VII. HYDROLOGY

Introduction

The following section documents the existing conditions and the potential effects of the proposed action and its alternatives on the water resource. The issues addressed herein are the potential effects on water quantity (water yield) and water quality (sediment yield and nutrient yield). Refer also to the section in Chapter 3 titled Fisheries for corresponding information concerning this resource.

Information Sources

Information sources used in this document include:

- Data gathered by personnel from the Flathead National Forest (FNF)
- Natural resource databases maintained by the Flathead National Forest
- Data gathered by the U.S. Environmental Protection Agency during the watershed assessments of 303(d) listed streams in the North Fork Flathead River
- Scientific literature developed locally and literature pertinent to the topic based on similar physical, chemical, biological or issue parameters were considered and cited.
- Background field information from the analysis area, literature and computer model results were reviewed to assess existing condition

Methods of Evaluation and Models Used

Models are used to simplify, for analysis, extremely complex physical systems and are usually developed from a somewhat limited database. There may or may not be any relevant local data used in the development of the model. Both of the models used in this analysis, utilized northwest data during their development. Although the models generate specific quantitative values for water yield and sediment, the results are only estimates used as a tool to interpret how the natural system may respond, and are not intended to predict exact quantities of water or sediment being produced or routed. A model's output is meaningful only when it is used to evaluate existing conditions in light of the area watershed and stream characteristics, field data, and best professional judgment. The modeling results are interpreted in combination with the physical channel stability measurements to determine the risk of channel erosion to an individual stream channel.

Montana Department of Natural Resources and Conservation (DNRC) hydrologist Tony Nelson developed an Excel worksheet labeled “Water Yield Analysis” (WYA) in 2002 for the Flathead region. The WYA worksheets were used to estimate increased water yields for individual watersheds that had experienced past timber management and were affected by the 2003 wildfires. The WYA worksheet uses the procedure discussed in “Forest Hydrology, Hydrologic Effects of Vegetation Manipulation, Part II, (USDA Forest Service 1976) and the principles and components of the WATSED model (USDA Forest Service 1990). The procedure uses the equivalent clearcut area (ECA) concept to estimate water yield and this model is referred to by that acronym in the remainder of this document. Data inputs include: elevation, aspect,

precipitation zones per watershed, and roads within each precipitation zone to estimate the water yield increase resulting from removal of over-story vegetation cover from an acre of forestland. Water yield decreases for a harvested area as the vegetation recovers. The rate of decrease is based upon vegetation habitat types (USDA Forest Service 1976).

ECA Model Limitations: The ECA computer-based watershed response model was designed to address the cumulative effects of timber harvest operations, road construction, and to some extent, fire. This model does not attempt to analyze the effects of grazing and mining activities as there are no such activities in the analysis area. This model primarily estimates the water delivered to the main channel by forest management within the watershed, including the headwater stream channels. No main channel hydrologic or hydraulic processes are modeled directly.

The ECA model does not factor in extreme or rare events, such as very heavy rainfall on snow-covered ground or the occurrences of unusually high rainfall (thunderstorms), which could cause short-term high water flows (peak-flows). The ECA model relies on climatic conditions averaged over long periods; the models' accuracy is best when averaged over several years. Therefore, this model is less reflective of individual drought or flood years. Rain-on-snow precipitation events are discussed later in this report.

It should be noted that the ECA model calculates the estimated water yield percent increases assuming a fully forested condition prior to disturbance. This assumption results in a slight over-estimation of the water yield increase in these watershed groupings due to the shallow rocky soils (with no vegetation) and talus slopes in the headwaters areas, and the presence of wet meadows, marshes, and ponds with no forest cover. The ECA modeling results are interpreted in combination with the physical channel stability measurements to determine risk of channel erosion within an individual watershed.

The surface erosion potential for the proposed treatments was estimated using the Water Erosion Prediction Project (WEPP) computer model. The FuME (Watershed Analysis for Fuel Management Operations) interface estimates background erosion rates, and predicts erosion associated with mechanical thinning, prescribed fire, wildfire, and the road network in an analysis watershed. The model considers the amount and frequency of precipitation, as well as the runoff from rainfall and snowmelt events in combination with the typical slope length, slope steepness, surface soil texture and road density. The management variables of timing and amount of thinning and prescribed fire are entered along with the natural fire return interval. The model output predicts upland erosion rate, potential sediment yield and the probability of erosion and sediment delivery during the time period.

The WEPP - Roads interface was used to estimate the non-point sediment delivery from roads within the analysis areas. The potential sediment yield from each road crossing was calculated as an estimate of the background road associated sediment yield. The potential increase in road associated sediment due to the thinning was estimated calculating the number of additional stream crossings that would have to be constructed and the potential sediment from and new temporary road construction.

The Disturbed-WEPP model was used to estimate the potential erosion/sediment yield from the landings needed for the proposed thinning/timber harvest. The WEPP model calculates the runoff and erosion from a hill-slope for various types of disturbance activities. The output includes: inches of precipitation, the number and the amount of runoff from rainfall events, the number and the amount of runoff from snowmelt events, the upland erosion rate, the potential sediment yield and the probability of erosion and/or sediment delivery occurring during the time period.

For complete documentation of the WEPP model modules used in this analysis refer to the hydrology project file. The documentation on the WEPP model states the following:

> "At best, any predicted runoff or erosion value, by any model, will be within only plus or minus 50 percent of the true value. Erosion rates are highly variable, and most models can predict only a single value. Replicated research has shown that observed values vary widely for identical plots, or the same plot from year to year "

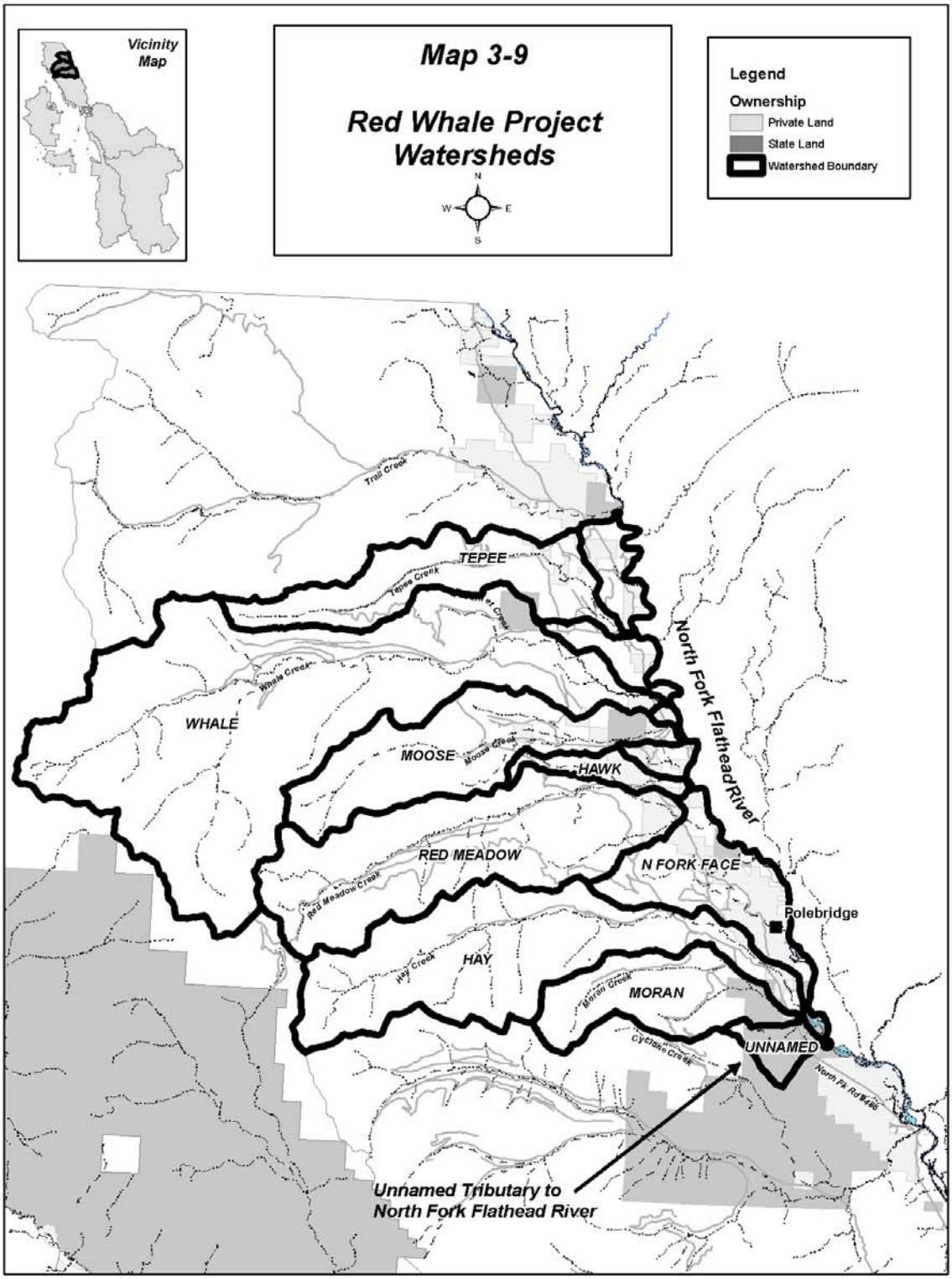
The soil scientist and hydrologists using the model for this analysis found the calculated erosion rates to be very reasonable for these hill slopes and treatment conditions.

Analysis Area

The analysis area used to conduct the hydrology effects analysis is bounded on the north by the northern boundaries of Tepee Creek and Whale Creek, on the west by the crest of the Whitefish Range, on the east by the North Fork Flathead River and on the south by Moran Creek and portions of Red Meadow Creek. All streams in the analysis area are tributary to the North Fork Flathead River watershed, which occupies portions of northwest Montana and southeast British Columbia, Canada. The hydrology analysis area is somewhat larger than the Red Whale Project area. The direct, in-direct, and cumulative effects analysis area includes nine analysis watersheds. Eight of these are true watersheds or basins, where the entire land area that collects and concentrates water is included in the watershed analysis area. The final watershed is the assemblage of streams that flow directly into the North Fork Flathead River from stream terrace or breakland landforms directly above the river. These are called face drainages, and they are typically 1st order streams. Analysis watersheds are labeled with the primary stream name in the watershed, or labeled as a tributary if unnamed. See Map 3-9 for a map of the analysis watersheds. Refer to Table 3-37 for a list of the analysis watersheds and the size of each.

Table 3-37. The Nine Analysis Watersheds in the Hydrology Analysis Area and Basin Size.

Watershed Name	Basin Size – Acres (sq. miles)
North Fork Flathead River Face Drainages	12,545 acres (19.6 sq. miles)
Tepee Creek	9,513 acres (14.9 sq. miles)
Whale Creek/ Hornet Creek	40,958 acres (64.0 sq. miles)
Moose Creek	11,816 acres (18.5 sq. miles)
Hawk Creek	1,778 acres (2.8 sq. miles)
Red Meadow Creek	18,901 acres (29.5 sq. miles)
Unnamed Tributary - North Fork Flathead River	1,506 acres (2.4 sq. miles)
Hay Creek	18,502 acres (28.9 sq. miles)
Moran Creek	7,388 acres (11.5 sq. miles)


Vicinity Map
Map 3-9
Red Whale Project Watersheds
N
W
E
S
Legend
Ownership
Private Land
State Land
Watershed Boundary
Trail Creek
TEPEE
Tepee Creek
Whale Creek
WHALE
MOOSE
Moose Creek
HAWK
North Fork Flathead River
RED MEADOW
Red Meadow Creek
N FORK FACE
Polebridge
HAY
Hay Creek
Moran Creek
MORAN
Cyclone Creek
UNNAMED
North Fk Rd #486
Unnamed Tributary to
North Fork Flathead River

Affected Environment

Introduction

Generally there are four attributes used to characterize the existing condition of a watershed and the water resource. These are upland/stream channel condition, upland/stream channel stability, water quality and water quantity. Both water quantity and water quality are a result of the geology, landforms, vegetation, climate and disturbance regimes that characterize an area. Water quantity in mountainous areas is generally characterized by the amount and timing of the surface water flow (streams) and/or subsurface water flow (groundwater). Water quality is characterized by the chemical (nutrient yield) and physical (sediment yield) properties of the water.

Herein is a discussion of the affected environment in and around the Red Whale analysis area. This section describes the general weather, geomorphology, stream channel, water yield, stream flow, and water quality/chemical characteristics within the analysis area, and past disturbances within the watersheds.

Site Description

Climate

The weather variations for the entire Flathead region are due to the influence of maritime patterns from the Pacific Ocean. The general easterly flows by lower layers of the atmosphere common at this latitude of the Pacific Northwest are modified by the mountain complexes of western Montana and central Idaho. The high mountains in the Continental Divide directly east of the Flathead region form an effective barrier against most cold Arctic patterns flowing south from Canada. During the winter months, the valleys experience many days with dense fog or low stratus cloud layers due to the trapping of dense, valley-bottom air by warmer Pacific air moving over the top.

Precipitation varies widely with season, elevation and location. Most precipitation falls as snow during winter months, although some rain-on-snow events are documented. The weather station at Polebridge, Montana (station I.D. 246615) is used to characterize the precipitation and air temperatures of the North Fork Flathead River basin (Western Regional Climate Center 2006, see Table 2.). A table showing average monthly climatic data for Polebridge is included in the Hydrologist report in section K of the project file.

Streamflow begins to increase in April as the snow pack melts, and peak flow is usually reached in late May or early to mid-June. Not all snowmelt or rainfall immediately becomes surface runoff. The majority of the precipitation infiltrates the soil surface to become groundwater that percolates downward into the subsoil and bedrock, resurfacing in wet areas, small ponds and perennial streams at various elevations below the point of infiltration. Slow release of groundwater provides stream baseflow beginning in mid-July and continues until the fall rains, which typically begin in mid-September.

Geology / Landforms

Glacial deposits or erosive surfaces occupy the entire Flathead National Forest portion of the North Fork Flathead River Basin. There are extensive surface deposits of alluvium, glacial till, glacial outwash and lacustrine sediments in the valley bottoms and on mountain slopes. The glacial till was deposited by continental ice sheets and tends to be compacted with a bulk density of 1.5 to 1.8 grams per cubic centimeter (Martinson and Basko 1998). The underlying bedrock is Precambrian meta-sedimentary rock including argillites, siltites, quartzites and limestones.

Climate, geology and geomorphic processes combine to create various landforms. Landforms, soils and the associated vegetation are the dominant physical features that affect watershed processes by regulating how and where water flows across the landscape. These same physical features influence the erosion processes that occur across the landscape. Landforms common in the analysis area are describe in Table 3-38.

Disturbances such as fire and timber harvest release nutrients from vegetation and soil. Many of the nutrients end up stored in soil and available for plants. Some of the released nutrients can end up in streams; nutrients are then routed downstream to the Flathead River and ultimately to Flathead Lake. Potential nutrient contribution for each individual landform is rated from low to high in 3-38. The nitrogen yield rating is based on the natural level of nitrogen in the soil, soil permeability and precipitation. The phosphorus yield is based on the natural level of phosphorus in the soil and sediment hazard.

Stream Type Characterization

The Rosgen Stream Classification System provides a method for identifying streams according to morphological characteristics (Rosgen 1996). The morphological characteristics include factors such as channel gradient, sinuosity, width/depth ratio, dominant particle size of bed and bank materials, the entrenchment of channel and the confinement of channel in the valley. A Rosgen Stream Type Classification (level –1) was developed for the Flathead National Forest in 1999 using digital elevation models (DEMs). The model only reliably identifies A, B, C and E stream types. Stream types in analysis watershed groups were extracted from the Rosgen coverage in the GIS library maintained by the Flathead National Forest.

The stream types summarized below are described fully in Rosgen, 1996:

- A-type: streams with gradients 4 to 10 %, characterized by straight, non-sinuous, cascading reaches with frequently spaced pools;
- B-type: streams with gradients 2 to 4 %, moderately steep, usually occupy narrow valleys with gently sloping sides;
- C type: streams with low gradients < 2% with moderate to high sinuosity and low to moderate confinement;
- E-type: streams with gradients < 2%, high sinuosity, and moderate confinement; gravel and small cobble channel bottoms and silt or clay banks.

The stream types typically occurring on the various landforms are described in Table 3-38.

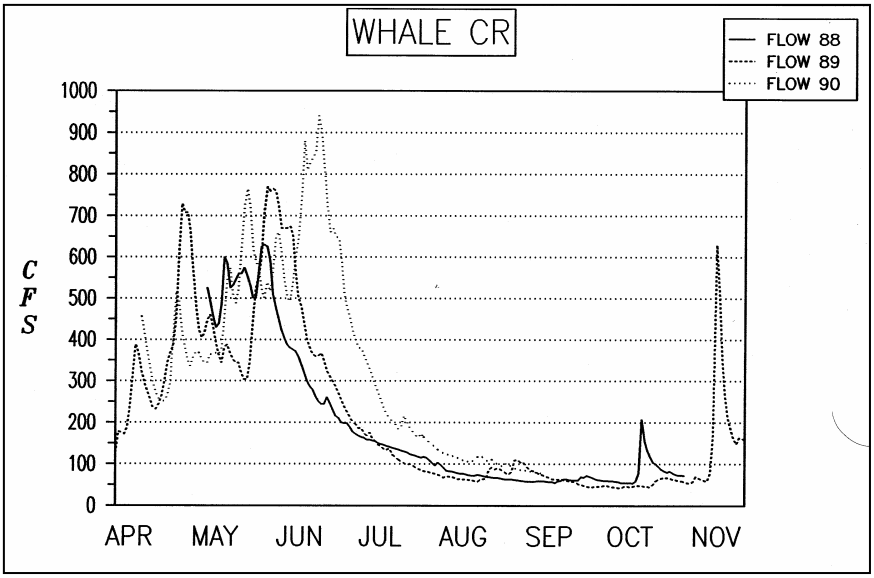
Table 3-38. A Summary of Typical Landforms that are Found in the Analysis Area, with their Associated Stream Types, and Relative Nutrient Yield Potential after Disturbance.

Landform Class	Total Landform Acres in Analysis Watersheds	Most Common Stream Type	Expected Nitrogen Yield after Timber Harvest	Expected Phosphorus Yield after Timber Harvest
Mass-Wasting Slopes	1494	A	Moderate	Moderate -High
Valley Bottoms	23315	C / E	Moderate	High
Breaklands	25385	A	Moderate	High
Steep Alpine Glacial Land	120240	A1/Aa+1 or A2/Aa+2	Moderate	High
Gentle to Moderately Sloped Glacial Land	76280	A or B	Low	Moderate
Mountain Slopes and Ridges	17055	A	Moderate	Low

Stream Flow within the Hydrology Analysis Area

Peak streamflow usually occurs in late May or early June due to spring snowmelt within the analysis area. Flood flows rarely overtop the channel banks 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 1997 from the snowmelt of an unusually deep snow pack. Hydrograph data for a stream in the analysis area is only available for Whale Creek; however, while Whale Creek has a slightly larger flow that the other analysis watersheds, it should have a very similar hydrograph. See Figure 3-2 for a representative hydrograph for Whale Creek.

Figure 3-2. A Comparison of Water Flow for 1988, 1989, and 1990 at Forest Road 486 Bridge for Whale Creek. Typical Peaks Occur in Late May to Early June with Base Flows Occurring from Late July to Early November.



Water Chemical Characterization. There have been water quality measurements taken for several years in two of the streams in the Red Whale analysis area. These data represent the expected ranges for those measured water quality parameters (chemical and physical) in the streams in the analysis area. Water quality measurements were taken in Whale Creek between 1977 and 1994; and in Red Meadow Creek between 1978 and 1981. Individual data for all the water quality parameters (i.e. temperature, stream flow, turbidity, pH, etc) for Whale and Red Meadow Creeks are included in the hydrologists report (project file, section K).

The best available information on the level of nutrients in the waters of the North Fork Flathead River is published in the Joint Water Quality and Quantity Committee Report – Flathead River International Joint Commission Study (Valiela and Thomas, et. al.1987). That reports documents the majority of the nutrient studies done on the North Fork Flathead River. As quoted in this report: "Waters of the Flathead River system contain very low amounts of the major nutrients, nitrogen and phosphorous. Autotrophic production in most lotic and lentic waters in the basin appear to be phosphorous limited (Sheehan et al. 1980; Cooper, 1983), although nitrogen may also be present in sufficient quantity or in the required forms to support much productivity during late summer in some waters. (Standford et al. 1983)"

Watershed Disturbances

Following natural or man-caused disturbances there can be changes in water yield, sediment yield and/or nutrient yield in the runoff water from the affected basin. The following are short discussions of how those water attributes can be changed by disturbances.

Water Yield

Water yields from a basin change with an increase or decrease of forest canopy coverage due to timber harvest, wildfires and/or natural vegetation growth. The relationship between removal of vegetation (timber harvest) and increases in water yield are well established (USDA 1976). The majority of the increase in water yield occurs during spring runoff (King 1989). Climate primarily determines the magnitude of large flood events (Dunne and Leopold 1974); however, land use practices have been shown to increase peak flows. (Troendle and Kaufmann 1987) The reduction in the number of live trees on a site, i.e. forest canopy cover, results in a reduction in the amount of transpiration of groundwater from that area. A reduction in forest canopy cover also reduces the interception and subsequent evaporation of rainfall/snowfall in the forest. The combination of decreased transpiration and increased ground interception of precipitation increases the amount of the precipitation available for runoff as stream flow. This is the water yield increase associated with timber harvest or burning in a watershed. The amount of water yield declines as the tree canopy cover recovers with re-growth. The stands types/habitat types that primarily occur in the proposed units normally are expected to have full vegetative-hydrologic recovery approximately 90 years after a clearcut or stand replacement fire. (USDA Northern Region 1976) (Galbraith 1973)

Watersheds exhibit great natural variability in flow and can accommodate some increase in peak flows without damage to stream channels and aquatic organisms. Increases in average high flows can cause variety of channel effects, such as increases in channel width, depth, erosion and

sediment deposition. Substantial increases in peak flows generally lead to a subsequent increase in sedimentation. If the amount of water yield increase exceeds the capacity of the stream channel, there would typically be an increase in the amount of stream channel erosion.
Snow accumulation and subsequent water yield are higher in open forest conditions, as would be created by timber harvest or fire (McCaughey and Farnes 2001; Skidmore et al. 1994; Molnau and Dodd 1995). Snowmelt may be advanced in time as well, moving peak flows to earlier time periods in the spring (Farnes 2000). Further details of the results of these studies can be found in the Hydrologist's report (section K of the project file

Sediment Yield

The amount of sediment routed to or eroded within a stream channel can affect the beneficial uses of water and is frequently used as a measure of overall water quality. Stream channel size and shape have evolved to carry the historical sediment load, and large increases in the sediment yielded to a stream may exceed the stream's ability to transport the load (Dunne and Leopold 1974). As a result, sediment deposition would occur in the stream channel, especially in low-gradient sections of a stream, as point bars and mid-channel bars. This leads to a wider, shallower, less stable channel than pre-deposition conditions, and can have a detrimental effect to the fisheries resource by clogging spawning gravels. Increased sedimentation impacts macro-invertebrates and other aquatic organisms. Bank erosion may also be increased, thus adding even more sediment to the load in the stream.

In managed forested areas, the main source of direct sediment is from road construction associated with timber harvest (Megahan and Kidd 1972). Channel alteration, road or other construction in, or adjacent to, live streams, and culvert or bridge installation may result in sediment being deposited directly into a stream. Implementation of water quality Best Management Practices (BMPs) for roads can significantly reduce sediment input into streams from these activities. Tree falling is not usually considered a major cause of increased sediment; although methods for removing harvested timber (e.g. tractor yarding) can cause erosion, gouging of slopes and the alteration of soil characteristics and permeability.

Nutrient Yield

Nutrients or the chemicals most tied to algae growth. Can increase following wildfires and timber management. Locally the best study of nutrient increases following wildfire was done in the North Fork of the Flathead River following the September 1988 Red Bench Fire. Spencer and Hauer (1990; 1991) measured significant short-term increases in nutrients (nitrogen and phosphorus) in several streams following the Red Bench Fire. Levels of nutrients declined steadily after the fire. By the fifth year following the fire, levels for nutrients ranged from within the background range for nitrates and ammonium, and a 2-3 fold increase over background for phosphorus levels (Hauer and Spenser 1998). They also observed that the highest levels of nutrient increases correlated to those areas with the high burn severity**.** Further details outlining the results of these studies can be found in the Hydrologists report (project file, section K).

Based upon WEPP soil erosion and sediment modeling, there is typically more than a 15-fold increase in the sediment produced from a wildfire area compared to a broadcast burn of the same

area. The increased sediment is due to the higher burn severity typically occurring with a wildfire and the resulting increased potential for runoff. This can result in significantly less sediment yield and nutrient yield from a hill-slope if it is broadcast burned rather than being burned during a wildfire.

Increased nutrient loading associated with wildfire can stimulate primary production (e.g. algae growth) (Hauer and Spenser 1998). Gangemi (1991) described an increase in stream periphyton growth in one burned watershed in the Red Bench Fire area, compared to an unburned watershed. Hauer and Spenser (1998) reported "we did not observe noticeable increases in algae growth in our larger 3rd and 4th order study streams."

Increases of some nutrients in the stream flow of Red Meadow Creek where higher levels of timber management had occurred were noted in a 1991 Flathead Basin Commission report. (Hauer and Blum 1991)

Past Natural or Man-Caused Watershed Disturbances in the Analysis Area

Past disturbances including road building, timber management and wildfires have the greatest potential to affect the current stream channel condition, water yield and sediment yield in the watersheds of the Red Whale analysis area.

Roads

The earliest road construction occurred on the main North Fork Road (county road) beginning in 1921. The majority of the Forest Service road construction occurred from the 1950s through the early 1960s, with some new road construction occurring on private lands during the 1970s. There are 202.9 miles of existing roads (all ownerships) within the effects analysis watersheds. In the mid 1990s the Forest Service began decommissioning roads for wildlife habitat improvement; since then approximately 45.3 miles of roads have been decommissioned within the analysis watersheds. There are 138 stream crossings on the existing road system in the analysis area. Stream crossings are the primary introduction point for sediment from the road system into a stream channel. The total annual sediment yield from the existing road system in the analysis area is approximately 37.3 tons (based upon sediment modeling discussed in detail in a later section).

Road Management Effects

The effects indicators of water yield, sediment yield and nutrient yield change slightly with the various ways a road can be managed. For this reason, the following discussion reviews the different road management strategies used on the Flathead National Forest and their effects to the water resource. The Red Whale Project proposes to change the road management scenario on several of the roads within the analysis area. The proposed road management scenarios are; a) open year-long, b) seasonally restricted with a gate, c) year-long closure with a gate, or d) year-long closure with a berm.

The Red Whale Project does not propose any new road decommissioning within the three grizzly bear sub-units affected. Because there is no road decommissioning proposed in the Red Whale Project, there will be no other discussion of that activity.

Roads that are gated and open seasonally may have an increased or decreased sedimentation potential when compared to a year-long open road. Both the seasonally closed road surface and the year-long open road surface are exposed to the same rain and snowmelt events that erode the surface. The amount of sedimentation depends on the drainage structures built into the road prism and the amount of maintenance the road surface and the drainage structures receive. Typically, when the roads are used but not graded (seasonally open roads) rutting occurs which reduces the effectiveness of road surface water BMPs. However, roads that are open year-long and receive heavy use and regular road grading can have high higher sediment yields because of the input of sediment following grading, especially when the ditches are graded out. A road that is open year-long, or seasonally closed with a gate, easily allows for periodic inspection and maintenance of culverts ditches, and cross-drain culverts, which reduces the risk of culvert plugging/failures and associated sedimentation potential. This road management scenario does not change the water quantity delivered to a stream from the road system.

When a road is restricted year long with a gate, typically some re-vegetation of the roadbed occurs with grass and brush species in this area. The amount of re-vegetation on the roadbed is determined by the amount of administrative road use, the type of vegetation on the site, and the local soil moisture conditions. In general, this scenario results in less erosion from the road surface and ditches. However, when gated, year-long roads are used for administrative purposes rutting can occur, and if the road is not maintained then increased sedimentation can result.

When a road is closed year-long with a berm, there are usually water-bars installed on the road surface to reduce water flow distances along the road surface in key areas. The density of water-bars is generally less than on a decommissioned road. When a road is closed year-long with a berm, the stream-aligned culverts may or may not be removed depending on the presence of high risk culverts (prone to plugging and/or failure). If a bermed road is used to maintain winter season access and a high risk culvert has been identified, the culvert would be up-sized in order to allow for winter access with minimal risk to watershed. The scenario of a bermed road allows for the monitoring and inspection of remaining culverts, however both the monitoring and the mechanical maintenance of these culverts is made more difficult/expensive with a berm in place. Consequently, the long-term risk of culvert plugging/failure and the associated sedimentation potential is increased when compared to road management scenarios utilizing gates. The amount of sediment that would be produced by a culvert failure can range between tens of tons to more than two hundred tons of soil material, depending on the depth of the over-burden on top of the culvert. Once the road is bermed and the roadbed is allowed to re-vegetate, the potential road prism soil erosion/sedimentation is significantly reduced. This road management scenario does not change the water quantity delivered to a stream from the road system.

In general, the potential sediment yield from various road management scenarios (greatest to least) is the following: 1) gated roads that are seasonally open; 2) roads open year-long; 3) roads closed year-long with a gate; and 4) roads closed year-long with a berm. There is no difference

between any of these road management scenarios and water yield that is associated with a constructed roadbed.

Timber Management and Wildfires

Timber management first occurred on National Forest System lands in the analysis watersheds beginning in early 1950s (1952, 1954, & 1955) with the most recent activity occurring during the winter of 2006-2007. Generally, there have been three periods of timber harvest activity within the Red Whale analysis watersheds. The first harvest activity was during the 1950s and early 1960s when the spruce bark beetles were affecting the North Fork Valley, the second in the 1970s, with mountain pine beetle affecting the forests in this area, and the third was the salvage logging after the 2003 Wedge Canyon Fire.

All types of slivicultural treatments have been used in this area. Since the early 1950s there have been 43,688 acres of slivicultural treatments and/or wildfires that have occurred within the 122,905 acres of the analysis watersheds.

A forest's cover and structure are also naturally affected by wildfire. The forest cover/growth stage historically would vary with fire disturbance cycles over time. Therefore, the water yield from a basin would also fluctuate naturally over time. Following a wildfire the burn size and burn severity determine the water yield increase. Within the analysis area, recent fire has affected the Tepee and Whale Creek watersheds. In 2003, the Wedge Canyon wildfire burned across large percentages of the Tepee and Whale Creek watersheds.

Approximately 35% of the forested lands in the analysis watersheds have been affected by timber management or wildfire since the 1950s. The current Equivalent Clearcut Area for the entire cumulative effects analysis is approximately 13.9%. An Equivalent Clearcut Area includes all areas where vegetation cover has been removed or decreased, e.g., roads, timber harvest, thinning, and burned areas. See Table 3-39 for a summary of the past man-caused and natural disturbances and their effect on the water yield and sediment yield in the analysis watersheds.

Table 3-39. The Red Whale Analysis Area Watersheds, Their Size, Total Miles of Existing Roads, Road Density, Existing Equivalent Clearcut Area, and the Percentage of Each Watershed that is Harvested Based upon ECA.

Analysis Watershed	Watershed Area (square miles	Annual Natural Water Yield (acre-feet)	Total Miles of Road Contribut-ing to Sediment & Water Yield (miles)	Road Density (miles/ sq. mile)	Total Acres of Past Timber Manage-ment (Year of initial harvest)	Existing Equivalent Clearcut Area {ECA} (acres)	Existing Annual Water Increase Above Natural (%)	Percent of Watershed Harvested/ Burned Based on ECA Acreage (%)
Tepee Creek	14.9	19185	17.0	1.1	7603 (1955)	3775	14.0	40.0
Whale Creek	64.0	106484	42.4	.7	9251 (1954)	3677	2.3	9.0
Moose Creek	18.5	26534	15.5	.8	2904 (1954)	738	1.4	6.2

Analysis Watershed	Watershed Area (square miles	Annual Natural Water Yield (acre-feet)	Total Miles of Road Contribut-ing to Sediment & Water Yield (miles)	Road Density (miles/ sq. mile)	Total Acres of Past Timber Manage-ment (Year of initial harvest)	Existing Equivalent Clearcut Area {ECA} (acres)	Existing Annual Water Increase Above Natural (%)	Percent of Watershed Harvested/ Burned Based on ECA Acreage (%)
Hawk Creek	2.8	1546	6.6	2.4	876 (1952)	199	4.2	11.1
Red Meadow Creek	29.5	43963	33.3	1.1	7967 (1952)	2632	3.6	13.9
Hay Creek	28.9	44406	18.0	.6	3782 (1954)	738	1.2	4.0
Moran Creek	11.5	14405	14.4	1.3	1471 (1968)	338	1.7	4.6
Unnamed Tributary – North Fork Flathead River	2.4	1363	7.8	3.3	303 (1980)	136	3.5	8.9
North Fork Flathead River Face Drainages	19.6	8497	47.9	2.4	9511 (1960)	4801	14.1	38.3

Flood Disturbances

Flood events are a primary natural disturbance processes affecting stream channels. A review of the U.S. Geological Survey's water flow records for the North Fork Flathead River near Columbia Falls indicates that there were two notable flood events in the flow records 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 (USDI Geological Survey, 2007). 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 USGS). A base flow was not established for the USGS gauge station at Big Creek; however, the recorded peak flow for the 1964 flood event was 2,130 cubic feet per second. The 1964 flood had a major impact on most of the stream channels in the analysis area. Based upon pictures of the flood damage and anecdotal information, the effects of the flood decreased the farther north the location in the North Fork Valley.

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 USGS). 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 Flathead River. Based upon personal observation, there was very little effect to any of the tributary streams of the North Fork Flathead River south of the Canadian border.

303(d) Impaired Water-body Listing – Water Quality Assessment and TMDL (Total Maximum Daily Load Analysis) Analysis

The Montana Department of Environmental Quality listed Red Meadow Creek and Whale Creek on the 303(d) Impaired Water-body List in 1996 and 2002, due to siltation (Montana Department of Environmental Quality 1996; 2002). Red Meadow Creek was also listed because of habitat alterations. Aquatic life and cold-water fishery beneficial uses were the listed impaired beneficial uses. Red Meadow Creek is a second order tributary flowing approximately 12 miles from its origin at Red Meadow Lake to its confluence with the North Fork Flathead River. The total watershed area covers roughly 30 square miles. Whale Creek is a third order tributary of the North Fork Flathead River flowing 21 miles from the headwaters to the mouth of the river. The total watershed area covers approximately 78 square miles.

The major natural and man-caused disturbances within the watersheds include: wildfire, road construction and timber harvest. The largest wildfire in recent history was the Red Bench Fire in 1988 that burned approximately 24 percent of the Red Meadow watershed. There have since been no significant fires in Red Meadow Creek.

A Watershed Assessment was done in Red Meadow Creek and Whale Creek to identify problems and solutions in the watersheds. The Water Quality Assessment and TMDLs for the Flathead River Headwaters Planning Area in Montana was completed in late 2004 (U.S. Environmental Protection Agency [EPA] 2004). A watershed scale approach was used to evaluate beneficial uses in twelve streams including Red Meadow Creek and Whale Creek. The following sections provide summary information, excerpts and data from this assessment.

The basis for the 1996 303(d) listing of Red Meadow Creek is unknown. "According to DEQ's Assessment Record Sheet (Chestnut 1999), the 2002 listing was based primarily on the results of a 1989 DEQ stream assessment conducted in two reaches of Red Meadow Creek. In the headwaters reach, DEQ concluded: '*…large amount of debris in channel, especially cut logs. Excessive sediment accumulation in pools behind debris jams. Scouring is also present. The channel has undergone migration due to debris. Several jams large enough to prevent fish passage. Impairments most likely due to logging operation. There is also litter from recreation users near the upper end.*' DEQ's Assessment Record Sheet also cited a decline in fish populations since 1983. It should be noted that DEQ's 1989 stream assessment was conducted one year after the Red Bench Fire occurred in the lower reaches of this watershed, resulting in a large amount of post fire large woody debris (Deleray 1999). Because of the fire, DEQ noted that it was difficult to attribute sediment related impairments in the lower reaches of Red Meadow Creek to anthropogenic sources" (EPA 2004).

The basis for the 1996 303(d) listing of Whale Creek is also unknown. According to DEQ's Assessment Record Sheet (Chestnut 1999), the 2002 listing was based primarily on the results of a 1989 DEQ stream assessment that indicated that the impaired reach extends from the headwaters to the confluence with Shorty Creek, and that *"Sedimentation problems, stream braiding, cut logs in channel all attribute to impairment. Improper logging procedures are most likely cause of the problems."*

This assessment also determined that the cold water fishery and aquatic life beneficial uses in Red Meadow Creek and Whale Creek are currently fully supported (refer to the project file in section K for a copy of this assessment).

These waters are not considered impaired due to sediment related causes (i.e., siltation or suspended solids) and, therefore, no TMDLs are required. Both water bodies were removed from the 303(d) impaired water body listing in 2005. Once a water body is removed from the 303 (d) list, there is no special procedure or consideration required prior to proposing a management activity within the watershed.

Flathead Headwaters TMDL Stream Channel and Water Quality Data

The data collected by the Forest Service and EPA for this Headwaters TMDL Watershed Assessment is some of the most recent and detailed information for Red Meadow Creek and Whale Creek. These are two of the major watersheds within the analysis area and most of the characterization data is very applicable to the other watersheds in the analysis area. A review of the stream channel and water quality data collected during the 2003/2004 watershed assessment is summarized in the following sections.

Suspended Sediment Concentration/Turbidity. Suspended Sediment Concentration (SSC) and turbidity data was collected in Whale Creek on a nearly annual basis between 1978 and 1994 (SSC n=221, turbidity n=192). In general, samples were collected to capture spring runoff (April, May and June) as well as baseflow conditions (July, August, September, October and November). Due to the lack of current SSC and/or turbidity data, the EPA did not use these parameters for their impairment determination; however, the data was used in evaluating long-term trends and in making historical comparisons with other reference streams. See Table 3-40.

Table 3-40. Suspended Sediment Concentration Data for Whale Creek Compared to Chepat Creek, a Reference Stream.

SSC Metric	Whale Creek Observed Values (mg/l)	Chepat Creek Observed Values (mg/l)
Mean (mg/l)	4.03	3.15 ± 5.83
Mean Annual Maximum (mg/l)	21.29	14.56
Maximum (mg/l)	97.80	61.60

The EPA stated in their report "The mean SSC concentration was below the range for the reference mean concentration. The mean annual maximum was similar (but slightly higher) to the reference value and the maximum value was higher than the reference value. It is expected that Whale Creek should have slightly higher sediment concentrations because the watershed size is much larger than Chepat Creek. Nonetheless, the maximum values were exceeded." (U.S. EPA 2004)

For the period of record the mean turbidity is 1.21 NTU and the median is 0.90 NTU. The maximum-recorded value was 17 NTU in May, 1987. The EPA noted that "The average and median turbidity values are well below the proposed core indicator of 10 NTU during summer

baseflow. The turbidity data suggests that sediment is not impairing beneficial uses in Whale Creek." (U.S. EPA 2004)

Pebble Counts. During 2003, pebble counts were collected in Red Meadow Creek from two sites, one on the South Fork of Red Meadow Creek and one on the main-stem of Red Meadow Creek. The percent surface fines less than 2 millimeters at the South Fork and main-stem sites were 18.75 and 12.71 percent, respectively (Wolman 1954). It was note by the EPA that both values were below the 20 percent core indicator value, and that suggested no impairment from siltation. (U.S. EPA 2004)

During 2003, pebble counts were collected from two reaches (three locations at each reach) in Whale Creek. The first reach in Whale Creek sample is located near the confluence with Hornet Creek. The composite average percent surface fines for this reach was 19 percent. The second reach sampled in Whale Creek is located just upstream of the confluence with Akinkoka Creek. The composite average percent surface fines for this reach is 16.9 percent. Both reach averages are lower than the EPA proposed core indicator of 20 percent. It was noted by the EPA the percent surface fines data suggest that Whale Creek is not impaired because of siltation. (U.S. EPA 2004)

Macro-invertebrates**.** Macro-invertebrate sampling was performed at one site on Red Meadow Creek and two sites on Whale Creek in August of 2003 by U.S. Forest Service and EPA personnel. Based upon this examination, no evidence of siltation or any other water quality problems exist in Red Meadow Creek. The upper site sampling in Whale Creek indicated no impairment due to sedimentation; the lower site may be slightly impaired due to natural causes. (U.S. EPA 2004)

Pfankuch Stream Channel Rating. The Pfankuch stream channel rating 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." (USDA Forest Service 1978) 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* or *fair* 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. This method shows whether the stream is headed towards or away from dynamic equilibrium.

Beginning in the late 1970s, the stream channels through the Flathead National Forest have had Stream Stability Ratings performed periodically. A significant shift of the ratings from *good* to *poor* can reveal a change in the stream channel stability. All the Stream Stability Ratings completed since the 1970s, on all the streams in the analysis area, fell into the *fair* to *good* category. The 2003 Pfankuch Stream Stability Ratings were carried out by the EPA/ USFS sampling crew, and were estimated at three locations along an approximately 1000 foot long reach of Red Meadow Creek and Whale Creek. Ratings were also conducted in 2006-2007 along an approximately 300 to 400 foot reach of the various streams in the analysis area. Individual ratings for each stream and year are included in the hydrologists report (section K, project file).

Summary and Interpretation of Existing Conditions

After the field review of many of the stream reaches, review of the water quality data (chemical, sediment, macro-invertebrate) and the physical stream channel measurements taken during the past several years, it is the District Hydrologist's conclusion that all of the streams in the analysis area are in *proper functioning condition*[1].

The stream stability ratings are either in the *good* range or in the higher portion of the *fair* range for all the streams in the analysis area. The high burn severity in some of the riparian areas of Red Meadow Creek and several of its tributaries during the 1988 Red Bench Fire caused a short-term decrease in the channel stability of several stream reaches. After revisiting several of those affected stream reaches this summer, significant improvements were noted in the stream channel stability that has occurred since the wildfire. In most cases the affected stream channels were in a *pre-burn condition*.

Sites where timber harvesting had occurred prior to the 2003 Wedge Canyon wildfire appear to be very well vegetated with medium sized trees, poles, shrubs and/or grasses; including areas such as skid trails, landings, and temporary roads. Due to the productive soils and climate, the past harvested stands are growing very well for their appropriate, potential vegetation condition (habitat type). While there are very limited portions within the 2003 Wedge Canyon fire perimeter that have not recovered as well, areas that have experienced a high soil burn severity and/or have had recent post-fire salvage logging, overall the vegetation recovery has been adequate. Harvested forest stands in this area have had rapid vegetation recovery with a somewhat delayed hydrologic recovery, which over time decreases the post-harvest/wildfire water yield increase to the streams in the analysis area. Based upon field reviews of past timber management areas, no significant soil erosion exists on any of these sites. Therefore, these past timber harvest areas are not considered to be contributing any sediment to the analysis area streams.

[1] "***Proper Functioning Condition*** – Riparian-wetland areas are functioning properly when adequate vegetation, landform, or woody debris is percent to dissipate stream energy associated with high waterflows, thereby reducing erosion and improving water quality; filter sediment, capture bedload, and aid floodplain development; improve flood-water retention and ground-water recharge; develop root-masses that stabilize streambanks against cutting; develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and support greater biodiversity." U.S. Department of the Interior, Bureau Of land Management - 1993

In general, after inspecting the analysis area stream channels and reviewing the applicable available water quality and physical stream data, it is concluded that all of the streams and their associated characteristics (physical & chemical) are within their natural range of variation for the stream-types that occur in the landscapes of northwestern Montana. These interpretations are based upon past monitoring reports, literature, field observations and professional judgment.

Environmental Consequences

Introduction and Effects Indicators

Three main indicators will be used to measure the potential effect of the proposed actions:

- Water yield
- Sediment yield
- Nutrient yield.

The evaluation of direct, indirect, and cumulative effects to water used the most recent and available information, as well as data related to past, present and reasonably foreseeable events that have occurred, or may occur, in the water resources analysis area. Applicable past, present and foreseeable events described in the introduction of Chapter 2 were considered during the evaluation of the affected environment. The condition of the affected environment, together with applicable reasonably foreseeable events, was considered during the analysis of the environmental effects of the alternatives. All of the listed events were discussed whether or not they were considered to have effects.

Direct and Indirect Effects of Alternative 1 (No Action)

There are no direct effects to the water resource if the analysis area if Alternative 1 is implemented. This is because no ground disturbing activities would be implemented with this alternative; therefore there would be no effect to water yield or quality.

There are two possible indirect effects to the water resource of the area if Alternative 1 is implemented. If a wildfire were to occur in the areas proposed for thinning there is an increased potential for *high soil burn severity*[2] to occur on a significantly higher portion of the acreage burned than if the thinning and/or prescribed burning were accomplished. Following a high intensity wildfire, sites that experienced high soil burn severity have the potential for significantly increased post-fire soil erosion for 2 to 3 years. This is especially true if a short duration, high intensity rainstorm occurs over the affected burn site. A post-wildfire soil erosion event, due to a high intensity rainstorm, can transport significant amounts of soil materials to

[2] *High Soil Burn Severity*: Is a result of the severe heating of the soil surface causing a modification in the surface soil properties. All organic litter is burned away. The surface soil aggregate stability has been significantly reduced, in some cases the soil structure has been broken down. Some soils may have hydrophobic (water shedding) layer develop for some time following the fire. The potential for rain-impact soil erosion is significantly increased as well as runoff potential. The natural re-vegetation on these sites is typically very slow.

stream channels. This in turn increases sediment and nutrient yields in the stream water reducing water quality and potentially impacting fish habitat.

The second possible indirect effect of implementing Alternative 1 would be an increased potential for culverts to fail (plugging and washing out the road prism) on perennial streams. These culverts would be up-sized or removed under Alternatives 2, 3, and 4. A culvert failure has the potential to increase sediment and nutrient yields in the stream water reducing water quality and potentially impacting fish habitat.

Direct and Indirect Effects Common to Alternatives 2, 3 and 4

Alternatives 2, 3 and 4 propose the construction of .3 mile of road to access the Montana DNRC lands in Section 16, Township 35 N and Range 21 W. This proposed road would be located on Landtypes 26G-7 and 26J-7. A worst case-scenario of road gradient, road width and buffer distance to the nearest stream was used in the WEPP-Road computer model to estimate the potential soil erosion and sediment yield. A 1000 foot section of non-drained road would have the potential erosion of 509 pounds/year on Landtype 26G-7, and a potential erosion of 357 pounds/year on a Landtype 26J-7. The sediment yield with a 250-foot vegetation buffer (the shortest potential distance to a stream) from both Landtypes is 0.0 pounds/year from a 1000 length of road. Because road construction BMPs would include surface road drainage structures spaced less than 1000 feet apart, the potential for sediment movement to a stream channel would be reduced. Therefore, due to soil conditions and landform slope there would be no potential sediment yield, nutrient yield or water yield effects from this proposed road construction.

Alternative 2 – Direct and Indirect Effects

Forest Thinning/Timber Harvest, Prescribed Burning, Road BMP's, Culvert Up-size/Removal Proposals

Forest thinning/timber harvesting and broadcast burning activities may affect both the water quantity and the water quality. There were three effects to the water resource that were analyzed and discussed for the proposed Alternative 2 forest thinning and prescribed burning activities. These effects included: 1) potential water yield increase associated with the live forest vegetation cover reduction due to thinning and/or broadcast burning, and/or temporary road construction activities; 2) potential soil erosion/sediment production increases associated with the proposed commercial thinning/timber harvest yarding process, broadcast burning, temporary road construction, landing construction, culvert replacements and culvert removals; and 3) potential water nutrient level increases associated with the thinning/timber harvest, broadcast burning, temporary road construction, landing construction, culvert replacements and culvert removals.

The proposed activities in Alternative 2 include thinning/timber harvest on 2,078 acres in 42 units; the prescribed burning of 1,360 acres in 8 units; the up-sizing of 8 culverts and 12 culvert removal sites; and the yarding of commercial size poles and logs utilizing ground skidding. There would be 5.9 miles of roads used during the hauling process; 5.6 of these miles would have been previously restricted (gated, bermed, historic) and .3 miles would be new, temporary road construction. BMP road improvements would be used on all haul routes. These activities

have the greatest potential for affecting the water quantity or water quality. The hand piling, excavator piling, and/or chipping of fuel materials would have no direct effect on water quantity or water quality.

Water Yield Effects

To assess the proposed thinning and broadcast burning effect on water quantity, a water yield analysis was performed. Once the analysis watersheds were delineated, the area of the watershed and the acreage of all past management activities (roads, timber management and wildfires) were summarized for each watershed. Using the WYA computer model the natural background water yield levels and the present day existing levels of water yield were modeled for each of the analysis watersheds, based upon the amounts of canopy cover removal/recovery. Then the estimated canopy cover removal from the proposed thinning/broadcast burning and new temporary road construction activities for each alternative were added to the existing situation and modeled for each alternative. The results of the WYA modeling for the analysis watersheds are reported in Table 3-41.

Table 3-41. For the Analysis Watersheds the Annual Natural Water Yield, the Existing Water Yield Increase above Natural Background (Alternative 1), and the Estimated Water Yield Increase Associated with Proposed Thinning, Broadcast Burns and New Temporary Roads for Alternative 2.

Analysis Watershed	Watershed Area (Acres)	Annual Natural Water Yield (Acre-feet)	Percent Existing Annual Water Yield Increase Above Natural (ECA Acres)	Alt. 2 Percent Annual Water Yield Increase Above Natural (ECA Acres)
Tepee Creek	9,511	19,185	14.0 (3,775)	14.0 (3,786)
Whale Creek	40,958	106,484	2.3 (3,677)	2.4 (3,928)
Moose Creek	11,816	26,534	1.4 (634)	3.2 (1,402)
Hawk Creek	1,778	1,546	4.2 (199)	7.3 (388)
Red Meadow Creek	18,901	43,963	3.6 (2,632)	4.1 (2.986)
Hay Creek	18,502	44,406	1.2 (738)	1.7 (1,209)
Moran Creek	7,388	14,405	1.7 (338)	2.8 (536)
Unnamed Tributary - North Fork Flathead River	1,506	1,363	3.5 (136)	3.5 (136)
North Fork Flathead River Face Drainages	12,545	8,497	14.1 (4,801)	16.4 (5,626)

Depending upon stream type, an increase in water yield above natural background levels of greater than about 10% is used as an indicator of increased risk for stream channel erosion. This

level is based upon past monitoring and professional judgment. Channels in the Pfankuch stream stability rating class of Good are capable of handling water yield increases with little risk of channel erosion or other major adverse effects. The channels in the Fair class are at a higher risk of channel erosion from the additional water yield. The channels with a Poor stability rating show signs of active channel erosion occurring at the present time and any additional water yield could have increased channel erosion potential. When a stream has a water yield increase of greater than 10% above natural background and also has a Fair or Poor stream stability rating, the existing stream condition and the potential increased stream erosion due to water yield increase is assessed.

The field review of stream channels in the analysis area verified that the streams potentially affected by the proposed thinning and broadcast burns are all in the Good, or the upper portion of the Fair Pfankuch stream stability rating classes. See the Stream Stability Table in the project file. The water yield increase after implementation of the proposed action in Alternative 2 would range from 0 to 3.1% in the analysis watersheds. The watersheds with the largest increases are Hawk Creek (3.1%) and the North Fork Flathead River Face Drainages (2.3%). Tepee Creek and the North Fork Flathead River Face Drainages currently have water yield increases above 10% and would continue to do so if Alternative 2 were to be implemented. The higher water yield increases in these two analysis watersheds are due to past timber harvesting and wildfires. The Tepee Creek area has had some past timber harvesting; however a high percentage (39.3%) of the watershed burned during the 2003 Wedge Canyon Fire and this is the predominant cause of the increased water yield. The North Fork Flathead River Face Drainages were also significantly affected by the combination of the 1988 Red Bench Fire and the 2003 Wedge Canyon Fire. In addition, this analysis watershed has a high percentage of private lands within it and a significant amount of these lands experienced timber harvesting during the 1970s.

Alternative 2 proposes to thin 13.1 acres in Tepee Creek, which would increase the ECA acreage by 12 acres in that basin; however this ECA increase would not be large enough to change the water yield increase 0.1%. Tepee Creek was examined by the District Hydrologist within and/or below the Wedge Canyon Fire area in the fall of 2006, and there were no significant changes noted in the stream channel that could be attributed to the post-fire water yield increases. Any signatures of post-fire water yield increase would be expected to have been seen in the fall of 2006, after last spring's normal runoff. Based upon this post-fire review of some of the most sensitive stream reaches along Tepee Creek, no change would be expected to the current stream channel conditions due to additional water yield increase from the Alternative 2 proposed thinning in the Tepee Creek watershed.

The North Fork Flathead River Face Drainages is the other analysis watershed that has a water yield increase greater than 10%. The landforms that make up the majority of this analysis watershed are different than the other analysis watersheds. The land area in the North Fork Flathead River Face Drainages does not concentrate runoff water flow from precipitation into a single channel as you move from the headwaters area to the mouth of the watershed. The vast majority of the lands in the North Fork Flathead River Face Drainages are alluvial or glacier outwash terraces that move precipitation in the form of groundwater, not as streams of concentrated surface water flow. The exceptions to this are portions of Spring Creek and Spruce Creek. The precipitation inputs into this area emerge as groundwater flow into the main or side channels of the North Fork Flathead River. Spring Creek and Spruce Creek have been examined

by the District Hydrologist and both stream channels have good stream stability throughout. The Alternative 2 proposed sapling thinning (approximately 370 acres) in Spring Creek and Spruce Creek would not increase the potential stream channel erosion due to the water yield increase associated with this thinning. Both of these creeks were extensively burned during the 1988 Red Bench Fire and stream channel erosion post-fire did not significantly increase even after this major disturbance. The increased water yield in the remainder of the North Fork Flathead River Face Drainages will be dissipated as groundwater into the North Fork Flathead River. The 2.3% water yield increase from this analysis watershed equates to 195 acre-feet of water which equals .0099% of the average annual water flow of the North Fork Flathead River. This amount of water yield increase, once combined with the flow of the North Fork Flathead River, is within the range of natural variation for the river. Therefore, the estimated water yield increase from the proposed Alternative 2 thinning and broadcast burning units should not significantly change the risk of stream channel erosion to any of the stream channels in the analysis watersheds from the existing situation.

Rain on Snow Event Risk: During the scoping process for this project a concerned public asked for an analysis of risk of additional water yield from the proposed harvest during rain-on-snow (ROS) events. I reviewed the U.S.G.S. flow records for the North Fork Flathead River at Glacier Rim, to determine the number of annual peak flow events tied to ROS events. The records for this monitoring station begin in 1929. There was only one year where the annual peak flow discharge was a ROS event, rather than a spring snowmelt event. November 6, 2006 there was a ROS event that occurred in the some watersheds in Glacier National Park and the Flathead National Forest. Therefore, this type of event is rare for the geographical location of the analysis area, but not unheard of.

A recent research paper discussing the causes of peak flow ROS and/or rain-on-spring-snowmelt events in six basins of Northwestern Montana and Northeastern Idaho concluded, "… there was no apparent correlation between the magnitude of peak flows and the amount of forest harvest."(Plum Creek 1997) In 1996 the Plum Creek Timber Company employed a consultant to model ROS events in the Swan River Valley. The basins they modeled were Goat and Squeezer Creeks. Based upon the research of the available local data on historic ROS events, the upper elevation limit for water to become available for runoff is approximately 5100 to 5200 feet. In other words, in this area, only the land below that elevation would yield runoff during a typical ROS event. That analysis estimated a 4.9% increase in runoff from a ROS event for a 25-year return interval storm, and 4.5% increase for a 100-year return interval storm. (Plum Creek Timber Company, 2001) These modeled increased runoffs are the amount of increase above the level for a fully forest versus the current forested situation for Goat and Squeezer Creeks. The amount and type of timber harvest/canopy removal in the lower elevations of Goat and Squeezer Creeks are qualitatively similar to the amount of canopy removal that would occur in the lower elevation portions of several of the analysis watersheds after the implementation of the proposed thinning/burning. These watersheds include: Red Meadow Creek, Whale Creek, Hay Creek and Tepee Creek. Considering that this was modeled in close geographical proximity, it is reasonable to hypothesize that a similar response could be expected with a ROS event in the analysis watersheds. Because of the reduction in canopy cover from the proposed thinning and broadcast burns, there is the potential for an increase in snow deposition on those sites. That slight increase in snow deposition could theoretically increase the runoff slightly during a ROS event in the area, depending on the intensity/duration of the event. The additive peak flow increase due

to the proposed thinning/burning activities would have the potential for very slightly increasing the amount of channel erosion during a typical ROS event in the analysis area. However, discerning the amount of this potential risk to the channel is impossible. The potential effect of increased peak flow during a ROS event due to the proposed actions would decrease with the recovery of the canopy cover due to tree growth.

Sediment Yield Effects

Proposed Thinning/Timber Harvest and Broadcast Burning. In managed forest areas, the main sources of sediment directly input to stream networks results from road construction associated with timber harvest, or from the skidding system in the units. The skidding of thinning materials or logs in the Red Whale Project fuels reduction units would reduce the amount of natural vegetation cover (grasses, forbs, and shrubs) for a short time following thinning/timber harvest. The reduction in vegetative cover in the thinning/harvest units increases the potential for soil erosion, which increases the potential sediment yield to streams. Ground-based skidding, without snow cover or down fuel layer, would result in the most vegetation reduction; winter tractor logging would result in the least reduction in vegetation. Tree falling is not considered a major cause of increased sediment.

The WEPP – Fuel Management computer model was used to predict both the background upland sediment yield and the amount of sediment increase associated with the proposed thinning/harvesting, broadcast burning, and potential post-wildfire soil erosion scenario for each alternative. The estimations of potential sediment yield are model for 30 years of precipitation events. Because some short-duration, high-intensity rainstorms are included in the 30-year average the soil erosion/sediment yield from broadcast burning or wildfires is probably a worst case scenario. In order for these amounts of soil erosion/sediment yield to occur, a high intensity rainstorm must impact the specific area that is burned within a short time span after the treatment/ wildfire, which is a low probability event. The time-frame is until the re-vegetation of a thinned, broadcast burn, or wildfire area. Based upon the experience of several hundred thousand acres of wildfires during the past decade in the Flathead River Basin, only a few hundred acres have had these post-fire erosion events.

The WEPP - Roads interface was used to estimates the non-point sediment delivery from roads within the analysis areas. The potential sediment yield from each road crossing was calculated as an estimate of the background road associated sediment yield. Each existing road crossing was grouped into one of three classes of typical stream crossing found in the analysis area according to its grade and width. The three groups modeled were: 1) a flatter (2%) grade narrow (14 foot) road stream crossing; 2) a flatter and wider (double lane) crossing; and 3) a steeper (5%) narrow crossing. The average sediment leaving the buffer and entering a stream channel for a given scenario was multiplied by the total number of each road crossing scenario within an analysis watershed. The total annual sediment yield from the existing road system in the analysis area is approximately 37.3 tons. The results of the modeled existing potential road associated sediment are summarized in Table 3-42 for each analysis watershed. See the project record for WEPP model assumptions and results.
Refer to Table 3-42 which summarizes for each analysis watershed the existing sediment yield and potential first year sediment yield increases from the Alternative 2 proposed thinning/timber harvest and broadcast burning. The table also displays a comparison between the sediment yield

from a high burn severity wildfire compared to the same area thinned and/or broadcast burned. The sediment yield from a broadcast burn/erosion event would be significantly less than the levels observed after a wildfire. This is due to the higher soil burn severity typically occurring with a wildfire. Included in Table 3-42 are the sediment yields from culvert placements on temporary roads, proposed culvert up-sizing, and culvert removals. These are discussed after the table, but are included to reflect all the Alternative 2 sediment effects. The timeframe for the potential sediment yield values reported in Table 3-42 are from the disturbance activity to the first growing season following that disturbance. There is approximately a 60-65% reduction in sediment potential following the first growing season after disturbance. The third growing season after the disturbance the potential sediment is reduced by approximately 80-85%, going to 100% reduction by the end of the fifth growing season. For more productive sites, this re-vegetation timeframe is shorter.

Table 3-42. Modeled Potential Sediment Yield From Existing Management Activities and Alternative 2 Proposed Actions for Each Analysis Watershed.

Analysis Watershed	Annual Natural Background Sediment Yield (tons) α	Annual Existing Roads Background Sediment Yield (tons)	Wildfire Sediment Yield 1st Year (tons) β	Broadcast Burning Sediment Yield 1st Year (tons)	Forest Thinning Sediment Yield 1st Year (tons)	Culvert Up-sizing Sediment Yield 1st Year (tons)	Culvert Removal Sediment Yield 1st Year (tons)	Sediment Yield Reduction From Thin/Prescribed Fire (tons) ϕ	Sediment Yield From Temporary Road Culvert Placement (tons)	Total 1st Year Sediment Yield From Alt. 2 Proposed Actions
Tepee Creek	.02	2.2	14.4	0	0	0	0	(14.4)	0	.1
Whale Creek	.06	3.6	789.3	0	2.80	2.1	0	(786.5)	0	4.9
Moose Creek	.02	.3	3,826.6	200.3	10.70	.7	4.6	(3,615.6)	0	216.4
Hawk Creek	.01	1.3	592.1	0	2.20	.7	0	(591.4)	0	2.9
Red Meadow Creek	.03	12.6	2,060.1	129.5	.05	2.7	73.3	(1,930.1)	0	206.1
Hay Creek	.03	1.8	2,472.0	121.0	0	0.0	0	(2,260.0)	0	121.0
Moran Creek	.01	2.7	2,117.0	121.6	0	.7	0.0	(1995.4)	0	122.4
Unnamed Tributary - North Fork Flathead River	.01	3.3	0	0	0	0	0	0	0	0
North Fork Flathead River Face Drainages	.02	9.5	1,685.0	0	.01	0	0	(1,685.2)	.9	.9

α : The modeled sediment yield from the totally vegetated uplands within the analysis watershed.
β : The modeled sediment yield following a wildfire, from the same area proposed, for the given Alternative to be either thinned or prescribed burned.
ϕ : The potential sediment yield reduction comparing the potential post-wildfire sediment yield to either thinning and/or prescribed burning the same area.

To put the modeled sediment yield into context, a cubic foot of soil weights approximately 110 pounds depending on its density; it takes 18.1 cubic feet of soil to yield a ton of suspended sediment. For the ten years that Whale Creek was monitored for suspended sediment yield, the average was 21.1 tons per square mile per year. (USFS1991) Note: Whale Creek is the only stream in the analysis area with long-term suspended sediment monitoring. Whale Creek is 64 square miles in size and the estimated sediment yield from Whale Creek would be 1,350 tons per year. The Alternative 2 proposed thinning in Whale Creek has an estimated 2.8 tons of sediment yield or a .2% increase above background. Compared to a 58.5% increase in sediment yield above background if the same area proposed for thinning were to burn with a wildfire and then experience a post-fire soil erosion event.

Due to the soil types, the landform slope, and the distance to any live stream channel, there is no potential for sediment production from the burning of burn slash piles.

Landings and Temporary Roads. The proposed Alternative 2 thinning would include the construction of .3 miles of new, temporary road and the use of .7 miles of historic or naturally re-vegetated road prism. The new road segments occur on nearly flat, 1 to 3% slope, glacial outwash terraces. The soils on these landforms are layers of mixed sand and gravel materials which have very high soil permeability. Due to soil types, landform slope, and distance to any live stream channel, there is no potential for sediment production from the construction of the new temporary road prism, or the use of the historic road prism. This is based upon WEPP-Road soil erosion modeling and observations of the district soil scientist and hydrologist. There would be one culvert needing to be replaced on the year-long bermed road to unit BB. Using the estimated sediment yield from the placement of a 4-foot culvert (Table 3-44) there is approximately a .9 ton sediment yield from this activity. This would be the only sediment yield effect from the additional roads needed to implement the proposed Alternative 2 thinning.

The proposed thinning/timber harvest units in Alternative 2 would require approximately 21 landings to extract logs from proposed units; based upon mapping the most logical location for necessary landings. As described in the temporary roads discussion, these soils and flat landforms have very little soil erosion potential and the sediment yield potential would be zero if the disturbed area were located some distance away from a stream channel with a streamside vegetation buffer (smz). Of the 21 potential landings, only the landing in the northern portion of unit P would be within 250 feet of a live stream. Using the WEPP-Disturbed Land erosion model for the Unit P site the sediment yield would be 0.0 pounds per acre per year. See project record for WEPP modeling results. Based upon this analysis, there is no measurable sediment yield, nutrient yield, or water yield associated with the proposed landing and temporary roads in Alternative 2. All applicable forestry BMPs would be applied during the thinning/logging operations, and all temporary roads and landings would be seeded and water-barred as soon as possible following the completion of timber/thinning harvest activities. See Appendix-A in the EA for a listing of appropriate project specific BMPs.

BMP Improvements. Segments of the existing road system that would remain in use would require improvements in the road surface drainage and stream drainage systems to meet current Montana State Best Management Practices and INFISH standards. The primary BMPs that need to be accomplished are directly associated with improving water drainage from the surface of

roads and improving the filtering of sediment coming from the road surface and from ditch drainage. The work activities include up-sizing culverts and adding more road cross-drains (culverts or drive thru dips), installing filter-windrows and sediment traps.

The installation of various BMP treatments at stream crossing can significantly reduce sediment yield from the road surface at these sites. Using the WEPP-Road soil erosion model, an estimate was made of the potential sediment entering the stream from the three general types of stream crossings found in the analysis area. A flatter (2%) grade narrow (14 foot) road stream crossing, a flatter and wider (double lane) crossing, and a steeper (5%) narrow crossing were modeled. The sediment estimate was completed with and without BMP improvement installed at each crossing type. See Table 3-43 for the estimated sediment yield from the various types of stream crossings with and without BMP treatments.

Table 3-43. Estimated Sediment Yield with and without BMP Practices at Various Road-Stream Crossing Types.

Road-Stream Crossing Type	Sediment Yield from Stream Crossing with No BMPs (pounds/year)	Sediment Yield from Stream Crossing with BMPs Installed (pounds/year)	Reduction in Sediment Yield (pound/year)
Flatter Narrow	30	1	29
Flatter Wide	551	3	548
Steep Narrow	791	5	786

A drive-thru-dip would be installed approximately 25-50 feet prior to the start of a road-stream crossing on the uphill side of the crossing, if the road has a continuous climbing grade through the stream crossing. There would be a need for a drive-thru-dip on each side of the stream crossing when the road grade "dips" downward into the stream-crossing from both sides. Drive-thru-dips constructed near to a stream crossing can allow some sediment to enter the stream channel. There would be approximately 250 square feet of newly exposed, un-armored road prism soil material available to produce sediment with the construction of each drive-thru-dip. The construction of each drive-thru-dip would have the potential to add 5.0 pounds per year of sediment to a stream until the road prism has re-armored through the dip area. Based upon map reviews of roads with BMPs improvements proposed, there would be 10 stream-crossing drive-thru-dips needed for the road BMPs work in Alternative 2. Construction would yield approximately 85 pounds/year of potential sediment for the first 2 to 4 years following construction. After the installation of drive-thru-dips and additional cross-drain culverts at the stream crossings, there would be significant reduction of road associated sediment entering the stream at these sites. There would be potentially 1.3 tons per year reduction in road associated sediment yield with the implementation of the BMPs proposed in Alternative 2.

Culvert Replacements/Up-sizing. The primary direct effects to the water resource under Alternative 2, would be increased sedimentation directly associated with the culvert replacement process. An estimate of the amount of erosion and associated sedimentation that occurs during the process of replacing and/or up-sizing a culvert follows. Erosion material could come from

two different sources: the area beneath a culvert in a streambed that is exposed to water-flow during the removal process; and the side-slopes of the road prism that would be excavated during the replacement process. Unless a stream is dry, there would be some erosion occurring in the streambed during the replacement process even with de-watering, due to the seepage of groundwater around or under the stream block. The road side-slopes would be bare ground following the excavation and even with erosion control and sediment reduction measures installed, some erosion could occur before these bare ground surfaces become re-vegetated. Both of these erosion areas would be within or directly adjacent to a stream and any fine eroded soil material would immediately become suspended sediment.

The short-term increase in sediment varies with the soil materials that the culvert would be placed in, and with the slope of the land at the culvert site. Generally, the potential for erosion increases with the steepness of the slope and in soils with few coarse fragments and a finer texture. This is particularly true with saturated soils that occur in the bottom of perennial streams.

The following assumptions were made to estimate the amount of erosion/sediment that would occur with a culvert replacement. These assumptions were based upon the combined experience of the I. D. Team soil scientist, hydrologist, and roads engineer.

1) The width of the excavated "stream bottom" that has potential for erosion is approximately twice the width of the culvert diameter to be put in the stream. For example a 2-foot diameter culvert would have an excavated 4 foot wide stream bottom.
2) If there is any water, either surface or sub-surface flow, in the stream channel, dewatering would not capture 100% of the flow. There would be some amount of seepage water available for erosion in the streambed.
3) The depth of the road prism above the top of a flatter/shallow culvert would be approximately 2 feet, and the length of a flatter/shallow culvert would be approximately 28 feet.
4) The depth of the road prism above the top of a steeper/deep culvert would be approximately 15 feet, and the length of a steeper/deep culvert would be approximately 40 feet.
5) The amount of eroded fine soil material (sand, silt, clay) for a flatter/shallow culvert replacement, would average approximately .5 inches under a normal replacement scenario, and approximately 1 inch under a worst case scenario. The glacial till soils in this area contain fine soil material ranging from approximately 35 to 65% of the total soil volume.
6) The amount of eroded fine soil material (sand, silt, clay) with a steeper/deep culvert replacement would average approximately 1 inch under a normal replacement scenario, and approximately 2 inches under a worst case scenario.
7) The potential erosion on the excavated road prism side-slopes is approximately .5 inches until the slope has re-vegetated and no erosion ceases. This assumes that grass seed and straw mulch would be applied to the excavated side-slopes.
8) The approximate weight of soil material is 110 pounds/cubic foot.
9) A dry normal scenario assumes no surface or groundwater flow during replacement with the only erosion originating from the road prism side-slopes. A wet normal scenario

assumes the stream is dewatered but that some amount of seepage would occur around the stream block. The wet worst-case scenario assumes that the stream is dewatered, but that there is either a major flow under the stream block, or that the dewatering process fails during the replacement procedure.

Refer to Table 3-44 for the estimated erosion/sedimentation model results for various diameter culvert replacement scenarios.

Table 3-44. Estimated Erosion/Sedimentation that Occurs During a Culvert Replacement Process, for both Shallow and Deep Sites, During both a Normal Replacement Scenario and a Worst-Case Scenario.

Culvert Width - Erosion Scenario	Estimated Erosion/Sedimentation Flatter/Shallow Site	Estimated Erosion/Sedimentation Steeper/Deep Site
3 Foot – Dry Normal Resize	.4 Tons/Culvert	1.3 Tons/Culvert
3 Foot – Wet Normal Resize	.7 Tons/Culvert	2.4 Tons/Culvert
3 Foot – Wet Worst Case Resize	1.1 Tons/Culvert	3.5 Tons/Culvert
4 Foot – Dry Normal Resize	.4 Tons/Culvert	1.4 Tons/Culvert
4 Foot – Wet Normal Resize	.9 Tons/Culvert	2.9 Tons/Culvert
4 Foot – Wet Worst Case Resize	1.4 Tons/Culvert	4.4 Tons/Culvert

Culvert Removal. A sensitivity analysis was done to display the possible effects from a culvert removal and the potential soil erosion until the excavated site is re-vegetated. The depth of roadbed over the top of a culvert would be directly proportional to the slope of the streambed at the installation site. The steeper the installation site, the more surface area that is exposed to erosion with a culvert removal. For this comparison, three culvert installations were analyzed: the first occurring on nearly level ground; the second a very steep installation; the third a typical moderate slope installation. Actual field measurements of culvert installations and many erosion monitoring observation measurements were used in the calculations. A best case and worst case scenario were analyzed: 1) a culvert removal in non-erosive soil conditions, with all BMPs applied; and 2) a culvert removal in erosive soil conditions, with limited BMPs applied. The surface area exposed for each scenario was calculated and then multiplied by the erosion depth to obtain the volume of eroded material. The reader should note that the volume of eroded material in the typical glacial till soils of this area would yield approximately 60 percent suspended sediment and 40 percent bed load sediments (any particle larger that coarse sand size). Refer to Table 3-45 for a comparison of the volume of eroded soil material for each scenario.

Table 3-45. A Comparison of Weight/Volume of Eroded Soil Materials from a Culvert Removal Site Versus a Culvert Failure and the Associated Road Prism Erosion.

Culvert Depth β	Culvert Removal Best Case Scenario For Soil Erosion	Culvert Removal Worst Case Scenario For Soil Erosion
Shallow Depth (4.1 ft.)	4.6 tons (3.1 cu. yds.)	11.0 tons (8.1 cu. yds.)
Moderate Depth (6.3 ft.)	4.4 tons (2.9 cu. yds.)	13.5 tons (9.1 cu. yds.)
Deep Depth (15.8 ft.)	12.5 tons (8.4 cu. yds.)	50.7 tons (34.1 cu. yds.)

β - Depth is measured from the top of the outside shoulder of the road vertically to the bottom of the culvert.

There are 8 proposed culvert up-sizing sites and 12 culvert removal sites proposed under Alternative 2. The sediment yield from the up-sizing work would be 14.1 tons, and 77.9 tons from the culvert removal activities. See Table 3-46 for a more detailed breakdown of the culvert up-sizing and removal proposal and sediment yield effects. The best-case scenario culvert removal soil erosion from Table 3-44 was used in the calculations because of the soil types found in the Whale Creek area. The number of culvert removals by depth class was multiplied by the erosion rate per site to give a total potential sediment yield.

Table 3-46. The Proposed Alternative 2 Culvert Removals and Culvert Up-Sizings, and the Associated Sediment Yield.

Culvert Removal Depth	Alternative 2 Proposed Removals	Culvert Removal Sediment Yield (tons)	Culvert Up-size Diameter	Alternative 2 Proposed Culvert Up-sizing	Culvert Up-sizing Sediment Yield (tons)
Shallow	4	18.4	3-Foot	4	4.9
Moderate	5	22.0	4-Foot	4	9.6
Deep	3	37.5			
Totals	**12**	**77.9**	**Totals**	**8**	**14.1**

The Alternative 2 proposed forest thinning (commercial and pre-commercial), broadcast burning, BMPs road drainage improvements, culvert up-sizing and culvert removals would have a short-term temporary negative impact to the water quality due to the increase in sediment yield of approximately 680 tons. This is a high estimate due to soil erosion/sediment yield potential following broadcast burning. There would be no sediment yield effects due to slash pile burning, slash piling, slash chipping, new temporary road construction or landing construction. The sedimentation potential from the thinning units is decreased rapidly as the vegetation cover is established. The Alternative 2 proposed actions should not cause a measurable increase to sediment yield that is outside the natural range of variation for the streams in the Red Whale

anlysis area. The highest sediment yield scenario would result if a wildfire with a post-fire soil erosion event occurred. The culvert up-sizings and removals would have a short-term effect to the water quality; however, there would be a long-term positive effect due to the reduction of culvert failure risk (and the associated sedimentation). The estimated 680 tons of delivered sediment due to the Alternative 2 proposed actions would not be discernable once the analysis area streams reach the North Fork Flathead River because of the dilution effect.

Nutrient Yield Effects

Within the Flathead Basin, phosphorus and nitrogen are the primary nutrients of concern that have been identified and studied in connection to timber harvest and fire activities. The primary concern with any nutrient increase in the headwater streams would be the potential for increasing the nutrient levels in Flathead Lake, which would lead to increased algae growth. This was specifically addressed in the Nutrient Management Plan and Total Maximum Daily Load for Flathead Lake, Montana (Montana Department of Environmental Quality, 2001), which identifies phosphorus and nitrogen as the primary nutrients of concern in the Flathead Lake Basin.

The proposed thinning/broadcast burning treatments in Alternative 2 may cause a slight short-term increase in the nutrient levels in analysis area streams. This would be due to the increased leaching of nutrients from small limbs and needles on the ground following thinning activities; and from the increased nutrients made available for leaching and/or plant uptake following the burning of biomass on site. The potential nutrient leaching from needles and burn piles is very low due to the soil types in this area (silt loam surface layer and silty clay loam subsoil), and the soil could be expected to rapidly absorb any nutrients made available after thinning or broadcast burning in most situations. There would be the potential for surface soil erosion/sedimentation if a high intensity rainstorm event were to occur on the steeper hillsides shortly (15 – 20 days) after broadcast burning. In this case, nutrient yield and sedimentation into the stream would be increased. However, the likelihood of this scenario is low as most high intensity rainstorms are associated with thunderstorm activity during the summer, not the spring and fall when broadcast burning occurs.

The temporary roads and landings associated with the Alternative 2 proposed thinning are all located on flat or slightly sloping sites and have significant buffer distances to any perennial stream. The potential for sediment entering a stream due to soil erosion from these areas of newly disturbed ground would be extremely slight or non-existent. Since there would be no sediment entering a stream, neither would there be sediment associated nutrients. Therefore, unless the rare post-burn rainstorm/soil erosion scenario occurs, there would be very low to no measurable increase in the stream-water nutrient levels following the Alternative 2 thinning and broadcast burning. If the rain/erosion event were to occur, there would be discernable levels of increased nutrients in the small analysis streams. The nutrient yield from a broadcast burn/erosion event would be significantly less than the levels observed after a wildfire, due to the higher burn severity typically occurring with a wildfire. The proposed 12 culvert removals would potentially yield 78 tons of sediment directly into the stream channels. The certainty of sediment and nutrient yield from the culvert removals would be much greater than from the thinning/broadcast burning. However, the amount of potential nutrient increase from the

Alternative 2 proposed actions would not be discernable from the background nutrient levels in the North Fork Flathead River, when the waters from the analysis watersheds and the North Fork Flathead River combine. This is due to the large volume of water and the natural levels of nutrients in the North Fork Flathead River as compared to the small creeks in the analysis area.

Due to a combination of streamside buffer zones and the large quantity of groundwater flow in analysis area streams, Alternative 2 proposed actions should not cause a measurable change to stream water temperature. An extensive review of water temperature data can be found in the fisheries section of this EA.

As all applicable forestry BMPs would be applied during the proposed salvage and construction activities in Alternative 2, it meets the intent of the Clean Water Act, the Montana Water Quality Law, and the Flathead National Forest Land Management Plan, Standards and Guidelines.

Alternative 2 - Road Management Proposal

See Table 3-47 for a listing of the five categories of road management, the existing mileage in each category, and the mileage after Alternative 2 is implemented.

Table 3-47. The Mileage of Existing Road and Motorized Trail Management Classes and Alternative 2 Road Management Proposal.

Closure Type	Miles by Road/Trail Mgmt Type Existing Today	Miles by Road/Trail Mgmt Type After Alt. 2 Implemented
Open Year-long	52.8	47.6
Open Seasonally	11.2	15.8
Closed Year-long/Gate	38.4	21.3
Closed Year-long/Berm	25.3	39.4
Motorized Trails (ATV &/or motorcycle)	25.1	1.5

With the implementation of Alternative 2 there would be 47.6 miles of road open year-long, which would be a decrease of 5.2 miles from the existing situation. The 5.2 miles of road would be in a more restrictive road management category; either open seasonally, closed year-long with a gate, or closed year-long with a berm.

Each road management prescriptions would have a different potential sedimentation risk. Year-long open roads typically receive more grading than seasonally open roads. Consequently, seasonally open roads would have a greater potential for wheel ruts to develop, thereby reducing the effectiveness of road surface water drainage BMPs. Roads closed year-long with a berm greatly increase the effort and cost for periodic inspection and maintenance of remaining culverts. These roadbeds re-vegetate with brush eventually, making the road impassable to machinery without brush removal, reducing timely access in an emergency situation. In the short term, the re-vegetation of the road surface reduces the potential for road surface soil erosion/sedimentation; in the long term the risk for culvert failure and associated sedimentation

is increased if difficult access results in the lack of periodic maintenance. Road maintenance budgets have been reduced lately, resulting in less emphasis on maintaining Maintenance Level – 1 roads. Bermed roads would be at greater risk than seasonally open roads, which are at greater risk than year-long open roads, for potential long-term sediment production.

Under Alternative 2 there are 15.8 miles of road proposed to be open seasonally, an increase of 4.6 miles over the existing situation. As discussed earlier, seasonally open roads receive less maintenance then roads open year-long, possibly resulting in slightly higher road surface erosion. Therefore, a 4.6 mile increase in the amount of seasonally open roads would have a slight negative effect on the water quality. Water quality would not be affected.

There would be 21.3 miles of roads closed year-long with a gate in this alternative, which is 17.1 miles less than the existing situation. The majority of the 17 miles would be converted to roads closed year-long with a berm. This would have the effect of slightly decreasing the sedimentation level, due to the increased vegetation on the bermed road surface, especially since no administrative use is allowed behind the berm except for major maintenance. The administrative use with no maintenance has the effect of increasing the potential to create ruts in the road surface.

The other category of road management that increases in mileage under Alternative 2 is the road closed year-long with a berm class. Under Alternative 2 there are 39.4 miles of road proposed to be closed year-long with a berm, which is 14.1 miles more then currently exists. The closed year-long with a berm road management scenario somewhat increases the long-term risk for culvert failure given the current funding for road maintenance emphasis. However, all high-risk culverts on existing bermed roads, or roads proposed to be bermed, were identified to be up-sized or removed to minimize this risk. There would be no change in water quantity with this change in road management.

All of the roads closed year-long with a berm would remain in the road system; no culverts in perennial and intermittent streams would be removed. An inspection of the road drainage structures would be done and any high-risk or undersized culverts will be replaced with larger culverts to meet the INFISH requirements of providing for a 100–year return interval flow capacity in culverts of Bull Trout of West-slope Cutthroat Trout streams. Water bars or drive-thru-dips would be installed if needed, to minimize the risk of a culvert failure resulting in the diversion of stream flow down the road surface, causing increased erosion/sedimentation. The road surface would significantly re-vegetate thus reducing mid-term sedimentation potential. The effects of this proposal were described in the previous section titled culvert replacements.

There would be 1.5 miles of motorized trail under Alternative 2, which is 23.6 miles less than the existing situation. Trails would be converted to non-motorized access only, slightly decreasing the soil erosion/sedimentation level due to the reduction in the rutting associated with motorcycle and ATV use. Based upon WEPP model estimation, a 250 foot section of 5 percent grade trail, 75 feet distant from a stream channel would see a 37 pound/year reduction in sediment yield to the stream from a non-rutted trail compared to a rutted trail. Sediment yield would be a small portion of the soil erosion from a trail, as the transport of eroded materials from a typical trail location to a stream channel would be very low.

There would be no new road decommissioning under Alternative 2.

Alternative 2 proposes to remove 7 culverts on road #9839 and 5 culverts on road # 1662 in Red Meadow Creek. The culvert removals would remove the risk of any future culvert failure, and associated sediment yield, from approximately 3.5 miles of road. The proposed culvert removals would potentially yield 78 tons of sediment directly into the tributary stream channels causing a short-term increase in sediment yield, but preventing substantially greater sediment yield were the existing culverts to fail.

Alternative 3 - Direct and Indirect Effects

Forest Thinning/Timber Harvest, Prescribed Burning, Road BMP, Culvert Up-size/Removal Proposals

The proposed activities in Alternative 3 include thinning/timber harvest on 927 acres in 22 units; the prescribed burning of 1,360 acres in 8 units; the up-sizing of 8 culverts and removal of 24; and the yarding of commercial size poles and logs utilizing ground skidding. There would be 3.5 miles of road used during the hauling process; 3.1miles of which were previously restricted (gated, bermed, historic) and 0.4 miles that would be new temporary road construction. BMP road improvements are proposed on all haul routes. These activities would have the greatest potential for affecting the water quantity or water quality. The hand-piling, excavator piling, and/or chipping of fuel materials on the ground would have no direct effect on water quantity or water quality.

Water Yield Effects

The discussion of water yield increase effects of Alternative 3 is substantially the same as for Alternative 2 with the following changes. The amount of proposed thinning would be reduced by 1,241 acres; consequently, the estimated water yield increase would be significantly reduced compared to Alternative 2. See Table 3-48 for the comparison of reported existing water yield increase to the Alterative 3 water yield increase. The estimated water yield increase from the proposed Alternative 3 thinning and prescribed burning units would not significantly change the risk of stream channel erosion from the existing situation. As discussed earlier, the ROS analysis and other information was used to assess the risk of water yield increase from a ROS event in the analysis area for the Alternative 3. Based upon that assessment, the thinning and prescribed burning proposed under this alternative would have an increased risk of yielding additional peak flow that would slightly increase the risk of channel erosion during a typical ROS event in the analysis area.

Table 3-48. For the Analysis Watersheds the Annual Natural Water Yield, the Existing Water Yield Increase above Natural Background (Alternative 1), and the Estimated Water Yield Increase Associated with Proposed Thinning, Prescribed Burns, and New Temporary Roads for Alternative 3.

Analysis Watershed	Watershed Area (acres)	Annual Natural Water Yield (acre-feet)	Percent Existing Annual Water Yield Increase Above Natural (ECA acres)	Alt. 3 Percent Annual Water Yield Increase Above Natural (ECA acres)
Tepee Creek	9,511	19,185	14.0 (3,775)	14.0 (3,786)
Whale Creek	40,958	106,484	2.3 (3,677)	2.4 (3,881)
Moose Creek	11,816	26,534	1.4 (634)	2.7 (1,041)
Hawk Creek	1,778	1,546	4.2 (199)	5.9 (308)
Red Meadow Creek	18,901	43,963	3.6 (2,632)	3.7 (2,738)
Hay Creek	18,502	44,406	1.2 (738)	1.6 (1,101)
Moran Creek	7,388	14,405	1.7 (338)	2.7 (532)
Unnamed Tributary - North Fork Flathead River	1,506	1,363	3.5 (136)	3.5 (136)
North Fork Flathead River Face Drainages	12,545	8,497	14.1 (4,801)	14.8 (5,049)

Sediment Yield Effects

The discussion of sediment yield effects of Alternative 2 would be the same for Alternative 3 except that the proposed thinning acreage in Alternative 3 would be reduced by 1,241 acres. Consequently, the estimated sediment yield from these activities would be significantly reduced compared to Alternative 2.

There would be 5 stream-crossing drive-thru-dips needed for the road BMP work in Alternative 3. This construction would yield approximately 50 pounds/year of potential sediment for the first 2 to 4 years following construction. There would potentially be a reduction of 0.1 tons per year in road associated sediment yield with the implementation of the proposed BMPs.

There are 8 proposed culvert up-sizing sites and 24 culvert removal sites proposed under Alternative 3. The sediment yield from the up-sizing work would be 14.1 tons, and 227.9 tons from the culvert removal activities. See Table 3-49 for a more detailed breakdown of the culvert up-sizing and removal proposal and sediment yield effects.

Table 3-49. The Proposed Alternative 3 Culvert Removals and Culvert Up-sizings and the Associated Sediment Yield.

Culvert Removal Depth	Alternative 3 Proposed Removals	Culvert Removal Sediment Yield (tons)	Culvert Up-size Diameter	Alternative 3 Proposed Culvert Up-sizing	Culvert Upsizing Sediment Yield (tons)
Shallow	4	18.4	3-Foot	4	4.9
Moderate	5	22.0	4-Foot	4	9.6
Deep	15	187.5			
Totals	**24**	**227.9**	**Totals**	**8**	**14.1**

The Alternative 3 proposed actions would have a short-term temporary negative impact to the water quality due to the increase in sediment yield of approximately 829 tons. This would be a high estimate due to soil erosion/sediment yield potential following prescribed burning. There would be no sediment yield effects due to slash pile burning, slash piling, slash chipping, new temporary road construction or landing construction. The Alternative 3 proposed actions would not cause a measurable increase to sediment yield outside the natural range of variation for the streams in the Red Whale analysis area. Refer to Table 3-50 which summarizes the existing sediment yield and potential first year sediment yield increases from the activities proposed in this alternative.

Table 3-50. Modeled Potential Sediment Yield From Existing Management Activities and Alternative 3 Proposed Actions for Each Analysis Watershed.

Analysis Watershed	Annual Natural Background Sediment Yield (tons) α	Annual Existing Roads Background Sediment Yield (tons)	Wildfire Sediment Yield 1st Year (tons) β	Broadcast Burning Sediment Yield 1st Year (tons)	Forest Thinning Sediment Yield 1st Year (tons)	Culvert Upsizing Sediment Yield 1st Year (tons)	Culvert Removal Sediment Yield 1st Year (tons)	Sediment Yield Reduction from Thin /Prescribed Fire (tons) ϕ	Sediment Yield from Temporary Road Culvert Placement (tons)	Total 1st Year Sediment Yield from Alt. 3 Proposed Actions
Tepee Creek	.02	2.2	14.4	0	0	0	0	(14.4)	0	.10
Whale Creek	.06	3.6	566.6	0	2.0	2.1	0	(564.6)	0	4.10
Moose Creek	.02	0.3	3,638.6	200.3	10.7	.7	4.6	(3,427.6)	0	216.40
Hawk Creek	.01	1.3	341.6	0	1.2	.7	0	(340.4)	0	1.90
Red Meadow Creek	.03	12.6	738.7	40.6	.5	2.7	223.3	(697.6)	0	267.10
Hay Creek	.03	1.8	2,242.3	112.4	0	0	0	(2,129.9)	0	112.40
Moran Creek	.01	2.7	2,108.9	121.2	0	.7	0.0	(1,987.7)	0	122.00

Analysis Watershed	Annual Natural Background Sediment Yield (tons) α	Annual Existing Roads Background Sediment Yield (tons)	Wildfire Sediment Yield 1st Year (tons) β	Broadcast Burning Sediment Yield 1st Year (tons)	Forest Thinning Sediment Yield 1st Year (tons)	Culvert Upsizing Sediment Yield 1st Year (tons)	Culvert Removal Sediment Yield 1st Year (tons)	Sediment Yield Reduction from Thin /Prescribed Fire (tons) ϕ	Sediment Yield from Temporary Road Culvert Placement (tons)	Total 1st Year Sediment Yield from Alt. 3 Proposed Actions
Un-named Tributary-North Fork Flathead River	.01	3.3	0	0	0	0	0	0	0	0
North Fork Flathead River Face Drainages	.02	9.5	504.7	0	.01	0	0	(504.6)	.9	.91

Nutrient Yield Effects

The discussion of nutrient yield effects for Alternative 3 would be the same as for Alternative 2, except that the acreage of proposed thinning in Alternative 3 would reduce by 1,241 acres; thereby significantly reducing the estimated nutrient yield as compared to Alternative 2. Unless a rare post-burn rainstorm/soil erosion scenario would occur, there should very low to no measurable increase in the stream-water nutrient levels following the implementation of Alternative 3 actions. The proposed 24 culvert removal sites would potentially yield 228 tons of sediment and nutrients directly into stream channels, primarily Red Meadow Creek. The sediment and nutrient yields from the culvert removals would be much greater than from the thinning/prescribed burning. The nutrient increase from the Alternative 3 proposed actions would not be discernable from the background nutrient levels in the North Fork Flathead River when the waters from the analysis watersheds and the North Fork Flathead River combine.

Road Management Proposal

See Table 3-51 for a listing of the five categories of road management, the existing mileage in each category, and the mileage after Alternative 3 is implemented.

Table 3-51. The Mileage of Existing Road and Motorized Trail Management Classes and Alternative 3 Road Management proposal.

Closure Type	Miles by Road/Trail Mgmt Type Existing Today	Miles by Road/Trail Mgmt Type After Alt. 3 Implemented
Open Year-long	52.8	44.1
Open Seasonally	11.2	7.0
Closed Year-long/Gate	38.4	15.3
Closed Year-long/Berm	25.3	57.5
Motorized Trails (ATV &/or motorcycle)	25.1	0.0

With the implementation of Alternative 3, there would be 44.1 miles of road open year-long, a decrease of 8.7 miles from the existing situation. These 8.7 miles would be in a more restrictive road management category; either open seasonally, closed year-long with a gate or closed year-long with a berm. There are 7.0 miles of road proposed to be open seasonally, which is 4.2 miles less then currently exists. As discussed earlier, seasonally open roads get less maintenance then open year-long roads resulting in slightly higher road surface erosion. The 4.2 mile decrease in the seasonally open roads would have a slight positive effect on the water quality over the existing situation. There would be no change in water quantity.

There would be 15.3 miles of roads closed year-long with a gate; 23.1 miles fewer than the existing situation. The majority of the 23.1 miles would be converted to roads closed year-long with a berm; having the effect of slightly decreasing the sedimentation level due to the increased vegetation on the bermed road surface.

Roads closed year-long with a berm would increase to 57.5 miles of road closed year-long with a berm; 32.2 miles more than the existing situation. There would be no change to the water quantity.

There would be 0.0 miles of motorized trail; 25.1 miles fewer than the existing situation. These 25.1 miles would be converted to non-motorized trails, which would have the effect of slightly decreasing the soil erosion/sedimentation level.

Under Alternative 3 there would be 24 culverts removal sites in Red Meadow Creek. The culvert removals would effectively remove the risk of any future culvert failure and associated sediment yield from approximately 10.9 miles of road. The culvert removals would potentially yield 228 tons of sediment directly into the tributary stream channels of Red Meadow Creek. There would be a short-term increase in sediment yield, but substantial reductions in the sediment yield were the existing culverts to fail.

Alternative 4 - Direct and Indirect Effects

Forest Thinning/Timber Harvest, Prescribed Burning, Road BMP, Culvert Up-size/Removal Proposals

The proposed activities in Alternative 4 include thinning/timber harvest on 3593 acres in 42 units; the prescribed burning of 1,431 acres in 8 units; and the yarding of commercial size poles and logs utilizing ground skidding. There would be 5.6 miles of road used during the hauling process; 5.3 miles of which would have been previous restricted (gated, bermed, historic) and 0.3 miles that would be new, temporary road construction. BMP road improvements are proposed on all haul routes. There are 8 culverts identified for up-sizing and 12 culverts removal sites proposed under Alternative 4. These activities would have the greatest potential for affecting the water quantity and water quality. The hand-piling, excavator piling and/or chipping of fuel materials would have no direct effect on water quantity or water quality.

Water Yield Effects

The discussion of water yield increase effects of Alternative 4 are virtually the same as described for Alternative 2, except for the acreages of proposed thinning and prescribed burning as listed above. See Table 3-52 for the reported existing water yield increase and the proposed water yield increase for Alternative 4. As noted in the Alternative 2 water yield discussion, Tepee Creek and the North Fork Flathead River Face Drainages are two analysis watersheds that have greater than a 10% existing water yield increase. The proposed thinning in Alternative 4 would slightly increase the ECA (53 acres) in Tepee Creek resulting in an increase in water yield of less than one tenth of a percent. As discussed earlier, there is no expected change to the current stream channel conditions in the Tepee Creek watershed caused by additional water yield from Alternative 4 proposed thinning. The proposed thinning would increase the water yield in the North Fork Flathead River Face Drainages by 2.9%. This increase in water yield should have no effect on any stream and/or river channel in the analysis watershed.

The ROS analysis was used as discussed earlier in this report. The thinning and prescribed burning proposed would have an increased risk of yielding additional peak flow and slightly increase the risk of channel erosion during a typical ROS event in the analysis area.

Table 3-52. Analysis Watersheds: Annual Natural Water Yield, the Existing Water Yield Increase above Natural Background (Alternative 1), and the Estimated Water Yield Increase Associated with the Proposed Thinning, Prescribed Burns and New Temporary Roads for Alternative 4.

Analysis Watershed	Watershed Area (acres)	Annual Natural Water Yield (acre-feet)	Percent Existing Annual Water Yield Increase Above Natural (ECA acres)	Alt. 4 Percent Annual Water Yield Increase Above Natural (ECA acres)
Tepee Creek	9,511	19,185	14.0 (3,775)	14.1 (3,827)
Whale Creek	40,958	106,484	2.3 (3,677)	2.4 (4,018)
Moose Creek	11,816	26,534	1.4 (634)	3.7 (1,678)
Hawk Creek	1,778	1,546	4.2 (199)	7.2 (388)
Red Meadow Creek	18,901	43,963	3.6 (2,632)	4.4 (3,339)
Hay Creek	18,502	44,406	1.2 (738)	1.9 (1,465)
Moran Creek	7,388	14,405	1.7 (338)	3.3 (749)
Unnamed Tributary - North Fork Flathead River	1,506	1,363	3.5 (136)	3.5 (136)
North Fork Flathead River Face Drainages	12,545	8,497	14.1 (4,801)	17.0 (5,791)

Sediment Yield Effects

The discussion of sediment yield increase effects of Alternative 4 are virtually the same as described for Alternative 2, except for the acreages of proposed thinning and prescribed burning as previously noted. There would be an increase in potential sediment yield from these proposed activities compared to Alternative 2, of 40 tons for the first season following disturbance.

There would be 23 stream-crossing drive-thru-dips needed for the road BMP work in Alternative 4. This construction would yield approximately 115 pounds/year of potential sediment for the first 2 to 4 years following construction. There would be potentially 1.6 tons per year reduction in road associated sediment yield with the implementation of BMPs proposed in Alternative 4.

There are 8 proposed culvert up-sizings and 12 culvert removal sites proposed under Alternative 4. The sediment yield from the up-sizing work would be 14.1 tons, and for the culvert removals it would be 77.9 tons See Table 3-53 for a more detailed breakdown of the culvert up-sizing and removal proposal and sediment yield effects.

Table 3-53. The Proposed Alternative 4 Culvert Removals and Culvert Up-Sizings, and the Associated Sediment Yield.

Culvert Removal Depth	Alternative 4 Proposed Removals	Culvert Removal Sediment Yield (tons)	Culvert Up-size Diameter	Alternative 4 Proposed Culvert Up-sizing	Culvert Up-sizing Sediment Yield (tons)
Shallow	4	18.4	3-Foot	4	4.9
Moderate	5	22.0	4-Foot	4	9.6
Deep	3	37.5			
Totals	**12**	**77.9**	**Totals**	**8**	**14.1**

The Alternative 4 proposed activities would have a short-term temporary negative impact to the water quality due to the increase in sediment yield of approximately 722 tons. This would be a high estimate due to soil erosion/sediment yield potential following prescribed burning. The Alternative 4 proposed actions should not cause a measurable increase to sediment yield that outside the natural range of variation for the streams in the Red Whale analysis area. The culvert up-sizings and removals would have some short-term effects to the water quality; however there is a long-term positive effect by reducing the risk of culvert failures and that associated sedimentation. The estimated 722 tons of delivered sediment due to the Alternative 4 proposed action would not be discernable once the analysis area streams reach the North Fork Flathead River because of the dilution effect. Refer to Table 3-54 which summarizes the existing sediment yield and potential first year sediment yield increases from the Alternative 4 proposed activities.

Table 3-54. Modeled Potential Sediment Yield From Existing Management Activities and Alternative 4 Proposed Actions for Each Analysis Watershed.

Analysis Water-shed	An-nual Natur-al Back-ground Sedi-ment Yield (tons)	An-nual Exist-ing Roads Back-ground Sedi-ment Yield (tons)	Wild-fire Sedi-ment Yield 1st Year (tons)	Prescribed Burning Sediment Yield 1st Year (tons)	Forest Thinning Sediment Yield 1st Year (tons)	Culvert Up-sizing Sediment Yield 1st Year (tons)	Culvert Removal Sediment Yield 1st Year (tons)	Sediment Yield Reduction from Thin /Prescribed Fire (tons)	Sediment Yield from Temporary Road Culvert Placement (tons)	Total 1st Year Sediment Yield from Alt. 4 Proposed Actions
Tepee Creek	.02	2.2	109.0	4.7	0	0	0	(104.3)	0	4.8
Whale Creek	.06	3.6	759.2	0	2.5	2.1	0	(756.7)	0	4.6
Moose Creek	.02	.3	4,711.7	200.3	14.0	.7	4.6	(4,497.4)	0	219.6
Hawk Creek	.01	1.3	592.1	0	2.2	.7	0	(591.4)	0	2.9
Red Meadow Creek	.03	12.6	3,385.8	129.5	4.0	2.7	73.3	(3,252.3)	0	209.6
Hay Creek	.03	1.8	3,116.3	150.7	.01	0	0	(2,965.6)	0	150.7
Moran Creek	.01	2.7	2,639.9	121.2	0	.7	0.0	(2,518.7)	0	122.0
Unnamed Tributary-North Fork Flathead River	.01	3.3	0	0	0	0	0	0	0	0
North Fork Flathead River Face Drainages	.02	9.5	2,022.7	0	.01	0	0	(2,022.6)	.9	.91

Nutrient Yield Effects

The discussion of nutrient yield increase effects of Alternative 4 are virtually the same as described for Alternative 2, except for the acreages of proposed thinning and prescribed burning as detailed above. There would be an increase in potential sediment yield from these proposed activities, compared to Alternative 2, of 40 tons for the first season following disturbance. There would probably not be any measurable difference in the nutrient yield in any one specific analysis watershed between the two alternatives. Therefore, unless the rare post-burn rainstorm/soil erosion scenario would occur, there should very low to no measurable increase in the stream-water nutrient levels following the implementation of the proposed Alternative 4 activities. If the rain/erosion event were to occur, there would be discernable levels of increased nutrients in the small analysis streams. The proposed 12 culvert removal sites would potentially yield 78 tons of sediment (and associated nutrients) directly into the stream channels. The certainty of this sediment and nutrient yield from the culvert removals would be much greater than from the thinning/prescribed burning. Due to the large volume of water and natural levels of nutrients in the North Fork Flathead River, the potential nutrient increase traced to proposed Alternative 4 actions would not be discernable from the background nutrient levels once the streams combine with the North Fork Flathead River.

Road Management Proposal

See Table 3-55 for a listing of the six categories of road/trail management, the existing mileage in each category, and the mileage after Alternative 4 is implemented.

Table 3-55. The Mileage of Existing Road and Motorized Trail Management Classes and Alternative 4 Road/Trail Management Proposal.

Closure Type	Miles by Road/Trail Management Type Existing Today	Miles by Road/Trail Management Type After Alt. 4 Implemented
Open Year-long	52.8	44.1
Open Seasonally	11.2	15.8
Closed Year-long/Gate	38.4	21.3
Closed Year-long/Berm	25.3	42.8
Motorized Trails (ATV &/or motorcycle)	25.1	7.1

With the implementation of Alternative 4 there would be 44.1 miles of road open year-long; a decrease of 8.7 miles from the existing situation. These 8.7 miles would be in a more restrictive road management category; either open seasonally, closed year-long with a gate or closed year-long with a berm. There are 15.8 miles of road proposed to be open seasonally; a 4.6 miles increase over existing conditions. As discussed earlier, seasonally open roads may experience slightly higher road surface erosion compared to roads open year-long. A 4.6 mile increase in the seasonally open roads would have a slight negative effect on the water quality. There would be no change to the water quantity.

There would be 21.3 miles of roads closed year-long with a gate; a decrease of 17.1 miles from the existing situation. The majority of the 17.1 miles would be converted to roads closed year-long with a berm. This would have the effect of slightly decreasing the sedimentation level.

There would be 42.8 miles of roads closed year-long with a berm; an increase of 17.5 miles over the existing situation. With reduce budgets for road maintenance the past few years, there would be less emphasis put on the periodic maintenance of these Maintenance Level – 1 roads. There would be no change to water quantity.

There would be 7.1 miles of motorized trail; a decrease of 18.0 miles than the existing situation. The 18.0 miles of trails would be converted to non-motorized trails, and would slightly decrease the soil erosion/sedimentation level from the trails.

The removal of 13 culverts (12 removal sites) in Red Meadow Creek would effectively remove the risk of future culvert failure and the associated sediment and nutrient yield from approximately 3.5 miles of road; a potential total of 78 tons of sediment and nutrients sent directly into the tributary stream channels. Therefore, there would be a short-term increase in sediment yield to reduce a substantially greater sediment yield were the culverts to fail.

Cumulative Effects Common to Alternative 2, 3 and 4

Cumulative direct and in-direct effects to the water quantity and water quality (sedimentation & nutrient levels) for past, proposed, and foreseeable actions are described for the Red Whale Project Cumulative Effects Area.

Cumulative Effects Analysis Area

All of the tributary streams having effects from the proposed action from the Red Whale Project drain into the North Fork Flathead River. The volume of water contained in the North Fork Flathead River effectively dilutes beyond measurable amounts the incoming water yield increase, sediment yield increase and nutrient yield increase from the proposed action in the analysis area watersheds. The stream with the most extensive flow record, which is also the largest watershed on the west-side of the North Fork Flathead River, is Big Creek. Typically, there would be approximately 18 times the water flow in the North Fork Flathead River than in Big Creek during spring snowmelt flow. The smaller tributary watersheds that are in the Red Whale analysis area would probably have a higher flow ratio than Big Creek. Because of the larger flow volume and velocity of the North Fork Flathead River, it dilutes the effect of any additional input from a small tributary streams very rapidly after their confluence. For example, the North Fork Flathead River has naturally high levels of sediments being transported downstream in the spring, due to extensive erosion of glacial outwash terraces and stream terraces (J. Ruth 1988). When the cleaner water (lower suspended sediment levels) from a tributary stream is mixed with the dirty water (higher suspended sediment levels) of the North Fork Flathead River, it is rapidly equilibrated to a suspended sediment level greater than that of the tributary stream. Usually there is only a very small percentage of sediment yield in a tributary stream attributable to man-caused disturbances. This amount of management related sediment would not be measurable compared to the natural background variation of the sediment rich North Fork Flathead River. There is virtually no statistically significant measurable effect of any proposed management activity to water quality or water quantity, once the tributary streams in the analysis area combines with the North Fork Flathead River. For that reason, the cumulative effects analysis area includes all the individual Red Whale analysis watersheds to their point of confluence with the North Fork Flathead River.

Past Natural or Man-caused Watershed Disturbance

Past Road Construction and Timber Management/Wildfire

Past activities, including road building, timber management and wildfires, are the disturbances that have the most potential to affect on the current stream channel condition, sediment yield and water yield in the watersheds of the hydrology analysis area. All past road construction and timber harvest/wildfire activities were analyzed by watershed to reflect the amount of man-caused disturbance in the Red Whale analysis area. The impact of past management actions were considered in the hydrology/watershed affected environment section to describe the existing condition of the analysis watersheds. This information was used in three specific ways during the watershed assessment. First, during the water yield modeling (ECA modeling) all past harvest, past wildfires (larger fires in last 30 years) and existing non-decommissioned roads

were used as input data during the analysis of the existing water yield amounts. Second, during the field review, the stream segments to be surveyed were partially determined based on the patterns of past timber harvest and road building. And third, the existing road network was analyzed to estimate the annual sediment yield from roads using the WEPP model.

There are 202.9 miles of existing roads (all ownerships) within the cumulative effects analysis watersheds. Road construction occurred on the main North Fork Road (county road) beginning in 1921 with the majority of the Forest Service road construction occurring from the 1950s to the earlier 1960s. During the 1970s there was some new road construction that occurred on private lands. Beginning in the mid 1990s the Forest Service started decommissioning roads for wildlife habitat improvement; approximately 45.3 miles of road have been decommissioned within the analysis watersheds.

There are two primary effects from road construction to the water resource. When a road is initially constructed the disturbed soil from road prism is open to precipitation which results in soil erosion. Once the cut-slopes and fill-slopes revegetate and/or a erosion pavement (rock surface layer) is established, the soil erosion reduces significantly. If a road has Best Management Practices applied to it, the road surface erosion is significantly reduced. The sediment source from an existing road (residual effects after revegetation) is from soil erosion in close proximity to a road stream crossing. With proper spacing of ditch relief culverts and with well vegetated filter strips between the roads and stream channels, there is very little sediment that would enter a stream channel from the road surface, except close to stream crossing. There are 138 stream crossings on the existing road system in the analysis area. Each road crossing was grouped into one of three classes according to its grade and width, and was then modeled using WEPP-ROAD to calculate an estimated annual sediment yield. The number of crossings was summed and multiplied by the sediment yield. The total annual sediment yield from the existing road system in the analysis area is approximately 37.3 tons. See project file for the WEPP- Road modeling assumptions and results.

The second effect of road construction to the water resource is a water yield increase to the stream channels due to ditch-intercepted groundwater. On road cut-slopes that are deeper than approximately 5-6 feet, groundwater that is flowing underground can deposited into a road ditch. A portion of this water can reach a stream channel, increasing how rapidly snowmelt reaches the stream channel in the spring. In the analysis area, this occurs primarily on mid-elevation, moderate to steep glacial till soils with a clayey subsoil. Because of the vegetation removal from a road prism, the road area is considered during the water yield increase modeling.

Timber management first occurred on Forest Service lands in the analysis watersheds beginning in early 1950s (1952, 1954, & 1955) with the latest activity occurring in the winter of 2006-2007. There have generally been three peroids of timber harvest activity within the analysis watersheds: during the 1950 and early 1960s when a spruce bark beetles was affecting the North Fork Valley; in the 1970s when mountain pine beetle was affecting the forests in this area; and the salvage logging after the 2003 Wedge Canyon Fire. All types of sliviculture treatments have been used of the years in the analysis area including individual tree selection salvage harvest, overstory removal/improvement cuts/thinnings, and regeneration cuts (clearcuts, seed tree removals). Since the early 1950s there has been 43,688 acres of various types of slivicultural

treatments and/or wildfire that have occurred within the 122,905 acres of the cumulative effects analysis watersheds. Or approximately 35% of the forested lands in the analysis watersheds have been affected by timber management or wildfire since the 1950s. The current Equivalent Clearcut Area for the entire cumulative effects analysis is approximately 13.9%. All of the sites observed, where past timber harvest has occurred prior to the 2003 Wedge Canyon wildfire, appear to be very well vegetated with medium sized trees, poles, shrubs and/or grasses; including skid trails, landings, and temporary roads. Because of the productive soils and climate in this area, the past harvested stands are growing very well for the appropriate, potential vegetation condition (habitat type). There are some areas within the 2003 Wedge Canyon fire perimeter that have not recovered the amount of vegetation cover that the sites can support. This occurs in areas with high soil burn severity and/or where post-fire salvage logging has recently occurred. My interpretation is that harvested forest stands in this area have rapid vegetation recovery with a somewhat delayed hydrologic recovery; which over time decreases the post-harvest/wildfire water yield increase to streams in the analysis area. Based on field reviews of past timber management areas, there are no identified areas with significant soil erosion. These past timber harvest areas are not considered to be contributing any sediment to the analysis area streams. See Table 3-56 for a summary of the past man-caused and natural disturbances and their effect on the water yield and sediment yield in the analysis watersheds.

The most recent timber management activities in the analysis watersheds were associated with the Wedge Canyon Fire. Hazard trees were removed by Forest Service, Montana DNRC, and several private landowners. There is a water yield increase associated with the removal of burned trees, and the water yield analysis accounted for burned areas. The sediment yield potential from hazard tree removal was very low because only those trees within reach of the road were felled and then yarded along the roads. The only disturbance was the loading of the hazard trees from the roadsides and/or ditches. This disturbed small areas of soil in the road prism that was somewhat more eroable until the rapid post-fire revegetation with grasses and natives forbes occurred in July following the fire. The amount of potential sedimentation is estimated to be less than 5 tons for the entire fire area.

There was post-fire salvage harvest operations by Forest Service, Montana DNRC, and several private landowners. The water yield analysis has already accounted for those areas having no vegetation cover (combination wildfire and/or salvage harvest) in the past activities water yield table. The potential sediment yield from those units were analyzed in an earlier NEPA document, (Robert-Wedge Post-fire Project - EIS, 2004 Page 3-255). The modeled maximum potential sediment yield from the salvage harvesting activities (cutting, yarding, landings, temporary road construction and culvert placements) was estimated at 119 tons. This included salvage activities in Whale Creek, Hornet Creek, Tepee Creek, and North Fork Flathead River Face Drainages. There was no observed sediment yield from any of the salvage units, and minor amounts of sediment yield due to the placement and removal of several culverts on temporary roads segments. The improper placement of a BMP surface road drainage structure (water-bar) cause a short-term problem in the Hornet Creek Salvage Sale Area. My estimation is that somewhere between 5 to 10 tons of total sediment yield resulted from the three Forest Service post-fire salvage sales following the Wedge Canyon Fire. I observed post-fire salvage on Montana State Lands and private lands, and there were very minor amounts of sediment yield, primarily associated with temporary road construction and culvert placements/removals. An

estimate of the sediment yield from state and private lands in the the fire area would be 10 to 15 tons. This is primarily due to streamside management zone buffers, the water quailty BMPs that were utilized, and the soil types in the fire area. These are all short-term impacts that are recovered when sites are revegetated. All of the disturbed sites should have significant vegetative cover by mid-June 2007.

The routine road maintenance done in the past has had very short-term effects to sediment yield as described in the direct effects of culvert up-sizing. After the first full growing season following culvert up-sizing, road grading, or sediment catch basin cleaning, the effects of that work has been ameliorated; there are no long-term effects from these management activities. There has not been any road maintenance done by the Forest Service since summers of 2004 and 2005 (flappers, dips, up-size culvert). Therefore the short-term effects from that work should be over. The 2004 relocation of .75 mile of the North Fork Road had no effects to water quality or quantity because of the soil types and distance from stream channels at the road relocation site.

Table 3-56. The Red Whale Analysis Watersheds, Total Miles of Existing Roads, Sediment Yield from Existing Roads, Total Acres of Past Timber Management and/or Wildfire, Existing Equivalent Clearcut Area, and the Percentage of Each Watershed is Harvested Based upon ECA.

Analysis Watershed	Total Miles of Road Contributing to Sediment & Water Yield (miles)	Annual Sediment Yield from Existing Roads (tons)	Total Acres of Past Timber Management & Major Wildfire	Existing Equivalent Clearcut Area {ECA} (acres) α	Percent of Watershed Harvested/Burned Based on ECA Acreage (%)
Tepee Creek	17.0	2.2	7,603 (1955)	3,775	40.0
Whale Creek	42.4	3.6	9251 (1954)	3,677	9.0
Moose Creek	15.5	.3	2,904 (1954)	738	6.2
Hawk Creek	6.6	1.3	876 (1952)	199	11.1
Red Meadow Creek	33.3	12.6	7,967 (1952)	2,632	13.9
Hay Creek	18.0	1.8	3,782 (1954)	738	4.0
Moran Creek	14.4	2.7	1,471 (1968)	338	4.6
Unnamed Tributary - North Fork Flathead River	7.8	3.3	303 (1980)	136	8.9
North Fork Flathead River Face Drainages	47.9	9.5	9,511 (1960)	4,801	38.3

α : Equivalent Clearcut Area includes all area where vegetation cover has been removed or decreased such as: roads, timber harvest, thinning, and burned areas.

Red Bench and Wedge Canyon Wildfires. The 1988 Red Bench Fire was the primary natural disturbance to the Red Meadow Creek watershed since the 1964 flood event, and the 2003 Wedge Canyon Fire was the primary natural disturbance in Whale Creek. Both of the fires have areas of land where high soil burn severity occurred within analysis watersheds. The sites have the greatest potential for soil/watershed effects, especially soil erosion, due to the increased post-fire runoff potential and the reduced natural re-vegetation potential. There was some post-fire emergency rehabilitation grass seeding that occurred in both Whale Creek and Red Meadow Creek to speed up the re-vegetation on these sites. There was no significant post-fire soil erosion observed in any of the seeded areas.

There is increased nutrient transport in runoff associated with the increased post-fire soil erosion potential, until vegetative cover is re-established. There was a post-fire stream chemistry study reporting a short-term increase in the nutrient levels of Red Meadow Creek following the wildfire; however the increase in nutrients lasted less than a year and would have been diluted once Red Meadow Creek mixed with the North Fork of the Flathead River. (Spenser and Hauer 1990)

Most of the riparian vegetation along the perennial streams burned with a low to moderate burn severity; resulting in the rapid natural re-vegetation of these sites. Large woody debris recruitment would increase in the short term as a result of the fire. A large number of trees have already fallen into the stream channels and many more are likely to do so over the next several years. The effect of this woody debris would be to trap some sediment movement and increase fish habitat complexity.

The following are my interpretations of the post-fire situation in Red Meadow and Whale Creeks based upon the review of the applicable scientific literature and personal observation of the effects of wildfire. Following the wildfires, the watershed has an increased potential for upland soil erosion and channel erosion due to the reduced vegetative cover and soil infiltration, resulting in additional overland flow and streamflow. The additional water would cause an increase in the springtime and annual water yield. The melt of the snowpack in the fire areas would be somewhat earlier than pre-fire conditions, and the snowmelt peak-flows in the basin would probably be earlier especially on the southern aspects. This situation was observed in several of the local fire areas. The peak-flows associated with precipitation events would probably increase in intensity and decrease in duration for several years. The overall effects to the stream channels in the fire can take several years to occur. There were two stream channels in Red Meadow Creek, one ephemeral and one perennial, where the district hydrologist observed post-fire channel erosion. There was some stream channel down cutting and widening observed for the first three years following the Red Bench fire on these two streams. This situation has since naturally ameliorated itself. The potential for post-fire soil erosion has ameliorated within the Red Bench Fire area based upon field observation of the fire area.

Other wildfires small and large have occurred in the cumulative effects analysis area in the past century. The current vegetation cover and soils/watershed conditions do not reflect any remaining long-term affect due to any of these pass wildfires. The Red Bench and Wedge Canyon Fires still have effects to the water yield of the streams within those fire boundaries. The water yield analysis includes the effects of these two recent large wildfires. There have been no

areas of significant post-fire soil erosion identified on the ground in either the Red Bench Fire or the Wedge Canyon Fire areas. For this reason no additional sediment yield from the fire areas was added into the existing sediment yield estimate.

Fire Suppression. Because of the extreme fire behavior during the initial stages of both the Red Bench and Wedge Canyon Fires, aerial attack of the fires using fire retardant was utilized. Aerial fire retardant drops from airplanes were done on the Wedge Canyon Fire from July 18, 2003 to August 2, 2003 and again on August 25, 2003. There were 41 retardant drops made on the Wedge Canyon Fire with approximately 85,362 gallons of retardant dropped. A portion of this would have been used in the Whale Creek, Tepee Creek, and the North Fork Flathead River Face Drainages analysis watersheds. The type of retardant applied in this fire area was Phos-Chek D75-R retardant. Similar records are unavailable for the 1988 Red Bench Fire.

The protocols for the use of retardant restrict application within 300' of streams. Norris and Webb (1989) reported that when retardant is applied outside the riparian zone there are minimal long-term effects to water quality. Little and Calfee (2000) reported that there are two possible effects to water quality that can affect aquatic organisms associated with some types of fire retardant. The first possible effect is the when some types of fire retardant are exposed to sunlight (UV light) the sodium ferrocyanide used as a corrosion inhibitor in the retardant can undergo photoactivation, significantly increasing the toxicity of these formulations. The Phos-Check D75-R retardant does not contain any sodium ferrocyanide in its formulation. Little and Calfee (2000) reported, "No free cyanide was detected for either Phos-Check D75-R or Phos-Check D75-F under any lighting condition." Therefore, no water quality/aquatic organism effect occurred in the Wedge Canyon Fire area watersheds from sodium ferrocyanide associated with the fire retardant.

The second water quality/aquatic organism effect of fire retardant tested by Little and Calfee (2000) is the release of ammonia from the fire retardant into water. The most probable entry of fire retardant into stream water occurs by direct application, or in association with overland water flow. Little and Calfee (2000) reported that for Phos-Check D75-R the un-ionized ammonia ranged from 0.11-0.14 mg/liter, which fell within a range of concentrations that are acutely toxic (0.08-1.1mg/liter) for rainbow trout. Phos-Check D75-R contains 11.3% by weight the active salts ammonia sulfate and ammonia phosphate. Each gallon of mixed retardant contains the equivalent of 1.12 pounds of the Phos-Check D75-R formula. For fires in heavy slash/forest retardant use is at least 6 gallons per 100 square feet (Adams and Simmons 1999)

To the best of our knowledge (based upon the combination of aerial reconnaissance and walk-through reviews), retardant application did not affect any stream channels in the either the Red Bench or the Wedge Canyon Fire Areas due to either misapplication or wind drift. We know of no fuel spills associated with the fire suppression activities in any riparian area or stream channel in the cumulative effects analysis area. There were no fish kills noted in any streams. The amount of fire retardant applied in the wildfire area has no doubt increased the post-fire background ammonia levels in analysis area watersheds. The ammonia levels in burned watersheds increase sharply after fires and then return to pre-fire levels rather quickly. This is probably due to the absorption of moderate to low levels of any available ammonia by the volcanic ash topsoil found in this area. Therefore, as Norris and Webb (1989) discussed there should be no long-term

effects to the water quality from the application of fire retardant in the upland portions of the Red Bench or Wedge Canyon Fire areas.

Firelines (catlines & handlines) were constructed within the analysis watersheds in several locations. There were several short sections of handline constructed across ephemeral and/or perennial stream channels. Some sediment likely entered the creek during the construction of these lines, but the amount would have been very small and impossible to detect. All firelines were rehabilitated as soon as was fire conditions made it safe to do so. Rehabilitation included replacing disturbed soil, covering the soil with slash and debris, and the construction of water-bars on slopes. Post-fire observations of these firelines have revealed significant re-vegetation has occurred and no areas of significant soil erosion have been identified. Other than the longer-term effects of increased water yield from the burned watersheds, no other post-fire negative watershed effect from the wildfires are apparent in any of the analysis watersheds.

Post-fire BAER and/or Road Drainage Treatments. Following both the Red Bench and Wedge Canyon Fires, there were Burned Area Emergency Response or special post-fire road drainage treatments implemented in the high soil burn severity areas and along roads and stream crossings in the fire area. These included grass seeding, log-erosion barrier installation, in-channel log structures, culvert up-sizing, trail water-bars, herbicide treatments and road drainage structure cleaning and installation. The primary objective of these treatments was to reduce post-fire sediment yield; this was observed to have occurred in several fire areas. Some of the treatments have short-term sediment yield potential e.g. culvert up-sizing. All of the short-term effects of the BAER treatments to water quality were ameliorated in the first year following the installation work; 1989 for the Red Bench Fire and 2004 for the Wedge Canyon Fire. Therefore, there are no long-term cumulative effects from these past actions.

Road Decommissioning

There have been 45.3 miles of road decommissioned in Whale Creek, Moose Creek, and Hornet Creek in the 10 years since the Center Mountain and Hornet Wedge Timber Sale decisions were signed. As discussed in the direct effects sediment yield section, the removal of culverts would yield sediment from the active stream channel and the removal area back-slopes. This sediment yield is usually very short term. Sediment from the back slopes is ameliorated by the second growing season when the grass re-vegetation covers the slopes. The stream channel erosion that occurs after culvert removal would usually occur after the first high water event following the removal. All of the stream crossings where culverts were removed on the decommissioned roads have occurred more than two years ago, the sites should be re-vegetated and stabilized. Therefore, there are no long-term cumulative effects (sediment yield) from these past actions.

Recreation and Miscellaneous Past Management Activities on National Forest Lands

The past activities/actions on national forest lands with no effects to the water quality or quantity include:

- Noxious weed treatments
- Recreation activities: hiking, hunting, fishing, mountain biking, snowmobiling, sight-seeing etc.

- Firewood cutting/other products gathering (mushrooms, huckleberries, misc. poles, etc.)
- Rentals of the Wurtz Cabin
- Normal trail maintenance
- Tree planting
- Road closure device placement
- Precommercial thinning (saplings)

The no effect determination is based on the fact that ground disturbance associated with these past activities is very minimal and there are no long-term cumulative effects.

Ongoing and Reasonably Foreseeable Activities

Recreation and Miscellaneous Management Activities on National Forest Lands

The foreseeable activities/actions on national forest lands with no effects to the water quality or quantity include:

- Noxious weed treatments
- Recreation activities: hiking, hunting, fishing, mountain biking, snowmobiling, sight-seeing etc.
- Firewood cutting/other products gathering (mushrooms, huckleberries, misc. poles, etc.)
- Rentals of the Wurtz Cabin
- Normal trail maintenance
- Tree planting

The no effect determination assumes: 1) that application of any herbicide is per the label instructions; 2) that woodcutters follow the limitations associated with the wood gathering permits; and 3) that roads used by tree planting contractors are not so wet that rutting would occur.

Private Land Development. There are no major private land developments currently occurring within the cumulative effects analysis area, although there is speculation that future subdivision could occur. If significant acreages of timber harvest were to occur, the water yield increase above natural background would be affected. There was no effort to estimate near future timber harvesting on private lands for the following reasons: 1) many of the private lands within analysis area have had significant timber harvesting in the mid 1970s during the pine beetle build-up in the North Fork; 2) the opportunities for timber harvest on private lands are currently somewhat limited due to the past harvest and wildfires; and 3) conservation easements have been signed, or are being considered, on several areas of private land within the analysis area.

Sediment yield from new private road construction should be very minimal, due to flat slopes, permeable soils, and the general lack of defined stream channels on most of the private lands in the analysis area. Therefore, the limited amounts of near future development on private lands should not have any significant impact to the water resources in the cumulative effects analysis area.

Timber Management on State of Montana Lands. In April 2007, the State of Montana will begin the initial planning for timber harvest activities on Section 36 in the Moose Creek area. At this point in time there is not a precise proposal developed, but the upper range of the estimated area to be treated is 450 acres. This was the acreage used to estimate potential sediment and water yield from this foreseeable action. The estimated water yield increase from clear-cutting 450 acres in the Moose Creek analysis watershed would be a .4% increase in water yield above the existing condition, which is presently 1.4% above natural background. The best estimation for road access into this state section would require up to 3 stream crossings. The estimated sediment yield from those stream crossings with BMPs in place is 15 pounds of sediment annually. Using the WEPP disturbed land erosion model the potential soil erosion from a clearcut on a representative hill-slope in this area is 0.0 tons/acre following harvest. This is due to the flatter slopes and permeable soil properties in this area.

Routine Road Maintenance. There is a cumulative effect of routine road maintenance (road grading) that would be done by Flathead County and private individuals along the county road and the private access roads that are located in the cumulative effects analysis area. The Forest Service currently, and in the foreseeable future, has no funding for road grading on Forest Service roads within the analysis area; any grading would be part of a timber sale project. An estimate of three major road maintenance efforts is done annually. There are 12 stream crossings on the county maintained gravel road and 4 on private access roads. Using the WEPP – Road Erosion Model, an estimate of erosion from the road surface and potential sediment entering a stream channel was completed for the road proposed for routine maintenance. A worst-case scenario of the amount of sediment entering a stream from the road and ditch surfaces is estimated to be 499 pounds at each crossing for each grading. The total annual potential sediment estimated for routine road blading is 12.0 tons. The project file includes the WEPP runs.

DNRC Road Easements. There is no effect to water quality or quantity from the easement authorization to Department of Natural Resources and Conservation. There are no additional stream crossings to be constructed, and the road drainage BMPs have been installed on the road segments that would be accessed.

Summary Cumulative Effects

All of the tributary streams having effects from the proposed action from the Red Whale Project drain into the North Fork Flathead River. The volume of water contained in the North Fork Flathead River effectively dilutes beyond measurable amounts, the incoming water yield increase, sediment yield increase, and nutrient yield increases from the proposed action in the analysis area watersheds. The stream with the most extensive flow record, which is also the largest watershed on the west-side of the North Fork Flathead River, is Big Creek. Typically there is approximately 18 times the water flow in the North Fork Flathead River than in Big Creek during spring snowmelt flow. The smaller tributary watersheds that are in the Red Whale analysis area would probably have a higher flow ratio than Big Creek. Because of the larger flow volume and velocity of the North Fork Flathead River, it dilutes the effect of any additional input from a small tributary streams very rapidly after their confluence. For example the North Fork Flathead River has naturally high levels of sediments being transported downstream in the

spring due to extensive erosion of glacial outwash terraces and stream terraces J. Ruth (1988). When the cleaner water (lower suspended sediment levels) from a tributary stream is mixed with the dirty waters (higher suspended sediment levels) of the North Fork Flathead River, they are rapidly equilibrated to a suspended sediment level greater than the tributary stream. Typically, there is only a very small percentage of sediment yield in a tributary stream that is attributable to man-caused disturbances. This amount of management related sediment would not measurable compared to the natural background variation of the sediment rich North Fork Flathead River. There is virtually no statistically significant measurable effect of any proposed management activity to water quality or water quantity, once the tributary streams in the analysis area combines with the North Fork Flathead River. For this reason, the cumulative effects analysis area includes all the individual analysis watersheds within the Red Whale analysis area to their point of confluence with the North Fork Flathead River. All analysis watersheds included in the cumulative analysis area are displayed in Map 3-9.

Alternative 1 (No Action) - Summary Cumulative Effects

Past Actions

There is a cumulative effect to water quality due to the existing road network of 202.9 miles within the cumulative effects analysis area. This road network has an annual sediment yield of approximately 37.3 tons per year, along with the increased nutrient yield associated with that sediment. There were past timber harvest and/or wildfires occurring on approximately 43,688 acres of Forest Service, State of Montana, and private lands in the analysis watersheds. The 1988 Red Bench and 2003 Wedge Canyon Fires burned significant acreages in four of the analysis watersheds that resulted in a major portion of the water yield increase. The existing water yield increase ranges from 1.2% to 14.1% in the analysis watersheds. Due to the fire suppression activities, there were short term increases to sediment yield and nutrient yield in the Whale Creek, Tepee Creek, and the North Fork Flathead River Face Drainages analysis watersheds. The areas of land where past timber management occurred are rapidly recovering pre-disturbance vegetation cover and the associated hydrologic recovery. Lands affected by the Red Bench and Wedge Canyon Fires have had very good natural re-vegetation occur, with only very small areas of post-fire soil erosion observed in the fire area. There has been some short term sediment yield due to past road maintenance and road decommissioning work. The effects from these activities have been naturally ameliorated. The sediment yield from the existing road system is the primary long term effect from past man-caused activities.

Present and Foreseeable Action

There is a cumulative effect of routine road maintenance (road grading) done several times a year by Flathead County on the main county road and by several private landowners in the analysis area. The estimated sediment yield from the road grading is 12.0 tons per year. There are also potential cumulative effects from the future timber harvest by the Montana DNRC in Moose Creek, with an estimated water yield increase of .4%. The estimated sediment yield increase would be approximately 15 pounds/year, with a small amount of associated nutrient yield from the sediment. All of the other discussed present and foreseeable actions have no effect to the water quality, water quantity or the stream channels.

Indirect Actions

A possible indirect effect of implementing Alternative 1 would be an increased potential for high soil burn severity to occur on the acreage proposed for thinning and/or prescribed burning in the other alternatives, if a wildfire were to burn those same lands. The potential post-fire sediment yield post-fire is much greater on the high soil burn severity sites. A second possible indirect effect of implementing Alternative 1 would be an increased potential for the culverts to fail (plugging and washing out the road prism) on perennial streams where they were proposed to be up-sized or removed in Alternatives 2, 3 and 4.

Cumulatively the past, present and foreseeable future actions associated with the no action alternative should not cause a measurable increase to water yield, sediment yield, and/or nutrient levels that is outside the natural range of variation for the streams in the Red Whale analysis area. These interpretations are based upon past monitoring reports, literature, field observations and professional judgment.

Alternative 2 - Summary Cumulative Effects

Past Actions and Present and Foreseeable Actions

The past actions and present and foreseeable actions are as described for Alternative 1.

Proposed Actions

Water Quantity Effects. There would be an increase in the existing annual water yield in several of the streams in the analysis area due to the proposed thinning and/or prescribed burns proposed in Alternative 2. The water yield increase due to the proposed action ranges from <.1% to 3.1% in the analysis watersheds. Refer to Table 3-57 for the existing water yield and the changes for each analysis watershed under Alternative 2 proposed actions. There would be potential for increased peak-flows due to proposed thinning and/or prescribed burning, but these would be within the natural range of variability for these watersheds. The historic highest water yield increases in these watersheds are due to past wildfire. The potential for increased stream channel erosion due to the water yield increase would be very low due to good stream stability and the small amount of potential water yield increase all of the analysis watersheds.

Water Quality Effects. The effect of increased sedimentation, slightly decreased ground cover, and increased needles and fine branches on the ground associated with the proposed thinning operations could cause a slight increase in the level of soluble nutrients in the stream water. The initial runoff following prescribed burning would elevate nutrient levels, but these levels would rapidly decrease after the initial flush. If a high intensity rainstorm were to occur shortly after the prescribed burns, there would be the potential for a flush of sediment and associated nutrients. This potential increase in the background levels of nitrogen and phosphorus would be within the natural range of variability for the streams in the analysis area. This is due to the very high levels of nitrogen and phosphorus observed in the stream water following a wildfire, with high burn severities. The nutrient increase would not be discernable once the analysis area streams reach the North Fork Flathead River because of the dilution effect.

The proposed thinning, temporary road/landing construction, and the prescribe fire in the thinning units would potentially increase the sediment loading in the analysis watersheds by 16 tons for 1-2 seasons depending on the season of harvest. The proposed prescribed burning would potentially increase the sediment loading in the analysis watersheds by 572 tons for 1-2 seasons depending on the season of the burning. The combination of the potential sediment yield increase with the thinning and prescribed burning activity is significantly less (12,879 tons) than the potential sediment yield from a wildfire event on the same acreage. These estimates are dependent upon a high intensity rainstorm occurring shortly after the prescribed burn and/or the wildfire. Refer to Table 3-58 for the potential sediment yield due to the Alternative 2 proposed actions.

The proposed culvert up-sizing would potentially increase the sediment loading in the analysis watersheds by 14 tons the first season following implementation. The proposed culvert removals would potentially increase the sediment loading in the analysis watersheds by 16 tons the first season following implementation. There would be a small amount of nutrient yield associated with the sediments from the proposed culvert up-sizing and culvert removals. The potential total sediment yield from all of the proposed actions in Alternative 2 would be 680 tons.

There should be no measurable change to water temperature in the analysis area streams due to no activity within the stream buffer zones. A rare high intensity rainstorm shortly after the prescribed burning could potentially initiate overland flow, resulting in some warmer temperature water entering streams, rather than the typical cooler subsurface flow.

Table 3-57. The Modeled Potential Water Yield Increase for each Analysis Watershed, for the Existing Condition and Each Alternative.

Analysis Watershed	Existing Annual Water Yield Increase Above Natural (%)	Alt-1 Annual Water Yield Increase Above Existing (%)	Alt-2 Annual Water Yield Increase Above Existing (%)	Alt-3 Annual Water Yield Increase Above Existing (%)	Alt-4 Annual Water Yield Increase Above Existing (%)
Tepee Creek	14.0	0	<.1	<.1	.1
Whale Creek	2.3	0	.1	.1	.1
Moose Creek	1.4	0	1.8	1.3	2.3
Hawk Creek	4.2	0	3.1	1.7	3.0
Red Meadow Creek	3.6	0	.5	.1	.8
Hay Creek	1.2	0	.5	.4	.7
Moran Creek	1.7	0	1.1	1.0	1.6
Spruce Creek	3.5	0	nc	nc	nc
North Fork Flathead River Face Drainages	14.1	0	2.3	.7	2.9

Table 3-58. The Modeled Potential Sediment Yield for Each Analysis Watershed by Alternative.

Alternative	Prescribed Burning Sediment Yield 1st Year (tons)	Forest Thinning Sediment Yield 1st Year (tons)	Culvert Up-sizing Sediment Yield 1st Year (tons)	Culvert Removal Sediment Yield 1st Year (tons)	Sediment Yield Reduction from Thin /Prescribed Fire Compared to Wildfire (tons)	Total 1st Year Sediment Yield from Alt. 3 Proposed Actions
Alt. 1	0	0	0	0	NA	0
Alt. 2	572	16	15	78	(12,879)	681
Alt. 3	572	14	15	228	(9,667)	829
Alt. 4	606	23	15	78	(16,709)	722

Road Management Proposals. There are only slight differences in the proposed road management scenarios and potential watershed effects between Alternative 2 and Alternative 4. From a watershed perspective, Alternative 2 would be slightly more positive because it has 3.4 miles less of bermed roads than Alternative 4; resulting in less risk of the culvert failure associated with Alternative 2 due to lack of timely maintenance. The negative impact of the bermed roads in Alternatives 2 and 4 would be lessened with the removal of culverts on approximately 3.5 miles of the bermed roads. This would have a short term sediment yield increase and a long-term reduction in culvert failure potential. Alternative 4 would be slightly better than Alterative 2 for miles of road open year-long and the potential sedimentation from the road surface. With the long intervals between grading on most of the open roads on the forest, there is the potential for wheel ruts to develop which reduce the effectiveness of road surface water drainage BMPs.

Alternative 3 would have the greatest potential for negative watershed effects due to the 18.1 additional miles of bermed road compared to Alternative 2, and the increase of 14.7 miles of bermed road over Alternative 4. The negative impact of the bermed roads in Alternative 3 would be lessened with the removal of culverts on approximately 10.9 miles of bermed roads. This would have a short-term sediment yield increase and a long-term reduction in culvert failure potential. Alternative 3 has the least miles of seasonally open roads of the three alternatives. Seasonally open roads have the greatest potential to be rutted, thereby reducing the effectiveness of the surface road drainage BMPs. This is due to the long maintenance intervals on seasonally open roads.

Cumulatively, the past, present and foreseeable future, and proposed actions should not cause a measurable increase to water yield, sediment yield, and/or nutrient levels outside of the natural range of variation for the streams in the Red Whale analysis area. These interpretations are based upon past monitoring reports, literature, field observations, and professional judgment.

Alternative 3 - Summary Cumulative Effects

Past Actions and Present and Foreseeable Actions

The past actions and present and foreseeable actions are as described for Alternative 1.

Proposed Actions

Water Quantity Effects. There would be an increase in the existing annual water yield in several of the streams in the analysis area due to the proposed thinning and/or prescribed burns in Alternative 3. The water yield increase due to the proposed action would range from <.1% to 1.7% in the analysis watersheds. Refer to Table 3-57 for the existing water yield and the changes for each analysis watershed. There would be potential for increased peak-flows due to the proposed thinning and/or prescribed burning. This water yield increase/ peak-flows due to vegetation cover reduction are within the natural range of variability for these watersheds. The historic highest water yield increases in these watersheds are due to past wildfire. The potential for increased stream channel erosion due to the water yield increase would be very low due to good stream stability and the small amount of potential water yield increase all of the analysis watersheds.

Water Quality Effects. The effect of increased sedimentation, slightly decreased ground cover, and increased needles and fine branches on the ground associated with the proposed thinning operations should cause a slight increase in the level of soluble nutrients in the stream water. The initial runoff following the burning of the prescribed burn areas would have elevated nutrient levels, those levels would rapidly decrease after the initial flush. If a high intensity rainstorm would occur shortly after the prescribed burns there is a potential for a flush of sediment and the associated nutrients. However, the potential increase of the background levels of nitrogen and phosphorus would be within the natural range of variability for the streams in the analysis area. This is due to the very high levels of nitrogen and phosphorus observed in the stream water following a wildfire with high burn severities. Also, the nutrient increases would not be discernable once the analysis area streams reach the North Fork Flathead River because of the dilution effect.

The proposed thinning, temporary road/landing construction and prescribe burning in thinning units under the proposed action would potentially increase the sediment loading in the analysis watersheds by 14 tons for 1-2 seasons, depending on the season of harvest. The proposed prescribed burning under the proposed action would potentially increase the sediment loading in the analysis watersheds by 572 tons for 1-2 seasons, depending on the season of the burn. The combination of the potential sediment yield increase with the thinning and prescribed burning activity would be significantly less (9,667 tons) than the potential sediment yield from a wildfire event on the same acreage. These estimates are dependent upon a high intensity rainstorm occurring shortly after the prescribed burn and/or the wildfire. Refer to Table 3-58 for the potential sediment yield due to the Alternative 3 proposed actions.

The proposed culvert up-sizing would potentially increase the sediment loading in the analysis watersheds by 14 tons the first season following implementation. The proposed culverts

removals would potentially increase the sediment loading in the analysis watersheds by 228 tons the first season following implementation. There would be a small amount of nutrient yield associated with the sediments from the proposed culvert up-sizing and culvert removals. The potential total sediment yield from all of the proposed actions in Alternative 3 is 829 tons.

There should be no measurable change to water temperature in the analysis area streams as there would be no activity within the stream buffer zones. A rare high intensity rainstorm shortly after the prescribed burning could potentially initiate overland flow, resulting in some warmer temperature water entering rather than the typical cooler subsurface flow.

Cumulatively the past, present and foreseeable future, and proposed actions should not cause a measurable increase to water yield, sediment yield or nutrient levels that would be outside the natural range of variation for streams in the Red Whale analysis area. These interpretations are based upon past monitoring reports, literature, field observations and professional judgment.

Alternative 4 - Summary Cumulative Effects

Past Actions

The past actions are as described for Alternative 1.

Present and Foreseeable Actions

The present and foreseeable actions are as described for Alternative 1.

Proposed Actions

Water Quantity Effects. There would be an increase in the existing annual water yield in several of the streams in the analysis area due to the proposed thinning and/or prescribed burns proposed in Alternative 4. The water yield increase due to the proposed action would range from <.1% to 3.1% in the analysis watersheds. Refer to Table 3-57 for the existing water yield and the changes for each analysis watershed. There would be the potential for increased peak-flows due to the proposed thinning and/or prescribed burning. This water yield increase/ peak-flows due to vegetation cover reduction would be within the natural range of variability for these watersheds. The historic highest water yield increases in these watersheds are due to past wildfire. The potential for increased stream channel erosion due to the water yield increase is very low due to good stream stability or the small amount of potential water yield increase all of the analysis watersheds.

Water Quality Effects. The effect of increased sedimentation, slightly decreased ground cover and increased needles and fine branches on the ground associated with the proposed thinning operations should cause a slight increase in the level of soluble nutrients in the stream water. The initial runoff following the burning of the prescribed burn areas would have elevated nutrient levels, which would rapidly decrease after the initial flush. If a high intensity rainstorm would occur shortly after the prescribed burns, there is a potential for a flush of sediment and the associated nutrients. However, the potential increase of the background levels of nitrogen and

phosphorus would be within the natural range of variability for the streams in the analysis area. This is due to the very high levels of nitrogen and phosphorus observed in the stream water following a wildfire, with high burn severities. The nutrient increases would not be discernable once the analysis area streams reach the North Fork Flathead River because of the dilution effect.

The proposed thinning, temporary road/landing construction, and the prescribe burning in the thinning units under the proposed action would potentially increase the sediment loading in the analysis watersheds by 23 tons for 1-2 seasons, depending upon the season of harvest. The proposed prescribed burning under the proposed action would potentially increase the sediment loading in the analysis watersheds by 606 tons for 1-2 seasons, depending on the season of the burning. The combination of the potential sediment yield increase with the thinning and prescribed burning activity is significantly less (16,709 tons) than the potential sediment yield from a wildfire event on the same acreage. These estimates are dependent upon a high intensity rainstorm occurring shortly after the prescribed burn and/or the wildfire. Refer to Table 3-58 for the potential sediment yield due to the Alternative 4 proposed actions.

The proposed culvert up-sizing would potentially increase the sediment loading in the analysis watersheds by 14 tons for first season following implementation. The proposed culvert removals would potentially increase the sediment loading in the analysis watersheds by 78 tons the first season following implementation. There would be a small amount of nutrient yield associated with the sediments from the proposed culvert up-sizing and culvert removals. The potential total sediment yield from all of the proposed actions in Alternative 4 would be 721 tons.

There should be no measurable change to water temperature in the analysis area streams due to no activity within the stream buffer zones. A rare high intensity rainstorm shortly after the prescribed burning could potentially initiate overland flow, resulting in some warmer temperature water entering rather than the typical cooler subsurface flow.

Cumulatively the past, present, foreseeable future, and proposed actions should not cause a measurable increase to water yield, sediment yield, and/or nutrient levels that is outside the natural range of variation for the streams in the Red Whale analysis area. These interpretations are based upon past monitoring reports, literature, field observations and professional judgment.

Regulatory Framework and Consistency

Clean Water Act

Section 313 of the Clean Water Act requires that Federal agencies comply with all substantive and procedural requirements related to water quality. Under Section 303 of the Clean Water Act, states have the primary responsibility to develop and implement water quality programs, which include developing water quality standards and Best Management Practices (BMPs). State water quality standards are based on the water quality necessary to protect beneficial uses.

Environmental Protection Agency policy requires each state to implement a Non-degradation Policy. Under this policy, water quality must be maintained to fully support existing beneficial uses. Existing water quality that is higher than the established standards must be maintained at

the existing level unless the board of health and environmental sciences determines that a change in water quality is justifiable due to social and/or economic reasons (CFR Vol. 48, No. 217, 131.12, Nov. 8, 1983; Montana Water Quality Act, Section 75-5.)

Montana State Water Quality Law

The State of Montana has classified the waters in Red Whale analysis area as B-1, as listed and described in ARM 17.30.608 (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." Naturally occurring is as defined by MCA 17.30.602 (17), includes conditions or materials present during runoff from developed land where all reasonable land, soil and water conservation practices (BMPs) have been applied. Reasonable practices include methods, measures or practices that protect present and reasonably anticipated beneficial uses.

The state water quality law relates to the Clean Water Act and the maintenance of beneficial water uses through the use of BMPs. The BMPs are designed to prevent soil erosion and protect water quality, as well as help prevent soil damage. In a memorandum of Understanding with the State of Montana, the Forest Service has agreed to follow Best Management Practices (BMPs) during timber harvest and road construction activities. The Red Whale Project would utilize all applicable BMPs during project design and implementation as described in Best Management Practices for Forestry in Montana – 1997. Also Forest Service - Soil and Water Conservation Practices (FSH 2509.22) would be combined with Montana State BMPs for incorporation into project design and implementation to ensure that soil and water resources are protected. The project specific BMPs are identified in Appendix A of the EA.

The DEQ's 1996 and 2000 303 (d) Reports - *Waterbodies in need of Total Maximum Daily Load (TMDL) Development*, describe Red Meadow and Whale Creeks 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 primarily silviculture practices. These waters are not considered impaired due to sediment related causes (i.e. siltation or suspended solids) and, therefore, no TMDLs are required. Both water bodies were removed from the 303(d) impaired water body listing. However, minor man-caused sediment sources were identified in Red Meadow Creek and Whale Creek. A Voluntary Water Quality Improvement Strategy is proposed to improve the overall watershed health in these two streams.

Within the Flathead Basin the primary nutrients of concern that have been identified and studied, in relationship to timber harvest and fire activities, are phosphorus and nitrogen. The primary concern with any nutrient increase in the headwater streams is a potential for increasing the

nutrient levels in Flathead Lake; which would lead to increased algae growth in the lake. This was specifically addressed in the Nutrient Management plan and Total Maximum Daily Load for Flathead Lake, Montana, which identifies phosphorus and nitrogen as the primary nutrients of concern in the Flathead Lake Basin (Montana Department of Environmental Quality 2001**).**

Montana Streamside Management Zone (SMZ) Law

By definition in ARM 36.11.312 (3), the majority of the streams in Big Creek meet the criteria for a class 1 stream. There are some first order ephemeral streams that meet the criteria of a class 2 or 3 stream based upon site specific criteria. All alternatives would meet, at a minimum, SMZ buffer zone requirements. In several situations, because of the INFISH requirements, RHCA width requirements, and/or the expanded RHCA buffer width, the required SMZ buffer width is expanded significantly.

Consistency with Forest Plan Standards

The Flathead Forest Plan directs under Forest-wide Management Direction to: 1) develop watershed activity schedules for key watersheds; 2) maintain an inventory of non-wilderness areas needing soil and water restoration, and complete restoration projects as funds permit; 3) apply Best Management Practices during Forest Plan implementation to ensure that Forest water quality goals are met. And under Management Area specific water and soils direction to: 1) maintain long term water quality to meet or exceed state water quality standards. To ensure meeting these standards, surface-disturbing activities would be monitored where this need is identified; 2) refer to Forest-wide standards under Water and Soils for Best Management Practices, Landtype Guidelines and standards applicable to projects or activities within this Management Area; and 3) all Project proposals would be analyzed and evaluated to determine the potential water quantity and quality impacts. Mitigation measures would be developed to minimize adverse impacts. These water and soils standards were reviewed for all proposed management activities on management areas MA 9, MA 13, MA 13a, MA 15, and MA 18. All proposed management actions in all the alternatives meet these forest plan standards.

INFISH Standards

The INFISH (1995) Standards are discussed in detail in the fishery assessment. All units were designed to meet the RHCA requirements under INFISH to protect the stream channel and maintain water quality and the aquatic habitat.

Wetlands

Wetlands are protected under Executive Order 11990. This act directs federal agencies to "minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands..." There are no activities proposed in any of the alternatives of the Red Whale Project that directly encroach upon any lodic or lentic wetlands in the analysis area. There are several wetland and/or riparian areas within or adjacent to treatment units. As part of the project mitigation all of the wetlands and/or riparian areas would have buffers around them to meet either INFISH or Montana State Streamside Management Zone

Law, whichever is of the greatest buffer distance. Therefore all alternatives would meet Executive Order 11990.

Regulatory Consistency

All of the proposed alternatives would meet Clean Water Act, Montana State Water Quality Standards, and Forest Plan Water Standards.