WATERSHED RESTORATION PLAN
For
Big Creek, North Fork of the Flathead River

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SECTION 1.0
INTRODUCTION

Big Creek is a major tributary (77 mile^2 or about 50,000 acres) to the North Fork Flathead River. The North Fork of the Flathead River occupies portions of northwest Montana and southeast British Columbia, Canada. The water yield in Big Creek is produced from an average annual precipitation in the basin that ranges from 62 inches at the top of Big Mountain to 28 inches along the North Fork Flathead River; approximately 60% of this precipitation falls as snow. Streamflows typically peak in late May or June as the snow pack melts. The gradient of Big Creek tributaries in the uppermost portions of the watershed is approximately 1,000 feet per mile (18% stream slope). The gradient of the mainstem of Big Creek is 400 feet per mile for the uppermost four miles (7% stream slope), 200 feet per mile for the stretch in which Big Creek meanders on its valley floor (4% stream slope), and 70 feet per mile in the lowermost 8 miles near the Big Creek Campground (1% stream slope). Big Creek is a key spawning stream for bull trout and westslope cutthroat trout because of the clean water and its physical characteristics.

The State of Montana has classified the waters in Big Creeks as B-1, which is one of the highest possible ratings. Waters classified as B-1 are suitable for drinking, culinary, and food processing purposes after conventional treatment. Water quality must also be suitable for bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply.

There have been many management activities in the Big Creek basin in the past fifty years. These include the construction of approximately 180 miles of roads. Also, vegetation management in one form or another, either timber harvest or thinning, has occurred on approximately 16,691 acres (32%) of the basin, which includes the clearing for portions of the Big Mountain Ski Area. The entire Big Creek basin is now currently owned and managed by the U. S. Forest Service.

Field examination, qualitative, and quantitative stream monitoring confirm that the source of sediments is from a combination of natural and man-caused upland and stream channel erosion. Big Creek is formed in a glacial valley where natural streambank erosion rates are high. Historically, major streambank erosion has occurred during extreme peak flow events, generally following past fires (1910 fire) and flood events (1964 flood). Currently there are several eroding stream terrace escarpments that contribute sediment during high flow events.

The past construction of roads and logging skid trail networks on both national forest and private lands have caused an increased sediment load to Big Creek. At the same time, an increase in water yield following the extensive timber harvest on Forest Service and private lands has been observed. This increased water yield, in combination with the excess sediment supply, has caused streambank instability and stream channel erosion. This has resulted in stream channel widening and stream pool filling from bedload sediments that could not be transported by the stream. During the 1960s and 70s when management activities were extensive, sediment supply exceeded transport capability in the upper basin of Big Creek. Where the gradient of Big Creek is low, particularly in the stretches with less than 4% slope, large quantities of sediments have been stored as point and mid-channel bars found upstream from organic debris in the stream such as individual logs or logjams.

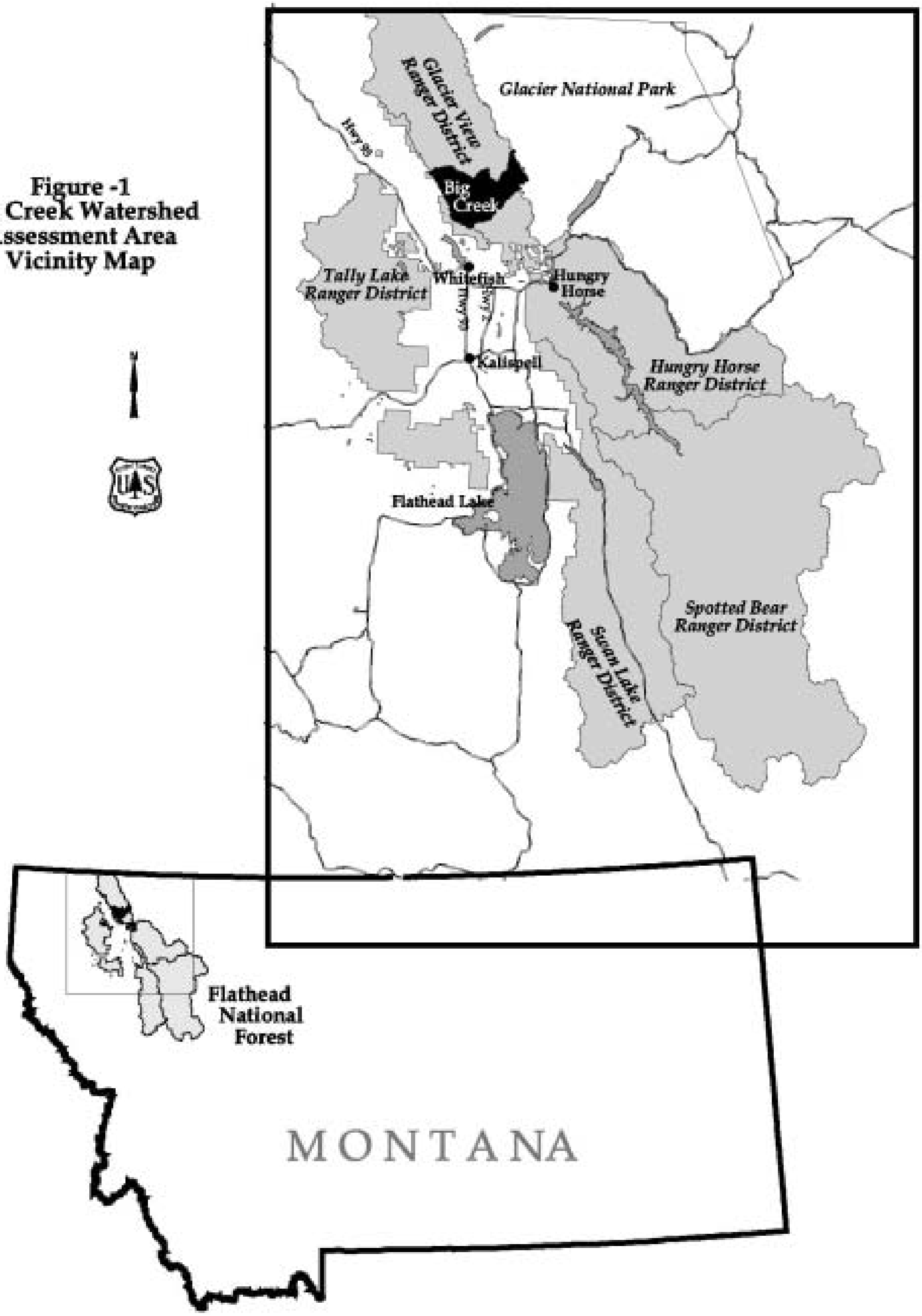
The sediment built up within the stream channel through the late 1970s and 80s became a concern because of its effects on the spawning bull trout population. In 1980, Montana Department of Fish, Wildlife and Parks began sampling the substrate in Big Creek to determine the percentage of fine sediments in the stream channel. Between 1980 and 1990, the percentage of fine sediments in the substrate increased from 23 to 53 percent (see McNeil core data in Table – 4, page 20). Given these factors, Big Creek is presently partially supporting the beneficial uses of aquatic life support and cold-water fishery as defined by the Montana Department of Environmental Quality (DEQ). The probable causes of impairment were listed as siltation and other habitat alterations on the 1996 and 2000 303(d) lists. The 303d list identifies waterbodies, which need Total Maximum Daily Loads (TMDL). The 2000 303(d) list also cited bank erosion and fish habitat degradation. All of the identified causes on the 1996 and 2000 303(d) lists pertain to sediment issues and are therefore addressed within the context of this watershed restoration plan which satisfies TMDL development requirements for sediment. Probable sources of impairment are primarily related to silviculture practices, although recreation such as ski area development and roads maintained primarily for recreational activities also contribute to the sediment load. This watershed restoration plan establishes targets for reducing sediment and streambank erosion. Achieving these targets will restore impaired fish and aquatic life habitat. Appendix A is a Big Creek TMDL "Cross-Walk" that describes the linkages between TMDL elements and this watershed restoration plan.

Refer to Figure -1 for a map showing the location of Big Creek Assessment Area. This is the area covered by the Environmental Analysis at the Watershed Scale that was just recently completed by the Glacier View - Hungry Horse Ranger District Staff (November, 1999). The entire Big Creek Basin is included in this assessment area. There are several excerpts from the assessment document used in this report. Refer to Figure - 2 for a map of the streams in the Big Creek Basin. Note that only the mainstem of Big Creek (stream #1020000) is identified as a water quality limited segment. The other named creeks in the basin have not been assessed for beneficial use support determinations. The watershed approach toward addressing Big Creek sediment impairments, as defined by this plan, incorporates all of the Big Creek tributaries such that restoration measures are expected to ensure full support of all beneficial uses for all water bodies in the drainage.

In November 1999 the Flathead National Forest was notified by DEQ that a sufficient credible data review for the impaired listing of Big Creek had been completed. The review had concluded that there was sufficient data to make a use impairment decision. After discussions with the DEQ staff, Region-1 Forest Service staff, and the Flathead Forest Supervisor, a decision was made to complete this watershed restoration plan. The initial watershed restoration plan was submitted to DEQ in 2001 for review, but before the plan could be finalized the Moose Fire occurred. On August 17, 2001 the wildfire started in the upper portion of the Big Creek watershed. By October 5th the fire had burned over 71,000 acres in the Flathead National Forest, Coal Creek State Forest, and Glacier National Park. Thirty-eight percent of the entire 52,000 acre Big Creek watershed was burned in the Moose Fire. The majority of the fire was a stand replacement fire with moderate burn severity (describes soil heating). This fire will have major effects on the vegetation structure and the streams within the burned area of Big Creek for many years. Refer to Figure – 9, page 44 for a map showing the Big Creek Basin and the portion of the Moose Fire on forest service lands.

Most of the past activity in the Big Creek drainage occurred in the headwaters; activities in the lower part of the watershed have been somewhat more spread out in time and location. Where management activities have been light or nonexistent in the upper reaches of Big Creek and its tributaries, stream channels are not eroding; rocks in the channels are covered with moss and algae, indicating low erosion. Since the major management activities in the 1960s and 70s, Big Creek and its tributaries are gradually improving due to natural revegetation recovery and artificial rehabilitation. However, additional rehabilitation can hasten return of the impaired portion of Big Creek to dynamic equilibrium.

Figure -1
Big Creek Watershed Assessment Area Vicinity Map



The primary stakeholders in the watershed restoration efforts in Big Creek are the Flathead National Forest (FNF), Montana Department of Fish, Wildlife, and Parks (MDFWP), and Winter Sports Incorporated (WSI). Listed in Table - 1 are proposed rehabilitation projects that are meant to decrease the sediment load, improve dispersion and infiltration of concentrated surface water on site, and to stabilize in-channel sediment deposits. These changes to the sediment and peak flow regime will help Big Creek to return to more stable condition. In addition, monitoring of the physical stream parameters over time is proposed to ensure the stream channel is attaining dynamic equilibrium. This includes McNeil Cores (instream fine sediments), channel crossections, and streambank erosion profiles.

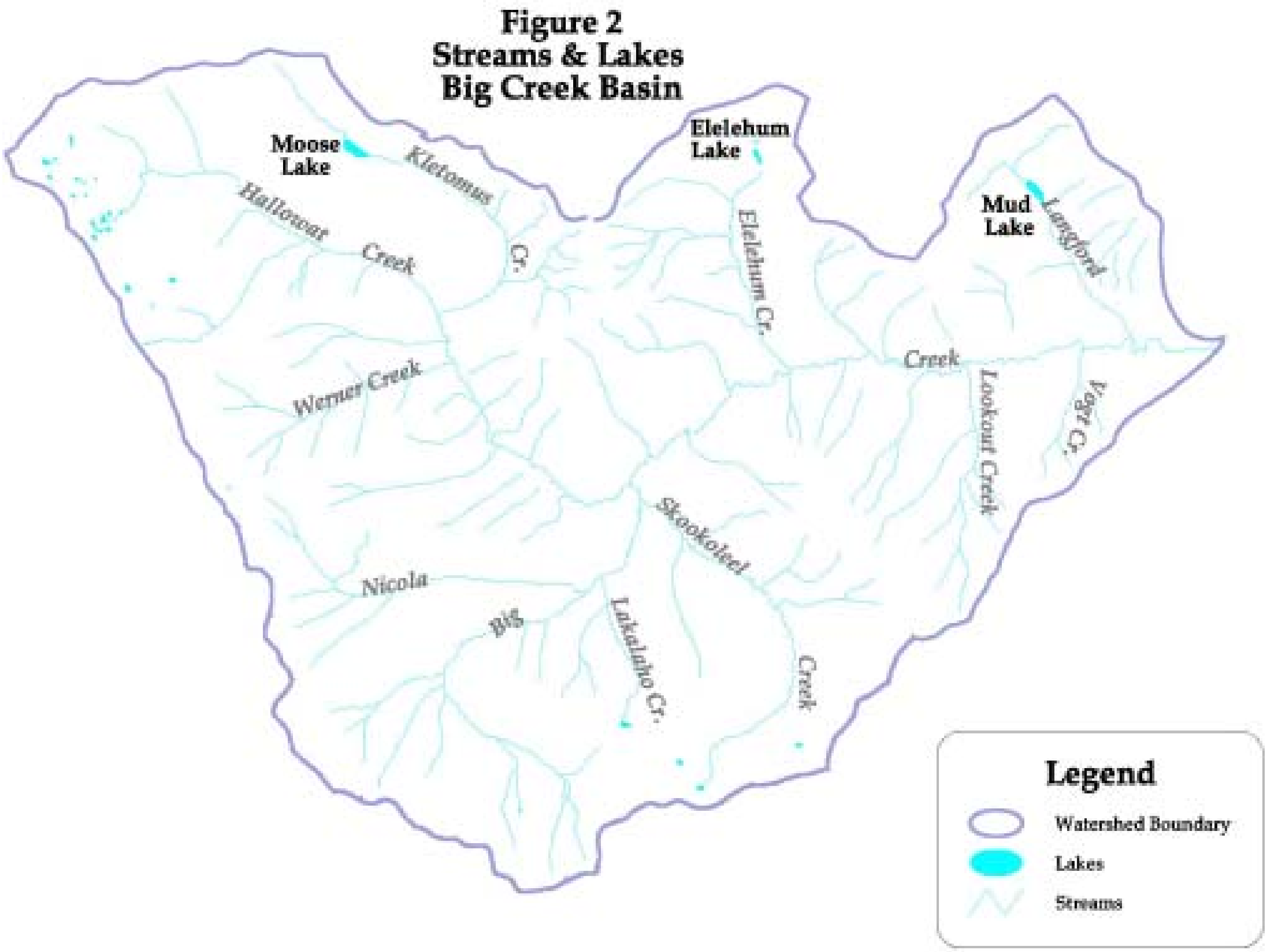


Table -1: Proposed watershed rehabilitation treatments within the Big Creek basin.

PROPOSED TREATMENTS	CURRENT CONDITION	CONDITIONS FOLLOWING TREATMENTS
Reclaim roads in the Big Creek drainage as needed to accomplish resource objectives, estimated to be 75 miles. Refer to page 30 for details.	Existing roads contribute to the soil erosion/sediment production, and add to peak flow responses within the Big Creek Basin.	These treatments will reduce soil erosion/sediment production off of road surfaces and cutslopes. The treatments will disperse water flow, which will help decrease peak flow responses in the basin.
Place large woody debris in streams where large wood recruitment is needed. Approximately 10 miles of streams will be reviewed for these treatments.	There are several riparian areas that have had timber harvest in the past. In some areas the long-term probability for large woody debris recruitment into the stream channel is poor.	Improved quantities of large woody debris for maintenance of streambed structure and fish habitat. These treatments will help decease the amount of in-channel erosion occurring in the reaches with limited large woody debris.
Stabilize existing logjams (concentrated piles of in-channel large woody debris) before they fail and remove trapped in-channel sediment from behind several existing logjams. Remove existing logjams where they are causing significant channel erosion. Prior to the Moose Fire 5 major logjams existed on Big Creek. Three of those jams partially or totally burned. All of these sites need to be assessed.	There are several sites along Big Creek where logjams in the stream are causing the stream to erode a new channel or widen the existing channel. In several logjams the woody materials are becoming rotten and weak. It would be beneficial to remove portions of the trapped sediments before the logjams are breached. In other cases it would be beneficial to remove portions of the logjams to reduce streambank erosion.	These treatments will help decease the amount of in-channel erosion in the reaches where the logjams occur. Also most of the sediments stored behind the logjams would not be allowed to move downstream into stream reaches where key spawning habitat occurs.
Construct waterbars and plant grass/shrubs on old skid roads. Approximately 20 to 25 affected acres will be reviewed for these treatments. (Portion of work completed 2000-2001)	Many historic upland harvest units have skid trails or temporary roads that concentrate overland water flow or diverted ephemeral stream flow. These situations are causing soils erosion.	These treatments will improve vegetative cover, and reduce soil erosion/sediment production off of upland harvest sites. The treatments will disperse water flow, which will help decrease peak flow responses in the basin.
Apply revegetation, drainage, and stabilization treatments to streambank slumps in Big Creek drainage. The treatments may include rock armoring, rock barbs, or tree stump armoring. Seven sites will be reviewed for treatment; approximately 8 to 10 affected acres maybe treated.	There are several existing natural/road associated slumps in Big Creek and it's tributaries that are sediment sources.	These treatments will improve vegetative cover, and reduce soil erosion/sediment production from these existing slumps.
Install improvements in the road surface and stream drainage systems to meet current Montana BMPs (approx. 48 miles). This work would include installation of additional road crossdrains (about 35 culverts or drive thru dips) and up-sizing approx. 77 culverts to INFISH standards.	The portion of the road system remaining in use needs improvements to the road surface and stream drainage systems, in order to meet current Montana State BMPs and INFISH standards.	These treatments will reduce soil erosion/sediment production off of roads surfaces and cutslopes. The treatments will disperse water flow, which will help decrease peak flow responses in the basin.

SECTION 2.0
CONDITION ASSESSMENT AND PROBLEM DESCRIPTION

2.1 Water Quality Standards and Concerns

The DEQ's 1996 and 2000 303(d) Reports - *Waterbodies in need of Total Maximum Daily Load (TMDL) Development*, describe Big Creek as partially supporting the beneficial uses of aquatic life support and cold water fishery. The probable causes of this impairment on both the 1996 and 2000 303(d) lists can all be linked to sediment, with probable sources being linked primarily to silviculture practices. This watershed restoration plan satisfies TMDL development requirements for sediment and impairment sources related to sediment (habitat alterations, siltation, bank erosion, and fish habitat alterations).

The State of Montana has classified the waters in Big Creeks as B-1. Waters classified as B-1 are suitable for drinking, culinary, and food processing purposes after conventional treatment. Water quality must also be suitable for bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply. Additional criteria specific to sediment are found within Section 17.30.623(2)(f) of Montana Water Quality Standards where it is stated that "(N)o increases are allowed above naturally occurring concentrations of sediment, settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife."

The logic for the watershed restoration plan is based upon two facts. First, sediments from past upland/stream erosion stored within the stream channel, along with streambank erosion from channel migration and widening, are the primary causes for Big Creek's listing as an impaired water body. The primary existing beneficial use for Big Creek is aquatic habitat for cold water fisheries. Second, the proposed watershed restoration activities would reduce significantly the input of sediments from the upland eroding sites and a large portion of the existing road system. Therefore, we believe that the watershed restoration objectives should be the following: 1) to reduce the sedimentation load thereby reducing the effect of sedimentation on fishery habitat; and, 2) concurrently with the sedimentation reduction, maintain or reduce the water yield, so that the Big Creek stream channel can achieve dynamic equilibrium.

The entire Big Creek Basin was included in the area of the watershed restoration plan for two reasons. First, the entire mainstem of Big Creek is identified in the 303(d) report as partially supporting beneficial uses, therefore requiring consideration of all potentially significant sediment sources to Big Creek throughout the watershed. And second, the Hungry Horse - Glacier View Ranger District planning team completed a watershed assessment for Big Creek (November 1999), and is proposing a series of management activities in response to the Moose Fire. These activities include road decommissioning, culvert up-sizing, road BMP work, reforestation, and burned timber salvage.

2.2 General Watershed Characterization

2.2.1 General Streamflow Regime Characteristics of Big Creek

Big Creek is a 77 mile^2 watershed with elevation ranging from 3,300 feet to about 6,817 feet. Big Creek is a fourth order stream about 14 miles long. The average annual precipitation in the Big Creek drainage ranges from approximately 62 inches at the top of Big Mountain to 28 inches along the North

Fork Flathead River. Approximately 60% of the precipitation falls as snow, which results in a snow pack of about 100 inches on top of Big Mountain. This precipitation results in an estimated average runoff of 36 inches per year at the highest elevations and approximately 9 inches at the mouth of Big Creek.

Streamflow begins to increase in April as the snow pack melts with warming spring temperatures. Peak streamflow usually occurs in late May or June. Not all snowmelt or rainfall of the study area becomes surface runoff, at least not immediately. Some may infiltrate the ground to become groundwater that percolates downward in the soil and bedrock and resurfaces in wet areas, small ponds, and perennial streams at various elevations below the point of infiltration. Slow release of groundwater provides the stream baseflow starting in mid July to mid September.

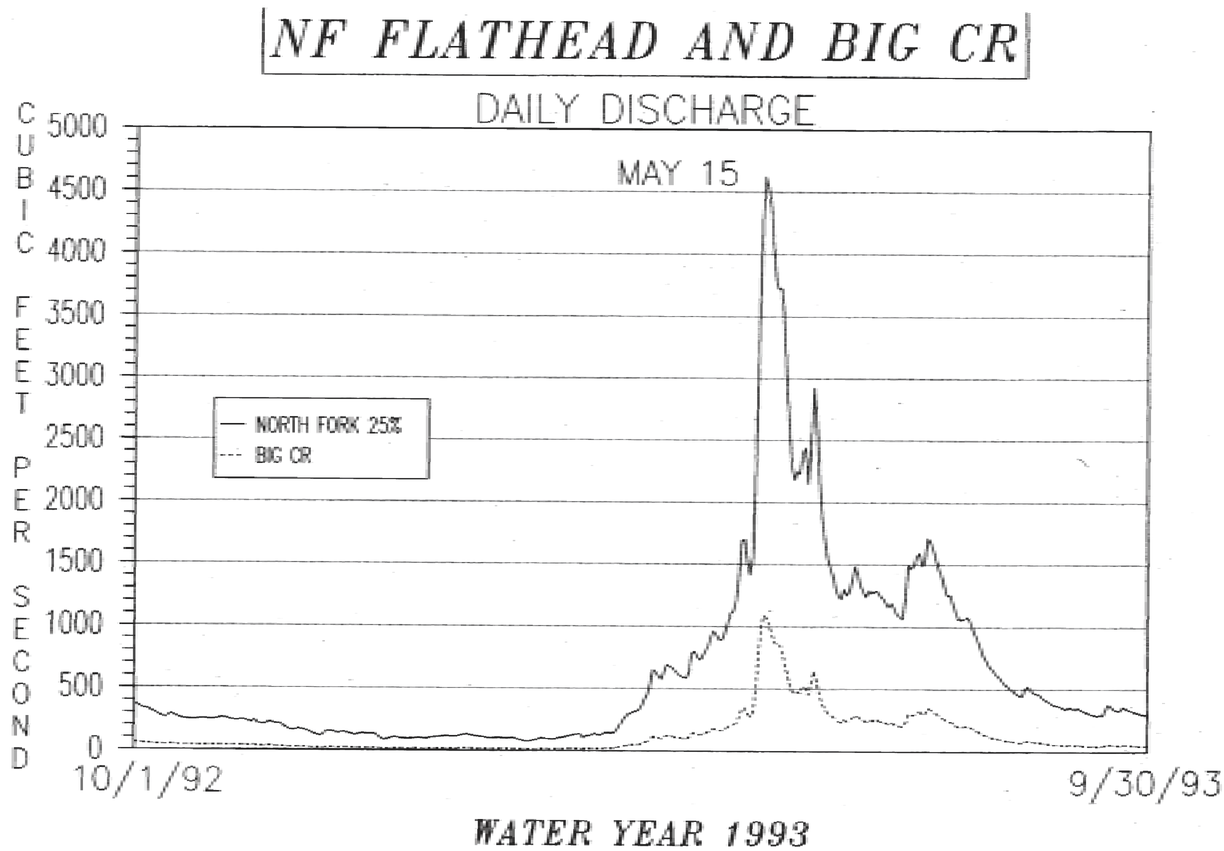
Table –2 displays the average monthly air temperatures and average monthly precipitation at Glacier International Airport (Kalispell, Montana). This National Oceanic and Atmospheric Administration weather station is 16 air miles southeast of the headwaters of Big Creek.

Table – 2: The average monthly air temperatures and average monthly precipitation at Glacier International Airport (Kalispell, Montana).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precip. (inches)	1.40	1.02	0.98	1.01	1.72	2.19	1.13	1.14	1.23	1.05	1.43	1.45	15.75
Temp. (deg. F)	21.1	25.5	33.5	43.7	52.0	58.5	65.1	63.4	53.8	43.5	31.9	24.2	43.0

As previously described, peak streamflow usually occurs in late May or early June from spring snowmelt. Flood flows rarely overtop the channel banks of Big Creek and erode adjacent land areas. High flows that erode the upper banks of the channel occur every three to five years. The last high flow was in the spring of 1998 from the snowmelt of an unusually deep snow pack. There was a stream flow gauge located at Lookout Bridge at Big Creek. Stream flow measurements were taken there from early spring till late fall for several years. During that time 2,424 cubic feet per second (cfs) flow levels were recorded. The maximum recorded flow was 2,404 cfs and the minimum flow was 9 cfs, with the mean flow being 187 cfs. Figure – 3 shows a comparison of the water flow in cfs for the 1992 water-year at the water quality monitoring site in lower Big Creek and on the mainstem of North Fork of the Flathead River, at Glacier Rim

Figure – 3: is a comparison of the water flow in cubic feet/second for the 1992 water-year at the water quality monitoring site in lower Big Creek and on the mainstem of North Fork of the Flathead River, at Glacier Rim.



Water quality-monitoring site (FL7012) is located at the Lookout Bridge, about two miles upstream from the mouth of Big Creek. Starting in 1986, Big Creek was one of the watersheds where suspended sediments and bedload sediments were measured to validate sediment yield assumptions made in the forest plan. Table - 3 displays the results of the suspended sediment monitoring data for seven years.

Table - 3: Annual Suspended Sediment Yield for Big Creek at Lookout Bridge in tons/square mile/year.

Monitoring Year	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**
Annual Sediment Yield (Tons/Square Mile/Year)	199.8	134.4	8.4	23.7	41.3	81.3	81.5

At this monitoring site, annual sediment yield is variable, as streamflow increases, suspended and bedload sediment loads increase. Sediment pulses occasionally move downstream after a mass failure or other major sediment producing action occurs upstream. However, it is during the annual snowmelt peak discharge that sediment transport rates are predictably high and the duration of high sediment transport rates seems to be a function of the duration of bankfull and higher streamflow. Graphs of relationship of total suspended sediment and bedload to stream discharge are displayed in Figures - 4.

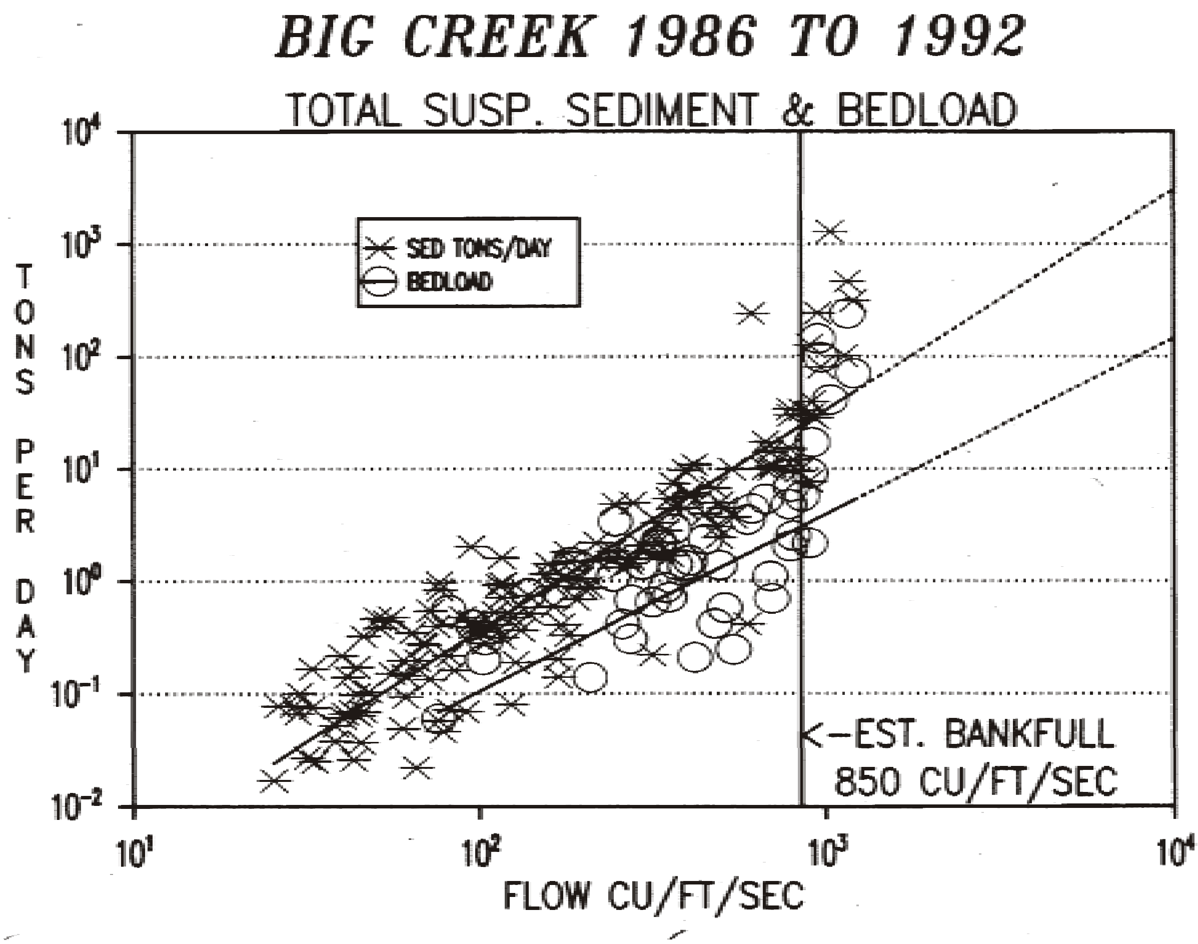


Figure – 4 The total suspended sediment and bedload versus stream discharge for Big Creek, for the years 1986 to 1992.

Suspended sediment/discharge samples were also collected at monitoring site (FL7007) located in the upper reaches of Big Creek, about one-half mile above Nicola Creek. Between 1979 and 1981 a total of 10 samples were gathered. Suspended sediment concentration was not significantly correlated with discharge from these data (Anderson 1988).

2.2.2 Geology/Landform/Stream Type Characterization of the Big Creek Watershed

The Big Creek area is underlain by Proterozoic meta-sedimentary rocks that consist mainly of calcareous argillite, dolomite, limestone and siltite. These rocks weather to form silty soils that are neutral to slightly alkaline with about 30 to 70 percent of the soil volume occupied by rocks. There is a volcanic ash surface present on surface of almost all the soils within the Big Creek basin. The ash is very light and porous and is enriched with organic matter, conditions that allow water to move into and through the soil reducing the occurrence of runoff and soil erosion.

Landform and vegetation are the dominant physical features that affect watershed functions and processes in the Big Creek watershed. Landforms regulate how and where water flows across the landscape. Vegetation influences the erosion processes that occur within the landscape.

Landforms in the Big Creek watershed include both steep mountains and narrow valley bottoms. These landforms include structural breaklands, stream breaklands and steep alpine glaciated lands on slopes in excess of 60 percent. Glaciated lands, mountain slopes and ridges and valley bottoms are on the gentle to moderately sloping portions of the watershed.

Disturbances such as fire and timber harvest release nutrients from vegetation and organic debris on the soil surface. Many of the nutrients end up stored in the soil where they can be used by plants. Some nutrients find their way into streams and ultimately end up in Flathead Lake, which is a state priority for nutrient reductions based upon the recently completed Nutrient Management Plan and Total Maximum Daily Load for Flathead Lake, Montana. The two primary nutrients of concern for Flathead Lake are nitrogen and phosphorus. The potential nutrient contribution for each individual landform is rated from low to high in the following landform descriptions. The nitrogen yield rating is based on the natural level of nitrogen in the soil, soil permeability and precipitation rate. The phosphorus yield rating is based on the natural level of phosphorus in the soil and the sediment hazard.

Another important component of these landforms are sensitive soils. Sensitive soils have an excess of water in the soil, usually on a seasonal basis, but in some cases year around. When sensitive soils are in their natural undisturbed condition they act as a temporary storage site for water, allowing the water to slowly move down slope until it reaches surface features such as springs, wetlands or streams or into groundwater if the underlying bedrock is permeable.

When sensitive soils are disturbed by management activities such as road building or timber harvesting, the water can seep out of the soil and onto the road, skid trail or landing where it moves quickly down slope. Water that would have moved slowly to a stream through the soil profile is now quickly routed to a stream. This re-routing of water increases water yields and the risk of erosion or sediment movement.

A general description of the landform groups and their associated attributes follows. The description includes a discussion of the potential nutrient contribution associated with forest disturbances and the sensitive soils within each landform group. Figure - 5 is a map of these general landform groups for Big Creek.

Valley Bottoms - (5,031 acres, 8.6% of Big Creek)

Valley bottoms occur low in the landscape and are composed of stream terraces, floodplains, glacial outwash plains and outwash terraces. Parent materials are sands, silts, or gravels underlain by siltstones, or glacial deposits. The dominant slopes have gradients of 2 to 20 percent. Steep slopes occur at the front edge of some terraces. The primary soils are deep with extremely gravelly sand and loam textures. The vegetation is a mosaic of deciduous forest, coniferous forest, and wet meadows or shrubland.

Streams in this map unit are typically perennial and are predominantly 3rd to 4th order. Streams in this landform group are typically a C stream type, which are low gradient systems (<2%), with moderate to high sinuosity and low to moderate confinement. They occupy broad valleys with wide flood plains bordered by abandoned terraces of alluvial soils (rounded rocks and sand). They are characterized by well defined meanders, point bars, and alternating riffles and pool sequences. The streambed materials typically range from fine sand to small boulder in size, with gravel to cobble size materials

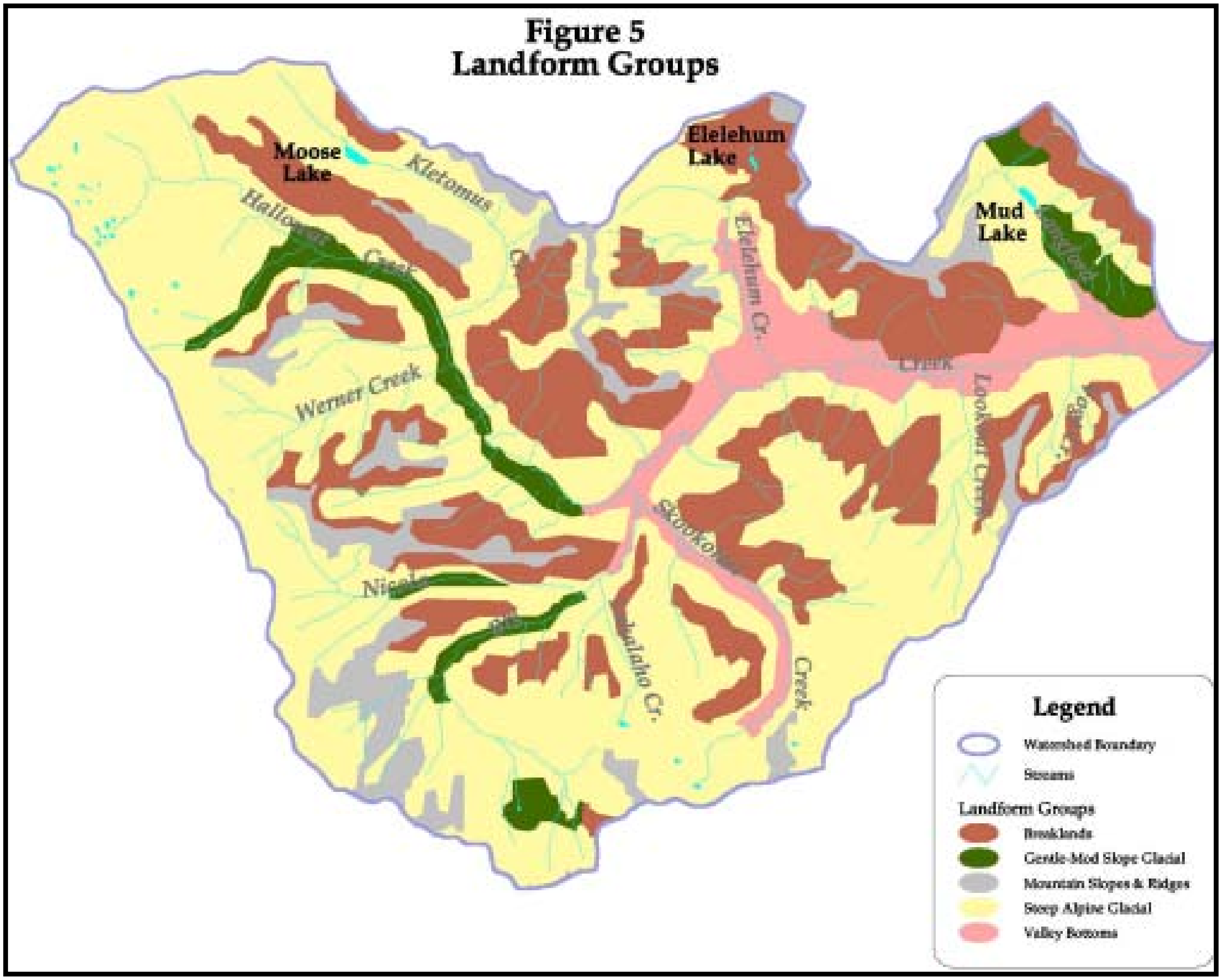


Figure 5
Landform Groups

being predominant. Most C-type streams have moderately high to very high sensitivity to increases in stream flow or changes in sediment loads. In an undisturbed state these streams would produce little sediment, even during large flood events due to the well-vegetated floodplains and streambanks.

The riparian vegetation is dominantly Abies lasiocarpa/Streptopus amplexifolius, Abies lasiocarpa/Calamagrostis canadensis and Picea/Cornus stolonifera riparian habitat types.

Under disturbed conditions the nitrogen yield is moderate and the phosphorus yield is high. The exceptions to these ratings are on coarse textured outwash materials, which have low phosphorus ratings because of their low erosion hazard. Sensitive soils occur on the wet, poorly drained flood plains and lacustrine deposits, and are a minor portion of this landform.

Breaklands - (13,370 acres, 22.8% of Big Creek)

Breaklands occur in both upland and alpine landscape settings and are typically composed of structural breaklands and stream breaklands. The dominant slopes have gradients of 55 to 70 percent. Parent materials are volcanic ash overlying bedrock composed of argillites, siltites, quartzites, dolomites, and limestones. The structural breaklands are formed in colluvial materials from weakly weathered meta-sedimentary bedrock. The dominant soils are shallow to moderately deep with very gravelly loam textures. The vegetation is a mosaic of coniferous forest, and mountain shrub/grass lands.

This landform group is slightly to moderately dissected by streams with the dominant stream patterns being sub-parallel and parallel. Streams in this map unit are typically ephemeral at the highest elevations and perennial at lower elevations. These streams are typically classified as A or Aa+ stream types with gradients from 4 to 10+%. They are characterized by straight (non sinuous) cascading reaches, with frequently spaced pools. When they are flowing through bedrock and boulders (A1 and A2) they are very stable with low sensitivity to increases in water yields, peak flows or sediment. Some of the stream reaches flow through finer materials - cobbles, gravels, or sands (A3 or A4); which can yield significant sediment if disturbed.

The riparian vegetation is dominantly Abies lasiocarpa/Streptopus amplexifolius is the riparian habitat type occurring on somewhat poorly drained sites. Abies lasiocarpa/Oplopanax horridum is the dominant habitat type occurring in small pockets of poorly drained soils.

The nitrogen yield is moderate and the phosphorus yield is high from the portion of this landform group having deep soils. A common situation on the rocky portions of these landforms is to have little or no soil. On these sites the low erosion rates result in low phosphorus yields, and the nitrogen yields are low because there is little nitrogen on these sites. Sensitive soils occur on dissected breaklands that receive more than 50 inches of precipitation per year.

Steep Alpine Glaciated Lands - (31,312 acres, 53.5% of Big Creek)

Steep alpine glaciated lands occur in upland and alpine landscape settings and are primarily composed of glacial troughwall, cirque headwall, and cirque basin landforms. Parent materials are alpine glacial debris and colluvium derived from and underlain by argillite, siltite, quartzite, limestone, and dolomite bedrocks. These landforms are typically in high elevation and high precipitation areas. The vegetation is a mosaic of coniferous forest, alpine meadows, and shrubland associated with avalanche chutes.

Glacial troughwalls are formed in glacial tills on the lower elevation slopes with volcanic ash influenced colluvium on the higher elevation slopes. Slope gradients range from 50 to 90 percent. Soils on the lower slopes of this landform are moderately shallow to deep, are moderate to highly developed, and have cobbly medium textures.

Cirque headwalls and cirque basins are formed in glacial till on the lower elevation slopes and volcanic ash influenced colluvium on the higher elevation slopes. Slope gradients range from 5 to 90 percent. Soils on these landforms are shallow to moderately deep and weakly developed with very gravelly medium textures.

The troughwall landforms are moderately to highly dissected by streams with the dominant stream pattern being parallel. Streams on this landform are usually either 1st or 2nd order, typically being intermittent or ephemeral at the higher elevations and perennial at the lower elevations. They are characterized by moderate to high entrenchment, moderate to high confinement, and low sinuosity. These streams are typically classified as Aa+ or A stream types with gradients from 4 to 10+ percent. The streams are characterized by straight (non sinuous) cascading reaches, with frequently spaced pools. When they are flowing through bedrock and boulders (A1/Aa+1 and A2/Aa+2) that are normally very stable. However, large flows produced from either rain on snow events, or large spring runoffs following wildfire events, would periodically erode these steep channels. This erosion produces fine sediments that are deposited in the lower gradient stream channels.

The cirque basin landform can have flatter gradient streams flowing through finer materials (small boulder to clay size deposits) than the troughwall landform. Many of these streams are B stream types. They are moderately steep streams with gradients from 2 to 4 percent. They usually occupy narrow valleys with gently sloping sides. Riffles are their dominant characteristics, with frequently spaced pools. They are usually very stable unless the stream is flowing through finer soil particles, in which case the stream can be moderately sensitive to channel erosion from increased peak flows. Cirque lakes and the associated wetlands are a minor component of this map unit.

The riparian vegetation is dominantly Abies lasiocarpa/Streptopus amplexifolius is the riparian habitat type occurring on somewhat poorly drained sites. Abies lasiocarpa/Oplopanax horridum is the dominant habitat type occurring in small pockets of poorly drained soils.

The nitrogen yield is moderate and the phosphorus yield is high. Exceptions to these ratings are in cirque basins that have a high nitrogen yield and cirque headwall, which are mostly rock and have low nitrogen and phosphorus ratings. All cirque basins have sensitive soils and the glacial troughwalls have sensitive soils where precipitation exceeds 50 inches per year.

Gently to Moderately Sloping Glaciated Lands - (3,467 acres, 5.9% of Big Creek)

Glaciated lands occur in both valley bottom and upland landscape settings and are primarily composed of glacial moraine landforms. Parent materials are continental or alpine glacial debris with or without volcanic ash surface layers. The soils are underlain by bedrock composed of argillites, siltites, limestones, dolomites, and quartzites. The dominant slopes range from 5 to 50 percent. On the valley bottoms the glacial moraines occur on rolling hummocky topography with slopes that range from 5 to 30 percent slope. On the uplands the glacial moraines occur on straight to slightly concave slopes that range from 20 to 55 percent in gradient. These glacial moraines typically occur at the base of glacial troughwalls. The primary soils are moderately deep to very deep with very gravelly moderately coarse and medium textures. The major vegetative cover is a dense coniferous forest with occasional meadow openings.

This landform is moderately to highly dissected by 2nd to 4th order perennial streams, with a dendritic stream pattern. The streams usually occupy narrow valleys with gently sloping sides. The streams are characterized by low to moderate entrenchment, low to moderate confinement, and have low to moderate sinuosity. These streams are typically classified as either A or B stream types. The A stream types have gradients from 4 to 10 percent. These are typically straight (non sinuous) cascading reaches, with frequently spaced pools. When they are flowing through boulders (A2) they are very stable with low sensitivity to increases in water yields, peak flows or sediment. The lower elevation flatter streams are B stream types. These steep streams have gradients from 2 to 4 percent. Riffles are their dominant characteristics, with frequently spaced pools. The streambed materials typically range from fine sand to small boulder in size, with gravel to cobble size materials being predominant. Large woody debris is the primary gradient control in these stream reaches. These streams are usually stable unless the stream is flowing through finer soil particles, in which case the stream can be sensitive to channel erosion from increased peak flows. Wetlands are a minor component of this map unit.

The riparian vegetation is dominantly Abies lasiocarpa/Streptopus amplexifolius, Abies lasiocarpa/Oplopanax horridium, Abies lasiocarpa/Calamagrostis canadensis, and Picea/Cornus stolonifera riparian habitat types.

The nitrogen yield is low and the phosphorus yield is moderate from this landform group. Sensitive soils occur where this landform receives more than 50 inches of precipitation per year.

Mountain Slopes and Ridges - (5,360 acres, 9.2% of Big Creek)

Mountain slopes and ridges occur in both the upland and alpine landscape settings and are typically composed of dissected mountain slopes, glaciated mountain slopes, and glacially scoured ridge tops. The geomorphic processes that occur on these areas include colluvial, fluvial and glacial, erosion or deposition. Parent materials are volcanic ash overlying bedrock composed of argillites, siltites, quartzites, and limestones. The vegetation is a mosaic of coniferous forest, mountain shrublands, and mountain grasslands.

This landform is a combination of glacially scoured ridge tops and dissected mountain slopes (fluvial). Glacially scoured ridge tops have been strongly modified by continental ice. The prominent features are ridge tops and ridge noses with exposed bedrock. These areas have slopes that range from 10 to 45 percent. Soils on these landforms are shallow to moderately deep, are weak to moderately developed with medium textures. Slope gradients range from 30 to 60 percent. Soils on these landforms are moderately deep, to deep, with weak to moderate development, and gravelly medium textures.

The dissected mountain slopes landform is moderate to strongly dissected by ephermal and perennial streams that occupy narrow "v" shaped valleys, with the dominate stream patterns being dendritic or sub-parallel. These streams are typically classified as A or Aa+ stream types with gradients from 4 to 10+ percent. They are characterized by straight (non sinuous) cascading reaches, with frequently spaced pools. When they are flowing through bedrock and boulders (A1 and A2) they are very stable with low sensitivity to increases in water yields, peak flows or sediment. The streams in the ridge tops landform position occur at the heads of drainages and are typically ephermal or intermittent streams associated with seeps and springs.

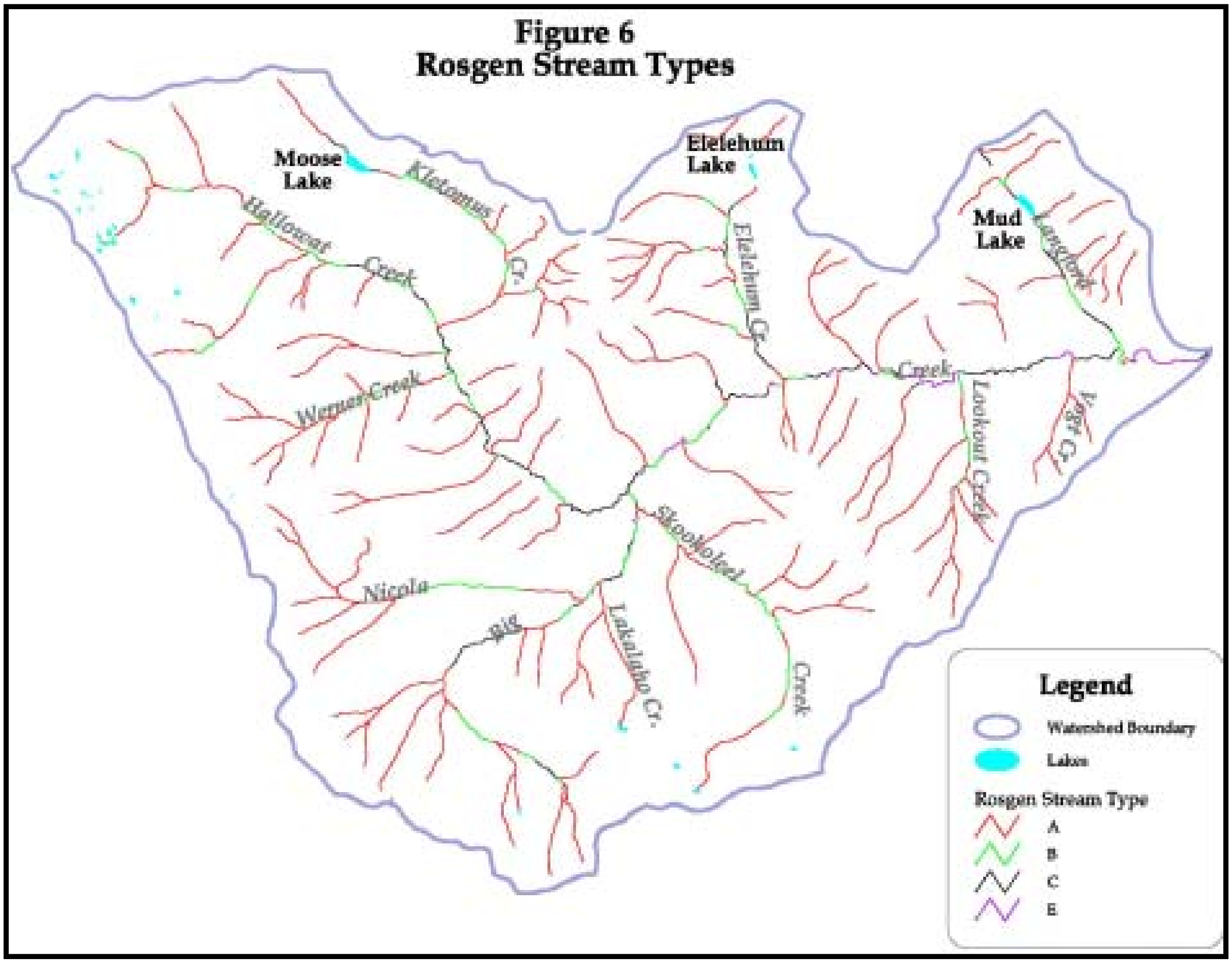
The riparian vegetation is dominantly Abies lasiocarpa/Streptopus amplexifolius, Abies lasiocarpa/Oplopanax horridium and Picea/Cornus stolonifera riparian habitat types.

The nitrogen yield from this landform group is moderate and the phosphorus yield is low. These are no sensitive soils in this landform group.

Stream Types Found in Big Creek

The stream channels and valley bottoms in the Big Creek basins represent the entire range of variability, from narrow "v" shaped valleys with bedrock waterfalls to broad flat valley bottoms meandering streams in unconfined valleys. These valley forms and stream shape represent different sediment transport and deposition processes. In its uppermost reaches, the capacity of Big Creek to transport sediments exceeds sediment supply, so erosion is more common than deposition. Where Big Creek flattens and begins to meander, at approximately the lower edge of the northeast aspect ski runs, the capacity to transport sediments about balances the amount of available sediments. Here a small change in water volume determines whether erosion or deposition occurs. As the stream gradient continues to flatten downstream, deposition is dominant over erosion, except when high peak flows occur to erode upper channel banks and transport the sediment downstream.

The Rosgen Stream Classification System provides a method for identifying streams according to various stream types by morphological characteristics (Rosgen, 1988). These morphological characteristics include such factors as channel gradient, sinuosity, width/depth ratio, dominant particle size of bed and bank materials, entrenchment of channel and confinement of channel in valley. A Rosgen Stream Type Classification (level -1) was developed for the Flathead National Forest in 1999 using digital elevation models (DEMs). The computer model will only reliably identify A, B, C, and E stream types. After review of the computer generated map the only other stream type found in the Big Creek basin were some short reaches of G stream type on the glacial terrace escarpments. Figure - 6 displays the distribution of the Level -1 Rosgen Stream Types.



2.2.3 Natural Disturbance Processes

Erosional Disturbances

Current surface erosion rates are low or non-existent in undisturbed portions of the watershed. Soil erosion occurs where the surface soil has been exposed by disturbances, either natural or man caused. These disturbances are concentrated on roads, landings, and skid trails associated with timber management. The amount of soil erosion on these disturbed sites depends on the soil type, the slope steepness, and the amount of residual vegetation remaining on the site after the management activity. It also depends on the type of erosion control features applied after the soil was disturbed. Waterbars, revegetation, and spreading of debris all reduce soil erosion and with time can eliminate erosion.

Within Big Creek mass failures are a minor erosional process. A few inactive mass failures are mapped in the Big Creek drainage. They probably occurred after the glaciers receded when there was an abundance of water and little or no vegetation to stabilize the slopes. Most active or recent mass failures are associated with roads that have drainage problems, or with streambanks that have been undercut by stream flow.

Wildfire Disturbances

The historic fire regime for the Big Creek watershed is predominantly a *Lethal* fire regime[1], with a 200+ year return interval. The remainder of the basin has a *Mixed* fire regime, with a 80 to 120 year return interval. Fires typically were large within the Big Creek watershed. A fire history analysis indicates that this area typically burned with large wildfires that ran through the tree crowns and killed most of the trees. There was 31% of the watershed burned in 1910, 6% in 1919, 5% in 1926, and less than 1% since fire suppression activities have been implemented (Moose Fire discussed below). Most likely large fires burning significant portions of the basin represent the type of fire activity that has been common in Big Creek since glacial times.

It seems reasonable to assume that there were times following these fires when large acreages lacked vegetative cover and the soils were exposed to the erosive forces of rains, wind, and snowmelts. However, there are few indicators that massive erosion occurred following these fires. When one looks at the current landscape in the Big Creek area there is little evidence that this type of erosion scenarios has occurred since the deposition of the volcanic ash layer (6-8 inches thick), from the eruption of Mt. Mazama in southwest Oregon. If numerous significant erosion events had occurred since the volcanic ash was deposited one would see areas that lack the ash surface or that have gullies. Instead, dry ephemeral channels are blanketed by the ash material. Another feature that would indicate severe soil erosion following fires or other natural disturbances would be the accumulation of eroded ash at the base of steep slopes. This situation is not apparent.

The amount of erosion that occurred after a wildfire could be deduced from observations following two large wildfires that have occurred on the Flathead National Forest since 1994: the Little Wolf and the Challenge fires on Tally Lake and Hungry Horst Ranger Districts respectively. Both of these fires burned about 10,000 acres of fuel that were similar to those in the Big Creek watershed. Both of these fires have had very little erosion. In most cases the fire left behind a charred layer of duff and litter that protected the soil surface from erosion.

Once a site has had the forest vegetation killed by wildfire there is a hydrologic response of increased water yield from that site. It takes many years for the site to hydrologically recover; for the habitat types that predominate in Big Creek the time frame for 100% hydrologic recovery can be in excess of 100 years (WATSED 1995, Galbreath 1973). Therefore risk of stand replacement fire and its effects on water yield increase must be considered during the development of the watershed restoration plan, as well as other proposed vegetation manipulation activities in Big Creek.

Effects of the Moose Fire August – November 2001

On August 17, 2001 a wildfire started in the upper portion of the Big Creek watershed. By October 5th the fire had burned over 71,000 acres on the Flathead National Forest, Coal Creek State Forest, and Glacier National Park. Thirty-eight percent of the entire 52,000 acre Big Creek Watershed burned in the Moose Fire. The majority of the fire was a stand replacement fire with moderate burn severity

[1] A lethal fire regime consumes the entire vegetative community (i.e. grasses, shrubs, and trees) and results in a forest canopy cover of less than 10%.

(describes soil heating). The following discussion described the existing post-fire situation for the burned lands in Big Creek. Refer to Figure – 9, page 39 for a map showing the Big Creek Basin and the portion of the Moose Fire on forest service lands.

- *Soil Erosion* - Soils under pre-fire conditions, generally supported an organic duff layer. The surface layer of organic duff ranges from 1 to 4 inches in depth. The upper soil contains typically contains a many fine plant roots, and many small pores and stabile soil aggregates, that in combination facilitated rapid water infiltration and percolation. The pre-fire surface erosion rates were very low to non-existent in undisturbed portions of the watershed.

  A wildfire has the potential to impact the soil beyond the limits of natural variability, including reduced soil aggregate stability, reduced permeability, increased runoff and erosion, and reduced organic matter/nutrient status. These combined effects will cause the runoff following a rain event to increase significantly, increasing the overland flow available to initiate soil erosion, either as sheet or rill erosion. The potential for erosion is highest on the steeper slopes that burned with a high burn severity. Burn severity describes the effects of the fire on the soil hydrologic function (amount of surface litter, erodibility, infiltration rate, runoff response) and productivity. Generally there is a close correlation between these soil properties and the amount of heat experienced by the soil as well as the residence time of the heat in contact with the soil.

  The low burn severity sites will naturally re-vegetate rapidly and have no/very low potential for soil erosion. The Moose Creek fire had several large areas of moderate burn severity with inclusions of smaller areas of high burn severity within these large burned patches. Most of the moderate and high burn severity occurred on shrub dominated sites, which typically have good natural re-vegetation potential following wildfire. The moderate burn severity sites are expected to re-vegetate rapidly. However, the high burn severity sites initially have will be less vegetation re-growth (vegetation cover) to protect the surface soil from erosion, especially when compared to the low burn severity areas.

  The post-fire aerial observations and follow-up ground investigations revealed that vast majority of the moderate burn severity on the Flathead NF did not have very much potential to deliver sediment into a stream channel. The primarily reasons for that interpretation is the expected natural re-vegetation response, and the general lack of expected soil erosion. The assumption of low rates of expected soil erosion is based upon the fact that the post-fire hydrophobic soil condition tends to ameliorate itself with 2 to 3 weeks with low intensity rain events which slowly wets the surface soil layers. Under normal precipitation events we would not expect to see any severe soil erosion from the vast majority of hill-slopes in the burn area. We would expect the post-fire responses in most watersheds that had a significant percentage of their area in moderate or high burn severity to be the following: (1) an initial flush of ash into the creeks; (2) to some extent rill and some small gully erosion in the ephemeral drainages on the steep valley walls with the high burn severity. However if intense rainstorm were to occur over the fire area some significant erosion could be expected from some of the moderate burn severity and the high burn severity sites. The potential soil erosion modeling shows that more than 30 tons per acre of soil loss could occur with an intense rainstorm before all the post-fire hydrophobic soil conditions recover and the sites are revegetated.

  The only area of significant upland soil erosion potential is a high burn severity area, located in steep to very steep hill-slopes (50-70% slope) in the SE1/4 of Section 34, the SW1/4 of Section 35, and NW1/4 of Section 3, of what is being called Skookoleel Creek North. This site has the potential for significant surface soil erosion to occur and for the eroded material to be delivered directly to creek, which would then be transported as sediment into the spawning gravel area in Big Creek, near the Skookoleel Bridge. During the Burned Area Emergency Rehabilitation (BAER) efforts there were several erosion reduction practices implemented in the Skookoleel Creek North area.

None of identified mass failure sites or the unstable stream reaches in lower Big Creek should have any significant increase in potential sediment yield due to the wildfire. These sources are basically unchanged from the fire, but they still need the restoration work planned prior to the fire. The only change from the fire was the loss of some riparian shrub plantings (2000 and 2001) along the streambanks of lower Big Creek that may need to be replaced.

- *Soil Nutrient Loss* - The heat of the wildfire will also affect the nutrient status of some of the soils. The soils that experienced high burn severity are generally the most affected. These soils are most susceptible to nutrient loss by either: 1) volatilization during the fire, 2) potential post-fire soil erosion, and 3) loss by leaching.

  There is expected significant increase in nutrients (nitrogen and phosphorus) delivered from the fire area, into the streams. This increased water nutrient level can probably be tracked into the North Fork River, but probably not beyond the confluence of the Flathead River. Increases from past fires, such as Red Bench, were measured on the order of 2-3 fold. This increase should not be a problem for the aquatic systems within or just outside of the fire.

- *Channel Effects* - Following the fire many of the stream bottoms were examined in the field and it was the interpretation of the soil scientist/vegetation specialist that the riparian shrub component was still viable and would reestablish rapidly on the majority of the burned streams. This is especially true for the flatter, low elevation mainstem stream-bottoms along Big Creek. However, several of the steeper, deeply incised perennial and ephemeral stream bottoms on Demers Ridge, and the unnamed drainage east of Skookoleel Creek burned with high or moderate burn severity. In these areas the natural re-vegetation of shrubs and trees is going to be significantly reduced for several years. This makes these draws very susceptible to channel erosion and debris torrents, with the right type of storm and/or snowmelt event.

  Big Creek is a large Rosgen “C” channel with a well-developed floodplain and high width/depth ratio. Large woody materials were common across the floodplain, especially along the channel margins. This gives it a wide area for “storage” of products from upland or in-channel erosion. Most sediment from upstream should settle out in this area, leaving only minor amounts of the finer sediment to travel downstream, and then probably only during the peak flow period.

- *Water Yield Increase Effects* - Extensive literature exists indicating that stream flows are increased after fires, through a combination of evapo-transpiration reduction, soil-surface storage reduction, and snowmelt modification. This is particularly true in watersheds where moderate and high fire severity occurs. The magnitude of the increase has been variable in different study watersheds, but an increase always occurs.

  The modeled water yield increase from historic timber management was done in 1996 for Big Creek. Results from R1WATSED are that the modeled percent water yield over natural conditions is 9% or less for the five sub-watersheds of Big Creek as well as the entire Big Creek drainage. Depending upon the channel stability, water yield increases in the 10-15% range may cause increased channel erosion. Both the annual water yield as well as the peak flow yield is expected to increase significantly in lower Big Creek due to the effects of the wildfire. The annual water yield increase is initially estimated (professional guess, no modeling completed as of this date) to be between 5 to 10 percent above pre-fire level for Big Creek at the mouth. The water yield increase and/or peak flows in the smaller mid/high elevation burned tributaries to Big Creek, could individually be greater. This is due to decreased response time of streamflow increases following rain events, because of the lack of a duff layer.

This increase in water yield has the most potential to cause short-term increases in channel erosion in several of the small tributary streams to Big Creek. This is due to the burning riparian vegetation and in some case large woody debris within the streambanks, along with the naturally erodible streambank materials, and the post-fire increased water yield. Along the mainstem of Big Creek there is some potential for increased streambank erosion in the *destabilized reach (*below Elelehum Creek and above Lookout Creek). But because there is not a large percentage of the watershed that is burned above this reach, the increased potential is not great. The lower Big Creek stream channel (below Lookout Creek) is much more stable; therefore, even with a higher percentage of the watershed above that reach being burned the overall risk to streambank erosion is not very great.

The BAER emergency treatments addressed increasing water flow capacity of any culverts that were deemed undersized for the expected post-fire storm flows. This was done in areas that had moderate or high burn severity only. Many of these undersized culverts were not up-sized; rather several armored overflow-dips were installed in the roads.

Flood Disturbances

Flood events are one of the primary natural disturbance processes for a stream channel. A review was done of the U.S. Geological Survey's water flow records for the North Fork of the Flathead River, near Columbia Falls. There are two notable flood events for the flow record of 1911 to 1997. The June 9, 1964 flood was the highest recorded flow record with a flow of 69,100 cubic feet per second. This is an increase of 628% above the base flow of 11,000 cubic feet per second. This flow is greater than a 2000-year return interval flood event (Personal communication Charles Parret, U.S.G.S.). A base flow was not established for the U.S.G.S. gage station at Big Creek; however the recorded peak flow for the 1964 flood event was 2130 cubic feet per second. The 1964 flood had a major impact upon the Big Creek stream channel in some areas according to anecdotal information.

The second highest flood event recorded was on June 7, 1995, with a flow recorded of 59,200 cubic feet per second. This is an increase of 538% above the base flow of 11,000 cubic feet per second. This flow is approximately a 500-year return interval flood event (Personal communication Charles Parret, U.S.G.S.). The majority of rainfall during this event occurred in British Columbia and stream effects were seen primarily in the northern portion of the North Fork.

2.2.4 Land Use Activities

The Big Creek watershed has been managed since the 1950s. The major activities have been timber harvest, road building, skid trail construction, and construction of ski runs. There have also been watershed restoration activities that have occurred in the watershed. See Table - 4 for a condensed timeline of management activities within Big Creek.

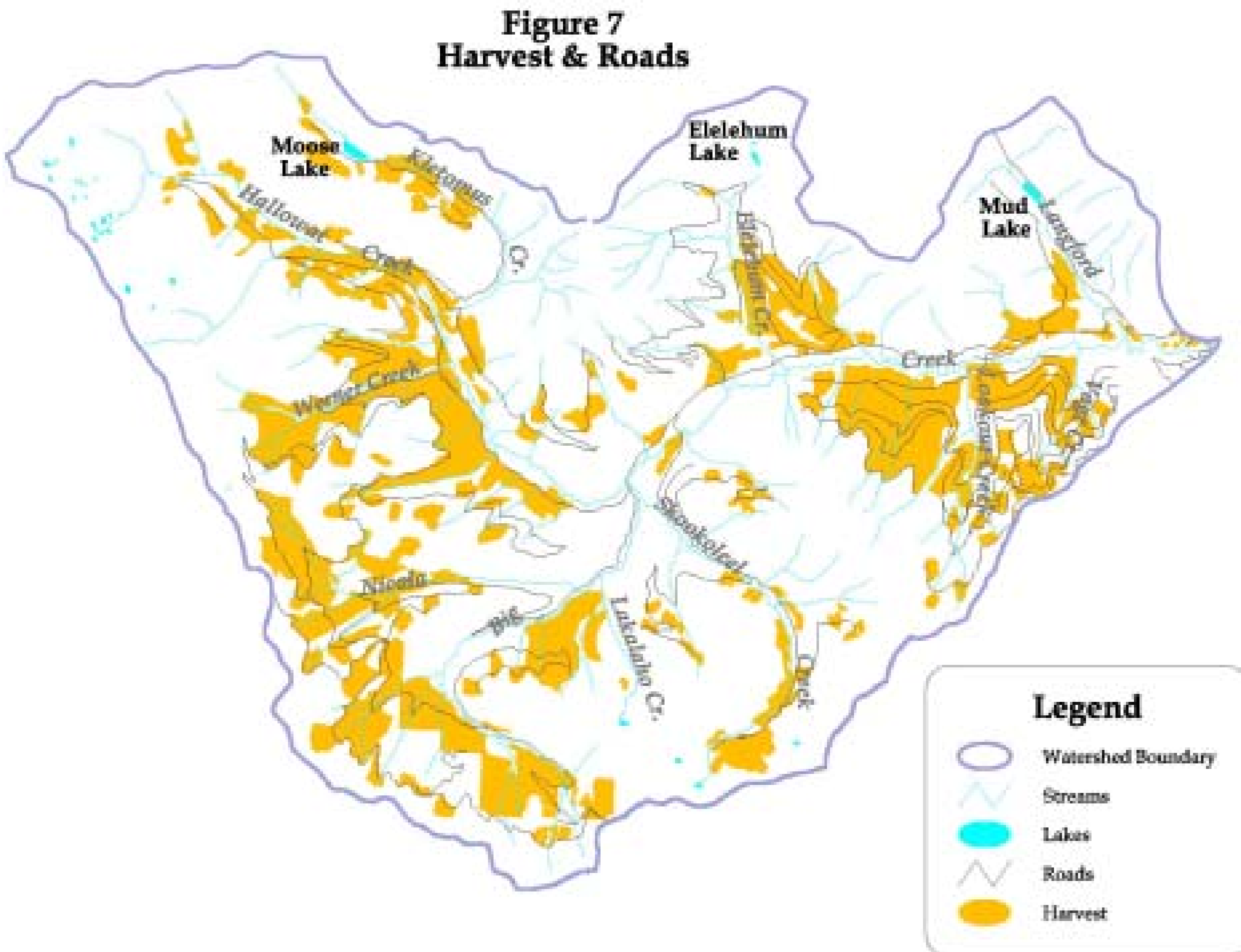
The constructed road system within Big Creek is approximately 190 miles of roads. There are numerous road crossings of the stream network, but very little of the road systems are located parallel to a stream in a riparian zone infringing upon the stream floodplain.

Vegetation management in one form or another, either timber harvest or thinning has occurred on 23 to 31 percent of the lands in the three 6 code HUCs of Big Creek. The high intensity harvest (e.g. clearcuts, seed tree cuts) older than 20 years has occurred on 8,307 acres, and on 2,489 acres in the last 20 years. Low intensity harvest (e.g. shelterwood cuts, salvage, commercial and non-commercial thinning) older than 20 years has occurred on 3,878 acres, and on 2,020 acres in the last 20 years.

Between the January 1985 and August 1997 there was 1768.66 acres of land that were transferred from private to Forest Service ownership. This land was located in the headwaters of Big Creek, in portions of sections 19, 20, 23, and 24. This area was extensively logged during the 1960's and is included in the harvest area discussed in the previous paragraph. The entire Big Creek basin is now currently owned and managed by the U.S. Forest Service. Figure - 7 displays the existing road system and all past forest management activities within the Big Creek basin.

Table - 4: Time Sequence of Management Activities in Big Creek

Approximate Date	Description of Management Activities
1950s and 1960s	Extensive logging on National Forest System lands within the watershed (approx. 1,500 acres in 77 sq. miles of the Big Creek watershed and approximately 1,200 acres in the upper 8 sq. miles of the watershed on private land)
1950	Main road in upper Big Creek built on land type prone to soil erosion (Rd# 316)
1950s and 1960s	Road building associated with logging (approx. 25 miles)
1974	Portion of Rd#316 fails and is repaired
1975	Portion of Rd #316 is closed and revegetated (upper Big Creek watershed)
1985	Clearing of forest for ski runs associated with Chair 7
1980s	Many upland and stream erosion control projects implemented
1990s	Road reclamation accomplished (17 miles) , continued upland soil erosion control projects, and large woody debris placement projects implemented
2000-2001	Erosion control vegetation plantings



Sensitive soils typically have excess water in the soil profile for at least part of the growing season. Roads on sensitive soils collect water in the ditches, and are more likely to have small cutslope failures associated with the roads than where they are built on non-sensitive soils. When sensitive soils are disturbed by management activities such as road building or timber harvest the water can seep out of the soil and onto the roads, ditches, skid trails, or landings where it moves quickly down slope. Water that would have moved slowly to a stream through the soil profile is now quickly routed to a stream. This efficient routing of water increases water yields, as well as increasing the risk of sedimentation from the areas of rutted soil, and/or the road ditches. There are 50.3 miles of roads and 3532 acres of past timber management activities on sensitive soils within the Big Creek basin.

2.2.5 Historic Watershed Rehabilitation Projects in Big Creek

There has been a series of watershed rehabilitation projects done by the Forest Service in the past twenty-five years. The logging that occurred on the private lands in upper Big Creek (sections 19, 20, 23, and 24) during the late 1960s early 1970s resulted in many sediment sources that were actively eroding into Big Creek. When the Forest Service acquired those lands through land exchanges, a series of erosion control practices were applied to eroding non-vegetated site associated with the past logging. Erosion control practices such as waterbars, grass seeding, and shrub planting were applied on sites where some improvement could be expected. The following page has a series of three photograph pairs showing the recovery that has occurred on some sites since the logging. Refer to photographs 1 thru 6.

Spruce trees killed by spruce-beetle in the 1960s, were removed from riparian zones along portions of the Big Creek, as part of the early timber management activities. This riparian harvest reduced or eliminated the number of trees available to be recruited into the stream channel as large woody debris. Large woody debris helps to control the gradient of the stream, dissipate stream energy, and acts as sediment traps within the stream. For the three field seasons during the 1990s, woody debris has been added to some of the headwater streams of Big Creek, including Skookoleel Creek. The goal was to help trap bedload that is currently stored behind woody debris that are beginning to root and fail. Retention of this bedload in the headwaters will help prevent pool filling in downstream fish habitat. Pools are critical for over-winter rearing, resting, and feeding areas for fish.

There were 34 acres of upland eroding areas, such as rills and small gullies stabilized by filling them with woody debris, and/or waterbarred by a Montana Conservation Corps crew during July 1997 field season.

There has been 17 miles roads reclaimed in the past few years in upper Big Creek and Skookoleel Creek. Also, there were approximately 4,950 shrubs planted in 2000 and 2001 on eroding upland sites and along streambanks.

The additional proposed restoration work is described in a later section.

1979

1989

2.3 Water Quality Status

This section discusses the relevant stream and water quality data for Big Creek that characterize the existing condition.

2.3.1 Pfankuch Stream Channel Rating

The Pfankuch stream channel rating (Pfankuch, 1978), was developed to "systemize measurements and evaluations of the resistive capacity of mountain stream channels to the detachment of bed and bank materials and to provide information about the capacity of streams to adjust and recover from potential changes in flow and/or increases in sediment production" (Pfankuch, 1975). This procedure uses a qualitative measurement with associated mathematical values to reflect stream conditions. The rating is based on 15 categories: six related to the bottom of the stream channel (the part of the channel covered by water yearlong), five related to the lower banks (covered by water only during spring runoff), and four related to the upper banks (covered by water only during flood stages). Streams rated *excellent (<38) or good (39-76)* are less likely to erode during high flow than streams in *fair (77-114)* or *poor (115+)* condition. Prime fish habitat usually occurs in streams with a *good* rating; streams in *excellent* condition usually do not have adequate gravels for good spawning habitat.

The rating is evaluated at a spot or reach of stream. Each rating represents one point in time; therefore, a series of ratings must be made over several years to show the trend of stream stability; i.e., whether the stream is headed towards or away from dynamic equilibrium. D. Sirucek reported a statistically significant correlation between the change in Pfankuch stream channel ratings and several measurements of stream health (e.g. McNeil core % fine sediment, water yield increase, nutrient levels and chlorophyll A).

In the late 1970s, stream channels at selected sites in the Big Creek drainage were rated as *good* using the Pfankuch stream channel rating scale. Some of those same areas were rated as *fair* and *poor* in a 1992 survey.

The *good* Pfankuch ratings of the late 1970s did not forecast that sediments that had been generated from road construction associated with timber harvest of the 1960s and 70s were working their way downstream. Had surveys been made occasionally during the 1980s, they would have indicated that the stream was becoming impaired. The *fair* and *poor* ratings of the 1992 survey are a result of sediment moving downstream into areas that had previously been rated as *good*. These same sites may rate *good* again, perhaps on the order of 10-20 years.

After the Moose Fire during late October and early November Pfankuch ratings were done on the triburaries and the mainstem of Big Creek within the fire boundary. These ratings would not reflect any changes to the streams due to the fires, rather they were done to be able to measure any changes following post-fire runoff events. The mainstem ratings were all f*air*; and the tributaries ranged from *good* to poor, with the majority being *fair*.

2.3.2 Riffle Stability Index

The riffle stability index (RSI) is a quantitative methodology used to for assessing stream equilibrium and channel stability (Kappesser, 1993). This technique looks at the relative mobility of streambed material deposited on riffles during bankfull discharge. The largest size particles that are moved during frequent (annual flood events) are measured at a deposition site such as a riffle point bar. That size and all smaller particles are therefore considered mobile. The average size of the largest mobile particle is compared to the total size composition of the riffle to determine the percent of riffle material that is moved during the annual runoff. The resulting percentage of movable particles becomes an index of riffle equilibrium called the riffle stability index (RSI).

It has been suggested that an RSI value of 70 or higher is a warning sign for Idaho's belt geology streams, similar to those found in the Flathead Basin; an RSI value greater than 90 indicates that a watershed is out of equilibrium with respect to the balance between sediment loads and water yields (Kappesser, 1993).

During the summer of 1993, riffle stability index measurements were made at nine sites in upper Big Creek from below the Lakalaho Creek junction upstream to within one-half mile of Road #1696 crossing. The RSI values ranged from 65 to 95, with eight sites having RSIs greater than 70, and three sites having RSIs greater than 90. The three sites with RSIs greater than 90 have a relatively high percentage of small particles, suggesting that sediment has accumulated in those areas. Also, the mean size of the largest moving particle for all sites was about 5.5 inches, a further indication that stream energy is high enough to move even large cobbles during annual peak flows. These results suggest that portions of Big Creek's channel are unstable and have a limited capacity to absorb additional water yield increases from hillslope development in the headwater basin.

2.3.3 McNeil Core Sediment Measurements

The size range of the streambed materials is indicative of fish spawning and incubation habitat. Increased fine sediments reduce pool depth; interstitial spaces needed for invertebrate production; and reduce embryonic survival of fry (Everest et al. 1987, Weaver and Fraley 1991). A McNeil corer (McNeil and Ahnell, 1964) is used to collect streambed samples which are dried and sieve analyzed to determine the particle size distribution, for materials less than 6.5mm in diameter (fines). As part of the Flathead Basin Forest Practices - Water Quality, and Fisheries Cooperative Research Program, Fraley and Weaver established a correlation between the streambed fines and the bull trout survival in the Flathead River Basin. A statistically significant correlation was identified, that streambed fines greater than 35% resulted in decreased survival of bull trout (Weaver and Fraley 1991). Base on this research, the Flathead National Forest uses the criteria that streams with greater than 35% fines are considered *threatened,* while a streams with greater than 40% fines are generally considered *impaired*. These threatened and impaired determinations do not necessarily correlate with MDEQ threatened and impaired designations associated with beneficial use support since the MDEQ may use values that can vary when reference conditions imply other numbers would better represent MDEQ guidance for making beneficial use support determinations (Water Quality Assessment Process and Methods, Appendix A of the 2000 303(d) List).

Since 1982 McNeil core samples have been taken in a sampling reach of Big Creek, near the Skookoleel bridge crossing (road # 316E). Table - 5 reports the results of the McNeil core monitoring program. The increasing trend of fine streambed sediments starting in 1989 is thought to be the movement of the earlier upland erosion sediments through the streambed monitoring reach in lower Big Creek. After the flushing flows in 1992 there has been a decline in the streambed fines in this monitoring reach.

Table - 5: McNeil Core samples (%fine sediment <6.4mm) in Big Creek.

Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
%< 6.4mm	23.8	32.6	28.2	27.8	28.7	21.6	29.1	40.3	48.4	53.4
Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
%< 6.4mm	32.9	37.4	37.2	34.5	32.2	30.0	31.1	32.2	33.1	31.4

Note the samples for year 2001 have been gathered but the data was unavailable to the author at the time of this report.

2.3.4 Modeled Water Yield Increase

R1WATSED is a computer model used to predict water yield increase from forest vegetation manipulation. The model has evolved from the procedure discussed in Forest Hydrology, Hydrologic Effects of Vegetation Manipulation, Part II (U.S. Forest Service 1978), and WATBAL a model developed on the Clearwater National Forest (Patten 1989).

It should be noted that R1WATSED calculates the estimated water yield over a fully forested condition. This is not the true natural condition for the headwaters area in Big Creek that have areas of rock outcrop, and wetlands. Results from R1WATSED are that the estimated percent water yield over natural conditions is 9% or less for the five subwatersheds of Big Creek as well as the entire Big Creek drainage (Big Mountain Ski and summer Resort EIS, 1995). Once modeled water yield increase approaches 10% then field examination, Pfankuch stream stability ratings, cross-sections, Wolman Peeble Counts, and RSI data are used to assess a stream channel's ability carry additional water yield increase without major stream erosion.

2.3.5 Wolman Pebble Counts/ Stream Cross-sections

Wolman pebble counts (Wolman 1954) is a quantitative field procedure for determining particle size distribution of the stream bed materials. This procedure however takes all size materials into consideration as compared to the McNeil core methodology. In 1997 two stream reaches in Big Creek were sampled using this procedure. At the same time a stream cross-section was done at the same location. A high width to depth ratio and lack of pools is symptomatic of an unstable stream channel, and in some cases a large amount of bedload in the drainage. There has not been reference reach data for Wolman pebble counts and stream cross-sections of comparable stream size developed yet, to compare these data from Big Creek to. However, the initial Big Creek data can be used as part of the initial monitoring data set that is proposed later in this report.

Following the Moose Fire eight additional stream reaches in Big Creek were sampled using these two procedures.

2.4 Key Indicators

The impairment of Big Creek is described as partially supporting the beneficial uses of aquatic life support and cold-water fishery, due to siltation and habitat alteration. Field examination, qualitative, and quantitative stream monitoring confirm that the source of sediments is from a combination of natural and man-caused upland and stream channel erosion.

The long-term goals for Big Creek to improve the current situation are the following: 1) To reduce the sediment sources, thereby reducing sedimentation loading and in turn reducing the effect of sedimentation on fishery habitat within Big Creek; 2) To concurrently with sedimentation reduction, minimize any increase in short-term water yield increase, and to foster long-term reductions in water yield increase so that the Big Creek stream channel can achieve dynamic equilibrium; and 3) Insure proper revegetation and reforestation occurs within the Moose Fire area.

The proposed indicators for assessment of an improvement in water quality trends are the following:

- The desired condition for cold water fishery habitat, is for interstitial fine sediments not to be a limiting factor to fish reproduction and survival in Big Creek. The key indicator for this objective would be the amount of interstitial fine sediments occurring in the fish spawning habitat, as measured using the McNeil Core methodology.

- The desired condition for surface flow in Big Creek watershed, is for stream channels to be in or approaching equilibrium; i.e., have minimal channel erosion or sediment deposition. The key indicator for this objective would be to have the same amount of streambank erosion occurring within the impaired sensitive reaches, as occurs in similar non-impaired reaches upstream and downstream. This objective can be monitored using channel cross-sections and bank erosion profile measurements (using bank erosion pins per Rosgen technique).

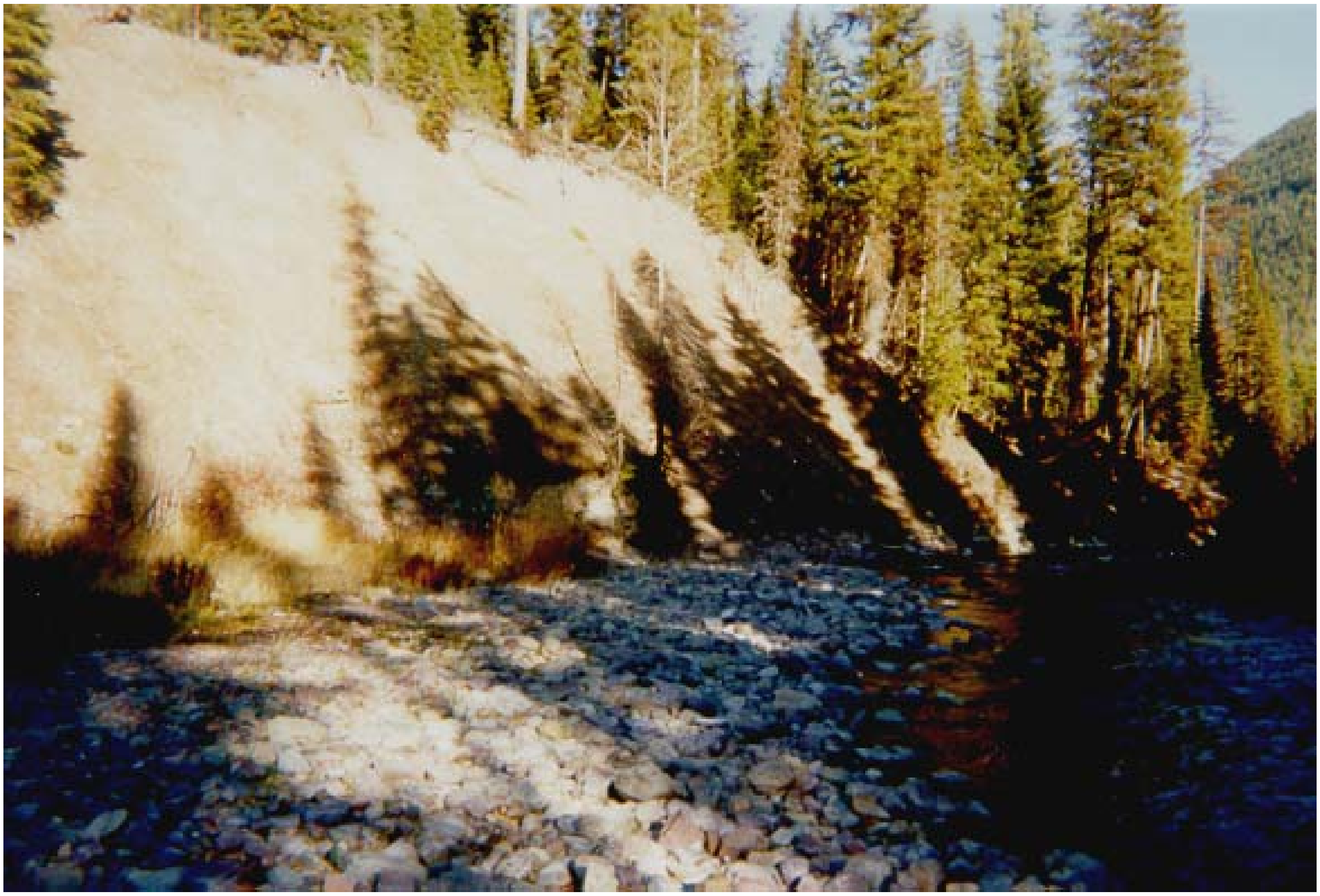
- The desired condition for the upland (ground surface between stream channels) would be to have a vegetation cover (grass, forbs, and brush) or to have a rock surface armoring, thereby not being a sediment sources. The key indicator for this objective would be the revegetation and/or armoring of the identified sediment sources.

2.5 Nonpoint Pollution Source Inventory and the Proposed Restoration Activities

The following is a short narrative description of the current upland and instream sediment sources in the Big Creek, along with proposed actions that are meant to decrease the sediment load, increase water dispersion and infiltration.

Situation - 1 Streambank Erosion: The mid to lower reaches of the mainstem of Big Creek flows through glacial-fluvial deposits, in which the stream has downcut in excess of 100 feet since the retreat of the glaciers (10 -12,000 years before present). This downcutting of the stream has resulted in an abandoned Pleistocene age stream terrace, with a very steep (60-80% slope) terrace escarpment leading down to the current stream terrace and floodplain. Some place along this escarpment the stream comes into contact with it during normal spring runoff or other peak flow events. During high flow periods, the toeslopes of these exposed soil banks are eroded by the flowing stream putting significant amounts of sediment into the stream. Streambank erosion in excess of one foot has been observed by the author during a high flow event on these types of escarpments. The erosion of these terrace escarpments is a natural process. However, the additional water flow during peak flow events caused by logging and road construction, causes the stream to be in contact with these sediment sources more often and for a longer duration than during pre-management times. At the same time, the steep escarpment banks have large areas of unvegetated eroding soil. Refer to photograph – 7 for an example of an eroding stream terrace.

There are seven areas along the mainstream of Big Creek, where the stream is impinging upon these escarpments causing a major sediment source. These sites will be examined carefully to see if instream structures such as vortex-weirs, rock barbs, or tree stump armoring would help the situation and can be logistically installed with the limited access to the stream. This examination needs to be done in concert with the Montana Department of Fish, Wildlife and Parks, along with the U.S. Fish and Wildlife Service. Once the eroding bank is armored then there will be an attempt to establish vegetation (shrubs) on the toes of the eroding slump banks, to trap the eroded soils from the steep



Photograph - 7: Example of an eroding stream terrace escarpment.

escarpment face before it reaches the stream. During the 2000 and 2001 field season there were hundreds of shrubs planted on toes of five of these slide areas in an attempt to establish vegetation and reduce erosion.

Situation - 2 Skid Trail Rehabilitation: Skid trails to remove logs from cutting units were developed by cats and skidders during past timber harvest activities. Most of the skid trails developed in the past 20 years were waterbarred when the skidding was completed. The waterbarring disperses the water before it is concentrated into a defined flow that causes erosion. Some of the earlier skid trails and/or the log landings where the skid trails converge have had very small streams (*skid-streams*) develop on them due to soil compaction and intercepted groundwater. These small skid-streams typically only run water during snowmelt or high intensity rainstorms, however, this does increase the peak flow response within the basin. The majority of these skid-streams have eroded away the fine textured soils within their stream bottoms and bank, causing them to be well armored by cobbles and stones, and typically well vegetated. Going back and constructing waterbars at this time would disturb the established vegetation and expose soil to be potentially eroded. Refer to photograph – 8 for an example of a skid-stream.

However, there are some sites that fine soil materials are still being eroded from. On these sites there are several proposed rehabilitation actions to be done singularly or in combination. The primary work includes dispersing water where it has concentrated on skid trails and landings through actions that may include: the construction of waterbars, the planting of shrubs, the planting of grass, the placement

Photograph – 8: An example of a skid-stream.

of rock armoring, and/or the construction of small check dams with pieces of wood. Where streams had been rerouted from their natural channel, work can be done to try to return the stream to its historical drainage path.

Situation - 3 Upland Sediment Source Rehabilitation Placement: Within the Big Creek basin, there are several upland sites that are sediment sources to the streams. Most of these sites occur on moderately sloping to steep silty glacial till soils. When exposed these soils can produce significant amounts of suspended sediment. Several of these upland sites are natural mass failures or road associated mass failures. Other sites include old log landings and erosion occurring on ski runs or streams in the ski runs. These sediment sources will be reviewed for rehabilitation actions, which may include: the construction of waterbars, the planting of shrubs, the planting of grass, and/or the placement of rock armoring. During the 2000 and 2001 field season there were several thousand of shrubs and tree seedlings planted on eroding uplands and in skid-streams in an attempt to establish vegetation and reduce erosion.

Situation - 4 In-Channel Large Woody Debris: Past timber harvest activities have included harvesting trees within riparian zones, or upland areas adjacent to riparian zones within one tree length of the stream. In some areas, this removal of trees has reduced the amount of large woody debris for current and/or future use in the stream channels. The large woody debris acts to reduce streamflow energy, trap sediments, and create pool habitat. In some areas, this reduction of large woody debris in the stream is increasing the amount of bank erosion. On these sites, we propose to add pieces of wood to the stream to augment the existing instream large woody debris.

Situation - 5 Log Jam Stabilization: There are several sites (5-6) along Big Creek where logjams (concentrated piles of large woody debris) in the stream are causing the stream to erode a new channel. Refer to photograph – 9. The removal of portions of the logjams, in some cases, would in the short-term reduce the amount of channel erosion. However, there are sediments trapped behind these logjams. Therefore, the removal of the any woody materials from these logjams would be done in a manner to minimize any movement of the trapped sediments. The removal of these logjams would cause minimal stream channel disturbance by the use of manual labor and chainsaws if possible, rather than heavy equipment.

Photograph – 9: Example of concentrated piles of large woody debris in the Big Creek stream channel.

In some of the logjams, the woody materials are becoming rotten and weak. We propose to review these logjams with the Mt. Department of Fish Wildlife and Parks, along with the U.S. Fish and Wildlife Service to see if it would be beneficial and logistically possible, to remove portions of the trapped sediments before the logs jams are breached. The removal of these sediments would require the use of heavy equipment. Refer to photographs 10 and 11 for examples of the bedload sediments behind a logjam. Three of the major logjams were partially or totally burned during the Moose Fire. These sites need to be reassessed whether or not any work is warranted.

Situation - 6 Road Decommissioning: Beginning in the early 1980's road closures and road reclamation was initiated primarily in order to improve wildlife habitat. However, there are watershed improvements realized from these road management actions. Currently there are approximately 100 miles of year-around road closures in the Big Creek Basin. The Big Mountain Expansion EIS-ROD, 1995 has identified and authorized 35 miles of road decommissioning. Approximately 16 miles of these roads have been reclaimed in the recent past. The remaining 19 miles authorized for reclamation will be accomplished as funding becomes available. Preliminary assessment indicates that additional road

Photographs –10

Photographs –11

decommissioning will be needed to achieve desired resource objectives. The amount and location of these roads is yet to be determined, however initial estimates indicate approximately an additional 56 miles of decommissioning may be necessary to achieve wildlife habitat, watershed restoration, and road management objectives. Road decommissioning projects are accomplished as the NEPA analysis and decision notice is completed for an area. The NEPA process is under now for Big Creek, and a decision notice is expected in fall 2002. The actual work is accomplished when funds become available to do the work. For the 2002 field season there are 4.7 miles of decommissioning planned in upper Big Creek, and 8.2 miles in Skookoleel Creek.

The road reclamation process includes: 1) water barring of the entire road length; 2) removal of the perennial and intermittent stream culverts; 3) the construction of an earth berm at the beginning of the road segment; and 4) revegetation of the soils disturbed during the water barring and culvert removal process. Roads that need to be closed for wildlife habitat improvement and that are not needed for management for several years, are proposed for road reclamation. The road reclamation is done in order to reduce the sediment yield from the road prism and decrease the probability of a culvert failure. There are short-term sediment increases associated with the culvert removal process, as the fine materials under the culvert in the streambed are eroded down to gravel/pebble surface. The initial estimate for the amount of erosion/sedimentation from road decommissioning is 510 tons. The reduction of sediment both from the road prism and the ditches are analyzed in Section 4.0 of this report.

Situation - 7 Road Drainage Improvements - BMP implementation: There are segments of the existing road system that are to remain in use, which needs improvements in the road surface drainage and stream drainage systems to meet current Montana State Best Management Practices and INFISH standards. This work would include up-sizing culverts (approximately 77), and adding more road cross-drains (culverts or drive thru dips) at approximately 35 sites. The road segments that need the work are primarily located along road numbers 316, 315, 1655, 1658, 5207, 5272, and 803, which represents more than 48 miles of roads. There is approximately an additional 18 miles of road that water-bars are proposed on that will be converted into snowmobile trails.

There is a small road used by Winter Sports Inc. to access portions of the north side of the Big Mountain in the Chair 7 area. The road starts near the Summit House and ends on Forest Service Road #316. Shallow water bars have been installed in the road so as to not impede snow grooming. However, these waterbars are occasionally topped by runoff after a rainstorm, and some sediment reaches a tributary of Big Creek. Winter Sports Inc. has agreed to improve the water drainage from this road segment.

SECTION 3.0
WATER QUALITY OBJECTIVES (TMDL TARGETS)

The full support of a cold water fishery is the primary goal behind the development of this watershed restoration plan. To assess the amount of interstitial fine sediments occurring in the fish spawning habitat, the McNeil Core methodology is proposed as a measurement tool.

The data presented in Table 5 (McNeil Core samples (% fine sediment < 6.4mm) in Big Creek) for the years 1981 – 1987 represents "reference" conditions for the purpose of determining targets for Big Creek. The target is the attainment of reference conditions in Big Creek. The mean % fine sediment (less than 6.4 mm) during that period was 27.4%. In defining a reference condition and determining compliance with water quality standards (fully supporting beneficial uses), consideration must be given to variation in natural systems, and sampling and analysis methodology used to compare conditions. One standard deviation from the mean of 27.4% fines or the reference period is +/- 3.63 (by definition, one standard deviation contains 68.26% of the normally distributed data). Therefore the target selected for percent fines is the reference condition, with the allowance of one standard deviation to account for natural variation and sampling and analysis methods. This translates to a target of between 23.77 and 31.03 % fines less than 6.4 mm. As a margin of safety, the target is set at less than 30 percent fines. As more McNeil Core percent fines data is collected, it may be appropriate to reduce the % fines target, based on an increased understanding of the uncertainty associated with the natural variation of the percent fines target and the sampling methodology.

A target of 30% fines is 5% less than the 35% threshold for a threatened stream recommended by the Flathead Basin Commission report "Flathead Basin Forest Practices Water Quality and Fisheries Cooperative Program Final Report" (1991), and adopted as a forest plan amendment to the Flathead N.F. Land Management Plan. This modification from 35% to 30% applies only to Big Creek since historic percent fines data from Big Creek indicates that the lower level is achievable and consistent with MDEQ criteria for making beneficial use support determinations (Water Quality Assessment Process and Methods, Appendix A of the 2000 303(d) List).

The second objective would be to reduce the amount of streambank erosion occurring in the most sensitive impaired reaches of Big Creek. The objective would be to have approximately the same amount of streambank erosion occurring (for several years running) within the impaired sensitive reaches, as occurs in similar non-impaired reaches upstream and downstream. This objective can be monitored using channel cross-sections and bank erosion profile measurements (using bank erosion pins per Rosgen technique). A successful measure of this target would be that the erosion rate of the monitored impaired reaches is not significantly greater than 125% of the erosion rate of the monitored reference reaches, based on a statistically valid comparison.

The third objective is to reduce the sediment input from upland and stream channel sources. The measure of the achievement of this objective would be the successful revegetation and/or armoring of at least 75% of the identified sediment sources.

These objectives may need to be reviewed after a few years of monitoring results are accumulated. Fires and other natural events may lead to a longer period of time before all of the above targets can be achieved. Even after the targets are achieved, it is recognized that there may be future periods when natural events lead to conditions where the targets are not satisfied for a limited time period. As long as management activities within the watershed are such that the system can recover back to conditions of full support within the normal time period, the water body would not be considered impaired and in need of TMDL development for sediment related conditions associated with the natural event.

SECTION 4.0
ALLOCATIONS

4.1 Pollutant Reduction

This portion of the watershed restoration plan is difficult, because with non-point sources it is difficult to model and/or estimate sediment yields or sediment yield reductions. The road reclamation effect on sedimentation reduction was modeled using the WEPP soil erosion model. The pollutant reduction for the other proposed restoration activities are described either qualitatively, or as an estimation of percent reduction from the current situation, based upon best professional judgment. Table - 6 lists the proposed pollutant reductions and the estimation of effect from those activities. Refer to Figure – 8 for a map of the locations of the proposed treatments within Big Creek.

The proposed watershed restoration activities would reduce significantly the input of suspended sediments from the upland eroding sites (e.g. skid trails, landings). Some reduction of suspended/bed load sediments will occur due to the erosion control/stabilization work on the natural mass failures. However, due to slope steepness and soil conditions portions of the slump scarps cannot be revegetated effectively, and will remain a suspended sediment source. There will be major reductions of suspended sediment input with the additional decommissioning of approximately 75 miles of roads. The waterbarring of these roads effectively ends the suspended sediment input from the road prisms except for very short distance directly adjacent to the stream channel. At the same time, road decommissioning reduces the amount of in-channel erosion due to the increased water flow from ditch-intercepted water. However, there are short-term sediment increases associated with road decommissioning during the culvert removal stage, as the fine materials under the culvert is eroded until a gravel pavement is re-established. Overall, the proposed reductions are expected to result in conditions where water quality objectives are met and conditions are significantly better than required to ensure full support of cold water fish and associated aquatic life in Big Creek.

The Table 6 proposed treatments represent a performance based approach to allocating actions needed to ensure protection of water quality and also ensure full support of beneficial uses within Big Creek. The estimated pollutant reductions in Table 6 represent a method for expressing the Total Maximum Daily Load (TMDL) in terms of anticipated yearly load reductions by treatment category. This is an acceptable TMDL surrogate approach consistent with EPA and MDEQ TMDL document development guidance and requirements.

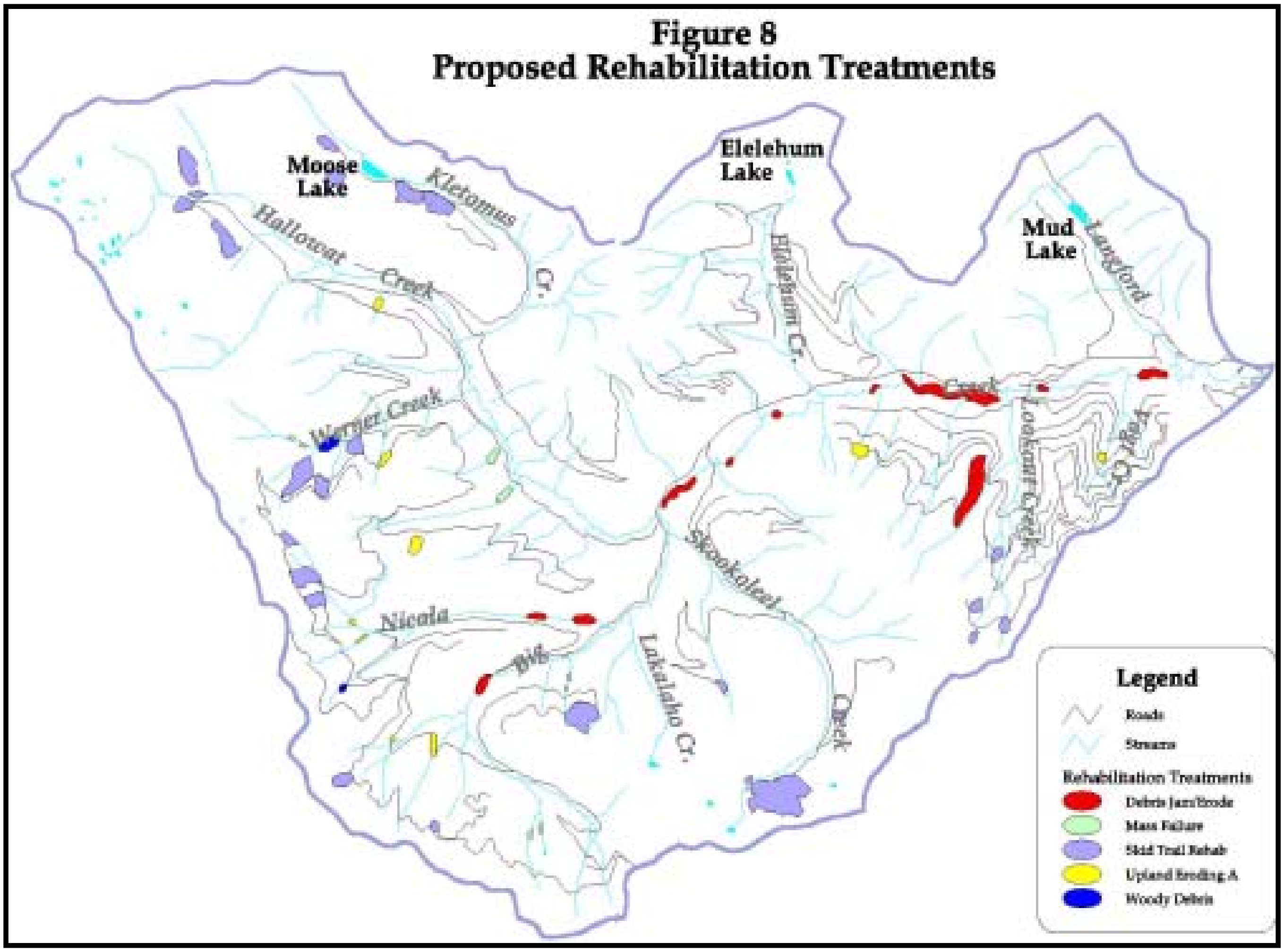


Figure 8
Proposed Rehabilitation Treatments
Moose Lake
Kletomus
Hallowat Creek
Cr.
Elelehum Lake
Elelehum Cr.
Mud Lake
Langford
Creek
Werner Creek
Lookout Creek
Skookoleel
Nicola
Big
Lakalaho Cr.
Creek
Legend
Roads
Streams
Rehabilitation Treatments
Debris Jam/Erode
Mass Failure
Skid Trail Rehab
Upland Eroding A
Woody Debris

Table - 6: Proposed restoration treatments and estimated pollutant reduction.

PROPOSED TREATMENTS	EFFECT OF TREATMENTS	POLLUTANT REDUCTION
Decommission roads in the Big Creek drainage as needed to accomplish resource objectives, estimated to be 75 miles. Currently an additional19 miles of decommissioning is authorized by an existing NEPA decision. Refer to page 30 for details.	These treatments will reduce soil erosion/sediment production off of roads surfaces and cutslopes. The treatments will disperse water flow, which will help decrease peak flow responses in the basin.	The WEPP modeled erosion reduction from the cutslopes, ditches and road surface for 75 miles of road reclamation, is approximately 26 tons of eroded soil annually. There is a short-term sediment increase associated with the culvert removals (approximately 510 tons total).
Place large woody debris in streams where recruitment is needed. Approximately 10 miles of streams will be reviewed for these treatments.	Improved quantities of large woody debris for maintenance of streambed structure and fish habitat. These treatments will help decease the amount of in-channel erosion occurring in the reaches with limited large woody debris.	The sediment storage capacity of these streams would be increased by 20 to 30 percent. The associated reduction in streambed and streambank erosion for the reaches lacking large woody debris would be from 25 to 40 percent.
Stabilize existing logjams (concentrated piles of in-channel large woody debris) before they fail, and remove trapped in-channel sediment from behind several existing logjams. Remove existing logjams where they are causing significant channel erosion. Currently 5 logjams exist.	These treatments will help decease the amount of in-channel erosion occurring in the reaches where the logjams occur. Also most of the sediments stored behind the logjams would not be allowed to move downstream into stream reaches where key spawning habitat occurs.	Associated with these logjams there are potentially several hundred cubic yards of coarse to fine sediments that can be removed or stabilized. The reduction in streambank erosion along the 1/2 mile of critical stream reach could be from 15 to 30 percent.
Construct waterbars and plant grass/shrubs on old skid roads. Approximately 20 to 25 affected acres will be reviewed for these treatments.	These treatments will improve vegetative cover, and reduce soil erosion/sediment production off of upland harvest sites. The treatments will disperse water flow, which will help decrease peak flow responses in the basin.	The erosion potential from these sites can be reduced on these sites by 60 to 90 percent with successful revegetation. The decreased water flow to streams could reduce the estimated in-channel erosion from 20 to 50 percent.
Apply revegetation, drainage, and stabilization treatments to streambank slumps in Big Creek drainage. The treatments may include rock armoring, rock barbs, or tree stump armoring. Seven sites will be reviewed for treatment; approximately 8 to 10 affected acres maybe treated.	These treatments will improve vegetative cover, and reduce soil erosion/sediment production from these existing slumps.	On the slumps that the lower portion of the slump is being directly eroded by the stream, a reduction of streambank erosion from 75 to 95 percent can be expected. A reduction of 10 to 20 percent surface erosion is from the steeper slump face, is probably the realistic expectation.
Install improvements in the road surface and stream drainage systems to meet current Montana BMPs. This work would include up-sizing culverts (approx. 77), and the addition of road crossdrains (culverts or drive thru dips) on approximately 35 stream crossing sites.	These treatments will reduce soil erosion/sediment production off of roads surfaces and cutslopes. The treatments will disperse water flow, which will help decrease peak flow responses in the basin.	The potential sedimentation reduction from the cutslopes, ditches and road surfaces on these road segments can be reduced on these sites by 60 to 90 percent. The WEPP modeled sediment reduction is approximately 9 tons annually, for 35 crossing sites. The decreased water flow to streams could reduce the estimated in-channel erosion from 2 to 5 percent

4.2 Dealing with Uncertainty

There are two areas of future uncertainty that could affect the reduction of pollutants and/or the rehabilitation of Big Creek. First, a major peak stream flow event could cause additional streambank erosion along portions of the streambanks. A peak flow event could be the result of a severe rainstorm event, a rain on snow event, or a major peak flow snowmelt event. The proposed road decomissioning and old skid trails waterbarring/revegetation would significantly reduce the impact of any future peak flow event, by reducing the efficiency of the road and ditches in routing water to the streams. This reduced runoff efficiency would, therefore, decrease the actual quantity of water during a peak flow event and result in less ditch and channel erosion; therefore, less sediment load to Big Creek.

The other type of natural or man-caused event that could affect the restoration plan would be additional wildfire. As described earlier, wildfire is a major disturbance process that operates in these forested watersheds. The Moose Fire is expected to have significant effects to the vegetation and stream conditions in lower Big Creek for many years. The natural forest fuels loading from dead and down fuel materials are quite high, for the higher elevation sites in upper Big Creek. These fuel loads are outside the natural range of variability for alpine sites. This fuel loading is caused by a combination of fire suppression and tree mortality from blister rust. The area around Big Mountain has a very high density of natural fire starts due to lightning. The combination of the fuel loading and the fire start potential makes upper Big Creek a prime candidate for a major wildfire. This uncertainty cannot be planned for in this restoration plan; however, there may be fuel reduction activities proposed in the future in Big Creek could reduce the hazard. Where fires and other catastrophic events occur, it will be necessary to ensure that recovery is not hindered in a manner that significantly increases sediment loading, causes significant negative stream habitat impacts, or increases the period of time needed for recovery to full support of cold water fish and associated aquatic life.

The restoration plan for Big Creek in theory attempts to maximize as much as possible, reductions in sediment sources, enhanced revegetation potential, and reduced water yield from road systems. Because of this proposed restoration plan, an additional increase in pollutant reduction to insure a *safety margin* for future uncertainty does not appear necessary. This is because the proposed actions are not only expected to meet percent fines and streambank erosion objectives (targets) discussed in Section C, but are also expected to result in conditions that are significantly better than required to ensure full support of cold water fish and associated aquatic life in Big Creek. Pursuing conditions that are significantly better than established targets allows for future flexibility in forest management decisions and accounts for the continued existence of a limited road system with some allowance for some future additional management activities consistent with existing forest plans. These management activities may include road BMP improvements, culvert resizing, road decommissioning, and post-fire salvage logging.

An additional margin of safety will also be ensured by the proposed monitoring program (See Section F), wherein the monitoring results will be reviewed to observe trends relative to sediment loading. If the monitoring results do not demonstrate a trend towards reduced sediment loading and achievement of the proposed targets, actions will be taken to identify the source of the continued loading and remedial actions will be defined (assuming that the continued loading is attributable to anthropogenic causes).

4.3 Management Practice Selection

There were seven pollution situations described in section 2.5 Pollutant Source Inventory. All seven situations are addressed entirely or to some extent within the proposed pollutant reduction treatments. The treatments proposed are based upon Montana Water Quality BMPs, scientific literature (e.g. road reclamation), and past professional experience of the stakeholders in implementing similar practices in this watershed or other watersheds. The actual measured sediment reduction or other response to the proposed treatments in several of the situations is difficult if not impossible to measure. We believe there are positive effects to the overall watershed health of Big Creek to be gained by each of the proposed activities, and all water quality objectives will be met with significant improvements to the resource above and beyond the objectives defined in this plan. The sediment source (primarily in upper Big Creek) healing both naturally and man-induced in the past twenty years in Big Creek has caused a positive response in the in-stream sediment levels, as measured by the McNeil Core samples. It should be noted that there is only a small portion of the Moose Fire area above the McNeil Core monitoring reach. However, that area includes a thousand acre plus high burn severity/high erosion potential unnamed watershed is directly above the monitoring reach. For this reason in the short-term one would expect the percent fines in the McNeil Cores to increase even though the planned restoration activities, continued revegetation improvement in upper Big Creek should reduce the sedimentation levels. The middle portion of the mainstem of Big Creek may, or may not change significantly with the effects of the Moose Fire; the cross-section and streambank profile monitoring sites will reveal any increase channel erosion associated with the Moose Fire.

There may be other potential sediment sources associated with the Moose Fire that become apparent in the next few years. If these are significant sedimentation source there is a funding mechanism Burn Area Emergency Rehabilitation funds for the next two field seasons.

SECTION 5.0
TIMELINE FOR IMPLEMENTATION AND COST ESTIMATE

The actual timeline for implementation of the proposed restoration projects in Big Creek cannot be specified exactly because of how funds are allocated by congress and distributed within the Forest Service. Once the NEPA analysis is completed for proposed actions in Big Creek, and as funds become available, the restoration work in Big Creek will be a high priority for the Flathead National Forest. The adoption of this watershed restoration plan by the DEQ and the EPA, will possibly allow for cooperative watershed restoration funding between the State of Montana, special interest groups, and the Forest Service. There have been post-fire rehabilitation funds allocated for work on Moose Fire projects. These funds should accomplish the BMP road improvement work, and portions of the culvert upsizing and road decommissioning work.

Coordination with the Montana Department of Fish, Wildlife and Parks and U.S. Fish and Wildlife Service will occur prior to initiation of the proposed stream associated restoration treatments to ensure potential impacts to state or federally listed threatened and endangered species are appropriately considered. Table - 7 displays the project sequencing, along with an estimation of time and cost to accomplish the various proposed projects.

The total estimated cost of this watershed restoration project work is $850,000 depending on when the work is completed. This cost does not include the annual monitoring cost.

Table - 7: The proposed watershed restoration activity, project timeline sequence, estimation of time and cost of accomplishment.

Proposed Project	Project Sequence	Location Within Big Creek Basin	Time to Complete Project	Estimated Time Labor/Machine or Materials	Estimated Cost
Construct waterbars and plant grass/shrubs on old skid roads. Approximately 20 to 25 affected acres.	Initial project to be completed, 1st or 2nd year.	Identified areas throughout Big Creek basin	1 - 2 field seasons	A 4 person crew (2 crew-months), small backhoe (1 week), grass seed and shrubs.	$15,000
Decommission approximately 56 miles of road in the Big Creek Basin as needed to accomplish resource objectives. Refer to page 30 for details.	Project completed after upland erosion sources rehabed.	Priority would be to reclaim road systems in the headwaters and move downstream.	5 - 6 field seasons	Bulldozer and large excavator (approx. 3 months), erosion netting, shrubs and grass seed.	(difficult $8000/mile) (easy $5500/mile) Total Est. $460,000
Stabilize/remove existing logjams. Remove trapped sediment from behind 5 existing logjams.	Initial project to be completed, 1st or 2nd year.	Identified stream segments in lower Big Creek. Consult MFW&P & USFWS.	1 - 2 field seasons	A 4 person crew (2-3 weeks), and small excavator (2 weeks).	$25,000
Place large woody debris in streams where recruitment is needed. Approximately 10 miles of streams will be reviewed for these treatments.	Project completed whenever funds available.	Headwater streams of Big Creek.	1 field season	3-4 days helicopter time, and a 2-man crew (3 weeks).	$14,000
Apply revegetation, drainage, and stabilization treatments to streambank slumps in Big Creek drainage. The treatments may include rock armoring, rock barbs, or tree stump armoring. Seven sites will be reviewed for treatment; approximately 8 to 10 affected acres maybe treated.	Project completed whenever funds available.	Identified stream segments in lower Big Creek. Consult with MFW&P and USFWS.	1 - 2 field seasons	A 4 person crew (2 weeks), small excavator (3-4 weeks) grass seed & shrubs.	$35,000
Install improvements in the road surface and stream drainage systems to meet current Montana BMPs (approx 48 miles). This work would include upsizing culverts (approx. 77), addition of approx. 35 road crossdrains (culverts or drive thru dips).	Project completed whenever funds available.	Identified areas throughout Big Creek basin	1 - 2 field seasons	A small excavator (3-4 weeks), grass seed, and culverts	$301,000 Total Estimate $850,000

SECTION 6.0
MONITORING AND EVALUATION

Our monitoring efforts will evaluate our proposed restoration efforts and success toward meeting water quality objectives. The purpose of the restoration activities will be to reduce sediments from upland eroding sites, the existing road system, and streambanks, as well as to reduce stored sediments within the stream channel. All the restoration efforts are aimed at improving the aquatic habitat for the beneficial use of cold-water fisheries.

Various techniques are proposed to monitor these restoration activities:

- The McNeil Core procedure would be used to measure amounts of fine sediments in the stream. This monitoring procedure is currently being done annually on a sampling reach in Big Creek near Skookoleel, by the Montana Department of Fish, Wildlife and Parks. The Forest Service would continue to support this effort on an annual basis.

- A combination of channel cross-sections, Wolman peeble counts, Bank Erosion Index, and bank profile monitoring (using bank erosion pins per the Rosgen technique) would be used to quantify the amount of streambank erosion occurring in the most sensitive reaches of Big Creek. Monitoring sites would be located above, below, and within sensitive stream reaches. The Forest Service would monitor these sites on an annual basis.

- The effectiveness of the BMP/erosion control practices would be reviewed by the Forest Service during the second year following implementation of the control practices.

Results from monitoring would be compiled biannually by the Forest Service in a report to be shared with the Montana Department of Environmental Quality. The physical monitoring results would be reviewed and interpreted to determine if Big Creek is improving from the impaired status, reaching equilibrium, or declining. We would then recommend monitoring to continue until streambank erosion has significantly improved. When improvements have been documented, continuation of the monitoring program would be discussed with the Montana Department of Environmental Quality. Where necessary, the monitoring information will be used to justify adjustments to this restoration plan. The estimated annual time/cost to complete the monitoring and reporting would be approximately 8-10 person-days, and $2,500 to $3,000.

As an additional margin of safety to ensure full support of beneficial uses, the MDEQ will also do macroinvertebrate and periphyton sampling once every five years to ensure that there are not any other indicators of aquatic life support problems associated with sediment.

SECTION 7.0
MAINTENANCE OF EFFORT OVER TIME

The activities both on private and Forest Service lands that cause the impairment of Big Creek occurred over several decades. The Flathead National Forest has had a commitment for the last two decades to improve the water quality concerns in Big Creek, and there have been tens of thousands of dollars spent toward that goal. At the same time the Regional Forester has made a commitment that the Forest Service will work toward improving any impaired streams as rapidly as possible. Therefore, there is a common interest for several reasons to see the restoration activities go forward in Big Creek. As stated earlier once the NEPA analysis is completed for the proposed actions in Big Creek, and as funds become available, the restoration work in Big Creek will be a high priority for the Flathead National Forest. There have been funds allocated for work on post-fire projects in the Moose Fire area. These funds should accomplish major portions of the work, but probably not all the work outlined in the plan.

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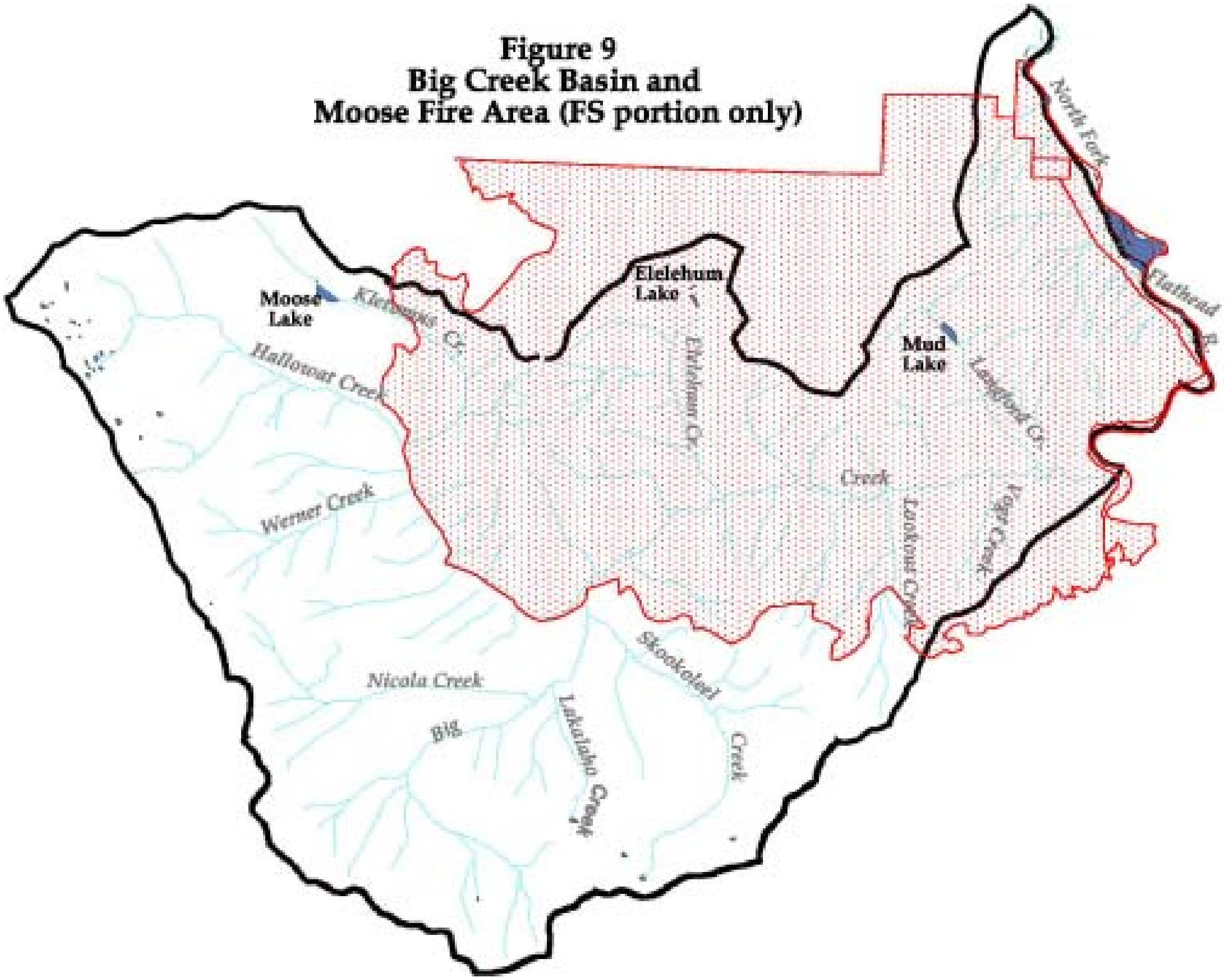
Figure 9
Big Creek Basin and
Moose Fire Area (FS portion only)



APPENDIX A: BIG CREEK TMDL "CROSS-WALK"

WATERSHED RESTORATION PLAN for Big Creek, North Fork of the Flathead River

WATER BODY INFORMATION		303 (d) List Information	
WATER BODY NAME:	***Big Creek*** Montana ID # MT76Q002_050	**Impaired Beneficial Uses:**	Partial Support: Cold Water Fishery & Aquatic Life
WATERSHED:	North Fork Flathead (HUC 17010206)	**Probable Cause(s):**	Siltation (1996 & 2000); Other Habitat Alterations (1996 & 2000); Bank Erosion (2000); Fish Habitat Degradation (2000)

Key TMDL Elements	Cross-walk	Summary
Condition Assessment and Problem Description	See Section B	An Environmental Analysis at the Watershed Scale was conducted. This constitutes a very thorough analysis of the existing conditions, impairments, causes, and sources.
Uses/Pollutants Addressed	See Section B	This document addresses cold water fisheries and aquatic life partial use support conditions associated with sediment and habitat related impairment causes.
Applicable Water Quality Standards	See Section B-1	Big Creek is classified as B-1. Narrative standards associated with beneficial uses supported by a B-1 classification as well as narrative standards associated with sediment are both addressed.
Water Quality Standards Target or Endpoint	See Section C	The targets are: 1) < 30% instream fine sediment. This endpoint links sediment loading/transport to the cold water fishery and aquatic life beneficial uses. 2) The erosion rate of monitored impaired reaches are not significantly greater than 125% of the erosion rate of the monitored reference reaches, based on a statistically valid comparison. 3) The successful revegetation and/or protection of at least 75% of the identified sediment sources.
TMDL – Reduction Target	See Table 6 & Figure 8	The TMDL is expressed as estimated percent reductions in erosion or sediment production for six categories of proposed restoration treatments, of which it is estimated that 75% or less of the total load reductions would be needed to meet the water quality targets and obtain full beneficial use support. Monitoring will be implemented to ensure that targets are achieved via performance of a sufficient level of proposed restoration work.
Significant Sources	See Section B.3.3	All significant sources and source types are identified and discussed. There are not any point sources or associated waste load allocation needs in this watershed.
Margin of Safety	See Section C, D.2	1) Percent fines target is based upon 80% of internal reference; MDEQ criteria for beneficial use support is based on 75% of reference conditions 2) Given current conditions being close to meeting beneficial use support targets associated with percent fines and habitat, it is estimated that addressing more than 75% of the total reductions in sediment loading will be more than adequate to meet the TMDL targets while still allowing for existing conditions with some future forest management efforts as a "future growth" component of the TMDL. 3) The monitoring plan provides for an adaptive management approach and includes additional indicators of stream health via macroinvertebrate and periphyton sampling.
Seasonality	Whole document	Sediment production data, problem definition and associated modeling all apply to yearly sediment loading and erosion during high runoff periods.
Allocation/Restoration Strategy	See Table 6 & Figure 8	Restoration treatments are proposed for virtually all of the identified sources potentially contributing to impairment conditions. This provides for a performance-based allocation scheme whereby it is assumed that completion of proposed efforts will result in conditions that are significantly better than required to ensure full support of cold water fish and associated aquatic life in Big Creek. This then provides a margin of safety and allowance for some level of future management flexibility within the drainage. This future management flexibility, or "future growth" consideration includes proposed salvage logging or any other activities where it can be shown that the activity will not create conditions where water quality targets could not be met or the ability to meet water quality targets would be significantly delayed.
MONITORING	See Section F	McNeil Core procedure will be employed to monitor fine sediment trends. Cross-sections, Bank Erosion Index, and bank profile measurements will be used to monitor bank erosion. Effectiveness monitoring will be conducted to evaluate success of implementation. This monitoring will be done yearly by the Forest Service and every five years by MDEQ. The first year, the Forest Service and/or the Montana DEQ will also collect samples for macroinvertebrates and periphyton. Based on the results, biological sampling by MDEQ may continue yearly. Data will be analyzed by the Montana DEQ. MDEQ five-year sampling will include macroinvertebrate and periphyton sampling as an additional confirmation of beneficial use support.
Section 7 Consultation	NA	The Big Creek Watershed is considered Core Bull Trout Habitat. To initiate the consultation process, this document has been submitted to the U.S.F.W.S. concurrently with submittal to the USEPA.
Public Involvement	NA	A thirty-day public comment period is part of the document preparation process. Implementation planning is an inherent part of the Flathead National Forest Plan, which has undergone public review. Many of the proposed treatment actions in this document would also undergo NEPA review and associated public comment. NEPA documentation and associated NEPA public review is accomplished through the Forest Service.

Appendix B

RESPONSE TO WRITTEN PUBLIC COMMENT DRAFT

Big Creek Watershed Restoration Plan

COMMENT: Protest the removal of roads. Roads are beneficial to the endangered lynx population. Plan to log the area with selective logging management plan in the future to promote endangered lynx.

> **RESPONSE**: DEQ is developing a water quality restoration plan to address the beneficial uses associated with the water resources in this watershed. Some road decommissioning is planned, in accordance with several management objectives. DEQ is not providing plans to the Forest Service for selective logging, as this is not within our jurisdiction.
>
> The Forest Service will evaluate lynx and other wildlife impacts associated with road decommissioning in the Moose Post-Fire Project EIS as required by NEPA (National Environmental Policy Act).

COMMENT: Isn't a huge part of the problem the Moose Fire of 2001? Isn't DEQ going to include any information regarding the fire?

> **RESPONSE**: The TMDL and Watershed Restoration Plan was being developed prior to the Moose Fire. Big Creek was on the State's 1996 and 2000 list of impaired waters bodies for partially supporting aquatic life and coldwater fisheries (trout). Sediment was identified as a probable cause of impairment. Fires do increase sediment loads to streams. However, this is a temporary phenomenon, and the Forest Service is implementing mitigation measures to reduce the impacts associated with the fire. The fire's impacts are addressed in the TMDL. The Watershed Restoration Plan is focused on issues associated with human activities that have resulted in water quality impairments.

COMMENT: The drainage has had soil movement in the past 50 years but disagree with the conclusion reached that the movement is mainly a result of timber harvesting and road construction.

> **RESPONSE**: The plan does not identify soil movement being mainly caused by timber harvesting and road construction. Natural processes, including landslides, bank erosion, fire and flood effects have been discussed in the Watershed Restoration TMDL. These processes as well as man's activities have resulted in the movement of soils.

COMMENT: First harvesting in the drainage occurred as a result of blow down and subsequent spruce bark beetle infestation in 1957. Logging and road building technology and economics used during the early harvest were those normally used at the time. The sediment that would have resulted from a wildfire on these acres would have been many times greater that what occurred. Roads and skid trails used in this early logging have been re-vegetated and re-contoured so they have not contributed sediment in the past 20 or more years. There are currently no open roads in the upper third of the drainage since the Forest Service took over management in the mid 1990's.

RESPONSE: We agree that a wildfire could have the potential of producing a significant amount of sediment mobilization (see response to a previous comment). However, upland sources of erosion as a result of human activities have been identified in the plan. In the last ten years most of the uplands have been re-vegetated. There are still several small areas that have not fully revegetated that are active sediment sources. The rehabilitation of these areas is discussed in the Watershed Restoration Plan. Several roads in the upper basin have also been gated. Some additional road decommissioning is proposed. Best Management Practices (BMPs) have been proposed for road drainage improvements on 48 miles of roads that have not been decommissioned. DEQ recognizes that much of the sediment problem in the stream is associated with historical erosion from human activities in the 1950's and 1960's. This sediment is still in the process of working its way through the system (Table 4).

COMMENT: The lack of large woody debris in the riparian area is due to the Forest Service's contract requirements to remove all blow down into or across stream, including branches and fine needles. The Moose Fire has established a very good example of what can happen to riparian woody debris.

RESPONSE: In the 1960's, logging contracts required slash removal. This historical requirement is no longer a necessary contract requirement. The current contract requirements require slash removal only when it will impede stream flow for cause erosion. There is a significant amount of spruce blow down which occurred after the Moose Fire, providing a large amount of woody debris input to some riparian areas. This is helping to provide a desirable balance to the sediment-loading situation.

COMMENT: Montana Fish Wildlife and Parks cooperated with private landowners and the Forest Service to replace some of the downfall in the upper reaches of the drainage. One of the treatments proposed appears to address the need for stabilization of existing log jams and adding and/or replacing others. This is a good step in the right direction.

RESPONSE: Two of the six proposed treatments relate to in-stream large woody debris. One is placing large woody debris in streams where these are needed (which equates to a 25-40 percent reduction in stream bank erosion in those areas (approximately 10 miles of stream in the watershed). The other proposed treatment is the stabilization of existing log jams before they fail in a critical ½ mile stream reach (estimated reduction in stream bank erosion of 15 – 30 percent in that section).

COMMENT: In this watershed very little snow melts until late May or early June and then the entire snow pack melts in a two week period causing very high stream flows with high velocities. Combining these high flows with glacial tills lead to the very high sediment loads.

RESPONSE: The Big Creek Watershed Restoration Plan is written to address pollutant (sediment) sources that are a result of man-caused activities, above and beyond those sources related to natural causes. We don't disagree that glacial stream system have naturally high sediment loads and movement.

COMMENT: Since there has been no timber harvesting in the area except for one helicopter sale since the early 1980s the vegetation that was disturbed has re-occupied the site. Over the entire history of the drainage 33.8 percent [16,691 acres] of the area has had some type of vegetative disturbance. If there is significant sedimentation from this 50 plus year history then what about the effect of 70,000 acres burning in a stand replacement fire in one year. Current information from the Forest Service indicates that there was minimal sediment generation from the burned area. How does the plan address this conflict?

> **RESPONSE**: The majority of your observations are correct. As previously stated, the Plan is written to address pollutant sources that are a result of man-caused activities. Roads, skid trails and timbering activities in or near the riparian area can act as direct conduits of sediment from land disturbing activities into waterbodies and act as continuing sources if steps are not taken to remediate their impact. Bedload sediments resulting from logging activities in the 1960s in the upper basin are still moving through the Big Creek system. We continue to see the effects of past logging activities. It can take many years for sediment to be routed through the system. In many instances the effects of roads and skid trails in routing water-flow is magnified following a wildfire. The post-fire rehabilitation treatments tried to identify any man-made or natural site that would be a significant post-fire risk and attempted to fix those situations.
>
> The Moose Fire was a natural event. Fires generally do not lead to the same type of sediment "routing" as roads, skid trails, and overall ground disturbance from skid trails. The Watershed Restoration Plan does address the impacts associated with fire. Note the two-page discussion on wildfire disturbances. The amount of actual burned acres in Big Creek proper is 12,280, not 70,000. As stated in the restoration plan the Forest Service has been engaged in erosion control activities to reduce erosion from burned areas (see section titled "Effects of the Moose Fire August- November 2001").
>
> The initial response of the Moose Fire to the mild precipitation events that have occurred is very favorable. However, there is still risk that with a high intensity rainstorm significant soil erosion could occur from the fire area. That risk decreases over time with revegetation.
>
> Sediment movement associated with human activities is potentially less than natural but together has resulted in the streams not fully supporting the beneficial uses. We do agree that there is still a lot of sediment load associated with natural conditions.

COMMENT: The monitoring station at Lookout Bridge only gives part of the picture. It includes a large natural slumping slope one mile above the bridge but ignores a very large sediment-generating slope about two miles below the bridge. These two areas have contributed more sediment to the stream than all other activities in the drainage. Bank stabilization is proposed, what is being done about these natural sediment producing areas?

> **RESPONSE**: Natural sources of fine sediment are included and identified in the development of the Total Maximum Daily Load and load allocation as part of the part of the background condition. There is not much that can be done about those areas. The monitoring station site was selected, in large part, because of its accessibility and convenience. It also provides a relatively good characterization of the watershed, capturing 85-90 percent of the area of the watershed.

The watershed restoration plan identified the eroding stream banks (Nonpoint Pollution Source Inventory, Situation - 1). The site upstream of the bridge has had some erosion control treatments implemented already, and is being considered for additional treatments. The landslide below the bridge has very few practical treatments available in order to reduce the natural erosion. The Forest Service and DEQ disagree with the comment that the two slumping areas above and below Lookout Bridge have contributed more sediment that all other sediment sources in the watershed combined.

COMMENT: Big Creek waters are prime Bull Trout and Cutthroat Trout habitat. The fishery needs to be maintained but unless vegetative management and access for management purposes occurs, the habitat will be lost. How are you planning to manage the sediment loads through your restoration efforts while ignoring the health of the vegetation that is necessary to protect the soil?

RESPONSE: We agree that the health of the vegetation is important to ensuring soil stabilization, however, intensive or active vegetative management may not be necessary to provide a healthy vegetative cover. Bull Trout and Cutthroat trout are native to this area. It is highly likely that these species evolved under a “natural set” of habitat conditions that did not include vegetative management or access for vegetative management purposes. Previously it was stated that the Forest Service indicated that there was minimal sediment generation from the Moose Fire burned area in the watershed. Finally the Watershed Restoration Plan identifies six proposed restoration treatments to manage sediment loads to a level that will fully support the beneficial use, and specifically, Bull Trout.

Decommissioning roads does not negate the use of those road surfaces for future management access. Decommissioning the road provides a means of “storage” of the road in a condition that minimizes the erosion potential and risk for contribution of sediment. During restoration/BMP work, efforts will be taken to avoid/reduce erosion. None of the actions identified in the watershed plan in any way negate future vegetative management if it is determined to be needed.

COMMENT: The Plan contains six proposed treatment categories. Other than reclamation of roads, these treatments are likely to have a sediment load reduction effect., but forest health is not addressed. To have a healthy riparian area and stream, a healthy vegetative structure is needed. How does the plan provide for a healthy vegetation cover in the watershed?

RESPONSE: We do not disagree that a healthy vegetative community is a necessary component in minimizing erosion and sedimentation. Road reclamation has been identified as a technique that will reduce sediment inputs to the stream by removing a direct sediment conduit from disturbed surfaces (i.e. roads, and adjacent cut and fill surfaces) to drainages, creeks, and streams. As proposed under the plan, decommissioning of 75 miles of roads is expected to lead to an eroded sediment reduction of 26 tons per year. The plan allows for and does not preclude vegetative management. Road drainage improvements are also part of the plan. Access is not a necessity in maintenance of a healthy riparian vegetative community.

Forest health should not be narrowly defined as a healthy vegetative community. Additional considerations, such as full support of aquatic life and beneficial uses of the waterbodies should also be included in the definition of forest health. The watershed restoration plan does not over-ride the existing Forest Plan direction that has a healthy vegetative community as a primary goal.

COMMENT: The fine sediment target is too high. The fine sediment target is almost 8 percent higher than the lowest McNeil Core value of 21.6 percent and is higher than the McNeil core value in five other years since 1981. The 30 percent sediment target is based on 80 percent bull trout survival, however at 30 percent fine sediment bull trout survival is only 39 percent. Setting a fine sediment target that allows for only 39 percent fry survival in a stream that has had much less fine sediment in the past and is entirely under federal jurisdiction is not consistent with bull trout recovery.

RESPONSE: The proposed fine sediment target of 30 percent was derived to achieve full beneficial use support (reference conditions) while acknowledging variability of natural conditions and sampling methodology.

Using Weaver and Fraley's survival equation for bull trout fry emergence (Weaver and Fraley, 1991), the amount of percent fines fully supporting bull trout was calculated to be 30.4 percent. As the comment points out, this does lead to emergence of 39 percent of the fry. DEQ points out that at 0 percent fines fry emergence success is less than 80 percent.

Based on reference condition percent fines (1981-1987) data (Watershed Restoration Plan section B.3.1, McNeil Core Sediment Measurements) mean percent fines plus or minus 1 standard deviation results in a value of 24 – 31 percent fines less than 6.4 mm. DEQ would like to see 100 percent of reference conditions, and has set the less than 30% fines target to account for inter-annual variability in the percent fines data, sampling methodology and a margin of safety.

COMMENT: Inconsistent road decommissioning information. How many miles of roads will be decommissioned in addition to the Big Mountain Record of Decision road mileage?

RESPONSE: DEQ agrees that the number of road miles identified for decommissioning needs to be clarified. The final document has been revised to reflect this comment. Nineteen miles of road decommissioning have been identified as part of the Record of Decision for the Big Mountain Environmental Impact Statement. An additional 56 miles of road decommissioning have been identified in the Moose Fire Timber Salvage draft Environmental Impact Statement's preferred alternative. This Forest Service preferred alternative is consistent with the Big Creek Watershed Scale Environmental Analysis (completed in November 1999) that was referred to on page 3 of the public draft Big Creek Watershed Restoration Plan. The Environmental Analysis identified a need for 75 miles of road decommissioning. The total number of identified miles of road decommissioning in our Big Creek Watershed Restoration Plan is also 75 miles.

COMMENT: Funding needs to be secured. In order for the TMDL to be effective and reduce sediment the roadwork needs to be done on a mandatory schedule with funding assured. This is especially important given the Moose Fire and the potential for culvert failures.

RESPONSE: The DEQ does not disagree that funding of road decommissioning and rehabilitation is important to meeting the targets set in the Big Creek Watershed

Restoration Plan. DEQ is required to develop TMDLs for all identified impaired waters of the State. This Watershed Restoration Plan includes an implementation plan that identifies what activities need to take place in order to protect the State's designated beneficial uses in the watershed. DEQ is willing to assist in securing appropriate funding to implement the actions identified in this plan. DEQ disagrees that the roadwork needs to be done on a mandatory schedule, as we have no legal or regulatory mechanism within either the Federal Clean Water Act or the Montana Water Quality Act that requires this.

The Forest Service following the Moose Fire secured funding to upsize any undersized culverts in Big Creek, and to implement the BMP improvement as discussed in the restoration plan. This work is virtually done as of this point in time. However, because of the federal budget process, monies cannot be allocated in advance of the current fiscal year. Until NEPA (see next response) is completed funding cannot be secured to decommission roads.

COMMENT: Roads to be reclaimed are not identified. The draft Watershed Restoration Plan does not disclose which roads will be reclaimed. A schedule of which roads will be reclaimed, what year the work will be done as well as funding to accomplish the work must be part of the TMDL.

RESPONSE: The plan states that the road segments that need drainage improvement are primarily located along road numbers 316, 315, 1655, 1658, 5207, 5272 and 804. As stated in the plan, approximately 48 miles of road should be brought up to current Montana BMP standards. DEQ disagrees that a schedule and funding must be part of the TMDL. DEQ has identified that the road reclamation work would likely take one-to-two field seasons and cost approximately $301,000. DEQ does not agree that the road reclamation requires a schedule or funding commitments as part of the TMDL. Again, neither the Federal Clean Water Act, nor the Montana Water Quality Act provides any authority for DEQ to require implementation of nonpoint source restoration activities.

The restoration plan restated the inter-disciplinary team's recommendations disclosed in the "Big Creek Ecosystem Assessment at the Watershed Scale" for roads to be decommissioned. Specific roads cannot be decommissioned until a NEPA analysis has been completed. That process is currently being done under the Moose Post-Fire Project. Once the NEPA analysis is done the work on roads identified for decommissioning can begin as funds are secured.

COMMENT: Road reclamation must be done to protect water quality and fish habitat.

RESPONSE: DEQ agrees that the road reclamation and road decommissioning should be done in a manner that protects water quality and fish habitat. DEQ will not address statements made in the Moose Fire draft Environmental Impact Statement, as this document is not under DEQ's jurisdiction.

COMMENT: TMDL components missing. The draft plan does not contain components needed for a TMDL. The plan contains no load allocation or margin of safety. The allocation of loads should be to individual identifiable sources. The TMDL should include a description of anticipated implementing actions or practices, provide a schedule of priorities for the required implementing actions and should identify the agency responsible for each implementing measure, including any necessary monitoring and enforcement. The timetable on page 38 does not contain this information.

RESPONSE: DEQ believes that the Big Creek Watershed Restoration Plan contains all required components for a fully approvable TMDL. The load allocation is a performance-based approach addressing virtually all of the identified sources potentially contributing to impairment. Seventy-five miles of road decommissioning is expected to reduce eroded soil by 26 tons per year. Creation of large woody debris dams is expected to increase in-stream sediment storage 20-30 percent. Stabilizing existing log jams is expected to continue to provide several hundred cubic yards of fine sediment storage and reduce stream bank erosion from 15 to 30 percent along the ½ mile of critical stream reach. Sixty to ninety percent reduction in erosion from 20 to 25 acres of skid roads and reduction in peak water flow from these areas is expected to reduce in-stream erosion by twenty to fifty percent. Stabilization of stream bank slumps is expected to provide a reduction of 75-95 percent of the sediment except for the steeper slope, which is expected to be reduced by ten to twenty percent. Finally, improvements to the existing road system are expected to decrease sediment loads by 9 tons per year and reduce in-channel erosion through peak flow reductions by 2 to 5 percent. If all of the practices identified in Table 6 are implemented, up to 25 percent additional sources of sediment could be generated without exceeding the established targets. This provides for a margin of safety and/or allows for some future sediment generating activities.

A margin of safety has been identified within the target of less than 30 percent in-stream fine sediment. As previously stated, this target provides a five percent margin of safety with respect to fry emergence from 75 percent of reference conditions. Additionally, benthic macroinvertebrate and periphyton sampling by DEQ, as indicators of the aquatic life beneficial use, will ensure that sediment is not limiting the beneficial uses.

Relative to implementation, this plan goes beyond the requirements of both the Federal Clean Water Act and the Montana Water Quality Act. Neither requires an implementation plan. However, the priorities for the work are addressed in Table 7. The implementing agency for these actions has been identified as the Forest Service, which manages these lands. Monitoring and evaluation activities and responsibilities have been identified (page 39).

COMMENT: The commenter does not agree with the assessment that the Big Creek drainage is impaired by sediment.

RESPONSE: Based on State law and DEQ's criteria for assessment of Sufficient Credible Data and Beneficial Use Support Determination, Big Creek is listed as partially supporting aquatic life and a cold water fishery due to siltation, other habitat alterations, bank erosion and fish habitat degradation. The fact that the stream segments are currently not meeting targets, which are based on DEQ's interpretation of State water quality standards, further supports the impaired status determination.

COMMENT: 1,768.66 acres of private land were extensively roaded and logged during the 1960's due to a windstorm blow down in 1957.

RESPONSE: DEQ does not dispute this.

COMMENT: Another factor that contributes to higher levels of sediment delivery is the snowmelt pattern that occurs over a shortened period of time, leading to greater peak flow events.

> **RESPONSE**: DEQ does not dispute this statement. Nevertheless, sediment impacts from man-caused activities have been identified which need to be addressed in a TMDL. This was also addressed in a previous comment and response.

COMMENT: Decommissioning of roads will reduce future forest management flexibility and fire suppression activities. More intense and larger wildfire will contribute to increased sediment delivery in the future. Improvements in road surface and stream drainage systems on some of these roads to meet Montana BMP standards would be a much preferred option.

> **RESPONSE**: As previously stated, road decommissioning does not preclude the future use of those roads. Road decommissioning does not preclude forest management. The plan does identify approximately 48 miles of roads that would be subject to road surface and stream drainage improvements. Road decommissioning does not eliminate fire suppression activities, however, decommissioning does limit some rapid fire response options (e.g. fire engines).

COMMENT: It is important that the water quality in the Big Creek drainage is improved so that this stream can be removed from the impaired status list as quickly as possible. Forest management activities, including salvage logging can occur while still protecting aquatic life and meeting water quality standards in the Big Creek drainage.

> **RESPONSE**: We agree.

COMMENT: The 30 percent fine sediment target is too liberal a target for this important bull trout watershed.

> **RESPONSE**: This target provides a five percent margin of safety over the State's criteria for determining impairment. DEQ believes that this target is appropriate.

COMMENT: We are supportive of using careful road decommissioning as a primary means of restoring the watershed, but the plan is confusing in this respect. It appears that the miles of roads to be decommissioned are the 19 miles remaining in the Big Mountain expansion EIS-ROD and some 56 miles of road being proposed in several alternatives in the recently released Moose Post Fire Project DEIS. The Watershed Restoration Plan must include a road decommissioning plan designed for water quality and fish, not just grizzly bear.

> **RESPONSE**: Road decommissioning is proposed as one of six means for restoring the watershed. The watershed restoration plan has identified 75 miles of road decommissioning, along with five other treatments which if implemented, will be adequate to protect the beneficial uses associated with the streams in this watershed, including a margin of safety and/or allowance for future sediment generating activities.
>
> The process of choosing the potential roads for decommissioning was a combination of identifying the roads that were preferred to be decommissioned for wildlife security, and the

roads that decommissioning would reduce significant road-associated soil erosion/sedimentation problems. The final step was selecting the priority roads for decommissioning that met as many resource needs and social desires as possible.

COMMENT: The Watershed Restoration Plan proposes to compromise the decommissioning of roads to provide easier and safer access for snowmobiles. The whole idea of road decommissioning is to get the culverts and the road fill out of and away from the streams.

RESPONSE: The purpose of road decommissioning in this proposal is to reduce sediment loading associated with 75 miles of roads to waterbodies in the Big Creek watershed. The road decommissioning activities, as stated in the plan, include water barring, removal of perennial and intermittent stream culverts, construction of an earth berm at the beginning of the road segment, and revegetation of the soils disturbed during the water barring and culvert removal process.

Improvements to some roads up to Best Management Practice Standards could allow for snowmobile access via the NEPA and Forest Service Planning.

The Big Creek Watershed Restoration Plan was developed prior to the Moose Post-Fire Project DEIS. The road decommissioning standards discussed in the restoration plan are the current flathead National Forest- Forest Plan standards. The Moose Post-Fire Project DEIS has one of five alternatives that would allow the 13 culverts or arch pipes to remain in place, with a maximum of 1.5 to 3 feet of fill material remaining over the culvert/arch pipe. At the same time these roads would be bermed and water-barred the same as any other decommissioned road, and the culverts remaining in place would meet the 100-year flow capacity required by INFISH. This alternative is provided to address the desire fore safe snowmobile access on some of the roads proposed for decommissioning. If this alternative is selected, then a site-specific amendment to the Forest Plan is required to implement the proposal in the DEIS alternative.

COMMENT: The watershed Restoration Plan needs to clearly develop a road reclamation plan that is designed for water quality and fish, not snowmobiles.

RESPONSE: The road reclamation plan is designed to address water quality and aquatic life beneficial uses. The plan includes specific work items such as up-sizing 77 culverts, adding more road cross drains (culverts or drive through dips) at about 35 locations, and 18 miles of installing water bars and conversion of roads to snowmobile trails. Use of these roads by snowmobiles during the winter season is not expected to significantly impact water quality.

COMMENT: The Watershed Restoration Plan road reclamation plan must contain a clear schedule for its funding and implementation. The road-decommissioning schedule must be on a very short time frame and mandatory.

RESPONSE: DEQ does not have the authority to require a schedule for implementation of the nonpoint source actions associated with this TMDL. As previously stated, we are available to work with project proponents in developing funding opportunities to implement the actions identified in the plan. DEQ legal counsel review of this issue occurred in April of this year and was summarized in a memo to Dean Sirucek, Flathead National Forest hydrologist dated May 2, 2002. "The primary conclusion is that the TMDL does not create additional implementation requirements for nonpoint source activities, and that none of the activities or commitments contained within the Big Creek Watershed Restoration Plan and Big Creek TMDL are binding under state and federal laws relating to TMDL development and implementation." Additionally, a recent decision in the 11th circuit court of appeals concluded that implementation plans were not a required element of a TMDL.