BUREAU OF LAND MANAGEMENT
ELKO FIELD OFFICE
BURNED AREA EMERGENCY REHABILITATION TEAM

Elko 21 Complex

SOIL AND WATERSHED RESOURCE ASSESSMENT

I. OBJECTIVES

- Assess overall watershed changes from fire, particularly those that pose substantial threats to human life, property, and critical natural resources.
- Identify the most critical soil and watershed areas and issues based on increased flood potential and loss of soil resources from water and wind, and prescribe treatments to mitigate impacts and risks.

II. ISSUES

- Threats to human life, property and critical natural resources in and adjacent to the burned area from accelerated runoff and erosion
- Threats to water quality of streams and reservoirs.

III. OBSERVATIONS

A. Background

Geology/Physiography: The Elko 21 Complex burned 220,497 acres within the Owyhee High Plateau MLRA (Major Land Resource Area) and the Central Nevada Basin and Range MLRA. The Owyhee High Plateau MLRA surrounds Elko, Nevada and extends to the northeast corner of the state. The Central Nevada Basin and Range MLRA lies south and east of Elko, Nevada.

Within both the Owyhee High Plateau MLRA and the Central Nevada Basin and Range MLRA are moderately steep to steep mountain slopes underlain by both volcanic and sedimentary rocks. Landscapes slope gently to foothills and valley floors, which are underlain by lake sediments and recent alluvium. Many canyons have well defined alluvial fans at their mouth spreading out onto valley floors.

Elevations range from 4,500 feet to more than 10,000 feet. Annual precipitation averages from 5 to 8 inches in lower elevations, 8 to 15 inches in most of the area, and 20 to 30 inches in the mountains. Precipitation is typically snow in the winter months, and rain in spring and summer.

In the uplands, the volcanic materials vary from basaltic to intermixed ash and tuffaceaous materials. Sediments include erosion-resistant, consolidated siliceous materials and conglomerates, to limestone, shale, and sandstone, with some layers of erodible bentonite clay. Debris flows and recent alluvial deposits in channels and foothills include a range of particle size from very coarse (boulders, stones, and cobbles) to very fine clays in wide flat valley bottoms.

Definitions of terms commonly used in soil and watershed assessments:

Term	Definition
Fire Intensity	Based on temperature, flame length, heat of combustion and total amount and size of fuel consumed. Accounts for convective heat rising into the atmosphere and fire effects on the over story.
Fire Severity	Based on temperature, moisture content of duff and fuels lying on the ground, heat of combustion and total amount of duff and ground vegetation consumed. Accounts for the amount of conductive and radiant heat that goes down into the soil, affecting soil characteristics.
Burn Severity	A relative measure of the degree of change in a watershed that relates to the severity of the effects of the fire on watershed conditions. Burn severity is delineated on topographic maps as polygons labeled high, moderate, and low/unburned.
Watershed Response	A qualitative degree and/or modeled measure of how a watershed will respond to precipitation. Parameters include pre-existing soil moisture; amount and duration of rainfall; lag time between initiation of storm and peak flow runoff; and peak flow discharge (maximum cfs generated by a storm) and sediment yield. Changes in the characteristics of a watershed brought about by a fire increase the efficiency with which a watershed yields runoff. Burned watersheds shed more water faster.

B. Reconnaissance Methodology

Reconnaissance and field evaluations were conducted to identify the spatial distribution and extent of the fire severity and resulting burn severity and soil conditions. Field evaluations included, but were not limited to:

- soil related fire effects;
- mapping burn severity;
- current channel and culvert condition;
- threats to structures and facilities from storm flow and debris;
- threats to human life and property from wind-blown dust.

Burn Severity: Burn severity is not the same concept as fire intensity. Fire intensity and severity relate to effects on vegetation. Burn severity relates specifically to effects of the fire on soil conditions and hydrologic function (e.g., amount of surface litter, erodibility, infiltration rate, runoff response). Although burn severity primarily is not a reflection of effects of fire to vegetation, vegetative conditions and pre-fire vegetation density are among indicators used to assess burn severity.

Site indicators used to evaluate and map burn severity include soil hydrophobicity (water repellency), ash depth and color (fire severity), size of residual fuels (fire intensity), soil texture and structure, and post-fire effective ground cover. These criteria indicate fire residence time, depth of litter layer consumed, radiant heat throughout the litter layer and ease of detachability of the surface soil. Using these indicators, burned areas are mapped into three relative burn severity categories. These include high, moderate, and low/unburned.

In some cases there may be complete consumption of vegetation by fire, with little effect on soil and watershed function. In general, the denser the pre-fire vegetation, the longer the residence time and the more severe are the effects of the fire on soil hydrologic function. For example, deep ash after a fire usually indicates a deeper litter layer prior to the fire, which generally supports longer residence times.

Increased residence times promote the formation of water repellant layers at or near the soil surface, and loss of soil structural stability. The results are increased runoff and soil particle detachment by water and transport off-site (erosion). The presence of white ash indicates a hotter fire and more complete consumption of organic matter. Powdery ash without identifiable remnants of twigs and leaf litter also indicates more complete consumption.

Generally there is a close correlation between soil properties and the amount of heat experienced by the soil as well as the residence time of the heat in contact with the soil.

The burn severity map then becomes a basis to predict the hydrologic response of soil to the fire, and the rate of natural revegetation of the site following the fire.

It is important to note that burned area map units usually are mapped at no less than 40 acres in size and may include areas of other burn severity, but which are too small to segregate. Small areas of different burn severity can be present in each map unit.

Soil Conditions: Soil related fire effects were evaluated for several parameters that affect soil conditions. These parameters are hydrophobicity, changes in vegetative ground cover and soil structure, and susceptibility to water and wind erosion. Hydrophobicity was evaluated by observing the depth and thickness of a water repellent horizon in surface soils where it exists, and duration of a water drop beading on this surface. Changes in vegetative ground cover as affected by the fire were noted and compared to pre-fire conditions. Loss of soil structure is usually indicated by a change to a powdery soil. Soils susceptible to wind erosion were examined in the field to determine if there was an increased risk of erosion. Soil survey maps and photos were used to assist in making predictions of areas with the greatest risks of wind or water erosion.

Formation of Hydrophobic Soil: When soils are heated by fire, one result can be development of a hydrophobic layer on or in the surface soil horizon. This occurs due to volatilization of organic matter in and on the surface soil that have high amounts of lignin and other waxy compounds. After the fire passes, the gasses cool to a waxy coating on soil particles. The effect is similar to putting wax on a car to cause water to bead up and run off. If the hydrophobic layer is thick, or the degree of water repellence is strong, it can seriously inhibit infiltration of rainfall, increase runoff and detach surface soil particles. This increases flooding, erosion and sedimentation. Some soils can be significantly hydrophobic, even without fire. Vegetation type, amount of organic matter and soil texture are the primary factors that determine whether or not soils will become hydrophobic.

Watershed Response: On-the-ground field observations and aerial reconnaissance were conducted to determine the potential for high runoff response. Channel morphology related to transport and deposition processes were noted, along with channel crossings and stream outlets. Observations included condition of riparian vegetation along perennial streams and the potential for vegetational loss and/or conversion. Burn severity and changes in soil infiltration were considered for runoff potential.

C. Findings

Several fires are not discussed in the findings because they were not identified as posing substantial threats to human life, property or critical natural resources. Those fires are: Wimpy Complex, Charlie, Gamble, 18 Mile, 21 Mile, O'Neil Complex, Chokecherry, Cold Springs, Sheep Pen, Three Mile, Mule, and PattyJack.

Vega

The area of concern in the Vega Fire is in the southwest portion of the fire along the county road. Elevation in this area of the fire ranges from 6,640 to 7,230 feet. Slopes are steep ranging from 30-40%. There are rock outcrops at the tops of the slopes. The average annual precipitation is from 12 to 14 inches. There are three ephemeral drainages in this portion of the fire that drain to and across the county road. The dominant vegetation for the area is Mountain big sagebrush and Douglas rabbitbrush interspersed with perennial grasses such as bluebunch wheatgrass and Idaho fescue.

Burn Severity: Burn severity of the Vega Fire was light to moderate. In the area of concern burn severity was moderate.

Soils: Soils within the area of concern occur on mountains with 15-50% slopes at elevations ranging from 6,500 to 8,000 feet. The soils are moderately deep to deep. Permeability is very slow to slow and runoff is rapid. Hazard of erosion due to water is moderate and hazard of erosion due to wind is slight. The hydrologic soil group for this association is Group C for the two soil types and Group D for the rock outcrop. Group C soils have slow infiltration rates and slow rates of water transmission. Group D soils have very slow infiltration rates and very slow rates of water transmission. In the case of the rock outcrop, there is no infiltration and all precipitation will be runoff. The soils after the fire were not hydrophobic.

Watershed Response: The area of concern has high runoff potential. Slopes are steep and infiltration rates are slow. Rock outcrop dominates the tops of the slopes. Most of the vegetative cover was consumed by the fire.

Values at Risk/Resources to be Protected: There is a county road running along the southern edge of the fire. Rock outcrops and steep slopes with high runoff potential and increased erosion along the road pose a threat to human life and property.

Recommendations: Straw wattles are to be placed on steep slopes and straw bale check dams are to be placed in the ephemeral drainages. The straw wattles will prevent erosion by reducing slope length and slowing the flow of water. Check dams in the ephemeral drainages will also prevent erosion by capturing sediment and will prevent downcutting in the ephemeral drainages.

Proposed location of straw wattles on Vega Fire.

Proposed location of straw wattles on Vega Fire.

Adobe

There are two areas of concern in the Adobe Fire. They are Dorsey Creek to the south and Willow Creek to the north. Elevations for Dorsey Creek range from 6,550 to 6,760. Elevations for Willow Creek range from 6,600 to 7,000. Slopes around Dorsey Creek are steep ranging from 30-40%. Slopes near Willow Creek are moderately steep ranging from 20-30%. The average annual precipitation for both Dorsey and Willow Creek areas is 14 inches. Dorsey Creek is perennial in the southwest portion of the fire and ephemeral from T. 37 N., R. 55 E., Sec. 35 up to its headwaters. Willow Creek is perennial downstream of Willow Springs and ephemeral to its headwaters. An ephemeral tributary to Willow Creek above Willow Springs is of concern within the fire. The dominant vegetation for the area incorporating both Dorsey Creek and Willow Creek is low sagebrush, Idaho fescue and bluebunch wheatgrass.

Burn Severity: Burn severity near the perennial section of Dorsey Creek was moderate. In its transition zone from perennial to ephemeral burn severity was high. In the headwaters, it was light to moderate. Burn severity near the perennial section of Willow Creek was moderate. In the tributary above Willow Springs, burn severity was high.

Soils: Soils in this area occur on mountains with 15-70% slopes at elevations ranging from 6,400 to 8,000 feet. The soils are shallow to moderately deep. Permeability is moderately slow to moderate and runoff is rapid. Hazard of erosion due to water is slight to moderate and hazard of erosion due to wind is slight. Sixty-five percent of this association is Hydrologic Group D, 20% is Group C and 15% is unknown. Group D soils have very slow infiltration rates and very slow rates of water transmission. Group C soils have slow infiltration rates and slow rates of water transmission. The soils after the fire were not hydrophobic.

Watershed Response: Runoff potential is moderate near the perennial reach of Dorsey Creek and high along the transition zone and ephemeral reach in Section 35. Dorsey Creek is incised approximately 15 feet in its transition zone and approximately 4 to 6 feet in the ephemeral reach above the transition zone. Erosion along incised banks was observed in the transition zone during a field reconnaissance. Runoff potential along Willow Creek was moderate below Willow Springs and severe in the tributary above Willow Springs. Willow Creek below Willow Springs is incised approximately 15 feet. Active erosion along the incised banks of Willow Creek was observed as well.

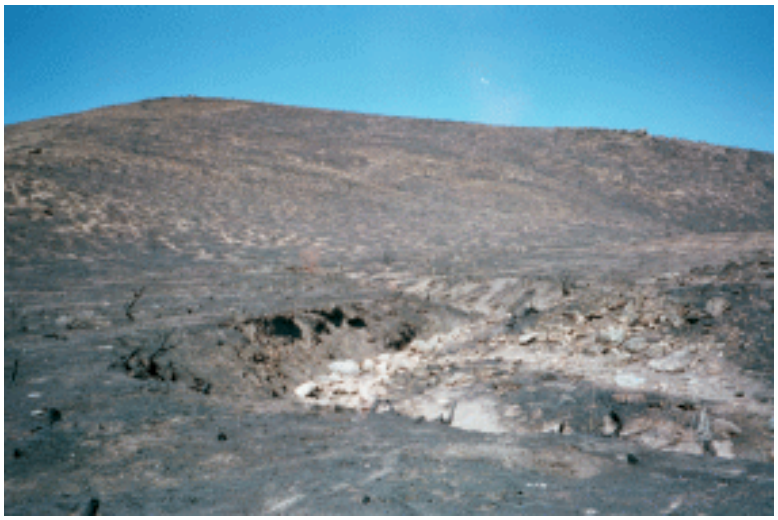
Values at Risk/Resources to be Protected: Dorsey Creek is historical habitat for Lahontan Cutthroat Trout (LCT). LCT populations were estimated at 228.8 fish per mile by the Nevada Division of Wildlife in 1985. In 1999, the were no LCT found. In 1984, the Dorsey Creek watershed experienced peak runoffs approaching 100-year storm events. As a result of the increased flow, Dorsey Creek had incised 10-15 feet in the reaches above Dorsey Reservoir and was causing siltation of the reservoir. The lower reaches of Dorsey Creek have since stabilized. Willow and perennial herbaceous plants species have established and are effectively trapping the excess sediment moving through the channel.

In the upper reaches (the area that burned), the creek has been slower to recover. It is mostly in a functioning-at risk stage with an upward trend. Because it is functioning-at risk, it is important to reduce the amount of sediment entering the upper reaches of Dorsey Creek and to dissipate the energy of overland flows.

The incised portion of Willow Creek is the result of a headcut moving upstream toward Willow Springs. Increased runoff and sediment moving through the system will result in the headcut moving upstream at a faster rate and eventually draining Willow Springs.

Recommendations: Dorsey Creek drainage should be seeded to establish protective cover through the winter and spring to reduce erosion. Excelsior matting should be placed along streambanks along the ephemeral reach for additional stabilization of the soil. Straw bales should be placed in the ephemeral tributary above the transition zone.

Excelsior matting should be placed along the incised portion of Willow Creek to prevent erosion. Straw bale check dams should be constructed along portions of the ephemeral tributary to Willow Creek to prevent sedimentation of Willow Springs. Straw wattles should be placed on steep slopes in the headwaters of the ephemeral tributary to Willow Creek.



Proposed location of Excelsior mat and riparian seeding along Dorsey Creek.

Proposed location of riparian seeding along Dorsey Creek.

Proposed location of Excelsior mat along Willow Creek.

Rabbit

There are two areas of concern in the Rabbit Fire. They are two unnamed watersheds in the central portion of the fire. They will be referred to as critical watershed A to the north and B to the south. Elevations for watershed A range from 6,400 to 8,000. Elevations for watershed B range from 6,700 to 8,300. The average slopes for A are steep at approximately 30%. Slopes for watershed B range from moderately steep to very steep in the headwaters (20-60%). The average annual precipitation for watershed A ranges from 12 to 14 inches. Precipitation for watershed B ranges from 12 to 20 inches. Both watersheds are ephemeral. The dominant vegetation of the watersheds is singleleaf pinyon and Utah juniper. Sagebrush and bunch grasses are also present.

Burn Severity: Burn severity was moderate to high for both watersheds. **Soils:** Soils in watershed A occur on hills with 15-50% slopes. Elevations typically range from 6,400 to 8,000 feet. The soils are shallow. Permeability is moderate and runoff is moderate to rapid. Hazard of erosion due to water is moderate to high and hazard of erosion due to wind is slight.

Soils in watershed B occur on mountains with slopes ranging from 15-50% and elevations ranging from 6,800 to 9,500. The soils are shallow to moderately deep. Permeability is moderate and runoff is medium to rapid. Hazard of erosion due to water is moderate to high and hazard of erosion due to wind is slight.

The majority of the soils in both watersheds belong to Hydrologic Group D. Group D soils have very slow infiltration rates and very slow rates of water transmission. The soils in both watersheds were also found to be slightly hydrophobic with a few seconds delay in infiltration.

Watershed Response: Runoff potential is high in both watersheds. Ground cover density is estimated at less than 25%. Slopes are steep and have hydrophobic soil conditions. In watershed A to the north, the main drainage paralleling the two-track road was actively eroding.

Values at Risk/Resources to be Protected: Watersheds A and B converge approximately 1 mile downstream of the burn. The combined watershed drains to a county road where the potential runoff and debris flows pose a threat to life and property. Additionally, approximately 1-1/2 miles from the critical watersheds is the Odgers Ranch located in Sec. 25, T. 28 N., R. 61 E.

Recommendations: Aerially seed both watersheds to increase ground cover, prevent erosion and decrease runoff. Place flood hazard warning sign in Sec. 35, T. 28 N., R. 61 E.

Proposed location of aerial seeding in unnamed watershed A.

Proposed location of aerial seeding in unnamed watershed A.

West Basin

The area of concern in the West Basin Fire is Goose Creek and two of its tributaries, Coon Creek and Stratton Creek. Goose Creek is perennial. Coon and Stratton Creeks are mostly ephemeral with some perennial reaches. Elevation in the area of concern ranges from 5,560 to 6,400 feet. Slopes are very steep at approximately 50%. The average annual precipitation is from 12 to 16 inches. The dominant vegetation for the area is sagebrush interspersed with perennial grasses such as Idaho fescue and Sandberg's bluegrass. Basin wildrye, snowberry and bitterbrush can also be found.

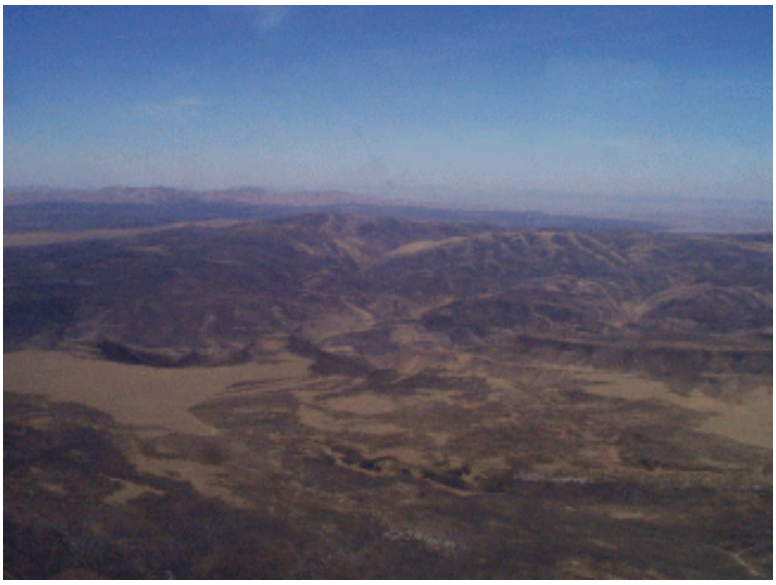
Burn Severity: Burn severity was high in Coon Creek and Stratton Creek drainages. Burn severity was moderate on hillsides in the Goose Creek drainage and moderate to severe in the drainage bottom. There were several live aspen stands on the hillsides of Goose Creek that were not burned which is indicative of low to moderate fire intensity in those areas. Throughout the entire area there were large unburned islands.

Soils: Soils within the area of concern occur on hills and mountains with 15-50% slopes at elevations ranging from 6,000 to 8,000 feet. The soils are mostly shallow. Permeability is moderate. The majority of the soils are within hydrologic soil group D. Group D soils have very slow infiltration rates and very slow rates of water transmission. The soils after the fire were not hydrophobic.

Watershed Response: The area of concern has high runoff potential. Slopes are very steep, soils are shallow and infiltration rates are very slow. With the exception of the unburned islands and the aspen stands within the Goose Creek drainage, most of the vegetative cover was consumed by the fire. Portions of Coon Creek seen during a field reconnaissance were disfunctional. The channel is incised with little to no vegetation, rocks or debris present to protect banks and capture sediment that may enter the stream as a result of the fire. The team was unable to visit Stratton Creek on the ground but relied upon the professional judgement of the rangeland management specialist that it was in a similar condition. Goose Creek has reaches in proper functioning condition and functional-at risk with the trend undetermined. The functional-at risk reach begins near the confluences Coon and Stratton Creeks. This reach is shallow and fairly straight for its landscape setting and point bars are not revegetating which indicates that the stream is unstable and would not be able to successfully transport increased flows and sediment as a result of the fire.

Values at Risk/Resources to be Protected: Downstream of the confluences of Coon and Stratton Creeks with Goose Creek approximately 3 miles is the Rancho Grande ranch. Potential flooding and debris flows is a threat to life and property at the ranch.

Recommendations: Coon, Stratton and Goose Creek drainages should be aerially seeded to increase ground cover, prevent erosion and decrease runoff. Place flood hazard warning sign in Sec. 22, T. 47 N., R. 68 E.



Coon Creek and Stratton Creek drainages from the air.

Coon Creek drainage.

Unburned aspen stands within Goose Creek drainage.

High burn severity in Goose Creek.

South Cricket

There are two areas of concern in the South Cricket Fire, Willow Creek in the east side of the burn that flows out toward highway 93, and the area along the railroad tracks in the southeast portion of the burn, along Independence Creek . Elevation of the Willow Creek watershed ranges from approximately 6,000 to 7,800 feet. Most of Willow Creek is perennial and is spring fed. Average annual precipitation for the watershed is 11 to 16 inches. Slopes are 2 to 50 percent.

Independence Creek watershed has elevations ranging from approximately 6,000 to 7,700 feet in the burned area. It is an ephemeral stream. Slopes are gentle in the valley to very steep in the mountains, ranging from 2 to 50%. The average annual precipitation is from 10 to 16 inches. The dominant vegetation for the area is Wyoming big sagebrush interspersed with perennial grasses such as Idaho fescue and Sandberg's bluegrass; low sage, bitterbrush, and bluebunch wheatgrass.

Burn Severity: Burn severity was high at the top of Willow Creek watershed on Black Mountain. The remainder of the watershed was primarily moderately burned, with a few small areas that were slightly burned along the south side of Willow Creek upstream from the reservoir.

The tributaries to Independence Creek and surrounding area near the railroad tracks had moderate to high burn severity, with little if any vegetation remaining. Most of the remainder of the watershed had moderate burn severity, with a few small islands in the upper watershed that were unburned.

Soils: Soils within the Willow Creek watershed occur on hills and mountains. Most of the soils have a high percentage of coarse fragments (gravel and cobble) on the surface and throughout the soil profile. The soils are shallow to moderately deep over a hardpan or bedrock. Permeability is moderate. The majority of the soils are within hydrologic soil group D, with a much smaller acreage in hydrologic soil group C. Group C soils have a slow infiltration rate when thoroughly wet, and a slow rate of water transmission. Group D soils have very slow infiltration rates and thus high runoff potential, and very slow rates of water transmission. The post burn soils were not hydrophobic at the low to mid elevation sites where they were tested.

Soils within the Independence Creek watershed also have a high percentage of coarse fragments, are dominantly shallow over bedrock at the higher elevations, and moderately deep over a hardpan at the lower elevations. These soils are found on fan piedmonts and fan remnants at the lower elevations, and in the mountains at higher elevations. Runoff is medium to rapid and water erosion hazard is predominantly moderate. Hydrologic soil groups in this watershed are almost entirely group D. Field inspection revealed unstable soils in the drainage bottom, and signs of previous large sediment deposition in the tributaries to Independence Creek in the lower watershed near the culvert. Wind erosion

hazard is slight, although some areas in the valley had visible sighs of wind erosion, and blowing dust and ash could be a localized problem until the area is revegetated.

Watershed Response: Willow Creek watershed is of concern because it has high runoff potential, the riparian area is in poor conditions with actively eroding banks, and there is a reservoir at the lower end of the burn that could breach in a large runoff event, sending water and debris flows down toward highway 93. Most of the vegetative cover was consumed by the fire. Portions of Willow Creek seen during a field reconnaissance were dysfunctional. The channel is incised as much as four feet in places with little vegetation, rocks or debris present to protect banks and capture sediment that may enter the stream as a result of the fire. The stream is unstable and would not be able to successfully transport increased flows that could occur following fire.

Values at Risk/Resources to be Protected: There are eight culverts along the railroad tracks that could be impacted from the fire with increased runoff. The culvert and railroad tracks at Independence Creek are of greatest concern, because this watershed drains the largest area of the eight culvert sites, it burned most completely, and would have the greatest flow following a precipitation event. The other value at risk, as mentioned previously, is highway 93 if the reservoir at Willow Creek should breach.

Recommendations: Nearly all the area in the Willow Creek watershed that needs stabilization is in private ownership, therefore the only watershed recommendation is to place a flood hazard warning sign in sec. 12, T.39 N., R.63 E.

A combination of three watershed treatments is proposed in the lower Independence Creek watershed. Aspen matting would be placed along the main drainage from the railroad culvert upstream approximately .2 miles, and along the length of the main tributary (most eastern) that has its confluence to Independence Creek at the culvert. This would stabilize the soil and reduce both wind and water erosion, to reduce the risk of the culvert from washing out and damage to the railroad. Straw bale dams would be placed in five channels just upstream of the culvert where the drainages had moderate to high burn intensity, and the slopes are steep. Lastly, straw wattles would be installed across the steeper slopes on the north side of Independence Creek to reduce runoff and sediment deposition, where past large sediment depositions were noted.

Independence Creek drainage near railroad culvert.

Culvert for Independence Creek.

Tributary to Independence Creek above railroad culvert.

Overflow channel for Willow Creek catchment.

Catchment in Willow Creek drainage.

Mahogany

The only area of concern in the Mahogany fire is the road along the south end of the fire. There are no perennial streams within the burn, only a couple small ephemeral drainages. Elevation in the Mahogany fire ranges from approximately 6,900 to 7,200 feet. Slopes are very steep, averaging about 30%. The average annual precipitation is14 to 16 inches. The dominant vegetation for the area is black sagebrush, bluebunch wheatgrass, Thurber needlegrass, and mountain mahogany.

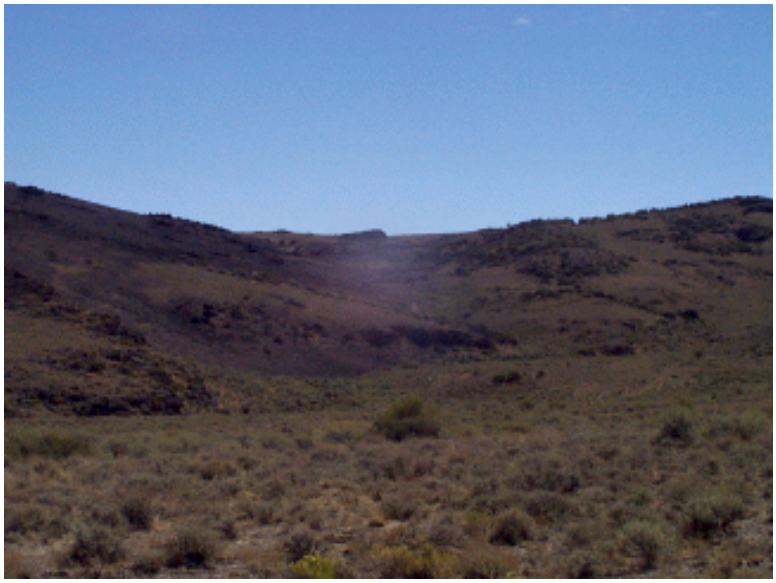
Burn Severity: Burn severity was light to moderate with a mosaic pattern..

Soils: Soils within the burn occur on mountains. They are shallow over bedrock or deep, and have a high gravel and cobble content throughout their profile. Runoff is medium to rapid and the hazard of water erosion is slight to moderate. Field investigation revealed a water erosion problem along the road to the south where rills were forming. Wind erosion hazard is slight due to the high percentage of surface coarse fragments. The majority of the soils are within hydrologic soil group D, with a smaller area in group B. Group D soils have very slow infiltration rates and very slow rates of water transmission, and thus high runoff potential. Group B soils have moderate infiltration rates when wet, and moderate rates of water transmission. The soils were not tested for hydrophobicity, however, parts of the burn with dense mountain mahogany stands that burned hot, would likely be hydrophobic.

Watershed Response: The area of concern has moderate to high runoff potential. Slopes are steep, soils are generally shallow, and infiltration rates are often slow. Increased runoff and sediment movement can be expected to concentrate along the road on the south end of the burn.

Values at Risk/Resources to be Protected: The road on the southern end of the burn already had rills forming from water running down the road. This problem would become worse following fire, with increased runoff. There are small reservoirs down below the road that could fill with sediment or breach.

Recommendations: Repair the road and install waterbars with wing ditches as necessary to decrease runoff and sediment moving down the road.



Drainage within Mahogany fire that parallels road.

IV. RECOMMENDATIONS

A. Management (specification related)

1. **Seeding:** Seed critical portions of the burns that have complete or nearly complete canopy consumption to reduce soil erosion, protect soil productivity and reduce runoff. (BAER-Spec W-1, grass reseeding)

2. **Post signs on high risk roads:** Develop, produce, and post signs on main roads and county roads in high risk watersheds to inform people of the hazards of being in the canyons during rain storms. (BAER-Spec S-2, road, trail, and safety signs)

3. **Straw bale check dams:** Construct straw bale check dams in first and second order streams to stabilize in-channel sediments. (BAER-Spec W-12, straw bale check dams)

4. **Excelsior soil matting:** Install strips of excelsior matting along drainages to help stabilize soil. (BAER-Spec W-3, erosion netting)

5. **Straw wattles:** Place straw wattles on steep slopes (greater than 30%) with irregular micro topography and on rocky surfaces. BAER-Spec W-4, straw wattles)

6. **Water bars:** Construct water bars with wing ditches on steep roads to prevent gully formation and excess runoff and sediment downstream. (BAER-Spec S-6, facility replacement)

B. Management (non-specification related)

1. **Maintain heightened awareness of flood risks.** Highway department and railroad company personnel as well as residents and the public should maintain a heightened awareness of the increased risks from flooding and debris flows within and around burned areas.

2. **Stock emergency flood response supplies.** BLM and Emergency Response Agencies should stock up on emergency response items such as sand bags, sand, and straw bales.

3. **Distribute BAER report to concerned agencies.** Provide copies to and review the BAER report with county, state and federal agencies as well as the general public.

4. **Conduct photo documentation.** Conduct photo documentation of streams, canyons and roads after significant rainfall events to monitor watershed and channel conditions.

5. **Defer grazing for one to two years.** Livestock will tend to migrate to new growth after a fire. This could adversely impact the vegetative recovery process which will prolong the exposure of soils to raindrop impact and erosion. Livestock will also concentrate in and around seeps and springs which could lead to compaction of the soils.

V. REFERENCES

USDA NRCS Soil Surveys for all Soil Survey Areas

USDA SCS, 1992, 1990. Nevada Site Descriptions. Technical Guide. Major Land Resource Areas.

USDI BLM. BLM Revised Emergency Fire Rehabilitation Handbook. H-1741-1. July 1999

USDI BLM 1999 Northern Nevada Fire Complex Burned Area Rehabilitation Plan

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