developed, High Intensity | 0.001 |
| 43 | Mixed Forest | 0.003 |
| 41 | Deciduous Forest | 0.003 |

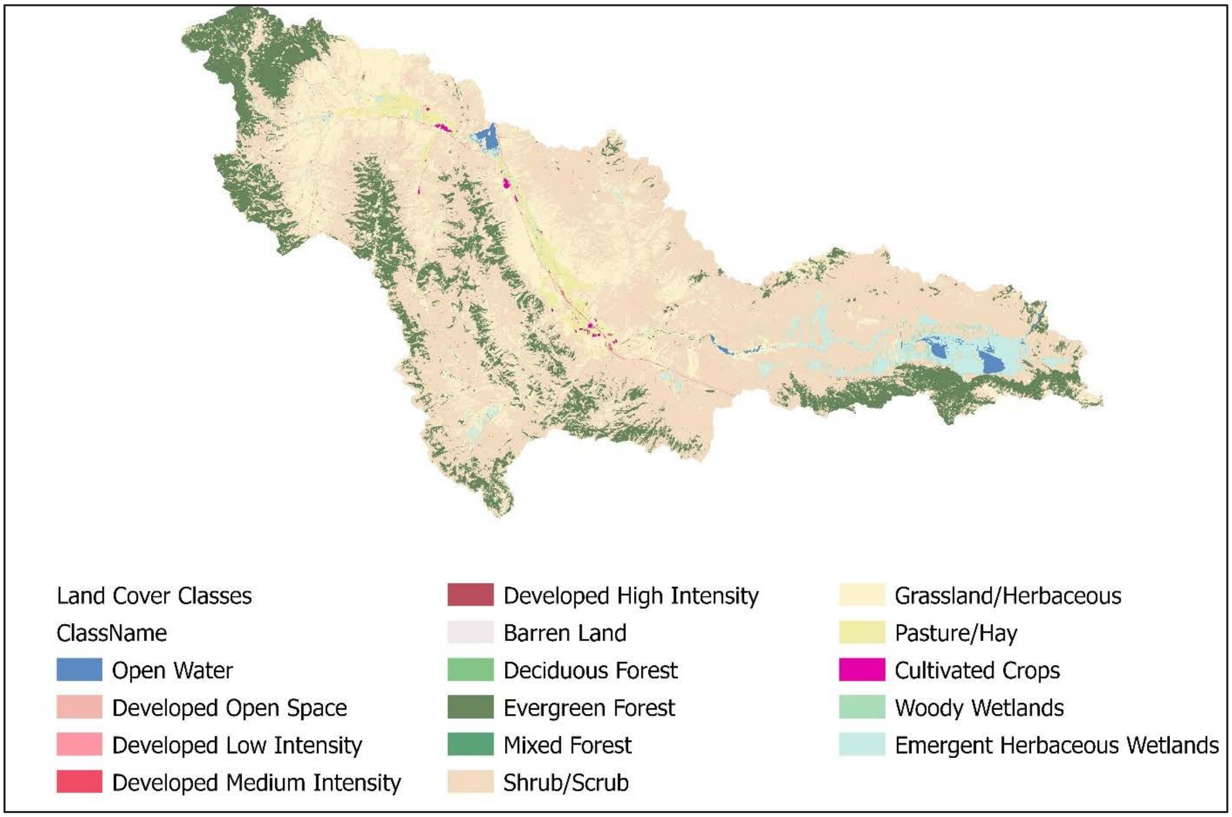


**Figure G-7. NLCD Landcover for the Red Rock TPA.**

## G4.8 Logging and Fire Adjustment

Adjustment for logging was accomplished by using fire and harvest record polygons provided by the U.S. Forest Service. Fires, clearcuts, or salvage logging activities occurring since 2016 were given a "transitional" designation and a c-factor of 0.030 to reflect additional sediment run-off. While sediment run-off varies, this value was chosen to reflect the amount of sediment generated post fire after some minimal recovery had occurred (**Figure G-8**).

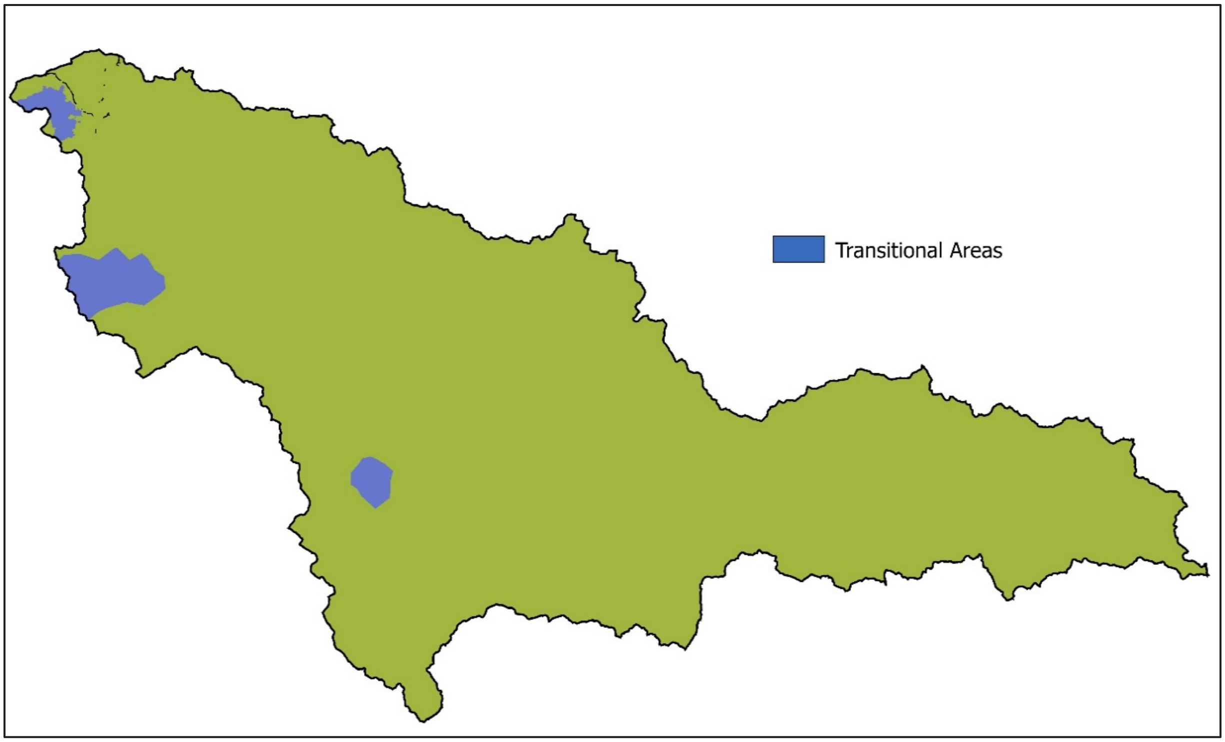


**Figure G-8. Transitional areas of fire, clearcut logging, or salvage loggin occurring since 2016.**

## G4.9 Distance based SDR

Megahan and Ketcheson (1996) found that the relationship between the percentage (by volume) of a sediment mass that travels a given percentage of the maximum sediment travel distance of that sediment mass is as shown in **Figure G-9**.

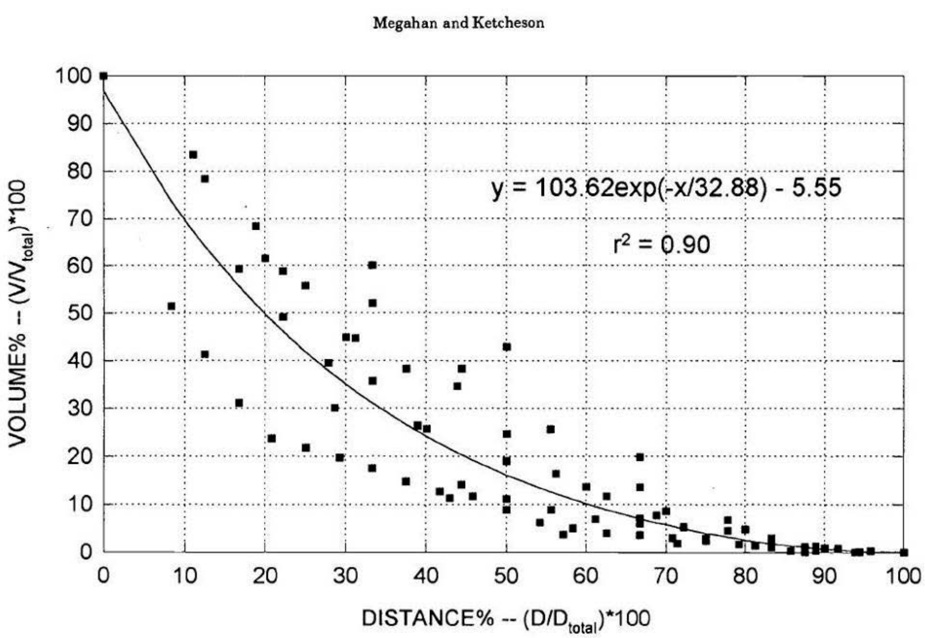

**Figure G-9. Figure 2 from Megahan and Ketcheson (1996), a dimensionless plot of sediment volume vs. travel distance.**

This relationship was derived from a dataset of approximately 100 observations of sediment transport downslope from a known source (forest roads) that was not intercepted by a stream. It thus represents the 'typical' transport distribution along the maximum transport distance under a variety of field conditions.

Megahan and Ketcheson's logarithmic regression of the data permits this relationship to be expressed by the equation:

*Volume %* = 103.62*EXP(-((D/Dtotal)/32.88))-5.55

where:

*Volume%* = the percentage of sediment mobilized from a source that travels at least distance D from that source

*D* = distance from the sediment source, and

*Dtotal* = the maximum distance that sediment travels from the source

The upstream and downstream flow length of each cell to the stream was determined using the flow length tool. The variable D was the downstream flow length to the stream and the variable Dtotal was the downstream flow length added to the upstream flow length.

## G4.10 RIPARIAN FILTERING CAPACITY

Riparian zone sediment filtering capacity is typically expressed as a given percent reduction in delivery of sediment entering a riparian zone of a given width. Literature review (Wegner 1997, Knutson and Naef 1997) indicates that a 100 foot wide (~ 30 meter), well vegetated riparian buffer zone can be expected to filter 75-90% of incoming sediment from reaching its stream channel. Filtering ability shows some variation due to vegetation type, but across natural vegetation types (grassland, wetland, shrubland, forest) this variation can be relatively small compared to the width of the riparian zone. Riparan zones with less than 30 m width can still filter a significant amount sediment (50-75%), though typically less than those with wider buffers (Wegner 1999). Finally, cultivated croplands immediately adjacent to the stream typically have some of the lowest filtering capacities. The knowledge from this research was used to estimate the reduction in sediment due to filtering capacity of the existing riparian zone.

The width of the riparian buffer between each upstream area and the stream was calculated as the length of natural landscape (forest, shrub, grassland, or wetland) between each pixel in the watershed and the stream using ArcGIS. The estimated sediment entering segments was further adjusted based on riparian zone quality and quantity estimated during the aerial assessment performed as part of the bank erosion assessment (**Table G-2**).

**Table G-2. Percent of USLE-generated sediment making it to waterways after adjusting for riparian buffers.**

| Estimated Riparian Buffer Width | Land Use | Percent Reduction in USLE-Model Generated Sediment |
|---|---|---|
| 0-90 feet | Cropland | 25% |
| 0-90 feet | Hayland | 65% |
| 0-90 feet | Minimal cropland,Low quality | 65% |
| 0-90 feet | Minimal cropland, High Quality | 80% |
| 90-120 feet | Any | 90% |
| > 120 feet | Any | 100% |

## G4.11 Incorporating Best Management Practices

For purposes of the base (existing conditions) scenario, the following scheme of reclassification was used to derive annualized USLE C-factors from the NLCD land cover classes present in the Red Rock TPA. This reclassification is based on the NRCS table "C-Factors for Permanent Pasture, Rangeland, Idle Land, and Grazed Woodland" and was developed with the assistance and input of local NRCS employees. A narrative description of the professional judgment involved in the selection of these factors and the NRCS table are provided in **Attachment FA**.

To estimate the potential reduction in sediment production that might be accomplished under the desired conditions scenario (application of best management practices), the model was re-run using a different c-factor reclassification scheme. The 'grasslands/herbaceous', 'shrub/scrub', and 'pasture/hay', c-factors were conservatively changed to reflect an increase in ground cover from approximately 10% to 20%, indicating a modest reduction in grazing intensity for grassland/herbaceous cover and potential use of cover crops for pasture/hay. The 'cultivated crops' BMP c-factor was changed to reflect a 20 percent increase in ground cover over existing conditions. The c factor assigned to the "transitional" class was chosen to reflect conditions similar to scrub-shrub with no BMPs, which might be expected at 10 years post-fire. No change was applied to the other land use types within the Red Rock TPA from the existing conditions scenario.

The c-factors for the two scenarios are presented in **Table G-3 and G-4,** and the adjustments to riparian buffers used in the model to represent BMPs are in **Table G-5**.

**Table G-3. Resulting c-factors after considering implementation of cover crops or other BMPs to reduce erosion.**

| NLCD Code | Description | C-Factor Existing Condition | C-Factor With BMPs |
|---|---|---|---|
| 71 | Grasslands/Herbaceous | 0.020 | 0.015 |
| 52 | Shrub/Scrub | 0.020 | 0.015 |

**Table G-3. Resulting c-factors after considering implementation of cover crops or other BMPs to reduce erosion.**

| NLCD Code | Description | C-Factor Existing Condition | C-Factor With BMPs |
|---|---|---|---|
| 42 | Evergreen Forest | 0.003 | 0.003 |
| 81 | Pasture/Hay | 0.020 | 0.015 |
| 82 | Cultivated Crops | 0.200 | 0.100 |
| 21 | Developed, Open Space | 0.003 | 0.003 |
| 22 | Developed, Low Intensity | 0.001 | 0.001 |
| 90 | Woody Wetlands | 0.013 | 0.013 |
| N/A | Transitional | 0.030 | 0.020 |
| 23 | Developed, Medium Intensity | 0.001 | 0.001 |
| 31 | Barren Land | 0.001 | 0.001 |
| 95 | Emergent Herbaceous Wetlands | 0.003 | 0.003 |
| 24 | Developed, High Intensity | 0.001 | 0.001 |
| 43 | Mixed Forest | 0.003 | 0.003 |
| 41 | Deciduous Forest | 0.003 | 0.003 |

**Table G-4 Changes in percent ground cover for agricultural land cover types between existing and improved management conditions when the c-factors are modified to reflect additional BMPs.**

| Land Cover | Existing % Ground Cover | Improved % Ground Cover |
|---|---|---|
| Shrub/scrub | 75 | 85 |
| Grasslands/Herbaceous | 75 | 85 |
| Pasture/Hay | 75 | 85 |
| Transitional | 90 | 95-100 |
| Woody Wetlands | 80 | 90 |
| Cultivated Crops | 20 | 40 |

**Table G-5 Percent reduction included in model for USLE-generated sediment making it to waterways after adjusting for riparian buffer BMPs.**

| Estimated Riparian Buffer Width | Primary Land Use/Condition | Percent Reduction in Sediment- No BMPs | Percent Reduction in Sediment- BMPs |
|---|---|---|---|
| 0-90 feet | Cropland | 25% | 50% |
| 0-90 feet | Hayland | 65% | 75% |
| 0-90 feet | Non-cropland, and showing significant signs of degradation | 65% | 80% |
| 0-90 feet | Non-cropland, and showing minimal signs of degradation | 80% | 80% |
| 90-120 feet | Any | 90% | 90% |
| > 120 feet | Any | 100% | 100% |

# G5.0 Model Results: Sediment Estimates By Land Cover Type

The following section provides results of the USLE model for the following scenarios: a) 1) original scenario using estimated c factors and riparian filering capacity for current conditions, b) the BMP scenario with decreased c factors reflecting potential improvement in upland BMPs, c) the BMP scenario with increased filtering capacity of the riparian zone, reflecting increased buffer widths or quality, and d) the BMP scenario incorporating both a decrease in c factor and riparian buffer improvements.

**Table G-6. Estimate tons of sediment reduced and percent reductions using original land cover, the riparian buffer BMP scenario, the upland BMP scenario, and the scenario with both riparian and upland BMPs.**

**Bean Creek**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| **Total** | **28.73** | **22.91** | **20** | **26.14** | **9** | **20.89** | **27** |
| Developed | 0.00 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| Forest | 18.33 | 14.81 | 19 | 18.33 | 0 | 14.81 | 19 |
| Grasslands | 1.34 | 1.33 | 1 | 1.01 | 25 | 1.00 | 26 |
| Scrub/Shrub | 9.03 | 6.76 | 25 | 6.78 | 25 | 5.07 | 44 |
| Wetlands | 0.019 | 0.013 | 27 | 0.02 | 0 | 0.01 | 27 |

**Big Sheep Creek main**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| **Total** | **1846.36** | **1463.49** | **21** | **1371.21** | **26** | **1087.81** | **41** |
| Barren | 0.00 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| Crops | 1.45 | 0.97 | 33 | 0.73 | 50 | 0.48 | 67 |
| Developed | 0.03 | 0.02 | 33 | 0.03 | 11 | 0.02 | 39 |
| Forest | 61.93 | 49.54 | 20 | 61.93 | 0 | 49.54 | 20 |
| Grasslands | 435.96 | 359.87 | 17 | 326.96 | 25 | 269.90 | 38 |
| Pasture/Hay | 2.19 | 1.29 | 41 | 1.64 | 25 | 0.96 | 56 |
| Scrub/Shrub | 966.42 | 766.43 | 21 | 725.30 | 25 | 575.06 | 40 |
| Transitional | 371.30 | 280.59 | 24 | 247.53 | 33 | 187.06 | 50 |
| Wetlands | 7.09 | 4.78 | 33 | 7.09 | 0 | 4.78 | 33 |

**Upper Big Sheep**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| Total | **2340.00** | **1896.00** | **38** | **1792.00** | **25** | **1452.00** | **38** |
| Barren | 0.00 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| Crops | 0.00 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| Developed | 0.00 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| Forest | 150.00 | 121.00 | 19 | 150.00 | 0 | 121.00 | 19 |
| Grasslands | 0.00 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| Pasture/Hay | 0.00 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| Scrub/Shrub | 2190.00 | 1775.00 | 19 | 1642.00 | 25 | 1331.00 | 39 |
| Transitional | 0.00 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| Wetlands | 0.00 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |

**Corral Creek**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| **Total** | **14.35** | **9.58** | **33** | **12.20** | **15** | **8.20** | **43** |
| Developed | 0.02 | 0.01 | 43 | 0.02 | 0 | 0.01 | 36 |
| Forest | 5.72 | 3.65 | 36 | 5.72 | 0 | 3.65 | 36 |
| Grasslands | 0.11 | 0.09 | 16 | 0.08 | 25 | 0.07 | 37 |
| Scrub/Shrub | 8.45 | 5.91 | 30 | 6.34 | 25 | 4.43 | 48 |
| Wetlands | 0.05 | 0.03 | 37 | 0.05 | 0 | 0.03 | 37 |

**East Fork Clover Creek**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| **Total** | **174.40** | **127.77** | **27** | **135.16** | **22** | **98.93** | **43** |
| Forest | 17.36 | 12.32 | 29 | 17.36 | 0 | 12.32 | 29 |
| Grasslands | 6.89 | 5.31 | 23 | 5.17 | 25 | 3.98 | 42 |
| Scrub/Shrub | 150.07 | 110.07 | 27 | 112.55 | 25 | 82.56 | 45 |
| Wetlands | 0.092 | 0.072 | 22 | 0.09 | 0 | 0.07 | 22 |

**Fish Creek**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| Total | **138.82** | **104.84** | **24** | **104.27** | **25** | **78.76** | **43** |
| Forest | 0.39 | 0.36 | 8 | 0.39 | 0 | 0.36 | 8 |
| Grasslands | 0.36 | 0.26 | 28 | 0.27 | 25 | 0.19 | 46 |
| Scrub/Shrub | 137.82 | 104.05 | 24 | 103.36 | 25 | 78.04 | 43 |
| Wetlands | 0.25 | 0.17 | 32 | 0.25 | 0 | 0.17 | 32 |

**Horse Prairie Creek main**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| **Total** | **4503.02** | **3586.22** | **20** | **3413.43** | **24** | **2731.17** | **39** |
| Barren | 0.16 | 0.09 | 44 | 0.16 | 3 | 0.09 | 41 |
| Crops | 6.19 | 4.14 | 33 | 3.09 | 50 | 2.07 | 67 |
| Developed | 5.24 | 3.15 | 40 | 5.24 | 0 | 3.33 | 36 |
| Forest | 411.03 | 347.77 | 15 | 411.03 | 0 | 347.77 | 15 |
| Grasslands | 882.96 | 734.18 | 17 | 662.21 | 25 | 550.63 | 38 |
| Pasture/Hay | 12.97 | 7.51 | 42 | 9.72 | 25 | 5.63 | 57 |
| Scrub/Shrub | 2354.10 | 1923.62 | 18 | 1765.56 | 25 | 1442.70 | 39 |
| Transitional | 821.86 | 560.42 | 32 | 547.90 | 33 | 373.61 | 55 |
| Wetlands | 8.52 | 5.33 | 37 | 8.52 | 0 | 5.33 | 37 |

**Jones Creek**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| **Total** | **45.10** | **33.91** | **25** | **40.18** | **11** | **30.07** | **33** |
| Developed | 0.01 | 0.01 | 0 | 0.01 | 0 | 0.01 | 0 |
| Forest | 25.39 | 18.53 | 27 | 25.39 | 0 | 18.53 | 27 |
| Grasslands | 0.17 | 0.11 | 33 | 0.13 | 25 | 0.09 | 50 |
| Scrub/Shrub | 19.50 | 15.24 | 22 | 14.63 | 25 | 11.43 | 41 |
| Wetlands | 0.021 | 0.015 | 30 | 0.021 | 0 | 0.015 | 30 |

**Long Creek**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| **Total** | **465.53** | **368** | **21** | **353.14** | **24** | **304.98** | **34** |
| Forest | 14.87 | 11.90 | 20 | 14.87 | 0 | 11.9 | 20 |
| Grasslands | 22.64 | 18.00 | 21 | 16.98 | 25 | 16.98 | 25 |
| Scrub/Shrub | 426.93 | 338.00 | 21 | 320.19 | 25 | 275 | 30 |
| Wetlands | 1.09 | 1.09 | 0 | 1.09 | 0 | 1.09 | 0 |

**Medicine Lodge Creek**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| **Total** | **2803.13** | **2195.22** | **22** | **2163.59** | **23** | **1693.81** | **40** |
| Barren | 0.23 | 0.23 | 0 | 0.23 | 1 | 0.23 | 0 |
| Crops | 6.45 | 4.28 | 34 | 3.22 | 50 | 2.14 | 67 |
| Developed | 0.53 | 0.34 | 35 | 0.60 | -13 | 0.40 | 26 |
| Forest | 296.59 | 230.15 | 22 | 296.59 | 0 | 230.15 | 22 |
| Grasslands | 301.64 | 244.78 | 19 | 226.22 | 25 | 183.59 | 39 |
| Pasture/Hay | 11.29 | 6.56 | 42 | 8.46 | 25 | 4.92 | 56 |
| Scrub/Shrub | 2046.58 | 1596.90 | 22 | 1534.93 | 25 | 1197.66 | 41 |
| Transitional | 139.46 | 111.73 | 20 | 92.98 | 33 | 74.49 | 47 |
| Wetlands | 0.35 | 0.24 | 32 | 0.35 | 0 | 0.24 | 32 |

**Muddy Creek**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| **Total** | **1398.77** | **1080.89** | **23** | **1070.52** | **23** | **827.00** | **41** |
| Barren | 0.66 | 0.49 | 26 | 0.66 | 0 | 0.49 | 26 |
| Forest | 90.628 | 70.071 | 23 | 90.628 | 0 | 70.071 | 23 |
| Grassland | 195.97 | 159.06 | 19 | 146.97 | 25 | 119.29 | 39 |
| Shrub | 1095.01 | 835.61 | 24 | 821.25 | 25 | 626.71 | 43 |
| Transitional | 16.50 | 15.65 | 5 | 11.00 | 33 | 10.43 | 37 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Wetlands | 0.01 | 0.01 | 31 | 0.01 | 0 | 0.01 | 31 |

**O Dell Creek**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| **Total** | **470.42** | **339.85** | **28** | **384.63** | **18** | **278.03** | **41** |
| Developed | 0.13 | 0.08 | 42 | 0.13 | **0** | 0.08 | 42 |
| Forest | 126.51 | 92.06 | 27 | 126.51 | **0** | 92.06 | 27 |
| Grasslands | 78.61 | 57.78 | 26 | 58.95 | **25** | 43.34 | 45 |
| Scrub/Shrub | 264.56 | 189.53 | 28 | 198.42 | **25** | 142.14 | 46 |
| Wetlands | 0.62 | 0.41 | 34 | 0.62 | **0** | 0.41 | 34 |

**Peet Creek**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| **Total** | **192.75** | **144.79** | **25** | **152.73** | **21** | **115.39** | **40** |
| Developed | 0.04 | 0.03 | 33 | 0.04 | **0** | 0.03 | 26 |
| Forest | 31.84 | 26.65 | 16 | 31.84 | **0** | 26.65 | 16 |
| Grasslands | 0.96 | 0.86 | 11 | 0.72 | **25** | 0.64 | 33 |
| Scrub/Shrub | 159.10 | 116.75 | 27 | 119.32 | **25** | 87.56 | 45 |
| Wetlands | 0.80 | 0.51 | 37 | 0.80 | **0** | 0.51 | 37 |

**Price Creek**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| **Total** | **134.68** | **101.11** | **25** | **105.94** | **21** | **79.67** | **41** |
| Developed | 0.64 | 0.43 | 34 | 0.64 | 0 | 0.43 | 34 |
| Forest | 18.85 | 14.77 | 22 | 18.85 | 0 | 14.77 | 22 |
| Grasslands | 3.91 | 2.99 | 24 | 2.93 | 25 | 2.24 | 43 |
| Scrub/Shrub | 111.04 | 82.77 | 25 | 83.28 | 25 | 62.08 | 44 |
| Wetlands | 0.24 | 0.15 | 36 | 0.24 | 0 | 0.15 | 36 |

**Red Rock Creek main**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| **Total** | **530.65** | **530.65** | **0** | **414.03** | **22** | **310.64** | **41** |
| Developed | 0.13 | 0.10 | 0 | 0.13101552 | 0 | 0.10 | 27 |
| Forest | 55.08 | 40.14 | 0 | 55.08107928 | 0 | 40.14 | 27 |
| Grasslands | 129.47 | 129.47 | 0 | 97.10390664 | 25 | 81.52 | 37 |
| Scrub/Shrub | 336.98 | 243.81 | 0 | 252.7349582 | 25 | 182.85 | 46 |
| Wetlands | 8.98 | 6.03 | 0 | 8.98127928 | 0 | 6.03 | 33 |

**Sage Creek**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| **Total** | **3454.11** | **2614.55** | **24** | **2600.77** | **25** | **1968.18** | **43** |
| Crops | 0.13 | 0.09 | 34 | 0.07 | 50 | 0.04 | 67 |
| Developed | 0.45 | 0.29 | 35 | 0.45 | 1 | 0.29 | 36 |
| Forest | 36.72 | 26.63 | 27 | 36.72 | 0 | 26.63 | 27 |
| Grasslands | 588.96 | 475.18 | 19 | 441.72 | 25 | 356.38 | 39 |
| Pasture | 4.51 | 2.61 | 42 | 3.38 | 25 | 1.95 | 57 |
| Scrub/Shrub | 2819.51 | 2107.42 | 25 | 2114.62 | 25 | 1580.55 | 44 |
| Wetlands | 3.82 | 2.34 | 39 | 3.82 | 0 | 2.34 | 39 |

**Selway Creek**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| **Total** | **167.51** | **121.42** | **28** | **140.51** | **16** | **101.83** | **39** |
| Forest | 59.40 | 43.05 | 28 | 59.40 | 0 | 43.05 | 28 |
| Grasslands | 21.21 | 14.60 | 31 | 15.90 | 25 | 10.95 | 48 |
| Scrub/Shrub | 86.32 | 63.27 | 27 | 64.74 | 25 | 47.45 | 45 |
| Transitional | 0.37 | 0.36 | 2 | 0.25 | 33 | 0.24 | 35 |
| Wetlands | 0.22 | 0.13 | 41 | 0.22 | 0 | 0.13 | 41 |

**Tom Creek**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| **Total** | **107.06** | **79.84** | **25** | **90.91** | **15** | **67.89** | **37** |
| Developed | 0.01 | 0.01 | 38 | 0.01 | 0 | 0.01 | 38 |
| Forest | 42.15 | 31.81 | 25 | 42.15 | 0 | 31.81 | 25 |
| Grasslands | 1.78 | 1.63 | 8 | 1.33 | 25 | 1.23 | 31 |
| Scrub/Shrub | 62.83 | 46.16 | 27 | 47.12 | 25 | 34.62 | 45 |
| Wetlands | 0.29 | 0.23 | 22 | 0.29 | 0 | 0.23 | 22 |

**Trail Creek**

| | Original | Riparian | % Reduction | Upland | % Reduction | Both | % Reduction |
|---|---|---|---|---|---|---|---|
| Total | **1603.61** | **1263.01** | **21** | **1104.69** | **31** | **869.16** | **46** |
| Crops | 0.69 | 0.46 | 33 | 0.34 | 50 | 0.23 | 67 |
| Developed | 0.10 | 0.06 | 36 | 0.10 | 0 | 0.06 | 40 |
| Forest | 33.88 | 23.84 | 30 | 33.88 | 0 | 23.84 | 30 |
| Grasslands | 66.82 | 51.30 | 23 | 50.11 | 25 | 38.47 | 42 |
| Pasture | 0.24 | 0.15 | 40 | 0.18 | 25 | 0.11 | 55 |
| Scrub/Shrub | 225.32 | 179.54 | 20 | 168.99 | 25 | 134.65 | 40 |
| Transitional | 1276.46 | 1007.60 | 21 | 850.97 | 33 | 671.73 | 47 |
| Wetlands | 0.11 | 0.07 | 38 | 0.11 | 0 | 0.07 | 38 |

# G6.0 SUMMARY OF REDUCTIONS WITH BMPS

Table G-7. Potential reduction in sediment contributions with upland BMPs, riparian buffer BMPs, or both, arranged from highest to lowest percent reduction.: * =includes tributaries

| **Subwatershed** | **Existing Load Delivered to Stream (Tons/Yr)** | **Upland BMP Only (Tons/Yr)** | **% Change from Existing Load** | **Buffer BMP Only (Tons/Yr)** | **% Change from Existing Load** | **Upland and Buffer BMPs (Tons/Yr)** | **% Change from Existing Load** |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Trail Creek | 1604 | 1105 | 31 | 1263 | 21 | 869 | 46 |
| East Fork Clover Creek | 174 | 135 | 23 | 128 | 27 | 99 | 43 |
| Fish Creek | 139 | 104 | 25 | 105 | 24 | 79 | 43 |
| Sage Creek | 3454 | 2601 | 25 | 2614 | 24 | 1968 | 43 |
| Corral Creek | 14 | 12 | 16 | 9 | 37 | 8 | 43 |
| Red Rock Creek* | 545 | 319 | 41 | 408 | 25 | 319 | 41 |
| Muddy Creek | 1399 | 1071 | 23 | 1081 | 23 | 827 | 41 |
| O Dell Creek | 470 | 385 | 18 | 340 | 28 | 278 | 41 |
| Price Creek | 135 | 106 | 21 | 101 | 25 | 80 | 41 |
| Horse Prairie Creek* | 9077 | 7165 | 21 | 6822 | 25 | 5395 | 41 |
| Peet Creek | 193 | 153 | 21 | 145 | 25 | 115 | 40 |
| Big Sheep Creek* | 5585 | 4234 | 24 | 4640 | 17 | 3366 | 40 |
| Medicine Lodge Creek | 2803 | 2163 | 23 | 2195 | 22 | 1693 | 40 |
| Selway Creek | 168 | 141 | 16 | 121 | 28 | 102 | 39 |
| Tom Creek | 107 | 91 | 15 | 80 | 25 | 68 | 37 |
| Long Creek | 466 | 368 | 21 | 353 | 24 | 305 | 35 |
| Jones Creek | 45 | 40 | 11 | 34 | 25 | 30 | 33 |
| Bean Creek | 29 | 26 | 9 | 23 | 20 | 21 | 27 |

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# Attachment GA – Assignment of USLE C-factors to NLCD Landcover Values

THE c-factors previously developed for estimating upland erosion for the nearby Beaverhead TPA, with similar landscale and land-use characteristics, were used in modeling efforts. The NRCS table "C-Factors for Permanent Pasture, Rangeland, Idle Land, and Grazed Woodland" (**Figure FA-1**) was used to develop C-factors for the various land use types as defined by the NLCD dataset. This table uses four sub-factors: the vegetative canopy type and height, the vegetative canopy percent cover, the type of cover that contacts the soil surface, and the percent ground cover to derive a C-factor. The resulting C-factor is very sensitive to the type and percent of ground cover and less sensitive to the type and percent of canopy cover.

The type and percent of canopy cover were determined based on the NLCD land use definition. In some cases the minimum percent canopy cover specified in the land use definition was used and resulted in a conservative C-factor. The type of ground cover was considered to be G (cover is grass, grasslike plants, decaying compacted duff, or litter at least 2 inches deep) for all of the land uses in the Red Rock TPA. The percent ground cover was considered to not only include the basal plant material, but also gravel and plant litter.

**Table FA-1** provides the C-factors for all land use types within the sub-basins of interest in the Red Rock TPA for the existing conditions. The C-factors for the 'barren land', 'developed, low intensity', 'developed, medium intensity', and 'developed, high intensity' land uses are the same C-factors previously recommended by Richard Fasching, the former Montana State Agronomist, for other hillslope USLE modeling efforts.

**Table FA-2** provides the C-factors for all land use types within the sub-basins of interest in the Red Rock TPA for the desired well managed scenario. The percent ground cover was increased by 10% over the existing percentage for the 'grassland/herbaceous', 'shrub/scrub', 'pasture/hay', and 'woody wetlands' land uses to reflect a decrease in grazing. For the 'cultivated crops' land use, the percent ground cover was increased by 20% over the existing percentage to reflect improved agricultural practices. For the 'transitional' land use, the desired scenario assumed a return to a forest land use. The C-factors for the other land use types were not changed. This is similar to the methods used by the DEQ for the Beaverhead Sediment TMDL and by Confluence for other hillslope USLE modeling efforts.

Exhibit MT510.03

"C" Factors for Permanent Pasture, Rangeland, Idle Land, and Grazed Woodland 1/

| Vegetal Canopy | | | Cover that Contacts the Surface (Vegetation, living and dead) | | | | | |
|---|---|---|---|---|---|---|---|---|
| Type and Height of Raised Canopy 2/ | Canopy Cover 3/ % | Type 4/ | Percent Ground Cover | | | | | |
| | | | 0 | 20 | 40 | 60 | 80 | 95-100 |
| No appreciable canopy | | G | .45 | .20 | .10 | .042 | .013 | .003 |
| | | W | .45 | .24 | .15 | .090 | .043 | .011 |
| Canopy of tall grass, weeds or brushes with average drop fall height of less than 3 feet 5/ | 25 | G | .36 | .17 | .09 | .038 | .012 | .003 |
| | | W | .36 | .20 | .13 | .082 | .041 | .011 |
| | 50 | G | .26 | .13 | .07 | .035 | .012 | .003 |
| | | W | .26 | .16 | .11 | .075 | .039 | .011 |
| | 75 | G | .17 | .10 | .06 | .031 | .011 | .003 |
| | | W | .17 | .12 | .09 | .067 | .038 | .011 |
| Appreciable brush or bushes (2 m fall ht.) | 25 | G | .40 | .18 | .09 | .040 | .013 | .003 |
| | | W | .40 | .22 | .14 | .085 | .042 | .011 |
| | 50 | G | .34 | .16 | .085 | .038 | .012 | .003 |
| | | W | .34 | .19 | .13 | .081 | .041 | .011 |
| | 75 | G | .28 | .14 | .08 | .036 | .012 | .003 |
| | | W | .28 | .17 | .12 | .077 | .040 | .011 |
| Trees but no appreciable low brush (4 m fall ht.) | 25 | G | .42 | .19 | .10 | .041 | .013 | .003 |
| | | W | .42 | .23 | .14 | .087 | .042 | .011 |
| | 50 | G | .39 | .18 | .09 | .040 | .013 | .003 |
| | | W | .39 | .21 | .14 | .085 | .042 | .011 |
| | 75 | G | .36 | .17 | .09 | .039 | .012 | .003 |
| | | W | .36 | .20 | .13 | .083 | .041 | .011 |

1/ All values shown assume: 1) random distribution of mulch or vegetation, and 2) mulch of appreciable depth where it exists. Idle land refers to land with undisturbed profiles for at least a period of three consecutive years. Also to be used for burned forest land and forest land that has been harvested less than three years ago.

For grazed woodland with high buildup of organic matter in the topsoil under permanent forest conditions, multiply the table values by 0.7.

2/ Average fall height of waterdrops from canopy to soil surface: m = meters.

3/ Portion of total-area surface that would be hidden from view by canopy in a vertical projection, (a bird's-eye view).

4/ G: Cover at surface is grass, grasslike plants, decaying compacted duff. W: Cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface), and/or undecayed residue.

5/ The portion of a grass or weed cover that contacts the soil surface during a rainstorm and interferes with water flow over the soil surface is included in "cover at the surface." The remainder is included in canopy cover.

**Figure FA-1. NRCS C-factor table**

**Table GA-1. C-factors for land cover types in the Red Rock TPA for existing conditions.**

| NLCD # | Name | Type and Height of Raised Canopy | Percent Canopy Cover | Type | Percent Ground Cover | C-factor |
|---|---|---|---|---|---|---|
| 21 | Developed, open space | no appreciable canopy | - | G | 95-100 | 0.003 |
| 22 | Developed, low intensity | - | - | - | - | 0.001 |
| 23 | Developed, medium intensity | - | - | - | - | 0.001 |
| 24 | Developed, high intensity | - | - | - | - | 0.001 |
| 31 | Barren land | - | - | - | - | 0.001 |
| 41 | Deciduous forest | trees | 75 | G | 95-100 | 0.003 |
| 42 | Evergreen forest | trees | 75 | G | 95-100 | 0.003 |
| 43 | Mixed forest | trees | 75 | G | 95-100 | 0.003 |
| 52 | Shrub/scrub | appreciable brush | 25 | G | 75 | 0.020 |
| 71 | Grassland/herbaceous | no appreciable canopy | - | G | 75 | 0.020 |
| 81 | Pasture/Hay | no appreciable canopy | - | G | 75 | 0.020 |
| 82 | Cultivated Crops | no appreciable canopy | - | G | 20 | 0.200 |
| 90 | Woody Wetlands | trees | 25 | G | 80 | 0.013 |
| 95 | Emergent Herbaceous Wetlands | tall grass | 75 | G | 95-100 | 0.003 |
| 99 | Transitional | trees | 25 | G | 90 | 0.030 |

Notes: Canopy cover percents were selected based on the land cover class definition.
Low, medium, and high intensity development land uses are assumed to be the same as barren land.
Deciduous and mixed forest land uses are assumed to be the same as evergreen forest.

**Table GA-2. C-factors for land cover types in the Red Rock TPA for BMP conditions.**

| NLCD # | Name | Type and Height of Raised Canopy | Percent Canopy Cover | Type | Percent Ground Cover | C-factor |
|---|---|---|---|---|---|---|
| 21 | Developed, open space | no appreciable canopy | - | G | 95-100 | 0.003 |
| 22 | Developed, low intensity | - | - | - | - | 0.001 |
| 23 | Developed, medium intensity | - | - | - | - | 0.001 |
| 24 | Developed, high intensity | - | - | - | - | 0.001 |
| 31 | Barren land | - | - | - | - | 0.001 |
| 41 | Deciduous forest | trees | 75 | G | 95-100 | 0.003 |
| 42 | Evergreen forest | trees | 75 | G | 95-100 | 0.003 |
| 43 | Mixed forest | trees | 75 | G | 95-100 | 0.003 |
| 52 | Shrub/scrub | appreciable brush | 25 | G | 85 | 0.015 |
| 71 | Grassland/herbaceous | no appreciable canopy | - | G | 85 | 0.015 |
| 81 | Pasture/Hay | no appreciable canopy | - | G | 85 | 0.015 |

**Table GA-2. C-factors for land cover types in the Red Rock TPA for BMP conditions.**

| NLCD # | Name | Type and Height of Raised Canopy | Percent Canopy Cover | Type | Percent Ground Cover | C-factor |
|---|---|---|---|---|---|---|
| 82 | Cultivated Crops | no appreciable canopy | - | G | 40 | 0.100 |
| 90 | Woody Wetlands | trees | 25 | G | 90 | 0.013 |
| 95 | Emergent Herbaceous Wetlands | tall grass | 75 | G | 95-100 | 0.003 |
| 99 | Transitional | trees | 75 | G | 95-100 | 0.020 |

Notes: Canopy cover percents were selected based on the land cover class definition.
Low, medium, and high intensity development land uses are assumed to be the same as barren land.
Deciduous and mixed forest land uses are assumed to be the same as evergreen forest.