Colorado Burned Area Emergency Response Assessment

MARSHALL FIRE

May 27, 2022

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List of Acronyms

BAER	Burned Area Emergency Response
BARC	Burned Area Reflectance Classification
BCPH	Boulder County Public Health
CDPHE	Colorado Department of Public Health and Environment
CN	Curve Number
CoBAER	Colorado Burned Area Emergency Response
CSU	Colorado State University
CU	University of Colorado
CWCB	Colorado Water Conservation Board
DHSEM	Colorado Division of Homeland Security and Emergency Management
DNR	Colorado Department of Natural Resources
DPS	Colorado Department of Public Safety
DWR	Colorado Division of Water Resources
EPA	Environmental Protection Agency
EWP	Emergency Watershed Protection
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
GIS	Geographic Information System
IA	FEMA Individual Assistance
NRCS	USDA Natural Resources Conservation Service
PA	FEMA Public Assistance
RSF	Recovery Support Function
SBS	Soil Burn Severity
SFHA	Special Flood Hazard Area
SRTF	State Recovery Task Force
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
VAR	Value-at-Risk
VOC	Volatile Organic Compound

Executive Summary

MARSHALL FIRE

Purpose
The Marshall Fire began as a grass fire near Marshall, Colorado on December 30, 2021. The cause is still under investigation. High winds, with gusts exceeding 100+ mph, rapidly caused an urban conflagration, destroying 1,084 homes, multiple commercial businesses, and causing two fatalities. This report summarizes the findings of the Colorado Burned Area Emergency Response (CoBAER) assessment for the Marshall Fire.

The purpose of the CoBAER assessment is to conduct a rapid evaluation to determine if critical values are at risk due to imminent post-fire threats and to develop appropriate actions to manage unacceptable risks. Burn severity assessments are conducted in coordination with the United States Forest Service (USFS) BAER team or led by the State of Colorado in the absence of a USFS BAER team assessment.

This preliminary CoBAER assessment for the Marshall Fire may not be comprehensive or conclusive, and is intended to help communities develop more detailed post-fire emergency response plans and make decisions about pursuing post-fire funding.

Mission
The CoBAER Team operates under the Natural and Cultural Resources Recovery Support Function (RSF) of the State Recovery Task Force (SRTF), a function of the Colorado Division of Homeland Security and Emergency Management (DHSEM). Primary objectives include:

- Identify imminent post-wildfire threats to human life and safety, property, and critical natural or cultural resources on state, county, and private lands;
- Take immediate actions, as appropriate, to manage unacceptable risks;
- Provide guidance to local governments on project funding opportunities;
- Provide an assessment report, including values at risk, and hydrological modeling.

Marshall Fire Incident Information

Date of Origin: December 30, 2021
Location: Boulder County, Town of Superior, City of Louisville
Size of Fire: 6,080 Acres
Fatalities / Injuries: 2 fatalities
Destroyed Homes: 1,084
Damaged Homes: 149
Total Home Damage Estimate: $513,212,589

Destroyed Commercial Buildings: 7
Damaged Commercial Buildings: 30

Summary of Key CoBAER Findings and Recommendations

- ***No*** increased risk to human life and safety from post-fire hydrological and geological hazards in or downstream from the burn area.
- ***No*** structures affected in Special Flood Hazard Areas (SFHA).
- ***No*** meaningful change to regulatory floodplains.
- ***No*** large-scale erosion is expected, but localized areas of erosion may be anticipated.
- ***No*** significant changes to conveyance through crossing structures (i.e. bridges and culverts); however, these should be monitored for debris and sediment accumulation which could further limit conveyance.
- ***No*** significant widespread soil contamination detected in the burn area as of May 2022.
- *Hotspots* along waterways identified in this analysis should be monitored on an ongoing basis for structural stability and integrity of channel banks.
- It is up to the *individual communities* as to whether to seek Emergency Watershed Protection (EWP) funding.
- This analysis did not comprehensively address water quality or debris removal needs, however, local governments and water providers can expect more debris and decreased water quality associated with potential areas of localized erosion of the channel and streambanks. Water quality should be monitored as normal, and identified hotspots may warrant additional monitoring for debris and sediment accumulation.

Introduction

The Marshall Fire began as a grass fire near Marshall, Colorado on December 30, 2021. The cause is still under investigation. High winds, with gusts exceeding 100+ mph, rapidly caused an urban conflagration, destroying 1,084 homes and multiple businesses (Figure 1).

Colorado Governor Jared Polis issued a verbal disaster declaration on December 30, 2021 and President Joseph R. Biden approved an expedited major disaster declaration, identified as incident number FEMA-4634-DR-CO on December 31, 2022. The declaration activated the FEMA Public Assistance (PA) Category A: Debris Removal and B: Emergency Protective Measures and Individual Assistance (IA) Programs for Boulder County. On February 4, 2022, PA Category C: Roads and Bridges, D: Water Control Facilities, E: Public Buildings and Contents, F: Public Utilities, and G: Parks, Recreational, and Other Facilities for permanent work were approved for Boulder County. The incident period spanned December 30, 2021, through January 07, 2022.

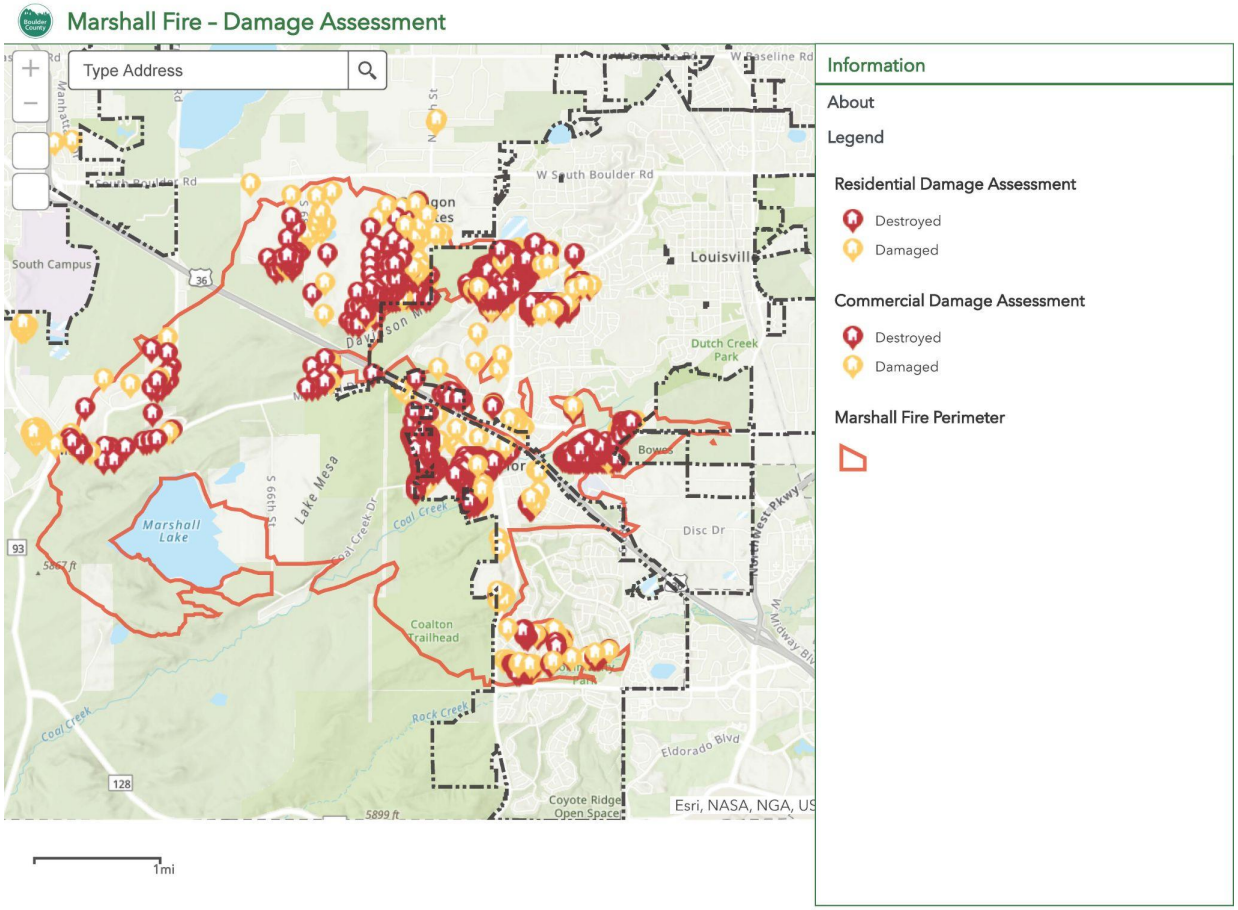

Figure 1. Map of Marshall Fire residential and commercial damage (Boulder County).

Burned Area Emergency Response (BAER) assessments are led by the U.S. Forest Service when a fire occurs solely or partially on federal lands; however, the Marshall Fire burned non-federal land. Due to the area's high population density and high density of potential values-at-risk (VARs), the Joint Field Office requested state agencies complete a burn severity and post-fire hazard assessment, resulting in the establishment of an interagency Colorado Burned Area Emergency Response Team (CoBAER) (Table 1). This report summarizes the findings of the resulting CoBAER Assessment.

Table 1. Marshall Fire CoBAER Team members.

Marshall Fire CoBAER Team
CoBAER Team Lead
Angela Boag, PhD, MS, Assistant Director for Climate, Forest Health and Energy, Colorado Department of Natural Resources angela.boag@state.co.us
Watershed & Agriculture State Recovery Taskforce Coordination
Christopher Hudak, MPA, DHSEM Disaster Recovery Coordinator, Natural & Cultural Resources Recovery Support Function (RSF) Lead christopher.hudak@state.co.us Kelly Strife, DHSEM Disaster Recovery Specialist, Natural & Cultural Resources RSF Support kelly.strife@state.co.us
Local Government Coordination
Kelly Romero-Heaney, Assistant Director for Water, Colorado Department of Natural Resources kelly.romero-heaney@state.co.us
Hydrological and Debris Flow Modeling
Kevin Houck, PE, Chief, Watershed and Flood Protection, Colorado Water Conservation Board kevin.houck@state.co.us Chris Sturm, Watershed Program Director, Colorado Water Conservation Board chris.sturm@state.co.us Jeff Sickles, PE, CFM, Enginuity Engineering Solutions jsickles@enginuity-es.com Gerald Blackler, PE, PhD, DWRE, Enginuity Engineering Solutions gblackler@enginuity-es.com
Soil Burn Severity Assessment and Photo Credit
Eric Schroder, Soil Scientist and BAER Program Coordinator, U.S. Forest Service eric.schroder@usda.gov

Landscape Characteristics

The wind-driven Marshall Fire burned primarily in grass, as well as pockets of ponderosa pine-dominated woodland and riparian vegetation before becoming an urban conflagration. The burned area is characterized by relatively flat topography and gentle hills, and includes two larger creeks (Coal Creek and Rock Creek), ditches, and several lakes and reservoirs that provide drinking water to residents of Boulder County, the Town of Superior, and the City of Louisville.

CoBAER Process

The state-led CoBAER process generally follows the same processes used in federal BAER assessments. After determining soil burn severity and identifying potential downslope/downstream values-at-risk, the Colorado Water Conservation Board (CWCB) modeled hazards to make recommendations about reducing exposure to runoff and flooding, erosion and sediment delivery, and debris flows. CoBAER then communicated findings to local governments, who then determined which funding opportunities (if any) to pursue to address potential impacts.

Potential values-at-risk considered:

- Human life-safety
- Property
- Critical facilities
- Transportation infrastructure
- Water infrastructure
- Water quality
- Recreation infrastructure
- Native plant communities
- Aquatic ecosystems
- Cultural sites

Modeling Results

Soil Burn Severity

Snowstorms in Boulder County immediately following the Marshall Fire and prolonged snow cover led to significant delays in securing Burned Area Reflectance Classification (BARC) imagery and conducting field surveys to validate the BARC. The USFS-based Burned Area Emergency Response (BAER) Imagery Support Program utilized satellite imagery to create a BARC in April 2022, which showed little pre- and post-fire contrast in part due to dormant grasses in December before the fire and low soil burn severity (SBS) throughout most of the

burn area. The BARC identified some small areas of potential medium burn severity. Field observations were made to validate the imagery and create a final soil burn severity map according to guidelines outlined in the Field Guide for Mapping Soil Burn Severity[1].

SBS field surveys determined that the vast majority of the burn area burned at low severity, and confirmed some small pockets of moderate burn severity. The initial BARC image was reclassified based on these observations to provide a map of estimated SBS (Figure 2). Soils on building sites were not evaluated.

General SBS observations:

- Grass-dominated areas within the burned area were mapped as low SBS.
- Small areas of moderate SBS occurred in conifer-covered areas.
- Small patches of moderate SBS occur within the Coal Creek riparian zone but the vast majority of that area has low SBS.
- The imagery does not provide a reasonable approximation of SBS in urbanized and developed areas within the burn perimeter.

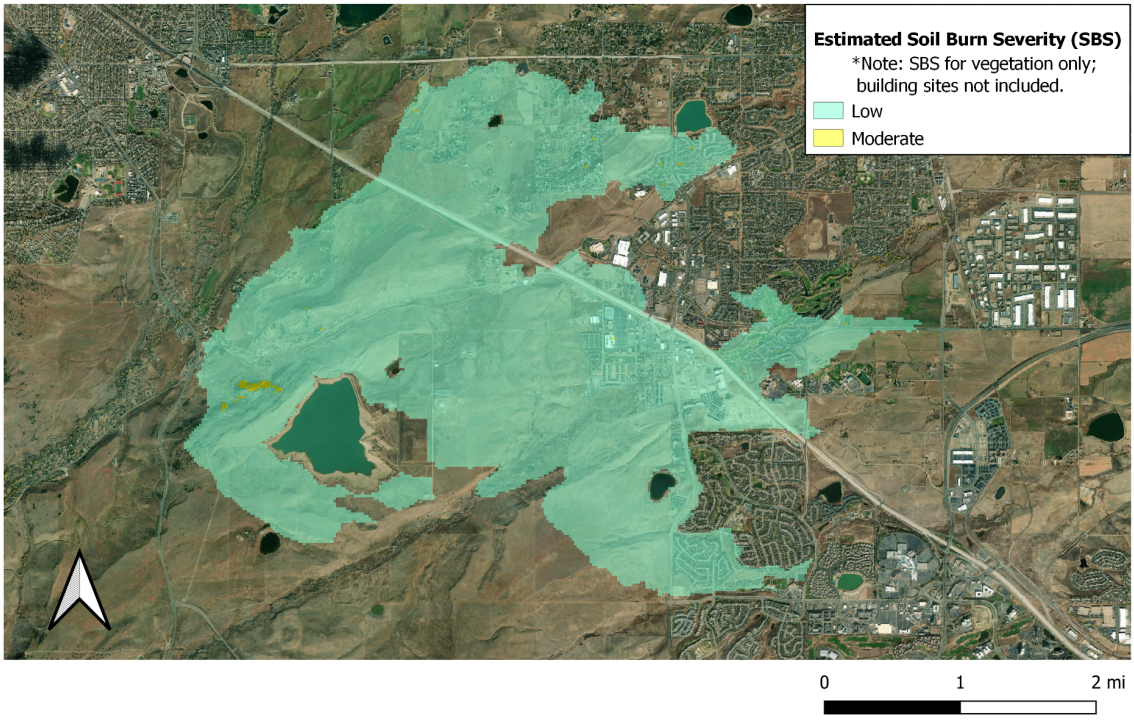

Figure 2. Estimated soil burn severity (SBS) for the Marshall Fire, showing low burn severity across most of the burned area, with small pockets of moderate burn severity. Note: This map only shows estimated SBS for open space and vegetation, not building sites. Most buildings destroyed in the fire burned at high intensity and soil burn severity at building sites was not

[1] https://www.fs.fed.us/rm/pubs/rmrs_gtr243.pdf

assessed. The soils on building sites have been and will continue to be altered by applications of hydromulch, debris removal activities and home rebuilding.

Hydrology and Debris Flow Potential

The Colorado Water Conservation Board led a rapid hydrologic analysis to approximate changes in hydrology and sediment transport from the Marshall Fire[2].

The Marshall Fire consisted of a small portion of Coal Creek and Boulder Creek Drainages. The larger upstream watershed controls the floodplain peak flow. The analysis indicates that the small burned portion of the watershed that burned will have localized increases in flows, but does not change the larger flood wave, which is dictated by the broader unburned upstream watershed (Figure 3).

Houses and developed areas where roofs and streets had a higher Curve Number (CN) and are now open dirt, have a slightly lower CN in the post-fire model. Curve Numbers are empirical values used in hydrologic analyses to estimate the portion of rainfall that infiltrates into the soil and the portion that is ultimately converted to runoff. Higher Curve Numbers result in less infiltration and higher runoff.

Generally, the results indicate:
1. Only 10% of the contributing watershed area of Coal Creek at US Highway 36 was impacted by the Marshall Fire.

2. Peak flows for the 100-year Flood Insurance Study (FIS)/Floodplain are not expected to change as a result of the Marshall Fire since the fire is located approximately 38 sq. miles downstream (meaning, the peak flow is controlled by the larger unburned areas).

3. Minor changes in depths and velocities of runoff from a thunderstorm over the burn scar should be anticipated.

4. These changes have been mapped and are available in an online Mapbook to local agencies for monitoring or more careful evaluation (details below).

Mapbooks showing flow depth and shear increases present more detail for local entities to assess erosion hotspot locations (Mapbook available here[3]; Figures 4 and 5). Depth and shear were combined to yield a ranking of low, medium, and high likelihood of increased erosion. Shear represents an erosive hydraulic force on the channel and streambanks. Together, values for shear and flow depths can indicate risk of erosion to waterways, and inform locations for monitoring and potential mitigation actions by local governments and flood districts.

As presented below, a section of Coal Creek may have a few high risk areas (hotspots) but also has lower and medium-forecasted changes. Such changes may warrant looking at a given stretch as a whole, and not just individual spots.

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[2] Backler, G. April 25, 2022. Marshall Fire Hydrology Story Map.
https://storymaps.arcgis.com/stories/278bfd29d6cc45bcaebb4a7f3068617d
[3] https://enginuity.egnyte.com/fl/Mx3WLmjyKo

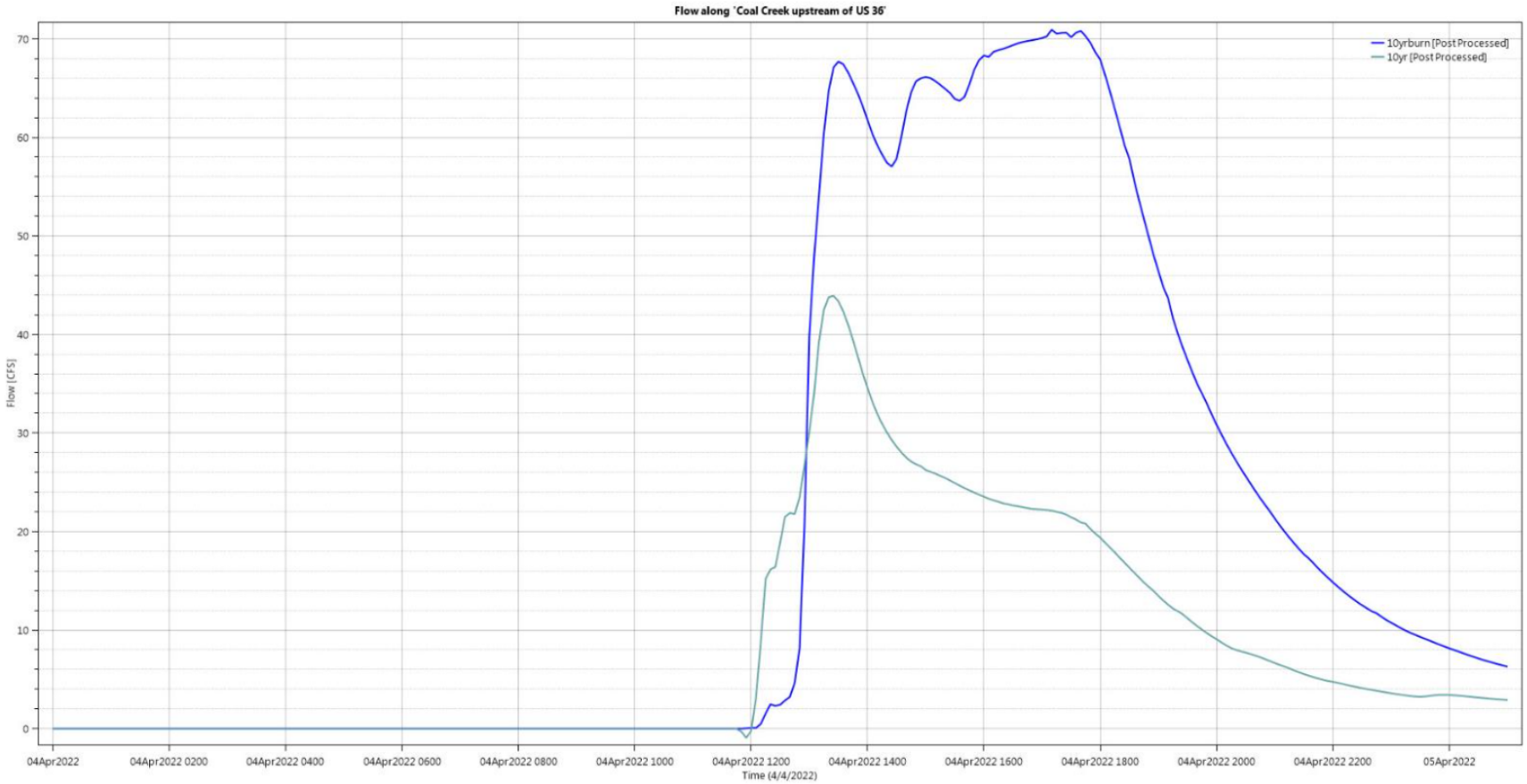

Figure 3. Hydrograph for the 10-year thunder burst over the Marshall Burn scar in Coal Creek, upstream of U.S. 36. Curves indicate that the predicted maximum 10-year rain event would yield 42 CFS of flow if the fire had not occurred (green line), and 71 CFS of flow following the fire (blue line). These flows are not anticipated to cause flooding or other major impacts.

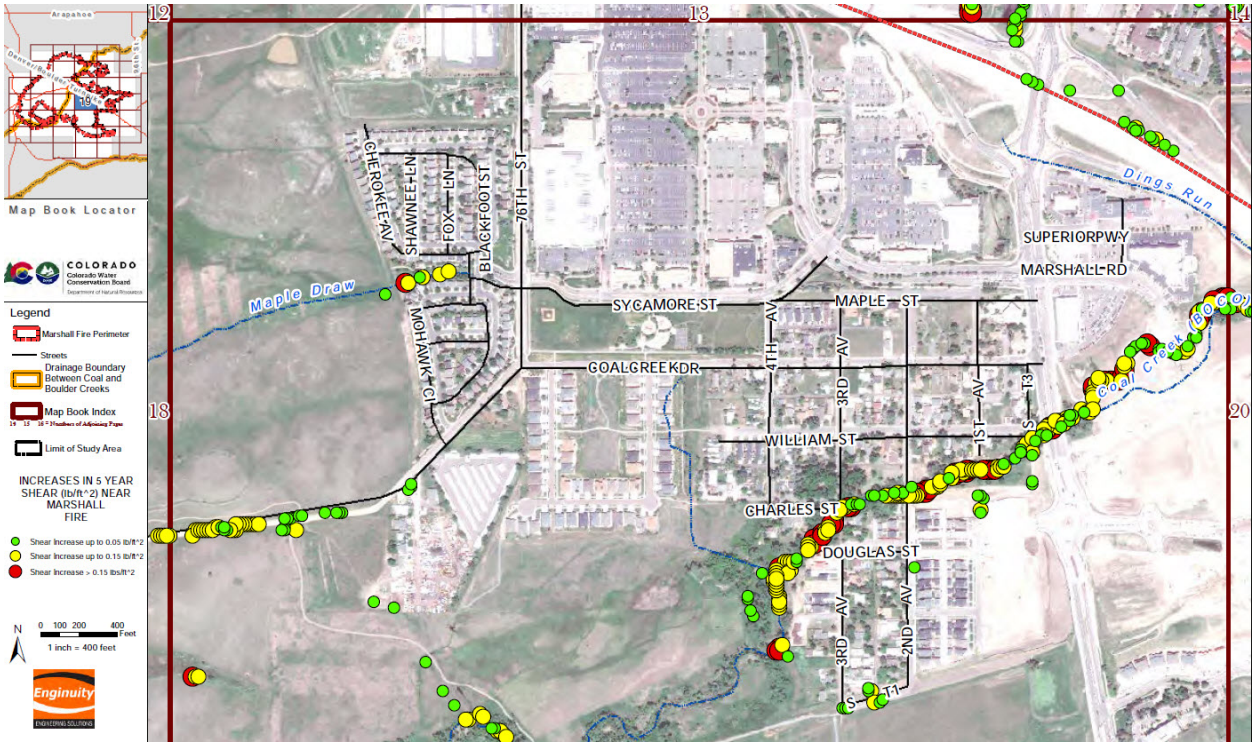

Figure 4. Example of Low, Medium, and High Ranking for increases in Shear Stress (5 Year Shear in lb/ft^2) at Coal Creek upstream of Highway 36.

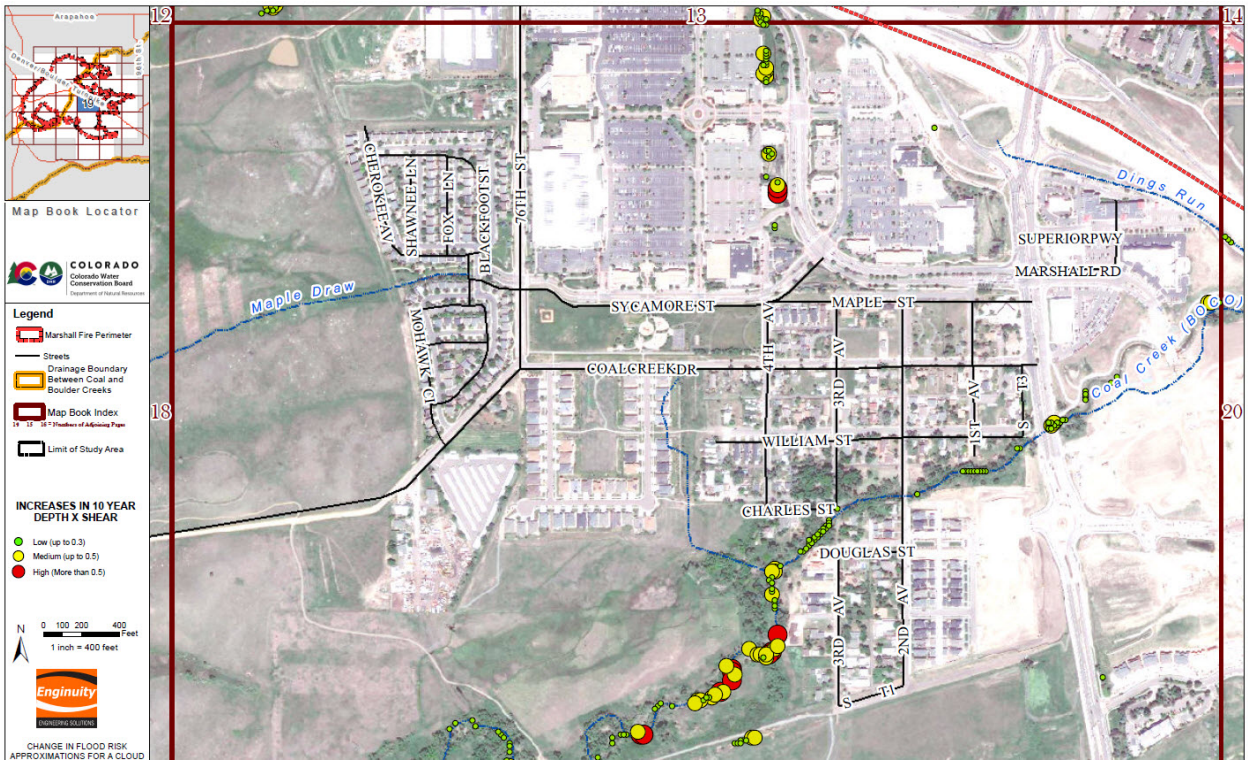

Figure 5. Example of Low, Medium, and High Ranking for increases in 10 year Depth X Shear (a measure of erosion susceptibility) at Coal Creek upstream of Highway 36.

In Summary, the findings from this analysis are:

- *No* meaningful change to regulatory floodplains.
- *No* large-scale erosion expected, but localized areas of erosion may be anticipated (see Mapbook).
- *No* significant changes to conveyance (the ability of the channel to carry water).
- This analysis did not address water quality or debris removal needs, however, more debris and decreased water quality may be associated with the hotspots.

Response Recommendations

Overall, this analysis indicated minor or no anticipated risks to values-at-risk from post-fire hazards. The CoBAER team recommends local agencies conduct monitoring in "hotspots" with increased erosion risks rather than recommending specific control measures at specific locations.

1. Human life and safety

The Marshall Fire resulted in no meaningful change to regulatory floodplains, and there were no affected structures in SFHA. The CoBAER does not anticipate any increased risk to human life and safety from post-fire hydrological and geological hazards in or downstream from the burn area.

2. Critical Infrastructure

Post-fire erosion due to the Marshall Fire is expected to have minor impacts on drinking water reservoirs, intake locations, and other water infrastructure. However, increased debris in ditches and creeks is expected and may need to be monitored and periodically removed.

The CoBAER Team does not expect significant changes to water conveyance through crossing structures (i.e. bridges and culverts); however, these should be monitored for debris and sediment accumulation which could further limit conveyance.

Site-specific mitigation measures involving containment and diversion structures should be designed by licensed professionals specializing in geotechnical engineering, soil erosion and engineering geology.

3. Natural and Cultural Resources

a. Water quality

This analysis did not address water quality specifically, however, local agencies may anticipate decreased water quality associated with the potential erosion hotspots identified in this analysis. The Colorado Water Quality Control Division anticipates working with the CoBAER Team, the public water systems affected, and local partnerships to address any potential gaps in the water quality analysis.

Local governments and water providers should continue to monitor water quality as normal and provide information to homeowners in and near the burn area on well water testing options.

Since the Marshall Fire, the Town of Superior has collected Volatile Organic Compounds (VOC) samples from all areas of the distribution system, with the majority of these samples collected at residential homes. Additionally, scientists from the Colorado Department of Public Health and Environment (CDPHE), University of Colorado (CU) and Colorado State University (CSU) have been involved in collecting and analyzing samples from raw water in Terminal Reservoir and treated water throughout the distribution system and at individual residences. All samples collected over the months of January and February were determined to be non-detectable or just slightly higher than detection, however, still well below the Environmental Protection Agency (EPA) threshold value to be considered a health concern[4]. Ongoing water quality sampling along Coal Creek and other identified stream segments will provide additional information on several water quality parameters through 2022/2023, including metal concentrations, major ions, nutrients and organic compounds.

b. Soil quality

Results from testing conducted by Boulder County Public Health (BCPH) in areas affected by the Marshall fire show the levels of metals and asbestos in the soil do not pose a significant health risk and are, in most cases, consistent with surrounding areas that were not impacted by the fire[5].

c. Cultural Resources

This analysis indicates minimal to no post-fire hazard impacts on cultural sites or recreation infrastructure.

[4]Town of Superior. Water Quality (Marshall Fire). https://www.superiorcolorado.gov/departments/public-works-utilities/potable-water/smoky-water
[5]Boulder County Public Health. Testing Shows Soil Safe in Marshall Fire Burn Areas. Media Advisory. https://content.govdelivery.com/accounts/COBOULDER/bulletins/31326e2

Acknowledgements

Thank you to local government staff from Boulder County, the City of Boulder, the City of Louisville, Town of Superior, and City of Lafayette and the Mile High Flood District for their time contributing to this process and assessment. Thank you to staff at the U.S. Forest Service and Natural Resources Conservation Service for your willingness to assist the state with completing Soil Burn Severity mapping, and to local, state, and federal entities for participating in the Watershed and Agriculture Advisory Group. In particular, thank you to the Colorado Water Quality Control Division for ongoing work on post-fire water quality impacts, and the Colorado Department of Agriculture for assisting impacted producers.

Appendix A: Values-at-Risk Table

Table A1. Potential Values-at-risk identified by local government representatives in the Marshall Fire burn area.

Site No.	Specific Feature	Community / Local area	Potential Hazards	Specific Concerns	Feature Category	Recommended Response
1	Marshallville Ditch	Boulder County (private property)	erosion; sedimentation; ash; debris (natural/post-fire); residential hazardous material		water infrastructure	Monitoring
2	Davidson Ditch	City of Boulder Open Space/Private property	erosion; sedimentation; ash; debris (natural/post-fire); residential hazardous material		water infrastructure	Monitoring
3	Goodhue Ditch	City of Boulder Open Space/Private property	erosion; sedimentation; ash; debris (natural/post-fire); residential hazardous material		water infrastructure	Monitoring
4	Community Ditch	City of Boulder Open Space/Private property/Boulder County	erosion; sedimentation; ash; debris (natural/post-fire); residential hazardous material		water infrastructure	Monitoring
5	Louisville Lateral	Louisville/Boulder County	erosion; sedimentation; ash; debris (natural/post-fire); residential hazardous material		water infrastructure	Monitoring
6	Marshall Reservoir	City of Boulder Open Space/Ditch company	erosion; sedimentation; ash; debris (natural/post-fire); residential hazardous material	Sedimentation may impact water storage	water infrastructure	Monitoring
7	Coal Creek	Boulder County/Superior/ Louisville	erosion; sedimentation; ash; flood; debris (natural/post-fire); residential hazardous material		drainage systems	Monitoring

8	Rock Creek	Superior	erosion; sedimentation; ash; flood; debris (natural/post-fire); residential hazardous material		drainage systems	Monitoring
9	Marshall-Mesa Trailhead	City of Boulder Open Space and Mountain Parks	debris (natural/post-fire)	cultural resources uncovered and exposed	recreational	Monitoring
10	Harper Lake	Louisville	erosion; sedimentation; ash; flood; debris (natural/post-fire); residential hazardous material	Sedimentation may impact water storage; City of Louisville's water supply	water infrastructure	Monitoring
11	Storm Sewer System	Louisville/Superior	erosion; sedimentation; ash; flood; debris (natural/post-fire); residential hazardous material		drainage systems	Monitoring
12	Wetlands/ Riparian Areas	City of Boulder Open Space/Superior	erosion; sedimentation; ash; flood; debris (natural/post-fire); residential hazardous material	habitat recovery	ecosystem services	Monitoring
13	Rangeland	City of Boulder Open Space/Boulder County	erosion	invasive species; forage impacts	ecosystem services	Monitoring
14	Terminal Reservoir	Superior	erosion; sedimentation; ash; flood; debris (natural/post-fire); residential hazardous material	3 ft of ash along the east end that is being removed; drinking water source; public complaints about smokey water	water infrastructure	Monitoring
15	McCaslin Trail	Superior	erosion		recreational; drainage system	Monitoring
16	Autrey Reservoir	Superior	erosion; debris (natural/post-fire)		water infrastructure	Monitoring
17	Retention Pond	Superior	erosion; debris (natural/post-fire)		water infrastructure	Monitoring

18	McCaslin retaining wall bank	Superior	erosion	habitat recovery	drainage system	Monitoring
19	Bridges and culverts	All impacted communities	erosion; flood; debris (natural/post-fire)	erosion impacting footings; debris blocking culverts	transportation infrastructure; drainage system	Monitoring and active debris removal as needed

Appendix B: Field Survey Photos

Photos by E. Schroder (4/1/22)

Figure B1. Low soil burn severity (SBS) above Community Ditch.

Figure B2. Low SBS around Marshall Lake.

Figure B3. Low SBS; grass and small wetland recovering.

Figure B4. Low SBS; some burned floatable material in the channel. Coal Creek South of Founders Park.

Figure B5. Low SBS in Coal Creek riparian zone. Some additional floatable material.

Figure B6. Mosaic of Low and Medium SBS; Ponderosa pine woodland south of Davidson Ditch.