

WILDFIRE MANAGEMENT THROUGH GIS:

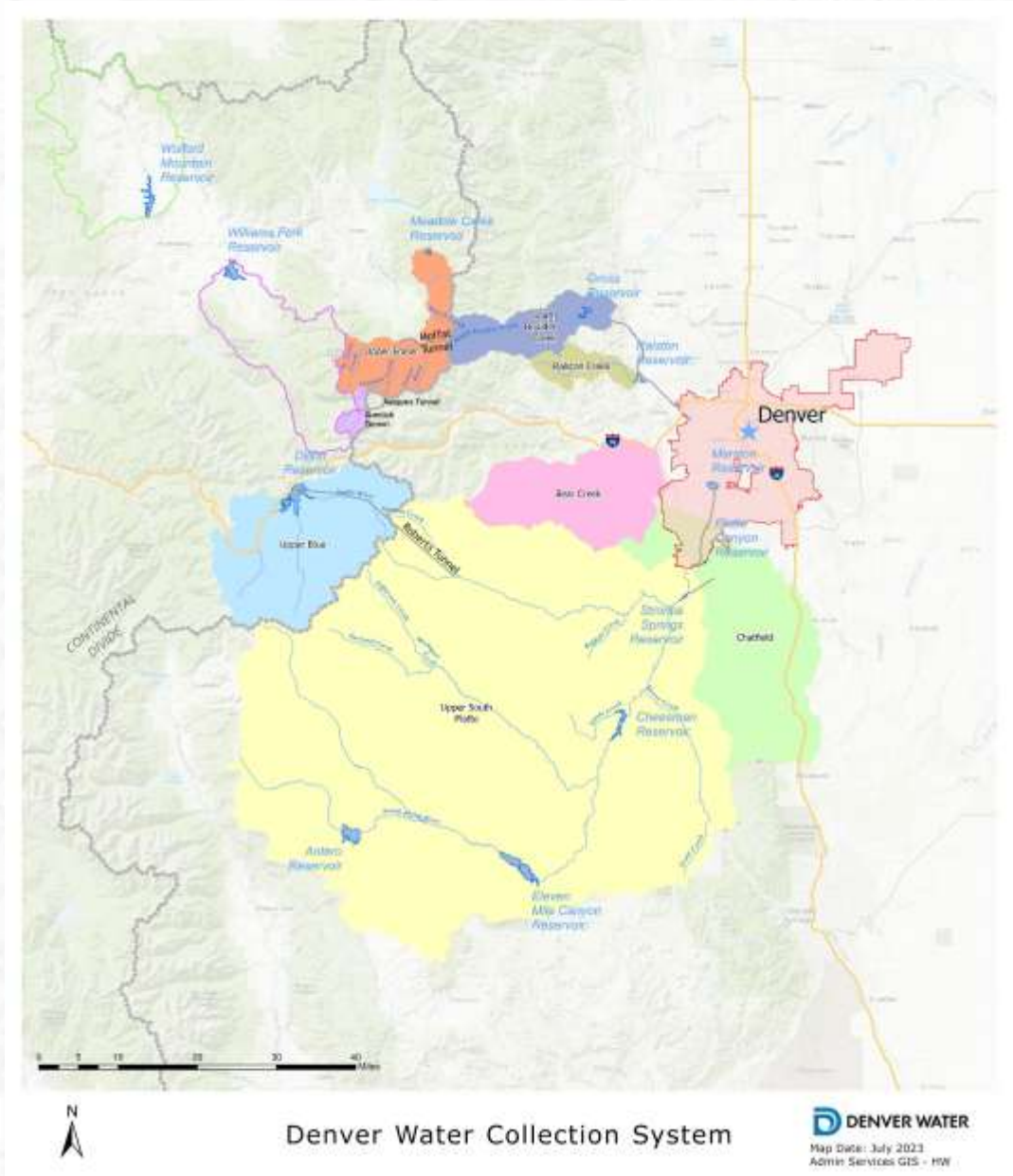
Inter-agency Collaboration in Pre-Wildfire Watershed Planning for Colorado

Hannah Walters, GIS Analyst, Denver Water

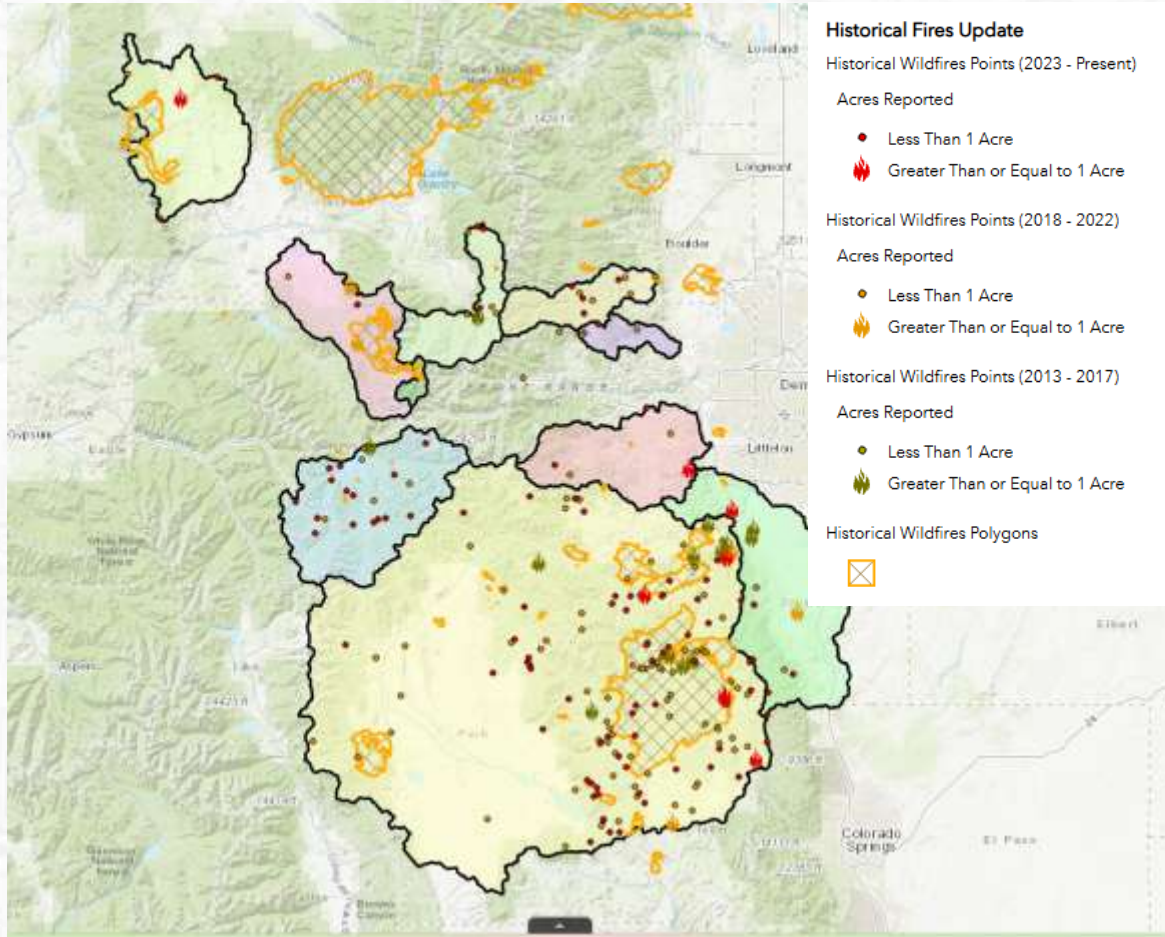


DENVER WATER

- One of the largest municipal water utilities in the United States
- Serve 1.5 million people
- All water comes from snowmelt
- Manage 7,800 sqkm of land in the Rocky Mountains

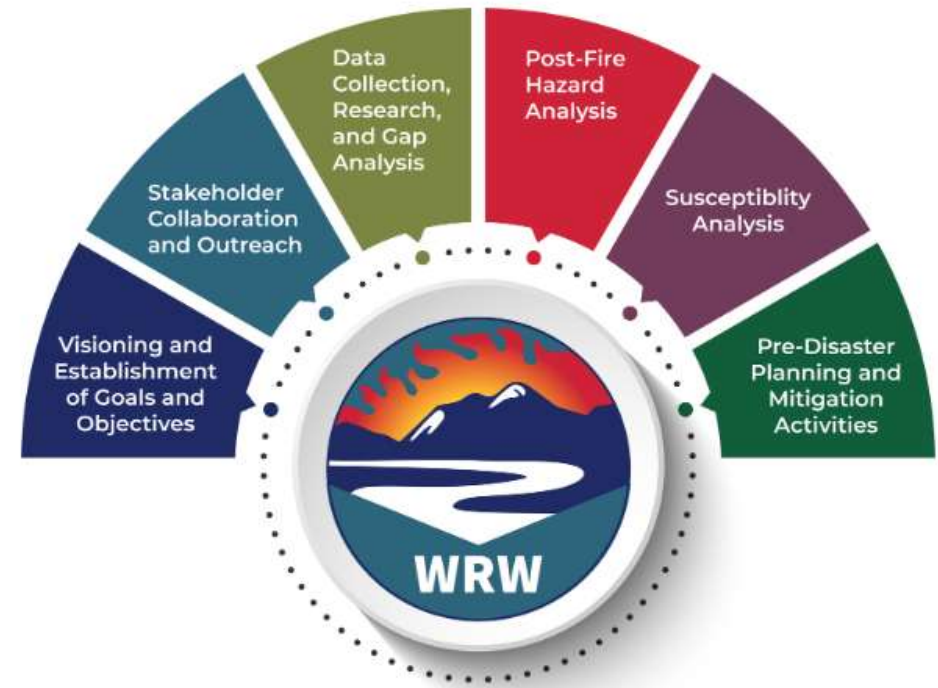


WILDFIRES IN COLORADO



WILDFIRE READY ACTION PLAN (WRAP)

- Collaborative effort between scientists, engineers, and local communities
- WRAPs are meant to provide guidance for pre- and post-fire management strategies
- Assess impact on specific Values-at-Risk (VARs), such as infrastructure, habitats, or water resources.
- Define Areas of Priority Areas for planning and grant applications



SUSCEPTIBILITY ANALYSIS & GIS

Technical
Team
Communications

Define
Watersheds

- Based on project criteria (size, relevance, data availability).
- Obtained from the NHD (HUCs) or custom

Determine
Hazards

- Selection of hazards depends on the specific analysis and regional context.
- Erosion, sediment deposition, etc.

Increased
Stakeholder
Engagement

Identify
VARs

- Community-based (structures, roads, critical infrastructure, energy, etc.)
- Water resource-based (reservoirs, streams/channels, lakes, wetlands, etc.)

Analysis and
Feedback

Impact
Analysis

- Overlay hazard layers with VAR locations to assess exposure and risk.

*Detailed technical guidance, processes and default data sources are outlined by Colorado Water Conservation Board

HAZARD ANALYSIS

■ Hydrologic Modeling

- Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS)

■ Hydraulic Modeling

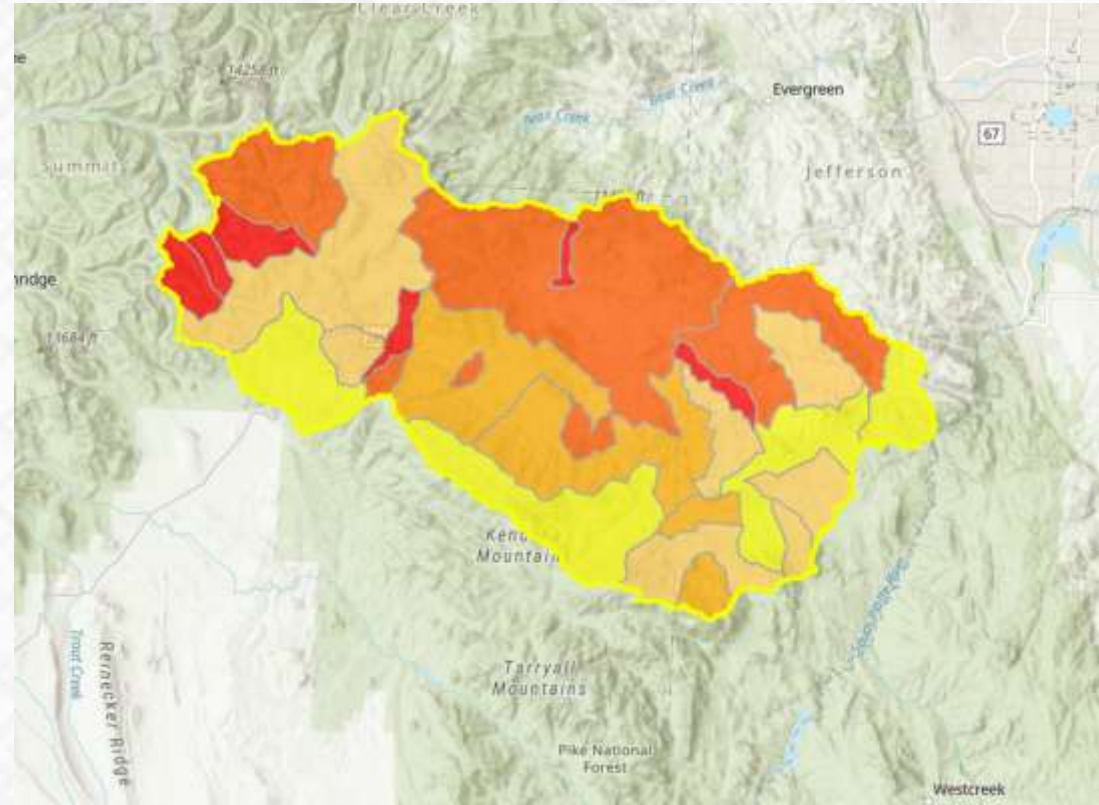
- Hydrologic Engineering Center's River Analysis System (HEC-RAS)

■ Fluvial Hazard Zones

- Colorado Fluvial Hazard Zone Delineation Protocol

■ Debris Flow and Soil Erosion

- USGS Debris Flow Model
- Revised Universal Soil Loss Equation



The results of the models were combined into one overall hazard score on a scale 1-10.

IDENTIFYING VALUES-AT-RISK



Transportation



Life +
Property



Reservoirs
+ Dams



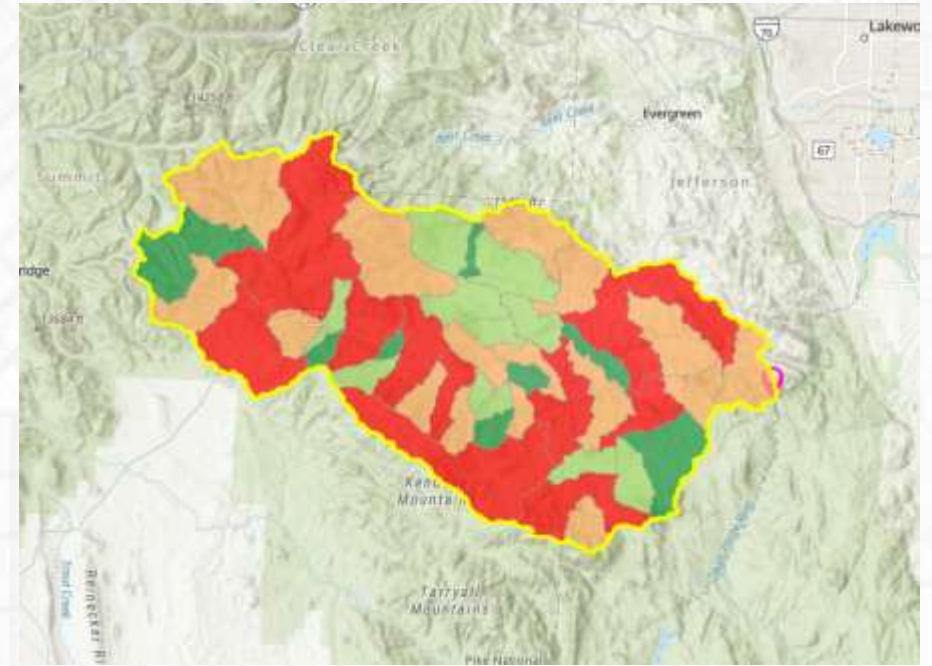
Aquatic
Ecosystems



Municipal
Water



Agricultural
Water



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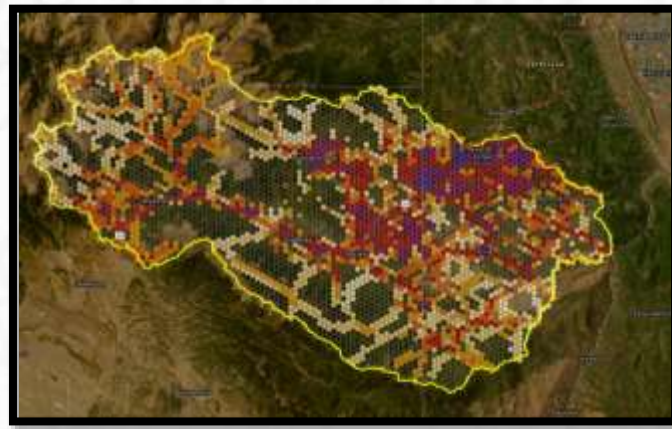
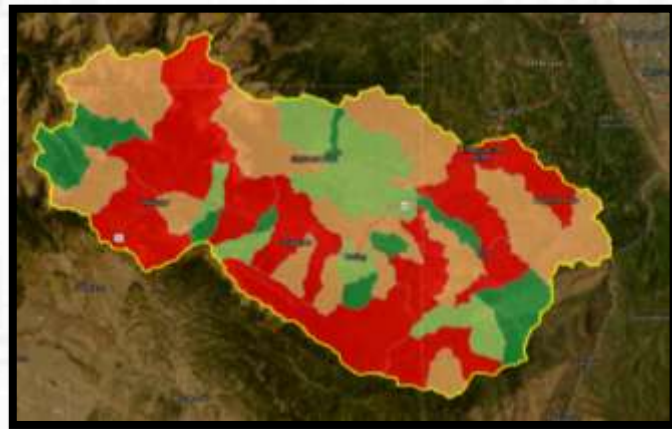
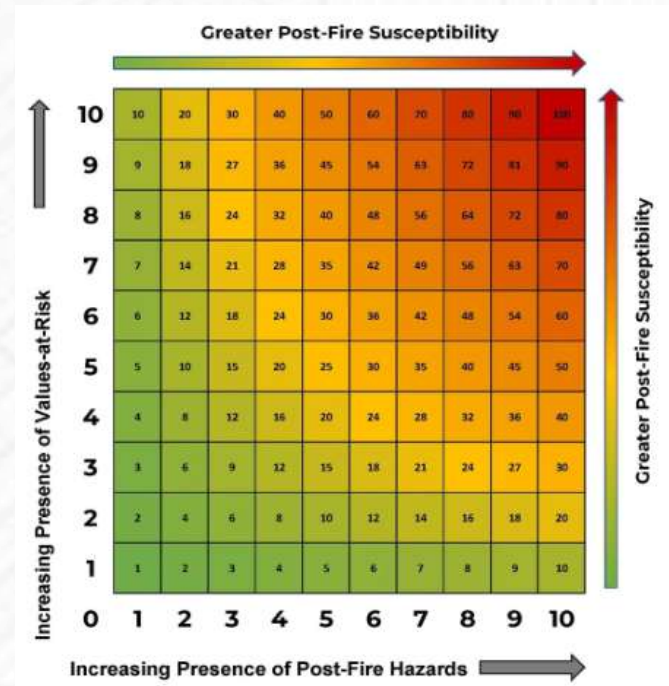
IMPACT ANALYSIS

Susceptibility Impact Score (Risk) = Probability of Hazard x Consequence (VARs)

- Not all Hazards affect VARs

Multi-Scale Analysis

- Aggregated Watershed Score
 - Geometric Interval (relative) Scoring
- Hexagon Scale



MITIGATION RECOMMENDATIONS

Area of Concern	Priority Area ID	Project Subregion Name	Parent HUC12	Relevant Hazards	Proposed Mitigation Actions
Grant	GR-1	CR 60	Headwaters of North Fork River	<ul style="list-style-type: none"> Debris flow Fluvial hazards (confined canyon) 	
	GR-2	CR 62	Geneva Creek	<ul style="list-style-type: none"> Debris flow Fluvial hazards (confined canyon) 	
	GR-3	Grant	Geneva Creek	<ul style="list-style-type: none"> Fluvial hazards Debris flows (proximal but upstream) Hydrology and hydraulics 	
U.S. 285 Corridor	RC-1	Santa Maria to Shawnee	Rock Creek	<ul style="list-style-type: none"> Fluvial hazards (confinement transitions, alluvial fans) Debris flows (many alluvial fans) Hydrology and hydraulics 	
	RC-2	Bailey	Rock Creek	<ul style="list-style-type: none"> Debris flows (Crow Creek) Hillslope erosion Hydrology and hydraulics 	
Craig Creek	CC-1	Non-Wilderness (Lower)	Craig Creek	<ul style="list-style-type: none"> Hillslope erosion Debris flow 	

Mitigation Approach:

Hillslope Erosion & Sediment Capture

Description, Setting, Applicability, and Limitations

Approach Description:
Hillslope erosion and sediment control techniques aim to reduce the supply of sediment leaving a watershed post-fire. Hydrophobic soil without living vegetation is highly susceptible to erosion through rain impact, sheet flow, and rill formation. The resulting increase in sediment supply negatively impacts aquatic organisms, habitat, and drinking water quality while obstructing normal riverine erosion and deposition patterns. Hillslope erosion mitigation techniques increase the bare soil's resistance to erosion using mulch, fabric, or vegetation. These measures are effective and speed soil recovery, but require very broad application across the burned area.

Sediment Capture features work to slow flows and encourage deposition in an easily accessible area that can be continuously maintained, like sediment forebays, sediment basins, and culvert clean-outs. These features are often deployed to support other infrastructure, like culverts or roadways, consolidating sediment and simplifying regular maintenance.

Secondary Benefits: Mitigating hillslope erosion allows vegetation to reestablish sooner after a fire, which then provides self-sustaining erosion mitigation.

Timing: Most hillslope erosion and sediment mitigation measures are only useful post-fire, but some preparation can be done pre-fire.

Appropriate Settings: To see measurable water quality improvements, erosion and sediment mitigation must be performed on vulnerable hillslopes across most of the burned watershed. Favorable settings include moderate slope (10-50 degrees), low vegetation (<15% low rock coverage, and high sun exposure. Point-based sediment capture technologies, like bins and ponds, should be placed in priority.

NPSR WRAAF Mitigation Approach Summary Sheet

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Fire-Related Hazards Addressed:

Hazards	Diversity Mitigates	Supports Mitigation
Burn Severity		
Hydrologic Response (Flooding)		X
Fluvial Hazards		X
Debris Flow		X
Water Quality	X	
Hillslope Erosion	X	

Next Steps: The Stanislaus Watershed Management Plan, developed with SWCA and Denver Water, was used to identify sediment issues in a pre-fire setting. The projects developed from this study should continue to be pursued (Priority, See also) additional areas for potential sediment basins in a post-fire setting have been identified based on geomorphic considerations and administrative considerations. Coordinate with CDOT or local transportation departments to establish a plan for detouring post-fire mitigation installation near key roads. Contact USFS, parks, and local landowners to select preferred mitigation techniques.

A sediment basin filled with post-fire sediment. Large boulders are present and require significant permitting, design, and maintenance. These boulders are not included in this scale ranking below.

Stakeholders

Funding Sources

- Federal Grants (MRCI), BACE (USFS)
- State Grants: Colorado Water Conservation Board (CWCB)

Partner Organizations

- Non-Profit: United Way
- United States Forest Service (USFS)
- Local Municipalities: Park & Jefferson County, Towns & Cities

Potential Permitting & Approvals

- USFS (Approach and Wilderness), Land Owner Approvals

Scale of Implementation

Summary of Overall Effort

Design & Permitting Effort

Construction Time & Impact

Maintenance Required (Scale & Frequency)

Rough Cost Magnitude

Comparison of hillslope erosion mitigation and sediment capture measures. Left: Shows wood chips are placed across a burned watershed covering erodible hillslopes. Middle: Shows, this method can quickly clear sediment areas quickly. Unfortunately, sediment results have not been able to verify consistently significant reductions in flow or sediment supply from burned watersheds. (Source: Sedimentation control with wood chip filling are applied to burned hillslopes. They catch sediment and prevent soil erosion, but require significant labor and \$1 weekly. (Right) Wood chips are used to capture sediment in a streamflow reach, concentrating deposition for eventual removal.

NEXT STEPS

North Fork Upper South Platte
Wildfire Ready Action Plan

[Summary](#)
[Map Viewer](#)
[Model Outputs](#)

[Project Partners](#)

WRAP Elements

Priority Projects

Projects

Download the Full Report

What is a Wildfire Ready Action Plan (WRAP)?

The Colorado Water Conservation Board's Wildfire Ready Action Plan (WRAP) framework identifies the susceptibility of Colorado's watersheds to post-wildfire impacts refined at a localized scale. WRAPs are developed to plan and prepare for these impacts before fires occur through the 6 major elements of a WRAP.

The WRAP framework is designed to serve as a guide for best planning practices in advance of a wildfire and will also support post-fire mitigation strategies. Projects constructed pre-fire provide the same or better protections compared to post-fire point-of-impact projects while also addressing multiple objectives in watershed health and water supply protection.

This WRAP was developed for the North Fork of the Upper South Platte River (North Fork WRAP) which is a vital drinking water source for over 2 million customers in the Denver and Aurora metro areas. The North Fork WRAP builds upon ongoing wildfire risk reduction efforts of stakeholders in the watershed by holistically examining further opportunities to restore landscapes and foster resilience in preparation for future wildfires.

The development of the North Fork WRAP involved the synthesis of previously completed analyses and planning documents; the compilation and review of infrastructure, forest, and watershed data; the identification of post-fire hazards; and the development of a susceptibility analysis. The information and analyses were used to create the pre- and post-fire preparedness plans, which identify and describe potential projects.

North Fork Wildfire Ready Action Plan

[Map Viewer](#)
[Documents](#)

Map Layers

- Areas of Concern
- North Fork WRAP Planning Area
- Stakeholder Inputs
- Susceptibility Analysis
- Hazard Analysis Layers
- Supporting Modeling Data
- Proposed Mitigation Actions (SWCA/lyres)
- Decision Support Layers

North Fork Upper South Platte
Wildfire Ready Action Plan

[Summary](#)
[Map Viewer](#)
[Model Outputs](#)

Projects

[Lower North Fork Sediment Stabilization Project](#)

Lower North Fork Sediment Stabilization Project

North Fork WRAP Area of Concern: East Resort Creek
North Fork WRAP Priority Area ID: UK-2
Denver Water Strotz Springs Watershed SMP Area of Concern: NISP_1
Mitigation Actions: Stream Stabilization, Process Based Restoration, Sediment Capture

Tentative Schedule
 February 2026: Mobilization, stormwater controls in place, earthwork begins clearing the site.
 March 2026: Install structural elements.
 April 2026: Revegetation (seeding and plantings), soil stabilization, demobilization.

Project Partners

- Denver Water
- Colorado Water Conservation Board
- Jefferson Conservation District
- Aurora Water
- Matrix Design Group, Inc. (Design and Construction Oversight Contractor)
- Total Terrain, Inc. (Construction Contractor)

Project Extent

[Download Construction Plan Sheet](#)

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Model Outputs

Hydrologic Modeling Output

Model: Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS)

Modeling Extent: All North Fork USP Watershed - Headwaters to Confluence with the Upper South Platte River mainstem.

Output: Converts rainfall to flow volumes under both pre-fire and post-fire scenarios. The focus is on the magnitude of expected change in flows based on modeled fire behavior.

Uses: Useful for mitigation planning and comparing potential post-fire flooding hazard across sub-watersheds. The model can be rerun using burn severity inputs from an actual fire scenario to further aide in post-fire response and recovery.

Limitations: Not focused on storm events that drive post-fire risk like high intensity short duration rainfall in smaller tributary channels.

[Download](#)

Hydraulic Modeling Output

Model: Hydrologic Engineering Center's River Analysis System (HEC-RAS)

Modeling Extent: 2 stream reaches along the North Fork (Gardens to Bailey; Pine to just past the confluence with Buffalo Creek)

Output: Converts the flow estimates from HEC-HMS to how the flow impacts the river system, including velocity, depth, inundation boundaries and stream power.

Uses: Useful for site-level design for projects including infrastructure protection, stream enhancement and community planning.

Limitations: Does not incorporate erosion and deposition of sediment or woody debris dynamics. The detailed outputs can provide false confidence in a highly uncertain post-fire flood environment.

[Download \(Grant/Bid\)](#)
[Contact Denver Water for More Outputs \(Sign In\)](#)

Fluvial Hazard Zone Modeling Output

Model: Colorado Fluvial Hazard Zone Delineation Protocol

Modeling Extent: Mainstem of the North Fork (Hoodler Creek Confluence to Upper South Platte River Confluence)

Output: Delineates the active stream corridor (ASC), fluvial hazard buffers

Debris Flow & Soil Erosion Modeling Output

Modeled by Colorado Forest Restoration Institute within the Four Forests to Fourty Partnership Wildlife Risk Assessment

Model: USGS Debris Flow Model
Revised Universal Soil Loss Equation

THANK YOU

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