Appendix 2: Methods for predicting post-fire erosion

We modeled erosion using the Water Erosion Prediction Project (WEPP) following the approach of Miller and others (2011) and Elliot and others (2016). WEPP is a process-based model that predicts runoff and sediment yields from hillslopes and small, unchannelized watersheds. WEPP models sheet and rill erosion and hydrological processes such as snow accumulation and melt, deep percolation of soil water, and subsurface lateral flow under different land uses, climate, and hydrologic conditions. The WEPP model was developed by the U.S. Department of Agriculture Forest Service, Agricultural Research Service, and numerous universities.

We used the WEPP batch processing spreadsheet available from the U.S. Forest Service to predict erosion from hillslopes within the Evergreen Protection District. We ran the WEPP model under 30 years of different weather conditions based on observed conditions at the weather station in Evergreen, CO from 1961-2012 (NWS cooperative station 052790). WEPP requires the following inputs: hillslope area, soil texture, slope profiles for upper and lower slopes, vegetation type and/or burn severity, vegetation cover, and percentage of soil as rock.

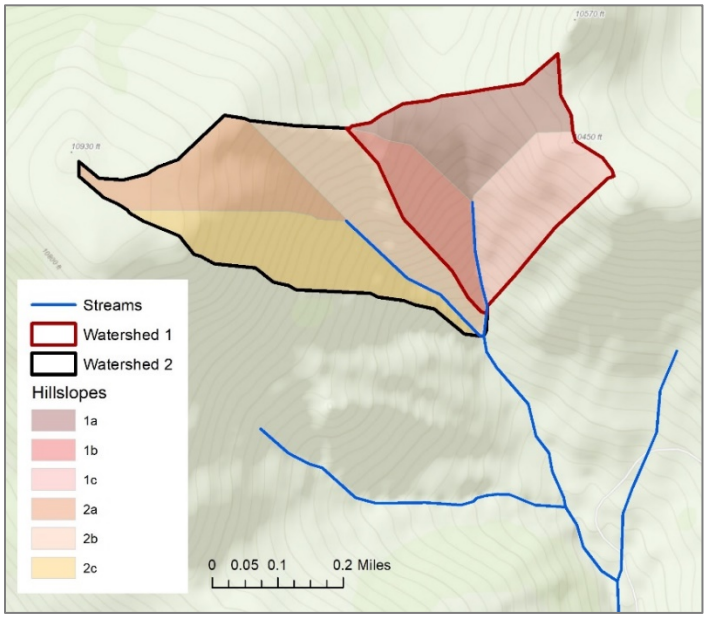

Figure A.1. Depiction of small watersheds and hillslopes.

We delineated hillslopes through ArcGIS using a modified version of the WEPP Hillslope Toolbox, which is based on TOPAZ (Topographic Parameterization Software) from the USDA Agricultural Research Service. Small watersheds can be subdivided into at least three hillslopes—one on each side of a stream or river and one above the headwaters of the watershed (Figure A.1). We modified the original toolbox to be compatible with ArcGIS 10.7.1 and to improve model performance. We used 30 m resolution digital elevation models from the U.S. Geological Service.

Hillslopes were delineated with a critical source area (CSA) of 15 acres and a minimum source channel length (MSCL) of 330 feet. Watersheds for visualization and data summary were delineated with a CSA of 495 acres and a MSCL of 330 feet. We delineated 5,532 hillslopes within the FPD with an average size of 17 acres (range of 3 to 154 acres), and we aggregated results within 155 larger watersheds with an average size of 600 acres (range of 3 to 3,270 acres). Watersheds contained an average of 36 hillslopes (range of 1 to 185 hillslopes). We used weighted averages based on the hillslope size in acres.

Hillslopes were assigned the most prevalent soil texture, burn severity, and vegetation types present on flow paths within the upper and lower portion of the hillslopes. Soil textures came from STATSGO2 (i.e., U.S. General Soil Map) from the USDA Natural Resource Conservation Service. We associated STATSGO2 soil textures with WEPP soil texture categories and assigned each soil type a percent rock value based on the NRCS Field Book for Describing and Sampling Soils (Schoeneberger and others 2012) (Table A.1).

Table A.1. Relationship between soil textures from STATSGO2 and WEPP soil textures and percent rock content.

STATSGO2 soil texture	WEPP soil texture	Percent rock[1]
Clay	Clay loam	7%
Clay loam	Clay loam	7%
Fine sandy loam	Sandy loam	7%
Gravelly coarse sandy loam	Sandy loam	25%
Gravelly loam	Loam	25%
Gravelly sandy loam	Sandy loam	25%
Loam	Loam	7%
Sandy loam	Sandy loam	7%
Very gravelly sandy loam	Sandy loam	48%

[1]Percent rock values are the midpoint of the percent rock associated with soil texture modifiers "gravelly" and "very gravelly" according to Schoeneberger and others 2012.

We associated predicted flame length from FlamMap under 90th percentile weather conditions with burn severity classes and percent cover values following Elliot and others (2016) (Table A.2).

Table A.2. Relationship between predicted flame length, burn severity, and percent cover following Elliot and others (2016).

FlamMap flame length (ft)	WEPP burn severity category	Percent cover (%)
0	Unburned	90
>0 to 4	Low	60
>4 to 8.2	Moderate	45
>8.2	High	15

Vegetation data came from associating 2014 LANDFIRE existing vegetation type (EVT) physiognomic subclasses with WEPP vegetation categories. Percent ground cover estimates for WEPP vegetation

categories were based on Elliot and others (2016) and default values from the online WEPPcloud Post-Fire Erosion Prediction tool (Table A.3).

Table A.3. Relationship between LANDFIRE existing vegetation type (EVT) physiognomic subclasses and associated WEPP vegetation categories and percent cover values.

LANDFIRE EVT physiognomic subclasses	WEPP vegetation type	Percent cover (%)
Deciduous open tree canopy Evergreen open tree canopy Evergreen closed tree canopy Evergreen sparse tree canopy Mixed evergreen-deciduous open tree canopy	20-year old forest	90
Evergreen open tree canopy (recently disturbed)	5-year old forest	90
Annual graminoid/forb Herbaceous – grassland Perennial graminoid grassland Perennial graminoid steppe	Short grass	70
Deciduous shrubland Evergreen dwarf-shrubland Evergreen shrubland Mixed evergreen-deciduous shrubland	Shrub	70
Snow-ice	Ice / snow	5
Developed	Developed	50
Open water	Open water	50
Sparsely vegetated	Barren	50

We presented four categories for potential post-fire sediment delivery: low (0-4.5 tons / acre / year), moderate (>4.5-8.5 tons/ acre / year), high (>8.5-11.0 tons / acre / year), and extreme (>11.0 tons / acre / year). Table A.4 describes the rationale behind the cutoffs for these categories.

Table A.4. Categories for potential post-fire sediment delivery used for Evergreen FPD.

Descriptor	Values (tons / acre / year)	Explanation
Low	0-4.5	The 1st quartile of sediment delivery rates for watersheds burned at low-moderate severity was 4.5 t/ac/yr under average weather conditions in Evergreen.
Moderate	>4.5-8.5	Sediment delivery rates for unburned conditions were <8.6 t/ac/yr for all watersheds under 30-year extreme weather conditions in Evergreen.
High	>8.5-11.0	All watersheds predicted for low to moderate-severity fires had post-fire sediment delivery rates <10.9 t/ac/yr in Evergreen.
Very high	>11.0-19.2	The maximum observed sediment delivery rate for Evergreen was 19.2 t/ac/yr.

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