Date of Report: 9-5-02

BURNED-AREA REPORT

(Reference FSH 2509.13)

PART I - TYPE OF REQUEST

A. Type of Report

[X] 1. Funding request for estimated WFSU-SULT funds
[ ] 2. Accomplishment Report
[ ] 3. No Treatment Recommendation

B. Type of Action

[X] 1. Initial Request (Best estimate of funds needed to complete eligible rehabilitation measures)

[ ] 2. Interim Report
[ ] Updating the initial funding request based on more accurate site data or design analysis
[ ] Status of accomplishments to date

[ ] 3. Final Report (Following completion of work)

PART II - BURNED-AREA DESCRIPTION

A. Fire Name: Green Creek

B. Fire Number: CO-RTF-318 P24997

C. State: Co

D. County: Routt and Grand Counties

E. Region: 02

F. Forest: Medicine Bow-Routt N.F.

G. District: Yampa and Hahns-Peak Ranger Districts

H. Date Fire Started: July 14, 2002

I. Date Fire Contained: August 30, 2002

J. Suppression Cost:$3.2 million

K. Fire Suppression Damages Repaired with Suppression Funds
1. Fireline waterbarred (miles): 2.1 miles dozer line, 2.25 miles hand-line
2. Fireline seeded (miles): 0 miles
3. Other (identify):

L. Watershed Number: 140500010301, 140500010304, 140100011401

M. Total Acres Burned: 4400 acres
NFS Acres(4400 acres) Other Federal ( ) State ( ) Private ( )

N. Vegetation Types: The fire burned through predominantly lodgepole and spruce-fir stands. The spruce-fir stands typically have a thick duff layer while the lodgepole stands have a relatively thin litter layer. Some past harvest activity has occurred in timber stands outside of the Sarvis Creek Wilderness. The fire burned hot through untreated stands, but generally did not burn in past clearcut areas.

O. Dominant Soils: Typic Dystrochrepts and Typic Cryorthents, that are loamy or sandy skeletal.

P. Geologic Types: Gore granitic

Q. Miles of Stream Channels by Order or Class:

a. Perennial: 6.2 Intermittent: 1.5 (based on USGS blue-lines)

R. Transportation System

Trails: 2.4 miles Roads: 2.25 miles

PART III - WATERSHED CONDITION

A. Burn Severity (acres): 793 (low) 691 (moderate) 1321 (high) *Remainder of area in the fire was unburned

B. Water-Repellent Soil (acres): 1485 acres

C. Soil Erosion Hazard Rating (acres):
660 (low) 2420 (moderate) 1320 (high)

D. Erosion Potential: 11 tons/acre

E. Sediment Potential: 1850 cubic yards / square mile

PART IV - HYDROLOGIC DESIGN FACTORS

A. Estimated Vegetative Recovery Period, (years): understory: 2 yrs, overstory: 80 yrs

B. Design Chance of Success, (percent): 80%

C. Equivalent Design Recurrence Interval, (years): 10 yrs

D. Design Storm Duration, (hours): 6 hrs

E. Design Storm Magnitude, (inches): 1.35 inches

F. Design Flow, (cubic feet / second/ square mile): 43 cfs/mi^2

G. Estimated Reduction in Infiltration, (percent): 20-80 % depending on burn severity

H. Adjusted Design Flow, (cfs per square mile): 68 cfs/mi^2

PART V - SUMMARY OF ANALYSIS

A. Describe Watershed Emergency: The Green Creek fire started on July 14, 2002 from a lightning strike in the Sarvis Creek wilderness. Initially it was managed as a Fire-Use fire. However, continuing dry conditions in July resulted in the fire flaring up in late July when it moved outside of the wilderness through a running crown fire with high burn intensities resulting in high burn severities. Once outside of the wilderness the fire moved into management areas 5.13-Forest Products and 5.12-General Forest and Rangeland, Range Vegetation Emphasis which were designated as suppression polygons in the 2002 Fire Management Plan for the Craig-Routt Fire Management Program. Once the fire moved outside of the wilderness suppression measures were implemented, and the fire was contained on August 30, 2002.

The fire burned through predominantly lodgepole and spruce-fir stands. The spruce-fir stands typically have a thick duff layer while the lodgepole stands have a relatively thin litter layer. In areas of high burn severity the fire completely consumed both the tree-crowns as well as the duff layer. The only remaining surface protection following the fire comes from 'punky' logs which have been lying on the ground for numerous years and are slowly deteriorating. While most of the fuels in the high severity burn areas were dry and readily consumed, field reconnaissance found the punky logs to still have a moist core which is why they were generally not consumed in the fire. While the punky logs will provide some surface protection during storm events however, the orientation and lack of surface contact will not have a significant effect on trapping either ash or sediment. As a result, the potential for increased surface erosion following storm events including spring snowmelt runoff is greatly increased in areas of high and moderate burn severity (see Soils Report).

Burning of the surface duff layer resulted in development of a strong hydrophobic layer at the soil surface that was uniform across the high and moderate burn severity areas. This hydrophobic layer severely limits infiltration during storm events which significantly increases storm runoff and surface erosion (see Soils Report). Depending on the topography of the watershed and proximity of high burn severity areas to the channel network, the increases in surface erosion can significantly increase sediment input to the stream system. Increases in storm runoff coupled with increases in the sediment load can result in channel instability and degradation of fish habitat.

There is a concern that the lack of ground cover coupled with coarse textured strongly hydrophobic soils will result in a loss of long-term soil productivity. Erosion rates will increase from essentially zero tons per acre to approximately 20 tons per acre in areas of high burn severity. In large areas of high burn severity within the 5.13 management prescription, maintaining long-term soil productivity is important in meeting Routt Forest Plan direction and Standards and Guidelines which are outlined in the Watershed Conservation Practices Handbook (FSH 2509.25).

There is a known remanant population of Colorado River Native cutthroat trout (CRN) in Little Green Creek which lies outside of the wilderness area, and the potential for a population in the Frantz Creek watershed. The CRN are managed as a sensitive species, and has been proposed to the U.S. Fish and Wildlife Service for listing by conservation groups as a Threatened or Endangered species. Even though the U.S. Fish and Wildlife Service has not determined the status of the CRN, the forest manages CRN as a conservation population.

B. Emergency Treatment Objectives:

1) Decrease the erosion from the uplands in order to maintain long term site productivity
2) Maintain the Forest Service Transportation system.
3) Reduce the threat to public safety by informing the public of the hazards that may exist from the wildfire.
4) Promote re-establishment of native plant communities to prevent the invasion of noxious weeds as a result of the fire.
5) Decrease the negative impacts upon the Colorado River Native cutthroat habitat.
6) Reduce the negative impact up the stream channel stability and water quality.
7) Protect the values identified through the Management Area Prescriptions in the Routt Forest Plan
8) Monitor the effectiveness of the BAER treatments.
9) Monitor the potential spread of noxious weeds.

C. Probability of Completing Treatment Prior to First Major Damage-Producing Storm:

Land **90** % Channel ___ % Roads **90** % Other ___ %

D. Probability of Treatment Success

	Years after Treatment		
	1	3	5
Land	75	80	90
Channel			
Roads	90	90	90
Other	90	90	90

E. Cost of No-Action (Including Loss): $1,476,800

F. Cost of Selected Alternative (Including Loss): $473,678

G. Skills Represented on Burned-Area Survey Team:

[X] Hydrology	[X] Soils	[X] Geology	[X] Range	[ ]
[X] Forestry	[X] Wildlife	[ ] Fire Mgmt.	[X] Engineering	[ ]
[ ] Contracting	[ ] Ecology	[X] Botany	[X] Archaeology	[ ]
[X] Fisheries	[ ] Research	[ ] Landscape Arch	[X] GIS	

Team Leader: Kirk Wolff assisted by Liz Schnackenberg and Tommy

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H. **Treatment Narrative:**

(Describe the emergency treatments, where and how they will be applied, and what they are intended to do. This information helps to determine qualifying treatments for the appropriate funding authorities. For seeding treatments, include species, application rates and species selection rationale.)

Land Treatments: Two land treatments are proposed: 1) Aerial straw mulching on the south-facing slopes, and 2) aerial seeding on the north-facing slopes. Both of these treatments are intended to reduce surface erosion and maintain long-term soil productivity to be consistent with the 1997 Routt Forest Management Plan.

Aerial straw mulching will consist of using weed-free straw that will be applied via a helicopter. Mulch rates will be applied at a rate of 2000 pounds per acre which equates to a maximum depth of two inches. Mulch will be applied on the south-facing slopes where the duff and litter layer was completely consumed, and there is less woody debris remaining compared to the north-facing slopes. Mulch will be applied in the extensive areas of high burn severity with management prescription 5.13 within Little Green Creek and the West Fork of Frantz Creek watersheds. Ground cover of 60 percent or more has been shown to reduce erosion to pre-fire levels. Reducing surface erosion and the quantity of ash and sediment delivered to the stream system will help to reduce of the fire on CRN, and to maintain watershed function.

The aerial seeding will also be done via helicopter. The seed mix will be Cereal Rye (Secale cereale) or a comparable sterile annual. Application rates will be 60 pounds per acre (22 PLS per square foot). Seed mixes will be tested for purity prior to application based on the August 20, 2002 protocol from Tom McClure in the R2 Regional Office. The seed will be applied this fall so that it can germinate in the spring and provide surface protection during 2003 thunderstorms. Seeding will be applied on the north-facing slopes where the coarse woody debris is more abundant to help provide short-term ground cover while native vegetation becomes established. Similar to mulching, but for a lower cost, seeding will reduce surface erosion and the effects to the aquatic ecosystem.

Channel Treatments: None prescribed at this time. The proposed upland treatments will reduce surface erosion and therefore effects to the channel network and aquatic ecosystem.

Roads and Trail Treatments: Ensure adequate culvert capacity and function to accommodate increased water and sediment yields following the fire. This will include: 1) replacing an existing culvert with inadequate capacity to accommodate increased water and sediment yields in the West Fork of Frantz Creek. The new culvert will be of a sufficient size to accommodate stormflows as well as maintain channel function and aquatic life passage. 2) Replace the inlet on an existing culvert in a Colorado River Native cuthroat trout stream in which water is piping around the culvert due to the poor location and orientation of the existing opening. 3) Add two additional drainage structures to FSR 100 so that the relief ditch can accommodate increased runoff from areas of the fire which drain directly into the road relief ditch. 4) Additional maintenance on the inlets and outlets of existing drainage relief structures to ensure proper functioning.

Structures: Warning signs will be placed at trailheads which access the burned area. The primary purpose will be to inform the users of potential hazards including snags resulting from the fire.

I. **Monitoring Narrative:**

(Describe the monitoring needs, what treatments will be monitored, how they will be monitored, and when monitoring will occur. A detailed monitoring plan must be submitted as a separate document to the Regional BAER coordinator.)

Noxious weeds: Monitoring for noxious weeds will be begin in early June 2003. Monitoring will focus on high risk areas adjacent to roads, trails, and highly disturbed areas. Monitoring will be conducted by the district range staff in consultation with the BAER team members. Monitoring will be primarily ocular observations in conjunction with photographs and GPS locations where weed populations are found. Information will be stored in the NRIS Terra database.

If weed populations are found to be spreading, treatment plans would be developed and an interim report filed for supplemental funding. Any treatment plans would be consistent with the1995 Medicine Bow-Routt National Forests Weed EA.

Land Treatment effectiveness: Monitoring will be initiated in the summer of 2003 for the effectiveness of the land and road treatments. For the land treatments, monitoring will focus on revegetation through ground cover transects in the seeded areas and photos, and infiltration in the seeded and mulched areas. Infiltration will be monitored through standard ring infiltration methods. Visual obeservations will also be made of whether the mulch was effective in reducing surface erosion relative to unmulched areas.

Road Treatment effectiveness: Monitoring of the road treatments will ensure that the drainage structures are properly functioning. This would include one patrol in late fall to ensure that beaver have not built dams which affect any of the live streams draining the burned area, and storm patrol during spring snowmelt runoff to ensure that none of the culverts are plugged by floatable debris. If beaver dams are a concern this fall, they would be removed to ensure proper functioning during spring runoff. Monitoring would include visual inspection to of the road surface and photos of any evidence of surface erosion. Visual inspections and photos would also be taken at the inlets and outlets of drainage structures to ensure that the structures are functioning.

Part VI – Emergency Rehabilitation Treatments and Source of Funds by Land Ownership

A. Land Treatments										
Aerial mulch	ac	$550	210	$115,500	$0		$0		$0	$115,500
Aerial seeding	ac	$64	192	$12,288	$0		$0		$0	$12,288
				$0	$0		$0		$0	$0
Insert new items above this line!				$0	$0		$0		$0	$0
Subtotal Land Treatments				$127,788	$0		$0		$0	$127,788
B. Channel Treatments										
				$0	$0		$0		$0	$0
				$0	$0		$0		$0	$0
				$0	$0		$0		$0	$0
Insert new items above this line!				$0	$0		$0		$0	$0
Subtotal Channel Treat.				$0	$0		$0		$0	$0
C. Road and Trails										
Road treatments	ea	$9,605	1	$9,605	$0		$0		$0	$9,605
Contract prep	day	$225	4	$900	$0		$0		$0	$900
COR on site	day	$225	5	$1,125						$1,125
Storm patrol	ea	$1,000	3	$3,000	$0		$0		$0	$3,000
Insert new items above this line!				$0	$0		$0		$0	$0
Subtotal Road & Trails				$14,630	$0		$0		$0	$14,630
D. Structures										
Trailhead signs	ea	$100	2	$200	$0		$0		$0	$200
				$0	$0		$0		$0	$0
				$0	$0		$0		$0	$0
Insert new items above this line!				$0	$0		$0		$0	$0
Subtotal Structures				$200	$0		$0		$0	$200
E. BAER Evaluation										
Assessment team	ea	$6,550	1	$6,550	$0		$0		$0	$6,550
RSAC	ea	$700	1	$700	$0		$0		$0	$700
Insert new items above this line!				$0	$0		$0		$0	$0
Subtotal Evaluation				$7,250	$0		$0		$0	$7,250
Monitoring										
land treatments	ea	1000	4	$4,000	$0		$0		$0	$4,000
weeds	ea	250	10	$2,500	$0		$0		$0	$2,500
Subtotal Monitoring				$6,500	$0		$0		$0	$6,500
G. Totals				**$156,368**	**$0**		**$0**		**$0**	**$156,368**

PART VII - APPROVALS

1. *_/s/ Mary H. Peterson_______* 9/9/02
Forest Supervisor (signature) Date

2. **/s/Richard Stem (for)**______ **9 Sept 02**
Rick D. Cables Date
Regional Forester (signature)

APPENDIX 1: Soils Report

Landforms

The dominant landform of the fire is broken Mountain slopes, with U-shaped valley and rounded ridges. These valleys have steep concave side slopes with large amount of exposed Rock outcrops high on the slope. The mountain slopes are dissected with numerous ephemeral draws that drain into the bottomland.

Geology

Geology consists of old glacial alluvium in the bottoms and interlayered felsic and hornblende gneisses. The upper reaches of the drainages are composed of intrusive rock, which give the large amount of steep rock outcrop. The highly dissected landforms are the result of the geologic erosion that has taken place overtime.

Climate

The climate of the Green Creek fire area is montane with the area receiving about 25 to 35 inches of precipitation with about 60 percent of it coming as snow. The weather in this area is dominated by upslope conditions as storms move up the Yampa valley and rise over the Park ranges.

Vegetation

The fire occur in an area where the upland vegetation is mixed conifer over story composed of lodgepole pine, Engelmann spruce and sub-alpine fir. The under story is dominated by elk sedge, grouse huckleberry and a variety of shrubs and forbs. The dominant habitat types include PICO/VASC, ABLA-PIEN/VASC, and ABLA-PIEN/CAGE.

Long-term soil productivity is one of the landscape features that BAER is accountable for. Soil quality, defined by the physical, biological, and chemical properties of the soil resources is a good way to address soil productivity for both the existing and potential natural environments. Soil quality factors are commonly determined through monitoring of many different factors such as infiltration, compaction, erosion and so on. However, due to the emergency nature of the BAER process in wild fires, time constraints dictate that these factors be estimated using surrogate measures, professional judgment, and published reports in the literature.

Soils

The soils found in the fire area are derived from granite in the uplands and alluvium in the bottoms. The soils found on the granite area are somewhat erosive and subject to water erosion when the vegetation is removed. The granite decomposes to sandy loams and loamy sands. Water infiltration rates are high and the water holding capacity is low.

The dominant soil type is classify as Typic Dystrochrepts and Typic Cryorthents that are loamy skeletal and sandy skeletal.

The erosion hazard group for the soil on this fire is broken down into the following groups: Low – 15 percent, Moderate - 55 percent, High – 30 percent The erosion hazard was based on the information presented in the soil survey report that cover the fire area, and field observations. Slope and the soil erodibility factor are the main driving factors in this rating.

The parent material of most of these watersheds is Gore granite, which weathers to coarse textures in the soil profile. The coarse textured parent material provides a moderately acidic substrate for soil development, which generally tends to be weakly developed and sandy to gravelly textured. The soils that develop on these coarse textured parent materials are all highly susceptible to erosion when exposed to direct impact of rain and wind. It is important to maintain the natural ground cover to keep erosion rates to acceptable limits.

The erosion hazard was based on the information presented in the soil survey reports that cover the fire area. Slope and the soil erodibility factor are the main driving factors in this rating.

The soils in the Green Creek Fire are highly erodible when exposed to the direct impacts of rain, sheet wash, rilling, or gullying. The primary processes controlling soil disturbance and erosion historically included wind and water. Wildland fire could have had negative impacts on soils by exposing them to the forces of erosion. A fire's intensity would determine the degree of detrimental impact.

The soils in the area consist predominantly of a couple of soil types. The Legault soil and Granile soil are the main soil types. Also, rock outcrop is a large major component in some of the soil-mapping units. In some valley bottoms, there are also soils originated from alluvium.

The Legault – Granile complex soil map unit covers most of the fire area. This soil unit occurs on slopes of 15 to 40 percent with an extremely stony surface. . This map unit consists of approximately 65 percent Legault soils, and 20 percent Granile soil, and 10 percent rock outcrop. The Legault soils are coarse textured, shallow and excessively well drained. They formed in material weathered from granite on mountainsides. The surface layer is stony sandy loam. Permeability is rapid and the available water capacity is low. Runoff is moderate to rapid and the hazard of water erosion is moderate to severe depending on slope. The Granile soil is a dark grayish brown, very cobbly sandy loam that has also formed from weathered granites. It is found on lower side slopes and foot slopes. Permeability is moderately rapid, and the available water capacity is low. Runoff is rapid and the hazard of erosion is moderate to severe depending on slope. The dominant vegetation is lodgepole pine and Engelmann spruce in the more favorable locations. .

Forest Erosion Processes

High severity burns areas experience higher rates of soil loss from erosion, increased peak flows of runoff, greater duff reduction, loss in soil nutrients, and soil heating. Water and sediment yields may increase as more of the forest floor is consumed. If the fire consumes the duff and organic layers of the soils and the mineral soil is exposed, soil infiltration and water storage capacities of the soil are reduced. These impacts may last weeks or decades, depending on the fire severity and intensity, any remedial measures, and the rate vegetative recovery. Fire directly affects a wide range of microorganisms that carry out nutrients cycling processes. Without a healthy population of microbes, plant recovery will be slowed due to the lack of nutrients needed for the plants. Some authors recommends treatment that increases organic matter content and active soil microbial activity.

Forest soils generally have very low erosion rates unless they are disturbed. Common disturbances include prescribed and wild fire, and harvesting operations. The impact of these operations, however, last only for a short time, perhaps one or two years. After that, the rapid regrowth of vegetation soon covers the surface with plant litter, and potential erosion is quickly reduced. In one study, Robichad and Brown (1999) reported that erosion rates dropped from almost 40Mg/ha the first year after a fire to 2.3 Mg/ha the second, and 1 Mg ha the third year. The regrowth of vegetation and subsequent increase in canopy and ground cover overshadow any differences due to climate variation among the years. For any one of the given years, however, the potential erosion depends the climate

Under burned conditions: if the year is normal or dry, then it is unlikely for there to be any significant erosion. If the year has above average precipitation, however, then would be significant soil erosion.

The WEPP (water erosion prediction project) model was used to calculate the erosion rates for all the different severity groups. Field review of the burned area was used to verify conditions and assumptions used in the modeling. The following are the erosion rates for the different severity classes. See appendix A for definition of burn severity classes.

Severity	Acres %
Unburned	1728 (36)
Low	805 (17)
Moderate	902 (19)
High	1336 (28)
Total	4771

The average erosion rate to the Himan fire is **11 tons per acre** based on the analysis done on the moderate and high severity. . The model also calculated the sediment potential, which for the Green Creek fire is 1850 cubic yards/square mile.

Fire induced Hydrophobicity is, in reality, formed when intense heat consumes litter and organics rich in waxy compounds, such as from conifer forests, or some chaparral vegetation. These waxy compounds are volatilized to gasses, which can be driven down into soil pore spaces. The more intense the heat and the longer the residence time, the deeper the gasses can penetrate into the soil, especially in coarser-textured soils. The soils on this fire are coarse to moderately fine textured on the uplands. As the fire passes and the compounds cool, they re-condense to form waxy compounds, which can coat soil particles. Whether the hydrophobic effect is due to ionic charge of the waxy compounds vs. water, or to the waxy compounds actually filling soil pore spaces, or that the surface tension of the water being stronger than the capillary tension in pores with these coatings, the important fact is that the soil repels water. The result is beading up of water on the soil surface, much as water beads up on a freshly waxed car. This can, of course, have serious implications for post-fire runoff and flooding during precipitation events. In a qualitative sense hydrophobic soils probably increase the net surface erosion of soils by retarding infiltration and thereby increasing sheet wash. The condition may be relatively short-lived following fire, which may limit the extent of erosion. However, hydrophobic soils played a role in the flooding of different large fires in the past. The hydrophobic layers for this fire was strong at the ash/mineral soil interface and extended down into the soil for an inch or two. There was some moderate hydrophobic observe up on some of the finer texture intrusive soils that is mix with strong hydrophobic places. The coarser texture glacial drift was consistently strong hydrophobic.

Appendix A

Burned Severity classes for the Green Creek Fire.

1. Unburned: No Burn in this area

2. Low:
Forest: light burn and char of litter, shrubs, and small trees. Large trees still living green crowns. Duff and litter intact, soil structure not altered. Soil may or may not be water repellent at the surface. Low and Unburned often mosaic together in large area. Many areas of steep slopes and rocky soils had sparse fuels, and fire residence time was short, thus burn severity is low.

Grass: Grass burned, blackened, already resprouting, soil impacts none to minimal.

3. Moderate:
Forest: litter and duff charred, not completely ached. Recognizable charred needles and leaves. Soil may or may not be water repellent at surface: common is moderate to strong layer just at soil/char interface, less than 1mm or so thick. Soil structure and very fine roots intact. Fine limbs remain in trees. Brown needles remain on trees and will provide needle cast mulch. Moderate burn severity is common around the edges of polygons of high severity, and in mosaic areas complexed with low or high burn severity.

High:
Forest: Litter and duff ashed completely, little to no recognizable char pieces. Strong water repellency at ash/soil interface, top 1 mm or so. Soil structure may be weakened or lost, very fine roots may be consumed in surface few mm. No fine fuels remain, no fine limbs or needles in trees. This condition is common especially around the base of pines where litter layer had been deeper before the fire. The size of the ring depends on the size of the tree, and is roughly correlated to the crown diameter/drip line. In many areas, interstices between trees had sparse litter and ground conditions area similar to those described for moderate, above.

In the Green Creek burned area there are many areas where the ground conditions appear more like the moderate condition than the high condition, but there area no needles remaining on trees. This combined with a thin but strong water repellant surface layer set the stage for substantial soil erosion by wind and water, and for rapid runoff during intense storms. These areas are classified as high. The ecological and watershed implications of the lack of needle cast potential are severe:

a) No needles to provide mulch to protect soil particles from detachment by wind and water;

b) No needles to provide mulch to moderate surface soil temperature and moisture environment for seeds and sprouts. Longer revegetation recovery.

c) No needles to provide immediate addition of organic matter to restore nutrient cycle.

Appendix B Treatments

Two main treatments are being proposed for this fire, 1) Aerial mulching and 2) Aerial seeding.

The criterion was that most of the high severity burn in the timber management precipitation would be treated. The south facing slopes that have little to no ground cover (including coarse woody debris) would be mulch. The north facing slope retained more of the coarse wood would be aerial seeded.

Treatment 1 will be Aerial seeding with a helicopter (the same helicopter would be used for aerial mulching). There are approximately 192 acres to be seeded. The seeding will be done in the late fall so that snow would be on the ground or soon after. The seed will germinate next spring and provide some ground cover next summer during the raining season. The seed to be used will be Cereal Rye (Secale cereale) or some other sterile annual. Once the seed germinates, it will provide cover and mulch when the plants die and fall over.

Cereal Rye (Secale cereale) 18,000 seeds per pound (Granite Seed Company)

At 22 PLS per square foot equal 60 lbs/acre.

192 acres times 60 lbs/acre = 11,520 lbs seed times $0.50 per lbs =$5,760 for seed delivered to site. Seed will be tested for noxious weed as outlined in Tom McClure memo of 8/19/02

Treatment 2 – Will be aerial mulching at a rate of approximately 1000 pounds per acre. This will equate to a mulch depth of no greater than 2 inches. The mulching will be focus on the south facing slopes where all ground cover and vegetation were consume by the fire. Ground covers of 60 percent or more have showed to reduce erosion to pre-fire levels.

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In order to meet the first objective of stabilizing the surface soil in the short term, it is necessary to achieve germination first thing next spring and be established by the mid growing season. In order to meet the second objective as well as the biotic integrity criteria, the seeded species should not be overly aggressive or persistent, should not have the ability to cross with natives, and should be available in adequate quantities at the time of seeding.

APPENDIX 2: Hydrology Report

Introduction

The Green Creek Fire lies in the Green Creek and Service Creek sixth level watersheds in the Yampa River basin, and the Muddy Creek sixth level watershed in the Colorado River basin. The North Fork of Service Creek and Green Creek were the primary streams affected in the Yampa River basin; the West Fork of Frantz Creek and Little Green Creek were the primary streams affected in the Colorado River basin. The areas affected by the fire in both the North Fork of Service Creek and Green Creek lie in the Sarvis Creek Wilderness; Little Green Creek and the West Fork of Frantz Creek are outside of the wilderness area.

In this analysis, seventh and eighth level subwatersheds were used to better display the direct effects of the fire on the individual streams and subwatersheds, except for Green Creek which is a sixth level watershed in itself. The total size of each subwatershed, acres burned, and percent of watershed burned are displayed in Table 1.

Table 1: Acres and percent of burn severity by subwatershed for the Green Creek Fire.

Watershed	Total watershed acres	Acres and % of high burn severity	Acres and % of moderate burn severity	Acres and % of low burn severity	Acres and % unburned
N.Fk. Service Cr. 7th	1961	463=24%	106=5%	107=5%	1291=66%
Green Cr. 6th	3951	263=7%	256=6%	89=2%	3343=85%
Little Green Cr. 7th	3115	145=5%	160=5%	158=5%	2652=85%
W.Fk. Frantz Cr. 8th	1482	450=30%	169=11%	439=30%	424=29%

Water and sediment yields are expected to increase in each of the watersheds with the degree varying by the percent of each watershed with high or moderate burn severity. The fire burned through predominantly lodgepole and spruce-fir stands. The spruce-fir stands typically have a thick duff layer while the lodgepole stands have a relatively thin litter layer. In areas of high burn severity the fire completely consumed both the tree-crowns as well as the duff layer. The only remaining surface protection following the fire comes from 'punky' logs which have been lying on the ground for numerous years and are slowly deteriorating. While most of the fuels in the high severity burn areas were dry and readily consumed, field reconnaissance found the punky logs to still have a moist core which is why they were generally not consumed in the fire. While the punky logs will provide some surface protection during storm events, the potential for increased surface erosion following storm events is greatly increased in areas of high and moderate burn severity (see Soils Report).

Burning of the surface duff layer resulted in development of a strong hydrophobic layer at the soil surface that was fairly uniform across the high and moderate burn severity areas. This hydrophobic layer severely limits infiltration during storm events which significantly increases storm runoff and surface erosion (see Soils Report). Depending on the topography of the watershed and proximity of high burn severity areas to the channel network, the increases in surface erosion can significantly increase sediment input to the stream system. Increases in storm runoff coupled with increases in the sediment load can result in channel instability and degradation of fish habitat. Table 2 shows the pre and post-fire storm runoff for a 6 hour storm event with a 10 year recurrence interval; see Appendix A for calculations and methods.

Table 2: Pre and Post fire runoff for a 6 hour storm event with a 10 year recurrence interval, and the expected percent increase in stormflow following the fire.

Watershed	Pre-fire runoff (cfs)	Post-fire runoff (cfs)	Percent increase
N.Fk. Service Cr. 7th	132	189	43%
Green Cr. 6th	267	308	15%

Little Green Cr. 7th	210	235	11%
W.Fk. Frantz Cr. 8th	100	157	57%

Based on the percent of watershed with high or moderate burn severity and the projected increases in discharge during storm events, the West Fork of Frantz Creek is the watershed with the greatest concerns. The following sections outline the condition of each subwatershed and recommendations for treatments by subwatershed.

Yampa River Basin

North Fork Service Creek subwatershed

The North Fork of Service Creek originates in a broad U-shape valley as a low gradient stream with a wide riparian area. It then descends through a steep narrow canyon to its confluence with Service Creek. The fire affected primarily the low gradient headwater area. While 30% of the watershed is mapped as high burn severity, the riparian areas were relatively unaffected. Water yield following storm events is expected to increase by 43%, and sediment yields are expected to increase by approximately 20%. While these increases in water and sediment yield will affect watershed function, the broad riparian area will help to filter ash and sediment and reduce the amount of sediment that actually reaches the stream system. Water yield increases have the potential to decrease channel stability. However, the North Fork of Service Creek is a stable E channel (Rosgen, 1994) with a healthy sedge riparian area. The combination of a stable E channel surrounded by a healthy riparian area will help to minimize channel instability and sediment delivery to the stream system following the fire. Due to its location in the wilderness and the presence of a stable healthy riparian area, no treatments are recommended in this watershed.

Green Creek watershed

Only 15 percent of the Green Creek watershed was affected by the fire, with 13% of the watershed being mapped as high or moderate burn severity. Similar to the North Fork of Service Creek, Green Creek originates in a broad U-shaped valley as a low gradient channel with a wide healthy riparian area. The riparian area was generally not affected by the fire. The presence of a healthy riparian area buffering Green Creek from the fire will reduce the quantity of sediment delivered to the stream channel from increased erosion following the fire. The fact that only a small portion of the watershed was affected by the fire coupled with its location in the Sarvie Creek wilderness and the presence of a wide healthy riparian area to act as a buffer suggest that no treatments are recommended at this time.

Colorado River Basin

Little Green Creek subwatershed

Little Green Creek is a tributary to Muddy Creek. This watershed lies outside of the wilderness in predominantly Management Area Prescription 5.13-Forest Products, with a small portion below FSR 100 in Management Prescription 5.12-General Forest and Rangelands, Range Vegetation emphasis. This watershed has a known population of Colorado River cutthroat trout. Only 15 percent of the watershed was affected by the fire, with only 10 percent being mapped as high or moderate burn severity.

Similar to the North Fork of Service Creek and Green Creek, Little Green Creek originates as a low gradient stream with a wide riparian area. The riparian area adjacent to the mainstem of Little Green Creek was not affected by the fire. While water and sediment yields will increase in Little Green Creek following the fire as indicated in Table 2 and the Soils Report, these increases are not expected to significantly affect watershed function due to only 15 percent of the watershed being affected by the fire, and the presence of a wide healthy riparian area to act as a filter and reduce the amount of increased surface erosion that actually reaches the stream channel. However, in areas of high burn severity there is a concern regarding long-term soil productivity, especially given that the management area prescription in 5.13. Treatments to reduce soil erosion including seeding and/or mulching are recommended. These treatments will decrease soil erosion and therefore sediment yield. This will help to maintain fisheries habitat for Colorado River Native cutthroat trout as well as watershed function.

Where FSR 100 crosses Little Green Creek there is a 54" (?) arch culvert. This culvert appears large enough to accommodate the increases in water and sediment following the Green Creek Fire. However, the inlet of the culvert where Little Green Creek crosses FSR 100 is rusted through, and bent up so that some water flows under and around the culvert rather than all of the water passing through the culvert. It is recommended that the inlet of the structure be replaced to ensure that all of the water passes through the culvert, and prevent increased piping around the outside of the culvert with increased water flows, increased piping around the culvert could result in a road failure and additional delivery of sediment to Little Green Creek. Considering that sediment yields are already expected to increase in Little Green Creek following the fire, and that this is a Colorado River Native cutthroat stream, minimizing the potential for road failure is critical.

West Fork of Frantz Creek subwatershed

West Frantz Creek is a tributary to Frantz Creek which is a tributary to Muddy Creek in the Colorado River basin. This watershed lies in predominantly Management Area Prescription 5.13- Forest Products, with a small portion in Management Prescription 5.12-General Forest and Rangelands, Range Vegetation emphasis.

The West Fork of Frantz Creek originates as a steep A or B channel (Rosgen, 1994) in a confined V-shape valley. The main channel then descends through a steep confined canyon before flowing into a U-shape valley where it then becomes a low gradient meandering E stream (Rosgen, 1994). A wide riparian area that is predominantly sedge and willow borders the low gradient reaches. The fire burned the majority of the riparian area including streambank vegetation. However, field reconnaissance found that resprouting of the sedges has already begun in most of the burned areas. The riparian areas that were not burned are those with a high water table due to beaver activity. Just above FSR 100 there are two well-established beaver dams which were not affected by the fire.

Field reconnaissance on September 4, 2002 found several pools with dead brook trout. The fire appears to have burned hot enough through the riparian area and streamside vegetation that the majority of the brook trout were unable to survive.

In addition to the riparian areas, the majority of the uplands in the West Fork of Frantz Creek down to FSR 100 were severely burned including the riparian areas. Strong hydrophobicity was noted throughout the high and moderate burn severity areas. On the south facing slopes the litter and duff layers were completely consumed. On the north facing slopes, hydrophobicity was strong, but there were pockets of the duff layer that were only partially consumed. Given that almost the entire watershed above FSR 100 was severely burned resulting in the presence of a strong hydrophobic layer, it is recommended that upland treatments including mulching and seeding be implemented to reduce the amount of surface erosion and maintain long-term soil productivity (see Soils Report).

Significant increases in water and sediment yields are expected in this watershed. Where the West Fork of Frantz Creek drains into Frantz Creek, storm flows are expected to increase by 55-60% for a 10 year, 6 hour precipitation event. Where FSR 100 crosses the West Fork of Frantz Creek, stormflows are expected to double due to almost the entire watershed being severely burned. The current culvert capacity on the West Fork of Frantz Creek at FSR 100 is inadequate given the expected increase in stormflow and sediment yields following the fire. For these reasons it is recommended that the existing culvert be replaced with a larger culvert or similar drainage structure that will accommodate both the increased water and sediment yields while maintaining channel function. Additional drainage structures should also be installed on FSR 100 as some of the burned areas drain directly onto FSR 100. Additional drainage will be necessary to accommodate the expected water and sediment yield increases.

REFERENCES

Rosgen, D.L. 1994: A classification of natural rivers. Catena 22 (1994): 169-199.

APPENDIX A: Peak flow calculations

Peak Flow Calculations - **Green Cr. Fire BAER assessment: Sept 3, 2002**

by Liz Schnackenberg, hydrologist Med Bow-Routt National Forests

Rational Method:

Q=CIA	Q	Peak Flow (cfs)
	C	Runoff Coefficient
	I	Rainfall Intensity (in/hr)
	A	Drainage Area (acres)

Duration of Design Storm:

Time of Concentration =		tc=L^1.15/(7700 H^0.38)
	L	Length of longest stream in Watershed
	H	Elevation difference between high and low point of watershed

Time of Concentration Calculation

Watershed	High Point	Low Point	H (ft)	L (ft)	Tc
N.FK Sarvis Creek 7th	9920	8880	1040	22545	0.94
Green Cr. 6th level	9500	6920	2580	43032	1.4 hrs
Frantz 7th level	9800	8300	1500	19958	0.71 hr
Little Green Creek 8th	9650	8480	1170	21806	0.86 hr

Note: Elevations from usgs 1:24,000 topo maps, stream length measured with a digital planimeter on 1:24:000 topo maps

6 Hour design storm was used as it is the lowest duration design storm with precipitation data available. Therefore The Rational Method should not overestimate Qpk.

Precipitation Frequency from the NOAA atlas located at:

http://www.wrcc.dri.edu/pcpnfreq/co10y6.gif

Watershed Condition Acres burned by intensity

	Total Acres	High	Mod	Low	Unburned	Total in fire
N.Fk. Sarvis 7th	1961	463	106	107	1291	1697
Green Cr. 6th level	3951	263	256	89	592	1200
Frantz 7th level	1482	450	169	439	88	1146
Little Green Creek 8th	3115	145	160	158	239	702

% Burned: total watershed	% High	% Mod	% Low	% Unburned
N.Fk. Sarvis 7th	24%	5%	5%	66%
Green Cr. 6th level	7%	6%	2%	85%
Frantz 7th level	30%	11%	30%	29%
Little Green Creek 8th	5%	5%	5%	85%

Peak Flow Calculation 10 year 6 Hour Storm Event

Design storm = 1.35 inches over 6 hours: 0.225 inch/hr

Pre-Fire Conditions

Watershed	Runoff Coef.	Area (acres)	I	Peak Flow
N.Fk. Sarvis 7th	0.3	1961	0.225	132
Green Cr. 6th level	0.3	3951	0.225	267
Frantz 7th level	0.3	1482	0.225	100
Little Green Creek 8th	0.3	3115	0.225	210

Post Fire Conditions:	Runoff Coefficient:
High Intensity Burn - 100% strongly hydrophobic soils	0.8
Moderate Intensity Burn - 50% moderately hydrophobic soils	0.5
Low Intensity or Unburned	0.3

Runoff Coefficient Weighted Average Calculation

Watershed	% High Int	% Mod int	% low or unburned	Weighted Average
N.Fk. Sarvis 7th	0.19	0.025	0.21	0.428
Green Cr. 6th level	0.056	0.03	0.26	0.347
Frantz 7th level	0.24	0.055	0.177	0.472
Little Green Creek 8th	0.04	0.025	0.27	0.335

Post Fire Peak Flows

Watershed	Runoff Coefficient .	Area	I	Peak Flow
N.Fk. Sarvis 7th	0.428	1961	0.225	189
Green Cr. 6th level	0.347	3951	0.225	308
Frantz 7th level	0.472	1482	0.225	157
Little Green Creek 8th	0.335	3115	0.225	235

Formulas and runoff coefficients from Dunne and Leopold (1978). Watershed area calculated from watersheds delineated in the N.F. GIS system. Burned areas were measured from a paper map by hand planimetry.

Form 2500-8 Hydrologist Design Factors

B. Design Chance of Success – 75- 80%
C. Design Recurrence Interval – 10 year
D. Design Storm Duration – 6 hour
E. Design Storm Magnitude – 1.35 in/hr
F. Design Flow:

Watershed	Pre-fire Peak Flows (cfs)
N.Fk. Sarvis 7th	132
Green Cr. 6th level	267
Frantz 7th level	100
Little Green Creek 8th	210

G. Estimated Reduction in Infiltration: 20 – 50 % for moderate and high burned areas

H. Adjusted Design Flow:

Watershed	Post Fire Peak Flows (cfs)
N.Fk. Sarvis 7th	189
Green Cr. 6th level	308

Frantz 7^{th} level	157
Little Green Creek 8^{th}	235