FORESTRY AND POST-FIRE BMPS

EROSION & SEDIMENT CONTROL

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<u>EROSION & SEDIMENT CONTROL</u>:

AERIAL SEEDING

DEFINITION

Re-establishing permanent vegetation after a wildfire provides long-term erosion control, may restore lost habitat values, and may help suppress weed invasion after a wildfire.

APPLICABILITY

Loss of vegetation leaves land vulnerable to increased runoff, erosion, and sedimentation. It also increases weed spread and growth; degrades habitat; and impairs forest regeneration.

It takes time and favorable climatic conditions to establish vegetation from seeding operations. Therefore, it may be six months or a year before the full benefits of seeding are realized. Seeding after wildfire must be combined with other land treatments, such as mulching or contour felling trees, to provide an immediate erosion control benefit, and to assure the seed remains in place until it can germinate.

When is the right time to seed after a fire?
Seed grasses and forbs in late fall or late winter (even if there are a few inches of snow). To improve the probability for a successful seeding, use a national or local weather services to time seeding within 30 days of precipitation. The prime time to seed is immediately prior to the ground freezing. Trees or shrubs should be planted in the early spring when plants are dormant.

What areas need to be seeded?
Severely burned sites should be seeded to decrease the likelihood of erosion and sediment movement down slopes, to discourage weed invasion, and to fulfill management objectives.

The area to be seeded should have adequate soil to support vegetation. Seeding slopes steeper than 60 percent is difficult, and not especially effective for reestablishing permanent vegetation. These steep slopes may need the use of erosion control mats or hydroseeding with a tackifier to keep soil and seed in place. These methods are expensive so use only on critical areas.

Vegetation in areas of light and moderate burn severity will recover on its own after a wildfire, and seeding perennial species is usually not necessary. Seeding a short-lived species may provide some ground cover, stabilize soil, and reduce weed spread until permanent vegetation reestablishes.

How should the seeding be done?
Most post-fire seeding is done by hand-held equipment, use of ground equipment, or by aircraft. Landowners can seed small areas using a hand-crank broadcast seeder. If there is equipment

access to the site and the slope is less than about 30 percent, it is usually easier and more cost effective to seed areas larger than 1to 2 acres with broadcast seeders mounted on all-terrain vehicles or tractors. Aerial seeding is used on large contiguous areas and on slopes too steep or otherwise inaccessible for ground equipment. Seeding with a hydromulching operation should be considered when revegetation is protecting high value properties immediately downstream of the area being seeded. If fire seals or rain smooths soil surface, then it may be helpful for small areas to rake by hand and for larger areas to roughen up the surface mechanically prior to broadcast seeding, for improved success.

What species should be used?
Native species seed mixes are well adapted to site soils and climate. Perennial native grasses and forbs can be slower to establish than introduced species but provide long-term cover for reseeded sites. Short-lived perennials can be added to the seed mix to provide immediate benefits. For example, slender wheatgrass is a short-lived native grass that establishes quickly. Over time, slender wheatgrass cover will decrease as other native species fill the site.

Small grains are useful when quick establishment is key; however, they only provide one year of protection. Revegetate with sterile annual species where perennial grasses will recover naturally, including moderately burned sites with slopes greater than 15 percent. For severely burned areas it would be appropriate to include perennial species with the small annual grains. When purchasing seed, use certified seed of a known variety to get the best results. If a specified variety is not available, be sure the original seed (germplasm) source is compatible with the precipitation, soil, and elevation of the revegetation site. Check the seed label to be sure seed does not contain any noxious weeds.

Most seeding recommendations are based on drill seeding rates and expressed in terms of pure live seed (PLS) pounds per acre (PLS = percent Purity x percent Germination). Broadcast rates for burned areas should be at least double the drill seed rates.

What variety of seeds should be used?
Contact the local NRCS, Extension Service, or conservation district office for recommended species, varieties, and seeding rates.

What should be done along with seeding?
Mulching will stabilize the soil surface to prevent movement of soil particles and loss of seed. Use certified weed-free straw or grass hay mulch applied at 70 pounds per 1,000 square feet. (about 43 bales per acre). Seed the site before applying mulch to ensure the seed is in contact with the soil. Do not include fertilizer because it will promote weed growth. Use netting to keep the mulch in place on small areas of steep slopes or use erosion control blankets that act as mulch. Hydroseeding with a tackifier can also provide site stability. It is expensive but it can be accomplished in one operation. Maintain seeded areas by repairing any spots of seeding failure with new seed and mulch, if possible.

LOP AND SCATTER

DEFINITION

A hand method of removing the upward-extending branches from tops of felled trees to keep slash low to the ground, to increase the decomposition rate, to lower the fire hazard or as a pretreatment prior to burning.

APPLICABILITY

Leaving more slash in the woods may be good for forest fertility, but there is a fi re hazard associated with slash, particularly on drier sites, where woody material decomposes more slowly. Most western states have rules to keep fire risk within acceptable limits. Logging slash must be reduced to an acceptable level to release the landowner or operator from liability for any forest fi res that start on or move through the property. Slash is often broadly described as branches and tops from logging or accumulated from a storm, but this article focuses primarily on material smaller than three inches in diameter. Material larger than three inches in diameter (coarse woody debris) is often best left in place, as it is much less of a fi re hazard and benefits wildlife and soil health.

Relatively small amounts of slash can be cut into smaller pieces (so they lay flatter to the ground) and scattered about the forest floor. This method, commonly referred to as “lop and scatter”, is fairly standard with pre-commercial thinning slash, but it can be used for logging slash as well. The objective is to reduce the slash to a depth of 24 inches (preferably less). For the first few years after the treatment there will be some elevated fi re risk (and it may not be too visually appealing either) but after one good winter’s snow, the material is typically compressed, needles fall off, and it is mostly out of sight. The slash will decompose more quickly on wetter sites.

LOG EROSION BARRIER (REVETMENTS)

Description

These revetments are systems composed of logs, rootwads, and boulders selectively placed in and on streambanks. These revetments can provide excellent overhead cover, resting areas, shelters for insects and other fish food organisms, substrate for aquatic organisms, and increased stream velocity that results in sediment flushing and deeper scour pools.

Applicability

- For stabilization and to create instream structures to improve fish rearing and spawning habitat.
- Suited to streams where fish habitat deficiencies exist.
- Should be used in combination with soil bioengineering system or vegetative plantings to stabilize the upper bank and ensure a regenerative source of streambank vegetation.
- This BMP has a narrow range of applications and should only be used based on as assessment by a professional river engineer.

Design Considerations

- Placement is critical with regard to the bank at full elevation and longitudinal profile.
- This type of BMP requires professional design and installation.

Effectiveness

- Effective on meandering streams with out-of-bank flow conditions.
- Will tolerate high boundary shear stress if logs and rootwads are well anchored.
- Enhance diversity of riparian corridor when used combination with soil bio-engineering systems.
- Have limited life depending on climate and tree species used.

BAER TREATMENTS (BURNED AREA EMERGENCY RESPONSE TREATMENTS)

DEFINITION

The Burned Area Emergency Response (BAER) program is designed to identify and manage potential risks to resources on National Forest System lands and reduce these threats through appropriate emergency measures to protect human life and safety, property, and critical natural or cultural resources. BAER is an emergency program for stabilization work that involves time-critical activities to be completed before the first damaging event to meet program objectives:

PURPOSE

- Determine whether imminent post-wildfire threats to human life and safety, property, and critical natural or cultural resources on National Forest System lands exist and take immediate actions, as appropriate, to manage the unacceptable risks.
- If emergency conditions are identified, mitigate significant threats to health, safety, human life, property and critical cultural and natural resources.
- Prescribe emergency response actions to stabilize and prevent unacceptable degradation to natural and cultural resources, to minimize threats to critical values resulting from the effects of a fire, or to repair/replace/construct physical improvements necessary to prevent degradation of land or resources.
- Implement emergency response actions to help stabilize soil; control water, sediment and debris movement and potentially reduce threats to the BAER critical values identified above when an analysis shows that planned actions are likely to reduce risks substantially within the first year following containment of the fire.
- Monitor the implementation and effectiveness of emergency treatments that were applied on National Forest System lands.

APPLICABILITY

While many wildfires cause minimal damage to the land and pose few threats to the land or people downstream, some fires result in damage that requires special efforts to reduce impacts afterwards. Loss of vegetation exposes soil to erosion; water run-off may increase and cause flooding, soil and rock may move downstream and damage property or fill reservoirs putting community water supplies and endangered species at-risk.

The BAER team presents these findings in an assessment report that identifies immediate and emergency actions needed to address post-fire risks to human life and safety, property, cultural and critical natural resources. This includes early detection and rapid response (EDRR) treatments to prevent the spread of noxious weeds into native plant communities. The BAER report describes watershed pre- and post-fire watershed response information, areas of concern for life and property, and recommended short-term emergency stabilization measures for Forest Service lands that burned.

In most cases, only a portion of the burned area is actually treated. Severely burned areas steep slopes, and places where water run-off will be excessive and may impact important resources, are focus areas and described in the BAER assessment report if they affect critical values. Time is critical if the emergency stabilization measures are to be effective.

A BAER assessment team conducts field surveys and uses science-based models to rapidly evaluate and assess the burned area and prescribe emergency stabilization measures. The team generates a “Soil Burn Severity” map by using satellite imagery which is then validated and adjusted by BAER team field surveys to assess watershed conditions and model potential watershed response from the wildfire. The map identifies areas of soil burn severity by categories of very low/unburned, low, moderate, and high which may correspond to a projected increase in watershed response. The higher the burn severity, the less the soil will be able to absorb water when it rains. Without absorption, there will be increased run-off with the potential of flooding.

SOIL AND SLOPE STABILIZATION

DEFINITION

Soil Stabilization is an eligible activity under FEMA and BAER programs that involves projects to reduce risk to structures or infrastructure from erosion and landslides, including installing geotextiles, stabilizing sod, installing vegetative buffer strips, preserving mature vegetation, decreasing slope angles, and stabilizing with rip rap and other means of slope anchoring.

PURPOSE AND APPLICABILITY

Wildfires can quickly alter a landscape and cause soil erosion. However, many ecosystems have the ability to regenerate after a wildfire. The recovery process following a wildfire can be broadly divided into several stages. In the years following a wildfire, the amount of soil erosion can change significantly, and can vary with soil type, climate, and fire intensity. The stages of recovery may include the following phases:

1. Initial response
2. Regeneration
3. Stabilization

During the initial response phase, there may be increased soil erosion due to lost vegetation cover. In the regeneration phase, new vegetation may begin to establish, reducing soil erosion. Finally, in the stabilization phase, the soil and vegetation have reached a state of equilibrium, minimizing erosion and promoting stability. Understanding the different recovery phases can help guide post-wildfire management decisions to promote successful ecosystem restoration.

Immediately Following Wildfire:
Shortly after a fire, soil erosion is usually most severe, with levels often several times higher than pre-fire erosion rates. In parts of Nevada wildfires can occur during the summer months, and monsoonal rains in late summer or fall can bring intense precipitation and winds that cause further erosion in recently burned areas. This is also when the potential for large, debris-filled flash floods is highest. Fall, spring, and summer convective storms, as well as the rainfall delivered by normal westerly storm tracks can also cause increased post-fire soil erosion immediately after fires.

Years Following Wildfire:
One to four years after a fire, soil erosion rates begin to decline as vegetation regrows and becomes established. Two years after wildfire, erosion may be noticeably reduced compared to the year of the wildfire. However, erosion can still be a significant concern, depending on factors such as ecosystem type, precipitation intensity, and fire severity. The potential for intense rain events to cause large-scale erosion and flash floods typically persists for up to four years following a fire.

Longer-Term Recovery:
Four or more years after a fire, as plant succession continues and the burned area becomes filled in with plants, soil erosion gradually decreases and may eventually return to pre-fire levels. The amount of time this takes depends on factors such as ecosystem type, fire severity, weather patterns, and larger climate trends in the years following the wildfire. With proper post-fire management, burned areas can become healthier than pre-fire ecosystems that may have been overcrowded due to fire suppression efforts.

Understanding Soil Erosion After Wildfire
The vegetation, fallen leaves, and accumulated duff that slow and capture water during rainstorms and protect soil particles from the wind can be lost during wildfires. Without a protective layer over the soil, the soil becomes vulnerable to wind and water erosion.

Soil Water Erosion Basics After Fire:
Soil water erosion after a fire occurs when raindrops hit exposed soil, dislodging soil particles that can move downslope as water flows over the soil surface, resulting in sheets of moving soil or concentrating soil and water into rills and gullies. Without plants or fallen leaves to slow the flow of soil and water after a wildfire, the amount of erosion and water that moves from burned slopes into water channels can be many times greater than before the fire.

Soil Wind Erosion Basics After Fire:
Soil wind erosion after a wildfire occurs when wind reaches a high enough velocity to pick up soil particles on exposed soil surfaces and send them airborne. These particles can become dust in the air or move horizontally along the soil surface. Fine ash produced after a wildfire is particularly prone to move by the wind. Soil wind erosion can redistribute soil nutrients and seeds and cause dust clouds near recently burned areas.

Deciding When and How to Stabilize Soils and Guide Recovery in a Burned Area:
After a wildfire, the best action is often to let the land recover naturally. If the burn was low or moderate severity and plant regrowth is visible in the weeks following the fire, intensive interventions may not be necessary. However, in cases of high-severity fires or when soil erosion or gully cutting is a concern, soil stabilization efforts can be implemented to slow erosion and steer land recovery. In some cases, treatments intended to enhance recovery after a wildfire can lead to further degradation due to mechanized disturbance of the soil surface. Consult post-fire professionals before taking actions that could have downstream or downslope consequences. Soil stabilization options vary in effort, cost, and utility, and often a combination of treatments is most effective in addressing erosion happening in different areas and at different scales. Give careful consideration when deciding what treatments to use in different contexts.

Assessing Immediate Risks:
Before taking actions after a wildfire, it is important to identify immediate or large-scale hazards, such as possible flooding or debris flows from upslope or upstream. County emergency managers and NRCS teams can identify these hazards and communicate with landowners after

completing initial burned-area surveys.

Erosion Control Techniques:

Each erosion control technique varies in effectiveness depending on the factors that influence soil erosion. Take care to weigh the pros and cons of each technique in deciding what is appropriate at different scales and locations.

Mulching:

Mulching can be a useful tool in reducing soil erosion after a wildfire, particularly when there is limited plant and litter cover left on the soil surface and limited regrowth occurring at the site. Here are some mulching techniques to consider:

Wood Shred and Wood Chip Mulch:

When immediate erosion control is needed, wood shred can be an effective technique to provide protective cover over the soil and reduce erosion. This mulch contains long, linear wood fragments that are less likely to wash or blow away and are less likely to introduce invasive plant species than other mulch types. Wood chips can also be used, but they may be less effective since they are uniform in size and don't interlock on the soil surface. Wood shred and wood chip mulch can be made on-site using a woodchipper.

Straw and Hay Mulch:

Straw or hay mulch is also effective in reducing erosion. Studies suggest that straw mulch is most effective when spread over 60%–80% of the ground surface within a given area, with a thickness of between 2–3 inches. It's important to ensure that the straw or hay is certified weed-free to reduce the potential for introducing invasive plants that can spread quickly in post-fire environments. Note that it's almost impossible to have completely weed-free mulch. Straw and hay mulches are more likely to blow away in high winds common in the Southwest.

Hydromulch and Soil Tackifiers:

Hydromulching and tackifiers involve applying a wet slurry of water, fiber mulch, and a tackifying agent over the soil surface. While they have been used to stabilize soils after a wildfire, they are not commonly used over large areas due to their tendency to concentrate water flows on long hillslopes and break down quickly after application. Hydromulching may be most appropriate around structures or in areas near surface water sources.

Distributing Slash:

Is made up of tree limbs cut down from burned, dead, or living trees. It can be redistributed on the soil surface and used to reduce soil erosion and create sheltered areas that allow seeds to germinate. However, because it does not create a continuous cover over the soil surface, it is less effective than other types of mulch in reducing soil erosion. Slash is most effective in areas with little to no slope since unanchored slash can easily be moved during rainstorms and cause debris buildup downslope. If used, the slash pieces should have the most contact with the soil surface as possible.

Mulching Considerations:

- Mulch that is deeper than 2 to 3 inches can reduce the ability of existing seeds in the soil to germinate and reduce the effectiveness of seeding efforts that may be applied along with mulch. Thick mulch can also hinder the presence or recovery of biological soil crust that stabilizes soils in some ecosystems.
- In some cases, mulch can facilitate invasive plant growth by keeping moisture close to the soil surface. In areas where weeds are a concern, weed barriers underneath the mulch or extremely thick mulch may reduce invasion.
- Mulching is best suited to areas of high erosion concern and areas that are carefully monitored for invasive plant growth. Extensive or thin mulching may be ineffective and promote the spread of invasive plants.
- Wood and straw mulch can be a fire hazard if a site still has the potential for fire. In such cases, exercise caution when using mulch around structures or near tree bases.
- Take care to minimize soil disturbance when distributing slash or other erosion control interventions. Generally, do not subject recently burned areas to heavy equipment due to the increased probability of soil erosion and potentially introducing invasive plants.

Seeding

A primary goal of post-fire recovery and erosion control is to restore plant cover to a burned area. Seeding with appropriate seed mixes can help achieve this restoration by returning plant cover and diversity to areas that have: (1) moderate- or high-severity burns; (2) large amounts of bare ground; (3) slow plant recovery; and (4) high risk of invasive plants. Seeds that successfully germinate typically begin to provide appreciable ground cover, soil protection, and competition with invasive species 1–3 years after distribution. Seeding is not considered an immediate solution to soil erosion or invasive species control due to the time it takes most native seeds to germinate and become established. The potential for low germination rates of distributed seeds, especially during drought years, means that seeding alone may not result in increased ground cover.

Below are some techniques that can create opportunities for successful seed germination. Using these techniques in combination may provide the best chance of success.

- **Establish a protected area:** Seeding can be most successful when there is a protected area for seeds to germinate. Mulch, erosion barriers, and slash pieces can hold in water and provide microhabitats for seeds. Distributing seeds on the upslope side of these cover types can be an effective way to increase seed germination and establishment.
- **Provide supplemental water:** Providing supplemental water can help seeds become established. Although not practical everywhere, periodic gentle watering with a sprinkler that thoroughly saturates the soil multiple inches below the soil surface can increase seed germination and success in priority areas.
- **Provide raking:** Gentle raking with a hand rake to break up the top 4 centimeters of soil before seeding can increase seed contact with the soil and germination success in areas that have physical soil crusting or hydrophobic soils. This is most appropriate over small

areas, as even minor disturbances to the soil over larger areas can increase soil erosion.

- **Apply seed during gentle rain periods:** Seeds may have a greater chance to successfully germinate when applied during times of the year when rain is expected to fall with low to moderate intensity. In burned areas, high-intensity rains, such as monsoonal rain, can wash seeds away while dry times of year can limit germination. Adding seeds after the monsoon season but before snowfall in burned areas may allow seeds to take advantage of early spring snowmelt and gentle spring rains, if they occur.
- **Use adapted seeds:** Purchasing seeds that are adapted to the local climate can increase the likelihood of their germination and establishment. Seed mixes that offer diverse plant types and do not contain non-native or aggressive plant species provide the best opportunity to increase plant diversity in the long term.

STORMPROOFING NON-PAVED ROADS

PURPOSE

Roads are storm-proofed when runoff and sediment delivery to streams is strictly minimized. This is accomplished by dispersing road surface drainage, protecting stream crossings from failure or diversion, and preventing failure of unstable cutbanks or fillslopes from delivering sediment to a stream.

IMPLEMENTATION

Stream Crossings:

- Ensure that culvert inlet, outlet, and bottom are open and in sound condition.
- Ensure that any plastic culverts have not melted due to exposure to heat.
- Ensure that culverted stream crossings have no diversion potential (functional critical dips in place).
- Ensure that culverted stream crossing inlets have low plug potential (single-post trash rack). You should expect streams to flow with more debris than has been previously observed.
- Ensure that bridges have stable, non-eroding abutments. Check the decking as well as the underside of wooden brigs for any significant damage.

Cutbanks and Fillslopes:

- Monitor cutbanks and fillslopes for slumping, rock falls, or other landsliding. These areas may become more unstable due to lack of vegetation.
- Excavated soil should be placed in locations where it will not enter a stream.
- Excavated soils should be placed where it will not cause further slope failures or landslides.
- Unstable soils may be too saturated to excavate during the rainy season so treatments may have to wait until dryer time of year.
- Monitor access and carry a chainsaw - fire-damaged trees may fall on road surface throughout winter.

Road Surface Drainage:

- All road surfaces can be storm proofed by implementing a variety of surface drainage techniques including construction of rolling dips and /or waterbars, and berm removal.
- Ditches and cutbanks can be storm proofed by frequently draining them with rolling dips or waterbars &/or ditch relief culverts. Ensure that these features

do not discharge to streams or onto active (or potentially active) landslide areas.

- Monitor outflow from rolling dips, waterbars, and ditch relief culverts during the rainy season.
- Watch for gully development along the outside edge of the road throughout the rainy season. If gullies do develop then dewater them to best extent possible.

INVASIVE WEED MANAGEMENT

NON-CHEMICAL

PURPOSE

Fire-produced disturbances directly favor colonization of new and existing noxious weeds. To prevent or reduce establishment of noxious weeds, burned and adjacent areas should he managed under a burned-area integrated weed management (IWM) plan.

When desired plant cover is inadequate, the first step of many burned- area IWM plans is revegetation. Revegetation, when needed, can decrease noxious weed invasion by introducing desired plants that compete with noxious weeds for resources.

An IWM plan identifies high-quality areas (that is, areas with high desired plant cover) and protects them from noxious weed invasion and establishment.
For small patches of weeds:

- prioritize your management efforts,
- map isolated weed populations, and,
- determine the size and density of weed patches. Low-density patches respond more quickly to eradication than high-density patches.

Large infestations are very difficult and expensive to manage. If infestations have developed, managers should work toward:

- reestablishing healthy plant communities by reducing the competitive vigor of the infestation through combinations of mechanical, chemical, cultural (including revegetation) or biological methods -or all these methods together.

Frequent monitoring of the site and annual evaluations w'4! determine the success of the plan. Comparing one year to the next allows the manager to identify and make changes needed to attain land management goals.

Evaluating the Potential for Natural Recovery:

Before formulating a burned-area weed management plan, determine the degree of burn severity and estimate the degree of noxious weed cover on the area before it burned. These facts will allow you to assess the potential for natural recovery of the plant community and whether to revegetate or to allow for natural regeneration.

Plant survival is largely determined by burn severity. Low-severity fires favor plant survival over high-severity fires. However, survival can also be influenced by a plant's reproductive and structural characteristics.

As a rule, plants that can sprout from roots, from soil surface crowns, and from rhizomes survive fire better than plants that reproduce strictly from seed. However, seeds produced by plants that evolved with frequent fires, such as lodgepole pine, are tolerant of higher fire temperatures and actually require heat to germinate.

Many noxious weeds can reproduce vegetatively from rhizomes. These weeds have extensive root systems that can grow quite deep. The roots of leafy spurge and Canada thistle can extend to depths of 26 feet and 22 feet respectfully. Because even the most severe fires typically damage roots only to four inches below the soil, these noxious weeds have an excellent chance of surviving even very severe fires.

Monitoring & Evaluation:
Monitoring is helpful in evaluating the effectiveness of grazing and weed management control efforts. The following monitoring components should be included to properly evaluate the effectiveness of an integrated weed management plan:

- **Annually monitor** areas like fire breaks (dozer lines), equipment staging areas, livestock feeding grounds, and other high disturbance areas, which are most likely to have weeds show up post-fire,
- **Evaluate** activities that minimize weed invasions, such as defer moving livestock through an area with a new weed species until it is removed or contained,
- **Measure** the size and density of weed infestations, and
- **Record** information on past and current weed management.