Burned Area Emergency Rehabilitation Report (BAER)

Battle Creek Fire

September 2002

Mystic District
Black Hills National Forest

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Battle Creek Fire, August 16 – 29, 2002
Mystic Ranger District
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Chapter 1

Battle Creek BAER Report

Executive Summary

This report has been prepared in accordance with the *Forest Service Manual 2523, Burned Area Emergency Rehabilitation*. The report provides emergency fire stabilization and rehabilitation recommendations for National Forest System land burned within the Battle Creek Fire.

Fire Background

The Battle Creek fire area is located near Rapid City, South Dakota. The area affected by the Battle Creek fire is administered primarily by the Black Hills NF. A total of 10,399 acres of national forest system land is within the area of affect. State and Private Lands affected lands affected by the fire totals 3,301 acres. Total area affected is 13,700 acres, which includes 1,250 acres of unburned land. The area of effect is located within Pennington County and within the following 7.5 minute quadrangles: Hayward, Mt. Rushmore, and Rockerville.

Cooperating agencies include South Dakota State Forestry, Natural Resource and Conservation Service, South Dakota Department of Transportation and Pennington County Roads. Total costs for the fire through August 29, 2002 were estimated at $7,000,000.

Resource Damages and Threats to Human Safety and Resources

The fire burned approximately 12,450 acres. Fire severity mapping conducted on the Battle Creek Fire classified 22% of the burn as high burn severity, 25% as moderate burn severity, and 53% as unburned or low burn severity.

Field reviews within the burned area and downstream of the burned area confirm that threats to life are unlikely except for ashflows and rock on Highway 16. Threats to homes and outbuildings that are located in or near the floodplain or at the mouth of drainages exist in and downstream of the burned area. The impact will be wet foundations and ash and sediment deposits. There are numerous culverts on state highway, private, county roads and Forest Service roads that could be damaged.

The BAER Team conducted intensive field surveys after the fire to identify impacts and compile the following recommendations for stabilization and rehabilitation of affected lands:

- Treat previously weed-free areas adjacent to known populations for next 3 years
- Install automated rain gage and Data Collection Platform (DCP) with GOES telemetry within burned area
- Install four straw bale check dams above the Highway 16 culvert near Rockerville
- Clean all ditches, outlets and drainage structures on 56 miles of system roads and 20 miles of unclassified roads

- Complete numerous road and trail specifications, including grade dip construction, template restoration, drop inlet installation, and trail protection (Flume Trail)
- Complete hazard tree removal and analysis along some roads and trails
- Assess unclassified roads

See Appendix A for a Fire Perimeter map and Appendix B for a Fire Progression map.

Chapter 2

Battle Creek BAER Report

Resource Assessments

SOIL AND WATERSHED

I. OBJECTIVES

- Assess overall watershed changes caused by the fire, particularly those that pose substantial threats to human life, property, and critical natural and cultural resources. This includes evaluating changes to soil conditions, hydrologic function, and watershed response to precipitation events.
- Identify the most critical soil and watershed areas and issues related to the Battle Creek Fire based on increased flood and debris flow potential and loss of soil resources.
- Prescribe treatments, if necessary, to mitigate impacts and risks to natural resources and local citizens.
- Develop maps of burn severity, values at risk, and treatments.
- Identify future monitoring needs.

II. ISSUES

- Potential threats to human life and property downstream of the Battle Creek Fire from potential increases in storm flow runoff, flooding and debris flows.
- Ability of drainage structures to pass flood and debris flows.
- Potential loss of soil productivity and increased erosion.
- Emergency Stabilization/Rehabilitation (ESR) cannot design treatments to protect against all scales of flood and debris flow events.

III. OBSERVATIONS

Background

1. Geology/Physiography:

The Battle Creek Fire is located approximately 10 miles west of Rapid City, South Dakota. The small communities of Rockerville, Keystone, and Hayward flank its boundary. Most of the burned area is characterized by the mountainous topography of the Black Hills, with many areas containing steep slopes and narrow canyon bottoms (Figure 1. Cross-Section of Geology, Physiography, and Soils). The eastern third of the fire area is located in the steeply dipping plateau lands of the Deadwood, Minnelusa, and Madison Limestone and Englewood Formations. The western two-thirds are situated in the central crystalline area, comprised primarily of greywacke with lesser amounts of metamorphosed sedimentary rock outcroppings. Slopes range from nearly flat on the plateau-like ridge tops and grassy meadows to greater than 80% on the steep eastern slopes and canyon walls. Elevations of the burned area range from approximately 3650 feet in the southernmost tip of the fire to 5400 feet at the summit of Silver Mountain in the northwestern portion of the fire.

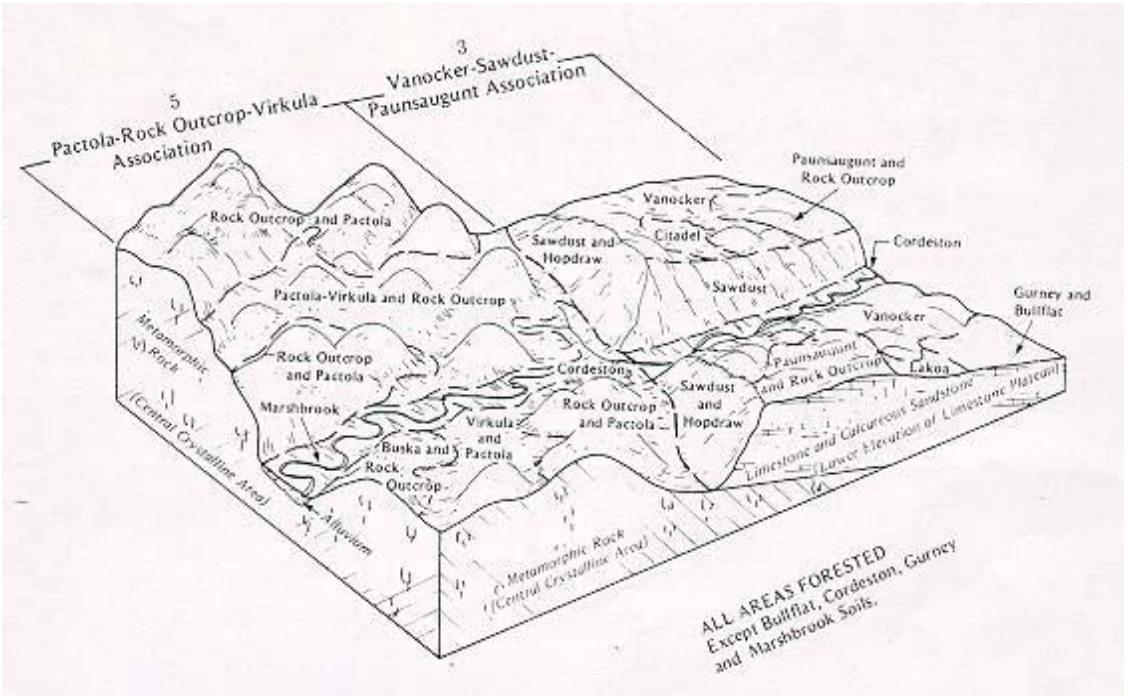

Figure 1. Cross Section of Geology, Physiography, and Soils

2. Soils

The information on soils is derived from the Soil Survey of Pennington and Custer Counties, South Dakota, Black Hills Parts and the Black Hills National Forest soils GIS layer.

The dominant soils within the fire perimeter are comprised of various complexes in combinations of the following soil types: Pactola, Virkula, Vanocker, Citadel, Sawdust, Buska, Paunsaugunt, Gurney, Hopdraw, Lakoa and rock outcroppings. These generally fall within two major associations – the Vanocker-Sawdust-Paunsaugunt and the Pactola-Rock Outcrop-Virkula.

The Vanocker-Sawdust-Paunsaugunt association consists of deep and shallow, well drained, gently sloping to very steep, loamy soils formed from weathered limestone and calcareous sandstone. It is located on mountains at the lower elevations of the Limestone Plateau. It is characterized by broad ridges and canyons, and is highly dissected by drainage ways and major streams. Some canyons are deeply entrenched and have very steep side slopes and rimrock ledges. Minor soil types in this association include Bullflat, Citadel, Cordeston, Gurney, Hopdraw and Lakoa, as well as areas of Rock outcrop. The deep Bullflat, Citadel, Cordeston, and Lakoa soils have fewer coarse fragments than the major soils. Bullflat, Citadel, Gurney, and Lakoa soils are on the less sloping parts of the landscape, with Cordeston soils found along drainage ways. The deep, sandy Hopdraw soils occur in scattered areas throughout the association. Gurney soils have bedrock at a depth of about 28 inches. The Rock outcroppings occur as ledges and ridges of limestone and sandstone. Nearly all of this association is managed for timber, with Ponderosa Pine as the dominant species, with most of the association also used for livestock grazing.

The Pactola-Rock Outcrop-Virkula Association consists of Rock outcrop and deep, well drained, gently sloping to very steep, loamy soils formed in material weathered from steeply tilted metamorphic rock. It is located on mountains in the Central Crystalline area. Ridges, peaks, and canyons characterize this association. It is highly dissected by drainage ways and major streams, which are deeply entrenched. The Rock outcrop consists of peaks, ledges, and dikes of extremely hard, highly fractured, steeply tilted metamorphic rock. The Virkula soils are on the slightly concave, mid and low side slopes. Minor soils in this association are the Buska and Cordeston soils and the poorly drained Marshbrook soils. Buska soils formed in material weathered from micaceous schist. They are in landscape positions similar to those of the Pactola soils. Cordeston and Marshbrook soils formed in alluvium and are along drainage ways. Nearly all of this association is forested, with small acreage used for range.

Approximately 33% of the fire area is comprised of soils that have a severe erosion hazard, prior to fire disturbances, with an additional 56% of the area comprised of soils with a moderate erosion hazard.

3. Climate:

Around the Battle Creek Fire, elevations range from 3800 feet near Hayward to over 5400 feet on the Silver Mountain. The Battle Creek Fire area has a semi-arid climate with low humidity throughout the year. Temperatures range from 100° F during summer months to well below 0° F in winter. Average annual precipitation for the area is 19 inches. Approximately 50% of the annual precipitation occurs May through July with approximately 75% of the annual precipitation occurring April through August. Localized intense thundercells associated with the monsoons can produce much greater rain than surrounding areas within one storm event. The largest recorded storm in the Black Hills occurred on June 9, 1972. About 10 to 15 inches of rain fell on the central Hills, resulting in the devastating flood of Rapid City that killed over 200 people.

4. Hydrology

The Battle Creek Fire area is primarily within the Battle Creek watershed. A small portion on the north edge of the fire is within the Spring Creek watershed. Within the Battle Creek watershed the named drainages include Deadman Gulch, Lead Draw, Foster Gulch, Tepee Gulch, Bobtail Gulch and Horsely Gulch. Some are perennial, but most are intermittent and ephemeral in nature.

Springs and seeps occur throughout the area as well. The area's riparian and wetland areas are associated with these streams and springs. The flow regime of the fire area is characterized by rain dominated peak flows in spring and peak flows in response to short duration, high intensity thunderstorms during the summer.

Reconnaissance Methods and Results

The purpose of a burned area assessment is to determine if the fire caused emergency watershed conditions and if there are values at risk from these conditions. If an emergency is not identified, the assessment stops. If emergency watershed conditions are found, and values at risk are identified, then the magnitude and scope of the emergency is mapped and described, values at risk and resources to be protected are analyzed, and treatment prescriptions are developed to protect values at risk. Emergency watershed conditions include both hydrologic and soil factors. Typically, wildfire increases the potential for flash floods, soil erosion, and debris flows. The deterioration of soil condition, particularly loss of soil cover, lead to a decline in soil productivity and watershed stability. Table 1 describes terms commonly used in assessing soils and watersheds that have been burned.

Table 1. Definitions of terms commonly used in soil and watershed burned area assessments.

Term	Definition
Fire Intensity	Based on temperature, flame length, rate of spread, heat of combustion and total amount and size of fuel consumed. Accounts for convective heat rising into the atmosphere and fire effects to the overstory.
Fire Severity	Based on temperature, moisture content of duff and fuels lying on the ground, heat of combustion of conductive and radiant heat that goes down in to 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 soil hydrologic function. Burn severity is delineated on topographic maps as polygons. Classes of burn severity are high, moderate, low and 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 of soil cover; amount and distribution of impermeable surfaces (rock outcrop, hydrophobic soils) amount and duration of rainfall; lag time between initiation of storm and peak flow runoff; and peak flow discharge and sediment delivery. Changes in the characteristics of a watershed caused by a fire will increase the efficiency with which a watershed yields runoff.

Burned area evaluations included, but were not limited to:

- Fire-caused changes in soil properties and hydrologic function;
- Aerial extent and strength of hydrophobic soil conditions;
- Mapping burn severity;
- Conditions of sediment source areas;
- Current channel and culvert capabilities;
- Elevations of structures facilities relative to anticipated or modeled post-fire flows; and
- Threats to human life and property from storm or mudflow and debris.

1. Burn Severity

Burn severity is not the same concept as fire intensity and fire severity as recognized by fire behavior specialists. Fire intensity and fire severity relate to fire behavior and fire effects on overstory and understory vegetation, respectively, while burn severity relates specifically to effects of the fire on soil conditions and hydrologic function (e.g., amount of surface litter and duff, erodibility, soil structure, infiltration rate, runoff response). Although burn severity is not primarily a reflection of fire effects on 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 provide clues about 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 - high, moderate, and low. A category of "unburned" may be mapped separately if there are large unburned islands inside the burn perimeter. Alternatively, mosaics of low and unburned areas may be lumped together for mapping and assessment purposes.

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 and the longer the residence time, the more severe the effects of the fire are 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 time promotes the formation of water repellent 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).

A classified satellite image using different spectral wavelength bands to delineate areas of low, moderate, and high burn severity at 30-meter resolution was produced by the Forest Service Remote Sensing Application Center using a Landsat7 image. However due to the timing of the satellite flight paths, the image was taken before the fire was completely contained and thus covered only the eastern portion of the burned area. The remaining western portion was hand mapped and the burn severity satellite image was verified by field visits, direct soil observations, and helicopter reconnaissance in order to produce the final burn severity map. The burn severity map becomes a basis to predict the hydrologic response of the watersheds, rates of erosion and the rate of natural revegetation of the site following the fire.

2. Soil Condition

Fire effects were evaluated in terms of soil condition parameters. These parameters included changes in litter and duff (vegetative ground cover), loss of soil structure, destruction of fine and very fine roots in the surface horizon, inherent susceptibility to erosion, and development of hydrophobic (water repellent) soil surfaces. Changes in vegetative ground cover as affected by the fire were noted and compared to pre-fire conditions. Surface soils were examined for the presence of fine and very fine roots. Water repellency was evaluated by observing the depth and thickness of a water repellent horizon in surface soils where it exists, and the length of time a water drop remained beaded on the surface.

Erosion potential was calculated using the Revised Universal Soil Loss Equation (modified for use on National Forests) in tons/acre in a spatially-based Arcview model. Input data was taken from NRCS Pennington and Custer County Soil Surveys and the Black Hills National Forest soils and vegetation GIS layers.

The RUSLE equation:

A (tons/acre) = *R*K*LS*C*

Where *A* is the on-site soil loss expected in tons/acre, *R* is the rainfall factor, *K* is the soil erodibility value taken from the soil surveys, *LS* is the slope factor accounting for slope length and step effect, and *C* is the cover factor.

A spatial model to predict erosion in tons per acre annually was run for the fire area in order to develop a sense of where the highest erosion potential occurs within the fire, as well as identify candidate areas for hillslope treatments. The model runs a user-specified precipitation event to predict erosion – for the Battle Creek fire, the storm event of concern was a short-duration, localized thunderstorm event, specifically 2 inches of rain in one hour. This value corresponds to a 10-year, 1-hour rain event and was obtained from the Intensity-Duration-Frequency (IDF) Curves developed by HDR Engineering. The other RUSLE inputs are incorporated spatially using a Digital Elevation Model (DEM) for the *LS* factor and by calculating *C* factors for each different vegetation type in conjunction with burn severity (i.e., an area of ponderosa pine in moderate burn severity burn is attributed with a lower Cover factor than an area of ponderosa pine in high burn severity).

3. Watershed Response

On-the-ground field observations and aerial reconnaissance within and downstream of the burn areas were conducted to determine watershed response. Channel morphology related to transport and deposition processes were noted, along with channel crossings and stream outlets. Observations included condition of riparian vegetation and the volume of sediment stored in channels and on slopes that could be mobilized. Burn severity and changes in soil rates infiltration were also considered. Cross sections were measured at the some of the values at risk that field observations indicated that they may be at risk.

Pre-fire and Post-fire Flow Modeling

The drainages impacted most significantly are in the areas of Deadman Gulch and Foster Gulch. The fire effects within Johnson Gulch and Cabin Creek are not considered extensive enough or to a magnitude that would cause concern. The distance from the headwaters, mixing of flows from unburned watersheds, and the large capacity of the channel and floodplains below the Battle Creek confluence with Iron Creek, will substantially attenuate peak flows attributable to fire effects. Therefore, downstream values are not anticipated to have an elevated level of risk related to the fire.

Soils in the Black Hills are shallow, typically less than 10 to 15 feet in most places (Orr 1959) and, within the fire boundary, often have high percentages of rock fragments. Drainage densities, which reflect how far water must travel before reaching a channel, are high. The fire area can receive large amounts of precipitation from both high intensity - short duration storms, and low intensity – long duration storms. Roughly 69 percent of the 19 to 20 inches of total annual precipitation falls between the middle of May and end of September (Orr 1959). For these reasons, it is important to note up front that the slopes burned by the Battle Creek Fire are naturally prone to flash flooding, but especially so following severe wildfires. Threats to human life and property existed before the fire because extensive development has occurred in and near channel bottoms and floodplains. Unfortunately, the conditions created by the Battle Creek Fire may, in some cases, elevate the pre-existing risk. The names and locations of the watersheds evaluated are displayed on the "Hydrologic Analysis" map. The fire is located on a mix of land ownerships including State and private lands, with the majority located inside Black Hills National Forest boundaries. Table 1 displays the acres and percent burned within each of the analysis watersheds.

Sources of Information: Several hydrologists reviewed resource conditions resulting from the Battle Creek Fire from the start of the fire till August 30, 2002. The BAER team made aerial reconnaissance flights in addition to on-the-ground reviews. From a hydrological standpoint, the main objectives for the field visits are to: 1) develop a fire severity map - locating areas containing hydrophobic soils; 2) inventory values-at-risk, 3) identify the physical and biological mechanisms that are creating risks; 4) review channel morphology and riparian conditions; 5) inspect hill slope conditions; and 6) to determine needs for rehabilitation. Values-at-risk are items located within or downstream of the fire and subject to hazards caused by the burn. These hazards could include flooding, erosion, or sediment. Values-at-risk for the Battle Creek Fire include:

- Numerous residential, and a few commercial developments
- Power transmission lines
- Federal, State, and County highways and Forest roads

The project hydrologists calculated important watershed parameters using a Geographic Information System (GIS). Storm flows and sediment predictions were made using an ArcView extension that uses a Rational Flow Method for runoff, and the NRCS curve method for time of concentration. The curve numbers were carefully selected to reflect pre- and post fire conditions and are included in the project file. Major parameters analyzed using GIS included soil types, stream lengths, stream orders, watershed sizes, vegetative composition, land ownership, burn severity and location, and slope. An Excel spreadsheet was used to store, manipulate, and analyze the resulting water and sediment data presented in this report. The spreadsheet also

documents the data sources and assumptions used. This spreadsheet is located in the project file.

NOTE: The numbers presented in this report are based on a rapid and preliminary assessment of hydrologic modifications caused by the fire and should not be relied upon exclusively for engineering structures.

Table 2 – Acres and percent of each watershed burned, by fire severity class.

Watershed Name	High		Moderate		Low		Unburned	
	acres	%	acres	%	acres	%	acres	%
Battle Creek	493	2 %	564	2 %	1,840	7 %	22,286	89 %
Tepee Gulch	341	9 %	243	6 %	745	20 %	2,407	65 %
Bobtail Gulch	63	6 %	145	13 %	410	37 %	502	44 %
Keystone Dump	0	0 %	4	2 %	49	24 %	148	74 %
Horsely Gulch	6	2 %	14	5 %	98	38 %	142	55 %
Foster Gulch	690	16 %	1,003	23 %	1,695	40 %	892	21 %
Johnson Gulch	38	1 %	178	6 %	329	12 %	2,213	80 %
Rockerville Gulch	43	5 %	60	8 %	320	40 %	376	47 %
Cabin Creek	12	1 %	37	4 %	266	26 %	706	69 %
North Deadman Trib in section 32	153	21 %	116	16 %	348	48 %	113	15 %
South Deadman Trib in section 32	242	18 %	305	23 %	664	50 %	120	9 %
Deadman Trib in section 5	175	42 %	140	33 %	100	24 %	5	1 %
Deadman Trib near Jackson Spring	146	25 %	262	45 %	177	30 %	1	0 %
Lost Cave & Dog House Gulch	251	22 %	187	16 %	478	42 %	232	20 %

Channel cross-sections and structure elevations were measured at residential sites that were considered at-risk. The data were input and analyzed in WinXSpro for comparison with the pre- and post event stormflow modeling. Parameters in the model include the cross-sectional area, slope, and roughness of the channel. This information gives an indication as to what size storm will exceed the channel capacity and come into contact with the buildings.

Stormflow to culverts below severely burned watersheds were modeled in GIS. The output flow results were compared to the estimated capacity of the culverts. Under post-fire conditions, 7 out of 14 culverts could have their capacity exceeded by a 10-year return interval storm. The values-at-risk section discusses these culverts and the other values-at-risk in greater detail.

Potential accelerated erosion from the burned areas was estimated using an ArcView GIS extension as discussed in the soils and geology section of this report. It is important to remember that at best, the potential error for the sediment estimates is on the order of plus or minus 50 to 100 percent given that erosion episodes are strongly dependent on climatic events and are inherently difficult to generalize and quantify.

Water Features: All of the catchments affected by the Battle Creek Fire are tributary to the Missouri River via the Cheyenne River. The fire does not directly impact perennial streams within or near the perimeter. A few ponds were seen, but no springs or lakes were evident. There is a dry stock pond with capacity to store runoff from a 2 to 5-year storm using post-fire modeling results. This estimate does not account for sediment storage. There is a 50 to 90 percent chance that a 2 to 5-year return interval flood will occur before the slopes have time to recover over the next 3 years.

Channel and Basin Morphology: The hill slopes within the fire perimeter vary from gentle and rolling to very steep. Average watershed slopes range from 6 to 14 percent so stream channels are typically not steep. The channels in and near the fire often have minimal or no surface flows, but this fact is deceptive. The broad, often gently shaped slopes adjacent to the channel indicate that large flows create and maintain many of the stream and valley forms within the assessment area. The historic stream flow records offer indisputable evidence that this is the case. Most of the channels have good connectivity to the existing floodplains through which they flow. This feature allows streams to dissipate energy by spreading water over a wider area, and by depositing sediment that would otherwise be transported downstream.

Table 2 shows the miles of channel within the high, moderate, and low fire severity classes. The risk of flash floods is typically higher in watersheds with higher channel densities. As can be seen from the table, the fire directly affected substantial amounts of the channel networks in Foster, Lost Cave, and Dog House Gulches, and in the unnamed tributaries in Deadman Gulch. The remainder of drainages was affected to a much smaller degree. The ability of vegetation to stabilize channel banks and filter upslope erosion will be compromised until the vegetation has time to recover. This process will take 3 to 10 years or more depending on the site and burn severity.

Table 3 – Miles of channel located within each fire severity class, and Channel Density.

Watershed Name	High	Moderate	Low	Total Burned	Unburned	Channel Density
	miles	miles	miles	miles	miles	mile/mile^2
Battle Creek	0.1	1.4	14.4	15.9	128.0	3.7
Tepee Gulch	0.1	0.9	6.8	7.8	13.9	3.7
Bobtail Gulch	0.0	0.3	2.5	2.8	3.2	3.4
Keystone Dump	0.0	0.0	0.3	0.3	0.8	3.6
Horsely Gulch	0.0	0.0	0.6	0.6	0.7	3.2
Foster Gulch	1.8	2.9	13.8	18.5	4.8	3.5
Johnson Gulch	0.0	0.1	2.0	2.1	12.9	3.5
Rockerville Gulch	0.0	0.0	2.2	2.2	2.8	4.0
Cabin Creek	0.0	0.1	1.5	1.6	4.4	3.8

North Deadman Trib in section 32	0.4	0.3	3.4	4.1	0.4	4.5
South Deadman Trib in section 32	0.2	1.4	4.1	5.7	1.2	3.3
Deadman Trib in section 5	1.1	0.6	0.7	2.4	0.1	3.8
Deadman Trib near Jackson Spring	0.2	1.6	1.4	3.2	0.0	3.6
Lost Cave & Dog House Gulch	0.7	1.0	3.4	5.1	1.8	3.9
Total	**4.5**	**9.4**	**46.9**	**60.8**	**175.0**	**N/A**

Water Quantity: An analysis comparing pre-fire and post-fire water flow rates and volumes is shown in Tables 4 through 7. These tables illustrate the predicted fire related changes in flood magnitude that could result from the burned slopes. The post-fire modeling approximates intense thunderstorm flood potential for the first year following the fire. Flood potential will decrease as soils re-vegetate, and infiltration capacity and slope roughness are restored. However, recovery of the strongly hydrophobic soils may take as long as 3 years. Table 3 gives the probability that a storm of a certain size will occur within the next three years. Table 4 shows the pre-burn magnitudes and Table 5 shows the post-burn magnitudes for different storm return intervals. The Rational Flow Method assumes, for example, that a 5-year return interval storm results in a 5-year return interval flood. Other disturbance factors such as roads (that are not inputs to the model) can lead to floods that have a larger return interval than the storm generating the precipitation. However, the assumption is reasonable for the purpose of this analysis given that the roads within the fire will be made hydrologically inert through implementing the prescribed cross-drainage treatments.

Table 4 - Probability that a given return interval storm will occur within the next 3 years.

2 Year Return Interval	5 Year Return Interval	10 Year Return Interval	25 Year Return Interval	50 Year Return Interval	100 Year Return Interval
88 %	49 %	27 %	12 %	6 %	3 %

Table 5 – Pre-fire flood analyses by watershed and by differing storm return intervals.

Watershed Name	Pre-fire 2 Year Return Interval Flood	Pre-fire 5 Year Return Interval Flood	Pre-fire 10 Year Return Interval Flood	Pre-fire 25 Year Return Interval Flood	Pre-Fire 50 Year Return Interval Flood	Pre-fire 100 Year Return Interval Flood
	cfs	cfs	cfs	cfs	cfs	cfs
Battle Creek	275	395	468	582	667	743
Tepee Gulch	41	59	70	86	99	110
Bobtail Gulch	53	76	90	112	129	143
Keystone Dump	2	3	4	5	5	6
Horsely Gulch	3	4	5	6	7	8
Foster Gulch	47	67	80	99	114	126
Johnson Gulch	30	43	51	64	73	81
Rockerville Gulch	9	13	15	19	21	24
Cabin Creek	11	16	19	24	27	30
North Deadman Trib in section 32	8	12	14	17	19	22
South Deadman Trib in section 32	15	21	25	31	35	39
Deadman Trib in section 5	5	7	8	10	11	12
Deadman Trib near Jackson Spring	6	9	11	14	16	17
Lost Cave & Dog House Gulch	13	18	21	27	30	34

Table 6 – Post-fire flood analyses by watershed and by differing storm return intervals.

Watershed Name	Post-fire 2 Year Return Interval Flood	Post-fire 5 Year Return Interval Flood	Post-fire 10 Year Return Interval Flood	Post-fire 25 Year Return Interval Flood	Post-Fire 50 Year Return Interval Flood	Post-fire 100 Year Return Interval Flood
	cfs	cfs	cfs	cfs	cfs	cfs
Battle Creek	2196	3163	3747	4654	5339	5943
Tepee Gulch	448	645	764	949	1089	1212
Bobtail Gulch	582	839	994	1234	1416	1576
Keystone Dump	7	10	11	14	16	18
Horsely Gulch	20	29	34	42	48	54
Foster Gulch	1121	1615	1913	2376	2726	3034
Johnson Gulch	120	173	205	255	292	326
Rockerville Gulch	87	126	149	185	212	236
Cabin Creek	56	80	95	118	136	151
North Deadman Trib in section 32	191	275	326	405	464	517
South Deadman Trib in section 32	378	544	645	801	919	1023
Deadman Trib in section 5	202	291	344	428	491	546
Deadman Trib near Jackson Spring	275	397	470	583	669	745
Lost Cave & Dog House Gulch	350	504	598	742	851	948

The gray shaded regions of the table indicate flow levels where at-risk values could be affected.

A Maximum Flood Envelope was developed using 46 gauged streams in the Black Hills. The gauged drainage areas range from 0.2 to 9810 square miles in size. The equation is:

$Q_p = 2100 Area^{-0.7}$

Where, Qp = cubic feet per second (cfs) per square mile
Area = square miles within the watershed

This equation estimates the maximum probable flow based on data from the last 100-years. The equation is useful for estimating a "worse-case-scenario" based on historic conditions. However, it is important to realize that the data does not reflect all possible climatic events and may not reflect all types or severities of disturbances such as grazing, wildfire, fire suppression, road building, logging, and water diversions. However the fact that a 1 square mile drainage area can generate 2100 cubic feet per second per square mile is a testament to the flashy nature of these watersheds. Table 6 shows the maximum probable floods for the selected watersheds within the Battle Creek Fire.

Table 7 – Maximum probable floods for selected watersheds within the Battle Creek Fire.

Watershed Name	Drainage Area	Maximum Flood
	square miles	cfs
Battle Creek	39.35	6320
Tepee Gulch	5.84	3565
Bobtail Gulch	1.75	2484
Keystone Dump	0.31	1484
Horsely Gulch	0.41	1603
Foster Gulch	6.69	3714
Johnson Gulch	4.31	3255
Rockerville Gulch	1.25	2245
Cabin Creek	1.60	2416
North Deadman Trib in section 32	0.98	2090
South Deadman Trib in section 32	2.08	2616
Deadman Trib in section 5	0.66	1851
Deadman Trib near Jackson Spring	0.92	2045
Lost Cave & Dog House Gulch	1.79	2502

Table 7 gives the acre-feet of water that would be generated by the 10 and 50-year design storms as modeled in HYDRAIN using post-fire watershed conditions for the pond below Lost Cave & Dog House Gulch. The pond has 12 to 13 acre-feet of storage capacity that will help dampen flood peaks provided the existing unarmored spillway does not scour and fail.

Table 8 – Acre-feet of water from 10 and 50 Year Return Interval Storms.

Watershed Name	10-Year Storm	50-Year Storm
	acre-feet	acre-feet
Houses below Lost Cave and Dog House Gulch	23	40

Water Quality: Battle Creek near Hayward is designated as an impaired water body in the 1998 State of South Dakota 305(b) report. The pollutants of concern are pH, temperature, and ammonia and the priority for development of a Total Maximum Daily Load is high. The sources of these pollutants are not listed, but municipal and residential developments in the canyon bottoms are likely candidates. There is potential for post-fire stormflow to contribute ash and eroded soil, which could increase pH and ammonia. However, the remaining and newly establishing vegetation will quickly capture most nutrients made available as a result of the fire. Temperature should not be impacted given that the fire only affected intermittent and ephemeral channels in Battle Creek.

Erosion and Sediment: Based on observed post-fire conditions and modeling, it is estimated that flows and soil erosion should return to pre-fire conditions in approximately 3 to 5 years. The initial erosion of ash and surface soil during the first storm(s) will reduce slope roughness by filling in depressions above rocks, logs, and any remaining vegetation. The ability of the burned slopes to detain water and sediment will be reduced accordingly. This will add to the potential for " flashy " runoff caused solely by hydrophobic soils and will increase the distance that eroded materials are transported. However, several factors favor a

quick recovery in terms of normal hydrologic response of the hill slopes. The mosaic burn pattern of fire severity creates zones of infiltration and sediment detention above and below many of the severely burned slopes. Needle cast beneath forested canopies on low and moderate burn severity sites will provide extra soil protection and promote water infiltration. Frost heave can break up hydrophobic layers and is likely given that persistent snow packs rarely develop in the Black Hills. Even in severely burned sites, the root crowns of the understory vegetation are often still viable.

Debris flows and landslides are not a likely sediment concern given the relatively gentle slopes and the well drained soils that often have a relatively high percentage of stabilizing rock fragments, and given the other favorable conditions described above. Unpublished measurements by Sue Cannon, USGS debris flow scientist, show that 2000 and 2001 wildfire debris flows typically occurred on 27 to 45 degree stream channels. Most of the channels affected by the Battle Creek fire have considerably less gradient. The primary sources of sediment will come from sheet, rill, and gully erosion, particularly in Lead Draw and the unnamed Deadman Tributaries. The severely burned slopes that were covered by conifers prior to the fire will have some loss in rooting strength for the next 3 to 7 years. However, this will not affect slope stability as already described. Remaining conifer seed sources exist to reforest areas where the previous tree overstory was consumed. The small inclusions of aspen and oak stands will regenerate naturally through sprouting.

Recommendations: Preventative measures, and the need for hillslope, channel, and road treatments to reduce or prevent immediate threats to human life and property, and to soil and water resources are discussed in the treatments section of the BAER report.

Findings

1. Burn Severity and Soil Condition:

Table 9 displays a summary of burn severity acres and percentages by severity class for the Battle Creek Fire. A burn severity map is included in Appendix C.

Table 9 - Acres and percent of burn severity.

Burn Severity	Acres	Percent
High	2,854	23%
Moderate	3,311	27%
Low/Unburned	6,285	50%
TOTAL	**12,450**	**100%**

The BAER soil scientists and hydrologists reviewed the post-fire soil conditions. Despite the fact that half of the Battle Creek fire is low severity, these low areas occur as small patches or thin strips between high and moderate severity areas. The remaining 50% of the fire area is a high and moderate severity mix, which dominates the eastern portion of the fire. This area includes Foster Gulch, Lead Draw, and tributary drainages to Deadman Gulch, as well as small areas contributing flow to Battle Creek. The area between Silver Mountain and Eagle Mountain, which is dissected by Highway 16, experienced relatively large areas of high burn severity as well. In these high burn severity areas, the litter and duff were entirely consumed; little to no protective groundcover exists; and soils exhibit strong water repellency at the surface. Soils in this area have a certain degree of natural water repellency before fire disturbance. However, an increase

in overland flow due to the fire-enhanced hydrophobic conditions and removal of vegetation and duff layers is expected and is coupled with increased rates of erosion. Fire-caused hydrophobic layers typically take six months to two years to break down. Plant root development, soil microbial activity, and mild soil disturbances can contribute to the degradation of hydrophobic conditions.

Areas of moderate burn severity exist throughout the entire fire across all vegetation types. In these areas, some leaves or needles remain and will drop to provide some initial protective ground cover. This will serve to help reduce runoff velocities, promote infiltration, and mitigate post-fire erosion potential. The litter and duff in the moderate severity areas was consumed in discontinuous patches. Hydrophobicity is predominately classified as weak with inclusions of moderate and no repellency at the surface in areas of moderate burn severity.

The majority of low severity and unburned polygons occurred along the outskirts of the fire and in grassy meadows. Areas of forest litter and grass may look black immediately post-fire, but in the low burn severity areas the litter and duff was charred but not entirely consumed. This remaining duff provides good ground cover to protect the soil from erosion and runoff. Areas of low severity were tested for water repellency but it was rarely exhibited, and was weak if present at all. Trees in low severity areas are generally mostly green and are expected to survive. Vegetation communities are expected to recover rapidly, and post-fire erosion will not be significantly higher than pre-fire erosion.

Table 2 shows the acres of each burn severity class in each analysis watershed. Please refer to the Appendix I for a hydrologic analysis map.

2. Erosion Potential

The results of the RUSLE model in ArcView, run for a short-duration thunderstorm (10-yr, 1-hour storm producing 2.0 inches) are presented in Appendices D and E, Pre- and Post-Fire Erosion Potential Maps. The maps indicate where the highest rates of erosion are likely to occur and helped watershed specialists identify hillslope treatment areas. It is important to note the *relative* increase in erosion between pre and post-fire, because of the error associated with the model (due to human inputs such as soil survey information, the burn severity map, and calculations of post-fire cover factors). Average annual rates of erosion potential (tons/acre) were calculated for 6 watersheds containing the burned area and are shown in Table 4 The average annual erosion potential across the entire analysis area is 63 tons/acre, which equates to 3/8 inch of soil loss across one acre. This is a three-fold increase over pre-fire erosion rates for the modeled storm.

Table 10 - Annual Pre-fire and Post-fire Erosion Potentials

Watershed Name	Area (acres)	PREFIRE (tons/acre)		POSTFIRE (tons/acre)	
		Max	Mean	Max	Mean
Spring	6492	201	25	1609	33
Deadman	4880	242	13	3472	106
Rockerville	2364	116	10	1306	28
Rushmore	1564	116	10	1758	90
Battle	15581	2800	25	3514	85
Boulder	2869	186	21	1609	38

Sheet, rill, and gully erosion are expected to occur at increased rates due to the fire. Prior to the fire, vegetation provided protective groundcover and duff layers played an important role in infiltration -- both key factors in reducing overland flow. However, due to the fire, soils are now bare and susceptible to accelerated erosion and increased runoff rates. The steep slopes found in the eastern portion of the fire (Deadman Gulch, Foster Gulch, Lead Draw, etc) as well as the slopes of Silver and Eagle Mountain have severe erosion potential. These slopes not only have a high burn severity, but also have soils with naturally high erosion potential, prior to fire disturbance.

3. Watershed Response

The primary watershed responses of the Battle Creek Fire are expected to include: 1) an initial flush of ash; 2) rill and gully erosion in drainages and sheet and rill erosion on steep slopes within the burn area; 3) debris flows and sediment deposition where stream gradients flatten or at tributary mouths; and 4) increases in peak flows. Elevated erosion, runoff, and stream flows are expected to occur for several years after the fire until the vegetation has recovered.

Approximately 23% of the fire experienced high burn severity. After a high severity fire, most of the vegetation and duff has been consumed, resulting in decreased interception of rainfall due to the lack of vegetation. Infiltration rates also decrease due to the removal of duff, which acts as a sponge, temporarily holding rainfall, allowing it to soak in slowly. The cumulative effect is increased surface runoff and erosion. In areas where high burn severity occurs, increased runoff and reduced ground cover is likely to cause hillslope erosion and could potentially cause debris flows. Recovery of grasses, forbs and shrubs is expected to occur in most areas within 3 to 5 years. Some high severity areas may not fully recover for ten or more years due to the high rock content, which limits the amount of productive soil available for vegetative growth. Once the soils and vegetation have recovered the watershed is expected to return to pre-fire conditions.

4. Values at Risk:

Values at risk from erosion, flood or debris flows include human life, safety and property and critical cultural and natural resources. Property values can include houses, outbuildings and roads. Critical cultural and natural resources can include archaeological sites, historical sites, range improvements and critical wildlife habitat. Teams comprised of individuals from the U.S. Forest Service, Natural Resources Conservation Service and the State of South Dakota, Department of Forestry, Forestry Division assessed property values at risk within and downstream of the Battle Creek Fire. Risk categories were high, moderate and low. Risk categories were assigned based on location of the value at risk. Stormflows for values listed in the following table were modeled using the GIS rational method as explained in the watershed response section of this report. See Appendix F for a Values at Risk map.

Table 11 – Values at Risk					
Map ID	**Value At Risk**	**Channel Capacity cfs**	**Return Interval to Fill Channel**	**Potential Risk**	**Risk Process**
S1	Residence – Klondike Road	NA	2-year	High	Flows from small drainage will damage house. House sits right in the path of the drainage.
S2	Outbuilding – Foster Gulch	Unknown	Unknown	Moderate	Flood flows could reach and surround outbuilding. Current occupants said there was about 12" of water in building during the '72 flood.
S3a	Residence – Children's Home			Low	House is near floodplain.
S3b	Shop – Children's Home	1127	5-year	Moderate	Flood flows from Tepee Gulch and Bobtail Gulch could damage shop.
S4a	Garage/Shop - Keystone			Low	Garage/Shop is near floodplain.
S4b	Residence - Keystone			Low	House is near floodplain.
S4c	Residence - Keystone	NA	2-year	High	Flood flows could damage house. House sits right in the bottom.
S4d	Residence - Keystone			Low	House is near floodplain.
S4e	Residence - Keystone			Moderate	House is near floodplain. House sits in the flow path.
S5a	Residence - Harney	NA	2-year	Moderate	House is near floodplain. House sits in the flow path.
S5b	Residence – Harney			Low	House is near floodplain.
S5c	Residence – Harney			Low	House is near floodplain.
S5d	Residence - Harney			Low	House is near floodplain.
S6a	Shop – Rushmore Cave	1912	10-year	Moderate	Building is in floodplain.
S6b	Barn – Rushmore Cave			Moderate	Building is in floodplain.
S6c	Bunkhouse – Rushmore Cave			Moderate	Building is in floodplain.
S6d	Bunkhouse – Rushmore Cave			Moderate	Building is in floodplain.
S7	Residence – Lost Cave Road	430	100-year+	Low	House is near floodplain.
S8	Residence - Burned	Unknown	2-year	Moderate	Flows from small drainage could damage house if it replaced in the same location. House sight sits right in the flow path of the drainage.
S9	Residence – Dog House	1142	100-year +	Low	House is near floodplain on the edge of the channel.
S10a	Residence – South – Small House	1436	5-year	High	House is within floodplain. Floodplain is very wide. Breach of dam spillway is of concern.
S10b	Residence – South – Log Cabin			High	House is within floodplain. Floodplain is very wide. Breach of dam spillway is of concern.

Some culverts that were observed during the risk assessment were also included in the strormflow calculations. On county roads the culverts on Tepee Gulch and Bobtail Gulch have a very high probability of not being able to pass the peak flows. Two culverts on State highway 40, on unnamed tributaries to Battle Creek also have a very high probability of not being able to pass peak flows.

IV. RECOMMENDATIONS

The Battle Creek Fire does not warrant widespread BAER slope treatments. However a few site specific spots are recommended for treatment such as the a Highway 16 culvert near Rockerville. The main focus of the Battle Creek BAER treatments is on road drainage to reduce concentration of overland flow and to protect the road investment. The other primary treatment needed is to treat expansion areas from known infestations of noxious weeks.

The Battle Creek Fire does warrant the addition of an additional Early Warning System precipitation gage on the watershed divide between Deadman Gulch and Foster Gulch. This gage will allow better forecasting of flood events relative to values of risk and will be operated by the USGS in coordination with the National Weather Service and Pennington County Emergency Services.

Much of the information in this report was developed to assist the NRCS, South Dakota Division of Forestry, and Pennington County to warn private landowners who have residences or property in potential flood areas of the increased risk from the Battle Creek fire. Homeowners in areas subject to flooding are advised to consider expanding their insurance to include flood insurance, which is effective 30 days after the policy is initiated.

See Appendix G for a Land Treatment Map.

V. CONSULTATIONS

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ROADS AND TRAILS

I. OBJECTIVES

- Identify and address any public safety issues related to future road use.
- Evaluate impacts of potential runoff on roads and trails, drainage structures, and down slope areas.
- Determine rehabilitations needs to repair roads and drainage structures.
- Assess fire impacts on roads and trails.

II. ISSUES

- Changes in the expected runoff from the burn areas will have short and long term impacts on roads given the nature and location of future rain and snow events and the rate of vegetation recovery.
- Potential threat to public and employee safety due to hazards along the traveled way.

III. OBSERVATIONS

Background

There are approximately 55.5 miles of national forest system road within the perimeter of the fire. There are also an estimated 31.8 miles of "non-system roads" or other roads that had been closed or otherwise considered unnecessary for the management and use of the national forest. Many of the non-system roads have been reopened during fire suppression efforts as fire breaks (dozer lines) and for equipment access. The scope of this report is directed at those roads that are not rehabilitated under fire suppression efforts. This includes all maintenance level 2, 3, 4 and 5 roads which had been open to public travel prior to the burn, all level 1 roads which had been previously closed to motorized travel and those non-system roads that are necessary to be recontoured or otherwise stabilized to prevent further degradation of the watershed. An estimated 28 miles of roads are within moderate and high severity burn areas (16 miles of classified and 12 miles of unclassified).

There is approximately 1 mile of national forest system trail within the perimeter, all in a low severity burn area.

Reconnaissance Methodology and Results

Roads and trails within the fire perimeter were inventoried to determine existing or potential emergencies. Treatments were identified and costs developed. All work was done in collaboration and with input from the BAER team.

Findings

- Roads are at risk due to the severely impacted areas adjacent to the road that results in increased runoff and soil movement onto and through the road drainage. One mile of the Flume trail is within the perimeter of the low severity burn area and is not to zeverely impacted.

- Existing drainage structures on the roads are not designed to accommodate the expected storm runoffs without severely damaging the road and adjacent down slope resources.

- Additional drainage structures and special design features such as overflow grade dips and armoring are required to carry the expected runoff from roads.

- Ditches and culverts need to be cleaned as soon as possible and kept cleaned to accommodate runoff.

- A portion of the Beretta Road #366 surface template was damaged resulting in an unnecessarily wide template. This needs to be narrowed to prevent excessive erosion.

- Safety signing has been lost in some areas and additional signing is needed due to unsafe conditions caused by the burn. Signs marking the Flume trail have been burned.

- Many hazard trees exist along the roads and trails.

- Numerous travel routes have been re-opened as a result of burned out vegetation that previously blocked the road or through fire suppression activities. Many of these roads are upslope from the main access and as a result may concentrate runoff onto the main road.

IV. RECOMMENDATIONS

1. Install Grade Dips. This treatment will decrease the threat from flood damage on roads and delivery of sediment to down slopes and streams by draining water from road surfaces in moderate and high severity burn areas.

    a. Overflow grade dips. These dips are installed just downgrade of road/stream crossing structures or at the lowest elevation of a through filll to insure the over topping stream flow is directed back into its natural channel. The grade dips will be designed to drain water off of the road, but still allow motorized vehicle crossing. The dips are typically skewed 30 degrees and the outlets will be armored with riprap in most areas, particularly those in close proximity to the streams or on a vulnerable fill slope. An estimated 6 dips are needed.

    b. Standard grade dips. These dips are additions to the existing grade dips on the roads. They are installed to handle the increased runoff by dispersing the flows quickly off the road way. An estimated 140 dips are required.

    c. Grade dips with armor. These dips are similar to the above however rock is added on the bottom of the dip and on the outlet end to limit erosion. An estimated 140 dips are required.

2. Drop Inlet installation. Installation of one drop inlet on the Boulder Hill Road #358.

3. Template Restoration. Restore the traveled way template of the Baretta Rd #366 to conform to the undamaged portion (14ft). Approximately 1.5 miles.

4. Signing replacement and installation. Signing need to be replaced or installed to provide warning and direction to users in the burned areas.

    a. Warning Signs. Warning sign must be installed to warn potential users and employees of hazards.

    b. Trail Sign Replacement. Trail signs identifying the locations of the trail must be replaced.

    c. Road Sign Replacement. Traffic warning signs must be replaced.

5. Hazard tree removal and analysis. Obvious hazards trees must be removed immediately along all open roads and trails within the burned areas. This treatment reduces the chance for damage to life or property by reducing the risk of trees falling on employees or the public. Twenty eight (28) miles of road and .3 miles of trail require hazard tree treatment. Additionally a hazard tree assessment must conducted to determine further needs.

6. Unclassified road assessment. Thirty-two (32) miles of unclassified roads are located within the burned area. Twelve (12) miles of these roads are within the moderate and high severity areas. These roads that are currently not on the transportation system, are typically very poorly constructed and have a high likelihood of contributing to erosion and sedimentation due to insufficient drainage. An assessment needs to be conducted to determine the extent of recontour treatment. This treatment will restore slope hydrology and facilitate the storage of water on the slopes, thus help eliminate the overall water yield and threat of flooding. This treatment also helps decrease the threat of soil erosion and sediment delivery to streams by reducing the chance of road fill failure onto slopes or streams

7. Flume Trail mitigation. One (1) mile of the historic flume trail lies within the burned area . A historic rock drainage structure is threatened by siltation. One silt fence or hay bale silt barrier is recommended immediately upslope from the structure. Approximately 100 hazard trees need to be felled.

8. Culvert and Ditch Cleaning. Clean all ditches, outlets and drainage structures to improve the existing structure's ability to handle storm runoff. (55.5 miles of system roads and those portions of the 31.8 miles of unclassified roads that are not recontoured (estimated 20 miles) for a total of 75.5 miles). Particular attention must be paid to the 29 miles within the moderate and high burn severity areas. Cleaning must occur at a greater frequency than for unburned areas.

See Appendix H for a Roads and Trail Treatment map.

V. CONSULTATION

Roads: Alan Anderson, Ray Ollila, and Dave Blackford
Trails: Juanita Garcia and Alan Anderson.

VEGETATION

I. OBJECTIVES

- Identify and evaluate fire related impacts to the timber resource both in and outside of the suitable timber base.
- Identify direct/indirect effects on forest health.
- Address needed treatments.

II. ISSUES

- Tree mortality and potential salvage of commercial forest products.
- Regeneration of commercial tree species within severely burned areas.

Tree Damage and Mortality

A detailed analysis of post-fire stand conditions in the burn area has not been completed. General observations are as follows:

High intensity burn: stand replacement fire, the leaves and needles of the trees were completely consumed.

Moderate intensity burn: some torching of dominant and co-dominant trees, very heavy mortality of understory trees, moderate scorching of overstory trees which may lead to future extensive mortality. Post-fire stand retains it's pre-burn size class but at significantly reduced densities. Additional future mortality will change size classes.

Low intensity burn: occasional torching of dominant/co-dominant trees, light to moderate under-burning of ladder fuels and dead/down material. No significant overstory structural or density changes.

Potential Salvage and Recovery of Timber Value

Decisions regarding potential salvage and recovery of killed or damaged timber on NFS lands will require intensive field reconnaissance and will need to be made through an interdisciplinary NEPA process. One existing timber sale (Beagle) and two planned timber sales are within the burn area. There is an extensive road system in place from past timber management activities accessing most of the suitable timber base. Additional roads may be needed to access some of the burned over area. Conventional ground-based logging systems will access most of the area. At this time there does not appear to be a need to salvage using cable and/or helicopter logging systems.

Reforestation

Decisions regarding reforestation of burned over lands will also require intensive field reconnaissance and analysis through the NEPA process.

It is reasonable to expect natural regeneration to occur. Most of the low and moderate intensity burn areas have residual living pine within them that can provide a seed source for natural regeneration of the areas as well as residual pine seed within the organic soil layer that was not consumed by the fire. The high intensity burn areas may be lacking a seed source if the size of the area is larger than 5 acres. If areas are identified for artificial planting during future NEPA analysis the probability of success is very good. Soil profiles do not appear to be excessively damaged. Quaking aspen in the western portions of the burn and bur oak in the eastern portions of the area will regenerate easily and in some areas be restored where pine has invaded historic hardwood areas. The success of natural regeneration of ponderosa pine within this area is largely dependent on its ability to compete with grasses in the area. If grasses become established, especially sod forming grasses, the natural establishment and growth of ponderosa pine is significantly reduced.

IV. RECOMMENDATIONS

Tree Mortality and Potential Salvage: Unless there is other resource needs to retain commercial timber killed by the fire, it is recommended that the commercial timber be removed through salvage operations. Included with this mortality pine should be green timber infested with mountain pine beetles or Ips beetles to reduce mortality in adjacent pine. In addition, pine with 75% scorch of the crowns or obvious “fading” should also be removed

Reforestation: Unless it is necessary to seed grasses for stabilization of highly erodable soils or disturbed areas such as roads, fire lines, and safety zones, it is my recommendation not to seed large areas of the burn. This especially applies to areas within the suitable timber base. If seeding is necessary then grass species that are non-sod forming should be used.

WEEDS

I. OBJECTIVES

- Determine treatment (direct and indirect) and monitoring needs of area where noxious weeds are present and/or believed to be invading.
- Detect noxious weed locations within the burned area and areas of high infestations near the burned area.
- Prioritize which species have the highest potential to cause substantial and persistent long-term degradation of ecosystem function.
- Design restoration activities to minimize import and establishment of noxious weeds and invasive non-native plants.

II. ISSUES

- Suppression effects and short/long-term impacts to resources from invasive and noxious weed species.
- Monitoring of impacted lands for the early detection and control of invasive and noxious weed species.
- Complex land jurisdictions within the burned area for mapping and treatment of invasive and noxious weed species.
- Determining most threatening invasive species to native vegetation.

III. OBSERVATIONS

1. The Battle Creek Fire was a mixture of USDA Forest Service and Private lands. The lands other jurisdictions adjacent to NFS lands need to be managed for noxious and invasive weeds due to the amount of traffic and ground disturbance in and out of the fire area. Fire campgrounds also need to be treated on private property due to vehicle traveling in and out of the known infestations area.

2. Close coordination needs to be followed between the NFS and Pennington County Weed and Pest/Ordinance Department. Chemical application needs to be a coordinated effort to prevent road rights-of ways from being sprayed by both organizations. This would cause overuse of chemicals in some areas. Roads going into and out of the fire area need to be treated to help prevent the spread of noxious and invasive weeds.

3. Many of the private lands adjacent to the burned areas have established noxious weed populations including, but not limited: Canada thistle, Leafy spurge, Houndstongue, Yellow toadflax, Musk thistle, Bull thistle, Scotch thistle, Whitetop, Chicory, St. Johnswort, Common tansy, Burdock, Common mullein, and Perennial sow thistle. During the suppression efforts, vehicles and heavy equipment moved onto public from the weed infested private and county lands. Many vehicles and heavy equipment used on the fire were from all over the country, potentially carrying noxious weed seed and increasing the potential for noxious weed infestations by at least 30-40 percent. Dozer lines and hand lines created during the suppression efforts are expected to further increase the potential for noxious and invasive weed infestations. NFS roads, county roads and the NFS trail are expected to continue to contribute to the spread of noxious weeds.

4. The Battle Creek Fire has created a favorable seedbed to establish noxious weed populations, especially in severely burned areas. Noxious weeds will establish quickly is areas that take native vegetation much longer to establish, taking advantage of the resources (soil nutrients, soil moisture) with little competition.

5. Field work was conducted on the burned area on 8/27-28/02 to evaluate burn intensity, determine and document losses of vegetation and determine areas of potential infestations of noxious weeds. Established noxious weed populations within the burned area have been mapped using GPS units. County and private lands surrounding and interior of the fire area have established noxious weed populations that have been identified through mapping and coordination with the Pennington County Weed and Pest Supervisor. Dozer lines built during the suppression efforts are being recorded with GPS units as well as hand lines to monitor for new weed invasions. FS roads, the FS trail and county roads within the fire perimeter have been GPS-ed to facilitate monitoring of their spread into/within the burned areas.

6. Biocontrol sites within the burn area were burned over; however, the severity to the damaged to flea beetle larva for Leafy spurge will not be known until next summer. Grasses were starting to come up and so were the Leafy spurge plants. With the short suspense on this report, time did not permit to check root systems for the Aphthona larva. The biocontrol measures within the burn cannot be assessed fully until late spring if and when the adult Aphthona beetles emerge.

IV. RECOMMENDATIONS

Management

1. Reseed severely burned areas with noninvasive annual grasses and perennial native grasses to reduce the potential for noxious and invasive weeds establishment. Weed free seed needs to be checked prior to actual seeding. This seeding needs to start immediately since there has been some moisture in the area and the weather has spurned regrowth.

2. Use integrated weed management practices, in accordance with Environmental Assessment for the Management of Control of Noxious Plants on the Black Hills National Forest, USDA Forest Service to provide timely treatments of noxious and invasive weeds.

3. Identify and treat species with the highest potential to cause substantial and persistent long-term degradation of ecosystem function. These species include, but are not limited to: Canada thistle, Leafy spurge and Common Mullein.

4. Use weed free mulch and erosion materials.

5. Select natives or non-invasive introduced species. Provide for testing of seed to verify the absence of noxious weed seed. Monitor and treat areas within the perimeter of the fire adjacent to known private land weed infestations.

6. Provide for the use of an Aphthona flea beetle insect mix in the Leafy spurge areas as a means of integrated noxious weed control.

7. Provide to Pennington County and the South Dakota Department of Transportation a list of natives and non-invasive seed species for restoration of rights-of-ways and hill sides along all state/county road systems.

    - Private land area is approximately 3,500 Acres.
    - Infested acres is approximately 1,000 Areas
    - Miles of road is approximately 60 Miles

8. Monitor and treat known distributed soil locations that occurred during the fire suppression efforts.

Dozed line	50 Miles	1212 Acres
Hand lines	2 Miles	48.48 Acres
Helispots/Safety Zones	Private 25 Acres	NFS 100 Acres
Fire Camp	Private 18 Acres	
Trails	1 Mile 24.24 Acres	
Roads	60 Miles	1,454.4 Acres

Monitoring

1. Identify and monitor areas of concentrated human or animal activity prior to the fire where new weed infestations are likely to occur.
2. Identify and monitor severe ground disturbance due to fire suppression activities, such as dozer lines, hand lines, safety zones, staging areas, heliports, etc.
3. Identify and monitor areas, including private and county lands, which had weed populations prior to the fire to detect density and spatial growth of populations.
4. Monitor areas for three years for presence and persistence of invasive species and treat as required.

Treatment Costs

Spraying per acre: $127.00 x Acres

Monitoring to include 2 seasonals GS-4/01 $10.58 per hour. Time from mid-May through Mid October, 40 hour weeks, 80 hours per pay period. 13 pay periods.
$11,003.20 x 2 = 22,006.40 for wages. + overhead GS-5/03 40 days = $2,019.20

Time needs to cover a 3 to 5 year time frame due to the characteristics of the noxious weeds.

See Appendix G for a Land Treatment Map.

RANGE

I. OBJECTIVES

- Determine where forage has been lost in areas of high burn severity.
- Develop grazing plan for allotments affected by the fire for the next two years
- Identify areas where emergency temporary fences will be needed to protect recovering vegetation from livestock/elk grazing.
- Identify private land fences that were destroyed and will affect pasture rotation in coming years if not replaced.

II. ISSUES

- Losses of range improvements where the fire burned severely and where suppression efforts took place will negatively affect grazing rotation systems.
- There are two grazing allotments within the burned area. The allotment management plans may need to be modified to reflect the change in forage availability.
- There may be areas of high burn severity that will recover faster if reseeded. They will need to be protected from livestock grazing for up to two years.

III. OBSERVATIONS

Field reconnaissance of the burned area was conducted between August 21st and August 25th to evaluate burning intensity, determine and document losses of vegetation and to determine range structural improvements destroyed by the fire. Range structural improvements were identified by

obtaining the recorded data in the INFRA database (condition) and comparing the location to allotment maps, then field reviewing within the fire perimeter. The field reconnaissance recorded the post-fire condition of range improvement structures.

1. The Battle Creek Fire burned both private land and NFS lands. The fire perimeter includes the northern portion of the Rockerville Allotment with three permittees, one pasture (Koopman) in the southern portion with one permittee, and the Bitter Creek Allotment with one permittee. These are both cattle allotments.

Table 12

Allotment	Pasture	Total Acres	Burned Acres*	% Burned
Bitter Creek	Boulder Hill	4463	1190	27%
	Middle	1922	288	15%
	South	4832	0.26	0%
	North	1657	0	0%
Rockerville	Foster	2122	1787	84%
	Upper Deadman	1503	1500	100%
	Lower Deadman	1323	1208	91%
	Teepee	5996	2919	49%
	Koopman	2117	1109	52%

*Does not correlate to total fire acres which includes other pvt land.

2. Approximately 68% of the northern portion of the Rockerville allotment is encompassed inside the fireline. The pastures remaining to be grazed in this season's rotation were burned greater than 90%. Cattle permitted on those units were sent home.

3. 52% of the Koopman pasture in the southern portion of the allotment is inside the fireline. This is the northern half of that pasture. Cattle were returned to the pasture following the fire due to available forage.

4. Acreage burned on the Bitter Creek Allotment was 11% of the total allotment acres. Much of that was in unsuitable for livestock grazing due to terrain. Some areas of former timber canopy will revegetate with grasses/shrubs and become transitory range in the future. Cattle were moved to the North Pasture.

5. Much of the burn is in a mosaic pattern which overall did not damage forage values and may have even improved forage in some cases. Some allotments burned severely and may have areas that need deferment from grazing for 1-2 years. Cattle have been removed from the Rockerville Allotment for the remainder of the season. Cattle from Bitter Creek have been herded to a pasture not affected by the fire.

6. Private land fences that formed allotment/pasture boundaries have been destroyed. Several landowners are questioning why they should have to bear the expense to rebuild fences if they didn't build them in the first place. Standard answer is that if they don't want cows on their land, they need to fence. The FS is not going to cost-share on these fences.

7. Areas where the fire was mapped as high to moderate burn severity shows a surprising amount of green-up where grasses existed before the fire. In areas under pine canopy along ridgetops, there is a need for seeding to encourage grass cover to reduce erosion potential.

IV. RECOMMENDATIONS

Management

1. Monitor cattle use continuing on the Koopman Pasture through the remaining 2002 season. Remove cattle if use greater than 10% is occurring within the burned area.

2. Evaluate which areas of the allotments may require adjustment in grazing use.

3. Identify areas needing temporary fencing to restrict livestock/elk from recovering (aspen/oak) sites that will reduce resource impacts and allow vegetation recovery.

4. Identify fire-damaged range structures that are in critical need of replacement for desired management practices. (Will be done through Rapid Assessment Team). Replace lost structures within the next two years for future management needs.

5. Utilize seed mixes that emphasize non-invasive introduced and native perennial species to provide for soil stability and potential natural community.

6. Remove old fence posts and wire from fences burned.

Monitoring

Monitor areas where there was a moderate to high burn severity for vegetation recovery. Include litter cover depth in forage monitoring.

CULTURAL RESOURCES

I. OBJECTIVES

- Assess damage and potential damage to known cultural resources (archaeological sites, historic sites, cultural landscapes, Areas of Critical Environmental Concern (ACEC), and traditional cultural properties (TCP's)) which are listed on, eligible for, or not evaluated for, nomination to the National Register of Historic Places, from the adverse effects of wildland fire, suppression activities, rehabilitation projects, and emergency stabilization activities.
- Develop and implement treatments to stabilize and rehabilitate archaeological sites, historic sites, cultural landscapes, ACECs, and traditional cultural properties adversely affected by wildland fire, fire suppression activities, rehabilitation projects and other emergency stabilization activities.
- Conduct assessments and implement treatments in a manner that meets federal legal requirements

II. ISSUES

- Assessment of impacts to the ACEC by fire, fire suppression, and proposed rehabilitation activities
- Assessment of impacts to cultural resources by the fire, suppression activities and proposed rehabilitation projects
- Protection of sacred/respected places within the burn areas
- Evaluation of previously recorded, but unevaluated cultural resources
- Consulting on effects of the fire, suppression activities, and proposed rehabilitation measures as per the National Historic Preservation Act
- Reducing effects of erosion upon cultural resources
- Reducing or avoiding effects to cultural resources during the rehabilitation process
- Development of treatments to protect, stabilize, and rehabilitate cultural resources

III. OBSERVATIONS

Background and Culture History

Cultural resources are affected by fire and fire related activities in many ways. During the actual burn, historic structures and other perishable resources may be consumed well before archaeologists have the chance to formally document those sites. In this instance, historic structures are particularly vulnerable. Fire suppression activities pose a more direct impact to cultural resources, but are far more preventable. The construction of dozer and handlines impact the integrity of archaeological sites through ground disturbance that alters their scientific and cultural value. Removing sediment during those operations often obliterates surface visibility of archaeological sites and alters their subsurface integrity. Heavy equipment use at helipads and bulldozer operations can physically break artifacts and compress the ground surface further altering their scientific and cultural value. Identification of significant cultural resources prior to rehabilitation efforts is equally significant for cultural resource preservation. During rehabilitation ground crews and heavy equipment use pose threats to cultural resources in a similar manner as discussed above. However, failure to identify significant cultural resources prior to rehabilitation efforts may lead to their damage or destruction through the occurrence of natural processes that occur after a fire has consumed significant portions of the vegetation. Flood and debris flow may obliterate or significantly damage historic and prehistoric archaeological sites without mitigating measures.

The prehistoric chronological framework used by archaeologists in the Black Hills is generally one adopted from the northwest plains (Frison 1991) although use of the region by eastern woodlands groups has been documented (Rom Church and Church 1996). The appropriateness of this framework for the Black Hills has not been discussed in depth. However, it is clear that the Black Hills region is unique as an area of use and cultural significance for both western and eastern populations through time. Prehistoric occupations have been organized into a number of broadly defined time periods including Paleoindian, Archaic, Late Prehistoric, and Proto-historic and historic Native America. These major chronological periods and their sub-divisions are defined by major climatic shifts, distinctive diagnostic tool types, and differing patterns of adaptive land use through time.

A wide variety of site types can be found in the Black Hills including lithic concentrations representing a variety of subsistence activities, quarry sites, stone circle sites, rockshelter or cave sites, rock art (petroglyph or pictograph) sites, and traditional cultural properties, many of which

are still used by Native Americans today. The most significant site type located within the fire boundary is that related to the mining history around Rockerville. The Rockerville flume is located at the northern most boundary of the fire. When gold was discovered in the area in December 1876, Rockerville quickly turned into a roaring Black Hills mining camp. By 1880 the town boasted a hundred buildings and a population of nearly 1,000. The Flume Trail begins near Sheridan Lake. This trail follows the route of an old gold mining flume that once went from Spring Creek near Sheridan Lake to Rockerville. It is an interesting trail because it is nearly level and passes through two very narrow tunnels carved out by the flume makers more than 100 years ago. The 1880 Rockerville Flume was constructed to facilitate gold mining in Rockerville Gulch. The old timbers and rock retaining walls used by the miners can be seen along the trail. By the 1930s placers were played out, and the Rockerville flume was in ruins and miners moved away.

Reconnaissance Methodology and Results

During the initial attack and early stages of suppression, information concerning the location of significant cultural resources was passed to the Fire Incident Command Team. The Team was asked to avoid these locations during suppression activities if the safety of firefighters, the public, and property would not be compromised. Cultural resource file reviews and field inspections were used to identify the presence of cultural resources and potential effects to those properties within the Area of Potential Effect of the Battle Creek Fire. These initial reconnaissance efforts are incomplete but do provide a baseline from which initial site damage assessments and rehabilitation treatments can be developed.

The District Archeologist was called to the incident as Cultural Resource Advisor on August 17, 2002. A meeting with Division Supervisors, Dozer bosses, and hand crews was conducted to inform them of known significant resources in the fire area. On August 17, 2002, the Forest Service Archeologist began preparing field maps for the incident with known significant site locations and projected fire perimeters identified. Orders were placed for fire-line qualified archaeologists to serve on line during suppression activities. Archaeologists arrived the third day and were assigned to dozer and hand crews in order to avoid or minimize impacts to cultural resources during fire suppression activities. Maps and copies of site forms were taken to the field. The location of the Rockerville Flume was added to the Incident Action Plan map for avoidance.

The heritage inventory team was assembled and an inventory of fire suppression activities was initiated on August 19, 2002. Archaeologists began an inventory of suppression lines, drop points, and staging locations. New sites discovered as a result of fire suppression were recorded, mapped and a GPS location was taken. Sites located within the fire perimeter that had been previously evaluated as eligible or recoded and not evaluated were visited and a brief damage assessment form was completed. GPS coordinates and photographs were also taken for these previously recorded sites.

Findings

1. During fire suppression activities 50 miles of dozer lines were constructed and less than 5 miles of hand lines were constructed. A professional archaeologist surveyed these lines upon arrival to the incident. All lines have been covered by heritage resource surveys.

2. A total of 10,399 acres administered by the Forest Service burned in the Battle Creek Fire. Suppression efforts resulted in construction of approximately 50 miles of dozer line and hand lines. File searches conducted for cultural resources on the Black Hills Forest revealed that 73 percent of the area within the Area of Potential Effect (APE) for the Battle Creek Fire had been intensively surveyed. Three eligible prehistoric sites, one unevaluated historic site, and one eligible historic property are located within the Battle Creek. In addition 24 historic properties and six prehistoric properties located within the Battle Creek Fire have been recorded and evaluated as not eligible for nomination to the National Register of Historic Places.

3. Currently no Traditional Cultural Properties (TCP's) have been formally identified within the Battle Creek Fire perimeter. There is a potential for significant unrecorded sites to be located within the Battle Creek Fire area. Approximately 2,845 acres of NFSL remains to be surveyed. Sites located during such survey need to be evaluated due to risk of loss from the fire's effects. A complete extensive file search was conducted for the fire suppression compliance report, and will aid in the final assessment of cultural resources and potential impacts. The need for additional site evaluations and damage assessments may be identified as a result of that file search.

4. The Black Hills have a special and critical level of cultural and religious significance to Native Americans throughout North America. Native Americans have maintained this connection over time through continued use of the area for spiritual, cultural, and plant collection activities. An area located in the northern portion of the fire area, reportedly contained locations of spiritual use. Prayer bundles and tobacco ties were noted. The fire impacted two of these locations; however, none were damaged by suppression activities. The sites represent small, probably family oriented use. The area should be noted for such use, and its importance noted during all activities.

IV. RECOMMENDATIONS

Management (specifications-related)

1. **Cultural Resource Damage Assessment – Fire**
   Of the four previously documented archaeological sites identified, one requires further field assessment and documentation of damage sustained during fire and fire related activities. A condition assessment for resource compliance and rehabilitation, if warranted, must be completed. The Rockerville Flume (Site 39PN0377) has been determined to require restoration, rehabilitation, and monitoring to mitigate further damage from erosion and increased visibility.

2. **Rockerville Flume Mitigation**
   A catch basin and rock filter was located at a small drainage along the flume. The basin is currently fairly full, and it is expected that more material will be washed down into it and completely fill it. That would then cause additional material to be washed over the flume and flume trail potentially causing additional damage. The basin should be cleaned out and the rock work enhanced to control water flow in the area. Additionally 20 hay bales should be placed up slope to provide screening of materials washed off the slope. The slope has a moderate grade and the potential to carry a significant amount of material

during a storm event. A log removed from the flume/ trail bed should be replaced with rock work to aid in avoiding erosion impacts.

Approximately 100 trees were identified for hazard tree removal. The trees pose a threat to forest users and this heritage resource. Trees will be identified on the ground and cut by Forest Service crews. Trees will be directionally felled away from the flume to minimize impacts. The downed trees should be cut and scattered along the slope, and used to aid in erosion control along steep slopes.

Monitoring

Each of the four archaeological sites identified as eligible for protection require monitoring to mitigate the processes of erosion over time and their increased visibility from decreased vegetative cover. Monitoring will also evaluate the effectiveness of rehabilitation efforts.

Management (non-specifications related)

Stabilization – Fire Suppression Rehabilitation

An inventory of areas disturbed by suppression activities resulted in the location of an extensive historic site. The site exhibits the characteristic of a CCC camp. The burn area consists of a moderate burn. Numerous features and metal artifacts were located. It is unknown if wooden remains existed at this site. There were no direct impacts from fire suppression activities and the site does not need any stabilization or protection from erosion damage. Should any timber salvage or hazard tree removal be needed in this area, an archaeologist should be on hand for direction in removing the timber.

Suppression activities resulted in impacts to two sites that are National Register Eligible Properties. The first property consists of The Historic Rockerville Flume. This site is currently utilized as a recreational trail and interpretative site. The site is located just below a slightly rolling saddle with a short grass and pine needle duff cover. The site was exposed to a moderate level of burning in which the pine duff floor was totally blackened. The impacts were a result of a dozer line that destroyed a section of flume bed, retaining wall, and trenched portion of flume. Approximately 20 feet of ditch will need to be cleaned up and restored to its original shape. This will be done by a hand crew, and using hand tools only. An archeologist will work with the crew at all times. A second portion of the flume will also be restored by a hand crew. These areas are on either side of the dozer line. The dozer line will be restored by use of mechanical equipment preferably a bobcat, to reshape and stabilize the flume bed as best as possible. This work will be accomplished by the equipment operators assigned to the Resources and Rehab division. All work will be supervised by a district archeologist.

The second property is the Jackson Spring site. Impacts at this site were negligible. The site had been previously capped for its protection and impacts were restricted to this portion of the site. Minimal work to restore the road capping may be conducted. The resource Advisor will work with the Resources and Rehab equipment operators to accomplish this work.

V. REFERENCES

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WILDLIFE/THREATENED AND ENDANGERED SPECIES

I. OBJECTIVES

- Assess the effects of fire and suppression activities on Threatened, Endangered, and Candidate Species and their habitats
- Initiate Emergency Section 7 Consultation as required by the Endangered Species Act if necessary.
- Assess effects of proposed emergency rehabilitation treatments on Threatened, Endangered, and Candidate Species and their habitats.

II. ISSUES

- Determine the impacts, if any, of the Battle Creek fire to all federally listed species and R-2 Sensitive species and their habitats.
- Determine the impacts of suppression activities to these species.
- Determine the impacts of rehabilitation efforts on these species.

III. OBSERVATIONS

Background

The purpose of this Burn Area Emergency Stabilization and Rehabilitation Plan (BAER) wildlife assessment is to determine and document the effects of the fire, suppression actions and proposed emergency rehabilitation work to all federally listed species and Region 2

Sensitive species and their habitats (FSM 2670, R-2 ID 2600-94-2) and a letter from the Regional Forester (memo dated June 14, 2000). This document is prepared in accordance with legal requirements set forth under Section 7 of the Endangered Species Act of 1973 (19 U.S.C. 1536(c)), and follows the standards established in the Forest Service Manual direction (2672.42) and the Code of Federal Regulations (50 CFR S402). This document tiers directly to the revised Black Hills National Forest Land and Resource Management Plan and the BA/BE completed for the Black Hills National Forest, Land and Resource Management Plan Revision.

A list of Federally threatened, endangered and proposed species has been provided by Nell Mc Phillips of the U.S. Fish and Wildlife Service (USFWS), South Dakota Office, and last verified on September 17, 2001. The Sensitive Species list for the Rocky Mountain Region was published as a Regional Supplement (2670-94-2), effective March 21, 1994. The additional listing of the black-tailed prairie dog as sensitive was issued by the R-2 Regional Forester (memo dated June 14, 2000). The species list for this assessment was derived from current lists of Threatened and Endangered Species for South Dakota and the Regional Foresters Sensitive Species List (See Appendix A).

The Battle Creek Fire area has been logged extensively in the past. Currently, the area south of the Hwy 16 is included in the Beagle Timber Sale. The area to the north of Hwy 16 is scheduled for timber sales in the next two years (See DN for Hollow and Bitter Project Areas). The fire started on August 16, 2002 from unknown man-caused ignition. The fire area consists of 13,700 acres, mostly National Forest.

The Battle Creek fire was a wind driven fire that has burned a mosaic pattern with large area of high to moderate intensity mostly on the ridge-tops and through dense thermal cover, designated late successional stands and seed/sap stands of ponderosa pine. The terrain is dominated by upland meadows and draws deeply dissected by steep granite drainages and limestone outcrops. Wildlife species typically found in the Battle Creek fire are elk, deer, mountain goats, bighorn sheep, Merriam's turkey, prairie falcons, woodpeckers, and trout species.

The Bald Eagle has been observed in the fire area as a winter resident and migrant. There are no known roosts in the affected area and only casual observations have been made. No nesting is known to occur in the fire area. The Black Hills is not considered critical habitat for this species.

Although there are numerous prairie dog towns adjacent to the burn area, the Black-footed Ferret has not been observed in the fire area. There are no documented prairie dog towns within the fire area; therefore the likelihood of this species being found in the fire area is low.

Reconnaissance Methodology and Results

Information used in this assessment is complied from field reconnaissance conducted during August 22 through August 30, 2002. In addition, sensitive plant inventories, literature, South Dakota Natural Heritage Database, and habitat maps provided in the Forest Plan BE/BA, determinations in the Beagle BE/BA, Hollow BE/BA and the Bitter BE/BA were also a source of information.

Findings

The purpose of this section is to discuss the potential effects of the fire, suppression actions, and proposed emergency rehabilitation activities to federally listed species and R-2 Sensitive species, which occur in the fire area. The species discussed in this assessment have ranges or territories, which extend beyond the fire areas and across, land ownerships. Direct effects refer to mortality or disturbance that results in displacement, harassment or mortality of the individual. Indirect effects refer to modifications of habitat and/or effects to prey species.

1. The Bald Eagle is found during the winter months and is considered migratory. The Battle Creek fire did not affect roosting habitat along Battle Creek, therefore there are no adverse effect to this species or its habitat.
2. The Black-footed Ferret has been documented in Pennington County but has been associated with the re-introduction of Black-footed Ferrets in the Badlands National Park. There is no habitat or prey species found in the fire area. Therefore, there are no adverse effects to this species or its habitat.
3. For R-2 Sensitive species, a table of effects due to the fire, suppression activities and rehabilitation varied depending on the species habitat needs. For most species that require forested environment with downed wood and vegetation, adverse effects where caused by the fire itself. This loss of habitat will be long term for some species. A review of the affects has been completed and can be found in Appendix A. No sensitive plants were documented in the fire area during plant surveys.
4. Streams and drainages were impacted most by the wildfire and suppression activities (e.g. control lines). Sedimentation potential increased due to loss of upstream vegetation. Water temperature will also increase with loss of over-story vegetation and the moist microclimate.
5. One Frest site is located in the fire area. Dr. Frest surveyed this site, but not land snails were found at this location (See Frest and Johannes, 2002).
6. The fire destroyed one known goshawk nest. A goshawk was sighted after the fire in the vicinity of the goshawk nest. This nest was successful this year with two young fledged. There may have been another territory affected by the fire but since the nest location has not been found, it is difficult to assess the loss.
7. Sensitive species that use riparian habitats (e.g. Northern Leopard Frog) will be impacted the most by suppression activities (fire lines) and by storm run-off. These areas will need to be monitored for adverse impacts to these species and potential loss of riparian habitat and standing water. (See Hydrology Resource Report)
8. Caves and Mines in the area have been directly affected by the fire, fire suppression and rehabilitation. Loss of cover adjacent to mine and cave entrances may impact the temperature within the cave or mine that would normally support a bat hibernacula or maternity roost. Since there are no known caves/mines that are important bat habitat in the area, losses may not be determined. These habitats may be found during the rehabilitation stage and value recovery stages of post fire activities. These habitats should be monitored for changes in temperature. Rehabilitation activities that would change the entrance habitat should avoid these areas.
9. Effects on Habitat Improvement Projects - Four wildlife guzzler projects were damaged with the fire. Two will need total replacement. Since these structures do present a human safety concern, these structures do not constitute replacement under the BAER analysis and funding.

IV. RECOMMENDATIONS

Emergency Stabilization

1. Stabilization of soils in areas where riparian habitat or streams is recommends protecting water quality and quantity. Recommend aerial grass seeding where fire destroyed litter layer and soil movement potential is high to moderate.
2. Provide barriers to storm run-off that will slow the run-off and prevent scouring effect on unburned riparian/hardwood habitats (e.g. Foster Gulch)

Rehabilitation

Recommend stabilization of control lines in the Teepee Gulch and Foster Gulch area to prevent further sedimentation of these streams. Close and/or stabilize roads/trails that are located in drainages that experienced moderate to high intensity burn activity and have steep side walls that will funnel water down into streams and creeks (e.g. U270057 and Lead Draw).

Management Recommendations (non-spec.)

1. Avoid disturbance to riparian/hardwood habitat that would cause sedimentation and stream health degradation for fish and amphibian species. Repair and stabilize all stream crossings where fire suppression activities may have cause sediment to add to the stream at those areas.
2. Avoid all cave entrances and mine entrance (open audits) that may be potential bat habitat. If it is necessary to disturb these sites, a wildlife biologist should be consulted to mitigation adverse affects.
3. Follow Black Hills Forest Plan standards and guidelines for sensitive species and their habitat.

V. CONSULTATIONS

On January 14, 1997, the USFWS concurred with the Forest Service Biological Assessment that the proposed Forest Plan revision may affect but not likely to adversely affect the bald eagle, peregrine falcon, and American burying beetle. The USFWS also concurred that the Plan revision will not affect the Black-footed Ferret and the Gray Wolf. Therefore emergency consultation with the USFWS under Section 7 was not warranted for this assessment

VI. REFERENCES

USDA Forest Service Black Hills National Forest Plan (1997) and Phase I Amendment (2001)

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RECREATION

I. OBJECTIVES

- Inventory and assess the effects of fire and suppression actions and impacts to recreation trails
- Specify rehabilitation and replacement measures to mitigate fire and suppression impacts
- Assess the effects of fire and suppression actions on recreation opportunities at risk
- Determine the effects of fire and suppression actions to recreation trail values at risk
- Prescribe emergency rehabilitation measures and/or monitoring

II. ISSUES

- Fire impacts to recreation trail.
- Visitor safety in areas in proximity to the fire from hazard trees
- Potential threat to public from hillside erosion adjacent to Flume Trail.

III. OBSERVATIONS

Background

The purpose of this Burn Area Emergency Rehabilitation (BAER) Recreation Assessment is to document the effects of the fire, suppression activities, and proposed rehabilitation work to the recreation trail resources on lands under the jurisdiction of the Mystic Ranger District, Black Hills National Forest . Fire and suppression activities sometimes create areas that are unsafe for members of the public and staff. Recreational travel corridors such as trails may be impacted by the fire, which affects the availability of the recreational experience within the burned area. There is one National Historic Trail within and along the boundary of the fire area.

Reconnaissance Methodology and Results

On August 26, 2002, the interagency BAER team assembled at Supervisors Office in Custer, South Dakota to begin the assessment process. The team leader met with the recreation staff officer from the Mystic RD to begin assessing the different aspects of the fire's impact to the trail system. Field reconnaissance of the trail by the district archaeologist in the fire area was conducted between August 20 and August 29 by walking the trail and inspecting the impacts from the fire and suppression activities. Two segments of the trail were impacted by the suppression efforts.

Findings

Trail System

Flume Trail – This is a popular recreation trail that enters the fire area and then meanders in and out along the fireline perimeter to the north of Highway 16. The trail will have to be closed until all rehab work on the trail can be accomplished. Trail values at risk include:

- Hiking – This is a very popular activity on the Mystic Ranger District because of its proximity to the Rapid City Metro Area.

- Visitor Safety – There is definitely a visitor safety issue on the Flume Trail that burned. This will not be reopened until hazard trees are removed and the area is deemed safe. Any hazards or unsafe conditions adjacent to the trail may make it difficult to keep the public safe on the trail.

Other Recreation Opportunities

Other opportunities impacted by the fire include: hiking, mountain biking, backpacking, horseback riding, OHV use, sightseeing and dispersed camping. These opportunities will not be available for an extended period of time since some parts of the burn area will not be safe and useable by the public.

IV. RECOMMENDATIONS

Management

1. Meet all requirements set by the district archaeologist for the rehabilitation of the Flume Trail to return to the previous existing state of the historic nature of the trail.

2. Close the Flume Trail segments to the public that have been burned and need to be reconstructed, have hazard trees adjacent to the trail, and/or are in a potential debris flow area from the side slopes of the trail. .

3. Determine all road access routes to the trailheads that are within the fire perimeter where tree hazards exist and/or potential debris flow areas and mitigate these areas.

Management recommendations that are beyond the scope of BAER (no specifications)

Replace all interpretative, directional and mileage signs destroyed that were impacted by the fire.

Chapter 3

Battle Creek BAER Report

BAER Team Members

Name	Organization	Team Position
Mark Story	Gallatin NF	Team Leader
Monte Williams	Black Hills NF	Hydrologist
Dave Blackford	Black Hills NF (retired)	Operations lead
Neil Bosworth	Deschutes NF	Resource lead
Dale Dieter	Fishlake NF	Hydrology lead
Sarah Peterson	Fishlake NF	Hydrology
Ray Olilla	Black Hills NF (retired)	Roads and Trails
Jessica Gould	Black Hills NF	Hydrology/Soils
Ken Marchand	Black Hills NF	GIS
Mike Bobbit	Black Hills NF	Hydrology Tech
Les Gonyer	Black Hills NF	Hydrologist
Alan Anderson	Black Hills NF	Engineering
Lois Zieman	Black Hills NF	PAO/Writer Editor
Juanita Garcia	Black Hills NF	Cultural
Gene Bolka	Black Hills NF	Range/Weeds
Steve Keegar	Black Hills NF	Visuals
Gale Gire	Black Hills NF	Timber/Vegetation
Patty Lynch	Black Hills NF	Wildlife/TE Species
Dave Slepnikoff	Black Hills NF	Travel Management
Deama Rehyer	Black Hills NF	Soils
Park Owens	Pennington Co. EMS	Consultant
Randy Michaels	SD DOT	Consultant
Gene Waterson	NRCS	Consultant
Jessica Smith	SD Forestry	Consultant

Battle Creek BAER Report

Appendices

A – Fire Perimeter (Base Map)

B – Fire Progression Map

C – Burn Severity Map

D – Pre-Fire Erosion Potential Map

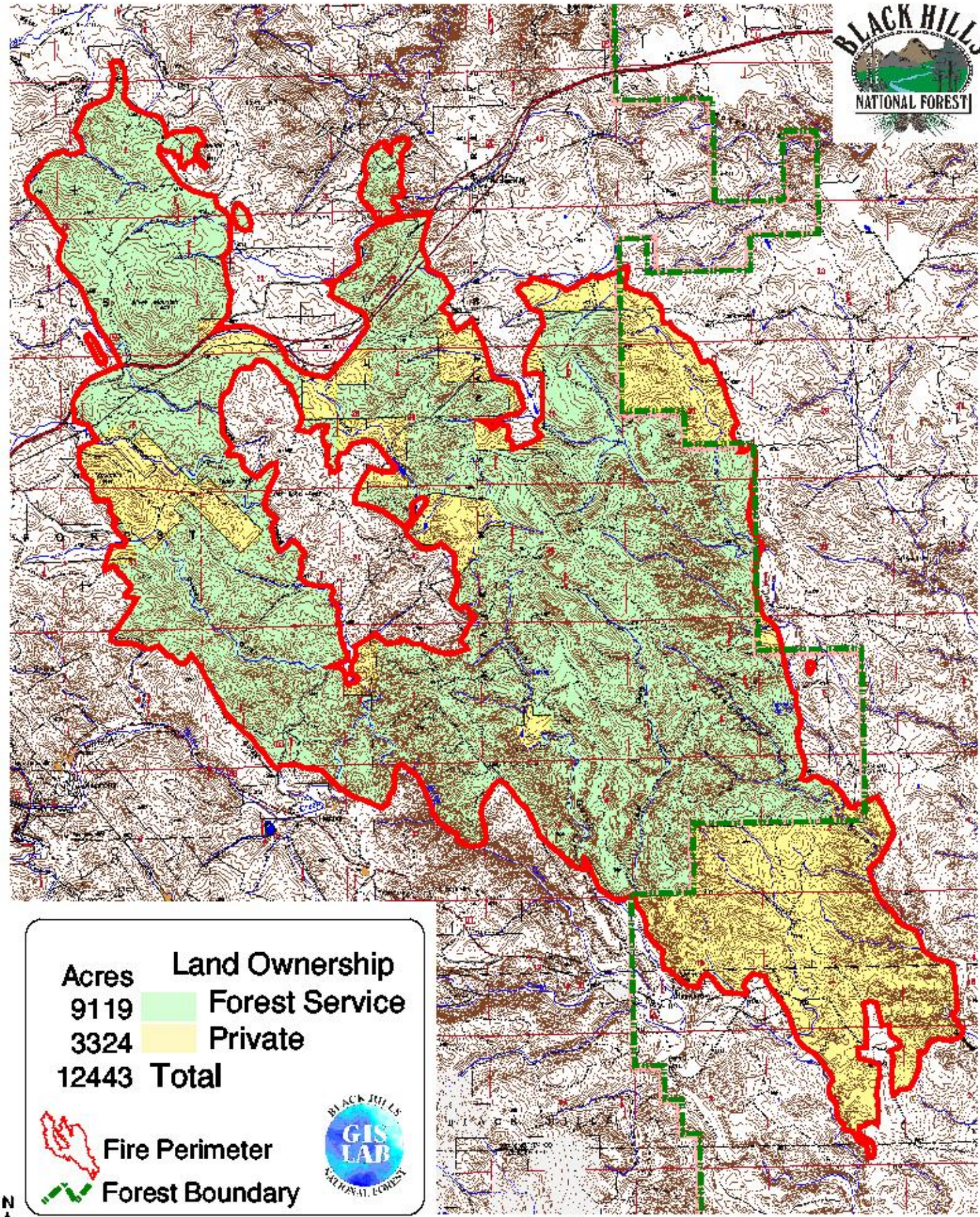
E – Post-Fire Erosion Potential Map

F – Values at Risk Map

G – Land Treatment Map

H – Roads and Trails Treatment Map

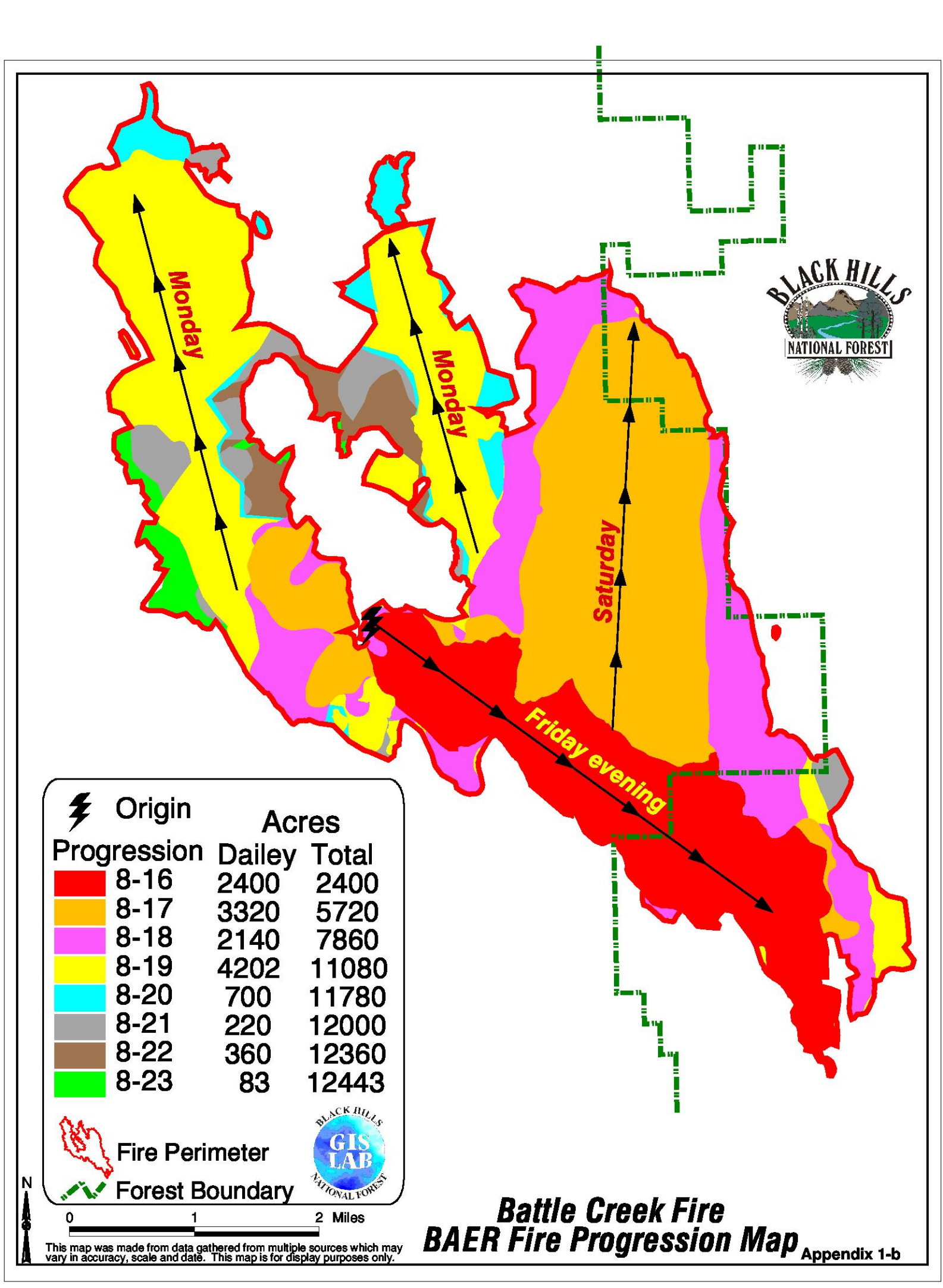
I – Hydrologic Analysis Map



This map was made from data gathered from multiple sources which may vary in accuracy, scale and date. This map is for display purposes only.

Battle Creek Fire
BAER Base Map

Appendix 1-a


Monday
Monday
Saturday
Friday evening
BLACK HILLS
NATIONAL FOREST
Origin
Acres
Progression
Dailey
Total
8-16 2400 2400
8-17 3320 5720
8-18 2140 7860
8-19 4202 11080
8-20 700 11780
8-21 220 12000
8-22 360 12360
8-23 83 12443
Fire Perimeter
Forest Boundary
BLACK HILLS
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NATIONAL FOREST
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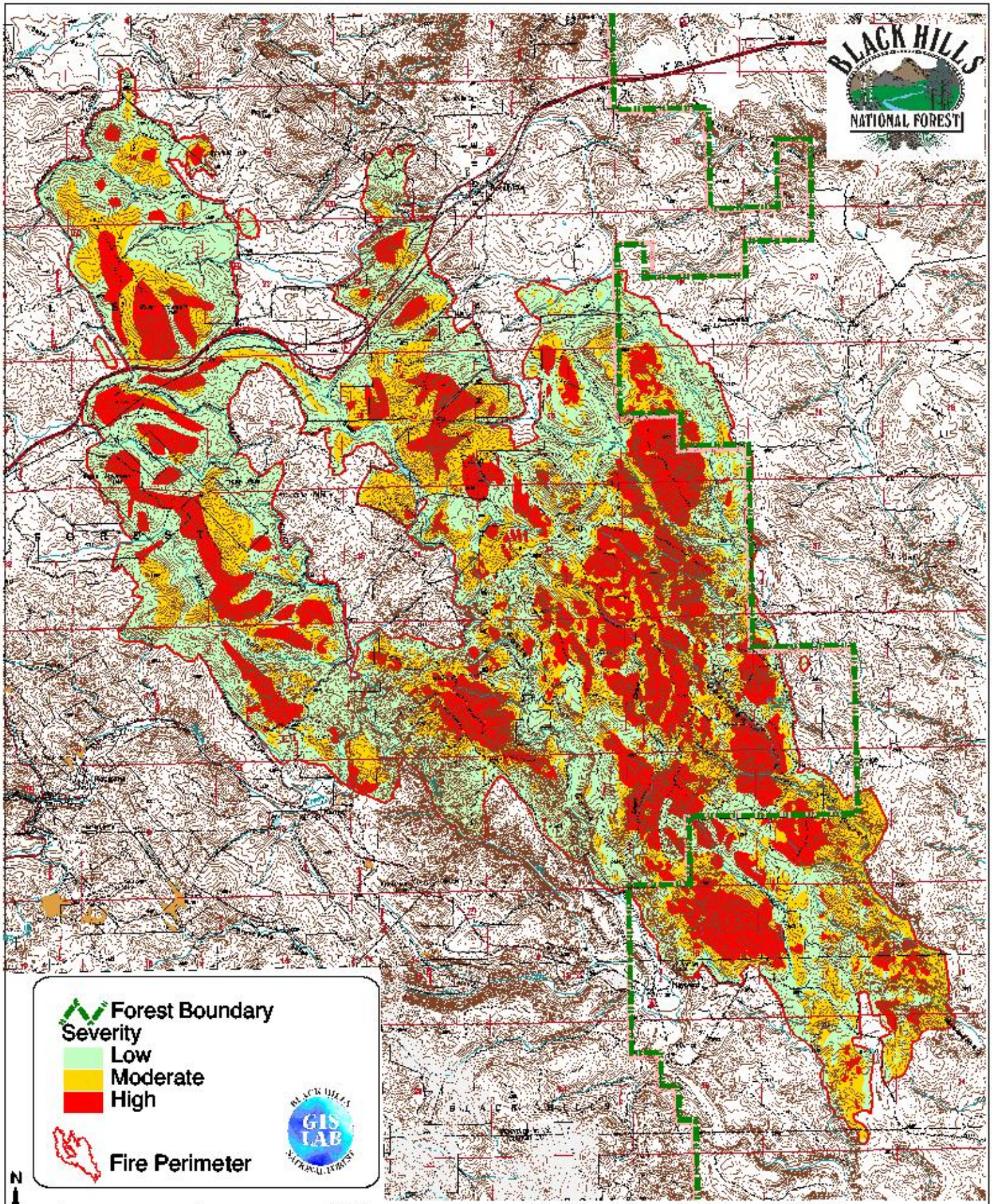
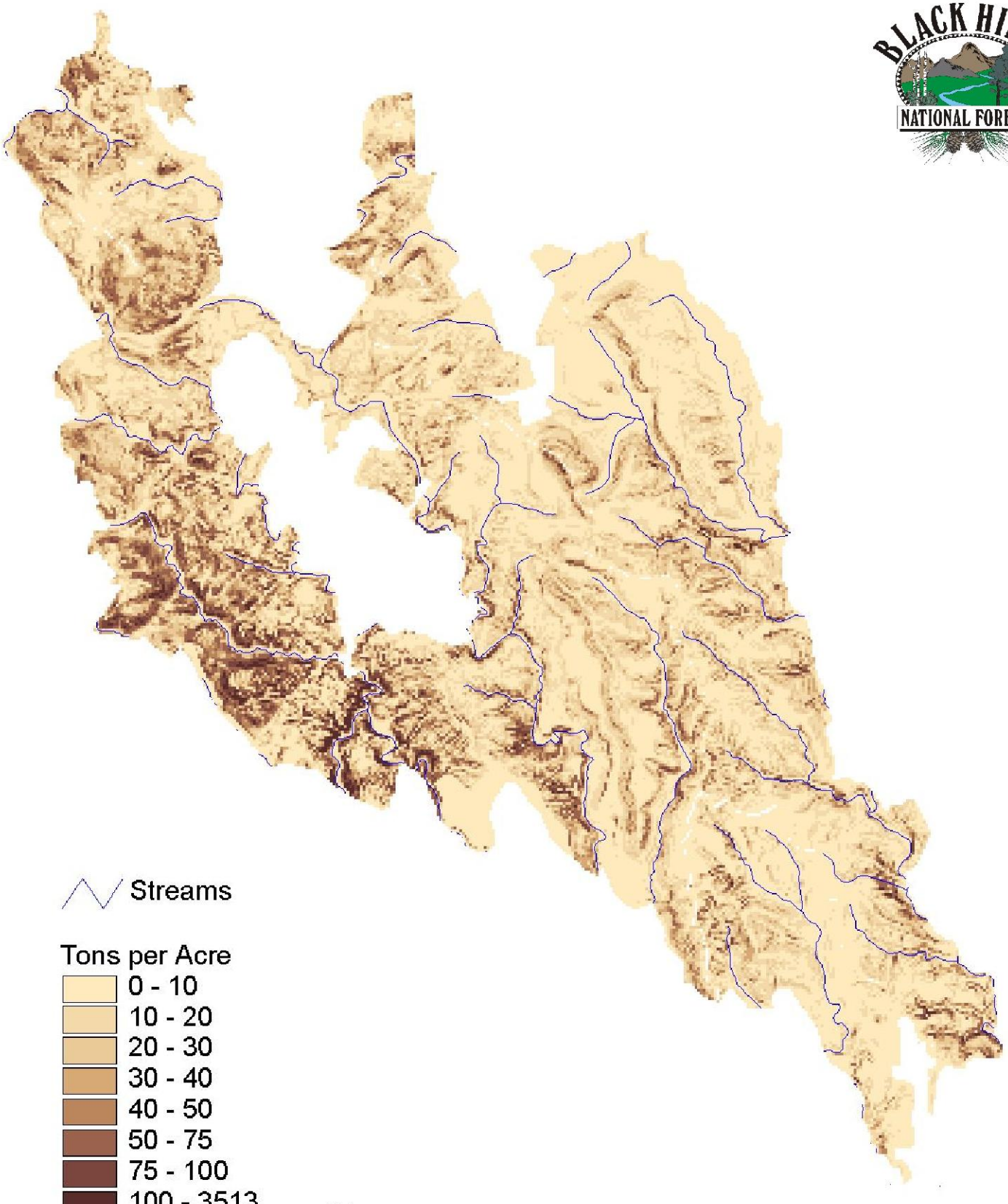
This map was made from data gathered from multiple sources which may vary in accuracy, scale and date. This map is for display purposes only.
Battle Creek Fire
BAER Fire Progression Map
Appendix 1-b



This map was made from data gathered from multiple sources which may vary in accuracy, scale and date. This map is for display purposes only.

Battle Creek Fire BAER Burn Severity Map

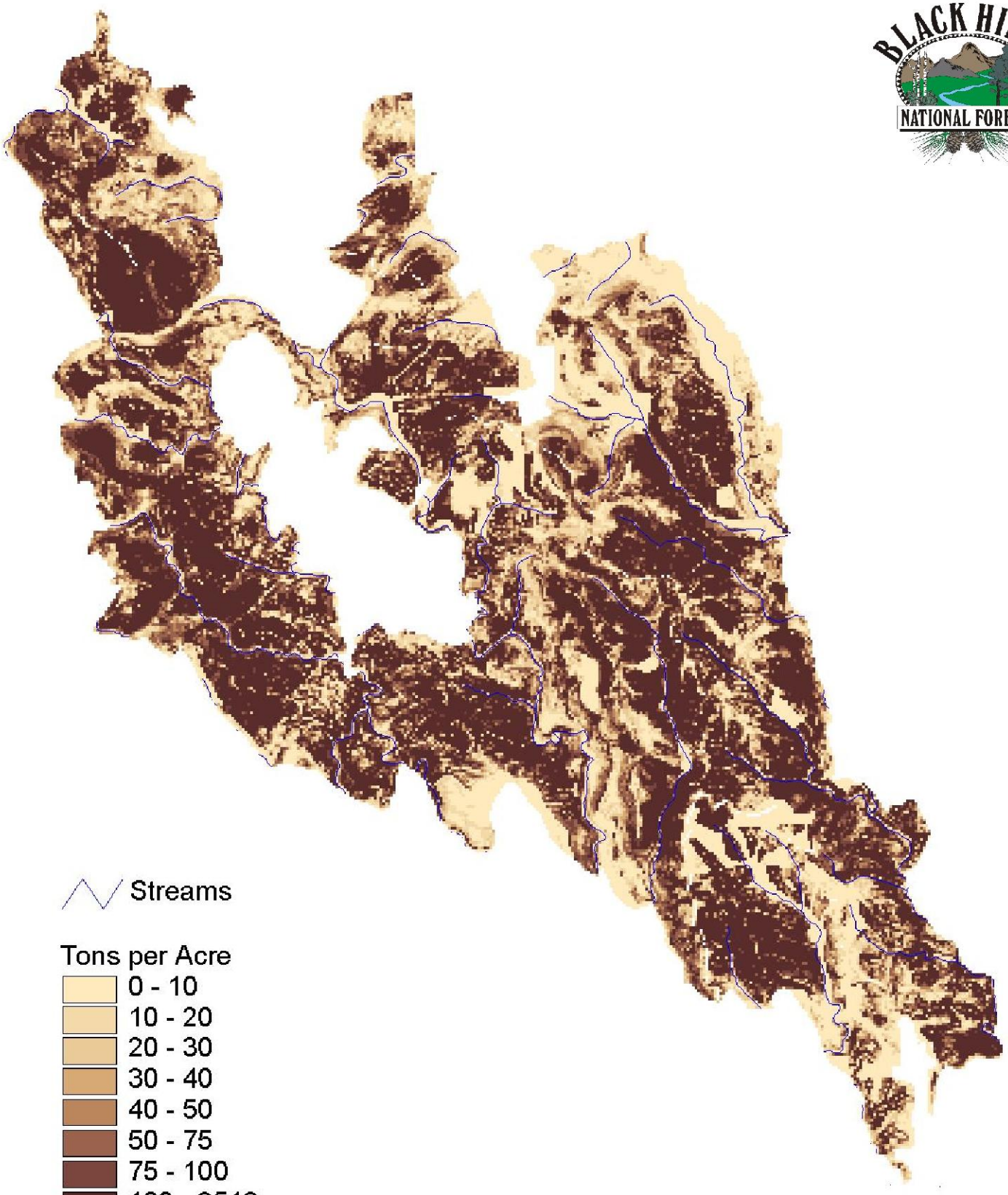
Appendix 1-c



Battle Creek Fire
Pre Fire Erosion Potential Map

Appendix 1-d

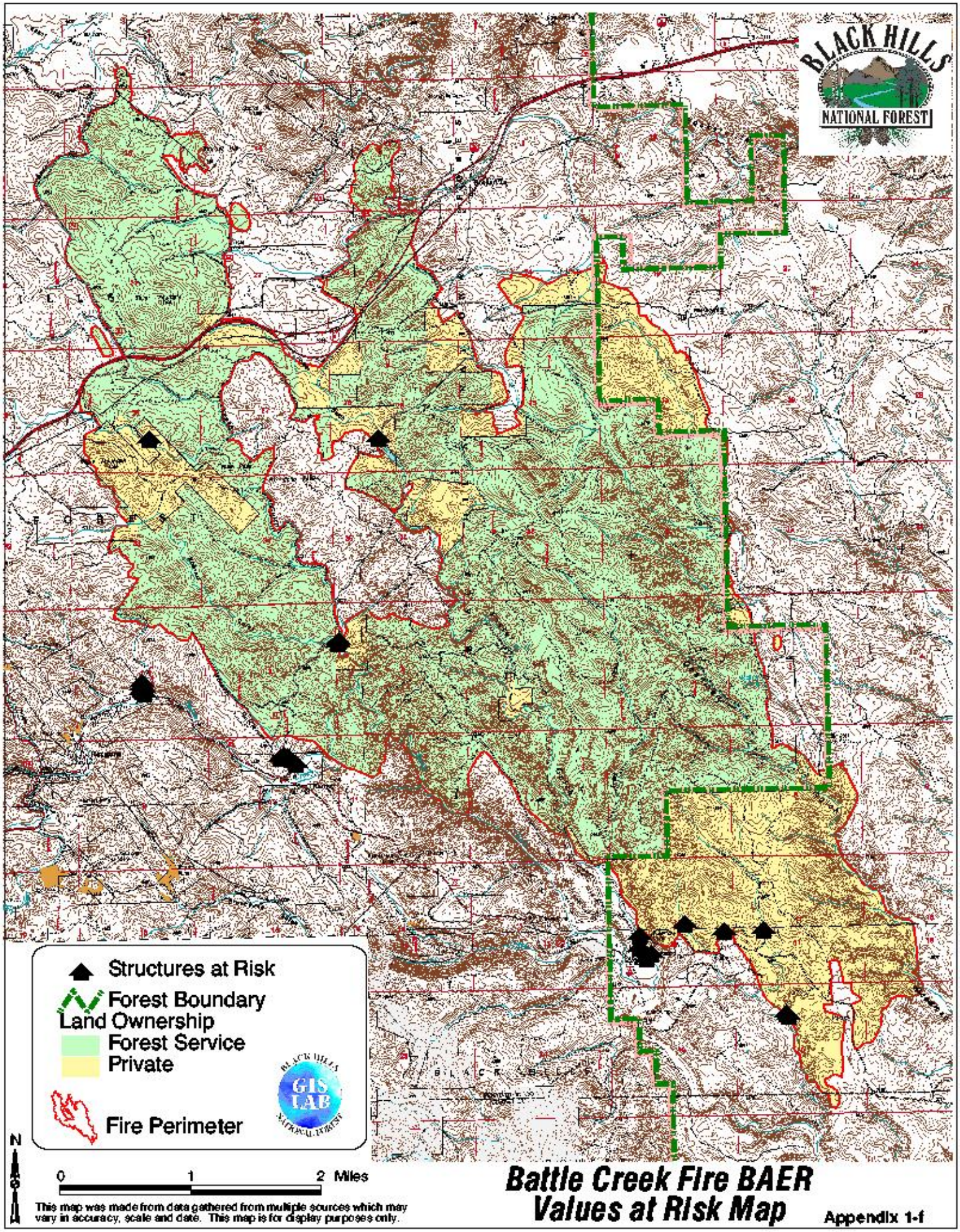
This map was made from data gathered from multiple sources which may vary in accuracy, scale and date. This map is for display purposes only.



Battle Creek Fire
Post Fire Erosion Potential Map

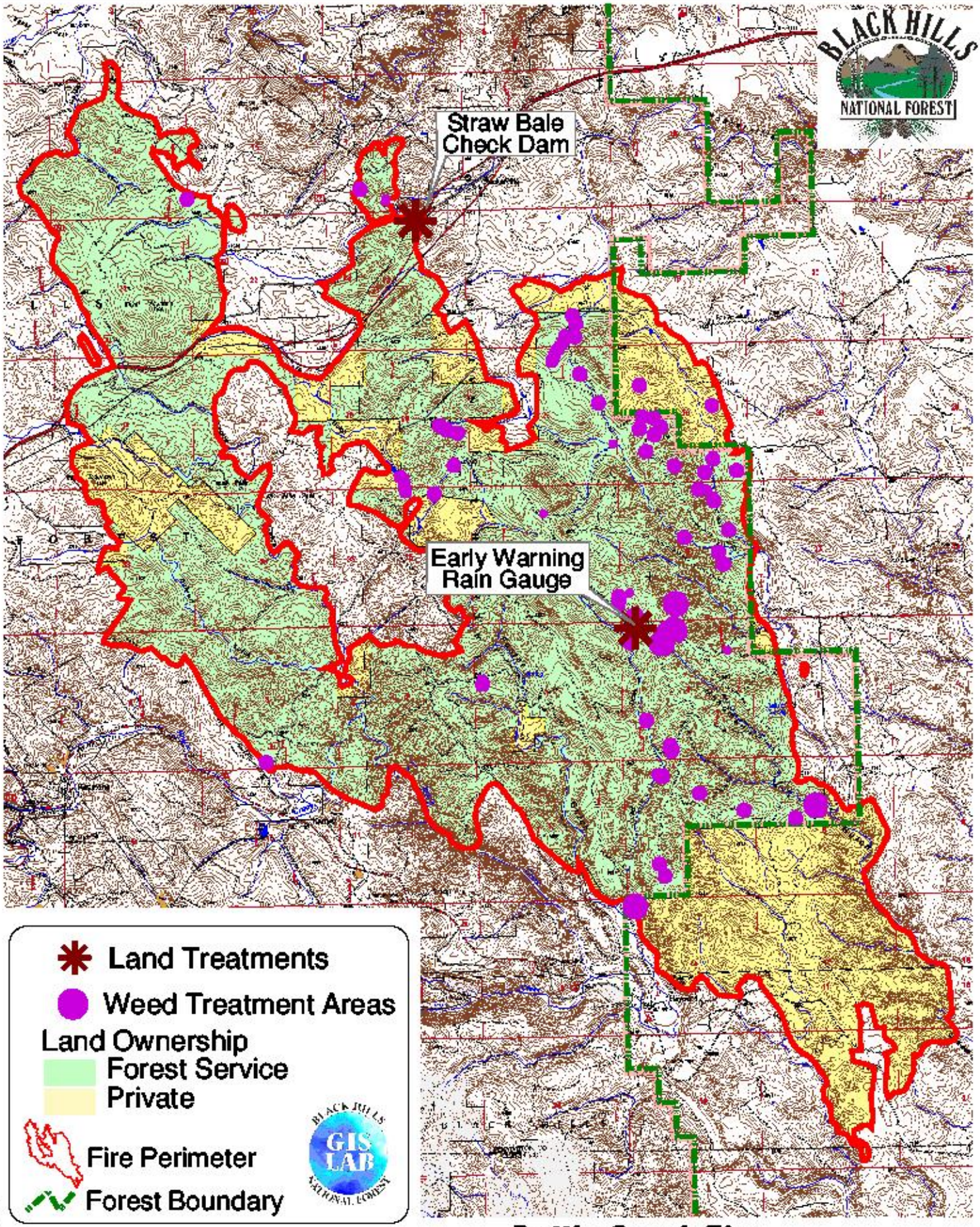
Appendix 1-e

This map was made from data gathered from multiple sources which may vary in accuracy, scale and date. This map is for display purposes only.



Battle Creek Fire BAER Values at Risk Map

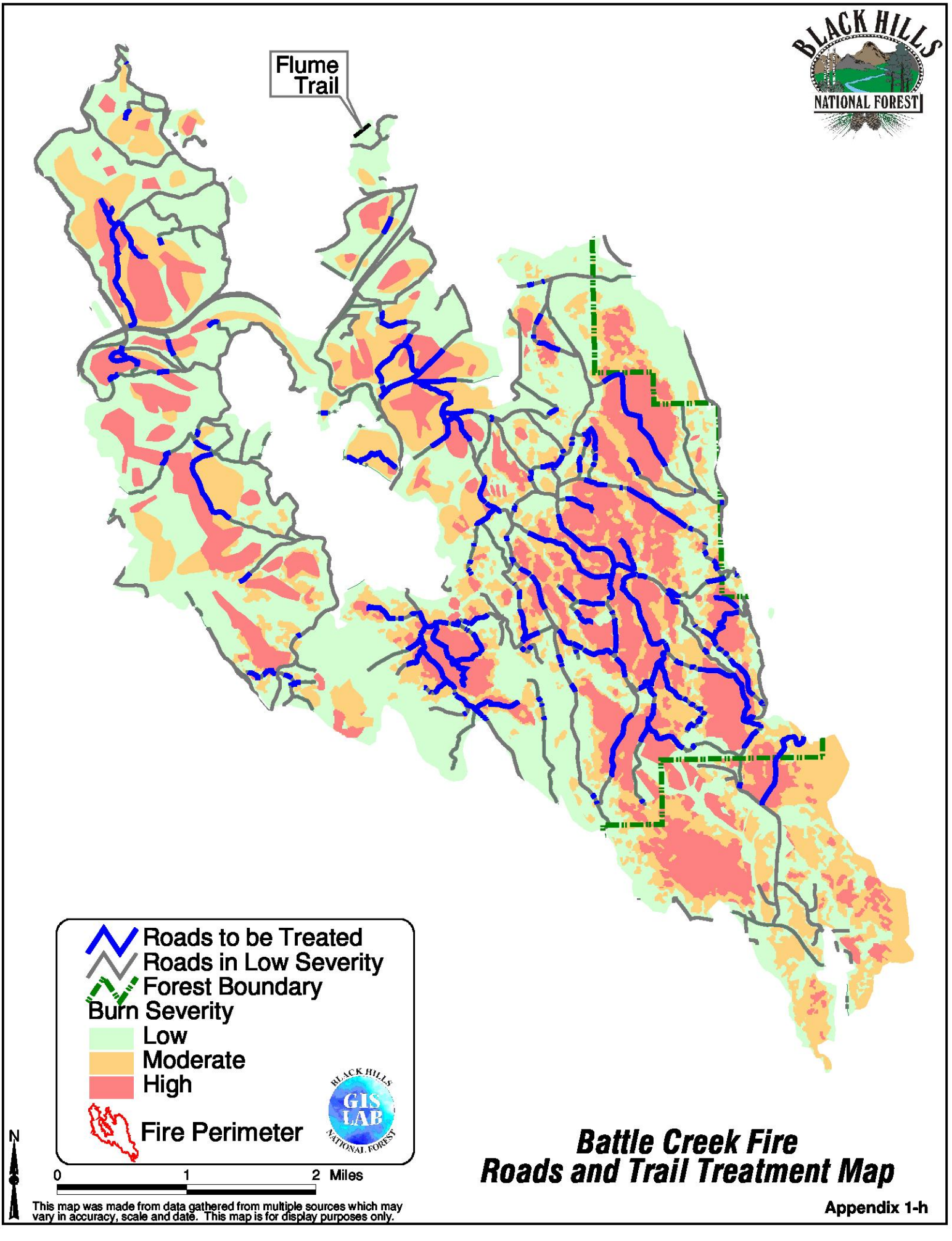
Appendix 1-f

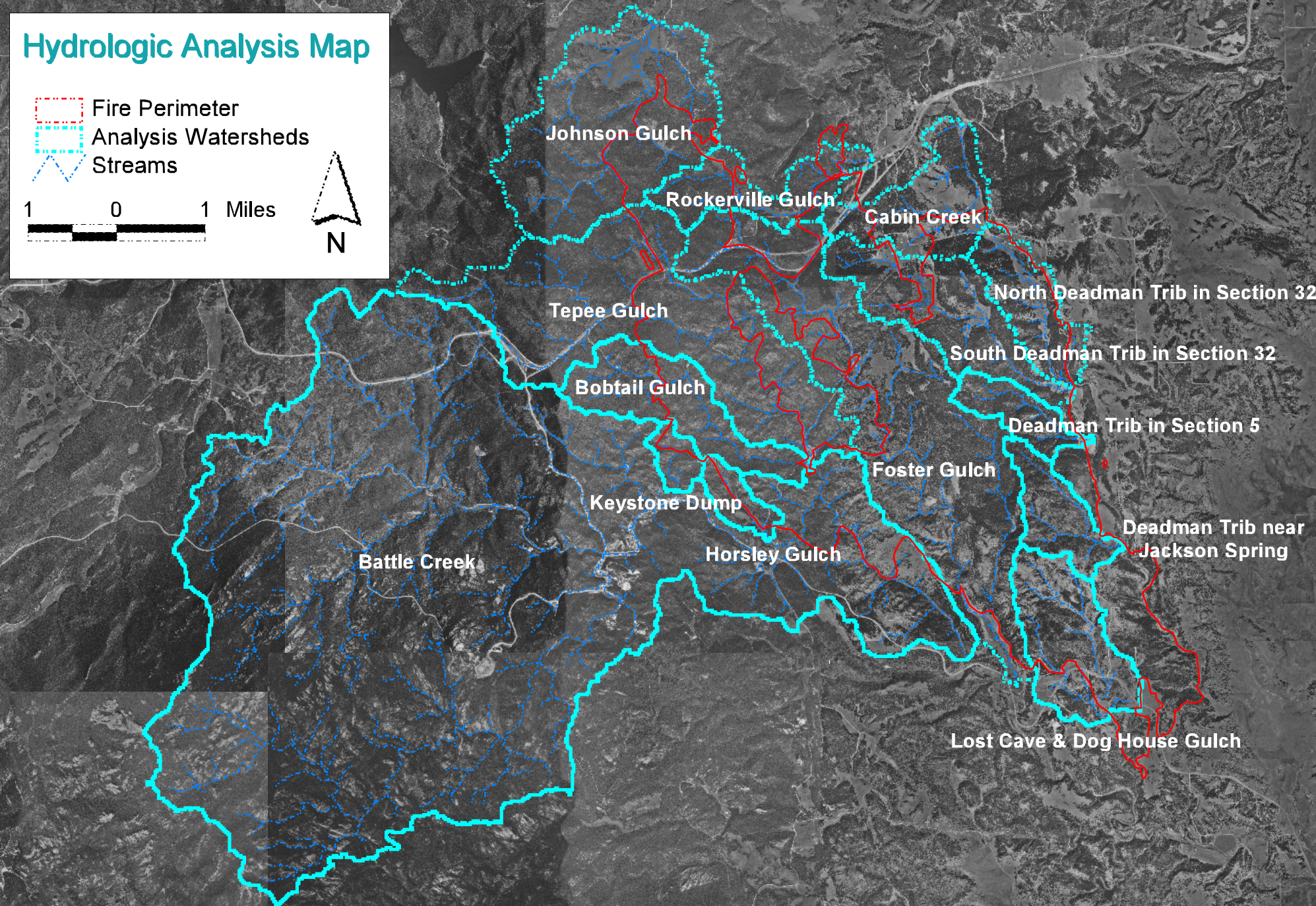


This map was made from data gathered from multiple sources which may vary in accuracy, scale and date. This map is for display purposes only.

Battle Creek Fire
BAER Land Treatment Map

Appendix 1-g


Flume Trail
BLACK HILLS NATIONAL FOREST
Roads to be Treated
Roads in Low Severity
Forest Boundary
Burn Severity
Low
Moderate
High
Fire Perimeter
BLACK HILLS GIS LAB NATIONAL FOREST
N
0
1
2 Miles
This map was made from data gathered from multiple sources which may vary in accuracy, scale and date. This map is for display purposes only.
Battle Creek Fire
Roads and Trail Treatment Map
Appendix 1-h


Hydrologic Analysis Map
Fire Perimeter
Analysis Watersheds
Streams
1 0 1 Miles
N
Johnson Gulch
Rockerville Gulch
Cabin Creek
North Deadman Trib in Section 32
Tepee Gulch
South Deadman Trib in Section 32
Bobtail Gulch
Deadman Trib in Section 5
Foster Gulch
Keystone Dump
Deadman Trib near Jackson Spring
Horsley Gulch
Battle Creek
Lost Cave & Dog House Gulch