Lightning Creek Restoration Project

Aquatics Report

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Regulatory Framework

The principle regulatory framework governing management of watershed resources on the Idaho Panhandle National Forests (IPNF) for the analysis includes:

- National Forest Management Act of 1976 (NFMA)
- Idaho Panhandle National Forests Forest Plan (USDA 1987)
- Federal Water Pollution Act (Clean Water Act) as amended
- State of Idaho's Implementation of the Clean Water Act
- Rules Pertaining to the Idaho Forest Practices Act (Title 38, Chapter 13, Idaho Code 2000)
- Idaho Stream Channel Protection Act
- Executive Order 11988 - Management of Floodplains
- Executive Order 11990 – Management of Wetlands
- The Endangered Species Act of 1973 (ESA), as amended
- Executive Order 12962 – Recreational Fishing
- State of Idaho Governor's Bull Trout Plan

The National Forest Management Act of 1976 (NFMA)

The National Forest Management Act of 1976 (NFMA) requires that forests provide for diversity of plant and animal communities based on the suitability and capability of the specific land area. Direction is also included in the Idaho Panhandle National Forests Forest Plan (USDA 1987). The Inland Native Fish Strategy (INFS; USDA 1995) amended some Forest Plan direction regarding stream and fish habitat protections measures.

Idaho Panhandle National Forests Plan Direction

The IPNF Forest Plan directs that water resources be managed at levels designed to meet management objectives for watersheds. Riparian areas are to be managed to feature dependent resources (fish, water quality, maintenance of natural channels, certain vegetation, and wildlife communities) while producing other resource outputs at levels compatible for the objective for dependent resources (IPNF Forest Plan Section II-6).

Management activities will comply with state water quality standards through the use of Best Management Practices (BMPs) and through scheduling the rate and location of activities to ensure that State Water Quality Standards are met or surpassed (IPNF Forest Plan Section II-9) (IPNF Forest Plan Section II-33). The outcome of these BMPs will be monitored to determine their effectiveness. Water quality that is below Forest standards will be improved through restoration projects. Management activities on Forest lands will not significantly impair the long-term productivity of the water resources and ensure that state water quality standards will be met or surpassed (IPNF Forest Plan Section II-33).

Lands within public water systems will be managed for multiple-uses within the water quality standards for public water supplies. The application of appropriate conservation practices will ensure that the quality of individual water bodies will not be significantly affected by sediment production (BMP Guidelines).

The IPNF Forest Plan Section II-33 also indicates that it is the intent of the Forest Plan that models be used as a tool to approximate the effects of National Forest activities on water quality values. The models

will be used in conjunction with field data, monitoring results, continuing research and professional judgment, to further refine estimated effects and to make recommendations.

Federal Water Pollution Act (Clean Water Act) and Idaho State Water Quality Standards

The Clean Water Act stipulates that states are to adopt water quality standards. Included in these standards are provisions for identifying beneficial uses, establishing the statutes of beneficial uses, setting water quality criteria, and establishing BMPs to control non-point sources of pollution. The "no net increase" criterion is a provision in the Idaho Water Quality Standards for high priority water bodies prior to approval of a Total Maximum Daily Load (TMDL).

Idaho Water Quality Standards designate beneficial uses for Lightning Creek. Lightning Creek and its tributaries are listed as supporting cold-water biota, salmonid spawning, primary contact recreation, secondary contact recreation, domestic water supply, and is also listed as special resource water. Lightning Creek is listed under the Idaho Department of Environmental Quality's IDAPA 58.01.02, "Water Quality Standards and Wastewater treatment requirements". This refers to specific watersheds that support certain beneficial uses that are protected by the rules as established by Idaho DEQ. In the 2002 DEQ Integrated Report, Lightning Creek, Rattle Creek, Wellington Creek, Cascade Creek, Savage Creek, and East Fork Creek are listed in Section 5 (equivalent to the 303(d) list of impaired waters) as being impaired for temperature. East Fork Creek is also listed for sediment, and Lightning Creek is also listed for "unknown". In the draft 2008 Integrated Report the unknown pollutant in Lightning Creek is changed to sediment, and many of the tributaries are listed for sediment and temperature. In 2007 a Total Maximum Daily Loads (TMDL) assessment was finalized for the Lower Clark Fork River Subbasin. Under the pending status of the TMDL, there will be no net increase in sediment or temperature due to management activities in Lightning Creek.

Idaho Forest Practices Act

The Idaho Forest Practices Act regulates forest practices on all land ownerships in Idaho. Forest practices on national forest system lands must adhere to the rules pertaining to the Act (IDAPA 20.02.01). The Forest Service has agreements with the State to implement Best Management Practices or Soil and Water Conservation Practices for all management activities. Proposed activities will comply with the guidelines in the Soil and Water Conservation Handbook (Forest Service Manual 2509.22), which outlines Best Management Practices that meet the intent of the water quality protection elements of the Idaho Forest Practices Act.

Idaho Stream Channel Protection Act

The Idaho Stream Channel Protection Act regulates stream channel alterations between mean high water marks on perennial streams in Idaho. Instream activities on national forest system lands must adhere to the rules pertaining to the Act (IDAPA 37.03.07). The rules are also incorporated as BMPs in the Idaho Water Quality Standards.

Executive Order 11988 – Protection and Management of Floodplains

Federal Executive Order 11988 provides for the protection and management of floodplains. The rules are also incorporated as BMPs in the Idaho Water Quality Standards.

Executive Order 11990 – Protection and Management of Wetlands

Federal Executive Order 11990 provides for the protection and management of wetlands. The rules are also incorporated as BMPs in the Idaho Water Quality Standards.

Endangered Species Act

Section 7 of the 1973 Endangered Species Act (ESA) includes direction that Federal agencies, in consultation with the U.S. Fish and Wildlife Service, will not authorize, fund, or conduct actions that are likely to jeopardize the continued existence of any threatened or endangered species or result in the destruction or adverse modification of their critical habitat.

The ESA, as amended, requires the Forest Service to manage for recovery of threatened, endangered, and proposed species and the ecosystems upon which they depend. The direction requires the completion of a biological assessment to evaluate the potential effects of proposed actions on listed species or identified habitats and a determination as to the effects of those actions. The Forest is required to consult with the U.S. Fish and Wildlife Service if a proposed activity may affect the population or habitat of a listed species.

Executive Order 12962 – Recreational Fisheries

Executive Order 12962 (June 7, 1995) states objectives "to improve the quantity, function, sustainable productivity, and distribution of U.S. aquatic resources for increased recreational fishing opportunities by: (h) evaluating the effects of Federally funded, permitted, or authorized actions on aquatic systems and recreational fisheries and document those effects relative to the purpose of this order."

State of Idaho Governor's Bull Trout Plan

The mission of the Governor's Bull Trout Plan is to "…maintain and or restore complex interacting groups of bull trout populations throughout their native range in Idaho" (State of Idaho 1996). Through a process involving state and federal agencies, interested groups and individuals (i.e., Basin Advisory Groups, Watershed Advisory Groups, Technical Advisory Teams), a Draft Problem Assessment was prepared (Panhandle Bull Trout Technical Advisory Team; PBTTAT 1998) for the Pend Oreille Lake Basin.

Methodology for Analysis

Aquatics

The objective of the aquatics analysis is to disclose the potential effects of the alternatives on watershed and fisheries resources in the Lightning Creek watershed. The whole of the Lightning Creek watershed was chosen as the analysis area, as proposed activities will occur in many of the sub watersheds within the watershed, therefore affecting aquatic conditions through the terminus of the main stem of Lightning Creek. Because Lightning Creek enters the lower Clark Fork River sub basin just before entering Lake Pend Oreille and the Lake Pend Oreille sub basin, the effects of proposed activities would be masked by land use activities across a very large geographic area. There would be no detectable impact to aquatic conditions for either of the sub basins. The issues relevant to watershed and fisheries resources in the Lightning Creek watershed include watershed condition, sediment yield, channel morphology, and water quality; all of which are components of fish habitat. See Table 1 for the issues and indicators used in measuring these issues.

Table 1. Issue indicators used to measure effects

Issue	Indicator used for measurement
Watershed Condition	Road density as measured in miles of road per square mile of land base
Sediment Yield	Sediment yield will be quantified in terms of tons per year and percent change from the existing condition and condition prior to the November 2006 flood.
Water Quality	Water quality parameters of sediment and temperature will be discussed qualitatively in terms of how the alternatives will move conditions toward meeting the load allocations outlined in the TMDL.

Effects to watershed condition will be assessed through an analysis of road density. The effect of roads on watershed condition has been widely documented in terms of increasing the rate of sediment delivery to streams (King, 1995; Luce, 1999; Haupt, 1959; Megahan, 1991; and others). In the Lightning Creek watershed, a majority of mass failures are documented as being associated with roads. Road and road/clearcut related slides comprise 58% of the slides and 76% of the total slide volume. Of those slides related to land management, 75% are exclusively related to roads (Cacek, 1989). By reducing road densities in the Lightning Creek watershed we expect to see improved watershed conditions through a reduction in chronic sediment input to streams from roads and a reduced potential for mass failure associated with roads.

The analysis of road densities in the Lightning Creek watershed will be carried out through a Geographic Information Systems (GIS) comparison of the road network under each of the alternatives. Road densities will be quantified as miles of road per square mile of land base. They will be calculated for the overall watershed, in riparian habitat conservation areas, and areas of high and moderate mass failure potential. It is important to note that pre and post flood road densities mileages are the same due to the way roads are considered in this analysis. All roads, regardless if they are opened and traveled or not, are being considered in the mileage because they present some level of anthropogenic effect, or risk on the landscape.

Sediment yield will be assessed for each of the alternatives using a combination of modeling, field surveys, and research. As previously mentioned, sediment from forest roads is a widely documented phenomenon that compromises water quality and beneficial uses of water. Sediment yield is important as it affects aquatic habitat, as well as stream morphology and stability.

The roads module of the Water Erosion Prediction Project (WEPP - Roads) is one of the tools used to compare alternatives in terms of tons of sediment per year (tons/year) being generated from roads. Limitations and assumptions to this modeling process are discussed in the project file. In isolated areas where roads were damaged during the November 2006 flood event, and sediment modeling using WEPP – Roads is not possible, sediment input values will be calculated using Bank Erosion Hazard Index (BEHI) methodologies (see project file). Coefficients used to calculate erosion/sedimentation values are adapted and derived from similar work done in the adjacent West Fork Blue Creek, which experienced a similar runoff event in 2006, and has similar geology, soils, and channel morphology (see project file). Short term and long term sediment recovery rates from decommissioned road will be taken from commonly accepted and peer reviewed literature and research.

In the 2002 Integrated Report issued by the Idaho Department of Environmental Quality (IDEQ), Lightning Creek and many of its tributaries are listed as being water quality impaired by temperature and “unknown” (IDEQ, 2005). In the draft 2008 Integrated Report, this “unknown” listing was changed to sediment. Long-term changes in sediment yield from activities proposed in the watershed will be

quantified in terms of percent change from the existing condition and prior to the flood damage in 2006. This percent change will be discussed in qualitative terms as to the degree to which proposed activities contribute to meeting the reduction called for in the current TMDL for the Lightning Creek watershed (IDEQ, 2007). Changes in temperature will be discussed in qualitative terms from the point of view of changes in potential natural vegetation shading the stream channel, and assessed in terms of trend. An assessment of potential natural vegetation is the methodology used by the IDEQ in assessing temperature for waters in the state of Idaho (IDEQ, 2007).

The existing condition of roads, stream crossings and stream channels were established through several field seasons of survey work. Detailed road and road/stream crossing surveys were initiated in 2004 and continued through 2006. Following the November 2006 flood another set of road surveys were conducted to assess the extent of damage to the road system and generate Damage Survey Reports (DSRs) that were submitted to Federal Highways for Emergency Relief for Federally Owned Roads (ERFO) funding (project file).

Aerial photo analysis and other historic U.S Forest Service documentation was used for historical analysis and to establish existing condition. Some of the historical documentation was used for cumulative watershed effects analysis.

Fisheries

Lightning Creek is an important spawning and rearing drainage for both bull trout (*Salvelinus confluentus*) and westslope cutthroat trout (*Oncorhynchus clarki lewisi*). It is also used by rainbow (*Oncorhynchus mykiss*), brown (*Salmo trutta)*, and brook trout (*Salvelinus fontinalus*), as well as kokanee (*Oncorhynchus nerka*), sculpin (*Cottus spp*.) and mountain whitefish (*Prosopium williamsoni*).

Stream surveys were conducted in 2007 and 2008 using a modified R1/R4 methodology (Overton et al., 1997). In some areas, stream surveys were used to establish baseline conditions following the flood. In others, they were used for current and for future monitoring purposes. Original PWA surveys were repeated for monitoring purposes. New monitoring reaches were also established and will be repeated during and following project implementation.

Threatened, Endangered and Proposed Species

On April 9, 2008, the U.S. Fish and Wildlife Service issued a list of threatened and endangered species that may be present on the Idaho Panhandle National Forests (USDI Fish and Wildlife Service 2008a), including Kootenai River white sturgeon and bull trout.

Species Screen

Species surveys were conducted for some species, where relevant and applicable, to determine presence. However, presence surveys do not necessarily determine absence of a species. Therefore, a more meaningful and creditable approach in conducting an analysis is to assume presence based on the attributes of a particular stream, using survey information to help validate suitability of streams. In some cases, surveys can identify key habitats (e.g. spawning sites) that can be further protected through mitigation measures.

The Council on Environmental Quality (40 CFR 1502.2) directs that impacts be discussed in proportion to their significance. Some fish species require a detailed analysis/discussion to determine effects of an action on them. Other fish species may not be impacted or impacted at a level that does not increase risk to the species. Some species may be adequately protected through altering the project design. Generally, these species do not require a detailed discussion and analysis.

The appropriate methodology and level of analysis needed to determine potential effects are influenced by a number of variables including presence of a species or its habitat, the scope and nature of the activities associated with the proposed action and alternatives, and the risk to factors that could ultimately result in a meaningful adverse or favorable effect. The screening process includes the review and use of the following documents and uses a variety of information including scientific literature, resource inventories and sighting records:

- Integrated Scientific Assessment for Ecosystem Management in the Interior Columbia Basin
- Idaho Panhandle National Forest Land and Resource Management Plan
- Conservation Assessments and Strategies for fish species

Species Not Analyzed in Detail

A preliminary analysis was conducted for each potentially affected fish species and their habitat to determine the scope of analysis. The species listed in the following table would not likely be affected by the proposed activities because:

- they do not have suitable habitat,
- they are not regularly present,
- they are not expected to be in streams within the project area or
- the species would not be impacted,
- they are impacted, but at a level that does not pose a risk to the species or
- the potential impacts would be adequately mitigate by altering the project design.

For these reasons, these species were not analyzed in detail. Preliminary analysis information for species not analyzed in detail is located in the Fisheries section of the project file.

Table 2. Fisheries species not analyzed in detail

Species	Rationale for Elimination from Detailed Analysis	Preferred Habitat
Threatened and Endangered Species		
Kootenai River White Sturgeon (*Acipenser transmontanus*)	No suitable habitat is present within the project area. The project area is outside recognized sturgeon habitat.	Large lakes and rivers. In Idaho, found only in the Kootenai River System.
Sensitive Species		
Burbot (*Lota lota*)	No suitable habitat is present within the project area. The project area is outside recognized burbot habitat.	Large lakes and rivers. In Idaho, found only in the Kootenai River System.
Interior Redband Trout (*Oncorhynchus mykiss gairdneri*)	No suitable habitat is present within the project area. Effects to this species and its habitat will be analyzed using westslope cutthroat and bull trout as MIS species.	Cool, clean, relatively low gradient streams. On the IPNF, pure interior redband trout found only in isolated tributaries of the Kootenai River outside of the cumulative effects analysis area.

Species Analyzed in Detail

This section describes the status and distribution of fish species analyzed in detail that have been identified as species of concern within the project area and could potentially be affected by proposed activities. It also describes the environmental baseline and relevant habitat components that may or may

not be affected by the alternatives, if they were to be implemented. Information presented in this section is based on scientific literature, fisheries databases, professional judgment and recent field surveys and habitat evaluations conducted over the last two years.

Table 3 summarizes the species analyzed in detail, the rationale for analyzing them, and their preferred habitat

Table 3. Fisheries species analyzed in detail

Species	Rationale for Detailed Analysis	Preferred Habitat
Threatened and Endangered Species		
Bull Trout (*Salvelinus confluentus*)	Lightning Creek and many of its tributaries are known spawning and rearing locations.	Cold, clear streams with gravel/cobble substrate for spawning and lots of deep pools
Sensitive Species		
Westslope Cutthroat Trout (*Oncorhynchus clarki lewisi*)	Suitable habitat is present and occupied within the project area.	Cold, clear streams with rocky, silt-free riffles for spawning and deep pools for feeding and resting

Ultimately, the effect of the project on stream habitat is the main concern for fisheries resources. Important fish habitat parameters that are often affected by management activities include water temperature, large woody debris frequency, bank stability, undercut bank, width to depth ratio, pool quality and frequency, and sediment. The analysis of direct and indirect effects is based on how the various components of the project (e.g. road repairs, culvert upgrades, road decommissioning, road maintenance and reasonably foreseeable actions) are expected to affect stream habitat (e.g. changes in sediment and/or water yield) within the analysis area.

Although bull trout and westslope cutthroat trout utilize streams differently based on their unique natural histories and biological requirements, considerable overlap occurs in the habitat use for these species. Bull trout are fall spawners and westslope cutthroat trout are spring spawners; however, both species require cold, clear streams with a mixture of riffles and deep pools in order to sustain their populations. Project activities are designed to limit or eliminate the impact to both species and project activities would potentially affect these species similarly. Therefore, the potential impacts to bull trout and westslope cutthroat from project activities will be analyzed collectively.

Due to the number of fish species within the cumulative effects area (Lightning Creek), analysis of direct, indirect, and cumulative effects to fish will use the concept of management indicator species (MIS). Under this concept, larger groups of organisms or communities are believed to be adequately represented by a subset of the group (USDA Forest Service 1987). The Idaho Panhandle National Forests Forest Plan identifies cutthroat trout and bull trout as potential MIS for fisheries conditions. Westslope cutthroat trout or bull trout are native to all fish bearing streams within the cumulative effects area. They are also likely sensitive indicators for all cold water biota within the stream segments (Meehan 1991). Therefore, westslope cutthroat and bull trout are appropriate MIS for the fisheries analysis of this project.

Table 4. Issue indicators used to measure effects

Species	Indicator
Threatened and Endangered Species	
Bull Trout	Changes in the quality of stream habitat as measured by: (1) qualitative change in sediment yield, (2) qualitative change in large woody debris and (3) qualitative change in water temperature
Sensitive Species	
Westslope Cutthroat Trout	Same as above

Affected Environment

Introduction to Physical Watershed Characteristics

Lightning Creek is the largest tributary to the Clark Fork River in Idaho. It flows south draining a portion of the Cabinet Mountains along the Idaho/Montana border. Lightning Creek is approximately 35 km long and drains about 306 square kilometers (118 square miles) and is oblong in shape. Vertical relief in the watershed ranges from 7,009 feet on Scotchman Peak to 2,080 feet at the confluence with the Clark Fork River. Lightning Creek receives some of the highest amounts of precipitation in the state of Idaho, with a recorded 30-year average of 94 inches of precipitation annually. Much of this precipitation falls as snow. The main process that influences streamflow in Lightning Creek is spring snowmelt. Because of the range in elevation and position with respect to prevailing weather patterns, Lightning Creek is also susceptible to rapid changes in streamflow from rain-on-snow events. It is considered a flashy system due to its characteristics of very high levels of precipitation, unstable landtypes, exposed bedrock, shallow soils, steep terrain, and much of the watershed exists within the rain-on-snow zone.

Lightning Creek has seven larger tributary streams within the project area: Moose, Quartz, Rattle, Wellington, Porcupine, East Fork, and Spring Creek. There are many smaller tributaries and the resulting drainage pattern exhibited on the landscape is a combination of rectangular and dendritic. The geology of the basin, a big influence on the landscape, is the product of mosaic block faulting of Belt Series sedimentary rock worn by several glacial events and mass wasting.

Because of the high precipitation levels forested areas can exist in dense stands on all aspects with the exception of exposed bedrock areas. Vegetation patterns in the watershed have been largely influenced by fire but vary also with respect to aspect, elevation, and proximity to water. Old growth stands of western red cedar are common in riparian zones, floodplains and wetlands. Because of their great size and direct proximity to the stream environment, western red cedar has had a large influence on stream morphology and channel function through thermal regulation, bank stabilization and incorporation in the channel. Midslope species range from western hemlock, Douglas fir, grand fir, western white pine, western larch, and lodgepole pine and vary in species mix with aspect and elevation. Midslope vegetation has played an important role in slope stabilization of unstable landtypes. The highest elevations in the watershed are subalpine ecosystems where the dominant tree species are subalpine fir and Englemann spruce. Patches of whitebark pine are common on exposed ridges.

Land ownership in the analysis area is almost entirely federal, but there are small tracts of private ownership in the southern portion of the analysis area.

Geology/Soils

Geology plays a mayor role in the physical processes that characterize the Lightning Creek watershed. The dominant rock type in the region occupied by the Lightning Creek watershed consists of the Precambrian metasedimentary rocks of the Belt Supergroup Series. Subsequent faulting and folding altered the structure of the Belt Series rock strata and helped to establish the current drainage pattern exhibited by the watershed. In certain areas, mainly along the east side of the drainage, this creates a hazardous situation known as an adverse dipslope. An adverse dip occurs where the contour of the slope is parallel to the strike of the rock strata and where the dip of the rock strata is parallel to the natural slope. This creates a situation where soils are perched on potential sliding planes created by the dipping bedrock. Mass failures of large volume are sometimes a result of this condition (Straley 1974). Extensive fracturing of certain formations of rock is also partly responsible for slope instability and mass failures.

Subsequent glaciation, from about 2.5 million years ago to 9,000 years ago, Pleistocene glaciers invaded into and retreated from the area, scouring the mountains (Straley 1974). It is generally accepted that there were at least two advances of continental ice, and evidence suggests that these advances reached their maxima approximately 36-42 thousand years ago and about 11-17 thousand years ago (USDA Forest Service unpublished report). The ice from the second advance, for which terrestrial evidence remains, was sufficiently thick to dam the Lightning Creek watershed and create a proglacial lake. Sediments accumulated to a substantial depth in the quiescent backwaters.

Higher in the watershed, alpine cirque glaciers eroded the high elevation areas where the glaciers were accumulating and advancing downward. Near the termini depositional areas of glacial outwash and coarser tills accumulated. Along with the lacustrine deposition influenced by the proglacial lake the outwash and tills tended to accumulate in valley bottoms. Lateral moraines, however, could be deposited on steeper sideslopes along the margins and confluence zones of advancing glaciers. In the centuries immediately following glacial recession, before soil profiles developed and a good vegetation cover became established, these outwash bodies must have produced large quantities of sediment. There is no question that Lightning Creek has been overloaded with sediment since glacial recession. The conditions left upon glacial recession guarantee that high flows in the drainages will mobilize large quantities of sediment and produce frequent channel instability (USDA Forest Service unpublished report).

Soils in the Lightning Creek watershed formed primarily through weathering processes on the underlying parent rock of the basin. Because of the large scale of glacial events, much of the former soil layering is eliminated and replaced by the most recent event. Thus, most of the soils present in Lightning Creek were generated since the most recent glacial event which occurred between 11 and 17 thousand years ago. The soils consist of glaciofluvial outwash, glaciolacustrine deposits, loose upper till, an underlying compact basal till, and material from mass wasting deposits. The layering of the tills produces an inherently unstable situation where the upper till allows precipitation to infiltrate into the soil. The lower impermeable till layer creates a contact zone where the overlying soils become saturated, pore pressures increase, and slide planes become lubricated. This is often a process that leads to slope failures on steep hillsides.

Climate and Watershed Processes

The climate of North Idaho is influenced by mild, moist, westerly winds from the Pacific Ocean, which produce cloudy, humid winters with heavy snowfall in the mountains and warmer temperatures relative to other locations of comparable latitude and distance from the ocean (PWA 2004). The types of storms that deliver the heaviest moisture are most common in the winter months, particularly from November to January, with November being the wettest month as indicated by a 25-year NRCS dataset for monthly precipitation averages at Bear Mountain. These moisture-laden storms are further intensified as they track over North Idaho and meet the orographic front of the Cabinet Mountains. The steep rise in

elevation creates heavier precipitation in the mountains and the north-south trend of the watershed and proximity to a large water body, Lake Pend Oreille, also combine to influence heavy precipitation.

Winter precipitation is about evenly divided between rain and snow at elevations of 3000 feet. Below this elevation, most of the snow is likely to melt completely several times during the winter, often the result of rain-on-snow events (Cacek 1989). Rain-on-snow events have played a major role in defining the morphological characteristics of stream channels and adjacent landscape due to the large volume of water that is introduced to the watershed in a very short time period. In Lightning Creek, 15% of the watershed lies within the 3,000 to 4,500 feet elevation range that is denoted as the rain-on-snow zone. Rain-on-snow events can happen at any elevation depending on the weather patterns and snowpack conditions but it is most common for rain to fall on an isothermal (equal-temperature) snowpack and result in runoff in the elevation band from 3,000 to 4,500 feet. Above this elevation snowmelt is buffered by colder temperatures in a deeper snowpack and below this elevation the accumulation of winter snowpack is considerably less and more transitional.

Rain-on-snow events are a primary triggering mechanism for mass failures in the watershed. Because of the steep topography, deposits of unconsolidated glacial drift, and expanses of exposed bedrock that concentrate runoff, the watershed is exceptionally prone to natural mass failure events like, debris torrents and avalanches, slump-earthflows, and soil-moisture failures. In the Lightning Creek watershed, 27% is underlain with highly sensitive landtypes prone to mass failures. The major contributing watersheds exhibit high percentages also: Moose (13%), Quartz (26%), Rattle (24%), Wellington (21%), Porcupine (20%), East Fork (23%), and Spring Creek (25%). The Land System Inventory (LSI) identifies management recommendations for various landtypes on the Idaho Panhandle National Forests. Recommendations in upper Lightning Creek for landytpe unit 289 (high risk for mass failure) identifies that these areas have rapid runoff response from high intensity storms and/or rain-on-snow events. This produces major floods, mass failures and damage to roads and bridges, culverts, and other structures (LSI). The inherent characteristics of intense precipitation events, high percentage of rain-on-snow coverage, and steep, unstable geology combine to create the foundation for a watershed that is naturally dynamic, exhibits high peak discharge, is susceptible to large channel changes laterally and vertically, has a rapid streamflow response to precipitation runoff, and mobilizes a large volume of sediment, debris, and bedload. The Lightning Creek drainage can be generalized as being an active drainage area which struggles to reach an erosional/depositional equilibrium. The drainage is still in the process of flushing unconsolidated glacial material (USDA Forest Service report 1981). Periodic pulse flood events that can substantially alter the stream channel dimensions and their associated floodplain, as well as effect more upland hill slopes through mass erosion is within the expected natural range of variability for this drainage (Figure 1).

Upper Lightning Creek and all major tributaries are classified as transport reaches, using the Montgomery/Buffington system of stream classification (PWA Table, p. 86-89, project file). In general these transport reaches can be defined by steep stream gradients, high velocity flow, narrow and confined stream channels, very steep contributing primary streams, coarse bedload, with hillslopes and tributary streams being the dominant sediment sources. Relatively high amounts of woody debris occupy the channel and act to store and slow the downstream movement of sediment during storms. Debris flows are a primary mechanism of sediment transport in steep, low order streams and can lead to significant amounts of material delivered to downstream reaches. Fires periodically burned in the Lightning Creek watershed and killed vegetation and affected hill slopes adjacent to transport reaches by reducing root strength, which over time, contributed to soil instability.

Figure 1. Lower Rattle Creek and floodplain alterations and mass wasting

Much of the transport reach system of the Lightning Creek watershed was considered to be functioning within a natural range of variability for sediment transport and discharge balances (PWA table, p.86-89, project file). Conditions have changed in some tributaries due to the November 2006 flood event, which will be addressed specifically in a later section. Tributary confluences with the main stem of Middle Lightning Creek, downstream from Rattle Creek, are a primary transition zone from transport reach to response reach. Therefore, this section of Lightning Creek is particularly susceptible to inputs from the upper transport reaches.

In contrast to most other tributary mainstem reaches in the Lightning Creek watershed, Middle Lighting Creek represents the uppermost continuous section of low-gradient channel (response reach). Therefore, this reach would be expected to be the first to show responses due to changes in the sediment supply delivered to it (PWA, 2004). An example of this response is the shifting of the Lightning Creek channel around numerous alluvial fans at the confluences with steeper tributary streams. Excessive sediment deposition around these confluence zones is associated with corresponding increases in width/depth ratios, stream slope, lateral migration, and decreases in sinuosity and meander width ratio (Rosgen, 1996). Channel braiding, the formation of multiple channels at low flow, is evident in short sections but Middle Lightning Creek is primarily a single-thread channel. In Middle Lightning braiding is more a response to impacts upstream and is not the dominant natural channel form. A 1998 survey of Middle Lightning Creek identified some of the lowest densities of coarse and large woody debris of all surveyed reaches in Lightning Creek. It is possible that the lack of large wood is influencing a wider and shallower channel and much of the sediment is moving through Middle Lightning Creek and forming braided channels where bedload pulses are most pronounced. Comparison of aerial photos from 1935 to 2006 of Middle Lightning Creek just upstream of the East Fork Lightning Creek confluence display a wider and straighter channel in 2006 that is less likely to retain wood and possesses higher stream competence to transport more and larger sediment.

The stable form of Lower Lightning Creek appears to be a braided rather than a meandering, single-threaded channel based on historic aerial photo interpretation and the current slope-discharge relationship (PWA, 2004). In Lower Lightning Creek, the coupling between hillslopes and lower-gradient channels is buffered by wider valleys and depositional flood plains, making these reaches less susceptible to direct disturbance from hillslope processes (Montgomery, 1997). Processes functioning within the stream channel dominate as the valley widens downstream and the channel is more able to handle excess stream flow and bedload (Figure 2).

Figure 2. Lower Lightning Creek above Clark Fork

In addition to the sediment/discharge balance influencing braided channels, large woody debris can also influence braided and divergent channel types. Flow obstructions can force a reach morphology that differs from the free-formed morphology for a similar sediment supply and transport capacity. In forested mountain drainage basins, for example, large woody debris may force local scour, flow divergence, and sediment impoundment that respectively form pools, bars, and steps (Montgomery, 1997). In Lightning Creek, adjacent riparian areas and floodplain are colonized by western red cedar and western hemlock. An established climax forest typically supports very large individual trees of both species. The processes influenced by recruitment of old growth trees; divergent channels, aggradation of bedload, subsurface flow, downcutting and remobilizing of aggraded bedload, have been a force in shaping Middle and Lower Lightning Creek and associated tributaries for many years and large woody debris is an important component of maintaining conditions within the natural range of variability. Prior to the November 2006 flood the Lightning Creek system was lacking in large woody debris.

Roads/Logging

Forest Service road logs show that the first road into Lightning Creek in the early 1930s was built from the town of Clark Fork to the confluence with Rattle Creek. With the road up the main drainage spur roads began to be constructed up the major tributaries. In the subsequent years until the early 1970s roads were constructed into all the major tributaries to Lightning Creek. The roads were built to access timber stands. The first logging activities in the basin began in the early 1950s in response to a spruce budworm blight. During the late 1960s and 1970s an infestation of white pine beetle prompted increased logging and roading on previously unmanaged slopes. Regular timber harvest and road building continued through the 1980s, then drastically tapered off in the 1990s with the last timber sale taking place on National Forest land in 1999/2000. By the time the majority of the road building was done 220 kilometers of roads were constructed (1.6% of total area) in the watershed and 35.3 square kilometers were subject to

harvest prescription (17.1% of total area), of which 16.57 square kilometers were clearcut (Cacek 1989). Table 5 displays road densities and stream crossing frequencies in the Lightning Creek watershed.

Table 5. Road densities, stream crossings, and encroaching roads in Lightning Creek

Watershed name	Road Density (mi/mi2)	Road Density of Highly Sensitive Landtypes (mi/mi^2)	Crossing Frequency (#/stream mi.)	Encroaching Roads % streams
Lighting Creek (Lower)	1.56	0.09	0.46	6%
Lightning Creek (mid)	1.9	1	0.4	10%
Lighting Creek (Upper)	0	0	0	4%
Moose Creek	0.6	0.3	0.2	3%
Quartz Creek	3.6	0.7	1.5	16%
Deer Creek	0	0	0	0%
Rattle Creek	1.2	0.6	0.9	14%
Wellington Creek	2	0.6	0.7	8%
Porcupine Creek	0.8	0.3	0.4	4%
EF Lightning Creek	0.6	0.3	0.3	4%
Morris Creek	0	0	0	0%

Harr (1976) reports in studies of storm flow responses to forest practices in western Oregon that large peak flows appear to be increased only when greater than about 12% of the watershed area is severely compacted by roads, skidtrails, and landings (King 1995). Watershed problems arose as a result of the intense road building and logging. For example, in Rattle Creek an aerial photo analysis shows the steady degradation of road conditions from 1968 to 1983 and the resulting stream channel impacts. The analysis describes numerous road failures, channel alterations, and sediment addition to the creek, which eventually culminated in evidence of excess bedload resulting in channel braiding at the mouth of Rattle Creek (unpublished FS data, 1999). In a study conducted on the Nez Perce National Forest in Northern Idaho, sediment yields were increased in both the small watersheds and the large watershed primarily as the result of road construction (King, 1995). Furthermore, attributes of roads significantly increase the potential for failure or sediment addition to streams; road segment length and slope (Luce 1999), frequency of cross-drainage (Haupt 1959), soil texture (Luce 1999), and gravel or vegetation in the ditchline (Megahan 1991). In Lightning Creek, road and road/clearcut impacted slides comprise 58% of the slides and 75.5% of the total slide volume. Of road and road/clearcut impact-related slides, 75% of the slides originated on the fillslope or below the road, producing 88% of the road and road/clearcut slide volume (Cacek 1989). Road and road/clearcut impacts clearly have elevated channel scour and bedload transport in the watershed to levels at or above the natural range of variability, and this is most apparent after 1974. For example, the #340 road was constructed to Mud Creek in 1974. Aerial photos prior to this date show a well-vegetated watershed with good riparian canopy coverage. Photos from 1975 show road construction to Mud Creek. The stream course is functioning within a range of natural variability. The 1983 photos display the watershed after the 1980 flood event and show 3 mass failures, which initiated below the road with visible coarse sediment addition to Mud Creek. The channel is visibly widened below the mass failure sites and the alluvial fan near the confluence with Lightning Creek is totally disturbed where it was previously vegetated with large cedar and hemlock.

Roads result in vegetation removal and groundwater interception. Logging poses similar changes to slope processes and hydrology. The loss of vegetation can increase the amount of sediment delivered to streams since the forest canopy protects the ground from direct rain splash and ground disturbance exposes bare

soil. As stumps decompose after harvest sensitive slopes are more prone to mass failure. The upper transport reaches of Lightning Creek have a relatively low sediment storage capacity and most bedload is transported to lower reaches. Therefore, lower Lightning Creek has responded to increased bedload delivery. By removing the vegetative cover logging increases exposed areas, which accumulate more snowpack which is then prone to more rapid snowmelt in the spring. This can increase the sensitivity of a watershed to climatic events such that storms have impacts disproportionate to their size (Madej 1995; Nolan and Marron 1995). Overall, Cacek's (1989) work indicates that the frequency of mass failures increased during the period of active logging in Lightning Creek and represents a major component to slope destabilization and excess sediment supply to the creeks.

Referencing the flood event of 1980, an engineering damage report states, timber harvest and road construction have undoubtedly contributed to these types of events, however, damage during this flood occurred in both areas with activities and areas with absolutely no activity (USFS Forest Service unpublished report, 1981). The West Fork of Blue Creek, a neighboring watershed to the south, is a good example of a fairly pristine drainage that received significant channel changes from the November 2006 flood (figure 3).

Figure 3. (Left) West Fork Blue Creek in 2005; (right) West Fork Blue Creek in 2007

In the summer of 2007 River Design Group (RDG) performed a watershed assessment in the Lightning Creek drainage that concluded the scale of erosion, sediment loading, and channel instability are natural processes that will likely require decades to sort out (RDG, 2008). This demonstrates that management activities in areas with inherent instability, especially road construction and logging, are very difficult endeavors. Even well-planned management in these sensitive drainages is prone to a high degree of risk for failure.

Currently, numerous sections of open system road are damaged due to the November 2006 flood. Some damaged sites are recurring problems, #642 Porcupine Bridge, lower sections of #473 Rattle Creek Road, and 5 mile on Lower #419 Lightning Creek Road, while others are new washouts, #419 Fall Creek culvert, upper #1184 East Fork Road, and upper #473 Button Creek culvert.

Floods

Lightning Creek has a long history of flooding. The earliest documented event occurred in 1894, long before resource management had entered the drainage. The city of Clark Fork, near the mouth of Lightning Creek, documented damaging floods in the following years of 1913, 1918, 1921, 1922, 1932, and 1933. In response to the 1922 flood, the city of Clark Fork constructed a levy on the east side of

Lightning Creek to protect the town. Flood activity is not well documented for the next couple of decades but 1948, 1964, and 1969 appear as years of high flow (PWA 2004). From 1969 to the present floods were documented with more regularity. The following is a summary of recorded flood events and damage to infrastructure from 1974 to the present.

- **1974** – Major flood. #419 road washout at milepost 5; East Fork bridge abutment washed out; surface erosion; alluvium over road; blown culverts. Significant cost.
- **1980** – Major flood. East Fork bridge lost; Porcupine bridge lost; major road failure on Lightning Creek road; surface erosion; alluvium over road; plugged/blown culverts; mass failures. Cost, approximately $1,800,000.
- **1986** - Flood. East Fork gabion crossing destroyed; west approach to Porcupine bridge partly washed out; surface erosion; alluvium over road; plugged/blown culverts. Cost, approximately $100,000.
- **1990-1991** – Major flood. #419 road destroyed at milepost 5; approaches to the Porcupine bridge washed away; major failures on Porcupine road; mass failure at East Fork crossing; surface erosion; alluvium over road; plugged/blown culverts. Cost, approximately $350,000.
- **1996** – Flood. 1,800 feet of the Rattle Creek road severely eroded; surface erosion; alluvium over the road; pluggbed/washed out culverts. Cost, approximately $70,000.
- **2003-2004** – Flood. East Fork crossing destroyed months after repair.
- **2006** – Major flood. The largest recorded flood stage in period of record. Numerous road washouts; Porcupine, Rattle, and Char Creek bridges damage; alluvium over road; severe road erosion; extensive riparian damage. Cost, approximately $2,500,000.

  (Information taken from PWA 2004 and Cacek 1989.)

If the 17 flood events are averaged for the period of record it results in an average recurrence of once every 6.7 years. Since 1974, the flood frequency increases with an average recurrence of once every 4.8 years. Lightning Creek has been, and will continue to be, a drainage with a very active flood cycle. This will occur with a fairly regular pattern on a decadal cycle and with a more random pattern when observed on a yearly basis. The hydrograph for the 1995/96 water-year gives an example of a very active flooding cycle within the course of one year (Figure. 4).

The channel characteristics of Lightning Creek have been profoundly shaped by frequent large floods. Evidence of past flood events is visible in the adjacent floodplain; vegetated overflow channels, coarse deposits of cobbles and boulders, and scour damage on trees. The hydraulic interaction between the floodplain and main channel is an integral function to maintain the channels capacity to handle the volume of water and transport sediment and bedload. The proper hydraulic function of Lightning Creek is dependant on this interaction. Roads and logging can interfere with this vital function by; removing trees from the floodplain, thereby reducing the streams ability to slow the velocity of water and store sediment, and by encroachment and limiting the ability of the stream to reach the floodplain to dissipate discharge and energy.

Infrastructure and resource management in the Lightning Creek watershed has had various levels of impact on the function of the hydrologic system. For instance, the Porcupine Bridge over Lightning Creek washed out, once completely, and twice partially lost fill to the bridge approach and abutments. Review of aerial photos taken before bridge construction show a well-vegetated stream meander with a dynamic yet well-established meander pattern beginning just upstream from the Porcupine-Lightning Creek confluence. In the early 1950s the bridge was constructed over a newly formed channel on the west side of the valley. The original meander channel on the east side was completely filled to form the approach to the bridge. The site was extensively disturbed during construction as is shown in 1958 aerial

photos. Aerial photos from 1963, 1965, 1968, and 1975 show a steady recolonization of plants, willow, dogwood, and cottonwood, in the disturbed areas of the floodplain immediately surrounding the bridge site.

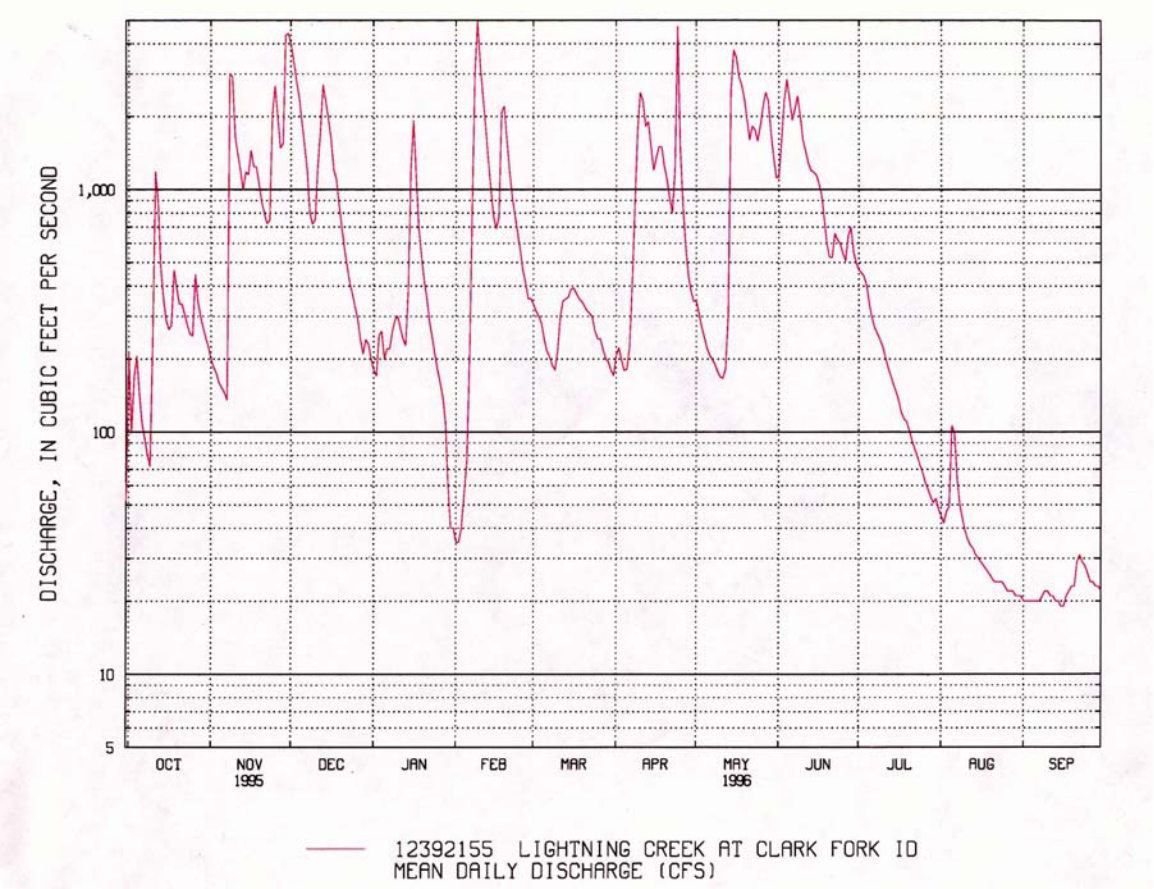

Figure 4. 1995/96 Lightning Creek hydrograph

The 1983 aerials show extensive damage to the bridge site after the 1980 flood. Most of the fill in the east side channel is gone. Other photos show the Porcupine Bridge completely washed out. The channel upstream of the bridge shows large-scale aggradation indicating flood flow velocities were markedly reduced by the Porcupine Bridge. Fill material around the bridge site acted as a partial dam during the flood event. This caused the aggradation of bedload, and influenced the channel to shift and widen considerably. Following bridge and fill failure, the channel downstream widened and resulted in significant bank scour and braiding.

During high runoff events, channel alterations also result from indirect influences such as stacked roads and canopy removal. Logging activity on a steep northeast aspect in Savage creek influenced an increase in runoff and sediment transport from steep colluvial draws. Increased deposition in Savage Creek is visible in 1983 aerial photos after clearcut logging. The deposition is most pronounced at the base of the draws but the main channel appears to be widened for a considerable distance downstream. In comparison, aerial photos from 1935 show a well-vegetated hillside dissected by three steep colluvial draws. Savage Creek is covered by a mostly unbroken canopy of trees and the channel is mostly obscured from view. These changes in Savage Creek illustrate past impacts that have put certain reaches of streams in a declining trend and have increased the vulnerability of downstream reaches to future perturbations in the system.

Effects from the 2006 Flood Event

In November of 2006, a flood event occurred of such large scale that many stream reaches were significantly altered from previously recorded conditions. In that event, a state record for precipitation occurred with 9.4 inches of rainfall recorded at the Bear Mountain snotel site in a 24-hour period. The previous record was 7.17 inches. In three days 14.2 inches of rain fell on a snow pack that contained 2.9 inches of water, completely melting the snow. One recorded estimate of peak flow by the United States Geological survey was as high as 18,700 cubic feet per second, breaking the previous recorded record of 6220 cubic feet per second set in 2003 (gauge was installed in lower Lightning Creek in 1988).

Observed impacts to transport reaches were; aggradation/degradation of coarse bedload in channel, streambank erosion, floodplain erosion and headcutting, recruitment of large riparian vegetation, and heavy sediment and debris addition from mass failure sites. Surveys of the Rattle Creek drainage, the upper extent to heavy flood damage, revealed severe alterations to the channel and floodplain (Figure 5).

Figure 5. Rattle Creek spring 2007

Stream reaches in lower Rattle Creek that had formerly been single-thread channels were converted to multiple channel sections from aggrading bedload. Vegetated areas of floodplain were now gravel bars. Thermal protection from adjacent forest cover was seriously reduced which will have the effect of increasing water temperature for the near future. Lower Rattle Creek reaches 1 and 2 were defined as “At Risk” in the 2004 PWA survey and likely still are, but it will require further monitoring to determine the ramifications of the flood on fish habitat and channel function. The upper reaches of Rattle Creek were less impacted by the flood and are possibly still stable reaches with an improving trend. In the mainstem of Lightning Creek, below the confluence with Rattle Creek, channel impacts were acute with many of the same changes that occurred in Rattle Creek but on a larger scale. Multiple channels formed causing extensive erosion in the floodplain. This caused the active channel to widen and several road sections of the Lightning Creek #419, #473, and East Fork #1184 were damaged as a result (Figure 6). Dry stretches of stream during summer low flows will be common due to shifting channels and accumulating bedload.

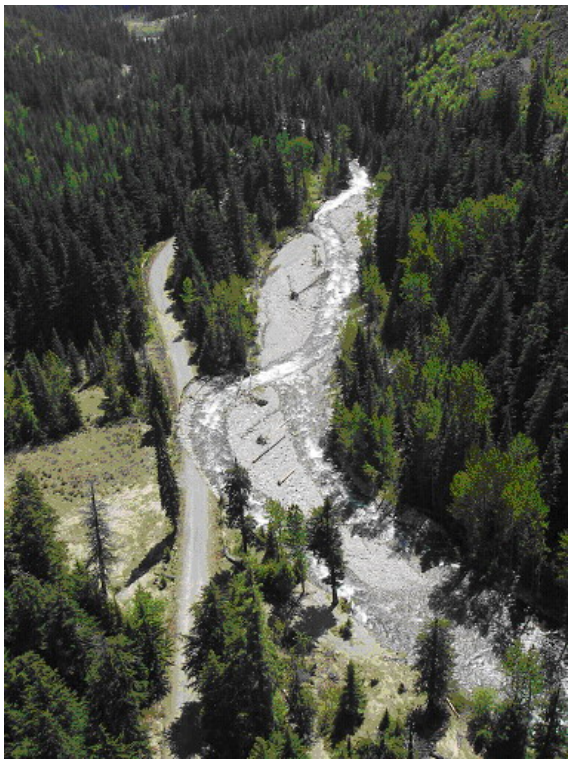

Figure 6. Lightning Creek and road #419 damage

Changes from the November 2006 flood were pronounced in the East Fork watershed as well. Reproduction of a 2001 stream survey in the summer of 2007 revealed the extent of some of the changes. Upper as well as lower portions of the watershed were severely impacted. The East Fork of Lightning Creek experienced a historic flood event that will continue to change the dynamics of the stream for some time to come. Stream banks along the East Fork are very unstable, with loose boulders and gravel providing most of the bank material (USFS Forest Service unpublilshed report 2007). Several sections of road 1184 along the East Fork were washed out. A beneficial effect of the 2006 flood was the introduction of a large amount of woody debris to the East Fork channel (Figure 7).

Wood in the stream channel, as was discussed earlier, is a necessary component for channel stability. Lack of wood in stream channels prior to the flood was commonly recognized as being a limiting factor to proper channel function and fish habitat. Scattered large woody debris in channels reduces the rate of sediment movement downstream, routing sediment through the ecosystem slowly, except in cases of catastrophic flushing events or when the storage capacity is filled (Naiman, 1992). Stream reaches where large wood has increased would benefit from improved sediment retention processes and enhanced fish habitat. Perhaps the single most important function of large woody debris in forming salmonid habitat is the creation of rearing pools (Bisson and Sedell, 1992). The 2006 flood deposited large amounts of beneficial wood into the system as seen in figure 8, but lost critical canopy cover in places. However, wood in the system will contribute to bank stability, cover for fish, scour for pool formation, and trap sediment (USFS Forest Service unpublished report 2007). As channel stability improves, riparian vegetation will regenerate, and over time canopy cover will be recovered.

Figure 7. Large woody debris in East Fork Lightning

While the recruitment of wood is considered to have been a benefit to streams in much of the mid to lower Lightning Creek watershed, in summer of 2008, almost 100% of the large woody debris was removed from lower Lightning Creek above the Clark Fork Bridge for approximately 3.5 stream miles to the National Forest boundary. The large woody debris (LWD) was machine piled and burned on gravel bars within the floodplain. Anecdotal information from outfitters in the area reported excellent fishing conditions in lower Lightning Creek prior to wood removal. Conditions deteriorated drastically following the removal of wood.

Figure 8. Wood removal project in Lower Lightning Creek

The short-term trend of effects from the 2006 flood in the Lightning Creek watershed is expected to be continued stochastic changes to the channel and floodplain as Lightning Creek adjusts to the inputs of sediment and woody debris. Road sections adjacent to the channel or encroaching on the floodplain may be vulnerable to damage in future high flow events. Aggradations of coarse bedload from mass inputs, i.e. from mass failures, would likely influence channel changes and potentially create intermittent reaches of stream.

The long-term trend of effects from the 2006 flood in Lightning Creek depends on future management activities in the watershed. As discussed in more detail later, the mitigation of certain problem areas would likely promote a gradual stabilizing of channel features as coarse sediment pulses are reworked and moved through the system. Large woody debris would help to retain more coarse and fine sediment and define the stream channel to a more regular pattern and profile. During this time, floodplains would form, or be replenished, and riparian vegetation communities would become better established. Fish habitat would improve especially in areas where large wood is abundant. Without some restoration efforts, recovery may be episodic or delayed. In any case, floods will continue to occur as a regular process in the Lightning Creek watershed but the potential for negative impacts to the watershed should decrease more rapidly with corrective mitigation.

Due to several major factors, such as the amount of bedload movement, the amount of fine sediment delivered, the magnitude of the peak hydrograph, and the timeframe of occurrence, the majority, if not all, of bull trout redds in the Lightning Creek watershed were likely destroyed or entombed during the 2006 flood event. Additionally, fish habitat was severely altered as a result of the flooding.

Water Quality

Sediment and temperature are identified as the pollutants limiting beneficial uses of streams in the Lightning Creek watershed. Sediment interfering with beneficial uses in this system is related to large bed load material (IDEQ, 2007). Some of the reasons for the large amounts of bedload in this system as it relates to geology were discussed earlier. Other contributing factors are linked to the anthropogenic factors of timber harvest (PWA, 2004; IDEQ, 2007). Modeling for this assessment by the IDEQ assigned sediment coefficients to various land use types that were multiplied by the number of acres identified in a certain land use category. The results were then compared to a pre settlement scenario where the watershed was assumed to be completely forested, and was assigned a background sediment coefficient. The sediment load capacity that was set for Lightning Creek and other subwatershed within the Lower Clark Fork subbasin is 54% above background. Evidence suggests that a target of 54% above background levels is protective of beneficial uses and is consistent with load capacities in other Idaho Panhandle TMDLs (IDEQ, 2007).In the *Lower Clark Fork Subbasin Assessment and Total Maximum Daily Load* (IDEQ, 2007), all streams other than Morris Creek were assigned load reductions in order to pull sediment levels to within the 54% above background outlined in the TMDL (IDEQ 2007).

Water temperature in Lightning Creek is largely affected by, and can vary with, changes in elevation, aspect, climate, weather, riparian vegetation, groundwater inputs, and channel morphology (DEQ, 2007). The Forest Service has monitored water temperatures in the watershed since 2001 and almost all years of monitoring show exceedence values for cold water aquatic biota and salmonid spawning. Since it is not known what natural temperature levels are in the watershed IDEQ adopted a method known as potential natural vegetation (PNV) to assess target levels for temperature in Lightning Creek. According to Idaho Water Quality Standards, if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered to be a violation of water quality standards (DEQ, 2007). In other words, if stream temperatures exceed a set level for cold water biota, but riparian and channel conditions are unchanged from a natural state, then the existing conditions become the standard. Many upper watershed reaches in Lightning Creek exhibit elevated temperatures but still possess the natural vegetation and

stream channel qualities, (Morris, Upper Lightning, and Savage Creeks), and therefore comply with temperature standards. However, many stream reaches have experienced a loss of riparian vegetation and a widening of the stream channel, which influences temperature increases in these reaches and downstream (IDEQ Table 6).

Table 6. Excess Solar Load and Percent Reduction to Achieve Loading Capacity for Lightning Creek and Associated Tributaries (from IDEQ Lower Clark Fork Subbasin and TMDL report, July 2007)

Stream Name	Assessment Unit	Excess Load (kWh/day)	Percent Load Reduction Required
Mainstem Lightning Creek	ID17010213PN010_04 ID17010213PN011_04 ID17010213PN013_04 ID17010213PN016_03 ID17010213PN017_03 ID17010213PN019_03 ID17010213PN019_02	4,802,544	64%
Lunch Creek	ID17010213PN019_02	7,158	73%
Quartz Creek		5,352	27%
Moose Creek		12,140	52%
Gem Creek		5,830	66%
Gordon Creek		8,221	59%
Deer Creek		3,633	40%
Fall Creek		13,719	53%
Sheep Creek	ID17010213PN017_02		
Bear Creek			
Rattle Creek	ID17010213PN018_02	86,076	57%
Steep Creek	ID17010213PN016_02	30,101	61%
Jost Creek			
Mud Creek			
Silvertip Creek			
Trapper Creek			
Unnamed between Mud and Trapper Creeks			
Wellington Creek	ID17010213PN020_02	30,465	44%
Porcupine Creek	ID17010213PN016_02	36,545	58%
East Fork Creek	ID17010213PN014_02 ID17010213PN014_03	198,640	61%
Savage Creek	ID17010213PN015_02		
Morris Creek	ID17010213PN013_02	32,734	67%
Regal Creek		6,064	58%
Unnamed between East Fork And Morris Creeks		22,828	79%
Cascade Creek	ID17010213PN012_02	37,981	67%
Spring Creek*	ID17010213PN021_02	57,736	56%

* This Assessment Unit is not identified as impaired by temperature on the 2002 Integrated Report. The shade analysis was completed for advisory purposes only.

Fisheries

Fish species that may be affected by the project (bull trout and westslope cutthroat trout) are also distributed across the Forest. For example, bull trout trout are found in eight of 13 (61%) of 4th code HUC watersheds (i.e., large watersheds, such as Pend Oreille Lake) on the IPNF. Cutthroat trout currently occur in 100% of 4th code watersheds on the Forest. There is no connectivity between the Lower Clark Fork River Basin watershed, which includes Lightning Creek, and nine of the other 4th code HUC watersheds on the Forest (e.g., Kootenai River, St. Joe River).

At the smaller watershed scale (e.g., Wellington Creek, a 6th code HUC watershed), bull trout are known to inhabit approximately 80% of the watersheds in the Pend Oreille Lake, while westslope cutthroat trout occur in approximately 100%.

Threatened and Endangered Species

Bull Trout

Bull trout are listed as "threatened" by the U.S. Fish and Wildlife Service (USFWS) with respect to section 7(c) of the 1973 Endangered Species Act (ESA) (April 9, 2008 letter, FWS 1-9-08-SP-0067). Lightning Creek is an important spawning and rearing drainage for both bull and westslope cutthroat trout. Bull trout are known to spawn in the mainstem of Lightning Creek as well as seven of its tributaries, including Morris, Savage, Char, Porcupine, Wellington, and Rattle Creeks (Pratt 1985, IDFG 2000), although a significant percentage of bull trout spawning occurs in East Fork Creek. It is also used by rainbow, brown, and brook trout, as well as kokanee and mountain whitefish.
Excess bedload, changed runoff patterns, and lack of large woody debris, contributing to unstable stream channels, are believed to be the most limiting factors to bull trout production in the Lightning Creek complex, followed by poaching and exotics. As recently as 1983 the basin supported more bull trout spawning activity than any other tributary system in the Pend Oreille key watershed, exceeding even Trestle Creek. Historic redd count information, provided by Idaho Fish and Game from 1983-2008, shows a declining trend of redd counts conducted in Lightning Creek and its tributaries (Table 7).

Habitat Requirements - Bull trout appear to have more specific habitat requirements than other salmonids (Rieman and McIntyre 1993). Habitat characteristics including: water temperature, stream size, substrate composition, cover and hydraulic complexity have been associated with distribution and abundance (Dambacher et al., in press; Jakober 1995; Rieman and McIntyre 1993).

Stream channel equilibrium (stability) is the balance between sediment yield, water yield, and channel morphology that exists within a stream system. Studies indicate that shifts away from channel equilibrium can result in negative changes in the structure and function of stream ecosystems (Bilby and Likens 1980, Schlosser 1982) and their dependent fish populations. Bisson and Sedell (1982) reported that where stream channels became destabilized, riffles elongated and in many cases extended through former pool locations resulting in loss of pool volume. They suggested that declines in older fish might be the result of their dependency upon deeper water habitats. Maintaining lateral and instream habitat complexity, in association with channel stability, can best provide persistence of bull trout over time (Karr and Freemark 1983, Karr and Dudley 1981, Gorman and Karr 1978).

Table 7. Bull trout redd counts for Lightning Creek and tributaries

YEAR	Lightning Cr.	East Fork	Savage Cr.	Char Cr.	Porcupine Cr.	Wellington Cr.	Rattle Cr.
1983	28	110	36	18	37	21	51
1984	9	24	12	9	52	18	32
1985	46	132	29	11	32	15	21
1986	14	8	--	0	1	7	10
1987	4	59	0	2	9	2	35
1988	--	79	--	--	--	--	--
1989	--	100	--	--	--	--	--
1990	--	29	--	--	--	--	--
1991	--	--	--	--	--	--	--
1992	11	32	1	9	4	9	10
1993	2	27	6	37	6	4	8
1994	5	28	6	13	1	9	0
1995	0	3	0	2	2	1	1
1996	6	49	0	14	0	5	10
1997	0	22	0	1	0	2	2
1998	3	64	0	16	0	1	15
1999	16	44	4	17	4	22	13
2000	4	54	2	11	4	8	12
2001	7	36	4	2	0	7	67
2002	8	58	15	8	0	7	33
2003	8	38	7	7	5	8	37
2004	9	77	15	14	10	7	34
2005	22	50	7	15	14	6	34
2006	9	51	25	20	8	29	21
2007	3	34	0	1	8	9	2
2008	10	38	8	5	8	10	24
AVG (83-07)	10	50	8	11	9	9	21

Stream temperature (below 15 degrees Celsius; Goetz 1989) and substrate composition are important characteristics of suitable bull trout habitats. Bull trout have repeatedly been associated with the coldest stream reaches within basins. The lower limits of many strong bull trout distributions mapped by Lee et al. (1997) correspond to a mean annual air temperature of about 4 degrees Centigrade (ranging from 3 to 6 degrees Centigrade) and should equate to ground water temperatures of about 5 to 10 degrees Centigrade (Meisner 1990). Water temperature can be strongly influenced by land management (Henjum et al. 1994).

Vegetation can strongly influence the habitat conditions of bull trout streams. Canopy cover adjacent to streams provides shade and helps to maintain cooler water temperatures during the summer months. During the winter, conifers can also reduce the risk of freezing and the formation of anchor ice by providing insulation (PBTTAT 1998). Large trees that fall into the stream channel can benefit habitat conditions by creating pools, providing cover and shade, introducing nutrients, contributing to channel stability and dissipating stream energy (Murphy and Meehan 1991).

Bull trout are fall spawners and their preferred spawning habitat generally consists of lower gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989). However, if the substrate and habitat attributes are suitable, spawning can occur in steeper reaches.

Risks to Bull Trout Populations and Habitat - Bull trout are vulnerable to human-induced factors that increase water temperature and sediment loads, change flow regimes, block migration routes, and establish non-native trout, particularly brook trout (Behnke and Tomelleri 2002).

As part of the Bull Trout Problem Assessment for the Lake Pend Oreille Key Watershed, threats and limiting factors to bull trout were assessed and prioritized by watersheds (PBTTAT 1998). Within the cumulative effects analysis area, only Lightning Creek is known to support bull trout. While the assessment concentrated on bull trout, the threats and limiting factors apply, to varying degrees, to all aquatic species and habitat in the Lightning Creek watershed.

According to the assessment, “Excess bedload, loss of large woody debris and altered water delivery and flow patterns have resulted in unstable channels and are believed to be the major limiting factors to bull trout production in the main stem of Lightning Creek” (PBTTAT 1998). Although the natural morphology and geology of Lightning Creek plays a role in the fluctuating conditions of bull trout habitat in Lightning Creek, road construction and timber harvest, particularly in the upper portions of Lightning Creek watershed have added to the instability of the stream.

In a recently completed Lightning Creek Watershed Assessment (PWA 2004), it was concluded that the Lightning Creek watershed is naturally unstable and has been impacted by natural processes including fires and floods, as well as human management, most notably in the form of roads and logging. In their assessment, decreased channel stability, increases in areas with intermittent water flow, increased levels of fine sediments in spawning areas, elevated stream temperatures, and the interaction between habitat alteration and the presence of non-native fish species, affect the abundance and population stability of bull trout in the Lightning Creek watershed.

Other factors posing a threat to bull trout in the Lightning Creek watershed are illegal harvest (an unquantified amount of bull trout poaching), exotic species (predation, reproductive advantages, competitive exclusion) and urbanization (channel constrictions at crossings, diking to prevent flooding). (PBTTAT 1998).

Designated Critical Habitat - On the Sandpoint Ranger District, National Forest System Lands were excluded from being Designated Critical Habitat for bull trout. However, the lower reaches of Lightning Creek are on private land and are therefore designated as bull trout critical habitat.

Sensitive Species

Westslope Cutthroat Trout

Westslope cutthroat trout are listed as "sensitive" by Region 1 of the USDA Forest Service and are listed as a "species of special concern" by the State of Idaho. However, in 2000 the U.S. Fish and Wildlife Service (USFWS) determined that westslope cutthroat trout did not warrant listing as a threatened species (USDI 2000). In 2003, the U.S. Fish and Wildlife service reconsidered the listing of westslope cutthroat trout and again determined that their listing was not warranted (USDI 2003).

Westslope cutthroat trout have been documented in Lightning Creek and ten of its tributaries, including Cascade, Char, East Fork, Porcupine, Quartz, Rattle, Savage, Smorgasboard, Thunder, and Wellington Creeks. A population status review of westslope cutthroat trout in Idaho has determined that populations in northern Idaho have declined (Shepard et al 2002). However, they currently occupy over 18,000

stream miles in Idaho, which is approximately 95 percent of their historical distribution (Shepard et al. 2002). Reiman and Apperson (1989) also concluded that populations of westslope cutthroat trout in northern Idaho have declined, but they estimated that there were viable populations existing in only approximately 36 percent of their historical Idaho range. Shepard et al (2002) concluded that the discrepancy between the two assessments is likely due to differences in the mapping scales used, the response of some westslope cutthroat trout populations to protective measures, the inclusion of new information and earlier assessments were made during drought conditions without the benefit of long term data.

Habitat Requirements - The preferred habitat of westslope cutthroat trout is cold, clear streams with rocky, silt-free riffles for spawning and slow, deep pools for feeding, resting, and over-wintering (Reel et al. 1989). Pools are a particularly important habitat component as cutthroat trout occupy pool habitat more than 70 percent of the time (Mesa 1991). Other key features of westslope cutthroat trout habitat are large woody debris (LWD) for persistent cover and habitat diversity, as well as small headwater streams for spawning and early rearing.

Resident life history strategies of westslope cutthroat trout are currently present in watersheds within the project area. Resident populations remain in river tributaries throughout their life. Certain life histories (e.g. fluvial and adfluvial fish) use river tributaries for early rearing and spring spawning as adults, but typically migrate to river or lake habitat as they mature. In the fall, fish that have not previously returned to river and lake areas migrate to deeper water where they congregate and over-winter (Bjornn 1975). Westslope cutthroat trout exhibiting the fluvial and adfluvial life strategies are present within the Lightning Creek Watershed.

Risks to Westslope Cutthroat Populations and Habitat - The primary cause of the decline in westslope cutthroat was found to be habitat loss and degradation (Rieman and Apperson 1989). Competition, predation by non-native species, genetic introgression and overfishing has also contributed to the decline of westslope cutthroat trout populations (McIntyre and Rieman 1995).

Westslope cutthroat trout have been negatively affected by the presence of introduced rainbow trout and eastern brook trout. Rainbow trout have been stocked extensively into Lightning Creek and some of its tributaries by the Idaho Department of Fish and Game and eastern brook trout are present in the project area (project file – Fisheries).

Lightning Creek Fisheries Habitat

Natural events and processes (e.g., wildfires, floods), as well as human activities (e.g., logging, road building), have influenced the environmental conditions within the cumulative effects analysis area. Effects of natural disturbances have interacted with other land changing processes to form the basic character of watersheds and the dependent stream resources. Due to the variability in location, frequency, and intensity of the effects of natural processes on the physical environment, dynamic landscapes with diverse conditions are formed at various spatial scales. Biological communities including native fish populations led to the development of functional ecosystems that are inherently resilient to effects from natural disturbance regimes representing pulse-type disturbances, such as periodic fire (Reeves et al. 1995). Pulse disturbances influence the natural range of environmental conditions that are expected for ecosystems functioning at broad geographic scales, but typically allow systems to begin recovering to pre-disturbance conditions relatively soon after the disturbance.

Natural disturbance regimes (e.g., flood, wildfire, etc) and their associated properties (e.g. sedimentation rates and other influences on aquatic habitat) have been altered in the cumulative effects area by human activity. Land use activities that have modified natural disturbance characteristics include, but are not

limited to roads, logging, fire suppression and stream modifications (constriction, diversions, culverts, etc.). Many of these human influences are considered press-type disturbances that continue to affect the condition and trend of fisheries resources long after the initial disturbance. Press disturbance differs from pulse disturbance in several aspects, but generally press disturbance is persistent in ecosystems and impairs the ability for ecosystems to recover to pre-disturbance conditions (Reeves et al. 1995). Within the cumulative effects area, the recovery process from pulse disturbances has been hindered to some degree by the presence of various press disturbances, such as chronic sediment delivery from roads immediately adjacent to streams in the Lightning Creek watershed.

Generally, water temperatures throughout the Lightning Creek watershed are below the 13° Celsius bull trout requirement for rearing, although some exceedences have been documented during summer months. Elevated levels of fine sediment delivery from riparian roads and mass failures has degraded pool quality and increased embeddedness values, however, the high frequency of LWD has helped to control its movement through the system. The flood of 2006 deposited high amounts of LWD throughout the system, therefore creating backwaters, pools, and overhead cover. Connectivity throughout the watershed is good, with the exception of the lower Lightning Creek dewatering during low flows late in the season. Nearly every major sub watershed in the Lightning Creek drainage has been impacted to some degree by road building adjacent to the stream. In general, the habitat requirements for both bull and westslope cutthroat trout are met for a significant portion of the year, as evidenced by their continued occupancy and use (i.e. spawning and rearing) of the Lightning Creek system and its tributaries.

The cumulative effects analysis area for this project has primarily been affected by fires and flooding (natural disturbances), as well as logging and road construction (human activity). The disturbance history has played a large role in determining habitat conditions in fish-bearing streams.

Environmental Consequences

This section provides information regarding the potential consequences on watershed condition, water quality, aquatic habitat, and those fish species identified in the preceding section that may be affected by the alternatives. All direct, indirect and cumulative effects are disclosed. Effects will be discussed in quantitative and/or qualitative terms as appropriate.

Past activities contribute to the baseline conditions and provide a foundation for the analysis (e.g. previous timber harvesting, road building, and fire suppression actions since the early 1900s). The way in which past activities (such as timber harvest) and natural processes (such as vegetation succession and floods) have contributed to baseline watershed conditions and stream habitat are described in the Affected Environment. A list of the past, ongoing and reasonably foreseeable activities that could contribute to the cumulative effects are identified in the beginning of Chapter 3 of the EA.

Alternative 1 – No Action

Direct and Indirect Effects

Under the No Action Alternative, watershed and fisheries resources in the Lightning Creek watershed would remain in a state where roads would continue to pose a chronic anthropogenic source of risk to watershed conditions (see tables 8 to 10), and sediment (see table 11) that affect aquatic ecosystems and water quality in the basin. Roads that traverse steep hillsides on moderate to high mass failure potential land-types would continue to be at risk of mass failure. Roads in riparian areas would continue to be susceptible to damage during flood events. Since the damage that occurred during 2006 flood event, sediment delivery is elevated (see table 11) in the Lightning Creek watershed. As Lightning Creek, Rattle Creek, and East Fork Creek roads continue to erode, sediment rates would continue to exceed those of

pre-flood conditions in areas where creeks are now directly adjacent to damaged and over-steepened road fills.

The effects to stream temperature from no active management would be somewhat variable. In places where riparian vegetation was lost, the channel has aggraded, and/or has become braided, increased direct solar radiation may increase stream temperatures. However, where large woody debris is contributing to channel stabilization and deeper pools, providing cover to the stream channel, or the channel has decreased its width to depth ratio by incising itself into aggraded alluvium, direct solar radiation may decrease and help to lower temperatures. These effects are likely to offset one another to some degree.

The No Action Alternative would not directly affect fisheries habitat in the project area, since no changes would occur under this alternative. However, the continued effect to the watershed from the erosion of stream crossings and road segments that were washed out during the flood would likely continue to increase embeddedness values and fine sediment levels. Salmonid production was found to be inversely proportional to cobble embeddedness and fines in spawning gravel (Stowell et al. 1983, Bjornn and Rieser 1991, Everest et al. 1987). Excessive sediment interferes with water flowing through spawning gravels and reduces the transport of oxygen to incubating eggs (Chapman 1988), which in turn lowers egg and fry survival (Stowell et al. 1983, Burton et al. 1990). Fine sediments in cobble substrate fill interstitial spaces and reduce summer and winter rearing habitat for salmonids, as well as impacting macroinvertebrate abundance and diversity, an important food source for salmonids, particularly juveniles (Bjornn et al. 1977, Chapman and McCleod 1987). Sediment can also reduce the volume of pools, further degrading summer and winter rearing habitats for salmonids.

Cumulative Effects

The cumulative effects of no action in the Lightning Creek watershed would be variable. With respect to water quality parameters of sediment and temperature, and progress toward attainment of the TMDL, maintaining roads in their current condition would not improve resource conditions. Some potential foreseeable activities that would help to improve conditions would be the replacement of three culverts that present a fish barrier as well as chronic source of sediment to tributaries of Lightning Creek. While removal of these barriers would open up several miles of habitat for native fish, these replacements would not contribute significantly to the overall reduction of sediment needed to attain resource objectives with water quality in the drainage. There would be no effect to temperature.

One of the mitigating factors for increased sediment generation from damaged road sections from the 2006 flood event was the addition of large amounts of wood to the stream. Individual pieces and aggregates of large wood in the stream and on floodplains serve to benefit aquatic habitat, stream morphology, and stream stability, as well as to catch and retain sediment and bedload. On the 3.5 miles of stream below National Forest Land, wood was removed from the channel and floodplain during the spring of 2008 (as previously discussed). This activity also removed the benefits that wood provided lower Lightning Creek. With additional sediment being generated from damaged road segments and an absence of wood in lower Lightning Creek, the cumulative effect of a no-action alternative may be most pronounced in the lower reaches with a deterioration of aquatic habitat and channel instability. This could lead to the exacerbation of subsurface flows through heavy cobble bedload in lower reaches, which would therefore cause a loss of connectivity in Lightning Creek for migrating bull trout and westslope cutthroat trout.

Table 8. Road densities in the Lightning Creek Watershed

Pre and Post Flood condition Alternative 1	Alternative 3	Alternative 4a	Alternative 4b
1.27	0.80	0.68	0.66

Road density includes all open and closed roads

Table 9. Road densities within riparian areas of the Lightning Creek Watershed

Pre and Post Flood Condition Alternative 1	Alternative 3	Alternative 4a	Alternative 4b
2.09	1.5	1.23	1.29

Road density includes all open and closed roads

Table 10. Road densities within moderate to high mass failure potential landtypes

Pre and Post Flood Condition Alternative 1	Alternative 3	Alternative 4a	Alternative 4b
1.00	0.39	0.28	0.28

Road density includes all open and closed roads

Table 11. Sediment from Forest Service roads in the lightning creek watershed

Pre Flood Condition	Alternative 1	Alternative 3	Alternative 4*
941 tons/year	1,235 tons/year	150 tons/year	112 tons/year

*Sediment yield differences between Alternatives 4a and 4b are negligible and therefore not differentiated.

Direct and Indirect Effects to Action Alternatives

The effects to watershed and fisheries resources from activities in Alternatives 3, 4A, and 4B are all designed to benefit aquatic resources in the long term. Road rerouting, improvements, and decommissioning, along with stream bank stabilization, point bar structures, and stream crossing improvements are all designed to improve watershed conditions and aquatic habitat. Direct and indirect effects will be divided into three categories and addressed in term of road work, in-stream work, and stream crossings.

Direct and Indirect Effects Common to Alternatives 3, 4A and 4B

Road Work

One component of each of the action alternatives is the restoration of a travel route on the main Lightning Creek, road (#419). During the 2006 flood the road was affected by erosion of surfacing material, large deposits of alluvium across the road, blown culverts and damaged bridges at stream crossings, and destruction of the road prism by the lateral migration of Lightning Creek. In areas where the road was affected through the erosion of surface material, deposits of alluvium over the road, and damaged stream crossings, the travel way would be restored in place. This would also be the case for areas where relatively minor amounts of the road prism were destroyed. However, there are three areas (miles posts

5.0, 13.1, and 14.2) where road damage was so extensive that rerouting of the road is proposed as the most viable solution to decrease effects on watershed resources, and risk of future failure.

Road resurfacing is considered routine maintenance and is designed to reduce sediment production from roads. This would have a positive effect on watershed and fisheries resources. The removal of the vast majority of alluvial material on dry portions of alluvial fans over the road would have no effect on aquatic resources. The excavation of buried drainage structures and installation of their replacement will generate some sediment during the period of operation. Machinery will operate outside of the channel and best management practices (Appendix A) as well as site specific mitigation measures will help to reduce sediment inputs. This is true for other failed drainage structures as well. The long term benefits of chronic sediment reductions gained by replacing and improving buried and blown drainage structures will outweigh the short-term sediment production during construction.

At the site of the Rattle Creek Bridge crossing (milepost 14.2-14.3) a road surface will be reestablished leading to and from the bridge. Decking on the bridge will be replaced, wing walls will be replaced, and riprap and log vanes will be installed on the upstream side of the bridge to reduce the risk of bridge failure by protecting abutments and directing the energy of high flows toward the center of the center of the bridge span (project file). Work on the wing walls, riprap reinforcement and log vanes would take place during low flow periods and would largely occur outside of the active channel. Bank and floodplain material in the vicinity of the bridge consists of cobble, so no soils and vegetation disturbance would occur during construction. Some minor disturbance of stream banks would occur during this process, but would not compromise their overall competence. Any sediment generated during construction would be minor and short lived. Machinery will not operate inside the stream channel.

In areas where the road prism was affected by the lateral migration of Lightning Creek, a combination of repair and mitigation measures will be used to reestablish a travel corridor. In areas where the center line of the road can be maintained in place, or only moved slightly (within the width of the road), a combination of riprap, root wads and log vanes will be used to protect the road and bank from erosion, and divert some of the energy of high flows away from the stream bank. In order to install root wads and log vanes, the bed and banks of the stream will be excavated so that the woody material can be adequately buried to resist being dislodged and transported during high flow periods. Riprap installation would also require some excavation of the bed and bank to install below scour depths. This work would produce suspended sediment during periods of operation, but the short term production of suspended sediment would be less than what is generated through the chronic delivery of sediment from over steepened raw cut banks immediately adjacent to the stream. The use of machinery within the active channel will be held to a minimum.

As previously mentioned, there will be three sections of road that will be completely realigned. Similar treatment of the over steepened banks would occur as described above to reduce erosion and sedimentation. The reroute at milepost 5.0 would be approximately 1100 feet in length, milepost 13.1 would be approximately 450 feet in length, and milepost 14.2 would be approximately 1500 feet in length. While all of these reroute locations will remain within the riparian habitat conservation area of 300 feet from the stream, locations at mileposts 5.0 and 14.2 would be chosen to minimize the risk of future road damage by pushing road location to the toe of the valley wall, elevating the road and protecting the fill material with rip rap. The reroute location at milepost 13.1 was chosen to eliminate impact to old growth riparian vegetation. In all cases, shading of the channel would not be decreased from the existing condition with the proposed rerouting. With the associated restoration work and planting that will occur on remnant road pieces within the limits of the road rerouting, site productivity along the stream margins will greatly increase. The long-term indirect effects of vegetation growth on these sites will provide further bank stability, shade to the stream channel which will help lower water temperatures,

and provide an increased buffer of vegetation to help filter sediment potentially generated in upland areas nearby. Although road rerouting in these areas will not decrease road densities, it will help to trend water quality parameters of sediment and temperature toward the attainment of load reductions outlined in the TMDL. Estimated long term sediment generation values for rerouted sections of road were accounted for in modeling values presented in Table 11.

The road surfacing at crossings would reduce sediment delivery at these locations. There would be no direct effects expected to LWD frequency or water temperature from the road work described above. However, the road realigning would move the road farther away from the stream and likely lead to healthier riparian areas, which would eventually result in increased canopy cover, thus resulting in increased shade (lower water temperatures) and increased LWD recruitment. Ultimately, the long term benefits from road improvements discussed above would trend Lightning Creek and its tributaries toward higher quality fish habitat (i.e. reduced sediment, decrease water temperature, etc).

Road decommissioning is a component of the project that would be common to any of the action alternatives. In general, the effects of this activity include possible short-term sediment generation with long-term benefits to watershed condition, site productivity, and water quality. The details of effects are discussed under each alternative. The means by which decommissioning would take place would vary by site. In many cases, this work would be carried out using machinery to decompact and/or recontour slopes, and remove drainage structures. In some cases however, roads that would be decommissioned are for the most part situated on relatively stable land-types, and have been closed so long that they have become heavily vegetated with trees and brush. While much of the overall length of these roads have stabilized, they still contain drainage structures that produce some level of chronic sediment and present an ongoing risk of failure. Clearing vegetation, in some cases for miles, to facilitate the use of machinery for culvert removal would set back progress on site recovery and could destabilize fill material. In these cases, site-specific drainage structure removal would be accomplished using explosives and a hand-crew to recontour stream banks to their proper dimensions. Each site would be planted, seeded, and BMPs would be installed as described in Appendix A to this document to lessen the potential for sediment generation during recovery. Additional benefits to the use of blasting in site-specific situations are a shortened duration of disturbance and sediment production during removal. Turbidity levels were observed to return to baseline levels within 30 minutes on a tributary to Snow Creek where a culvert was removed by these means. Here too, the long-term benefits to watershed condition and water quality would outweigh the short-term sediment production that could potentially occur during removal.

The short-term potential for sediment generation discussed above could have localized effects to individual fish, if present, such as temporary displacement. In areas where mechanical removal of culverts is unfeasible, such as heavily brushed in roads that require extensive work to access the culvert(s), explosives may be used to remove the culvert(s) and associated road fill, as discussed above. In most instances, the sites where blasting may be used are dry or have small flows that would be easily dewatered. The majority of the road fill would be lifted and removed by the blast, however, a short term increase in turbidity could force adult bull trout, if present downstream, to temporarily relocate. Since several stages of bull trout life history are present in Lightning Creek or its tributaries throughout the year, there is the potential for some mortality of juvenile bull trout, if present in rearing habitat or gravels in the immediate vicinity, during blasting operations or dewatering. Overall, these culvert removals would result in an immediate reduction in risk of failure and sediment delivery to downstream habitat occupied by bull trout.

Instream work

Many of the channels on the east side and main stem of the Lightning Creek watershed experienced significant alterations due to the November 2006 flood event. Although channel aggradation, degradation,

and bank erosion were a component of these alterations, so was the recruitment of large volumes of coarse woody debris to the active channel and floodplain. In some areas where the channel was previously devoid of large woody debris (LWD), we have observed the channel characteristics change from high width to depth ratios with little habitat complexity to a channel containing deep pools, cover, and a diversity of spawning, rearing, and holding habitat for fish.

In areas of large aggregates or large individual scattered pieces of wood attached to root-wads on the floodplain or intersecting the stream bank, we have observed active floodplain building processes, bank stabilization, and the natural regeneration of vegetation in newly formed depositions of fine grained sediment on point bars and flood plains. This naturally recruited large wood component is a critical tool in recovery, long term stability, and a properly functioning riverine environment.

The effects of in-stream work for stream bank and point bar stabilization would have similar effects as described above in terms of improved local channel morphology and stability, as well as improved aquatic and riparian habitat complexity. Pointbar stabilization structures, engineered debris jams, and other in-stream bank stabilization structures such as root wads and keyed-in pieces of large wood, coupled with riparian planting are designed to reduce or divert stream energy in key areas within the watershed.

Direct effect of point bar structures in lower East Fork Creek would be a reduction of stream energy, the recruitment of free floating woody debris and formation of aggregates, and the creation of a depositional environment during high flows in the area of pointbars and some mid channel bars. Indirect effects of these structures would likely be an increased deposition of fine-grained sediment on the floodplain, and an improved medium for the natural recruitment and planting of riparian species. Other anticipated indirect effects are improved channel formation (i.e., decreased width to depth ratios, increased pool frequency, improved pool/riffle ratios), increased aquatic habitat complexity, and overall improved channel stability. With decreased width to depth ratios, deeper and more frequent pools, increased cover formed by LWD, in-stream temperatures will likely trend toward colder temperatures. A more complex stream channel also provides more velocity breaks which helps to slow the routing of sediment in the channel. Similar structures have been installed in the nearby Grouse Creek drainage with good results (see Aquatics project file).

Engineered debris jams would be incorporated into restoration efforts in Lightning Creek in association with the milepost 5.0 site restoration, and in lower East Fork Creek upstream from the main Lightning Creek road crossing. The direct effects of these structures would similar to those listed above. The primary purpose for engineered debris jams is to dissipate energy during high flows in key areas for bank/channel protection, and to form quality habitat with deep pools and cover for fish.

In areas of raw banks where road damage had occurred during the 2006 flood event, a combination of root wads, engineered debris jams, and log veins (see engineering plans in Aquatics project file)in combination with riparian planting would be used to reduce stream energy and the accelerated erosion on stream banks, and to improve site conditions. Direct effects of bank stabilization would be a decrease in bank erosion and in stream sedimentation. Indirect effects include increased recruitment of free floating woody debris and improved habitat complexity. All of these factors would contribute to a trend in improved water quality conditions.

The short-term potential sediment remobilization from the activities discussed above could have localized negative effects to individual fish, if present, such as temporary relocation. LWD frequency and water temperature would not be directly affected by these activities. In the long term, sediment delivery would be reduced and fish habitat would improve over time. Additionally, the long-term benefits from improving channel formative features with this project would trend Lightning Creek and its tributaries toward higher quality fish habitat (i.e. connectivity, vegetated banks).

Alternative 3

Alternative 3 would restore access to full sized motorized vehicles on the main Lightning Creek road (#419), East Fork Road (#1184), and Porcupine Road (#642; via the construction of a 3-span bridge when funding becomes available). Rattle Creek Road would be decommissioned from the junction of the 419 to Button Creek. Most secondary and closed roads throughout the drainage would be decommissioned as described under the proposed action (see Chapter 2). The Lake Darling trail (#52) would remain a motorized trail. In-stream work in lower East Fork Creek, bank stabilization at select road damage sites, and aquatic organism passage components of the project would also be carried out as described under the proposed action (see Chapter 2).

Direct and Indirect Effects

Road Work

Road Decommissioning - The direct effects of the proposed action on watershed resources through road decommissioning are a long term improvement of watershed condition through a decrease in road densities (see Tables 8-10), a decreased risk of road failure, a long term reduction of chronic sediment delivery to streams (see Table 11), and a contribution to decreased peak flows.

In Alternative 3, road densities for the watershed would decrease 37% from 1.27 miles/square mile to 0.80 miles/sq. mile. Decreased road densities would greatly improve watershed condition by decreasing the primary mechanism by which sediment is routed to streams (Megahan and Kidd 1972, Anderson and Potts 1987, Megahan and Ketcheson 1996, Luce and Wemple 2001). Ditches and other confined runoff paths from roads that are connected to streams increase the drainage density of a watershed by effectively creating additional first order streams that efficiently move sediment and additional surface runoff to the stream network. Although peak flows were not considered a key issue for analysis because of the naturally flashy nature of runoff in the watershed, concentrations of overland flow via the road system will also be reduced through a reduction in road densities. As previously discussed, measurable increases in peak flow occur at much higher road density levels.

Road decommissioning in high risk areas such as riparian areas and land type areas of moderate to high mass failure potential is most critical for realizing improved watershed conditions. In riparian areas, roads are more apt to be hydrologically connected to hydrologic systems through ditches, ruts, rills and unconfined overland flow. This connection can provide a chronic source of sediment and a more direct conveyance of surface runoff to streams. The positioning of roads in riparian areas also puts roads at an increased risk of damage through road/stream crossing failure and lateral migration of the stream channel as has been extensively documented in the Lightning Creek watershed. Alternative 3 provides a long-term reduction in hydrologic connectivity of roads to streams and reduces the risk of road failure (as well as the associated sediment pulse) by reducing riparian road densities 28% from 2.09 miles/square mile to 1.5 miles/square mile (see Table 9).

Additional indirect effects of the removal of roads in riparian areas would leave lands adjacent to streams better adapted to riparian plant and tree growth, which would eventually provide shade to stream channels and reduce water temperatures. Cold water is a key habitat component for native salmonids. Many of the streams in the Lightning Creek watershed were identified as being impaired by temperature (IDEQ, 2007). Riparian road decommissioning would help streams in the Lightning Creek watershed trend toward the thermal load allocations outlined in the Lower Clark Fork TMDL (DEQ, 2007). Improved production in riparian areas would also contribute to large woody debris recruitment to streams in the project area. Large woody debris recruitment provides greater habitat complexity to fish species by creating pools, backwaters, overhead cover, in-stream shade, contributing nutrients, etc. Riparian planting

would also help in this respect. Improved site conditions also provide improved riparian habitat complexity and helps in the attainment of riparian management objectives (RMOs) described in the Inland Native Fish Strategy (1995).

In areas where roads traverse highly erodible glacial and lacustrine deposits, cut and fill or full-bench engineering of roads results in over steepened slopes and an increased risk of road failure and ultimately can contribute to the mass failure of slopes (Luce, 1999). Alternative 3 would provide a long term decrease in road densities and risk of failure in land type areas rated as having moderate to high mass failure potential by reducing densities 61% from 1.0 miles/square to 0.39 miles/square mile (see Table 10). A reduced risk of failure also reduces the risk of large pulses of sediment followed by inputs from chronic wasting being added to the hydrologic system, further hill slope destabilization, a loss of productive soils, and a reduction in soil-groundwater holding capacity.

In Alternative 3, projected sediment inputs from roads compared to pre-flood conditions are estimated to drop approximately 84% from 941 tons/year to 150 tons/year for a net decrease of 791 tons/year. Sediment differences for future condition compared with existing conditions are estimated to decrease 88% from 1235 tons/year to 150 tons/year for a net difference of 1085 tons/year (see Table 11). Besides road decommissioning, other project design features and best management practices (BMPs) discussed in Chapter 2 such as road surfacing at crossings and wet areas, and improved drainage would further add to sediment reductions. Design features for bank stability at road repair and decommissioning sites will also contribute sediment reductions beyond those calculated for road decommissioning, repair, and rerouting.

Although there is a substantial long term reduction in sediment, there is the possibility of some short term sediment generation from the act of road decommissioning. The potential of sediment delivery would be minimized through the implementation of BMPs, slashing, mulching, seeding, and/or planting. Research has shown sediment generation drops off very quickly, and recovery of decommissioned roads occurs within 3-5 years (Hickenbottom, 2001, USDA Forest Service 2001, and Redente et al. 1994).

The short term potential sediment generation discussed above could have localized effects to individual fish, if present, such as temporary displacement. However, there would be no direct effects expected to LWD frequency or water temperature. Indirectly, the road decommissioning would likely lead to healthier riparian areas, which would eventually result in increased canopy cover, thus resulting in increased shade (lower water temperatures) and increased LWD recruitment. Ultimately, the long term benefits from vast reductions in sediment delivery from road decommissioning and road improvements associated with this project would trend Lightning Creek and its tributaries toward higher quality fish habitat (i.e. reduced sediment, decrease water temperature, etc).

Road Reconstruction - The primary road reconstruction that would occur under Alternative 3 would be on East Fork Road (#1184). Approximately 1.3 miles of road would be rebuilt in the riparian area of East Fork Creek. Reconstruction would occur to the extent possible as described above for the road #419. However, because the valley becomes so constricted in the locations of major road damage, opportunities for rerouting road #1184 do not exist. Therefore, reconstruction would require introducing fill material sufficient to achieve the desired road width. To do this, East Fork Creek would have to be diverted off of its north bank for approximately 500 feet. This would allow for road reconstruction and the installation of stream bank stabilization measures such as root wads and log vanes. The road fill would be protected by riprap. In other sites not immediately adjacent to East Fork Creek, reconstruction would primarily consist of restoring a deeply eroded road surface and drainage structures. Integrated road design features, timing restrictions, BMPs and site specific mitigation measures would be put in place to minimize sediment production during construction and in the long-term.

The direct effects to watershed resources associated with reconstructing of road #1184 would be sediment generation during the period of reconstruction. The long-term indirect effects of reconstruction are roughly equivalent to the effects road #1184 had on watershed condition, water quality, and riparian and aquatic habitat prior to the flood. Some of these effects include a potential for chronic sediment generation which would affect water quality, and a risk of failure due to its proximity to the stream and location on moderate mass failure land types (project file) that would affect watershed condition. Effects would be somewhat reduced through the before mentioned mitigation measures. Others include continued issues associated with no riparian productivity for approximately 1000 feet where the road is immediately adjacent to the stream. This would continue to have long-term effects on water quality through reduced shade to the stream channel, thereby contributing to increased temperatures, and eliminating the potential for large woody debris production from this site that contributes to riparian and aquatic habitat complexity.

East Fork Creek historically has been considered the primary bull trout-spawning tributary to the Lighting Creek watershed. As previously mentioned, spawning surveys by IDFG have shown a negative trend in redd counts since 1983. The effects to native fish associated with the reconstruction of road #1184 would likely have a short-term detrimental effect associated with sediment generation and in-stream operations that could potentially displace fish, if present, in close proximity to operations. Elevated temperatures, chronic sediment, and reduced potential for future large woody debris recruitment will continue to compromise habitat quality and would ultimately maintain existing productivity levels, or contribute to a decreasing trend in East Fork Creek.

Another element of road reconstruction under Alternative 3 involves restoring access to Porcupine Lake via road #642. The vast majority of the work and related effects are discussed below associated with bridge construction. However, some minor resurfacing of road #642 would occur to improve road conditions. Because the majority of this road system is outside of the riparian area of Porcupine Creek, the effects to water quality are minimal. There would be an ongoing risk to watershed condition and water quality associated with potential failure and the need for ongoing maintenance of at-risk culverts on tributaries to Porcupine Creek. The potential for detrimental effects to fish in the Porcupine system are associated with sediment production in the event of a culvert failure.

Stream Crossings - There is one primary change that would occur with stream crossings that are not directly associated with road repair or decommissioning. This is the building of a bridge that would cross Lightning Creek and its overflow channel, creating a direct intersection of road 642 with road 419. During the November 2006 flood event, the approach to the bridge was removed as the active Lighting Creek channel migrated to the north-east, leaving the existing bridge structure spanning dry cobble[1].

During the construction phase of this project, anticipated land disturbing activities associated with the triple span bridge building would take place outside of the existing floodplain. BMPs would be put into place to minimize the potential for sediment being delivered to the stream from sites where bridge abutments would be installed (Appendix B). During construction, machinery would be crossing the channel via a temporary bridge. This would serve to minimize sediment inputs during construction. Some equipment operation may be required on gravel/cobble bars, but would be minimized. Any disturbed areas on site would be rehabilitated following construction, and planted with native species.

The short-term effects of any extra sediment generation that may occur during construction would be substantially offset by the long term reduction in risk of failure and the elimination of any negligible amount of sediment generated by vehicular traffic through the ford of the side channel leading to the

[1] No funding source has been identified for this project. Access to Porcupine Lake would be restricted to ATV use through a low-water ford as discussed in Alternative 4

bridge approach. Conversion to a triple span bridge crossing would also eliminate the risk of motorists damaging their vehicles on coarse substrate while attempting to ford the side channel, and of pollutants entering the stream from damaged vehicles.

In the short term, any increases in sediment delivery levels from the activities described above would likely have minor adverse impacts on fisheries, such as temporary avoidance of the immediate work area due to localized turbidity. LWD frequency and water temperature would not be affected by these activities. In the long term, overall reductions in sediment risk from catastrophic failure of the bridge or approach would likely result in improved fish habitat below this site and could ultimately lead to higher fisheries survival rates thru increased connectivity and higher quality overwintering habitat.

Alternative 4 – Modified Proposed Action

Alternative 4 would restore access to full sized motorized vehicles on the main Lightning Creek road (#419). A bridge would be constructed over East Fork Creek. Char Creek road 1030, and upper Rattle Creek road 473 from just below the high bridge to Clatter Creek would be converted to non motorized trail. Lower Rattle Creek road 473 from the junction of the 419 to just below the high bridge would be decommissioned. Porcupine road 642 would be converted to a motorized trail open to vehicles 50 inches and less. The Porcupine Bridge would be removed, and the trail would be accessed via a low water ford. Most secondary and closed roads throughout the drainage would be decommissioned (see Chapter 2). The trail to Lake Darling would be converted to a non motorized trail. In Alternative 4a, road 2240 in Auxor Basin would be converted to a motorized trail. In Alternative 4b, the road would be decommissioned. In-stream work in lower East Fork Creek, bank stabilization at select road damage sites, and aquatic organism passage projects would be implemented as described in Chapter 2.

Direct and Indirect Effects

Road Work

As discussed under Alternative 3, the effects of the proposed action on watershed resources through road decommissioning are a long term improvement of watershed condition through a decrease in road densities (see Tables 8-10), a long term reduction of chronic sediment delivery to streams (see Table 11), and a contribution to decreased peak flows. Road decommissioning would also provide a long term decreased risk of road failure on mid-slope roads in land type areas of moderate to high mass failure potential, and a long-term decreased risk of damage to roads in riparian areas through road/stream crossing failure and lateral migration of the stream channel.

In the modified proposed action, road densities for the watershed would decrease 46% from 1.27 miles/sq. mile to 0.68 miles/sq. mile throughout the watershed (see Table 8). Within sensitive areas of the watershed such as riparian areas and land types of moderate to high mass failure potential, road densities will decrease 41% from 2.09 miles/square mile to 1.23 miles/square mile and 72% from 1.0 miles/square mile to 0.28 miles/square mile respectively. With respect to riparian road densities, the modified proposed action (Alternative 4a) would provide an additional 13%, or 0.27 miles/square mile reduction over Alternative 3. The additional riparian road decommissioning that would take place in Alternative 4a and b is primarily adjacent to East Fork Creek, an important stream for bull trout spawning. Recovery in this area would help to improve water quality parameters of sediment and temperature, and would better contribute to recovery in the basin. Road density reductions in areas of moderate to high mass failure potential under Alternatives 4a and b would exceed reductions calculated under Alternative 3 by 11%, or 0.11 miles/square mile.

Projected sediment inputs from roads under this alternative compared to pre-flood conditions are estimated to drop 88% from 942 tons/year to 112 tons/year for a net decrease of 830 tons/year. Sediment

differences for future condition compared with existing conditions are estimated to decrease 91% from 1,235 tons/year to 112 tons/year for a net difference of 1,123 tons/year (see Table 11). The difference between Alternatives 3 and 4 in this case is an additional decrease of 4% (38 tons) in sediment per year. Because much of the reduction would be associated with the decommissioning of roads in the East Fork drainage where they are closely situated to the channel, it would have an especially meaningful contribution to recovery of water quality parameters, as well as aquatic and riparian habitat in that subwatershed. As previously discussed, integrated design features for bank stability at road repair and decommissioning sites and BMPs would also contribute sediment reductions beyond those calculated for road decommissioning, repair, and rerouting. Other related benefits are discussed under Alternative 3.

The anticipated indirect effects to watershed and fisheries resources from reduced road densities and sediment input are improved water quality, and aquatic habitat parameters. As previously discussed, Lightning Creek and many of its tributaries are listed as being water quality impaired for sediment and temperature. The sediment reductions calculated in Table 11 would provide considerable gains in attaining water quality objectives for sediment. In correspondence with the IDEQ it was recognized that the proposed activities in the Lightning Creek Restoration Project would contribute substantially to load reductions described in the TMDL, with reductions in Rattle Creek and East Fork Creek meeting or exceeding sediment load reductions allocated for those subwatersheds (project file). In terms of aquatic habitat, reduced fine-grained sediment input would result in greater water flow thru the interstitial spaces in spawning gravels, which allows for oxygen delivery and waste removal.

The removal of roads in riparian areas would leave lands adjacent to streams better adapted to riparian plant and tree growth, which would eventually provide shade to stream channels and reduce water temperatures (IDEQ, 2007). Cold water is a key habitat component for native salmonids. Improved production in riparian areas would also contribute to large woody debris recruitment to streams in the project area. Large woody debris recruitment provides greater habitat complexity to fish species by creating pools, backwaters, overhead cover, in-stream shade, contributing nutrients, etc. Riparian planting would also help in this respect.

As discussed in Alternative 3, the short term potential sediment generation discussed above could have localized effects to individual fish, if present, such as temporary displacement. Direct effects of reductions in sediment delivery and sediment risk are even greater than Alternative 3. However, there would be no direct effects expected to LWD frequency or water temperature. Indirectly, the road decommissioning would likely lead to larger decreases in sediment delivery, healthier riparian areas, which would eventually result in increased canopy cover, thus resulting in increased shade (lower water temperatures) and increased LWD recruitment. Ultimately, the long term benefits from road decommissioning and road improvements associated with Alternative 4 modified would trend Lightning Creek and its tributaries toward higher quality fish habitat (i.e. reduced sediment, decrease water temperature). Alternative 4 reduces road densities and sediment delivery even more than Alternative 3 and would therefore be of even greater benefit to fish populations in the Lightning Creek watershed in the long term.

Stream Crossings - Two primary components of the proposed action involving stream crossings that are not directly associated with road repair or decommissioning are the decommissioning of the Porcupine Bridge, coupled with access conversion to a low-water ford, and construction of a bridge over East Fork Creek converting access from a low-water ford.

The direct effect of bridge removal at the Porcupine Bridge site would be a decreased risk of future failure and the associated pulse of sediment that occurs during a failure event. This bridge has been affected in two separate flood events. In 1980, the entire bridge structure and the through-fill material to the bridge were lost. In 2006, the through fill to the bridge was lost. Natural channel evolution and migration puts

this bridge site at a constant threat of being compromised during high flows. In this location, there is a bend in the valley to the east. Because the bridge is on the west side of the valley floor, when the channel is under the bridge, its potential for migration will always be to the east as evidenced by remnant and overflow channels to the east (see Porcupine Bridge report, project file). It is likely that minor amounts of sediment would be added to Lightning Creek in the short term during the decommissioning process. All of the disturbed area associated with the decommissioning process would be outside of active channel, and for the most part above the floodplain. During the removal process, a crane would be partly stationed within the active channel on large blocks to provide stability to the machinery, and to minimize impacts to the channel. Appropriate mitigation measures and BMPs would minimize the potential for sedimentation during operations at this site. Any detrimentally disturbed banks would be rehabilitated.

A low-water ford would replace bridge access, for approximately four months out of the year, to the motorized trail going to Porcupine Lake. The ford would leave from the original approach to the bridge on the east side of Lightning creek through the secondary channel, and emerge from Lightning Creek over cobble outwash, and up a sandy bank on the west bank just down stream of the current bridge location. At low water, both approaches to the ford near the active channel are well armored, and would not likely produce any detectible sediment. The greatest risk to water quality associated with the ford crossing would be the potential for pollutants entering the water from a damaged OHV. In balancing the risk associated with the low-water ford that is open to OHV use and motorcycles on Lightning Creek with the low-water ford open to all vehicles on East Fork Creek (that would be replaced by a bridge under this alternative), there would be a net reduction in risk. The ford through Lightning Creek would receive less traffic, and would only be attempted by OHVs designed for off-highway travel.

As explained above, there would be no expected effects to fisheries habitat components, such as bank stability, water temperature, pool quality and frequency, except sediment delivery, by removing this bridge and converting it to a low water ford for ATVs. A localized, short term increase in sediment delivery could result from bridge removal activities and ATVs fording Lightning Creek could potentially result in short duration turbidity during fording and temporary displacement of individual fish, if present, through their avoidance tactics. The bedload material in the reach adjacent to the FSR 642 bridge mainly consists of large cobble and boulders. This large size of substrate makes a highly unlikely area for spawning, so the potential for any disturbance of bull trout redds in the fall would be extremely low. Bull trout spawning in the mainstem Lightning Creek is concentrated in the area below Quartz Creek, but above the Rattle Creek confluence (personal communication, Chris Downs). Rearing habitat is present adjacent to the current ford, in a small backwater area, however, there is adequate overhead vegetation, LWD, and large rock present to provide protection to juvenile fish from ATVs. The potential for petroleum pollutants would be reduced compared to the East Fork ford, as OHVs are designed for off-road use and are armored heavily compared to passenger vehicles and light trucks.

The low-water ford crossing through East Fork Creek would be replaced by a 135-foot single span bridge. The bridge would be over-designed in terms of passing peak flows, as the primary concern in this location is not water volume, but the passage of large amounts of bedload and debris (see project file). Some in-stream work would be required to move the existing channel to a more central location under the bridge and within the channel margins. The relocated channel design would be approximately 500 feet in length and incorporate log and/or large rock vanes, in order to direct stream energy, as well as for grade and bank stabilization (Aquatics/Fish project file). Channel design would incorporate the proper geometry to accommodate flood events of a normal return interval, as well as 100+ year events (Aquatics/Fish project file).

Preliminary designs for the East Fork Bridge construction have land-disturbing activities that would take place outside of the existing and/or reconstructed floodplain (project file). BMPs would be put into place

to minimize the potential for sediment being delivered to the stream from sites where bridge abutments would be installed (Appendix A). During construction, machinery would be crossing the channel via a temporary bridge. This would serve to reduce sediment quantities beyond what is normally generated during periods of high use at the same time of year, compared to a ford. Any disturbed areas on site would be rehabilitated following construction, and planted with native species, including the current approach on the north bank of the creek that has been disturbed by shifting entrance/exit points. The southern approach is well armored. The short term effects of any extra sediment generation that may occur during construction would be substantially offset by the long term reduction in sediment generated by eliminating vehicular traffic through the ford. The conversion to a bridge crossing would also eliminate the risk of motorists damaging their vehicles on coarse substrate while attempting the ford, and of pollutants entering the stream from damaged vehicles.

It is expected that the effects of channel reconstruction through the area of the bridge would produce sediment at levels that would exceed normal levels for this time of year. Here too, the short term effects of sediment delivery and disturbance to aquatic organisms would be substantially offset by the long term benefits of sediment reduction, and improved aquatic habitat through the reconstructed reach. Channel building would be accomplished in the dry, prior to turning the stream into the rebuilt segment. This would shorten the overall period of downstream turbidity related to construction. The material that the channel would be built into is a large deposition of primarily coarse-grained (cobble to boulder sized) fluvial material, with a relatively low percentage of fine grained mineral material, soil or organic material. When the water is turned into the new channel, it is expected that there would be a period of downstream settling for coarse-grained material, accompanied by a dispersion of sand sized sediment that would clear up within a period of an hour.

Although the vast majority of bridge construction activities would be outside of the active channel, some level of localized turbidity would likely occur as a result. Channel re-alignment activities (i.e. re-establishing the thalweg closer to the middle of the floodplain) would also result in some short-term turbidity downstream of the crossing once the water is turned into the new channel. Other fish habitat parameters, such as bank stability and pool quality would indirectly benefit from these activities since vehicles would not be fording the stream at this location any longer and would therefore allow the stream banks and point bars to revegetate naturally.

Overall, the effects to watershed and fisheries resources from activities in the modified proposed action would be most beneficial to aquatic resources in the long term. As in Alternative 3, road rerouting, improvements, and decommissioning, along with stream bank stabilization, point bar structures, and stream crossing improvements are all designed to improve watershed conditions and aquatic habitat. In Alternative 4 road decommissioning and bank stabilization measures are more extensive and will better meet the purpose and need of trending watershed condition, sediment production, water quality, and aquatic habitat conditions in a positive.

Timing – Instream Construction Date Restrictions

In order to implement this project in the most timely and economical fashion possible, some phases of project related activities may need to occur beyond the September 1st deadline for in-channel work and/or the September 15th deadline for activities that may introduce additional sediment into a live stream channel (see Appendix A of the Draft Biological Assessment). Although most of the in-channel work is within the stop work dates to protect bull trout, some culvert removal, removal of alluvium, and culvert upgrades could potentially occur up to October 31. The majority of sites where these activities are scheduled are dry tributaries to Lightning Creek, although some are perennial, specifically in the Porcupine drainage. Since bull trout are fall spawners, which typically is also concurrent with the lowest flows of the season, the potential for increased turbidity to have a negative effect on spawning adults or

their redds downstream of culvert removals can not be avoided or mitigated, although Foltz et al (2007) shows that turbidity measurements drop to pre-disturbance levels an average of 810 meters downstream of culvert removals. With the knowledge that some stages of bull trout life history are present in Lightning Creek or its tributaries throughout the year, there could be the potential for some isolated, temporary displacement of individuals during in-channel operations and potential mortality from dewatering activities.

Bull Trout Designated Critical Habitat

The bull trout designated critical habitat (DCH) in Lightning Creek is identified as being from the confluence with the Clark Fork River to approximately 2.5 miles below East Fork Creek and encompasses all the private land in the lowest parts of the drainage. A recent study by Foltz et al, 2007, showed that turbidity associated with culvert removals travels an average of 810 m downstream before returning to pre-activity, undisturbed levels. Since project related activities begin at the first washout on FSR419 (approximately the 5 mile), which is on private property. Some sediment delivery and increased turbidity is likely to occur in the DCH as a direct result of project activities at this location. The proposed activities at this site include the road is being relocated closer to the eastern valley edge, which is farther away from the stream and some additional armoring of the raw meander bend at this location. This would be necessary to retard future erosion and stabilize the eroding bank. This additional armoring would include rip rap, boulder placement, and LWD aggregate burial as energy reduction features during spring runoff and flooding events. Bank stability would be improved as a result. Although sediment delivery would increase in the short term during implementation, recovery would be rapid and sediment delivery from this site would be expected to return to baseline levels within a short timeframe. Other fish habitat parameters, such as LWD frequency, pool frequency and quality, water temperature, undercut banks, and width to depth ratio in DCH would not be directly or indirectly affected.

Cumulative Effects for Alternatives 3, 4A, and 4B

The synergistic effects of disturbance from land management or natural phenomena throughout the watershed over time have all contributed to some degree to the existing condition of watershed and fisheries resources as previously discussed. Some of these activities include timber harvest, road building, urban development, recreation, and wood and bedload removal from the stream channel (project file). The effects to watershed and fisheries resources from these activities are generally considered to be unfavorable to various degrees over time in terms of erosion, sedimentation, and effects to riparian and aquatic habitat complexity. Some natural phenomena include wildfire and large floods may have similar effects to watershed and fisheries resources in terms of temporarily generating erosion and sedimentation rates in excess of background rates. However, fire and flooding are also known to have restorative effects to watershed and fisheries resources in terms of stimulating vegetation growth, improving habitat, building and replenishing floodplains, providing wood and nutrients to riparian and aquatic ecosystems, and enhancing aquatic habitat niches. Other past activities such as road maintenance, decommissioning, and culvert removal or upgrades (project file) have also had a restorative effect on watershed and fisheries resources

In examining the net effects of past management and/or disturbance, as described in the Affected Environment section of the Aquatics Report, it is clear that the lingering effects of logging and roads continue to out-weigh recovery, or the restorative efforts in contributing to an undesirable watershed condition, elevated sediment loads, and water quality conditions that do not support beneficial uses. Although logging units are in various stages of recovery and will continue to trend in that direction, the infrastructure of roads (system and nonsystem) continues to impact slope stability, riparian productivity, and contribute sediment to aquatic systems.

Another of these past management activity that will continue to have a detrimental impact to aquatic habitat, channel stability, and sediment generation (as discussed under Alternative 1) is the wood removal that occurred on the 3.5 miles of stream below National Forest Land during the spring of 2008. With the current level of bedload movement through the system and the large runoff events that the watershed is susceptible to, even repairs made to the upper watershed will not mitigate the potential for substantial channel adjustments (aggradation and lateral migration), increased bedload routing, and effects to aquatic species (Aquatics Report, p. 30). Although it is beyond the scope of this project, restoration of this section of Lightning Creek would have a substantial impact on channel stability and aquatic habitat.

At this time there are very limited foreseeable activities within the watershed outside of what is being proposed in this project. Some activities include very minor timber extraction (project file), and home building/urbanization in the lower parts of the watershed on private land, road maintenance, and fish passage improvement projects on Cascade and Quartz Creeks.

The additive effect of this project with past and reasonably foreseeable activities within the watershed will only serve to improve watershed conditions, improve water quality, improve riparian and aquatic habitat, and decrease the risk of future road failure.

Project Monitoring

Monitoring of project implementation and watershed resources would take place during and after project completion. Best Management Practices (BMPs) would be incorporated into many different phases of the project. The Zone Hydrologist and/or an engineering representative would review the planned design of all road work and monitor implementation of activities to assure compliance with BMPs. Following the completion decommissioning, roads would be checked periodically by district personnel during the first year (and periodically thereafter if no problems are noted) to monitor effectiveness of erosion control, noxious weed control, and wildlife security.

Because the implementation of the entire project is likely to take at least six years, repeat surveys of specific stream sections for monitoring purposes are likely to occur even before all work items are complete. This monitoring would continue following the full implementation of the project. Continued monitoring of bull trout spawning will be carried out by Idaho Fish and Game on an annual basis. Biological inventories will occasionally be supplemented by U.S. Forest Service fish presence and abundance surveys.

Compliance with the Forest Plan and Other Regulatory Direction

Idaho Panhandle National Forests Land and Resource Management Plan

Both action alternatives meet the requirements of the IPNF Forest Plan for fisheries resources, as amended by the Inland Native Fish Strategy. Specific requirements and how this project meets them are listed in the following section (A.3-d) on Fish Management Direction.

Fry Emergence Amendment to the Forest Plan

On June 2, 2005, the Forest Supervisor for the Idaho Panhandle National Forests signed a Decision Notice and Finding of No Significant Impact that amended the Forest Plan to modify or remove objectives, standards and monitoring requirements pertaining to fry emergence success (IPNF 2005). The amendment was implemented because the fry emergence objectives, standards and monitoring requirements that were in the IPNF Forest Plan did not contribute as well as INFS objectives, standards, guidelines and monitoring direction towards meeting the goals of providing sufficient habitat in support of maintaining diverse and viable populations of fish species across the forest. In addition, because of the

limited application of the fry emergence models and their unreliability, and the inability to determine fry emergence success in the field due to high variability affected by multiple natural and human-caused factors, the Forest Service was not able to state with any degree of certainty whether measures for fry emergence success were accurate or precise.

Clean Water Act, Including State of Idaho Implementation

All alternatives would be consistent with the requirements of the Clean Water Act, 33 U.S.C. §1251. Sediment and temperature, the pollutants of concern, would not increase in the water quality limited segment on Lightning Creek or its tributaries. Risks to beneficial uses in Lightning Creek would not be changed by this project. In compliance with the current TMDL status, there would be significant gains made toward the attainment of pollutant load reductions through the proposed management activities in Lightning Creek.

Idaho Forest Practices Act

Best Management Practices or Soil and Water Conservation Practices would be applied under all alternatives, and all activities are in compliance with the guidelines in the Soil and Water Conservation Handbook.

Idaho Stream Channel Protection Act/Idaho Stream Alteration Rules

This project meets the required BMPs in the Idaho State Water Quality Standards (IDAPA 37.03.07) and (IDAPA 58.01.02.350.03).

Executive Order 11988 - Floodplain Management

This project meets the requirements of Executive Order 11988, which apply to protection of floodplains. These features are protected through implementation of BMPS and Forest Plan Standards and Guidelines. The riparian restoration components of the project are designed to improve condition of riparian areas and floodplain function.

Executive Order 11990 - Protection of Wetlands

This project meets the requirements of Executive Order 11990, which apply to protection of wetlands. These features are protected through implementation of BMPS and Forest Plan Standards and Guidelines. The riparian restoration components of the project are designed to improve condition of riparian areas and floodplain function.

Endangered Species Act

Both action alternatives meet the requirements of the Endangered Species Act. The project is likely to adversely affect threatened bull trout in the short term, but would not jeopardize their continued existence. Additionally, the project may affect, but is not likely to adversely affect bull trout designated critical habitat in Lightning Creek.

Executive Order 12962 – Recreational Fishing

Both action alternatives are consistent with this executive order regarding aquatic systems and recreational fisheries. Short-term effects may affect westslope cutthroat trout individuals, but would not lead toward a trend in federal listing. Long-term effects (i.e., net reduction in sediment) are expected to benefit westslope cutthroat trout survival and habitat.

State of Idaho Governor's Bull Trout Plan

Both action alternatives are consistent with the direction in the Governor's Bull Trout Plan. Long-term effects from the decommissioning of roads with known sediment sources are expected to benefit bull trout and their habitat.

References

Anderson, B., and Potts, D.F. 1987. Suspended sediment and turbidity following road construction and logging in western Montana. Water Res. Bull. 23(4): 681490.

Behnke, R.J. 2002. Trout and Salmon of North America. New York: Free Press.

Bilby, R.E. and G.E. Likens. 1980. Importance of organic debris dams in the structure and function of stream ecosystems. Ecology 61:5 1107-1113.

Bisson, P.A. and J.R. Sedell. 1982. Salmonid populations in streams in clearcut vs. old growth forests of western Washington. In: Meehan, W.R., T.R. Merrall, J.W. Matthews Eds. Fish and Wildlife Relationships in Old-Growth Forests. Proceedings of a Symposium. Amer. Inst. Fish. Res. Bios. pp 121-130.

Bission, P.A. and J.R. Sedell. 1982. Salmonid populations in streams in clearcut vs old growth forests of western Washington. In: Meehan, W.R., T.R. Merrall, J.W. Matthews, Eds. Fish and Wildlife Relationships in Old-Growth Forests. Proceedings of a Symposium. Amer. Inst. Fish. Res. Bios. 121-130.

Bjornn, T.C. 1975. The St. Joe River cutthroat fishery – a case history of angler preference. Presented at the Western Association of State Game Commissioners. pp. 1-2.

Bjornn, T.C., M.A. Brusven, M.P. Molnau, J.H. Milligan, R.A. Klamt. 1977. Transport of granitic sediment in streams and its effect on insects and fish. University of Idaho, Forest, Wildlife and Range Experiment Station, Bulletin No. 17. 43 pages.

Bjornn, T.C. and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Special Publication 19: 83-138.

Burroughs, E.R. and J.G. King. 1989. Reduction of Soil Erosion on forest roads. USDA Forest Service General Technical Report INT-264, 21 p.

Burton, T.A., G.W. Harvey and M.L. McHenry. 1990. Protocols for assessment of dissolved oxygen, fine sediment and salmonid embryo survival in an artificial redd. Report 1. Idaho Department of Health and Welfare, Division of Environmental Quality. Boise, ID.

Cacek, Charles C. 1989. The relationship of mass wasting to timber harvest activities in the Lightning Creek basin. Masters Thesis, Eastern Washington University.

Chapman, D.W. 1988. Critical review of variables used to define effects of fines in redds of large salmonids. Transaction of the American Fisheries Society. 117(1): 1-21.

Chapman, D.W. and K.P. Mcleod. 1987. Development of criteria for fine sediment in the northern Rockies ecoregion. EPA 910/9-87-162. 279 pages.

Dambacher, J.M. and K.K. Jones. 1997. Stream habitat of juvenile bull trout populations in Oregon and benchmarks for habitat quality. Pages 353-360 in Mackay, W. C., Brewin, M. K., and M. Monita, editors. Friends of the bull trout conference proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Canada, Calgary.

Everest, F.H., R.L. Beschta, J.C. Scrivener, K.V. Koski, J.R. Sedell and C.J. Cederholm. 1987. Fine sediment and salmonid production: a paradox. In: E.O. Salo and T.W. Cundy, Eds. Streamside management: forestry and fishery interactions. University of Washington, Institute of Forest Resources, Seattle, WA. Contribution 57, pages 97-142.

Foltz, Randy B. and Mark A. Truebe. 1995. Effect of Aggregate Quality on Sediment Production from a Forest Road. Proceedings of the 6th International Conference on Low-Volume Roads, 1995 June 25-29, Minneapolis, MN. Washington, DC: National Academy Press. Pgs. 49-57.

Fraley, J.J. and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and River system, Montana. In: Northwest Science, Vol. 63, No. 4.

Karr, J.R. and D.R. Dudley. 1981 Ecological perspectives on water quality goals. Environmental Management 5:55-68.

Karr, J.R. and K.E. Freemark. 1983. Habitat selection and environmental gradients: dynamics in the "stable" tropics. Ecology 64:6: 1481-1494.

Goetz, F. 1989. Biology of the bull trout *Salvelinus confluentus*: a literature review. Willamette National Forest, Eugene, OR.

Gorman, O.T. and J.R. Karr. 1978. Habitat structure and stream fish communities. Ecology 59:3: 507-515.

Harr, R.D. 1986. Effects of clearcutting on rain-on-snow runoff in western Oregon: A new look at old studies. Water Resource Research, Vol. 22, No 7. pg 1095-1100.

Haupt, H.F. 1959. Road and slope characteristics affecting sediment movement from logging roads. Journal of Forestry. 57(5): 329-332.

Henjum, M.G., J.R. Karr, D.L. Bottom, D.A. Perrry, J.C. Bednarz, S.G. Wright, S.A. Beckwitt,, E. Beckwitt. 1994. In: J.R. Karr and E.W. Chu Eds. Interim protection for late-successional forests, fisheries and watersheds. National Forests East of the Cascade Crest, Oregon and Washington, Eastside Forests Scientific Society Panel. Bethesda, MD: The Wildlife Society: 129-168.

Hickenbottom, Jennifer A.S. 2001. A comparative analysis of surface erosion and water runoff from existing and recontoured Forest Service Roads: O'Brien Creek Watershed. Master Thesis. University of Montana. Missoula, MT.

Hoelscher, B. and T.C. Bjornn. 1989. Habitat, densities and potential production of trout and char in Pend Oreille Lake tributaries. Job Completion Report. Project F-71-R-10. Subproject III, Job No. 8. Federal Aid in Fish Restoration. Idaho Department of Fish and Game. Boise, ID.

IDEQ, 2005. Principles and Policies for the 202 Integrated (303 (d)/305 (b)) Report. State of Idaho Department of Environmental Quality. Boise, Idaho.

IDEQ, 2007. Lower Clark Fork River Subbasin Assessment and Total Maximum Daily Loads. Final Report. Idaho Department of Environmental Quality. Boise, Idaho.

Jakober, M.J. 1995. Autumn and winter movements and habitat use of resident bull trout and westslope cutthroat in montana. Master's Thesis. Montana State University. Bozeman, MT.

Karr, J.R. and D.R. Dudley, 1981. Ecological perspectives on water quality goals. Environmental Management 5:55-68.

Karr, J.R. and K.E. Freemark. 1983. Habitat selection and environmental gradients: dynamics

in the "stable" tropics. Ecology 64:6: 1481-1494.

King John G. 1995. Streamflow and Sediment Yield Responses to Forest Practices in North Idaho. Ecology and Management: symposium proceedings. Washington State University. P. 213-220.

Lee, D.C., J.R. Sedell, B.E. Rieman, R.F. Thurow and J.E. Williams. 1997. Chapter 4: Broadscale assessment of aquatic species and habitats. In: T.M. Quigley and S.J. Arbelbide, Technical Eds. An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins, Vol. III. PNW-GTR-405.

Luce, Charles H. 1997. Effectiveness of Road Ripping in Restoring Infiltration Capacity of Forest Roads. Restoration Ecology. Vol. 5. No. 3. Pgs. 265-270.

Luce, C. H. and B. Wemple. 2001. Introduction to the Special Issue on Hydrologic and Geomorphic Effects of Forest Roads. Earth Surface Processes and Landforms 26(2): 111-113.

Madej, M.A. 1995. Changes in channel-stored sediment, Redwood Creek, Northwestern California, 1947-1980. Chapter O in U.S. Geological Survey Professional Paper 1454. Geomorphic Processes and Aquatic Habitat in the Redwood Creek Basin, Northwestern California. K.M. Nolan, H.M. Kelsey, and D.C. Marron, eds. [Book Chapter]

McIntyre, J.D. and B.E. Rieman. 1995. Westslope cutthroat trout. In: M.K. Young, Technical Ed. Conservation Assessment for Inland Cutthroat Trout. General Technical Report RM-256. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. 61 pages.

Meehan, W.R. 1991. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 17.

Meisner, J.D. 1990. Effect of climatic warming on the southern margins of the native range of brook trout, Salvelinus fontinalis. Canadian Journal of Fisheries and Aquatic Sciences 47: 1065-1070.

Mesa, M.G. 1991. Foraging efficiency and body size: a study of optimal diet and habitat use by bluegills. Ecology 62: 1370-1386.

Megahan, Walter F., D.B. Monsen, D.B., M.D. Wilson, 1991. Probability of Sediment Yields from Surface Erosion on Granitic Roadfills in Idaho. Published in Environmental Journal Qual. 20:53-60. Pgs 53-60.

Megahan, W.F. and W. J. Kidd, 1972. Effects of Logging and Logging Roads on Erosion and Sediment Deposition from Steep Terrain. Journal of Forestry. Vol 70, No 2, March 1972, pp. 136-141.

Megahan, W.F. and G.L. Ketcheson. 1996. Predicting downslope travel of granitic sediments from forest roads in Idaho. American Water Resources Association. Water Resources Bulletin, Vol. 32, No. 2. April 1996.

Montgomery D. R., and J. M. Buffington 1997. Channel reach Morphology in Mountain Drainage Basins. GSA Bulletin. Vol. 109.

Murphy, M.L. and W.R. Meehan. 1991. Stream ecosystems. American Fisheries Society Special Publication 19: 17-46.

Naiman R. J, 1992. Watershed Management: Balancing Sustainability and Environmental Change. New York, NY. Springer-Verlag.

Nolan, K.M. and Marron, D.C. 1995. History, causes, and significance of changes in the channel geometry of Redwood Creek, northwestern California, 1936 to 1982. United States Geological Survey Professional Paper 1454N.

PBTTAT. 1998. Lake Pend Oreille key watershed bull trout problem assessment. Prepared for the Lake Pend Oreille Watershed Advisory Group and the State of Idaho. Panhandle Bull Trout Technical Advisory Team. 100 pages.

Pratt, K.L. 1984. Habitat use and species interactions of juvenile cutthroat (Salmo clarki lewisi) and bull trout (Salvelinus confluentus) in the upper Flathead River basin. Masters Thesis. University of Idaho, Moscow.

Pratt, K.L. 1985. Pend Oreille trout and char life history study. Idaho Department of Fish and Game in cooperation with Lake Pend Oreille Club. Boise, ID.

Philip Williams and Associates, Ltd., 2004. Lightning Creek Watershed Assessment. PWA REF #1621.

River Design Group, 2008. Blue Creek Watershed Assessment and Restoration Prioritization Plan. 108 pp.

Redente, E., N. Cotts, R. Schiller. 1994. Abandoned road restoration methods tested at Grand Tetons National Park. 14(2) Spring 1994. Park Science.

Reel, S., L. Schassberger and W. Ruediger. 1989. Caring for our natural community. USDA Forest Service. Northern Region Wildlife and Fisheries publication.

Reeves, G.H., L.E. Benda, K.M. Burnett, P.A. Bisson and J.R. Sedell. 1995. A disturbance-based ecosystem approach to maintaining and restoring freshwater habitats of evolutionarily significant units of anadramous salmonids in the Pacific Northwest. American Fisheries Society Symposium 17: 334-349.

Reid, L.M. and S. Hilton. 1998. Buffering the buffer. In: Conference of Coastal Watersheds: The Caspar Creek Story, May 6, 1988, Ukiah, California. USDA Forest Service PSW-GTR-168.

Rieman, B.E. and K. Apperson. 1989. Status and analysis of salmonid fisheries: westslope cutthroat trout synopsis and analysis of fishery information. Idaho Department of Fish and Game. Project F-73-R-11, Subproject No. 11, Job No. 1. 112 pages.

Reiman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for the conservation of bull trout. General Technical Report INT-302. USDA Forest Service, Intermountain Research Station. Ogden, UT. 38 pages.

Rosgen, D. 1996. Applied river morphology. Wildland Hydrology, Pagosa Springs, CO.

Schlosser, I.J. 1982. Trophic structure reproductive success and growth rate of fishes in a natural and modified headwater stream. Canadian Journal of Fisheries and Aquatic Sciences 39: 968-978.

Seyedbagheri, K.A. 1996. Idaho Forestry Best Management Practices: Compilation of Research on Their Effectiveness. Gen. Tech. Rep. INT-GTR-339. Ogden UT: USDA, Forest Service, Intermountain Research Station. 89 p.

Shepard, B.B., B.E. May and W. Urie. 2003. Status of westslope cutthroat trout (*Oncorhynchus lewisi*) in the United States: 2002. 94 pp.

Sheridan, Gary J., Philip J. Noske, Robyn K. Whipp and Nimal Wijesinghe. 2005. The Effect of Truck Traffic and Road Water Content on Sediment Delivery from Unpaved Forest Roads. Hydrologic Processes. Wiley Interscience. P1683-1699

Stowell, R., A. Espinosa, T.C. Bjornn, W.S. Platts, D.C. Burns, J.S. Irving. 1983. Guide for predicting salmonid response to sediment yields in Idaho batholith watersheds. USDA Forest Service, Northern Region and Intermountain Region. 95 pages.

State of Idaho 1996. Fovernor Philip E. Batt's State of Idaho bull trout conservation plan. July 1. Boise, ID.

Straley, W. F. 1974. Lightning-Trestle Planning Unit: Mining, Minerals, and Environmental Geology. Unpublished Forest Service Report.

USDA Forest Service report 1981. Lightning Creek Flood. Unpublished Forest Service Report.

USDA Forest Service. 1987. Idaho Panhandle National Forests Forest Plan, Northern Region. Coeur d'Alene, ID.

USDA Forest Service. 1995. Inland Native Fish Strategy Environmental Assessment: Decision Notice and Finding of No Significant Impact. USDA Forest Service: Intermountain, Northern and Pacific Northwest Regions. 17 pages.

USDA Forest Service1995 – 2006. Idaho Panhandle National Forests Forest Plan Monitoring and Evaluation Report. Coeur d'Alene, ID.

USDA Forest Service. 1999. Idaho Panhandle National Forests Forest Plan Monitoring and Evaluation Report. Coeur d'Alene, ID.

USDA Forest Service. 2000. Idaho Panhandle National Forests Forest Plan Monitoring and Evaluation Report. Coeur d'Alene, ID.

USDA Forest Service. 2001. Idaho Panhandle National Forests Forest Plan Monitoring and Evaluation Report. Coeur d'Alene, ID.

USDA Forest Service. 2002. Idaho Panhandle National Forests Forest Plan Monitoring and Evaluation Report. Coeur d'Alene, ID.

USDA Forest Service. 2003. Idaho Panhandle National Forests Forest Plan Monitoring and Evaluation Report. Coeur d'Alene, ID.

USDA Forest Service. 2005. Fry Emergence Ammendment: Decision Notice and Finding of No Significant Impact. USDA Forest Service: Northern Region. 70 pages.

USDI Fish and Wildlife Service. 2000. Endangered and threatened wildlife and plants: 12-month finding for an amended petition to list the westslope cutthroat trout as threatened throughout its range. Federal Register. 65(73): 20120-20123.

USDI Fish and Wildlife Service. 2003. Endangered and threatened wildlife and plants: Reconsidered finding for an amended petition to list the westslope cutthroat trout as threatened throughout its range. Federal Register. 68(152): 46989-47009.

USDI Fish and Wildlife Service. 2008. Upper Columbia Fish and Wildlife Office. Biannual Species List for the Idaho Panhandle National Forests, FWS Reference No. 1-9-08-SP-0067.

Appendix A - Best Management Practices (BMPs)

Introduction

The Forest Service is required by law to comply with water quality standards developed under authority of the Clean Water Act. The Environmental Protection Agency and the States of Idaho are responsible for enforcement of these standards. The Idaho Panhandle National Forest Plan states (Chapter II, p. 27) that the Forest will "maintain high quality water to protect fisheries habitat, water based recreation, public water supplies and be within state water quality standards". The use of BMPs is also required in the Memorandum of Understanding between the Forest Service and the State of Idaho as part of our responsibility as the Designated Water Quality Management Agency on National Forest System lands. The State's water quality standards regulate nonpoint source pollution from timber management and road construction activities through application of Best Management Practices (BMPs). The BMPs were developed under authority of the Clean Water Act to ensure that Idaho's waters do not contain pollutants in concentrations, which adversely affect water quality or impair a designated use. State recognized BMPs that will be used during project design and implementation are contained in these documents:

a. Rules and Regulations Pertaining to the Idaho Forest Practices Act, (IFPA), as adopted by the Idaho Land Board; and

b. Rules and Regulations and Minimum Standards for Stream Channel Alterations, as adopted by the Idaho Water Resources Board under authority of the Idaho Stream Channel Protection Act (ISCPA).

Many of the rules and regulations for stream channel alterations are contained, in slightly different forms in two Memorandum of Understandings (MOU) between the USFS and the State of Idaho. These MOUs are incorporated into the Forest Manual and R-1 Supplement 31, contains provisions which are not currently state recognized BMPs.

The practices described herein are tiered to the practices in FSH 2509.22. They were developed as part of the NEPA process, with interdisciplinary involvement, and meet state and Forest water quality objectives. The purpose of this appendix is to: 1) establish the connection between the Soil and Water Conservation Practice

(SWCP) employed by the Forest Service and BMP's identified in Idaho Water Quality Standards (IDAPA16.01.2300.05) and 2) identify how the SWCP Standard Specifications for the Construction of Roads, and the Timber Sale Contract provisions meet or exceed the Rules and Regulations pertaining to the Idaho Forest Practices Act, Title 38, Chapter 13, Idaho Code. The relevant portions of the Rules and Regulations developed under the Idaho Stream Protection Act are also covered.

The objective of this appendix is to provide conservation practices for use on National Forest Lands to minimize the effects of management activities on soil and water resources. The conservation practices were compiled from Forest Service manuals, handbooks, contract and permit provisions, to directly or indirectly improve water quality, reduce losses in soil productivity and erosion, and abate or mitigate management effects, while meeting other resource goals and objectives. They are of three basic forms: administrative, preventive and corrective. These practices are neither detailed prescriptions nor solutions for specific problems. They are purposely broad. These practices are action initiating process mechanisms, which call for the development of requirements and considerations to be addressed prior to and during the formulation of alternatives for land management actions. They serve as checkpoints, which are considered in formulating a plan, a program and/or a project.

Although some environmental impacts may be characteristic of a management activity, the actual effects on soil and water resources will vary considerably. The extent of these management effects on soil and water resources is a function of:

1. The physical, meteorological and hydrologic environment where the activity takes place (topography, physiography, precipitation, channel density, geology, soil type, vegetative cover, etc.).

2. The type of activity imposed on a given environment (recreation, mineral exploration, timber management, etc.) and its extent and magnitude.

3. The method of application and the duration of the activity (grazing system used, types of silvicultural practice used, constant vs. seasonal use, recurrent application or onetime application, etc.).

4. The season of the year that the activity occurs or is applied.

These factors vary within the National Forests in the Northern Region and from site to site. It follows then that the extent and kind of impacts are variable, as are the abatement and mitigation measures. No solution prescription, method, or technique is best for all circumstances. Thus the management practices presented in the following include such phrases as "according to the design", "as prescribed," "suitable for," "within acceptable limits," and similar qualifiers. The actual prescriptions, specifications, and designs are the result of evaluation and development by professional personnel through interdisciplinary involvement in the NEPA process. This results in specific conservation practices that are tailored to meet site specific resource requirements and needs.

BMP Implementation Process

In cooperation with the States, the USDA Forest Service's primary strategy for the control of nonpoint sources is based on the implementation of BMP's determined necessary for the protection of the identified beneficial uses. The Forest Service Nonpoint Source Management System consists of:

1. BMP selection and design based on site-specific conditions; technical, economic and institutional feasibility; and the designated beneficial uses of the streams.

2. BMP Application

3. BMP monitoring to ensure that they are being implemented and are effective in protecting designated beneficial uses.

4. Evaluation of BMP monitoring results.

5. Feeding back the results into current/future activities and BMP design.

The District Ranger is responsible for insuring that this BMP feedback loop is implemented on all projects. The Practices described herein are tiered to the practices in the R1/R4 FSH 2509.22. They were developed as part of the NEPA process, with interdisciplinary involvement, and meet State and Forest water quality objectives. The purpose of this appendix document is to: 1) establish the connection between the SWCP employed by the Forest Service and BMP's identified in Idaho Water Quality Standards (IDAHO APT 16.01.2300.05) and 2) identify how the SWCP, Standard Specifications for the Construction of Roads, and the Timber Sale Contract provisions meet or exceed the Rules and Regulations Pertaining to the Idaho Forest Practices Act, Title 38, Chapter 13, Idaho Code (BMP's). The

relevant portions of the Rules and Regulations developed under the Idaho Stream Protection Act are also included.

Format of the BMPs

Each Soil and Water Conservation Practice (SWCP) is described as follows:

Title: Includes the sequential number of the SWCP and a brief title.

Objective: Describes the SWCP objective(s) and the desired results for protecting water quality.

Effectiveness: Provides a qualitative assessment of expected effectiveness that the implemented BMP will have on preventing or reducing impacts on water quality. The SWCP effectiveness rating is based on: 1) literature and research (must be applicable to area 2) administrative studies (local or within similar ecosystem); and 3) professional experience (judgment of an expert by education and/or experience). The expected effectiveness of the SWCP is rated either High, Moderate or Low.

> **High**: Practice is highly effective (>90%) and one or more of the following types of documentation are available:
>
> a) Literature/Research - must be applicable to area
> b) Administrative studies - local or within similar ecosystem
> c) Experience - judgment of an expert by education and/or experience.
> d) Fact - obvious by reasoned (logical response).
>
> **Moderate**: Documentation shows that the practice is effective less than 90% of the time, but at least 75% of the time.
>
> Or
>
> Logic indicates that this practice is highly effective, but there is little or no documentation to back it up.
>
> Or
>
> Implementation and effectiveness of this practice will be monitored and the practice will be modified if necessary to achieve the objective of the BMP.
>
> **Low**: Effectiveness unknown or unverified, and there is little to no documentation
>
> Or
>
> Applied logic is uncertain in this case, or the practice is estimated to be less than 75% effective.
>
> Or
>
> This practice is speculative and needs both effectiveness and validation monitoring.

The effectiveness estimates given here are general, given the range of conditions throughout the Forest. More specific estimates are made at the project level when the BMPs are actually prescribed.

Compliance: Provides a qualitative assessment of how the implementation of the specific measures will meet the Forest Practice Act Roles and Regulations pertaining to water quality.

Implementation: This section identifies: (1) the site-specific water quality protection measures to be implemented and (2) how the practices are expected to be applied and incorporated into the Timber Sale Contract.

Items Common to All Soil and Water Conservation Practices

Responsibility For Implementation: The District Ranger (through the Presale Forester) is responsible for insuring the factors identified in the following SWCPs are incorporated into contracts; or Public Works Contracts through the inclusion of specific contract clauses.

The Contracting Officer, through his/her official representative (Engineering Representatives for contracts; and Contracting Officers Representative for public works contracts) is responsible for insuring that the provisions are properly administered on the ground.

Monitoring: Implementation and effectiveness of water quality mitigation measures are also monitored annually. This includes routine monitoring by road construction inspectors, and resource specialists, which is documented in diaries and project files. Basically, water quality monitoring is a review of BMP implementation and a visual evaluation BMP effectiveness. Any necessary corrective action is taken immediately. Such action may include modification of the BMP, modification of the project, termination of the project, or modification of the state water quality standards.

Abbreviations

TSC = Timber Sale Contract
SAM = Sale Area Map
TSA = Timber Sale Administrator
COR = Contracting Officer Representative
PWC = Public Works Contract
IFPA = Idaho Forest Practices Act
SCA = Stream Channel Alteration Act
SWCP= Soil and Water Conservation Practices
BMP = Best Management Practices
SMZ = Streamside Management Zone
SPS = Special Project Specifications
EPA = Environmental Protection Zone
CFR = Code of Federal Regulations

Key Soil and Water Conservation Practices

Class * Soil and Water Conservation Practice (FSH 2509.22)
*** Classes of SWCP (BMP)**
A = Administrative
G = Ground Disturbance Reduction
E = Erosion Reduction
W = Water Quality Protection
S = Stream Channel Protection/Stream Sediment Reduction

11 WATERSHED MANAGEMENT
W 11.01 Determination of Cumulative Watershed Effects
W 11.02 Soil and Water Resource Monitoring and Evaluation
W 11.03 Watershed Improvement Planning and Implementation
W 11.04 Floodplain Analysis and Evaluation
W 11.05 Wetlands Evaluation and Analysis
W 11.06 Public Supply Watershed Management
W 11.07 Oil and Hazardous Substance Spill Contingency Planning
W 11.09 Management by Closure to Use
W 11.11 Petroleum Storage and Delivery Facilities & Management

13 VEGETATION MANIPULATION
E 13.05 Soil Protection During and After Slash Windrowing

14 TIMBER
E 14.05 Protection of Unstable Areas
S 14.17 Streamcourse Protection (Implementation and Enforcement)
E 14.18 Erosion Control Structure Maintenance

15 ROADS AND TRAILS
A 15.02 General Guidelines for Road Location/Design
E 15.03 Road and Trail Erosion Control Plan
E 15.04 Timing of Construction Activities
E 15.05 Slope Stabilization and Prevention of Mass Failures
E 15.06 Mitigation of Surface Erosion and Stabilization of Slopes
E 15.07 Control of Permanent Road Drainage
E 15.09 Timely Erosion Control Measures on Incomplete Road and Streamcrossing Projects
E 15.10 Control of Road Construction Excavation & Sidecast Material
S 15.11 Servicing and Refueling of Equipment
S 15.13 Controlling In-Channel Excavation
S 15.14 Diversion of Flows Around construction Sites
S 15.16 Bridge & Culvert Installation (Disposition of Surplus Material and Protection of Fisheries)
E 15.17 Regulation of Borrow Pits, Gravel Sources, and Quarries
E 15.18 Disposal of Right-of-Way and Roadside Debris
S 15.19 Streambank Protection
E 15.21 Maintenance of Roads
E 15.22 Road Surface Treatment to Prevent Loss of Materials
E 15.23 Traffic Control During Wet Periods
G 15.24 Snow Removal Controls

Best Management Practices Relevant to the Lightning Creek Restoration Project

PRACTICE 11.01 – Determination of Cumulative Watershed Effects
PRACTICE 11.02 – Soil and Water Resource Monitoring and Evaluation
PRACTICE 11.03 – Watershed Improvement Planning and Implementation
Objectives: To determine the cumulative effects or impacts on beneficial water uses by multiple land management activities. Past, present or reasonably foreseeable future actions in watershed are evaluated relative to natural or undisturbed conditions. To monitor watershed conditions for comparison with State standards, Forest Plan Standards, and estimation of long-term trend; to ensure the health and safety of water users; to evaluate SWCPs effectiveness; and to determine the adequacy of data, assumptions, and coefficients. To improve degraded watershed conditions, to minimize soil erosion, and to improve water availability or quality.
Effectiveness: High
Compliance: Meets FPS rules

PRACTICE 11.04 – Floodplain Analysis and Evaluation
PRACTICE 11.05 - Wetlands Analysis and Evaluation
Objectives: To delineate floodplains and wetlands within sale areas in order to prevent damage to facilities or degradation of soil and water resources. To protect floodplains and wetlands and avoid,

where possible, the long and short-term adverse impacts to soils and water resources associated with the occupancy and modification of such.
Effectiveness: High
Compliance: FPA Rule 4.d.v(c) – Meets

PRACTICE 11.06 – Public Supply Watershed Management
Objectives: To manage community and noncommunity public supply watersheds to comply with State water quality standards.
Effectiveness: High
Compliance: Meets FPA rules

PRACTICE 11.09 - Management by Closure to Use
PRACTICE 15.23 - Traffic Control During Wet Periods
Objective: To reduce the potential for road surface disturbance during wet weather and to reduce sedimentation probability by excluding activities that could result in damages to facilities or degradation of soil and water resources.
Effectiveness: Moderate
Compliance: FPA Rule 4.d.v(c) - Meets
Implementation: Roads that must be used during wet periods should have a stable surface and sufficient drainage to allow such use with a minimum of resource impact. Rocking, paving and armoring are measures that may be necessary to protect the road surface and reduce erosion potential. Roads not constructed for all weather use should be closed during the wet season.

PRACTICE 13.05 – Soil Protection During and After Slash Windrowing
Objective: To reduce erosion and sedimentation from road surfaces and fill slopes, slash is windrowed below the fill slope.
Effectiveness: Slash filter windrows are logging slash placed at the base of fill slopes and below culverts where fish passage is not required has been shownto reduce sediment leaving fill slopes by 75 to 85 percent (Cook and King, **Construction Cost and Erosion Control Effectiveness of Filter Windrows on Fill Slopes**. Research Paper INT-335, Intermountain Research Station, 1983; Burroughs, et. al., **Relative Effectiveness of Fillslope Treatment in Reducing Surface Erosion, Horse Creek Road, Nez Perce National Forest**. Intermountian Fesearch Station, 1985.) Slash filter windrows are effective immediately and during the first few years thereafter; they may later be near capacity and in some cases would have begun to decompose. By that time, though, revegetation would have become more effective.
Compliance: No directly related FPA Rule.
Implementation: Slash windrows will be installed 100 feet on both sides of all new stream crossings where sediment delivery from the fill slope can be expected. Slash filter windrows will also be used on fill slopes where there is a possibility of erosion or sedimentation into a nearby stream or channel (STD FS Spec 201).

PRACTICE 15.04 - Timing of Construction Activities
Objective: To minimize soil erosion, sedimentation and soil productivity loss by insuring activities, including erosion control work, road maintenance, etc., are done: (1) within the time period specified in the construction contract; or (2) when ground conditions are such that erosion and sedimentation can be prevented.
Effectiveness: Moderate
Compliance: FPA 4.c.ix - Meets
Implementation: Within the project area, earthwork shall be postponed during wet periods if, as a result, erodible material would enter streams (FPA 4(c)(ix))

PRACTICE 14.05 – Protection of Unstable Areas
PRACTICE 15.05 – Slope Stabilization and Prevention of Mass Failures
Objective: To identify and protect unstable areas and to avoid triggering mass movements of the soil mantle and resultant erosion and sedimentation.
Effectiveness: Avoidance is the most effective measure on high-risk landforms. Risk assessment based on experience is essential. Effectiveness is expected to be moderate
Compliance: FPA Rule 3.d.iii - Meets
Implementation: Unstable areas will be avoided by project design within the project area. The following are guidelines that will be followed:

1. Avoid road locations on or adjacent to active landslides, slump blocks and other mass wasting processes.
2. If road construction is necessitated in an area of moderate instability, the embankment should be layer placed or as recommended by a geotechnical engineer.
3. Identify any opportunities to stabilize existing unstable areas or minimize the adverse impacts associated with the unstable areas.

PRACTICE 14.17 – Streambank Channel Protection (Implementation and Enforcement)
PRACTICE 15.19 – Streambank Protection
Objective: To protect stream beds and streamside vegetation, during and after forest practice operations and road construction, by (1) maintaining unobstructed passage of stormflows; and (2) reducing sediment and other pollutants from entering streams.
Effectiveness: Much of this mitigation consists of avoiding the impact, minimizing the impact, or rectifying the impact [40 CFR 1508.20 (a-c)]. The Forest Service has near-complete control over construction operations. Effectiveness is expected to be high.
Compliance: FPA Rules 3.f.i, ii; 3.g.i,ii - Meets SCA Rules
Implementation: To reduce sediment and channel bank degradation at sites disturbed by construction of stream crossing or roadway fill, it may be necessary to incorporate "armoring" in the design of a structure to allow the water course to stabilize after construction. Riprap, root wads, and other measures are commonly used to armor stream banks and drainage ways from the erosive forces of flowing water. These measures must be sized and installed in such a way that they effectively resist erosive water velocities. Stone used for riprap should be free from weakly structured rock, soil, organic material and materials of insufficient size, all of which are not resistant to stream flow and would only serve as sediment sources. Outlets for drainage facilities in erodible soils commonly require rip-rapping for energy dissipation (FSH 7709.56B, and Std. FS Spec. 619).

The intent of the regulations and clauses is to protect the integrity of stream channels, and minimize adverse impacts to the channel and downstream resources and beneficial uses. The following items highlight some of the principal provisions incorporated into the engineering contract that will govern channel protection in the sale area.

1. Care shall be taken to cause only the minimum necessary disturbance to streambanks. Streambank vegetation shall be protected except where its removal is absolutely necessary for completion of the work [SCPA Rule 9,1(c) and TSC Provisions B6.3 and C6.50].

2. If the channel is damaged during construction, it will be restored as nearly as possible to its original configuration without causing additional damage to the channel.

3. All excess project debris shall be removed from streamcourse, in an agreed manner that will cause the least disturbance. (B6.5 Streamcourse Protection).

PRACTICE 14.18 - Erosion Control Structure Maintenance
Objective: To insure that constructed erosion control structures are stabilized and working effectively.
Effectiveness: High
Compliance: No directly related FPA Rule
Implementation: TSC provision B6.66 requires that during the period of the contract, the Purchaser shall provide maintenance of soil erosion control structures constructed by the Purchaser until they become stabilized, but not for more than one year after their construction. After 1 year, any erosion control work needed is accomplished through performance bond earmarked for that use. TSC provision C6.6(F) requires the Purchaser to maintain erosion control structures concurrently with his operations under the sale and in any case not later than 15 days after completion of skidding each unit or subdivision.

PRACTICE 15.02 - General Guidelines for the Location and Design of Roads and Trails
Objective: To locate and design roads and trails with minimal soil and water resource impact while considering all design criteria.
Effectiveness:

1. **Route location** ground-truths the results of transportation planning and provides site-specific information on possible problem areas (Gray and Megahan, 1981; Cline et. al., 1981; Megahan and Kidd, 1972; King and Gonsior, 1980).

2. **Designed and controlled cut slopes, fill slopes, road width, and road grades** effectively reduce sediment production by fitting the roads to the land (Bethalmy and Kidd, 1966; Burroughs, Watts, King, and Hanson, 1985; King, 1979; Megahan, 1978).

Compliance: FPA Rules 4.b.i,ii,iii & 4.c.i – Meets; SCA Rules 9,7 - Meets
Implemenation: The following listed items are incorporated in general road location and design guidelines for minimizing impacts on water quality:

Design:

1. Roads shall be planned no wider than necessary to safely accomodate the anticipated use and equipment needs . Cut and fill volumes shall be minimized by designing the road to fit natural terrain features as closely as possible. As much of the excavated material as possible shall be used in fill sections. Minimum cuts and fills shall be planned, particularly near stream channels [FPA Rule 4.b.ii]

2. At a minimum, erosion control measures will be implemented within 100 feet of the stream channel on both sides of live stream crossings and where installation would minimize sediment delivery to nearby streams or channels. Erosion control measures would also be installed where fill slope erosion is possible, or where road derived erosion may be delivered; (i.e. outflow area of culverts or rolling dips, etc.). Erosion control measures may include slashing, mulching, slash filter windrows, straw wattles, and or erosion fencing.
3. Seeding and fertilization of exposed erodible surfaces would be accomplished within the same season of construction. Monitoring would dictate where next season seeding would occur to supplement original treatment. Supplementation would occur if seeding is less than 50% successful.

Location:

1. Utilize natural benches, follow contours, avoid long, steep road grades. Balance cut/fill where possible to avoid waste areas.

2. Locate on stable topography. Embankments and waste shall be designed so that excavated material may be disposed of on geologically stable sites [FPA Rule 4.b.iii].

3. Avoid slumps and slide-prone areas, and steep sidehills.

4. Road construction shall be minimized within stream protection zones. Areas of vegetation shall be left or re-established between roads and streams [FPA Rule 4.b.i and Standard Road Specifications-Special Project Specification 204.01].

Stream crossing sites:
Minimize the number of stream crossings, and choose stable sites. Culverts will be sized, based on hydrologic analysis, to withstand 100 year peak flows.

Road drainage: SEE SWCP 15.07

a. Locate and design roads and trails to drain naturally by appropriate use of out-sloping, rolling dips, and grade changes, where possible. Cross drains will be installed in ditched areas to 1) carry intercepted flow across constructed areas; 2) to relieve the length of undrained ditch; and 3) to reduce disruption of normal drainage patterns. Road and trail drainage should be channeled to effective buffer areas, either natural or manmade, to maximize sediment deposition prior to entry into live water.

b. Ditch lines and road grades will be designed to minimize unfiltered flow into streams. A rolling dip, relief culvert or similar structure will be installed to minimize direct sediment and/or water input directly into streams. Structural means of sediment filtration or settling will be used if road design features are insufficient for the minimization of sediment delivery to streams.

c. Roads shall be planned to drain naturally by out-sloping or in-sloping with cross drainage and by grade changes where possible. Dips, water bars and/or cross drainage will be planned when necessary [FPA Rule 4(b)(iv)].

d. Relief culverts and roadside ditches shall be planned whenever reliance upon natural drainage would not protect the running surface, excavation, or embankment. Culvert installations shall be designed to prevent erosion of the fill. Drainage structures shall be planned to achieve minimum direct discharge of sediment into streams [FPA Rule 4.b.v].

PRACTICE 15.03 - Road and Trail Erosion Control Plan
Objective: To minimize the effects of erosion and the degradation of water quality through erosion control work and road design.
Effectiveness: Moderate
Compliance: No Related FPA Rule
Implementation: Prior to the start of construction, the Contractor shall submit a schedule for proposed erosion control work as required in the Standard Specifications. The schedule shall include all erosion control items identified in the specifications. Erosion control work to be done by the Contractor will be defined in Standard Specification 204 and/or in the Drawings. The schedule shall consider erosion control work necessary for all phases of the project. The Engineer will certify that the Contractors Erosion Control Plan meets the specifications of Std. FS Spec. Section 204.

PRACTICE 15.06 - Mitigation of Surface Erosion and Stabilization of Slopes
Objective: To prevent, limit, and mitigate erosion, sedimentation, and resulting water quality degradation prior to the initiation of construction and to minimize erosion from road cutslopes, fillslopes, and travelways during and after construction.

Effectiveness: Moderate. Seeding and fertilizing cut slopes, fill slopes, and other disturbed areas reduces erosion from these sources after one growing season. Effectiveness has been rated at 85 percent or better once the vegetation has become established (King and Burroughs, 1988).
Compliance: FPA Rule 4.c.iii & d.ii - Meets
Implementation:

1. Areas where exposed material is potentially erodible, and where sediment would enter streams, shall be stabilized prior to fall or spring runoff by seeding, compacting, riprapping, benching, mulching, or other suitable means [IFPA Rule 4(c)(iii), and Standard Road Specifications-Special Project Specification 204.01].

   a. These areas are avoided by design.

2. Slash and debris may be windrowed along the toe of the fill [FPA Rule 4(c)(iv) and General Road Specifications-Special Project Specification 201.5].

   Measures to reestablish vegetation will be accomplished by November 15 on exposed cut and fill slopes. Various operating seasons on varied units and sales within the project area will require seeding and fertilization specs to vary. Mulching or slashing will be required on erodible slopes where difficulty in re-establishing vegetation is anticipated.

   Areas requiring mitigation of surface erosion will occur during the life of the project. When these are found, the following provisions will be implemented.

a. All disturbed areas associated with road construction, decomissioning, or stream bank stabalization will be seeded. The first seeding will be applied as soon as practical within seeding seasons. A second seeding in the fall or spring season following road construction will be required where original seeding did not adequately revegetate exposed soil area.

f. Additional cross drains and/or french drains will be constructed where intercepted moisture is encountered on incised stream approaches. Erosion control blankets and straw bales will be used to prevent sheet or rill erosion where needed.

PRACTICE 15.07 - Control of Permanent Road Drainage
Objective: To minimize the erosive effects of concentrated water and the degradation of water quality by proper design and construction of road drainage systems and drainage control structures.
Effectiveness: Moderate. Designed and controlled ditches, cross drain spacing, and culvert discharge prevent water from running long distances over exposed ground.
Compliance: FPA Rules 4.c.viii; 4.d.iii(a) & (b) - Meets
Implementation: The following items will be included in the project contract.

a. Rerouted and reconstructed roads will include appropriately sized pipes and/or design on to provide fish passage (if needed), pass 100 year flood discharges, and prevent diversion of streamflow by the road, or hydro connectivity runoff from roads to streams.
b. Unstable cut and fill slopes will be stabilized.
c. Additional relief culverts will be installed to drain roads as needed.
d. The grade of outsloped and insloped roads will be varied with graded rolling dips, drivable dips, or drivable waterbars to frequently cross drain surface water and to safely return water to stream channels in the event the culvert plugs.
e. Gravelling will be used on native road surfaces to reduce surface erosion - especially near stream crossings, or other wet areas. A minimum of a 6 inch lift is recommended.

g. During and following operations on out sloped roads, retain out slope drainage and remove berms on the outside except those intentionally constructed for protection of road grade fills [IFPA Rule 4(c)(vi)].
h. Construct cross drains and relief culverts to minimize erosion of embankments. Minimize the time between construction and installation of erosion control devices. Use riprap, vegetative matter, downspouts and similar devices to minimize erosion of the fill.
i. Install relief culverts at a minimum grade of 1 percent greater than road gradient [IFPA Rule 4(c)(viii) and Standard Road Specifications-Special Project Specification 204.1].
j. Drainage ways shall be cleared of all debris generated during construction and/or maintenance that potentially interfere with drainage or water quality [IFPA Rule 4(c)(ii), and Standard Road Specifications-Special Project Specification].

PRACTICE 15.09 - Timely Erosion Control Measures on Incomplete Road and Stream crossing Projects
Objective: To minimize erosion of, and sedimentation from, disturbed ground on incomplete projects.
Effectiveness: Moderate
Compliance: FPA Rules 4.c.ii,iii,iv; & 4.d.iii - Meets
Implementation: The following measures will be implemented during projects:

1. Temporary culverts, side drains, flumes, cross drains, diversion ditches, energy dissipaters, dips, sediment basins, berms, debris racks, or other facilities needed to control erosion will be installed as deemed necessary by the hydrologist, fisheries biologist, or engineer. The removal of temporary culverts, bridges, or diversion structures will be completed as soon as practical;
2. The removal of debris, obstructions, and spoil material from channels and floodplains;
3. Seeding with an erosion control seed mix approved for use on the Idaho Panhandle National Forests to minimize erosion.
4. Install drainage structures or cross drain uncompleted roads that are subject to erosion prior to fall or spring runoff. (Std Spec 204)

Erosion control measures must be kept current with ground disturbance, to the extent that the affected area can be rapidly "closed," if weather conditions deteriorate. Areas must not be abandoned for the winter with remedial measures incomplete.

PRACTICE 15.10 - Control of Road Construction Excavation and Sidecast Material
PRACTICE 15.18 - Disposal of Right-of-Way and Roadside Debris
See also Practice 13.05
Objective: To insure that unconsolidated excavated and sidecast material, construction slash, and roadside debris, generated during road construction, is kept out of streams and to prevent slash and debris from subsequently obstructing channels.
Effectiveness: High
Compliance: FPA Rule 4.c.iii,iv; & 4.d.i,ii,iii
The slash windrow and other erosion control devices will not be placed in existing stream channels or obstruct culvert outfalls. Large limbs and cull logs may be bucked into manageable lengths and piled alongside the road for fuelwood.
Implementation: In the construction of road fills near streams, compact the material to reduce the entry of water, minimize the amount of snow, ice, or frozen soil buried in the embankment. No significant amount of woody material shall be incorporated into fills. Slash and debris may be windrowed along the toe of the fill, but in such a manner as to avoid entry into a stream and culvert blockage.

Where slash windrows are not desirable or practical, other methods of erosion control such as erosion mats, mulch, and straw bale or fabric sediment fences will be used (Must be agreed upon by the hydrologist, fisheries biologist, and/or engineer). Where exposed material (excavation, embankment,

borrow pits, waste piles, etc.) is potentially erodible, and where sediments would enter streams, the material will be stabilized prior to fall or spring runoff by seeding, compacting, rip-rapping, benching, mulching or other suitable means.

The following standard specs will be included in all road contracts that include clearing and excavation.

1. Standard Specification 201 (Slash Treatment)
2. Standard Specification 203 (Excavation and Embankments)

PRACTICE 15.13 - Controlling In-Channel Excavation
Objective: To minimize downstream sedimentation by insuring that all in-channel excavations are carefully planned.
Effectiveness: High
Compliance: SCA Rule 9,1(a) - Meets
Implementation: Location and methods for stream crossings, in-stream structures installation, and stream bank stabalizatin will be designed and agreed to prior to construction. The following items highlight some of the principal provisions incorporated into the construction contract that will govern channel protection:

1. Construction equipment may cross, operate in, or operate near streamcourses **only** where so agreed to and designated by the Forest Service prior to construction. Crossing of perennial stream channels will be done in compliance with the specifications in the Stream Channel Alteration Act Rules and Regulations and included in the project specifications.

2. During culvert installation, no construction equipment shall be operated below the existing water surface except to ford streams. Fording will be limited to one location. Work below the water level that is necessary for culvert bedding or footing installations will be permitted to the extent that it does not create unnecessary turbidity or stream channel disturbance [SCA Rule 9,1 (a) and Standard Road Specifications-Special Project Specification 204.04].

3. Where extended periods of operation are required to install bridges with frequent crossing of machinery, temporary bridges will be used to protect watershed and fisheries resources.

4. Construction of any in-stream structures requiring operations within the stream channel will be permitted only when no other practical manner of operation is possible, and will be in compliance with the Rules and Regulations pertaining to the Stream Channel Protection Act, Title 42, Chapter 38, Idaho Code).

PRACTICE 15.14 – Diversion of Flows around Construction Sites
Objective: To minimize downstream sedimentation by insuring that all stream diversions are carefully planned.
Effectiveness: High
Compliance: Meets SCA Rules
Implementation: Flow in stream courses may only be diverted if the Forest Service deems it necessary for the contractor to meet contractual specifications. Such a diverted flow shall be restored to the natural stream course as soon as practicable. Stream channels impacted by construction activity will be restored to their natural grade, condition, and alignment.

PRACTICE 15.16 - Bridge and Culvert Installation (Disposition of Surplus Material and Protection of Fisheries)
See also Practice 15.13.
Objective: To minimize sedimentation and turbidity resulting from excavation for in-channel structures.

Effectiveness: High
Compliance: SCA Rule - Meets
Implementation: The following preventive measures will be included in contract specifications for such installations:

1. Diverting stream flow through or around project sites if needed during construction in order to minimize erosion and downstream sedimentation. Active streams will be de-watered or diverted during culvert installations.
2. Erodible material shall not be deposited into live streams.
3. Any material stockpiled on floodplains shall be removed before rising waters reach the stockpiled material.
4. During excavation in or near the streamcourse, it may be necessary to use suitable coffer dams, caissions, cribs or sheet piling. This will usually be the case where groundwater is contributing a significant amount of water to the immediate excavation area. If any of the aforementioned devices are used, they will be practically watertight and no excavation will be made immediately outside of them.
5. Water pumped from foundation excavation shall not be discharged directly into live streams, but shall be pumped into settling ponds or into locations where water will not re-enter water.
6. All fill material shall be placed and compacted in horizontal lifts. Areas to be filled shall be cleared of all vegetation, debris, and other materials that would be objectionable in the fill [SCPA Rule 9,1(d) and Standard Road Specifications-Special Project Specification 203.15].
7. Any disturbed areas along stream banks or in the riparian area associated with construction activities will be mulched, and/or slashed; and seeded with an appropriate native seed mix.
8. Runoff from disturbed areas will be controlled with straw wattles or bales, slash filter windrows, or erosion fencing until vegetation is well established and effectively controlling erosion.

PRACTICE 15.17 - Regulation of Borrow Pits, Gravel Sources and Quarries
Objective: To minimize sediment production from borrow pits, gravel sources, and quarries, and limit channel disturbances in those gravel sources suitable for development in floodplains.
Effectiveness: High
Compliance: No Related FPA Rule
Implementation: Minimize opportunities for erosion from Borrow pits and gravel sources from entering streams.

1. Complete any crushing and/or screening of excavated bedload away from any active stream channels and minimize future opportunities for waste materials to enter area streams, even under flood conditions.
2. Identify opportunities to minimize erosion from existing borrow pits within the drainage.
3. If development of new rock sources are needed within the watershed, complete a pit development plan or rock source development plan which outlines all mitigation measures needed to control future erosion at the rock source.

PRACTICE 15.21 - Maintenance of Roads
Objective: To conduct regular preventive maintenance operations to avoid deterioration of the roadway surface and minimize disturbance and damage to water quality, and fish habitat.
Effectiveness: Moderate
Compliance: FPA Rule 4.d.i, ii, iii, iv, v - Meets
Implementation: For roads in the active project area, the operating contractor is responsible the necessary maintenance of roads as described in the contract. This responsibility shall cover the before, during, and after operation period during any year when operations and road use are performed under the terms of the contract. The contractor shall perform road maintenance work, commensurate with use on roads controlled by Forest Service and used in connection with this project. All maintenance work shall

be done concurrently, as necessary, in accordance with specifications set forth in the construction contract.

1. Sidecast all debris or slide material associated with road maintenance in a manner to prevent their entry into streams [IFPA Rule 4(d)(i), and Standard Road Specification-Special Project Specification T108].
2. Repair and stabilize slumps, slides, and other erosion features causing stream sedimentation [IFPA Rule 4(d) (ii)], to be approved by the hydrologist, or fisheries biologist.
3. Active Roads. An active road is a forest road being used as a travel way for or a component of project implementation. The following maintenance shall be conducted on such roads.
    (a) Culverts and ditches shall be kept functional.
    (b) During and upon completion of seasonal operations, the road surface shall be crowned, out-sloped, in-sloped or water barred, and berms removed from the outside edge except those intentionally constructed for the protection of fill material.
    (c) The road surface shall be maintained as necessary to minimize erosion of the subgrade and to provide proper drainage.
    (d) If road oil or other surface stabilizing materials are used, apply them in such a manner as to prevent their entry into streams [IFPA Rule 4(d)(iii)].

PRACTICE 15.22 - Road Surface Treatment to Prevent Loss of Materials
Objective: To minimize the erosion of road surface materials and reduce the likelihood of sediment production.
Effectiveness: Stabilization of road surface and ditch lines over 6 percent with competent rock is often over 90 percent effective (Burroughs, et.al., 1983a, 1983b, 1984, 1985; King and Burroughs, 1988). High
Compliance: No directly related FPA Rule
Implementation: Contractor shall undertake measures to prevent excessive loss of road material if the need for such action has been identified. Road surface treatments may include: watering, applying magnesium chloride, sealing, aggregate surfacing, chip-sealing, or paving.

PRACTICE 15.24 - Snow Removal Controls
Objective: To minimize the impact of snow melt on road surfaces and embankments and to reduce the probability of sediment production resulting from snow removal operations.
Effectiveness: Moderate
Compliance: No directly related FPA Rule
Implementation: For Forest roads that will be used for project access during early or late season operations, the following measures will be employed:

1. The Purchaser is responsible for snow removal in a manner that will protect roads and adjacent resources.
2. Rocking or other special surfacing and/or drainage measures may be necessary before the operator is allowed to use the roads.
3. During snow removal operations, banks shall not be undercut nor shall gravel or other selected surfacing material be bladed off the roadway surface. Ditches and culverts shall be kept functional during and following roadway use. If the road surface is damaged, the Purchaser shall replace lost surface material with similar quality material and repair structures damaged in blading operations.
4. Snow berms shall not be left on the road surface or shall be placed to avoid channelization or concentration of melt water on the road or erosive slopes. Berms left on the shoulder of the road shall be removed and/or drainage holes opened at the end of winter operations and before the spring breakup. Drainage holes shall be spaced as required to obtain satisfactory surface drainage without discharge on erodible fills. On insloped roads, drainage holes shall also be provided on the ditch side, but care taken to insure that culverts and culvert inlets are not damaged.

PRACTICE 11.07 – Oil and Hazardous Substance Spill Contingency Planning
PRACTICE 11.11 – Petroleum Storage and Delivery Facilities & Management
PRACTICE 15.11 – Servicing and Refueling of Equipment
Objective: To prevent contamination of waters from accidental spills of fuels, lubricants, bitumens, raw sewage, wash water, and other harmful materials by prior planning and development of Spill Prevention Control and Countermeasure Plans.
Effectiveness: Although SPCC Plans cannot eliminate the risk of materials being spilled and escaping into waters, they can if followed be effective at reducing adverse effects to tolerable levels. Depending on the location and quantity of a spill, a properly implemented Plan can provide for up to 100 percent containment of a spill.
Compliance: FPA Rule 2.j.i,ii - Meets
Implementation: TSC provision C6.341 holds the purchaser responsible for taking appropriate preventive measures to insure that any spill of oil or oil products does not enter any stream or other waters of the United States. If the total oil or oil products storage exceeds 1320 gallons or if any single container exceeds a capacity of 660 gallons, the contractor will prepare a Spill Prevention Control and Countermeasures Plan. The plan shall meet EPA requirements including certification by a registered professional engineer. If necessary, specific requirements for transporting oil to be used in conjunction with the contract will be specified in the contract.

The Contracting Officer Representative will designate the location, size and allowable uses of service and refueling areas. The criteria below will be followed at a minimum:

1. Petroleum product storage containers with capacities of more than 200 gallons, stationary or mobile, will be located no closer than 100 feet from stream, water course, or area of open water. Dikes, berms, or embankments will be constructed to contain the volume of petroleum products stored within the tanks. Diked areas will be sufficiently impervious and of adequate capacity to contain spilled petroleum products. [FPA RULE 2(j)]

2. Transferring petroleum products: During fueling operations or petroleum product transfer to other containers, there shall be a person attending such operations at all times [FPA Rule 2(j)(i)].

3. Equipment used for transportation or storage of petroleum products shall be maintained in a leakproof condition. If the Forest Service Representative determines there is evidence of petroleum product leakage or spillage he/she shall have the authority to suspend the further use of such equipment until the deficiency has been corrected. [FPA Rule 2(j)(ii)]

4. For longer term storage, a sump pond lined with plastic will be constructed equal to the volume of fuel stored on the site.

In the event any leakage or spillage enters any stream, water course or area of open water, the operator will immediately notify the COR who will be required to follow the actions to be taken in case of hazardous spill, as outlined in the Forest Hazardous Substance Spill Contingency Plan.

Appendix B - Fisheries Management Direction and Guidelines

INFS Standards and Guidelines (A7-13)

Only INFS standards and guidelines that apply to the range of alternatives for the Lightning Creek Project are addressed here; those standard and guidelines that do not apply are in the INFS document located in the project file. These INFS standards and guidelines are addressed with comments in italics as follows:

Roads Management (A7-8)

RF-1. Cooperate with Federal, Tribal, State, and county agencies, and cost-share partners to achieve consistency in road design, operation, and maintenance necessary to attain Riparian Management Objectives.

The proposed activities are all on National Forest lands, but have been coordinated with all those listed where applicable.

Effectiveness: *High. This coordination is standard policy.*

RF-2. For each existing or planned road, meet the Riparian Management Objectives and avoid adverse effects to inland native fish by:

a. Completing watershed analyses prior to construction of new roads or landings in Riparian Habitat Conservation Areas (RHCAs) within priority watersheds.

This project area is not within a priority watershed. However, there will be a minimal amount of road construction within RHCAs to reroute the road prism further away from the stream.

b. Minimizing road and landing locations in Riparian Habitat Conservation Areas.

No new roads (other than the reroutes) or landings are proposed within RHCAs on National Forest lands under the action alternatives.

Effectiveness: *High.*

c. Initiating development and implementation of a Road Management Plan or a Transportation Management Plan. At a minimum, address the following items in the plan:

1. Road design criteria, elements, and standards that govern construction and reconstruction.
2. Road management objectives for each road.
3. Criteria that govern road operation, maintenance, and management.
4. Requirements for pre-, during-, and post-storm inspections and maintenance
5. Regulation of traffic during wet periods to minimize erosion and sediment delivery and accomplish other objectives such as protection of the road surface.
6. Implementation and effectiveness monitoring plans for road stability, drainage, and erosion control.
7. Mitigation plans for road failures.

The interdisciplinary team (IDT) evaluated access and road improvement needs within the project area and completed a Roads Analysis Report with standards and management objectives (see the project file).

Effectiveness: *Moderate.*

d. Avoiding sediment delivery to streams from the road surface.

1. Outsloping of the roadway surface is preferred, except in cases where outsloping would increase sediment delivery to streams or where outsloping is unfeasible or unsafe.

This standard is applied directly for all roads where feasible.

Effectiveness: *High. Roads would be constructed with this design.*

2. Route road drainage away from potentially unstable stream channels and hillslopes.

Effectiveness: High. Improved road drainage would be part of the road package. Water would be less concentrated below existing roads than at present.

e. Avoiding disruption of natural hydrologic flow paths.

Roadwork associated with this project including road reconstruction and decommissioning will be completed.

Effectiveness: High. Road reconstruction projects would restore the hydrologic flow paths.

f. Avoid sidecasting of soils or snow. Sidecasting of road material is prohibited on road segments within or abutting RHCAs in priority watersheds.

Sidecasting of snow and/or soils would be prohibited at all stream crossings.

RF-3. Determine the influence of each road on the Riparian Management Objectives. Meet Riparian Management Objectives and avoid adverse effects on inland native fish by:

a. Reconstructing road and drainage features that do not meet design criteria or operation and maintenance standards, or that have been shown to be less effective than designed for controlling sediment delivery, or that retard attainment of Riparian Management Objectives, or does not protect priority watersheds from increased sedimentation.

b. Prioritizing reconstruction based on the current and potential damage to inland native fish and their priority watersheds, the ecological value of the riparian resources affected, and the feasibility of options such as helicopter logging and road relocation out of Riparian Habitat Conservation Areas.

c. Closing and stabilizing; or obliterating and stabilizing; roads not needed for future management activities. Prioritize these actions based on the current and potential damage to inland native fish in priority watersheds, and the ecological value of the riparian resources affected.

The proposed road reconstruction and maintenance described in the proposed actions originate from the above standards. The action alternatives would meet this standard.

Effectiveness: High. Existing roads are proposed for reconstruction with the Lightning Creek Project, so the likelihood that the projects would be completed is high.

RF-4. Construct new, and improve existing, culverts, bridges, and other stream crossings to accommodate a 100-year flood, including associated bed load and debris, where those improvements would/do pose a substantial risk to riparian conditions. Substantial risk improvements include those that do not meet design and operation maintenance criteria, or that have been shown to be less effective than designed for controlling erosion, or that retard attainment of Riparian Management Objectives, or that do not protect priority watersheds from increased sedimentation. Base priority for upgrading on risks in priority watersheds and the ecological value of the riparian resources affected. Construct and maintain crossings to prevent diversion of streamflow out of the channel and down the road in the event of crossing failure.

The proposed road crossing improvements originate from the above standard. The action alternatives would meet this standard.

Effectiveness: High. *Many existing crossings will be brought up to this standard.*

RF-5. Provide and maintain fish passage at all road crossings of existing and potential fish-bearing streams.

Effectiveness: *High. There are currently no crossings that are known fish barriers in the project area. The proposed road design would maintain fish passage. The culvert upgrades planned for Cascade and Quartz Creeks will occur separately from this project.*

General Riparian Area Management (A-12)

RA-1. Identify and cooperate with Federal, Tribal, State and local governments to secure instream flows needed to maintain riparian resources, channel conditions, and aquatic habitat.

This project does not adversely affect instream flows.

RA-2. Trees may be felled in Riparian Habitat Conservation Areas when they pose a safety risk. Keep felled trees on site when needed to meet woody debris objectives.

Effectiveness: *High. This is a standard BMP that is part of the contract.*

RA-3. Apply herbicides, pesticides, and other toxicants, and other chemicals in a manner that does not retard or prevent attainment of Riparian Management Objectives and avoids adverse effects on inland native fish.

By following the BMPs listed in the Sandpoint Noxious Weed FEIS, all alternatives would meet this standard.

Effectiveness: *High. Standards would be met as required by the Sandpoint Noxious Weed EIS.*

RA-4. Prohibit storage of fuels and other toxicants within Riparian Habitat Conservation Areas. Prohibit refueling with Riparian Habitat Conservation Areas unless there are no other alternatives. The Forest

Service must approve refueling sites within a Riparian Habitat Conservation Area and have an approved spill containment plan.

Effectiveness: High. This is a standard BMP that is part of the contract.

RA-5. Locate water-drafting sites to avoid adverse effects to inland native fish and instream flows, and in a manner that does not retard or prevent attainment of Riparian Management Objectives.

Effectiveness: Moderate. This standard would be applied as watering of road surfaces for proper blading may be necessary.

Watershed and Habitat Restoration (A-12)

WR-1. Design and implement watershed restoration projects in a manner that promotes the long-term ecological integrity of ecosystems, conserves the genetic integrity of native species, and contributes to attainment of Riparian Management Objectives.

Effectiveness: High. The project originates from the above standard. The action alternatives would meet this standard.

WR-2. Cooperate with Federal, State, local, and Tribal agencies, and private landowners to develop watershed-based Coordinated Resource Management Plans (CRMPs) or other cooperative agreements to meet Riparian Management Objectives.

Effectiveness: Moderate to High. Cooperation at the multiple levels as listed occurred within the framework for developing the proposed activities of this project.

Fisheries and Wildlife Restoration (A-13)

FW-1. Design and implement fish and wildlife habitat restoration and enhancement actions in a manner that contributes to attainment of the Riparian Management Objectives.

Effectiveness: High. Improvements to culverts, road decommissioning, and riparian planting are habitat enhancement actions that will be implemented in a manner that contributes to attainment of Riparian Management Objectives.

FW-4. Cooperate with Federal, Tribal, and State fish management agencies to identify and eliminate adverse effects on native fish associated with habitat manipulation, fish stocking, fish harvest, and poaching.

Cooperation at the multiple levels as listed occurred within the framework for developing the proposed activities of this project. Using the INFS Standard Widths Defining Interim RHCAs for the project activities, habitat manipulation does not apply. Fish stocking, harvest and/or poaching are all regulated by State management guidelines.

Effectiveness: High. Existing habitat would be preserved under this project.

Forest Plan Guidelines (USDA 1987, pp. II-29 to 31)

Idaho Panhandle National Forests Land and Resource Management Plan

Both action alternatives meet the requirements of the IPNF Forest Plan for fisheries resources, as amended by the Inland Native Fish Strategy. Specific requirements and how this project meets them are listed in the following section (A.3-d) on Fish Management Direction.

Fry Emergence Amendment to the Forest Plan

On June 2, 2005, the Forest Supervisor for the Idaho Panhandle National Forests signed a Decision Notice and Finding of No Significant Impact that amended the Forest Plan to modify or remove objectives, standards and monitoring requirements pertaining to fry emergence success (IPNF 2005). The amendment was implemented because the fry emergence objectives, standards and monitoring requirements that were in the IPNF Forest Plan did not contribute as well as INFS objectives, standards, guidelines and monitoring direction towards meeting the goals of providing sufficient habitat in support of maintaining diverse and viable populations of fish species across the forest. In addition, because of the limited application of the fry emergence models and their unreliability, and the inability to determine fry emergence success in the field due to high variability affected by multiple natural and human-caused factors, the Forest Service was not able to state with any degree of certainty whether measures for fry emergence success were accurate or precise.

Endangered Species Act

All three action alternatives meet the requirements of the Endangered Species Act. The project may affect, and would likely adversely affect threatened bull trout, but would not jeopardize their continued existence. There is no designated critical habitat for bull trout within the cumulative effects area.

State of Idaho Governor's Bull Trout Plan

The following describes a "step down" process from the Governors Bull Trout Plan.
Governors Bull Trout Plan (State of Idaho 1996):

- The mission of the plan is to "…maintain and or restore complex interacting groups of bull trout populations throughout their native range in Idaho.
- The Plan created the Basin Advisory Groups, which oversee the Watershed Advisory Groups (WAG). The Technical Advisory Team's role is to assist the WAG with issues regarding recovery of bull trout in each key watershed.

Lake Pend Oreille Key Watershed Problem Assessment (Technical Advisory Team 1998)

- Threats and limiting factors to restoration of bull trout in Lightning Creek include degraded habitat from road destabilization and flooding.

Lake Pend Oreille Bull Trout Conservation Plan (Final Draft; LPOWAG July 1999)

- Watersheds were ranked by the TAT based on the following criteria:
  - The probability of persistence for bull trout;
  - Current habitat/watershed conditions;
  - The need for watershed restoration and/or protection;
  - The potential to increase bull trout numbers.
- The Lightning Creek Complex is a High Priority watershed for restoration.
- The conservation plan emphasizes restoration activities in High Priority watersheds only.

The Final Draft of the Lake Pend Oreille Bull Trout Conservation Plan was forwarded to the Governor's office as the final plan. The WAG has not regrouped to implement the plan; however, many of the restoration activities are being accomplished through other means (Dave Mosier, personal communication, 2001).

Appendix C – Design Features and Mitigation Measures

Measures Designed to Protect Water Quality and Aquatic Habitat and Species

Road Decommissioning – All road decommissioning would be accomplished with techniques appropriate to site-specific conditions. This may include full and partial recontouring; surface ripping or subsoiling for decompaction, removing all culverts; stabilizing fill slopes and restoring stream channel crossings back to natural grade. Seeding, fertilizing, mulching and/or placement of woody debris would follow to prevent erosion, establish desired vegetation and prevent noxious weed spread. Some road segments that are stable, hydrologically inert, and well vegetated may need no treatment. Decommissioned roads would be recontoured for one sight distance from the beginning of the road and a permanent closure structure, such as large boulders, would be put in place to eliminate the unauthorized, motorized use of the road.

Estimated Effectiveness: High; road-decommissioning activities provide long-term improvements in reducing erosion and sediment delivery to stream channels. Removing culverts would prevent them from plugging and prevent the associated fill from failing and delivering large quantities of sediment (USDA Forest Service 1999 and 2000).

Hydro-mulching – Various sites of soil disturbance associated with road reconstruction and/or decommissioning would require hydro-mulching within critical areas such as wet areas. Mulching would occur immediately following road reconstruction/decommissioning activities are complete.

Estimated Effectiveness: Moderate to High; this measure is 40-80 percent effective in reducing sediment (Burroughs and King 1989).

Spot Gravelling – To help reduce sediment delivery to streams, spot gravelling with approximately 6 inches of gravel would be required on high traffic roads at stream crossings, perennial wet areas, and other sensitive areas as needed.

Estimated Effectiveness: High; this measure is 92 percent effective in reducing the amount of sediment delivered to streams (Foltz and Truebe 1995).

Road Surface and Stream Crossing Maintenance to Improve Aquatic Habitat – The main source of erosion and sediment delivery from roads is usually from the road surface. Road maintenance activities that focus on reducing sediment delivery are blading along the road prism; spot surfacing at stream crossings; installing relief culverts where ditch lengths are too long; cleaning and improving ditches; cleaning the inlet and outlets of culverts; and installing rolling dips and outlet ditches. These activities would help improve road surface drainage and decrease sediment delivery to stream channels.

Road/stream crossings that pose a hazard and risk to aquatic species and their habitat from potential culvert failure, chronic sediment delivery, or a barrier to fish passage have been evaluated throughout the project area. Recommendations for each crossing may include replacing, redesigning or upgrading crossings as needed.

Estimated Effectiveness: High; proposed road surfacing and stream crossing improvements would occur with funding through Federal Highways contract for ERFO road work, Avista, or Forest Service appropriated budget.

The only practical options for managing this size fraction (silt sized) in forests are reducing the generation rate through better surfacing, or dispersing concentrated flows before they reach streams. Sheridan 2005 shows that if roads are surfaced with good quality aggregate, and road cross-fall and drainage is maintained correctly, then the sediment generation rate will be similar in both wet and dry conditions.

Sediment Reduction during Culvert Installation - Specific mitigation features to control sediment delivery during culvert installation and maintenance consist of the following:

- Standard erosion control measures such as temporarily diverting flow into a culvert, a plastic or rock-lined channel, pumping water below the site, or use of silt fences or hay bales would be used to minimize sediment transport downstream.
- Ditch relief pipes would be installed at a skew of 3% off of the road grade and have a minimum of a 5% grade. Installing relief pipes at an angle allows the pipe to be somewhat self-maintaining.
- Pipe locations would be marked with a flexible plastic marker to ease finding the pipes for future monitoring and maintenance. Clearly marking the location of the relief pipes and stream crossings would allow individuals assigned to regular maintenance to more easily locate pipes and track maintenance needs.

Estimated Effectiveness: High; prescribed BMPs which address standard erosion control measures would significantly reduce this risk of sediment delivery by controlling the water at the worksite and minimizing the contact of the water to the exposed soils (Seyedbagheri 1996).

Rootwads and Large Woody Debris (LWD) to Stabilize Road Fill and Mitigate Bank Erosion – Rootwads (LWD with rootwad attached) and LWD would be utilized for toe slope protection of road fills, structures built within the floodplain, and unprotected banks adjacent to flowing water. Rootwads and LWD would be incorporated into the fill material on road reconstruction sites to serve as flow deflectors and armoring against high velocity turbulent flows where shear stress rates and erosion in the near bank region are much higher. Rootwads and LWD would also be used in the channel at specific sites to deflect high velocity erosive flow and/or serve a multiple purpose as fish habitat creators. One particular site where this would be utilized is at the toe of the large mass failure above the bridge construction site at the East Fork of Lightning Creek.

Estimated Effectiveness: When anchored with large rock (riprap) and other interlocking large wood and buried in the fill, rootwads and LWD are effective at reducing lateral erosion of streambanks, preventing the loss of heavy toe slope protection in road base such as riprap, and diverting high velocity flows from fixed structures such as bridge abutments. Studies show Rootwads and LWD tolerate high boundary shear stress when logs and rootwads are well anchored (San Dimas Technology and Development Center).

Timing of Activities

- Project activities requiring the use of motorized equipment (e.g., excavators, chainsaws, helicopters) or explosives within core habitat would only take place in one subwatershed per year and would move systematically throughout the Lightning Creek watershed.
- The following chart represents a likely scenario on the timing of how project activities would be implemented:

Year of Project	Subdrainage (6th code HUC)	Activities within Core Habitat?	Roads/Trails with Ground Disturbance Activities
1	- Lightning Creek below East Fork Lightning Creek - Middle Lightning Creek - Lightning Creek above Rattle Creek	No	419, 419B, 642
1	- Middle Lightning Creek (Porcupine Creek)	Partially	642, 2759, 399, Section 26 Roads
2	- Middle Lightning Creek (Rattle Creek)	Partially	473, 473A, 473UA, 473UB, Section 36 Roads
3	- East Fork Lightning Creek	Partially	1030, 1184, Trail 61, Trail 212
4	- Middle Lightning Creek (Wellington Creek)	Partially	1006, 1016, 1053
5	- Middle Lightning Creek (Mud Creek)	Partially	340
5	- Middle Lightning Creek	No	1054A, 1054B
6	- Lightning Creek above Rattle Creek	Partially	1022A, 1091A, 1091UB, 419A, 419H

Estimated Effectiveness: High; the timing and spatial limitations would be implemented as part of the contract. Similar design features have been used in past projects such as the Kirby's Wildlife Habitat Improvement Project and have been effective in keeping project activities from impacting the entire landscape simultaneously