Post-Fire Treatments:
A Primer for New Mexico Communities



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Contributors to the Post-Fire Treatment Guide: New Mexico State University, USDA Forest Service, US Army Corps of Engineers, USDA Natural Resources Conservation Services, New Mexico State Forestry, and High Water Mark LLC.

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AFTER WILDFIRE

A GUIDE FOR NEW MEXICO COMMUNITIES

Post-Fire Treatments:
A Primer for New Mexico Communities

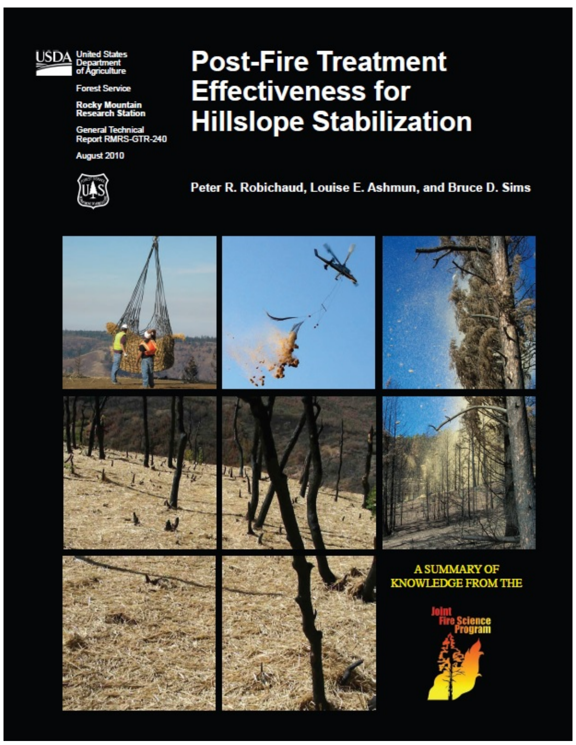
Contents

Introduction

Post-Fire Treatments: A Primer for New Mexico Communities

In recent years, New Mexico residents have witnessed runoff, flooding, erosion, and debris flow events following severe wildfires. These secondary fire effects can have significant and long lasting impacts to communities, private landowners, and high-value infrastructure. Mitigating these secondary fire effects using post-fire treatments is of great interest to stakeholders affected by severe wildfires.

This guide is designed to provide communities and individuals a primer on the different types of post-fire treatments, as well as a review of their effectiveness as reported in the scientific literature.



After a wildfire, federal, state, and local partners often work together to assess fire impacts and prioritize areas for post-fire treatment. These assessments identify focus areas such as severely burned watersheds, steep slopes, areas where runoff will be excessive, and other values at risk such as infrastructure.

Before implementing any treatments, it is recommended that individuals and communities consult with experts in the post-fire treatment profession who can provide perspective, insight, guidance, and advice in an ever evolving field of practice. Engineers and hydrologists are particularly important when considering any type of in-channel treatment. In some cases, permitting may be necessary before implementing treatments (contact your county permitting department, the U.S. Army Corps of Engineers, and/or the New Mexico Environment Department).

Keep in mind, differing opinions exist about the use and effectiveness of various post-wildfire treatments. It is not uncommon for one practitioner, for example, to have an affinity for a particular treatment based on personal experience, while another's experience contradicts the firsts. In fact, differing opinions and results are to be expected depending on how and where treatments are implemented as well as post-fire weather. In an attempt to address this circumstance, the authors of this section have based this review on published scientific studies where available (see references). Nonetheless, treatment effectiveness reviews are not intended to discount professional judgment and knowledge of place. Inclusion of treatments in this guide should not be interpreted as an endorsed of its viability or usefulness, but rather a simple accounting of its historic use.

Consider the following anecdotal story from the 2002 Missionary Ridge Fire in Colorado that illustrates how different objectives and experiences may call for different treatments and approaches, and how not all individuals or communities will have the same objectives, approaches, or in some cases financial resources.

> *"…several hillslope erosion control measures and some channel treatments were installed at higher than normal density above Lemon Dam to protect the intake structures of the dam from being filled with sediment. Since the dam is a critical component of the water supply system for the city of Durango, Colorado, the Water Conservation District was anxious to ensure continuous facility operation (deWolfe and others 2008). The hillslope treatments included: log erosion barriers (LEBs) at 90 to 250 LEBs per acre, 200 to 600 percent of typical; hand-spread and crimped straw mulch at 2.5 tons per acre, 125 percent of typical; and hand-spread seeding at 60 to 75 lbs per acre, 150 percent of typical. In addition, 13 check dams and 3 debris racks were installed in the main drainage channel of the basin. The erosion barriers, check dams, and debris racks were cleaned out and rehabilitated after each sediment-producing storm to ensure maximum performance for the next event. This combination of treatments virtually eliminated sedimentation into the reservoir. The authors attribute the success of this treatment combination to 1) the high density of application for each treatment, 2) the enhancement of treatments working in concert, 3) the quality of treatment installation, and 4) sediment and debris removal from*

barrier treatments and repair of treatments to extend their useful life (deWolfe and others 2008)." (From Robichaud et al. 2010)

The authors of this section of the guide hesitated to include a cost estimate for each of the treatments as this information is inherently variable and ever changing from year to year and location to location. However, we included it nonetheless in an attempt to provide some measure of comparison between treatments. Costs estimates came almost exclusively from *Burned Area Emergency Response Catalog* (2006).

Much of the text for this review comes directly from the following publications: *Evaluating the Effectiveness of Postfire Rehabilitation Treatments* by Robichaud, Beyers, and Neary (2000); *Burned Area Emergency Response Treatments Catalog* from the USDA Forest Service (2006); *A synthesis of postfire road treatments for BAER teams: methods, treatment effectiveness, and decision making tools for rehabilitation* by Foltz, Robichaud, and Rhee (2009); and *Post-fire treatment effectiveness for hillslope stabilization* by Robichaud, Ashmun, and Sims (2010).

We welcome your comments about this section. To send us a note, click on 'Contact' in the footer of the After Wildfire website (www.afterwildfire.org) or call 505-345-2200.

Index of Treatments

Hillslope Treatments – Cover Applications

Dry Mulch


What – Straw, woodchips or fiber materials are applied to burned areas using ground or aerial application.

Purpose – By providing immediate ground cover, mulch is intended to reduce surface erosion, reduce downstream peak flows by absorbing rainfall, and secure seeds stored in the soil or applied as emergency treatment. Mulch also provides favorable moisture and temperature regimes for seed germination.

Effectiveness – Straw mulch was reported as highly effective in reducing surface erosion when application rates exceeded 60% ground cover, and sometimes effective in reducing runoff. Sites prone to high winds reported reduced effectiveness. A combination of mulching and seeding was reported as more effective than seeding alone in regards to germination, but not necessarily in regards to surface cover. Wood based mulches (manufactured products and shredded on-site trees) were equal to or more effective than straw mulch in reducing post-fire erosion.

Where

- Areas with moderate- or high-burn severity.
- Due to cost, there usually needs to be prioritization for mulch application, focusing on where there is a threat to life and property. This may include steep slopes adjacent to communities, roads, and infrastructure; critical headwaters that feed municipal water supplies; and waste sites that pose serious environmental threats.

Cost – Straw aerial application $250–930 per acre; ground application $425–1200 per acre. Based on 1–2 tons per acre application rate (provides average mulch depth of 1–2 inches). Wood based aerial application $1500–2000. Additional factors include:

- Location and access.

Hillslope Treatments – Cover Applications

Wet Mulch (Hydromulch)


What – Combinations of organic fibers (e.g., wood shreds, paper, cotton, flax, etc.), tackifiers (i.e., glue), suspension agents, and seeds are mixed together with water and applied to the soil surface via ground or aerial applications.

Purpose – The matrix formed by hydromulch creates an immediate cover and holds moisture and seeds on steep slopes, which fosters seed germination while holding soil in place.

Effectiveness – Hydromulch may reduce sediment yields during the first few rainfall events (long-term effectiveness is unknown). Treatments are more effective on short slope lengths vs. longer slopes due to susceptibility to concentrated flows. This method is wind resistant. Multiple factors impact effectiveness (e.g., application rates, slope length and steepness, make/brand of tackifier).

Where

- Aerial application on inaccessible, highly erodible soils following moderate or high fire severity.
- Ground application on highly erodible soils near roads.
- Due to cost, there usually needs to be prioritization for mulch application, focusing on where there is a threat to life and property. This may include steep slopes adjacent to communities, roads, and infrastructure; also critical headwaters that feed municipal water supplies, and waste sites that pose serious environmental threats.

Cost – $2000–3000 per acre for aerial application; $1675–3000 per acre ground application. Additional factors include:

- Location and access
- Helicopter/fixed-wing aircraft turnaround time and production rate

Hillslope Treatments – Cover Applications

Slash Spreading

What – Felling, lopping, and then scattering trees and brush by hand or mechanical equipment.

Purpose – Intended to provide increased ground cover to reduce raindrop erosion.

Effectiveness – Scattering slash created by chain saw is generally ineffective due to slow labor production rates and the large amount of material needed for adequate soil cover. However, mechanized equipment (e.g., hydro ax) that masticates material is considered moderately effective.

Where

- Burn sites with moderate or high fire severity.

Cost – $220–1000 per acre. Additional factors include:

- Topography.

Hillslope Treatments – Cover Applications

Seeding

What – Aerial and ground application of seed across large areas. Native seed mixes are preferred, but non-invasive, non-native seed mixes are also used, often with sterile annual grass seeds or cereal grain seeds.

Purpose – Intended to reduce soil erosion.

Effectiveness – Seeding was generally reported as ineffective (i.e., provided < 60% surface cover) the first year following fire and neutral in subsequent growing seasons following fire. However, when combined with mulching, the potential for germination may increase as a result of seed and moisture being held by mulch. Sterile annual seeds and cereal grain seeds that germinate can reduce soil erosion after fire, yet not compete with native grasses in subsequent years. Please note that seeding has the possibility for introducing invasive and noxious species, so be aware of this possibility.

Where

- Hillslopes with moderate and high fire severity.

Cost – $20–170 per acre. However, trend analysis indicated costs increased over time (Peppin et al. 2011). Additional factors include:

- Availability of seed
- Number of species in seed mix
- Implementation time frame
- Number of landowners involved
- Elevation and climate
- Size of fire
- Aircraft type
- Topography
- Proximity of treatment blocks to staging areas
- Weather conditions during seeding

Hillslope Treatments – Cover Applications

Soil Scarification (with seeding)

What – Hand tools or mechanical equipment are used to break up and loosen topsoil to increase surface roughness.

Purpose – Intended to break down hydrophobic layer, prepare seedbed, and increase infiltration rate.

Effectiveness – Generally, this treatment did not provide significant improvement (e.g., reduced sediment yield) as compared to no treatment (Rough 2007).

Where

- Areas of high- and moderate-burn severity.
- Slopes with high erosion potential.

Cost – $245–300 per acre for hand crew; $50 per acre for ATV use. Additional factors include:

- Location and access

Hillslope Treatments – Erosion Barrier Applications

Erosion Control Mat

What – Lightweight synthetic or organic mats (netting or blankets) staked to soil surface.
Purpose – Intended to provide temporary (several months to years) soil stability to special interest sites (e.g., heritage resources) until vegetation can establish. Mats also reduce soil temperature and provide moisture conservation.

Effectiveness – products are expensive, but effective when installed correctly.

Where

- Small areas with high values at risk.

Cost – $0.35–1.00 per square yard + installation (labor). Additional factors include:

- Site location and access

Hillslope Treatments – Erosion Barrier Applications

Log Erosion Barrier (contour log felling)


What – Logs are partially entrenched or staked to soil surface parallel to the contour.
Purpose – Intended to slow runoff, cause localized ponding, and capture and store eroded sediment when arranged in a bricklayer pattern on hillslopes.

Effectiveness – Studies indicated that log erosion barriers may reduce runoff, peak flows, and sediment yields for low intensity rain events (< 1.8" per hour), but are unlikely to have a significant effect for high intensity rain events. Sediment storage was reported to decrease by 10–15% with each successive rain event. Although the potential volume of sediment stored is dependent on slope, tree size and length, frequency, and use of berm traps, with proper implementation effective sediment storage and creation of microsites can be achieved.

Please note: some agencies, such as the US Forest Service, no longer endorse this method. However, other users have reported success with this method when logs are properly placed and secured. Please consider the cost, ease of application, and safety, and ***consult with experts in the post-fire treatment profession*** *who can provide perspective, insight, guidance, and advice in an ever evolving field of practice.*

Where

- Hillslopes with high- and moderate-burn severity.
- Slopes between 25 and 60 percent.

- Soils with high erosion-hazard ratings.
- Watersheds with high values at risk.

Cost – $420–1200 per acre. Additional factors include:

- Terrain
- Site access
- Frequency of logs
- Labor experience

Additional Implementation Information: See USDA BAER Catalog page 45 (PDF page 53); and NRCS Log Erosion Barriers Fact Sheet.

Hillslope Treatments – Erosion Barrier Applications

Fiber Rolls (e.g., wattle)

What – Fiber rolls, commonly called wattles, are prefabricated rolls manufactured from rice straw and wrapped in degradable netting. In some cases, on-site woody debris can be rolled in netting to reduce costs. Rolls are ~ 9 inches in diameter and up to 25 feet long.

Purpose – Intended for low-surface flows not to exceed 1 cubic foot per second. They are not for stream channels or gullies. They are intended to reduce erosion by shortening the slope length to slow overland flow velocity as well as trap sediment and provide a seedbed for vegetative recovery.

Effectiveness – Studies indicated that erosion barriers may reduce runoff and sediment yields for low intensity rain events (< 1.8" per hour), but are unlikely to have a significant effect for high intensity rain events. Wattles reduced total runoff and peak flow rates (Robichaud et al. 2008 and 2010).

Where

- Areas of high- and moderate-burn severity.
- Slopes with < 40% ground cover.

Cost – $1100–4000 per acre. Additional factors include:

- Location and terrain
- Access
- Experience of crews

Hillslope Treatments – Erosion Barrier Applications

Silt Fence

What – a permeable fabric installed parallel to the contour and anchored with wooden stakes or metal t-posts.

Purpose – Intended to trap sediment and protect areas with high values at risk including heritage resources, water quality, and aquatic resources.

Effectiveness – Studies reported notably high effectiveness when fences were installed properly (i.e., anchored into soil and water allowed to pass through slowly while trapping sediment) and maintained (which requires significant effort and attention). Robichaud and Brown (2002) measured trap efficiency at over 90 %.

Where

- Areas accessible for inspection and maintenance.

Cost – $50 per roll (material); $150–250 labor for each fence installation. Additional factors include:

- Location and terrain
- Frequency of fences
- Soil characteristics

Channel Treatments

Checkdam

What – Mini-dams built with straw, logs, or rocks; size depends on channel gradient.

Purpose – Temporary erosion control measure designed to trap and store sediment mobilized from hillslope. Also intended to reduce downcutting and attenuate peak flows.

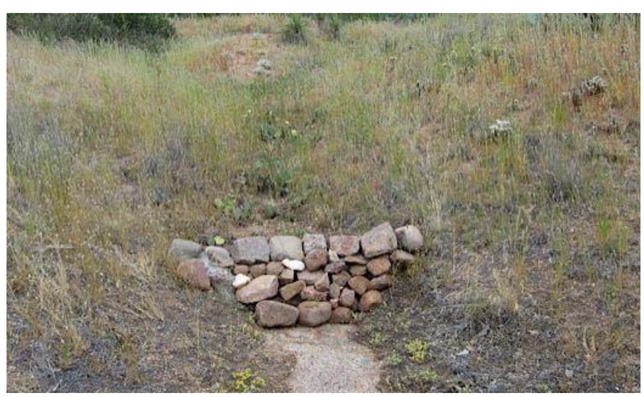
Effectiveness – All types of checkdams appear to work better when implemented in gentle gradients, high in the watershed, and placed in a series. Problems with checkdams include complete structure failure from large storms. In-channel treatments without adjacent hillslope treatments are ineffective.

Where

- Swales with gentle gradient that allow for sediment storage.
- High-burn severity areas with highly erodible soils.
- Areas with less than 20-percent ground cover.
- Areas with high values at risk.
- Watersheds with small drainage areas, generally less than 5 acres.

Cost – $150–600 each. Additional factors include:

- Treatment location
- Construction material used (log, straw, or rock) and availability



Channel Treatments

In-channel Tree Felling

What – Directionally felling trees in a staggered herringbone pattern with tops pointed upstream.

Purpose – Intended to trap floating debris and suspended sediment. Over time, large woody material dissipates stream energy, provides cover and habitat for fish while providing long-term channel stability.

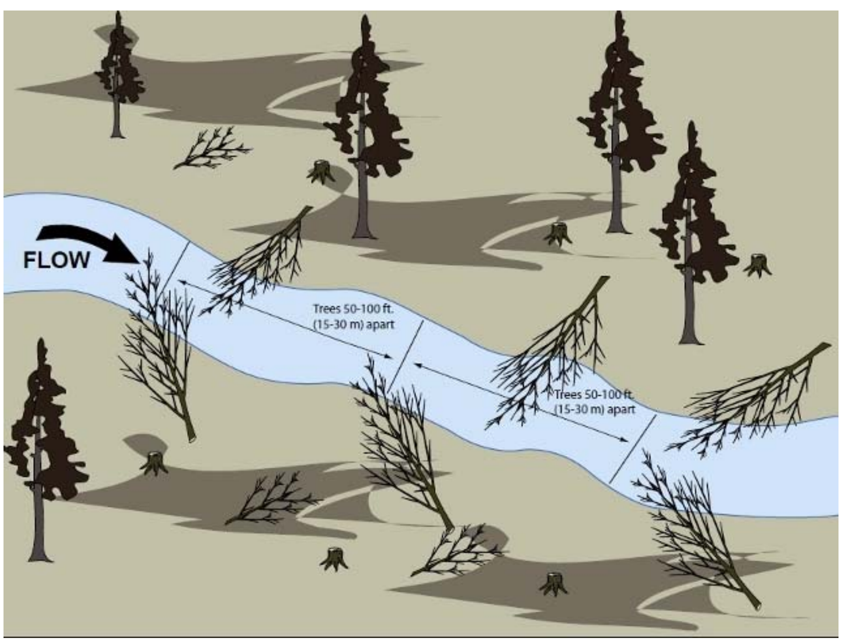
Effectiveness – Directional felling appears to work better when implemented in gentle gradients, high in the watershed, and placed in a series. Problems include complete structure failure from large storms. In-channel treatments without adjacent hillslope treatments are ineffective.

Where

- Areas of high-burn severity.
- Channels where energy dissipation is necessary.
- Channels with unstable bedload and high sediment-loading potential.

Cost – $3500–4000 per mile of treatment, based on approximately 100 trees felled per mile of channel. Additional factors include:

- Location of treatment area
- Amount of material (trees) available



Channel Treatments

Grade Stabilizer


What – Structure made of rocks, logs, or plant material installed in ephemeral channels at the grade.

Purpose – Provide grade control in channels that may become destabilized from increased storm runoff and velocities. Intended to prevent incising and downcutting in channel.

Effectiveness – Little quantitative data is available. This treatment may be most effective for areas of low or moderate flows. Grade stabilizers are likely to work better when implemented in gentle gradients, high in the watershed, and placed in a series. Problems include complete structure failure from large storms. In-channel treatments without adjacent hillslope treatments are ineffective.

Where

- Unstable channels.
- Large areas of high-burn severity in watershed.
- Seasonal channels with low to moderate flows.
- Channel gradient less than 6 percent.

Cost – $250–4000 per structure depending on materials and installation method. Additional factors include:

- Location and access to sites
- Availability of skilled workforce
- Mechanized equipment use (backhoe/excavator)

Channel Treatments

Stream Bank Armoring

What – Reinforcement of streambank with protective covering, such as rocks, vegetation or engineering materials (including boulders, riprap, and gabion baskets).

Purpose – Reduce bank cutting and erosion due to peak flows.

Effectiveness – No quantitative effectiveness monitoring data exists for this treatment. Streambank armoring is likely to work better when implemented in gentle gradients, high in the watershed, and placed in a series. Problems include complete structure failure from large storms. In-channel treatments without adjacent hillslope treatments are ineffective.

Where

- Highly erodible streambanks.

Cost – moderate to high (no specific estimates are available). Costs factors listed below:

- Location and access
- Size of material required (which then relates to mechanical equipment or hand labor requirements)

Channel Treatments

Channel Deflector

What – Engineered structures such as j-hooks, rock barbs, and single- or double-wing deflectors.

Purpose – Designed to direct increased streamflows and velocities away from unstable banks or structures of value such as a road parallel to the channel.

Effectiveness – There is no documented effectiveness monitoring data for this treatment. Channel deflectors are likely to work better when implemented in gentle gradients, high in the watershed, and placed in a series. Problems include complete structure failure from large storms. In-channel treatments without adjacent hillslope treatments are ineffective.

Where

- Locations where roads are parallel to stream channels.
- Locations where facilities are at risk from streambank erosion or flooding.

Cost – Treatment costs are variable depending on the structure installed. Costs factors listed below:

- Structure type installed
- Availability of material (rock, jersey barriers, riprap, logs)
- Site location and access

Channel Treatments

Debris Basin

What – Specially engineered and constructed emergency basin for storing large amounts of sediment moving in an ephemeral stream channel. Designed to trap at least ~ 50–70 percent of expected flows.

Purpose – Designed to store runoff and sediment; often the last recourse to prevent downstream flooding, sedimentation, or threats to human life and property. Provide immediate protection from floodwater, floatable debris, sediment, boulders, and mudflows.

Effectiveness – No quantitative information is available on effectiveness. Debris basins are considered to be a last resort because they are expensive to construct and require commitment to long-term repeated maintenance following runoff events.

Where

- Areas with moderate- to high-burn severity.
- Areas where high-value resources are imminently threatened.
- Sites with the capacity to trap the estimated debris flow volume.
- Sites with access available for construction and maintenance.

Cost – Expensive; costs depend on the following factors:

- Location and access
- Size of debris basin
- Availability of material
- Frequency of maintenance

Road and Trail Treatments

Outsloping

What – Altering road template. Outsloping is accomplished with an excavator, dozer, and grader (the excavator pulls back fill and places the material in the ditch; the dozer assists in moving and reshaping the road profile; and the grader completes the final profile).

Purpose – Disperse water along fill slope and reduce erosion; prevent concentration of flow on road surface that would otherwise cause rill, gully, and rut erosion.

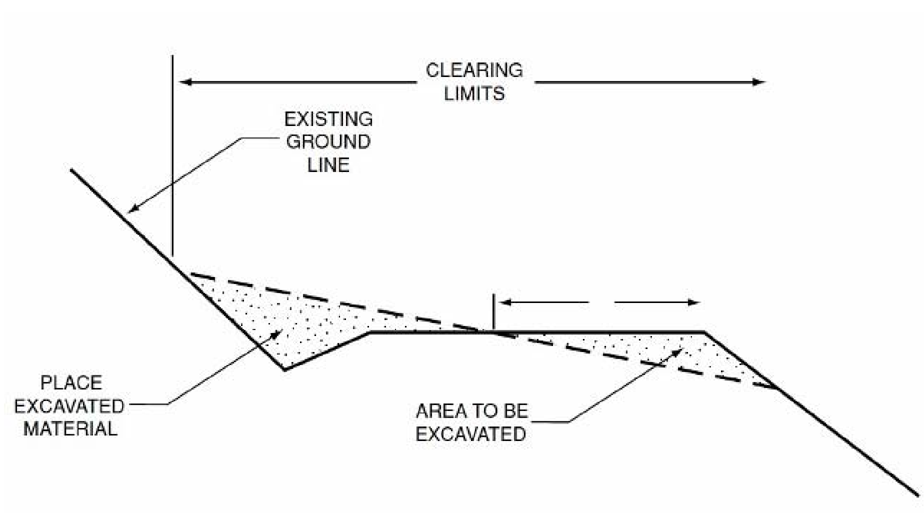
Effectiveness – No effectiveness monitoring data is available. Informal observations indicate immediate and long-term facility and resource benefits, including less sediment delivered to stream channels and reduced road maintenance. In areas with highly erodible soils, outsloping roads with unvegetated soils may increase erosion. Outsloping is often combined with other road treatments, including rolling dips and armored crossings to control water.

Where

- Within areas of high- and moderate-burn severity where loss of control of water is a risk particularly on flat road grades (< 10%).

Cost – $2 per linear foot. Additional factors include:

- Road prism shape (inslope or outslope)
- Size and extent of existing berm
- Presence and extent of vegetation



Road and Trail Treatments

Rolling Dip/Water Bar

What – Altering road template.

Purpose – Rolling dips are used to drain water effectively from the road surface and prevent concentration of water.

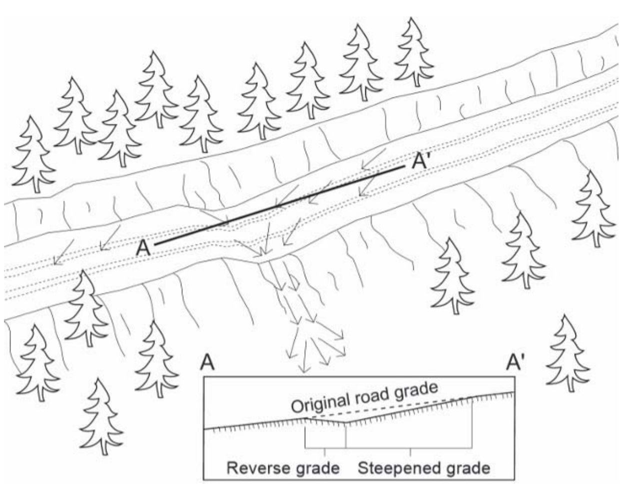
Effectiveness – No effectiveness monitoring data exists on rolling dips. Rolling dips and outsloping are common treatments used to disperse flows and prevent stream diversion. Rolling dips are constructed easily with a dozer but often are too short in length, or too shallow to contain the expected flows. Often, a rolling dip/water bar is armored and used instead of a culvert upgrade because of its relatively low cost. However, it may erode away with strong currents in high discharge.

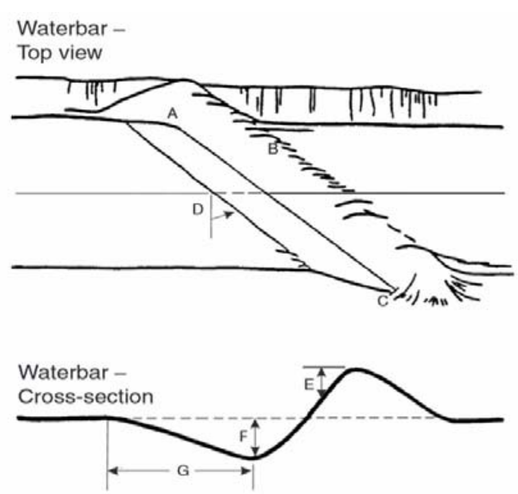
Where

- Roads with a continuous grade and infrequent drainage structures.
- Roads with grades less than 15 percent.

Cost – $390–1200 per dip. Additional factors include:

- Production rates
- Amount of excavation and material movement
- Equipment necessary
- Armoring requirements





Road and Trail Treatments

Overflow Structures

What – Structures such as armored rolling dip, overside drain, or imbricated (overlapping) rock-level spreader.

Purpose – Used on roads to control runoff across the road prism and to protect the road fill. Armored rolling dips provide increased water flow capacity when hydrologic analysis indicates the current pipe size is too small for the short-term increased storm runoff created by fire. Dips prevent stream diversion by safely channeling increased flows back into the channel. Overside drains (berm drains and down drains) are placed in stream crossings where no culvert or armoring exists and in locations where the embankment (fill slope) needs protection. Imbricated rock-level spreaders have been used on high standard roads including highways and county roads. The imbricated rock-level spreader is a permanent structure that is built with large rock placed in a stairstep (shingled) design on excavated benches with either little or no grade along the revetment's length. The spreader protects the road fill from overland flows.

Effectiveness – Armored rolling dips are effective low-cost treatments when properly designed and implemented. Qualitative monitoring data of armored rolling dips found erosion problems when the dip was too short and when insufficient riprap was used on the fill slope. Overside drains fail if not properly designed, installed, and maintained. Initial qualitative monitoring indicated imbricated rock-level spreaders (rock armored overflow) are effective when they discharge directly onto a vegetated/wooded zone.

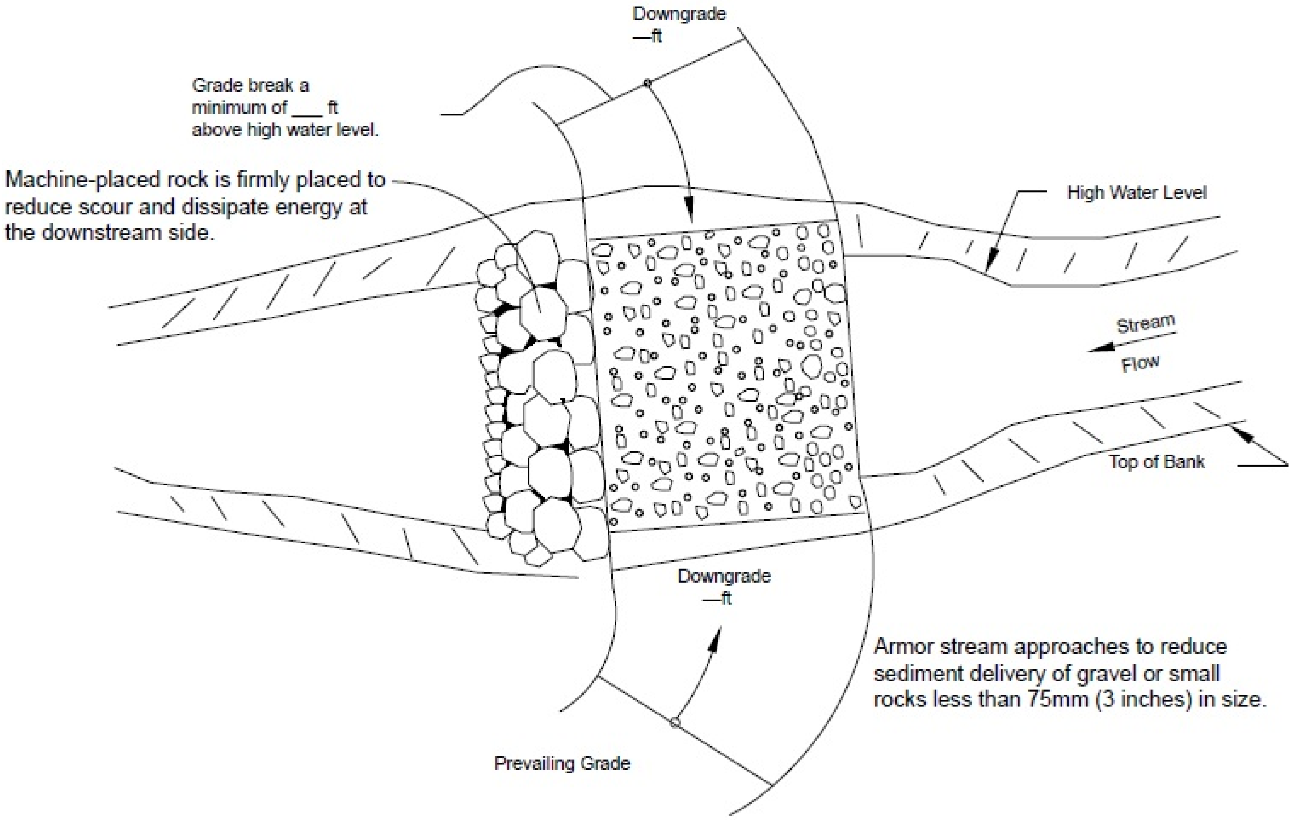
Where

- Roads located below high-and moderate-burn severity areas.
- Road segments that have a long continuous grade and infrequent drainage.
- Roads that are insloped.

Costs – Treatment vary in cost. Cost estimates can be developed based on material and installation requirements.

Road and Trail Treatments

Low-Water Stream Crossing



What – Culverts are temporarily removed and replaced with natural fords, vented ford pipes, and low water bridges during extreme runoff events.

Purpose – To prevent stream diversion and keep water in its natural channel. This prevents erosion of the road fill, reduces adverse effects to water quality, and maintains access to areas once storm runoff rates diminish.

Effectiveness – Ford crossings effectively eliminate loss of water control at road/stream crossing. However, poor design or implementation can result in damage to infrastructure and reduced water quality. Informal monitoring indicates that flexible structures adjust to changes and are not prone to undercutting. Boulder or riprap structures are long enough to avoid being outflanked by high flows. Jersey barriers are less effective as an endwall material since they are not flexible.

Where

- Roads crossing ephemeral or seasonally flowing channels.
- Culverts that are at risk of plugging and diverting from increased runoff and bedload.
- Road crossings where high sediment delivery is expected.
- Roads where water overtops the road continuously or intermittently during and following mild floods.

Costs – $500–2500 for an unvented ford; costs increase for a vented ford or low-water bridge. Additional factors include:

- Amount of material to be moved from stream channel
- Amount of riprap required to armor exposed and erodible slopes
- Location
- Depth of fill or embankment

Road and Trail Treatments

Culvert Modification

What – Culvert modification addresses flooding and debris concerns as a result of fire. Usually involves upgrading the culvert size for increased runoff and associated bedload and debris.

Purpose – By increasing the flow and debris passage capacity, road damage is prevented or reduced.

Effectiveness – Evaluation of this treatment is only qualitative. The treatment rates 'well' when new culverts are installed prior to the first rains. 'Poor' ratings reflect the inability to perform the upgrade in a timely manner or when culverts are still not large enough to handle runoff events.

Where

- High-burn severity watersheds.
- Drainages with undersized culverts.
- Road access is required.

Costs – $20,000 to $150,000 per structure. Additional factors include:

- Culvert size (diameter and length) and type
- Site location and access
- Fill (removal and replacement)
- Headwall and endwall

Road and Trail Treatments

Debris Rack and Deflectors

What – A debris rack is a structure placed across a stream channel to collect debris before it reaches a culvert entrance. A debris deflector is a structure (usually V-shaped with apex pointed upstream) placed at the culvert inlet to route the major portion of debris away from the culvert entrance.

Purpose – Designed to protect culverts from catastrophic failure by catching floatable debris that otherwise would likely plug culverts and cause stream diversion. By protecting culverts from failing, these structures protect transportation infrastructure, public safety, and downstream resource values.

Effectiveness – No quantitative data exists on the effectiveness of debris structures. However, anecdotal information indicates they can be effective with proper implementation and maintenance. Problems can occur if the design structure is too small for the stormflows and associated debris.

Where

- Culverts at risk of plugging with debris.
- Where downstream infrastructure, public safety, or other resources are at risk.

Cost – $100–4000 depending on material. Log racks built with onsite burned logs are economically efficient. Structures constructed with heavy rail or steel range from $3000 to $30,000 or more depending on the size and materials required. Additional factors include:

- Site location and access
- Materials required for implementation
- Number of structures

Road and Trail Treatments

Riser Pipes

What – Riser pipes function to sieve debris and allow passage of water. Riser pipe allows accumulation of bedload sediments released from a drainage due to the loss of soil cover and reduced infiltration from water repellant soils. The sediment and ash captured in the basin can be removed with a backhoe.

Purpose – Risers are used to protect road infrastructure, especially those with large fill, from failure. Riser pipes help prevent culverts from plugging with sediment and floating debris. Pipes capture sediment and reduce downstream impacts to water quality. Riser pipes also reduce peak flows by storing water and sediment.

Effectiveness – No formal effectiveness monitoring data exists for risers. However, reports indicate risers performed well when maintained. Problems occurred when structures were not routinely checked and debris was not removed from the basin. Risers are temporary treatments that are easily disassembled when no longer needed. Risers are installed quickly and at a low cost.

Where

- Access at road crossings with a culvert inlet is limited by conventional equipment (backhoe).
- Drainages with high-burn severity and erosion predictions indicate a high risk of sediment delivery.
- Channels that have high bedload transport capabilities.

Cost – $750–1400 for labor and material. Additional factors include:

- Location and access
- Culvert size and inlet condition

Road and Trail Treatments

Catchment-Basin Cleanout

What – Mechanical equipment is used to clean out organic debris and sediment deposits in stream channels, above culverts, and in catchment basins ahead of anticipated runoff events.

Purpose – To prevent organic debris and sediment deposits from becoming mobilized in debris flows and flood events. Intended to protect transportation and facility infrastructure.

Effectiveness – No quantitative effectiveness monitoring data is available on catchment basin cleanout. However, anecdotal information suggested the treatment is effective.

Where

- Locations where cleanout can be done prior to the first damaging rain.
- Road crossings where existing sediment reduces culvert capacity.
- Areas with high values-at-risk.

Cost – \$200–2000 for each basin. Additional factors include:

- Amount of material that is removed
- Location and access

Road and Trail Treatments

Storm Inspection and Response (Storm Patrol)

What – On-the-ground inspection and clean out, if necessary, of critical infrastructure during, after, or between precipitation events that may result in loss of water control.

Purpose – Intended to keep culverts and drainage structures functioning on roads where access is required by cleaning sediment and debris from the inlet. The treatment is used in lieu of more costly upgrades that are not feasible due to expense or time frame. Storm inspection and response performed during runoff events should be conducted with caution.

Effectiveness – No formal effectiveness monitoring data exists on storm inspection and response. Informal observations indicate cost effectiveness because some road problems are avoided with timely clearing and cleaning of road crossings. However, challenges include maintaining a dedicated inspection team over time, and where excessive areas to patrol result in inadequate coverage.

Where

- Road crossings where high sediment and debris is anticipated.
- Road access is necessary throughout the storm season.
- Roads susceptible to landslides.

Cost – Equipment rates per day: backhoe $390; front-end loader $465; four-person crew $970. Additional factors include:

- Location and access

Road and Trail Treatments

Trail Stabilization

What – Trail stabilization methods include rubber belt and rock waterbars, rock spillways, and rolling dips.

Purpose – Designed to provide drainage and stability to reduce trail damage and erosion.

Effectiveness – No quantitative data exists on the effectiveness of this treatment.

Where

- On trails lacking adequate drainage features for anticipated runoff.
- Trails within or below high-burn severity areas.
- Trails with sustained grade through burned areas that lack adequate drainage.
- Trail segments that have the potential to deliver sediment to streams.
- Trails where previous drainage structures were damaged by the fire.

Cost – $1000–3000 per mile. Additional factors include:

- Number of structures required within the treatment area
- Availability of material

Road and Trail Treatments

Road Decommissioning

What – Mechanical equipment such as an excavator or dozer is used to decommission unauthorized roads that are destabilized as a result of loss of vegetation following high burn severity.

Purpose – Intended to improve infiltration, restore hillslope hydrology, and reduce erosion following subsoiling (tilling), recontouring road fill, and restoring drainage through the road prism using mechanical equipment.

Effectiveness – No quantitative data is available on soil erosion rates. However, visual inspection revealed that treatment objectives to improve infiltration and reduce erosion by restoring the slope were achieved in treated areas.

Where

- Hillslope with multiple unclassified roads.
- Areas with high-burn severity and high soil erosion potential.

Cost – $7000–8000 per mile. Additional factors include:

- Location and access
- Equipment type and size necessary to implement the treatment

Treatment Selection Tables

Post-fire Treatments Comparison Table

Objective	Hillslope Treatments					Erosion Barrier Applications			
	Dry Mulch	Wet Mulch	Slash Spreading	Seeding	Soil Scarification (with seeding)	Erosion Control Mats	Log Erosion Barrier	Fiber Rolls	Silt Fence
Reduces Erosion	1	2	3	3	3	1			
Increases Cover	1	2	2	3		1			
Improves Moisture Retention	1	2	3	3		1			
Provides Surface Roughness	1	3	3	3	3	1			
Traps Sediment							2	2	1
Increases Infiltration	2	2		3	3	1			
Reduces Slope Length							2	2	
Slows Runoff Velocity							2	2	
Provides Seedbed	2	3			3	1	2	2	

1 = Meets objective

2 = Partially meets objective

3 = Rarely or seldom meets objective

No ranking indicates objective is not applicable to treatment.

Post-fire Treatments Comparison Table

Objective	Channel Treatments					
	Checkdam	In-Channel Tree Felling	Grade Stabilizer	Stream Bank Armoring	Channel Deflector	Debris Basin
Traps Sediment	1	2				1
Provides Grade Control			1			
Reduces Velocities	2	2				
Slows Sediment Delivery	2	2				1
Attenuates Peak Flow	2	2				1
Reduces Streambank Erosion				2	2	
Durability of Structure	2	2	2	2	2	1
Maintenance Needs	moderate	low	low	low	low	moderate

1 = Meets objective

2 = Partially meets objective

3 = Rarely or seldom meets objective

No ranking indicates objective is not applicable to treatment.

Post-fire Treatments Comparison Table

Road and Trail Treatments

Objective	Outsloping	Rolling Dip/ Water Bar	Overflow Structures	Low-Water Stream Crossing	Culvert Modification	Debris Rack & Deflectors	Riser Pipes	Catchment -Basin Cleanout	Storm Inspection & Response	Trail Stabilization	Road Decommissioning
Improves Hydraulic Capacity		1	1	1	1		1			1	
Shortens Flow Length	1	1									
Prevents/ Reduces Plugging of Culverts			1	1	1	1	1	1	2		
Prevents/ Reduces Diversion	1	1	1	1					2		
Traps Debris						1					
Reduces Road Erosion	1	2	1	2							2
Disperses Flows	1		1							2	2
Protects Road Fill	3		1				1				

1 = Meets objective

2 = Partially meets objective

3 = Rarely or seldom meets objective

No ranking indicates objective is not applicable to treatment.

Useful Definitions

Bedload: the sand, gravel, boulders, or other debris transported by rolling or sliding along the bottom of a stream.

Channel Deflector or Vane: act to guide flow away from bank, reduce bank erosion, promote local sedimentation and encourage vegetation growth. Common names and designs include j-hooks, rock barbs, and single- or double-wing deflectors.

Debris Flow: a moving mass of mud, sand, soil, rock, water and in the case of wildfires, woody material (tree branches of all sizes) that travels down a slope under the influence of gravity.

Ephemeral Stream: ephemeral portions of streams flow only in direct response to precipitation. Dry washes and arroyos are generally classified as ephemeral streams.

Fill slope: the surface area formed where soil is deposited to build a road or trail.

Hillslope: Hill side.

Inslope (road): grade slopes toward inside ditch.

Outslope (road): grade slopes toward fill slope.

Outsloping: the downhill side of a road where the side of the road slopes with the hill at or near the natural contour and runoff is allowed to drain down the hill without being channeled into a ditch or other water-control device. Outslopes are usually associated with a road in steep terrain which is literally cut into the side of the hill.

Overside Drains: pipes, downdrains and spillways used to protect slopes against erosion by collecting surface runoff and conveying it down the slope to stable drainage.

Runoff: Movement of water across surface areas of a watershed during rainfall events.

Slope/Grade: refers to the inclination of a physical feature, landform or constructed line to the horizontal.

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