Water Quality Restoration Plan and Total Maximum Daily Loads

for the

Upper Lolo Creek TMDL Planning Area

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Montana Department of
ENVIRONMENTAL QUALITY

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WATER QUALITY RESTORATION PLAN AND TOTAL MAXIMUM DAILY LOADS FOR THE UPPER LOLO CREEK PLANNING AREA

Purpose and Water Quality Restoration Plan Elements

This document is a water quality restoration plan (WQRP) for upper Lolo Creek (those lands above Lolo Hot Springs). The project area drains to Lolo Creek and then into the Bitterroot River southwest of Missoula, Montana.

The five waters in need of a total maximum daily load (TMDL) and restoration include West Fork Lolo Creek, East Fork Lolo Creek, Granite Creek, Lee Creek, and Lost Park Creek. TMDLs are proposed for sediment/siltation accumulation as required by section 303 of the Federal Clean Water Act (see Table E-1). This restoration plan also addresses other watershed issues outside the TMDL requirements, such as improving fish passage at stream crossing culverts. The remaining downstream water quality impacts on the main stem of Lolo Creek will be addressed as part of the Lolo Creek TMDL Plan, scheduled for completion by the year 2006.

Table E - 1. Upper Lolo Waterbodies' Impairment Listing.

Water Bodies and Pollution Sources				
Segment Name	**Waterbody Number**	Length (mi)	**Probable Causes**	**Probable Sources**
West Fork Lolo Creek	MT76H005_05	6.8	Other habitat alterations Siltation	Silviculture Habitat modification-other than hydromodification Bank or shoreline modification/ destabilization Highway maintenance and runoff
East Fork Lolo Creek	MT76H005_04	7.4	Other habitat alterations Siltation	Silviculture Logging road construction/ maintenance
Granite Creek	MT76H005_03	8.5	Other habitat alterations Siltation	Silviculture Logging road construction/ maintenance
Lee Creek	MT76H005_07	3.8	Other habitat alterations Siltation	Silviculture Logging road construction/ maintenance Habitat modification-other than hydromodification Bank or shoreline modification/ destabilization
Lost Park Creek	MT76H005_06	5	Other habitat alterations Siltation	Silviculture Logging road construction/ maintenance

Problem Description

The Upper Lolo water quality restoration area includes five waterbodies whose water quality does not meet Montana Water Quality Standards for aquatic life and fisheries. There are no point sources of water quality impairment. The streams are impaired from excessive sediment accumulation caused by human activities including silviculture, logging road construction/ maintenance, riparian/aquatic habitat modification (other than hydromodification), and streambank modification (see Table E – 1). The greatest impairment sources are from the approximately 340 miles of forest roads in the planning area and the sediment from Highway 12 sanding and bank erosion.

Restoration Targets and TMDLs

Restoration targets and TMDL allocations are developed for each stream. The targets describe the desired conditions, and the TMDL allocations describe the activities needed to reach the restoration target. The targets reflect conditions necessary to support beneficial water uses and meet Montana Water Quality Standards. The restoration goal is to provide conditions that fully support healthy aquatic life based on stream capabilities. A sediment target is established for each stream that would fully support aquatic life, including optimal conditions for salmonid reproductive success. Sediment standards for the percentage of fine sediments in pools are based on Rosgen stream channel type (see Table E-2). To account for the effects of stream characteristic variability and uncertainty, sediment targets are set for specific Rosgen stream channel types. These targets include very fine sediment (smaller than 2 mm) targets to protect aquatic embryo development and fine sediment (smaller than 6 mm) targets to protect emerging young. Additional performance-based targets interpreting narrative water quality standards for pool frequency, V* (fraction of a pool that is filled by fine sediment), and channel structure/stability will be established. Because of lack of data, these in-stream targets will be developed through the Upper Lolo Water Quality Protection Monitoring Plan using Rosgen II stream channel parameters, a road sediment assessment, and salmonid population monitoring.

Table E - 2. Upper Lolo Waterbodies' Restoration Strategies and Target Parameters.

TMDL Fine Sediment Targets with comparisons to existing Upper Lolo TPA conditions

Rosgen Stream Type	Target		Existing Data[1]	
	% Fines < 2MM	% Fines < 6MM	% Fines < 2MM	% Fines < 6MM
A	22	31	14	23
B	16	21	28	40
C	21	30	21	26

[1] Based on 1997 and 2001 data from the USFS Lolo National Forest. Values reported are the averages for each particular stream type.

Performance-Based In-stream Targets and Sediment Targets
for West Fork Lolo Creek, East Fork Lolo Creek, Granite Creek, Lee Creek, and Lost Park Creek

Life Stage & Channel Stability	Parameter	Targets
Rearing	Pool Frequency	Established following both reference and response reach data collection*
Channel Structure/Stability	V*	
Channel Structure/Stability	Entrenchment Ratio	
	Width/Depth Ratio	
	Sinuosity	

* Explanation of data collection approaches are outlined in Section 7.4, later in this document.

Total Maximum Daily Load Allocations

Achievement of the targets will reduce the annual TMDLs of human-caused fine sediments in these streams by 33 to 64 percent. Through implementation and mitigation efforts outlined in this WQRP, the annual human-caused forest road/Highway 12 sediment input into West Fork Lolo Creek would be reduced by 33 percent from 690-793 tons to 531 - 593 tons. Concurrently, the annual anthropogenic load from forest roads will be reduced in the East Fork Lolo Creek by 36 percent from 53 tons to 34 tons, in Granite Creek by 52 percent from 96 tons to 46 tons, in Lee Creek by 56 percent from 9 tons to 4 tons, and by 43 percent in Lost Park Creek from 21 tons to 12 tons (see Table E –3).

Table E - 3. Upper Lolo Waterbodies' TMDL Load Allocations.

Stream	Road Loads After TMDL Reduction (tons/year)	Percentage Reduction in Road Sediment & Traction Sand %	TMDL (tons/year)	Current Loads from Roads (tons/year)	Current Natural Sediment (tons/year)	Total Current Sediment (tons/year)
West Fork Lolo Creek	12 (Forest roads) 285-347 (Hwy. 12)	33% 33%	**543-605**	19 (Forest roads) 425-518 (Hwy. 12)	246	690-783
East Fork Lolo Creek	34	36%	**630**	53	596	649
Granite Creek	46	52%	**471**	96	449	545
Lee Creek	4	56%	**97**	9	95	104
Lost Park Creek	12	43%	**199**	21	192	213

TMDL Allocations *in tons per year unless otherwise indicated*

Improvement Strategy and Monitoring

The implementation methods include:

- upgrade remaining forest roads to meet Montana Forestry BMPs;
- reclaim forest roads that are surplus to the needs of forest land managers;
- improve inspection and maintenance of existing culverts;
- implement Montana's Forestry BMPs on all timber harvest operations;
- upgrade undersized culverts over time to better accommodate large floods;
- further reduce sediment delivery from U.S. Highway 12, through improved use and maintenance of sediment traps, plowing techniques, and guardrail cleaning; and
- correct those priority fish passage barriers that are significantly affecting the connectivity of native fish habitats.

The TMDL monitoring plan will help develop and refine the sediment and performance-based targets (see Table E – 2). These monitoring and implementation plans are summarized in the Water Quality Improvement strategy developed by major stakeholders. The targets and load allocations will be refined using an adaptive management strategy incorporating the results of the ongoing monitoring.

SECTION 1.0
INTRODUCTION

This document describes a water quality restoration plan (WQRP) for Upper Lolo Creek Total Maximum Daily Load Planning Area (TPA), which is approximately defined as the land area above Lolo Hot Springs. It includes the Granite Creek, West Fork Lolo Creek, and East Fork Lolo Creek watersheds (see Figure 1). The project area drains to Lolo Creek and the Bitterroot River near Missoula, Montana.

A principal focus of this planning document are four streams contained on Montana's 1996 list of impaired waters, and one stream subsequently listed by Montana DEQ based on a recent review of sufficient credible data. These streams include Granite Creek, Lost Park Creek, Lee Creek, East Fork Lolo Creek, and West Fork Lolo Creek. For these five streams, Total Maximum Daily Loads (TMDLs) are proposed for the pollutant of concern (sediment) as required by section 303 of the federal Clean Water Act. This restoration plan also addresses other watershed issues outside the TMDL framework, such as improving fish passage at stream crossing culverts.

While the project area boundary includes private lands associated with the Hot Springs, effects of these lands on main stem Lolo Creek (below the East Fork / West Fork confluence) are not considered in this report. Impacts to the main stem of Lolo Creek will be addressed with the rest of the Lolo Creek watershed. Under Montana's existing schedule, all necessary TMDLs for the Lolo Creek TMDL Planning Area must be completed by the end of 2006.

SECTION 2.0
GENERAL WATERSHED CHARACTERISTICS

2.1 Physical Characteristics

Elevations in Upper Lolo range from a low of 4100 feet where Granite Creek flows into Lolo Creek to over 7200 feet at the highest ridges (Pilot Knob and Skookum Butte). Slopes average 25-30%, and less than 10% of the project area exceeds 50% slope. Slope distributions for sub-watersheds in Upper Lolo are shown in Figure 2.

Alpine glaciers once mantled the higher ridges and valleys along the southwestern margin of the watershed. Landforms in the upper East Fork Lolo Creek and upper Lost Park Creek bear the strongest evidence of past glaciation (the broad, bowl-shaped [cirque] basins of upper Lost Park Creek and glacially-scoured exposures of bedrock in upper East Fork Lolo Creek). The upper West Fork Lolo Creek and upper Granite Creek have muted evidence of glacial landforms, and ice presumably overlaid these areas as well. Despite these glacial features in the headwaters, moraines, outwash deposits, kames, eskers, and glacial lakes do not significantly influence the surficial geology of the lower watershed (O'Connor 2000).

Figure 1. Location of Upper Lolo project area

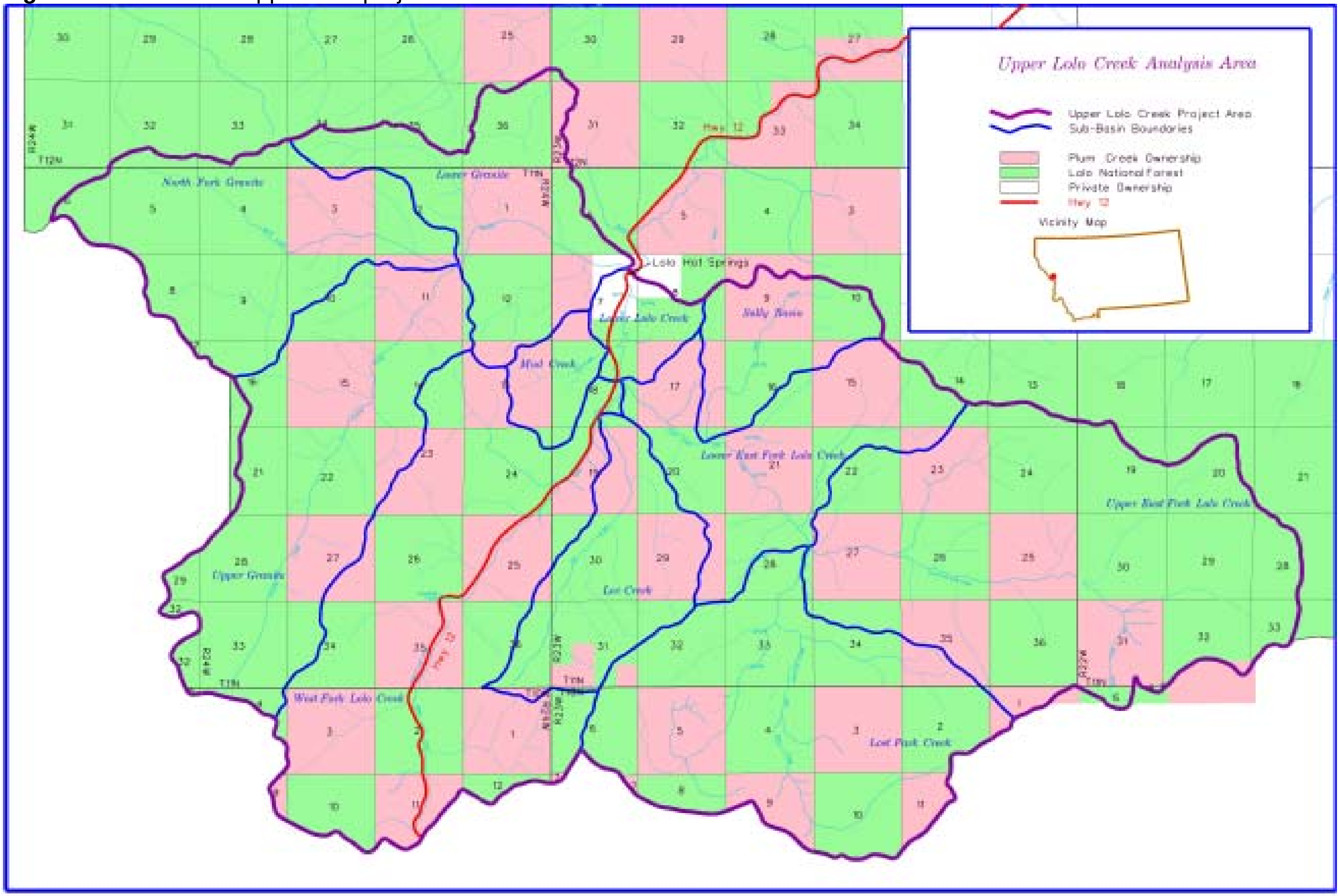
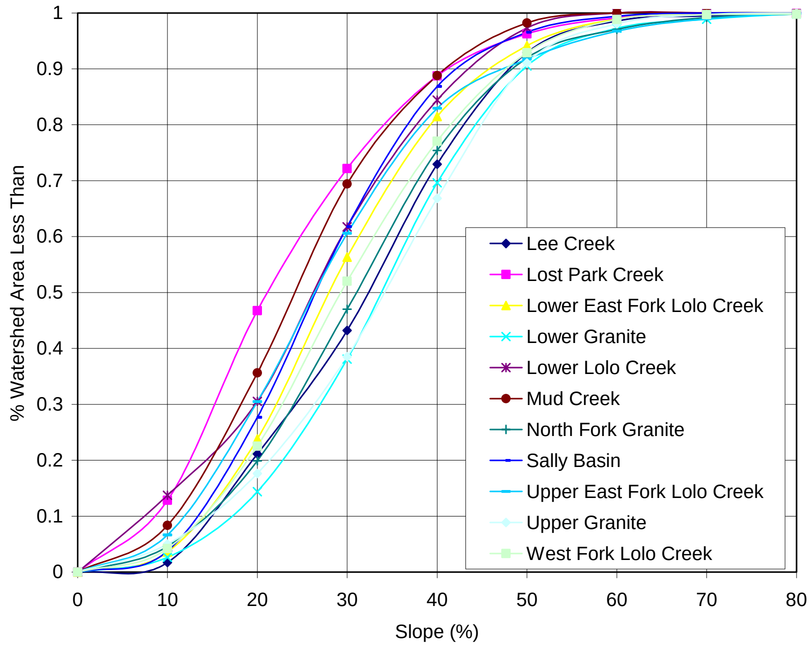


Figure 2. Cumulative slope distributions of sub-watersheds within the Upper Lolo project area.



2.2 Soils and Geology

The Upper Lolo Creek drainage is dominated by a granitic geology with some minor areas of metamorphosed Precambrian rocks to the northeast of Lolo Hot springs. The bedrock geology is dominated by weathered granitic rocks of the Idaho batholith, with small areas of meta-sedimentary Belt formation rocks along its northern edge (Granite Creek) and on ridges bordering Lee Creek (Sasich and Lamotte-Hagen 1989). Higher elevations include alpine glacial landforms, with till deposits on more moderate slopes and deep alluvial sands adjacent to streams. Rock outcrops, boulders and abrupt slope breaks are common in this area of complex terrain. Granitic soils are variations of shallow to deep cobbly and gravelly sandy loams have high natural erosion rates. Localized areas of remnant Glacial Lake Missoula deposits (finer textures) may occur on concave slopes below 4200 feet elevation. Volcanic ash surface soils of 4-12 inch depth occur on moister sites and promote more productive forest sites of Western red cedar to Alpine fir and spruce. Southerly aspects and ridges are more shallow and droughty, supporting drier Douglas fir habitats.

2.3 Climate and Hydrology

Mean annual precipitation in the project area ranges from about 35 inches per year at Lolo Hot Springs to over 70 inches at the highest elevations along the Bitterroot divide (Daly and Taylor 1998). Most of this precipitation occurs as snowfall. The Upper Lolo watershed has a strong seasonal pattern of runoff, with annual flow peaks typically occurring in May and June during periods of rapid snowmelt. Due to the high elevation, peak flows associated with mid-winter rain-on-snow events are uncommon. In this climate, with a spring snowmelt dominated runoff regime, the magnitude of floods is typically lessened by the gradual nature of snowmelt (versus more flashy, rain-dominated watersheds).

2.4 Vegetation

Approximately 80% of the Upper Lolo project area is considered a warm-cool/moist ecosystem (USFS 1999). Vegetation cover types in this ecosystem commonly includes western larch, Douglas-fir, lodgepole pine, and subalpine fir. Fire frequencies in this ecosystem type are possibly on the order of 80-200 years and were often stand-replacing events (USFS 1999). Most of the remaining project area is considered a warm/dry ecosystem, with cover types being ponderosa pine/Douglas-fir stands on warmer aspects and Douglas-fir/larch on cooler aspects. Historic fire recurrence intervals were more frequent in this ecosystem type, and were typically of lower-intensity (USFS 1999).

2.5 Stream Channels

The channel network in the Upper Lolo progresses from the low-gradient reaches of Lolo Creek (near the Hot Springs) and its forks, where there are well-developed and broad floodplains, through gradually steepening and narrowing valleys with a mixture of floodplain and terrace landforms adjacent to the channel. Moving upstream, tributaries and headwaters are moderately steep, and are in relatively broad valleys with a discontinuous floodplain of variable width.

The drainage density is moderately high for the region, but streams do not extensively dissect the landscape. Many hill slopes are planar with relatively long horizontal extent (e.g., upper Granite Creek, the east side of West Fork Lolo, Lee Creek, and the south side of the upper East Fork Lolo Creek), and areas where tributary networks are relatively well developed have modestly convergent topography. Lines of equal elevation on topographic maps crossing streams in the upper watershed are more often rounded or u-shaped, rather than v-shaped and crenulated (O’Connor 2000).

Geomorphic channel units (GCUs) were delineated by O’Connor (2000) using watershed analysis procedures (Washington Forest Practices Board 1997). GCUs were defined, and survey sites assigned based on several objective factors. These included channel geometry (slope, width, depth), a quantitative index of stream power (the product of channel width and depth at stream stage approximately equal to two-year recurrence interval flow), channel morphology according to the classification system of Montgomery and Buffington (1993, 1997), channel entrenchment (after Rosgen 1994), and sediment size distribution.

Selected characteristics of the GCUs are shown in Table 1 and a map of GCUs presented in Figure 3. Based on data collected, the channel sensitivity of each GCU to watershed inputs (coarse sediment, fine sediment, peak flows, LWD and catastrophic mass wasting events as per the Washington methodology), and channel sensitivity to supplementary riparian characteristics included in this watershed analysis (riparian vegetation and channel migration zones), is summarized in Table 2 as modified for fish habitat vulnerability. This table displays relative fish habitat vulnerabilities to modification of important input processes necessary for the creation and maintenance of habitat features within the Upper Lolo analysis area. For fish-bearing channel segments within each geomorphic channel unit, analysts considered habitat concerns for each life phase to ascertain the degree that fish habitat features are potentially vulnerable to changes in input processes that would significantly deviate from historic, "natural" variation. Degrees of vulnerability are rated as low, moderate, or high. That is, a vulnerability rating of high suggests that significant variations of the given input processes have a high probability of degrading fish habitat features critical to fish reproduction and survival. Conversely, a low vulnerability rating suggests that either significant shifts in habitat quality are not likely to occur, or if they do occur, fish populations are not likely to respond.

In most cases, habitat vulnerabilities are analogous to channel sensitivity ratings. Exceptions to this trend were identified, however. Analysts determined that, in these instances, important habitat features (primarily spawning habitat) were more sensitive to modifications of the given input factor than suggested by channel sensitivity ratings.

Figure 3. Map showing geomorphic channel units developed for Upper Lolo (O'Connor 2000).

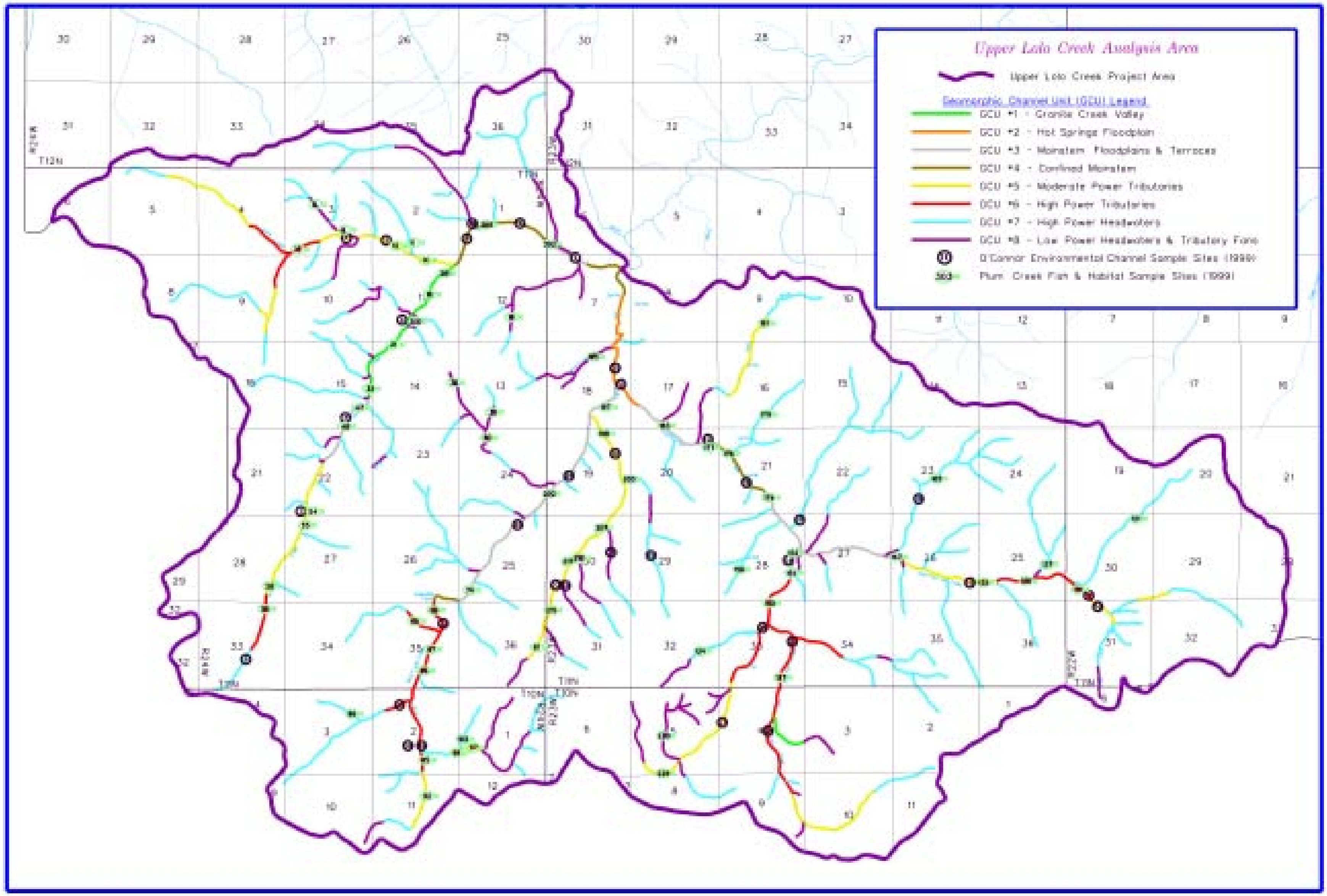


Table 1. Selected Geomorphic Channel Unit (GCU) characteristics for upper Lolo Creek watershed.

GCU	Slope (%)	Confinement	Channel Morphology	Bank-full Width (m)	Bank-full Depth (m)	Dominant Substrate	Sediment Routing Function	Floodplain & Hill slope Interactions
1-Granite Cr. Valley	< 1	Unconfined	Pool-Riffle	5	0.7	Fine gravel	Storage	Significant floodplain & bank erosion (CMZ)
2- Hot Springs Flood Plain	1	Unconfined	Pool-Riffle & Plane-bed	22	0.9	Gravel & Cobble	Transport and Storage	Significant floodplain & bank erosion (CMZ)
3-Mainstem Floodplains & Terraces Complex	1.2 (1-1.5)	Unconfined/ Moderately Confined	Forced pool-riffle & Plane-bed	9	0.7	Gravel & Cobble	Transport and Storage	Significant floodplain & bank erosion (CMZ)
4-Confined Main stem	3 (1.5-4)	Confined	Plane-bed & Step-pool	12	0.9	Boulder & Cobble	Transport	Connected to hill slopes; LWD, rock slide, & road fill slope inputs locally significant
5-Moderate Power Tributaries	3 (2-7)	Moderately Confined/ Confined	Step-pool & Forced pool-riffle	7	0.5	Cobble & Gravel	Transport and Storage	Bank/terrace erosion, incised in valley fill & moraines
6-High Power Tributaries	7 (5-8)	Confined/ Moderately Confined	Step-pool & Cascade	8	0.6	Cobble & Boulder	Transport with Significant Local Storage in Bars	Connected to hill slopes; LWD, streamside landslides, incised in valley fills & glacial debris
7-Moderate Power Headwaters	8 (3-13)	Confined	Cascade & Step-pool	2.5	0.4	Gravel & Cobble	Transport with Significant Storage in Bed	Moderately incised in shallow valley fills
8-Low Power Headwaters & Tributary Fans	5 (2-10)	Unconfined	Colluvial, Fans	3	0.3	Gravel & finer	Storage	Incipient channel conditions and alluvial fans

Table 2. Physical sensitivity of GCU's to watershed inputs and other riparian factors in the Upper Lolo Creek watershed. Initial physical sensitivity ratings are modified as warranted when ecological criteria supersede physical criteria or when a borderline physical sensitivity is present.(e.g., low-moderate); these are indicated by bold italics (From O'Connor 2000).

GCU	Coarse Sediment	Fine Sediment	Peak Flows	LWD	Landslides or Floods	Riparian Vegetation	Channel Migration Zones
1- Granite Creek Valley	High	Moderate	High	Moderate	High	High	High
2-Hot Springs Floodplain	Moderate	***High***	***Moderate***	***Moderate***	***Moderate***	High	High
3-Mainstem Floodplain & Complex	Moderate	***Moderate***	Moderate	High	Moderate	High	High
4- Confined Main stem	***Moderate***	Low	***Moderate***	***Moderate***	Low	***Moderate***	***Moderate***
5-Moderate Power Tributaries	Moderate	***Moderate***	Moderate	***High***	***Moderate***	High	***Moderate***
6-High Power Tributaries	Moderate	Low	***High***	Moderate	***High***	Moderate	***Moderate***
7-Moderate Power Headwaters	Moderate	Low	Moderate	***Moderate***	***Moderate***	Moderate	***Moderate***
8-Low Power Headwaters & Tributary Fans	Low	***High***	***Moderate***	***Moderate***	***Moderate***	High	Low

2.6 Fisheries and Aquatic Life

A variety of fish species are distributed throughout Upper Lolo, including bull trout, westslope cutthroat trout, rainbow trout, and Eastern brook trout. Also present in the vicinity of Lolo Hot Springs are German brown trout (Watson and Steiner 2001; Knotek, 2000). Of these, bull trout and westslope cutthroat trout are the only native salmonids.

Bull trout are currently listed as Threatened under the federal Endangered Species Act. Bull trout have been documented in all five 303(d)-listed streams in the Upper Lolo TPA and are designated for special management under Plum Creek Timber's Native Fish Habitat Conservation Plan (Plum Creek 2000). The presence of bull trout in these streams was recently confirmed by Plum Creek in 1999 (Watson and Steiner 2001). However, Upper Lolo tributaries have not been designated a "core bull trout area" for recovery efforts by the state (Montana Bull Trout Scientific Group 1995).

Macroinvertebrate data were historically collected by the Lolo National Forest in main stem Lolo Creek several miles downstream of the project area. No data are known to exist for the upper watershed.

2.7 Land Use, Ownership, and Cultural History

The predominant land uses in the project area are timber production and recreation. Recreational use in this area is extensive and includes hunting, hiking, snowmobiling, fishing, cross country skiing, horseback riding, and rock climbing. Much of this recreation emanates from either Lolo Pass or the private Lolo Hot Springs motel and restaurant complex. The project area also includes Highway 12, which travels along West Fork Lolo Creek up to Lolo Pass. It is a major travel corridor connecting Missoula, Montana and Lewiston, Idaho.

Ownership of the 45,906-acre TPA (See Figure 1) is distributed among the Lolo National Forest (62.6%), Plum Creek Timber Company (36.8%), and numerous small private landowners in the vicinity of Lolo Hot Springs (0.6%). Table 3 summarizes land ownership by individual sub-watersheds within the planning area. Because of the intermingled ownership pattern, the Lolo National Forest and Plum Creek jointly manage much of the forest road network in Upper Lolo. These roads are commonly referred to as cost-share roads.

Table 3. Land ownership by sub-watershed in the Upper Lolo project area.

Sub-Watershed	Lolo National Forest (acres)	Plum Creek Timber Company (acres)	Other Private (acres)	Total Acres
Lower Granite	2187	1121	70	3379
NF Granite	3520	708		4228
Upper Granite	3830	1855		5686
Granite Total (All)	9537	3684	70	13292
Upper EF	6036	3042		9078
Lost Park	4248	2197		6445
Sally Cr	864	713		1577
Lower EF	1582	1805		3387
East Fork Total (All)	12730	7757	0	20487
Lee Creek	1590	932		2522
WF Lolo	4123	4042		8165
Mud Cr	347	368		715
Lower Lolo	414	114	198	726
				12128
Upper Lolo (All)	28741 (62.6%)	16897 (36.8%)	268 (0.6%)	45906

The project area was of great historic importance to native peoples and early American explorers. Of principle cultural significance is the Lolo Trail, which has been designated a National Historic Landmark. As described the USFS (1999):

> *"American Indians used the area for thousands of years as a travel corridor as well as for hunting, plant gathering and spiritual needs. The Lolo Trail was an important travel corridor for the Nez Perce to the buffalo hunting areas east of the Rocky Mountains as well as for the Salish to access the salmon streams of the Lochsa and Clearwater rivers. The Lewis and Clark expedition, guided by American Indians, used the Lolo Trail to reach the Pacific Ocean in 1805 and again on their return in 1806. Captain William Clark reported a "10 acre quamish (camas) meadow" adjacent to the hot springs. In 1877 the Lolo Trail was used by the Nez Perce as they fled Idaho pursued by the U.S. Army. The Lolo Trail is a designated National Historic Landmark. It is also the route of two national historic trails; the Lewis and Clark National Historic Trail and Nez Perce National Historic Trail. In Montana, the Lolo Trail, Lewis and Clark NHT And Nez*

Perce NHT follow the same route. American Indians continue to use the area today for the same purposes.

A hotel was constructed at Lolo Hot Springs around 1903. The Lolo road ended at the resort. A restaurant, motel and hot pools have been provided almost continuously since. The Forest Service Mud Creek Ranger Station (adjacent to the Hot Springs) was constructed by 1915. Beginning in 1922, Ranger Bill Bell of the Elk Summit District used the Mud Creek Ranger Station as a base to supply Powell and Elk Summit Ranger Stations by pack trains. The packing operation continued until the road was constructed to Powell in 1928."

SECTION 3.0
WATER QUALITY CONCERNS AND STATUS

3.1 Water Quality Problem Statement

The Upper Lolo TPA contains approximately 340 miles of road. Of these, about 8 miles is Highway 12. The remaining length is unpaved forest road, which was primarily constructed for the long-term access and management of private and public timberland. Construction of the forest road network started in the 1950's and was largely completed by the early 1990's. The vast majority of the road network was built prior to the advent of Montana's forestry Best Management Practices in 1987 (Ethridge and Heffernan 2001). Mainline forest roads were constructed immediately parallel to lower reaches East Fork Lolo Creek and Lee Creek. Highway 12 parallels WF Lolo Creek for it's entire length.

Sediment delivery to streams from forest roads and Highway 12 are believed to be the greatest water quality issue in the Upper Lolo Creek project area. This has been a recognized concern of land and highway managers for the past two decades. Concern about cumulative effects in the early 1980's resulted in numerous meetings of landowners (Plum Creek, Champion International, and Lolo National Forest) to discuss the need to improve roads in the watershed. This resulted in many mainline forest roads being surfaced with gravel, installation of gravel filtration "berms" along the shoulders of stream-adjacent roads, and numerous other improvements made to the drainage of native roads. Much of this early work was completed by the late-1980's. Since the mid-1990's Plum Creek and the USFS Lolo National Forest have been aggressively bringing old roads up to current BMP standards. Improvements in highway maintenance activities were made as well, by reducing direct delivery during guardrail cleaning, and by construction of several sediment traps in 1995.

3.2 303(d) List Status

While water quality concerns have been recognized by land managers and the state highway department for many years, and numerous important steps taken, additional opportunities exist to further reduce sediment delivery to streams.

According to the most recent sufficient and credible data collections and beneficial use determination, these waters currently do not fully support their fisheries or aquatic life beneficial uses. Impairment is attributed to surface erosion and delivery from forest roads. Impacts to West Fork Lolo Creek also include sediment delivery from Highway 12 associated with surface erosion on poorly vegetated cut- and fill-slopes, and delivery of sand applied during the winter for traffic safety. Tables 4 and 5 provide a summary of streams currently listed as partially supporting aquatic life and cold-water fishery and the history of their designation on the Montana list of impaired waters (303(d) List).

In addition to sediment delivery from roads, connectivity of fish habitat is also believed to be a concern (associated with road culverts). While this threat is addressed by landowners as part of this restoration plan, it is outside the scope of the TMDL process, but part of a larger watershed scale process that is carried out through this WQRP.

Table 4. Upper Lolo waterbodies listed on the 1996 303(d) List in need of a restoration plan for partial impairments to aquatic life and the cold water fishery.

Segment Name	Waterbody Number	Estimated Length (mi)	Probable Causes	Probable Sources
Lost Park Creek	MT76H002_38	5	Other habitat alterations Siltation	Silviculture
East Fork Lolo Creek	MT76H002_4	7	Siltation	Logging road construction/ maintenance
Granite Creek	MT76H002_3	9	Other habitat alterations Siltation Thermal modifications	Agriculture Harvesting, restoration, residue management Logging road construction/ maintenance Range land Silviculture
West Fork Lolo Creek	MT76H002_14	6	Other habitat alterations Siltation	Highway/road/bridge construction
Lee Creek	MT76M002_12	10	Other habitat alterations	Highway/road/bridge construction Resource extraction

Table 5. Upper Lolo waterbodies listed on the 2002 303(d) List in need of a restoration plan for partial impairments to aquatic life and the cold water fishery.

Segment Name	Waterbody Number	Estimated Length (mi)	Probable Causes	Probable Sources
Lost Park Creek	MT76H005_06	5	Other habitat alterations Siltation	Logging/road construction/ maintenance
East Fork Lolo Creek	MT76H005_04	7.4	Other habitat alterations Siltation	Silviculture Logging/road construction/ maintenance
Granite Creek	MT76H005_03	8.5	Other habitat alterations Siltation	Silviculture Logging road construction/ maintenance
West Fork Lolo	MT76H005_05	6.8	Other habitat alterations Siltation	Silviculture Habitat modification-other than hydromodification bank or shoreline modification/ destabilization Highway maintenance and runoff
Lee Creek	MT76H005_07	3.8	Other habitat alterations Siltation	Silviculture Logging road construction/ maintenance Habitat modification-other than hydromodification Bank or shoreline modification/ destabilization

Internal reviews of this WQRP and the current 303(d) listings identified that the 2002 303(d) list included the North Fork of Granite Creek as partially supporting aquatic life. An internal quality control/quality assurance review of the 2002 303(d) list has determined that there was insufficient and credible data to determine if the North Fork Granite Creek is fully supporting it's beneficial uses. Therefore the impairment status of the North Fork Granite Creek will be determined during the reassessment required for the next 303(d) list and not affect this WQRP.

3.3 Applicable Water Quality Standards

The following sections summarize both the narrative and numeric standards that apply to the Upper Lolo Creek TPA.

3.3.1 Use Classifications

Waters in the Lolo Creek Basin are assigned a B-1 use classification.

B-1 Waters are *"to be maintained suitable for drinking, culinary and food processing purposes, after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply" ARM 17.30.637.*

3.3.2 Narrative Standards

The narrative standards applicable to the Upper Lolo TPA and the current impairments associated with this WQRP allow no increases over naturally occurring conditions. In this case, naturally occurring means conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil and water conservation practices have been applied. These are further described below:

> *In accordance with ARM 17.30.623(2)(f), no 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.*

3.3.3 Numeric Standards

Numeric surface water quality standards have been developed for the protection of beneficial uses. Montana standards vary by beneficial use class and apply to specific waters in the state. Numeric standards for all Montana surface waters (except ephemeral streams) are summarized in the MDEQ Circular WQB-7 (MDEQ, 2002b). The circular contains standards for numerous parameters for the protection of aquatic life and human health.

The numeric standards applicable to the Upper Lolo TPA and the current impairments associated with this WQRP are as follows:

*The maximum allowable increase above naturally occurring **turbidity** is 5 nephelometric units except as permitted in MCA, 75-5-318 [ARM 17.30.623(2)(d)].*

*A 1°F maximum increase above naturally occurring water **temperature** is allowed within the range of 32°F to 66°F; within the naturally occurring range of 66°F to 66.5°F, no discharge is allowed which will cause the water temperature to exceed 67°F; and where the naturally occurring water temperature is 66.5°F or greater, the maximum allowable increase in water temperature is 0.5°F. A 2°F per-hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55°F, and a 2°F maximum decrease below naturally occurring water temperature is allowed within the range of 55°F to 32°F[ARM 17.30.623(2)(e)].*

3.4 Summary and Analysis of Existing Data and Information

The Upper Lolo TPA has been subjected to three significant influences throughout the majority of this century. The primary influence is roads – U.S. Highway 12 and Forest roads. Timber harvest and grazing practices have also played an influential role. These influences have affected the watersheds, their aquatic habitat and fisheries, by causing increased bank erosion, increased water yield, and increased sediment, both bed load and suspended. These influences may also have changed stream dimension, gradient and pattern in some reaches and have caused decreased soil productivity (Sylte and Riggers, 1999).

During 1997 and 2001, the Lolo National Forest measured the percentage of surface fines at several locations in Upper Lolo Creek using standard pebble count procedures (Wolman 1954). The percentage of fine sediment at each site is summarized in Table 7. Additionally, 1997 and 2001 percent fines data is displayed in Figures 5-7. These data show a wide range of fine sediment levels in streams. This is thought to largely result from differences in channel types, but may also be influenced by watershed sediment supply.

The following sections give a brief summary of the existing conditions of each waterbody within the Upper Lolo TPA.

3.4.1 West Fork Lolo Creek

Both bull trout and westslope cutthroat trout have been identified during snorkel surveys conducted by Plum Creek Timber (Watson and Steiner, 2001) and the Lolo National Forest (Riggers, et al., 1994) in the West Fork Lolo Creek. Fish densities and species composition has changed significantly from historic conditions. Factors influencing change are habitat degradation by roads, highway sanding, timber harvest, grazing and loss of beavers (Sylte and Riggers, 1999). Exotic species and migration barriers also affect the fishery (US Forest Service, 1999). Additional factors at risk that are affecting the fishery and associated aquatic life are stream bank condition, floodplain connectivity, change in peak/base flows, and riparian area function (Torquemada et. al., 2000).

3.4.2 East Fork Lolo Creek

The Lolo National Forest also identified bull trout in reaches of the East Fork through snorkeling efforts. Fish densities and species composition have changed significantly from historic conditions (Sylte and Riggers, 1999). Torquemada and others (2000) described the East Fork as Functioning at Unacceptable Risk (FUR). Road densities are thought to be the greatest contributor to these conditions.

3.4.3 Granite Creek

Bull trout were also found in Granite Creek through snorkeling efforts of the Lolo National Forest. Similar conditions to the aforementioned stream channels occur along Granite Creek.

In addition to sediment impacts, Granite Creek was included on Montana's 303(d) list in 1996 for "thermal modifications." The probable sources of all impairments (including sediment) on the 1996 list included agriculture, harvesting, logging road construction/maintenance, rangeland, and silviculture.

Upon further review, Montana DEQ has determined that a TMDL for Granite Creek for thermal modifications is not warranted for several reasons:

1. While sheep grazing was a likely impact in the early 1900's (Horstman and Whisennand 1997), no current agriculture or rangeland is present in the watershed.

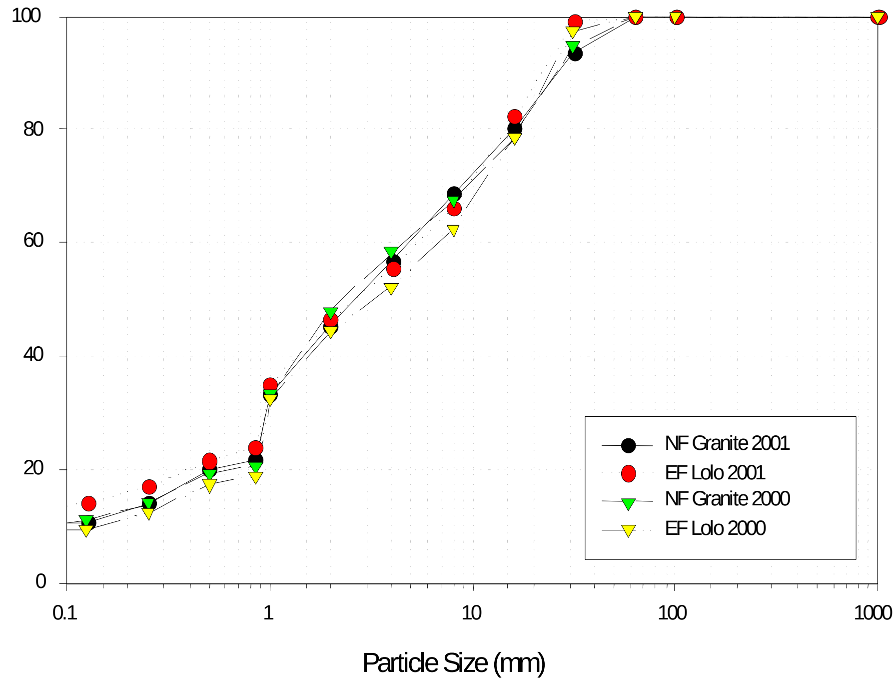
2. Based on a review of aerial photography and an onsite inspection, most riparian areas appear to be close to their natural potential for providing stream shading; and there are likely natural geothermal impacts occurring in lower Granite Creek associate with the Lolo Hot Springs.

3. Torquemada et al. (2000) identified Granite Creek as Functioning at Acceptable Risk (FAR) with regard to stream temperature.

Finally, it important to note that while a thermal modification impairment was deemed not warranted, additional investigations as outlined in Section 8.7 would be carried out to further assure or support this decision.

In 2001 and 2002, Plum Creek Timber measured spawning gravel quality in pool crest tail outs at two locations in the project area. Particle size distributions of these data are shown in Figure 4. The NF Granite site (located just above the Granite Creek confluence) is being used by Plum Creek as a control site and is believed to reasonably represent least-disturbed conditions in Upper Lolo.

Figure 4. Particle size distributions from McNeil core samples at two locations in Upper Lolo for 2000 and 2001. The vertical (y) axis represents the cumulative percentage.



3.4.4 Lee Creek

Due to its low gradient, drainage area, and location within the Bitterroot watershed, the Lolo National Forest has identified Lee Creek as one of the most significant spawning tributaries to the Bitterroot River for fluvial bull trout and westslope cutthroat trout (Sylte and Riggers, 1999). The Lolo National Forest has also identified Lee Creek as being limited by natural bed load and increased fines from existing roads (pers. com. Brian Riggers, 2002). As of 1998, water yield was estimated at the Forest threshold of 7%. Recent data and activities have not been used to estimate 2003 water yield. Additionally, because of Lee Creek's system of forest roads, the cumulative erosion rates in Lee Creek are nearly two times that of the unroaded North Fork Granite Creek.

3.4.5 Lost Park Creek

Bull trout are also present in Lost Park Creek. Lost Park Creek has been described to have similar increased sediment and instability conditions as the aforementioned stream channels (Sylte and Riggers, 1999; Torquemada, 2000). Eight of nine habitat parameters are rated as functioning at unacceptable risk (FUR) (Torquemada, 2000).

3.5 Reference Conditions

Reference condition is defined as the condition of a water body capable of supporting its present and future beneficial uses when all reasonable land, soil and water conservation practices have been applied. Reasonable land, soil, and water conservation practices are not always accomplished by using standardized best management practices (BMPs). BMPs are land management practices that provide a degree of protection for water quality, but they may not be sufficient to achieve compliance with water quality standards and protect beneficial uses. Therefore, reasonable land, soil, and water conservation practices generally include BMPs, but additional conservation practices may be required to achieve compliance with water quality standards and restore beneficial uses (MDEQ, 2002).

A dataset of 229 streams within the Bitterroot watershed was used to compare with streams in the Upper Lolo TPA. Each stream was used as a comparison stream, however, only reference streams as defined above were used for purposes of this analysis. Reference streams were also determined by their ability to function properly through efficient sediment transport (Garret Decker, 2002, Pers. Com.). For purposes of this analysis, the remaining streams from the dataset will be characterized as *non-reference* streams. This dataset was obtained from the Bitterroot National Forest. The reference reach data used shows a wide range of variability. This wide variability in percent fine levels is commonly observed (Bunte and MacDonald 1999).

Streams were stratified by Rosgen stream type (Rosgen, 1996) and by reference and non-reference streams. The reference streams by in large, were made up of managed drainages. The non-reference streams were made up of basins with more intensive management than that of the reference streams. While it would be logical to further stratify the reference streams by Rosgen substrate class, it was felt that this level of stratification was not appropriate given the current size of the dataset. The dataset containing 229 streams was stratified to 77 reference streams that were again stratified by 3 channel type classes. As additional data is collected and the overall sample size increases, it would be appropriate to stratify by substrate class to better understand subsurface fines.

Particle size distribution data was obtained for the aforementioned comparison streams. The data consisted of pebble counts through riffles within established cross sections using methods described by (Wolman, 1954). A variety of statistical analyses were conducted to try and make inferences about the data that would best represent reference conditions while still allowing for natural variability. Percent fines population mean, min, max, 25th percentiles and 75th percentiles were calculated for both reference and non-reference streams. These values are displayed and summarized in Figure 5 and Table 6 below.

Figure 5. Box-whisker Plots comparing reference to non-reference particle size data in the Bitterroot National Forest.

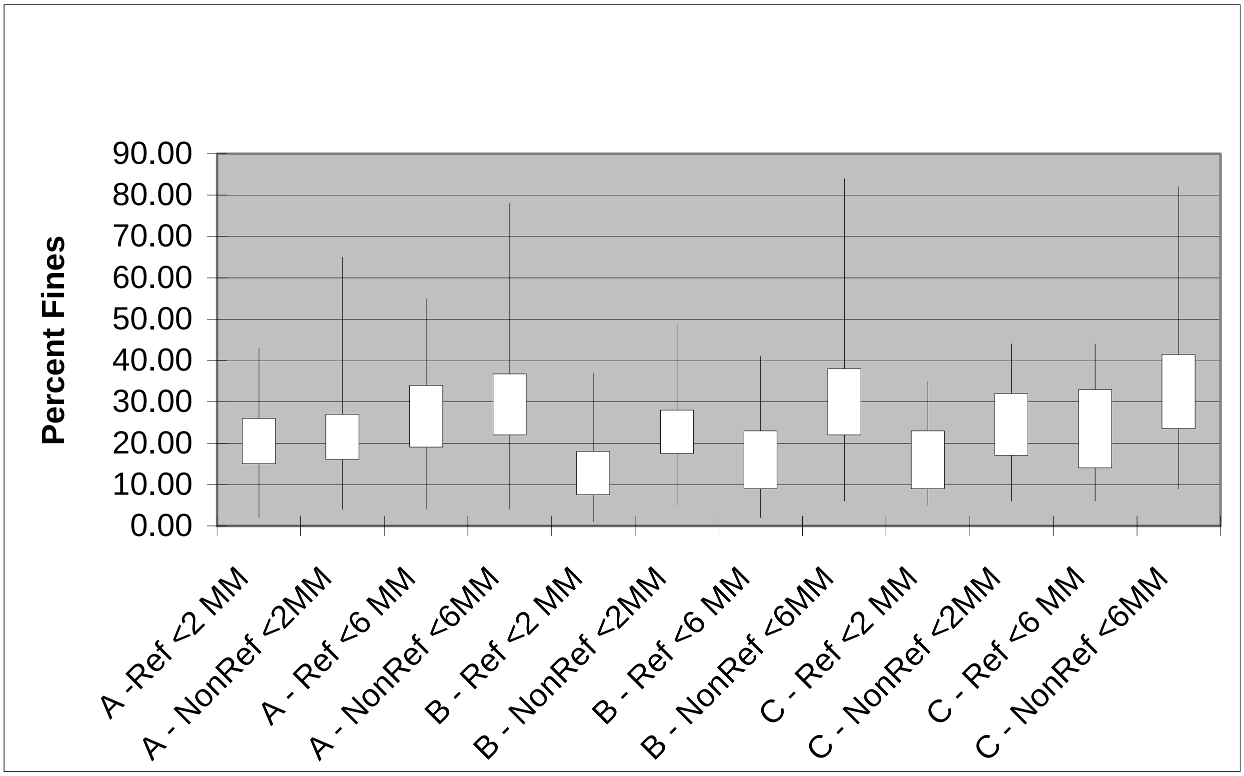


Table 6. Percent Fines Values for Streams within the Bitterroot River Watershed.

Stream	Sample Size	Rosgen Type	75th Percentile % < 2MM	75th Percentile % < 6MM	Average % < 2MM	Average % < 6MM
Reference Streams	33	A	24	34	20	27
Non-Reference Streams	74	A	27	37	23	32
Reference Streams	35	B	18	23	13	17
Non-Reference Streams	51	B	28	38	23	31
Reference Streams	9	C	23	33	17	27
Non-Reference Streams	27	C	32	42	24	33

Additionally, Table 7 below compares specific stream reaches within the TPA with reference reach stream averages of the same stream type as shown above (as described in Section 3.4).

Table 7. A Comparison of Reference Streams and The Upper Lolo TPA Streams.

Stream	Rosgen Type	Average % < 2MM		Average % < 6MM	
		Existing	Reference	Existing	Reference
Lee Creek	C	11.5	17	16.5	27
Lost Park Creek	C	16.0	17	17.0	27
Granite Creek 1	B	44.0	13	57.0	17
Granite Creek 2	B	19.5	13	33.0	17
W.F. Lolo 1	E	56.0	NA	65.5	NA
W.F. Lolo 2	B	16.5	13	31.0	17
E.F. Lolo	B	11.0	13	20.0	17
N.F. Granite 1	C	30.0	17	41.5	27
N.F. Granite 2	B	19.3	13	33.3	17
N.F. Granite 3	A	21.7	20	31.3	27

Since the reference reach streams were stratified by Rosgen type, there were summed as such and are displayed above in Table 7, whereby the Upper Lolo TPA streams are specific reaches. Additionally, percentiles were calculated for the Upper Lolo TPA streams, but are felt to be unreliable as only two data points are available. These values are reported in Table 14 (Section 5.3).

As shown in Table 7 above, there are a few streams (Lee Creek, Lost Park Creek and E.F. Lolo) that have lower existing mean values than the reference reaches. This might suggest that they are not impaired. However, we feel that this conclusion cannot be made from only two data points. Additional data collection as outlined in Sections 7 & 8 later in this document would help draw better conclusions in the future.

Figures 5-7 further display the numbers summarized in Table 7. These figures compare reference reaches and streams within the Upper Lolo TPA by individual Rosgen types.

Figure 6.

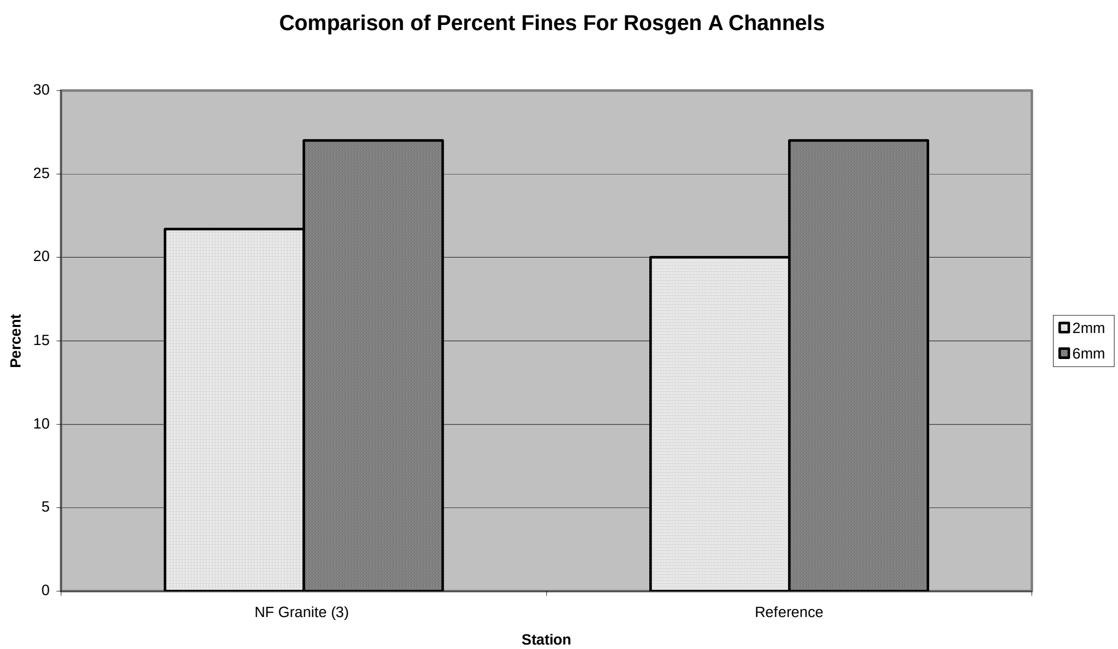


Figure 7.

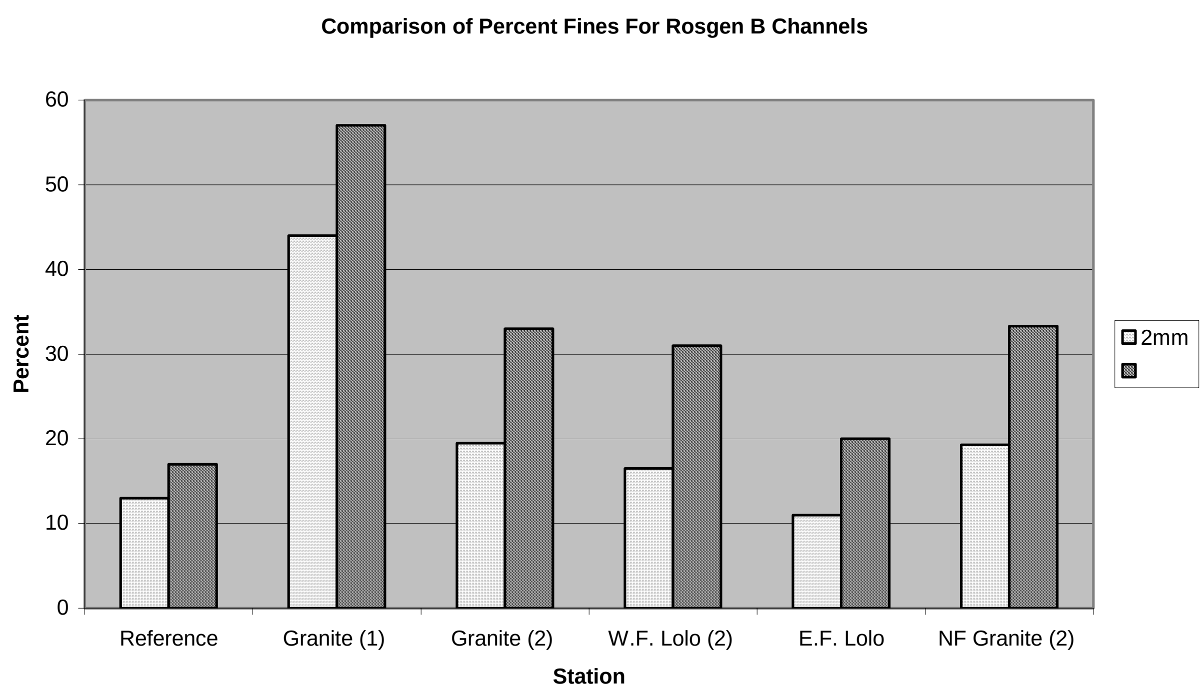
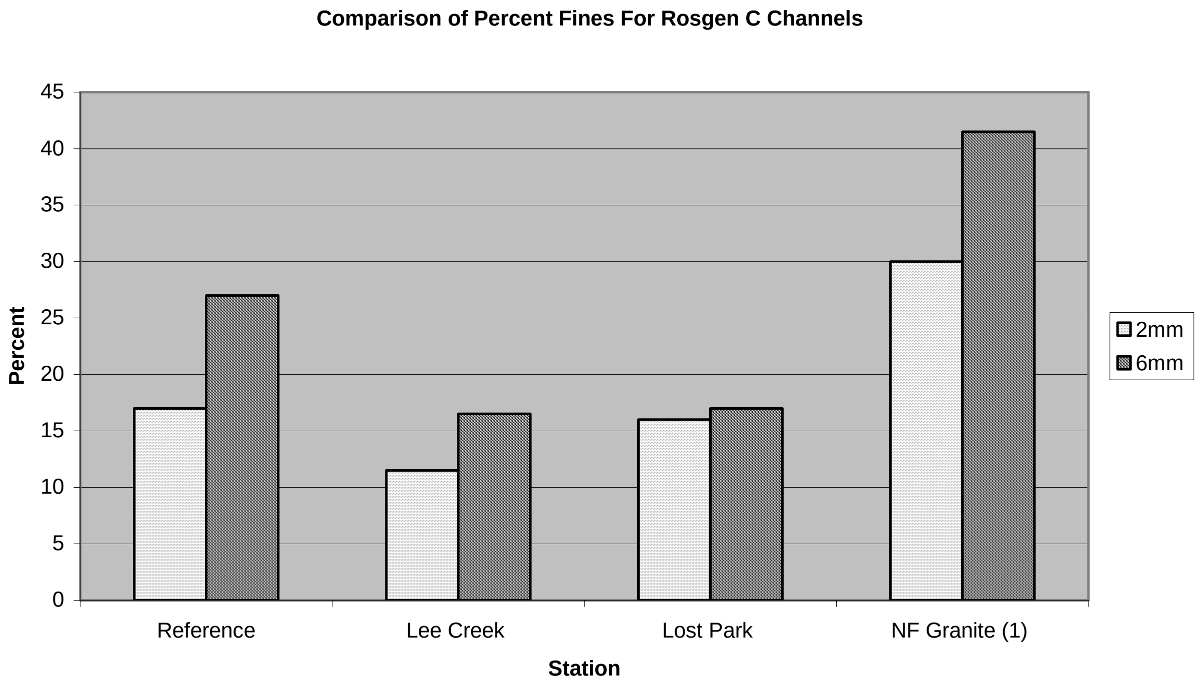


Figure 8.



Finally, we acknowledge that the methodology outlined in this section has a level of uncertainty and variability. We also acknowledge that other statistical methods could be used to represent the data and compare the streams at hand. However, other methodologies were explored and with the current dataset available, the methods used did not draw a high enough level of confidence to do comparisons. We recognize that additional data collection and analysis may be required in the future. We also acknowledge that further stratification of reference reach data may be necessary to draw more sound conclusions in the future. These issues are further discussed in Sections 7 and 8 later in this document.

3.6 Water Quality Impairment Summary

The listed impairments for water bodies within the Upper Lolo Creek TPA are summarized in Tables 4 and 5. In combination, the 1996 and 2002 303(d) lists indicate that beneficial uses are partially supported due to siltation impairments in Lee Creek, Lost Park Creek, Granite Creek, West Fork Lolo Creek, and East Fork Lolo Creek. Granite Creek was also listed for impairments associated with thermal modification in 1996. However, based on the 2002 303(d) List, thermal modifications are no longer considered a probable cause of impairment (see Section 3.4.3).

Section 3.5 provides a comparison between the substrate fine sediment characteristics in the 303(d) listed water bodies (Lee Creek, Lost Park Creek, Granite Creek, West Fork Lolo Creek, and East Fork Lolo Creek) and reference water bodies. The results of this comparison suggest that only Granite Creek and the West Fork of Lolo Creek are impaired as a result of siltation. Unfortunately, only two data points are available for the 303(d) listed water bodies.

In order to meet the court imposed TMDL development schedule (See, Friends of the Wild Swan, Inc. et al., vs. U.S. Environmental Protection Agency, CV 97-35-M-DWM), and given the limited data set upon which this comparison to reference streams is based, it is assumed herein that all five water bodies are impaired as a result of siltation as indicated in the 1996 and 2002 303(d) Lists.

The following sections of this document address each of the required TMDL elements regarding siltation impairments in Lee Creek, Lost Park Creek, Granite Creek, West Fork Lolo Creek, and East Fork Lolo Creek. An adaptive management strategy is proposed (see Section 8.7) to address the uncertainties associated with these impairment determinations.

SECTION 4.0
POLLUTANT SOURCE INVENTORY AND ESTIMATE OF EXISTING POLLUTANT LOADS

This section provides a summary of all potentially significant point, non-point and natural sources of the primary pollutant of concern (i.e., siltation). All significant sources identified will be considered in the selection of best management practices and restoration strategies included in the implementation plan.

4.1 Point Sources

There are no point source sediment loads in the project area. Additionally, airborne sediment sources are not perceived to be a significant source necessary for inclusion in the pollutant source inventory. The only significant sediment sources in the project area are non-point in nature and are discussed below.

4.2 Non-point Sources

In evaluating non-point sources in the project area, surface erosion from forest roads, stream crossing failures on forest roads, and erosion and maintenance activities associated with Highway 12 are believed to be the largest anthropogenic contributors. While sediment from forest roads could affect most project area streams, impacts of Highway 12 are limited to West Fork Lolo Creek.

4.3 Forest Roads

Roads networks have long supplied vehicle access to the forest for management purposes. However, roads and road systems affect watersheds in various ways, including generation of overland flow, surface drainage delivery to stream channels, concentration of runoff, and influence of the amount of subsurface water interception, which all can affect the local stream flow quantity and regime (King and Tennyson, 1984). Adverse effects to natural hydrologic processes in roaded watersheds increase as road densities increase (King and Tennysen, 1984; Rothrock et. al., 1998; King, 1989; USFS, 1998).

Riggers and others (1998) concluded that 20% of the variation of surface fine data (<6.5mm) was explained by road density in a study of roaded and unroaded watersheds in the Lolo National Forest. Fine sediment is 18.2% in developed watersheds and 7.4% in undeveloped watersheds (p=.001). Stratification of streams by size, channel type and geology showed similarly significant differences in nearly every group, with the most significant differences occurring in low-gradient riffle habitat types. Additionally, bank erosion is significantly higher in developed watersheds (2.09% and 0.35% respectively; p=.003). Table 8 below summarizes the road densities within the Upper Lolo TPA by watershed.

Table 8. Total Acres and Road Densities of the Upper Lolo TPA.

Watershed	Watershed Area	Road Density (Miles/Mile^2)
Lee Creek	2, 496 acres/3.9 mile^2	7.4
Lost Park Creek	6, 272 acres/9.8 miles^2	4.3
Granite Creek	12, 288 acres/19.2 miles^2	4.5
East Fork Lolo Creek[1]	20, 544 acres/32.1 miles^2	4.6
West Fork Lolo Creek[2]	12, 032 acres/18.8 miles^2	5.8

[1] East Fork Lolo Creek includes Lost Park Creek.

[2] West Fork Lolo Creek includes all the area that drains to the "main stem" Lolo Creek upstream from Granite Creek, excluding the East Fork Lolo, but including Lee Creek.

Sediment delivery from forest road erosion was evaluated in the Upper Lolo Creek watershed between 1998 and 1999 by two consulting firms. Western Watershed Analysts (Lewiston, Idaho) completed the analysis of the Granite Creek watershed in the fall of 1998. Land and Water Consulting (Missoula, Montana) conducted the analysis of the remainder of the Upper Lolo analysis area (East and West Forks of Lolo Creek) in the fall of 1999. Additional sites that were missed in 1998 and 1999 were subsequently inventoried in 2000 by Plum Creek Timber.

Analyses involved a field assessment of all stream-adjacent forest road segments in the watershed and followed the methodology outlined by Washington Forest Practices Board (1997) and further discussed by Callahan (1999). Stream adjacent road segments are typically locations where roads either cross or parallel streams. During the field assessment, data were collected on a variety of variables that affect road erosion and sediment delivery processes, including:

- Inherent soil erodibility (a function of geologic parent material)
- Traffic rates (heavy, moderate, or low traffic)
- Surfacing materials (native surfacing, heavy gravel, light gravel)
- Road dimensions (e.g., tread width/length, cut slope lengths, fill slope lengths)
- Drainage design (e.g., amount of road draining to streams)
- Vegetative cover (e.g., cut slope and fill slope vegetation)

The methodology calls for sampling selected road segments and extrapolating the results to the entire road system in the watershed. However, for the Upper Lolo Creek project area, road erosion was evaluated at every potential delivery site as determined by examination of topographic maps and field site inspections. This improvement over standard procedures was important because for purposes of watershed plan development, landowners wanted to be able to directly identify the location and relative importance of all sites that deliver sediment to streams. The intent of this effort was to conduct field site inspections at 100% of potential sediment delivery locations in the watershed. Details of the field inventory procedures and results are presented in Sugden, 2001.

Surface erosion from forest roads in the Upper Lolo Creek watershed is estimated to be 178 tons/year. Assuming 0.74 yd^3/ton, the volume of sediment delivered is estimated at 131 yd^3. On a per unit area basis, 178 tons corresponds to a loading rate of 2.5 tons/mi^2/year. Surface erosion delivery from forest roads in Granite Creek is estimated to be higher than the basin-wide average at 4.6 tons/mi^2/year. The East Fork Lolo Creek is somewhat lower than the basin-wide average at 1.9 tons/mi^2/year.

The road tread was found to be the source of most erosion and sediment delivery to streams in the Upper Lolo TPA. In Granite Creek, the tread produced 57% of erosion and sediment delivery. In the remainder of the analysis area the tread constituted 72%. Virtually all of the remaining erosion was produced by road cut slopes. Fill slopes were generally well-vegetated and produced less than 10% of the estimated erosion and sediment delivery.

Table 9. Estimated sediment delivery to streams from forest road surface erosion in Upper Lolo sub-watersheds.

Sub-Basin	Area (mi^2)	Forest Road Delivery (tons/yr)	Forest Road Delivery (Tons/mi^2/yr)
Lower Granite	5.3	33	6.2
NF Granite	6.6	7	1.1
Upper Granite	8.9	56	6.3
Granite Total (All)	20.8	96	4.6
Upper EF	14.2	11	0.8
Lost Park	10.1	21	2.1
Sally Cr	2.5	3	1.3
Lower EF	5.3	18	3.5
East Fork Total (All)	32.0	53	1.7
Lee Creek	3.9	9	2.4
WF Lolo	12.8	19	1.5
Mud Cr	1.1	0	0.2
Lower Lolo	1.1	1	0.6
Upper Lolo (All)	71.7	178	2.5

4.4 Stream Crossing Failures on Forest Roads

Sediment delivery to streams from culvert failure is another documented sediment source in the project area (Sylte and Riggers 1999). Because of the stochastic nature of this sediment delivery source and a lack of historic documentation of its magnitude and aerial extent, it is not possible to precisely quantify its contribution to the overall watershed sediment budget. Sylte and Riggers (1999) identified two major culvert failures during the 1996/1997 floods. These failures were on mainline roads crossing lower NF Granite Creek and a tributary to Lost Park Creek. Since this time, the culvert on the NF Granite was replaced by a bridge in 2000. The culvert that failed in Lost Park was reinstalled in 2002 and is now a bottomless arch.

While this sediment source does not lend itself to inclusion in the TMDL, a coarse filter risk assessment was completed to identify culverts that may be at greater risk of hydraulic exceedence and failure, and what the environmental consequences of that failure may be in terms of sediment delivery (Sugden, 2000). A total of 46 crossings of perennial fish-bearing streams were inventoried during September 1999 (Shown in green in Figure 9). Of these, 11 were bridges and deemed to be at a generally low risk of failure. The focus of this risk analysis was on the 35 culvert crossings. Crossing structure types vary by management entity. Montana Department of Transportation (MDOT) crossing structures on Highway 12 are generally concrete culverts, and include both round pipes and boxes. Crossing structures on forest roads managed by the Lolo National Forest and Plum Creek Timber generally consist of round and arch corrugated metal pipes (CMPs).

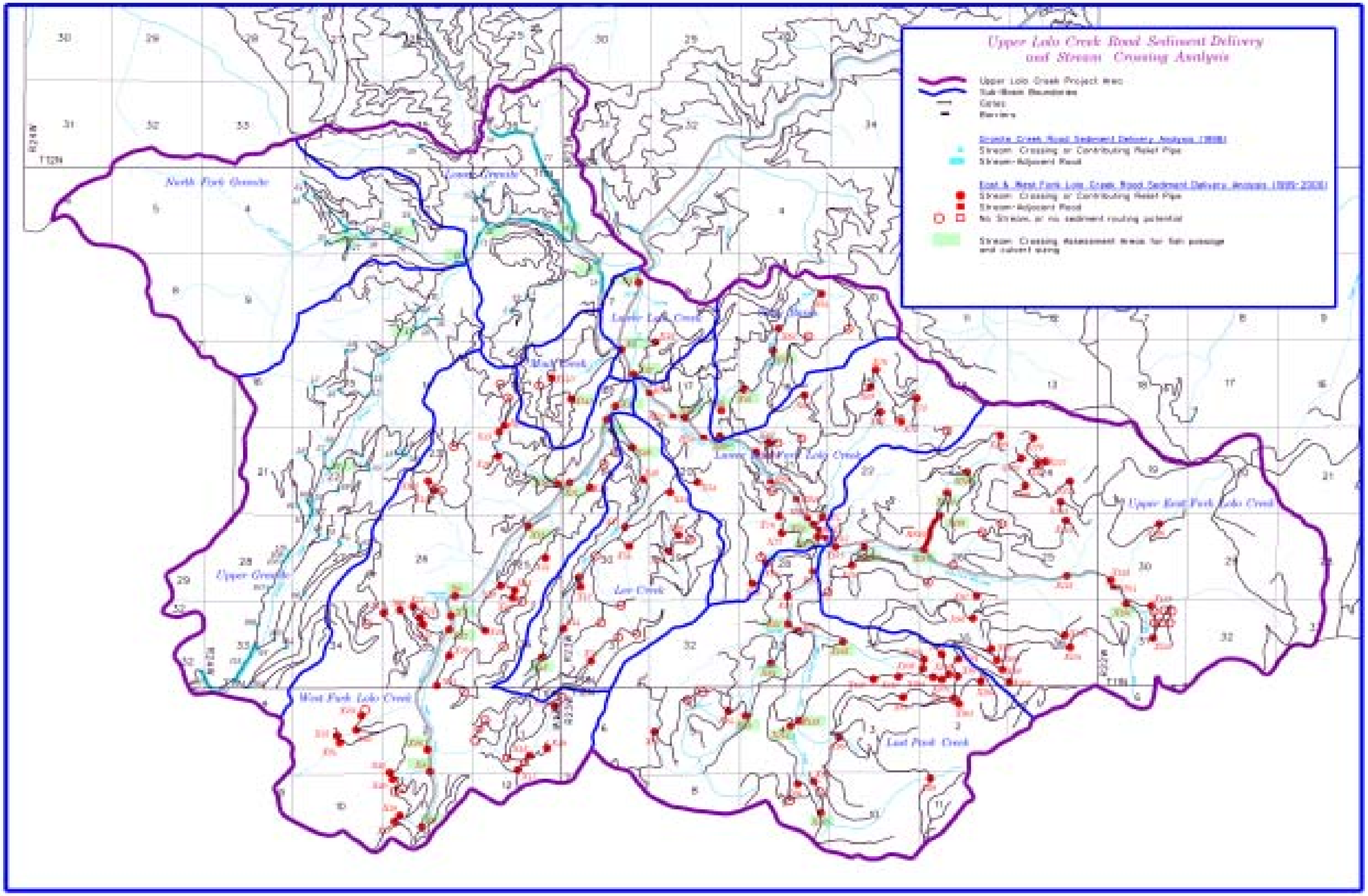
Results show that forest roads have significantly lower average fill heights and in turn have less volume subject to erosion. MDOT crossings have a total estimated fill volume over streams of 11,400 yds^3, while forest roads have an estimated volume over streams of 3200 yds^3.

Each crossing was assigned a priority ranking of 1 – 6 based on whether the culvert capacity was sized for the 2-year flood (priority 1), 5-year flood (priority 2), etc.

While these priorities represent relative risk of failure, a more detailed on-the-ground assessment should be completed prior to actual prioritization. Following a detailed analysis, a site-specific management action plan can be developed for reducing risk of crossing failures. Landowners plan to use this information in their water quality restoration plans to reduce the risk of this source of sediment delivery to streams.

It is important to note the aforementioned stream crossings are not contributing to the current total sediment load. However, proper planning as outlined in Sections 7 and 8 later in this document will assist at reducing the potential for existing crossings to become part of the total load in the Upper Lolo TPA.

Figure 9. Map of sediment delivery inventory locations, and crossings included in stream culvert risk assessment and fish passage analysis (highlighted in green).



4.5 Surface Erosion, Sanding, and Maintenance of Highway 12

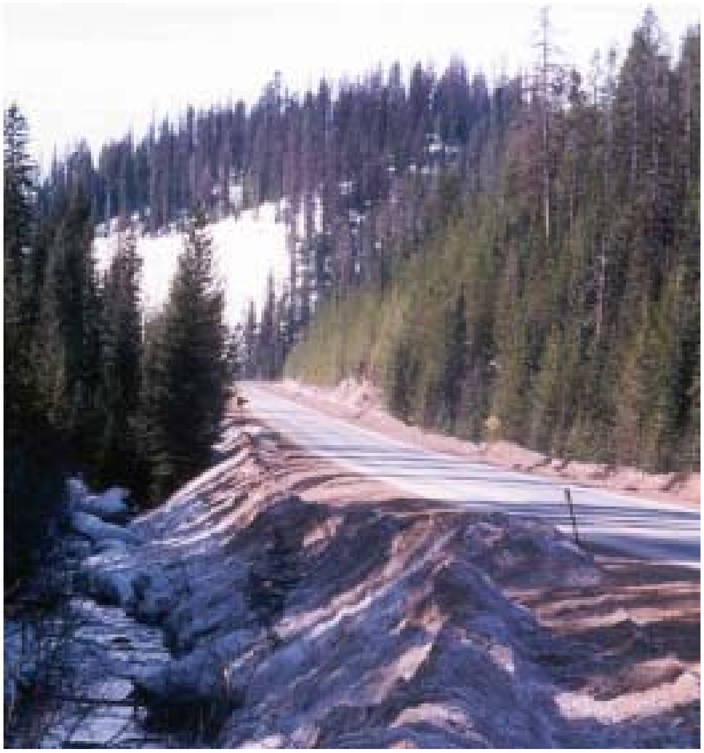
Within the Upper Lolo TPA, the West Fork of Lolo Creek is paralleled for a distance of 6.4 miles by U.S. Highway 12, a two lane paved highway that was constructed in 1964. With a traffic flow of nearly 350,000 vehicles per year, U.S. 12 is the only paved roadway connecting Montana and Idaho through the Bitterroot Mountains between Lookout Pass to the north and Lost Trail Pass to the south, a distance of 150 miles. As a principal route for transportation, commerce, and recreation in this part of Montana, U.S. 12 is maintained for motorized travel twelve months of the year by the State of Montana through the Montana Department of Transportation (MDT). Winter maintenance operations are performed by MDT with the principal mission of providing safe driving conditions for the traveling public in such a manner that does not endanger MDT's maintenance personnel. It is recognized that other goals of the State of Montana related to the maintenance and operations of U.S. 12 are secondary to the requirements of safety. Within this framework, MDT is committed to providing a transportation system that is sensitive to the environment.

In addition to other sources, U.S. Highway 12 contributes a notable portion of the accelerated sediment loading into the West Fork of Lolo Creek. Sediment is delivered to the stream channel via erosion from cut and fill slopes and via runoff carrying traction sand that is applied during winter maintenance operations. There are approximately eleven acres of cut slopes and approximately 18 acres of fill slopes above and below the roadway. Overland flow and erosion can occur at these locations due to lack of natural vegetation and steepness of slope.

Since only semi-quantifiable data exists to adequately describe the sediment load from U.S. Highway 12, the following pictures portray the existing conditions and current practices.

Figure 10. U.S. Highway 12 along W.F. Lolo Creek.

Figure 11. U.S. Highway 12 along W.F. Lolo Creek.



Although no accurate measurements of road sand usage are presently available, it was estimated that approximately 3, 300 tons was applied to the portion of U.S. Highway 12 within the Upper Lolo TPA during the winter of 1999-2000. Since sand application rates have increased over the years in response to public concerns for safety and with larger capacity equipment, this quantity of sand is larger than the amounts applied in earlier years.

Clearly there is a significant contribution of road traction sand input into the West Fork (Sylte & Riggers, 1999; Rosquist, 1997). Additionally, road surface runoff carrying road cut and fill sediment is resulting in erosion and subsequent delivery to the West Fork. However, to date not enough data exists to substantially estimate the exact percentage U.S. Highway 12 contributes to the total annual load.

A semi-quantitative study (Land & Water, 2000) suggests that the amount of highway traction sand reaching the West Fork of Lolo Creek may be substantial, and has triggered efforts to document more closely the amount of road sand that is applied and recovered from highway maintenance activities. From this study, a delivery figure of 518 tons/year was projected for the portion of U.S. 12 that lies within the Upper Lolo TPA. This would amount to nearly 2-times that of the predicted natural sediment load from the West Fork.

Additionally, another semi-quantitative analysis was conducted by DEQ to estimate the traction sand load off of Highway 12. This analysis used methodologies applied to another western Montana watershed and highway (Blackfoot River and U.S. Highway 200), but was adjusted to closely fit the characteristics of the West Fork Lolo Creek and U.S. Highway 12. This exercise resulted in a reasonable numeric value (425 tons) that is analogous to the one derived from the

Land & Water study. However, this method is still an estimate and contains noteworthy levels of uncertainty.

Comparatively, a TMDL/WQRP in Summit County, Colorado reported 3, 968 tons of traction sand delivery to nearby Straight Creek. This loading number equates to ~480 tons/mile (CDPHE, 2000).

Accelerated sediment loading into W.F. Lolo Creek from U.S. 12 has occurred for nearly 40 years. Traction sand is transported to the stream channel via overland flow from the road surface. It is also transported to the stream channel directly through plowing operations and side casting of road materials. Additionally, erosion of native materials on the road cut and fill surfaces erodes from road surface runoff and snowmelt, which in turn delivers sediment to the stream channel. At present time, it is not known exactly what percentage of the road sand applied to this section of U.S. 12 reaches the West Fork of Lolo Creek. Uncertainties exist, not only in the amount of road sand that is applied, but also in the amount of sand that is recovered by maintenance procedures during the spring and summer months. In 1995, MDT constructed eleven sediment collection basins along U.S. 12 between mileposts 0.0 and 3.0. In addition, ditch blocks intended to trap sediment were installed in the cut slope ditches throughout this segment. These features are cleaned and repaired as needed and have resulted in the capture of an unknown quantity of road sand in the seven years that they have functioned. Additionally, the Best Management Practices (BMPs) that MDT has used in sanding and maintenance of the road surface have varied in their effectiveness at reducing sediment contribution to Lolo Creek.

4.6 Other Minor Sediment Sources

Several other potential sediment sources were evaluated, but discounted for inclusion in the Load Allocation because of their perceived minor contribution. These include streambank erosion, mass wasting, hill slope erosion associated with timber harvesting, and streambank erosion associated with livestock grazing. The justification for discounting each of this is described below.

Enhanced streambank erosion due to land management activities and roads is not believed to be a significant source of sediment to these streams. Streambanks throughout the project area are typically stabilized by deeply rooted vegetation. In places where roads are in close proximity to streams, the channels are confined by bedrock. Additionally, as of 1998, water yield was estimated at the Forest threshold of 7%. Recent data and activities have not been used to estimate 2003 water yield (USFS 1999; Sylte and Riggers 1999).

Based on an aerial photograph review of the project area (O'Connor 2000), mass wasting is not felt to be a significant source of sediment in the project area. O'Connor concluded the following:

> *"Based on field observations of the watershed and review of 1:12000 scale color aerial photography from 1999, mass wasting of soil materials by landslides is of extremely limited significance in the upper Lolo watershed. Field evidence of shallow streamside landslides was found in one portion of the channel network only (refer to description of*

GCU 6). Although aerial photo interpretation efforts were focused on stream channels, the majority of the watershed was reviewed, and no landslides were observed.

In the absence of landslides, the dominant mass wasting process delivering sediment (and LWD) to streams are "creep" processes that gradually transfer soil material down hill slopes. These processes proceed slowly, but are pervasive across the landscape, and they are important where streams are adjacent to hill slopes. In these locations, windthrow of trees and bank erosion transfer soil from hill slopes to the stream channel."

O'Connor's finding is additionally supported by soils mapping (Sasich and Lamotte-Hagen 1989) which finds a low risk of mass wasting for land types in the project area. This is largely attributed to the lack of steep terrain (see Figure 2).

Surface erosion on hill slopes is believed to be a small sediment source to streams relative to forest roads in Upper Lolo (Sylte and Riggers 1999). This is because ground cover effectively prevents forest sub-soils from being detached from raindrop impact. Even in timber harvest areas, hill slope erosion and sediment delivery to streams is typically not observed when forestry BMPs are applied to logging skid trails and Streamside Management Zones (SMZs) are retained (as is required under state law). This observation has been made by local hydrologists familiar with the project area (Rosquist and Sugden, Personal Communication) and biennial state BMP audits (Ethridge and Heffernan 2001). In a review of watershed analyses completed throughout the pacific northwest (McGreer et al. 1998), this same conclusion was reached.

Regarding cattle grazing, the only current allotment in the project area is in the East Fork Lolo Creek watershed. While localized impacts were present historically (Lolo National Forest 1997), a recent riparian inventory (Miles 2001) found streams within the allotment on Plum Creek lands to be in Proper Functioning Condition (BLM 1993). This is attributed to improved range management practices (Plum Creek Timber Company 2000) and construction of grazing enclosures along impacted reaches on Lolo National Forest. Recent forest plan monitoring reports (Lolo National Forest 1998, 1999) have also found conditions greatly improved. Because the existing management system appears to be addressing grazing impacts, they are not incorporated into the TMDL.

4.7 Natural (Background) Sources

Three independent approaches for estimating background sediment yields from Lolo Creek sub-watersheds were utilized in an effort to depict a range of possible natural/background loading conditions. These included: 1) Estimates based on a soil creep equation (Washington Forest Practices Board 1997); 2) Estimates derived from USFS land type coefficients (Sasich and Lamotte-Hagen 1989; Sirucek et al. 1991); and 3) estimates based on the scientific literature for geologically- and geographically-similar watersheds (King and Megahan) (Larson and Sidle 1980). These three approaches are discussed in more detail in Sugden (2001b).

In general, the three independent approaches yield results that are generally within a factor of 3 of one another. When excluding high estimates based on literature estimates, the approaches are generally within a factor 2 of one another (Table 10). Therefore, the natural load calculation was derived by taking the average value of the three independent approaches; excluding the high literature estimate.

Table 10. Estimates of background (natural) loading to Upper Lolo sub-watersheds based on three independent approaches.

Sub-Basin	Area (mi^2)	Soil Creep Modeled Erosion Rate (tons/yr)	Landtype Modeled Erosion Rate (tons/yr)	Low Literature Estimate (tons/yr)	High Literature Estimate (tons/yr)
Lower Granite	5.3	139.1	59.9	148	253
NF Granite	6.6	135.6	93.0	185	317
Upper Granite	8.9	185.3	151.8	249	427
Granite Total (All)	20.8	460.1	304.7	582	997
Upper EF	14.2	128.8	244.5	397	681
Lost Park	10.1	107.6	186.7	282	483
Sally Cr	2.5	15.8	42.2	69	118
Lower EF	5.3	71.4	93.3	148	254
East Fork Total (All)	32.0	323.6	566.7	896	1536
Lee Creek	3.9	113.4	61.3	110	189
WF Lolo	12.8	145.9	235.0	357	612
Mud Cr	1.1	10.4	20.9	31	54
Lower Lolo	1.1	11.6	20.2	32	54
Upper Lolo (All)	71.7	778.2	1208.8	2008	3443

4.8 Source Assessment Summary

There are no point sources associated with the overall load of the Upper Lolo TPA. Non-point sources such as surface erosion and surface runoff from roads have been identified as the greatest factors to the overall anthropogenic sediment load. The primary contributors are forest roads and U.S. Highway 12. Airborne sediment sources are thought to be negligible. Table 11 below summarizes each source of sediment and the methodology used to calculate each load.

Table 11. Source Assessment Summary for the Upper Lolo TPA.

Waterbody	Source	Load Estimation Method	Estimated Load (tons/year)
Lee Creek	Forest Roads	FRS[1]	9
	Natural	3 Independent Approaches[2]	95
	Misc. Upland	Professional Judgment[3]	Negligible
	Predicted Culvert Failure	FRS	Not a Current Load
TOTAL:			**104**
Lost Park Creek	Forest Roads	FRS	21
	Natural	3 Independent Approaches	192
	Misc. Upland	Professional Judgment	Negligible
	Predicted Culvert Failure	FRS	Not a Current Load
TOTAL:			**213**
Granite Creek	Forest Roads	FRS	96
	Natural	3 Independent Approaches	449
	Misc. Upland	Professional Judgment	Negligible
	Predicted Culvert Failure	FRS	Not a Current Load
TOTAL:			**545**
East Fork Lolo Creek	Forest Roads	FRS	53
	Natural	3 Independent Approaches	596
	Misc. Upland	Professional Judgment	Negligible
	Predicted Culvert Failure	FRS	Not a Current Load
TOTAL:			**649**
West Fork Lolo Creek	Forest Roads	FRS	19
	Natural	3 Independent Approaches	246
	Misc. Upland	Professional Judgment	Negligible
	Predicted Culvert Failure	FRS	Not a Current Load
	Hwy. 12	2 semi-quantitative methods.	425-518[4]
TOTAL:			**690-783**

[1] FRS is the Forest Road Survey methodology described by the Washington Forest Practices Board (1997).
[2] Natural background loads were estimated using three independent approaches. These approaches are outlined in Section 3.7 previously in this document.
[3] Professional judgment and general knowledge of the basin was used by local hydrologists. This is further discussed in Section 4.6.
[4] As discussed in Section 4.5 the best estimates to date are semi-quantitative in nature, therefore a range is utilized to express the uncertainty.

SECTION 5.0
WATER QUALITY GOALS & RESTORATION TARGETS

This section is divided into three components, each designed to achieve full beneficial use support within the Upper Lolo TPA. 1). Water quality goals are the “big picture” objectives that would be met following implementation of each strategy outlined in this water quality restoration plan. 2). Targets are numeric criteria by which measurements can be made to show whether desired levels and ultimately water quality goals are being achieved. 3). Indicators are water quality controls that indirectly suggest that numeric targets are being met. Indicators allow for the many uncertainties and variability that exists in nature and account for parameters outside the control of land managers.

5.1 Water Quality Goals

The following “water quality goals” are the primary objective of this restoration project. These goals would be achieved through implementation efforts outlined in this restoration plan.

1. Ensure protection of all streams within the Upper Lolo TPA, with the intent of maintaining full support of water quality standards.
2. Ensure full recovery of aquatic life beneficial uses to all streams within the Upper Lolo TPA;
3. Work with landowners and other stakeholders in a cooperative manner to ensure implementation of water quality protection activities; and
4. Continue to monitor conditions in the watershed to identify any additional impairment conditions, track progress toward protecting water bodies in the watershed, and provide early warning if water quality starts to deteriorate.

These goals are further developed as part of the Implementation Strategy and Monitoring Plan Sections of this document (Sections 7 and 8). To help define measurable objectives toward meeting Goals 1 and 2; numeric targets are developed within this section of the document. These targets are meant to reflect those conditions that need to be satisfied to ensure protection and/or recovery of beneficial uses. Goals 3 and 4 were designed to ensure cooperation among all parties involved.

A secondary objective of the restoration plan is to improve the connectivity of aquatic habitats throughout the watershed. This would be accomplished by correcting fish passage barriers at stream crossing culverts as outlined in Section 7.3.4.

5.2 Targets

Targets were developed as part of the requirements of this water quality restoration plan.

5.2.1 In-Stream Targets

The numeric in-stream targets developed for the Upper Lolo TMDL are intended to interpret narrative water quality standards. The numeric targets represent the conditions expected for salmonid reproductive success and full beneficial use support. These numeric targets are based on available monitoring data, scientific literature, and best professional judgment. It is uncertain whether these targets will actually meet narrative standards and ultimately provide support for all beneficial uses. However, data collection as outlined in Sections 7 and 8, is intended to provide the basis for greater certainty.

Scientific literature suggests that percent fines, pool frequency, V* [1] and channel structure/stability are indicators that are most closely linked to fish habitat conditions which support salmonids and can be used to evaluate long-term impacts of upslope activities and erosion reduction efforts (Knopp, 1993, Chapman, 1988). Tables 12 and 13 below summarize the in-stream targets.

Due to the lack of existing data in 3 of the 5 in-stream targets, numeric targets will only be set for the percent fines parameters at this time. The other parameters (as summarized in Table 13) would be monitored as outlined in Sections 7 and 8 whereby numeric targets could be set upon future reevaluation processes.

Table 12. In-stream Targets for the Upper Lolo TPA.

Life Stage & Channel Stability	Parameter	Targets	
		Stream Type*	
Embryo Development	Percent fines < 2 mm	A	22%
		B	16%
		C	21%
Emergence	Percent fines < 6 mm	A	31%
		B	21%
		C	30%

* Based on Rosgen stream type classification (Rosgen, 1996).

[1] V* is a measure of the fraction of a pool's volume that is filled by fine sediment and is representative of the in-channel supply of mobile bedload sediment. Lisle (1993), demonstrated the usefulness of the parameter by comparing annual sediment yields of select streams with their average V* values. The comparison indicated that V* was well correlated to annual sediment yield. He also demonstrated that V* values can quickly respond to changes in sediment supply.

Table 13. Performance-Based In-Stream Targets for the Upper Lolo TPA.

Life Stage & Channel Stability	Parameter	Targets
Rearing	Pool Frequency	Established following both reference and response reach data collection*
Channel Structure/Stability	V*	
Channel Structure/Stability	Entrenchment Ratio	
	Width/Depth Ratio	
	Sinuosity	

* Explanation of data collection is outlined in Section 8-, later in this document

Sufficient reference reach data does not exist for Rosgen E channel types. Therefore, an adaptive management approach would be used to determine numeric targets for E channels and the parameters in Table 12. This is further explained in the monitoring plan (Section 8.7) later in this document. Additionally, the targets would apply to specific stream type reaches throughout each impaired segment. These specific streams types have not been fully mapped to date, but would be in the future as described in sections 7 and 8.

5.2.2 In-Stream Target Justification

The full support of a cold-water fishery and aquatic life are the primary goals behind the development of this watershed restoration plan. To assess the amount of interstitial fine sediments occurring in the fish spawning habitat, the Wolman pebble count methodology is proposed as the measurement tool. As outlined in section 8 later in this document, McNeil Core sampling will occur in the future to help better understand subsurface fines in the Upper Lolo TPA.

Based on upstream conditions, reference conditions, valley type, existing data and general knowledge of stream morphological evolution, several segments of stream channels within the Upper Lolo TPA are not currently meeting their full geomorphic potential and have lost significant stream length over the past 60 years (Sylte and Riggers, 1999).

Given the current status of data collected, we do not know what the percent fines numbers should be in the Upper Lolo TPA, however estimates based on reference data obtained from adjacent drainages can be made. Additionally, it is important to note that the available substrate data is surface fines data and may not fully represent subsurface fines. However, inferences can still be made towards percent fines values in the channel. As part of the five-year evaluation, the targets would be adjusted accordingly.

Percent fines targets (Table 12) were developed using reference reach data as outlined in Section 3.5. These targets were taken from a sub-sample of the aforementioned dataset containing 229 streams. As outlined in Section 3.5 the sub-sample is stratified by reference and non-reference streams. Additionally, the sub-sample was further stratified by Rosgen stream types. Population means, mins, maxs, 25th, and 75th percentiles were calculated for both reference and non-reference streams.

The data presented in Figure 5 and Tables 6 & 7 represents "reference" conditions for the purpose of determining targets for the streams in the Upper Lolo TPA. The percent fines targets (shown in Tables 12 and 14) are the attainment of reference conditions in the Upper Lolo TPA streams. In defining a reference condition and determining compliance with water quality standards (fully supporting beneficial uses), consideration must be given to variation in natural systems and sampling and analysis methodology used to compare conditions. The 75^{th} percentile represents 75% of the reference reach data. Therefore the target selected for percent fines is the reference condition, with the allowance of the 25^{th} percentile to account for natural variation and sampling and analysis methods. Additionally, a 10% margin of safety was used to set the final targets to account for uncertainty and variability. As more percent fines data is collected, it may be appropriate to reduce the percent fines target, based on an increased understanding of the uncertainty associated with the natural variation of the percent fines target and the sampling methodology.

As discussed above, the targets outlined in Tables 12 and 13 are designed to incorporate all life stages of fish and support other aquatic life beneficial uses. The targets in Table 13 were developed to account for the additional life stages of salmonids in the Upper Lolo TPA. At this time, data for these parameters is limited. Therefore, a phased approach (as outlined in section 8) would be used to further collect data and establish targets for these parameters.

5.2.3 Margin of Safety

Given the uncertainty that exists and the natural variability in percent fines data, a 10 percent margin of safety was applied to the percent fines reference values outlined in Table 6, which in turn, resulted in the in-stream targets outlined in Tables 12 & 14.

5.3 Comparison of Numeric Targets to Existing Conditions

Table 14 compares the proposed targets to the existing conditions of each stream within the Upper Lolo TPA. The values below are averages of each stream type. As indicated in previous sections, it would appear that some of the streams are not impaired based on the existing numbers. These numbers however, are based from only two years worth of data. Secondly, the numbers in Table 14 were summed and averaged for ease of display. Further detail and analysis is outlined in Section 3.5. Finally, we have acknowledged the level of uncertainty (Section 3.6) of the existing data and through efforts outlined in Sections 7 and 8, plan to focus efforts towards eliminating that uncertainty and ultimately meeting the goals and objectives of this plan.

Table 14. Comparison of Numeric Targets to Existing Conditions in the Upper Lolo TPA.

Stream Type	Target		Existing Data[1]	
	% Fines < 2MM	% Fines < 6MM	% Fines < 2MM	% Fines < 6MM
A	22	31	14	23
B	16	21	28	40
C	21	30	21	26

[1] The existing data is based on 1997 and 2001 data from the USFS Lolo National Forest. Values reported are the75th percentiles for each particular stream type with a 10% margin of safety.

5.4 Restoration Indicators

Additional goals have been set to serve as indicators of in-stream health and overall condition of the beneficial uses. Some of these indicators would be set following sufficient data collection as outlined in Section 8. Indicators will be used to help determine whether or not specific targets are being met. In general, the indicators to be used in evaluating the success of this restoration plan include the following:

1. Percent of forest road length and/or stream crossings meeting Montana Forestry BMPs.
2. Length of forest road that is surplus to the needs of forest land managers.
3. BMP application rates in timber harvest areas.
4. Traction sand application rates and percent of mitigations measures along U.S. being met.
5. Geomorphic indicators of proper pattern, profile and dimension.*
6. Sufficient number of age classes of native salmonids exist in the Upper Lolo TPA.*
7. Macroinvertebrate indicators associated with sediment and full support based on standard DEQ protocols.*
8. Number of human-caused fish passage barriers corrected.

* Note: These indicators are further discussed in Section 8.6.

5.4.1 In-Stream Indicator Discussion

Indicators 1 through 4 are designed to help track mitigation and changes in management designed to meet the objectives and goals of the WQRP. Indicator 5 was developed to show whether targets listed in Table 13 are being met. The methodologies are further discussed in Section 8.4. Indicator 6 was crafted to be a direct measure of the beneficial use. If multiple age classes of fish are present in the stream, it can be inferred that fish are successfully reproducing (propagating). Exact densities and population levels are not proposed as targets because of scientific uncertainty and insufficient data that would pertain to the Upper Lolo TPA. Through efforts outlined in the Implementation Strategy and Monitoring Plan (Sections 7 & 8), fish population indicators could be set following sufficient data collection. This determination would be made following the scheduled 5-year evaluation that is outlined in Sections 7 and 8. Indicator number 7 is based on biological data since ideally this would best represent aquatic life beneficial use support. Finally, the last indicator is designed to answer the secondary objective of this plan as discussed in Section 5.1.

5.5 Uncertainty and Adaptive Management

The targets have been developed based on the best available information and the current understanding of the impairments in the Upper Lolo TPA. The monitoring strategy described in Section 8 would be implemented on an annual basis. Additionally, the relationships between management activities, appropriate mitigation and sedimentation to stream channels will continue to be evaluated.

The above targets all apply under normal conditions of natural background loading and natural disturbance. It is recognized that under some natural conditions such as a large fire or flood event, it may be impossible to satisfy some of the targets such as percent fines for a period of time. The goal under these conditions will be to ensure that management activities within the watershed or individual tributaries are undertaken in such a way that the recovery time to conditions where the targets can be met is not delayed. Another goal will be to ensure that potentially negative impacts to beneficial uses from natural events are not significantly increased due to human activities.

While numeric targets have been developed for percent fines, applying them by stream type cannot be carried out at this time. This is due to the lack of available stream classification mapping in the Upper Lolo TPA. Therefore a phased approach would be used as mentioned in Section 5.2.2. This approach would properly map Rosgen stream types within the Upper Lolo TPA, so that the proposed targets could then be applied accordingly. This effort is further described in section 8.6.

Targets will be evaluated at least every five years for suitability and may be modified based on identification of more suitable reference and/or identification of a better indicator of habitat condition required to support fisheries and aquatic life.

SECTION 6.0
ALLOCATIONS AND TMDLS

Road sediment, along with habitat degradation and accompanying increases in eroded sediment, are the principle threats to water quality in the Upper Lolo TPA. By addressing current and potential future sources of these impacts, actions prescribed in this plan will reduce the severity of sediment input in the stream channels encompassed by the TPA and help ensure protection of beneficial uses from multiple threats. It is recognized, however, that natural forces could limit the rate and possibly the magnitude of the water quality improvements.

6.1 West Fork Lolo Road Allocations and TMDL

Both U.S. Highway 12 and forest roads are the major contributors to the sediment load in the West Fork Lolo Creek. As indicated in Section 4.5, the exact amount of total load coming from U.S. Highway 12 is unknown. As outlined in Section 4.5, two semi-quantitative methods were used to estimate the load from U.S. highway 12. Field studies and modeled estimates as described in section 4.8 were used to estimate the total load coming from forest roads in the West Fork. These results are displayed in Table 15 below.

Estimates for the load contributed by U.S. Highway 12 are semi-quantitative and therefore a range was selected for the source allocation. This range serves to express the uncertainty of the load. The load allocations for the West Fork Lolo Creek could therefore evolve as strategies outlined in Sections 7 and 8 are undertaken.

A 33% reduction in the load coming from all roads in the West Fork is proposed. Percent reductions on forest roads were calculated by incorporating BMP mitigations that were expected to reduce linear distances of potential road surface runoff and subsequent sediment delivery to local stream channels. Next, the total delivery distances and potential loads were recalculated and a percent reduction was derived from the difference. All calculations were based on actual field measurements. No specific measurements or calculations were used to develop percent reductions from U.S. highway 12 because too many uncertainties exist about sanding rates, delivery rates and new mitigation practice effectiveness. To help maintain consistency within the West Fork drainage, the same 33% reduction will be applied to U.S. Highway 12.

It is important to note that improved future estimates will be necessary in developing final or revised load allocations for West Fork Lolo Creek. These allocations would be reevaluated during the five-year review process (see section 8.6). However, until these improved estimates are developed, a reasonable preliminary estimate (or range of estimate) is more useful than either extremely wide bands of quantitative uncertainty or a qualitative estimate of “substantial” traction sand effects. Finally, the effects of the mitigation measures outlined in Section 7 would be monitored for their effectiveness and would dovetail with allocation efforts.

6.2 East Fork, Granite Creek, Lee Creek, and Lost Park Creek Road Allocations and TMDL

The reduction in human loading for all five streams in Upper Lolo TPA is shown in Table 15. These reductions were derived using the same approach discussed in Section 6.1. As this is a non-point source TMDL, no waste load allocation is necessary. The load allocation for the East Fork, Granite Creek, Lee Creek and Lost Park Creek are based on modeled sediment delivery given planned road BMP improvements and road closures on Lolo National Forest and Plum Creek lands. These load allocations also include estimates of natural background sediment loading as discussed in Section 4.7. As discussed above in Section 6.1, the allocations in the West Fork Lolo Creek were divided between U.S. Highway 12 and forest roads.

Table 15. Load allocations, percent reductions and TMDLs for the Upper Lolo TPA (all values are in tons/year).

Granite Creek	
Natural Load	449
Existing Forest Roads Load	96
Total Load	545
Reduction from Forest Roads	50 (52%)
TMDL	495
Lee Creek	
Natural Load	95
Existing Forest Roads Load	9
Total Load	104
Reduction from Forest Roads	5 (56%)
TMDL	99
Lost Park Creek	
Natural Load	192
Existing Forest Roads Load	21
Total Load	213
Reduction from Forest Roads	9 (43%)
TMDL	204
East Fork Lolo Creek	
Natural Load	596
Existing Forest Roads Load	53
Total Load	649
Reduction from Forest Roads	19 (36%)
TMDL	630
West Fork Lolo Creek	
Natural Load	246
Existing Forest Roads Load	19
Existing Highway 12 Load	425-518
Total Load	690-783
Reduction from Forest Roads	6 (33%)
Reduction from Highway 12	140-171 (33%)
TMDL	543-605

6.3 Margin of Safety

A margin of safety is implicitly incorporated into the TMDL because modeled erosion coefficients are conservative compared with other available models (USFS 1991; NCASI In Press), the high level of certainty in the sediment delivery inventory, and not including high literature estimates in the background erosion calculation. No allotment for future growth is incorporated in this TMDL as the forest transportation system is fully developed.

In addition to the margin of safety applied to the percent fines in-stream targets outlined in Section 5.2, a margin of safety is also incorporated into the TMDL through the adaptive management process (as outlined in Sections 8.6 & 8.7). This process accounts for the uncertainties that exist.

6.4 Additional Management Practices Allocations and TMDL

While sediment sources from water yield increases following timber harvest is thought to be minimal (Section 3.6.6), it cannot be completely discounted.

- As discussed in the targets section of this plan, a performance-based approach is allocated to silviculture practices to ensure that a high level (95%) of BMP compliance is in effect. This includes 100% compliance with the SMZ rules.
- Calculated water yield increases will be maintained less than the minimum value expected to produce channel sediment increases related to increased peak flows. Overall road density values will be evaluated to limit hydrologic impacts based on input from the stakeholders.

SECTION 7.0
RESTORATION PLAN

7.1 Ongoing and Past Water Quality Restoration Activities

As was discussed earlier in Section 3, land managers have been aggressively reducing sediment delivery to streams in Upper Lolo for more than 15 years. These actions included:

- Surfacing mainline roads that closely paralleled lower East Fork Lolo, Lee, and Granite Creeks. This work was completed in the mid-1980s.
- Construction of gravel "filtration" berms on the outside shoulder of streamside roads adjacent to lower East Fork Lolo Creek and Lee Creek. This work was also completed in the 1980's and recently upgraded in 2000.
- Numerous forest road BMP improvements since the mid-1990s on USFS and Plum Creek Timber Company roads. These improvements primarily included adding road drainage and reducing the length of road draining to streams.
- Upgrading priority undersized culverts on mainline forest road crossings of North Fork Granite Creek (2000) and a large tributary to Lost Park Creek (2002). These were stream crossings that failed during the floods of 1996-1997.
- Installation of sediment settling basins and ditch traps along U.S. Highway 12 in 1995.
- Improved maintenance practices for cleaning of sediment from guardrails along U.S. Highway 12 starting in about 1995.

7.2 Restoration Priorities

The following priority restoration actions in Upper Lolo have been identified:

- Upgrade remaining forest roads to meet Montana Forestry BMPs;
- Reclaim forest roads that are surplus to the needs of forest land managers;
- Improve inspection and maintenance of existing culverts;
- Implement Montana's Forestry BMPs on all timber harvest operations;
- Upgrade undersized culverts over time to better accommodate large floods;
- Further reduce sediment delivery from U.S. Highway 12, through improved use and maintenance of sediment traps, plowing techniques, and guardrail cleaning; and
- Correct priority fish passage barriers that are significantly affecting the connectivity of native fish habitats.

7.3 Water Quality Protection and Improvement Strategy

7.3.1 Agency and Stakeholder Coordination

An important component of implementation of this Water Quality Protection Plan will be to work closely with the major land stewards in the basin to maximize and document the effectiveness of their ongoing efforts. Achieving the targets and allocations set forth in this plan and as part of the TMDL development process, however, will require a coordinated effort between land management agencies, and private landowners.

Additionally, MTDEQ would take the lead in convening a meeting of the major stakeholders on an annual basis. These stakeholders could include:

- Missoula Conservation District
- Lolo National Forest
- Plum Creek Timber Company
- Montana Department of Transportation
- Montana Department of Environmental Quality

Additionally, community members unaffiliated with any group could be invited. The purpose of the meeting would be to track and help direct the implementation of this Water Quality Protection Plan and to address new threats to water quality as they arise. Specific tasks that could be undertaken during these meetings are:

- Discussion and data sharing of latest assessments, needs or findings pertinent to this WQRP.
- Discuss potential to work with and partner with group formed for the Lower Lolo TMDL and ultimately the Bitterroot River TMDL.
- Discuss any additional findings or technological advances that may benefit the current WQRP.
- Determine the feasibility for any physical restoration of the streams within the Upper Lolo TPA or any other streams. This restoration may include the installation of large woody debris or other measures to improve channel conditions.

Plum Creek, the Lolo National Forest and the Montana Department of Transportation have planned to undertake specific watershed restoration actions. A brief description of their specific plans are described below.

7.3.2 Lolo National Forest

On National Forest lands, restoration and improvement of road related sediment sources will be implemented through decisions made in the Upper Lolo Creek Road Reclamation Project. The Missoula Ranger District of the Lolo National Forest began an Environmental Analysis of this project in August 1999. The reclamation actions proposed as a starting point for this analysis are those recommended by the Upper Lolo Creek Watershed Report dated June 1999. The recommendations in the report emphasized: 1) closing and stabilizing as many roads as possible, especially roads in riparian areas, and 2) mitigating the impacts of roads that will remain in use. A list of the roads to be included in the analysis and the proposed treatments was made available to the public on August 30, 1999. The Environmental Analysis was delayed; it is now scheduled for completion in 2003.

The “purpose and need” for the reclamation project is to reduce sediment and improve aquatic habitat in Upper Lolo Creek by decommissioning or reclaiming approximately 60 miles of existing National Forest System roads. The proposed closures would reduce total road density by 0.9 mile/square mile to 3.7 miles/square mile. Permanent closures would generally be local roads not currently open to public motorized travel. Closure options would depend upon site-specific conditions and needs of each road. Roads selected for closure and decommissioning would have their culverts removed, stream crossings re-shaped, roadbeds deeply ripped and re-vegetated. Full re-contouring of some roads would occur where roads are in stream floodplains, where there is mass wasting potential, or if there are high to very high road densities. After the initial road closures are completed, additional closure opportunities may be present.

Many of the roads that will remain open in Upper Lolo creek will receive major improvements. Improvements identified for these roads include: surface drainage correction, surfacing, filter windrows, and sediment traps. In addition, seasonal access control on these roads as the snow melts off in the spring will further reduce erosion and off-site sedimentation.

Old “jammer” roads grown in with vegetation will be inventoried for existing culverts. An estimated two-thirds of these roads have culverts present in them. The watershed risks of leaving or removing culverts will be evaluated. Some culverts may be left in place if the risk of failure is low and/or the impact of accessing and removing them is high.

7.3.3 Plum Creek Timber Company

Water quality restoration in Upper Lolo Creek on Plum Creek lands will be guided by the company’s Native Fish Habitat Conservation Plan (Plum Creek Timber Company 2000). This plan was approved by the US Fish and Wildlife Service and National Marine Fisheries Service under Section 10 of the federal Endangered Species Act (ESA). The plan addresses the needs of native trout that are listed under the ESA (e.g., bull trout, redband rainbow trout, etc.) as well as species not presently listed (e.g., Westslope cutthroat trout). In exchange for incidental take coverage for bull trout under the ESA, Plum Creek has committed to implement 56 conservation measures on their land, which will minimize and mitigate impacts to native fish. Measures that Plum Creek will be implementing under their Native Fish Habitat Conservation Plan (NFHCP) in the Upper Lolo Creek area that will support attainment of the restoration goals and TMDL are summarized as follows:

- Granite Creek, East Fork Lolo Creek, and West Fork Lolo Creek are designed in the NFHCP as “High Priority Watersheds.” With this designation, Plum Creek will upgrade all roads to meet state BMP standards (with some specific enhancements) by the end of 2010. This work will include improving general road drainage, reducing the length of road draining to streams, and adding supplemental filtration (e.g., slash filter windrows, silt fences, etc.) where drainage feature outfalls discharge too close to streams for effective filtration.
- Where fish passage barriers exist, they will be corrected prior to 2010. This deadline may be extended if necessary to fully work out details with cost-share partners (e.g., USFS).

- New stream culvert installations will be designed to accommodate at least the 50-year peak flow.
- Roads that Plum Creek does not require for forest management will be abandoned (reclaimed) by the end of 2010.
- All roads will be periodically re-inspected for BMP conditions. In High Priority Watersheds, this will be at least every 5 years.
- While Plum Creek requires very few new roads in Upper Lolo Creek, should they be necessary they would be constructed to specific enhanced standards. These standards would require practices such as gravel road tread surfacing across streams.
- In addition to standard state Streamside Management Zone regulations, Plum Creek will be providing extra riparian protection along some streams. Extra protection is targeted for watersheds that contain bull trout, streams with channel migration zones, and streams that have plane-bed forced pool riffle morphology. Riparian buffers must also be enhanced with additional leave trees when streamside roads inhibit recruitment on the opposite side of the stream.

For more information on the NFHCP, the reader can visit Plum Creek's website at the following address: http://www.plumcreek.com/environment/fish.cfm.

7.3.4 Other Watershed Improvement Opportunities: Fish Passage Restoration

In support of this watershed restoration effort, thirty-two culverts were analyzed for their ability to pass adult native fish during migration periods (Hoffman and Sylte, 2001). Based on consultation with Lolo National Forest and Plum Creek fisheries biologists, these 32 culverts are thought to comprise the most important culverts in the watershed that could potentially restrict access to suitable upstream habitats (i.e., streams that have sufficient flow and suitable slopes). Assessed culverts include many that are cost-shared between the Lolo National Forest and Plum Creek. Several others are managed by the Montana Department of Transportation and a few are under separate Plum Creek or Lolo Forest jurisdiction.

Fish passage was assessed using the FishXing computer model. One or more fish passage limitations were predicted for all of the thirty-two culverts studied. FishXing predicted that high passage flows restricted passage in 81% of the modeled culverts for some period of time during the general migration period. Because we do not know the exact timing of cutthroat migration in the Upper Lolo Creek watershed, the magnitude or biological consequences of any delay is unknown.

Insufficient depth at low passage flow was predicted for eighteen of the thirty-two modeled culverts (56%). All of the twenty-two culverts with perched outlets were predicted to be leap barriers. However, it appears that the leap barriers were more a function of flow velocity than perch height.

Before this information is used to develop site-specific action plans, additional analysis is recommended. Where culverts are predicted to be velocity barriers, site specific validation of high passage flows and fish migration timing should be undertaken. In locations where culverts were found to pass cutthroat in the spring, but low flow-depths were predicted to prevent passage of adult bull trout, fish biologist should be consulted to verify that suitable bull trout spawning habitat occurs upstream. Additionally, biologist should inform land managers on the highest priorities for restoration to ensure the wisest use of limited financial resources.

In the original assessment culvert gradients were not measured to the accuracy needed for hydraulic modeling. Except for the Highway 12 culverts, all culvert gradients have been remeasured and results were incorporated into new hydraulic calculations. Currently, MDT is under contract with Maxium Technologies to remeasure existing culverts. For greater modeling accuracy, culvert gradients on the Highway 12 culverts should be re-measured. Before detailed action plans can be developed, it is recommended that local fisheries biologists perform additional on-site investigations to verify and prioritize actual migration needs.

7.3.5 Montana Department of Transportation

Accurate estimates of the sediment loading from both the cut and fill slopes and runoff carrying traction sand are difficult to achieve because of the historical sediment control and revegetation of these areas and the incomplete sand application and removal records. Additionally, there has not yet been sufficient effectiveness monitoring of BMP application to show whether current practices are working as expected.

MDT has initiated a detailed research project that will identify the most effective designs and maintenance procedures for keeping road sand from impacting nearby bodies of water. As the results of this research are identified, MDT will continuously incorporate these findings into management procedures in order to increase the effectiveness of its road sand management. In addition, results from a recent field study conducted by Maxim Technologies will help determine where upgrades and mitigation are needed most. The purpose of that study was to identify all fish passage barriers and to develop a map that depicts sections of the highway and their level of risk to impacting the stream channel.

Measurement procedures instituted by MDT for the 2002-2003 winter driving season are designed to develop a more accurate estimate of road sand usage and recovery and will be used to gauge the level of success of maintenance BMPs that have been developed. Additionally, MDT is planning to develop a statewide traction sand maintenance and application protocol following their current study. The outcome of this plan is expected to promote protection of both the motorists and the local stream channels.

With the goal of reducing the impacts of U.S. Highway 12 on sediment loading in the West Fork of Lolo Creek, MDT agrees to pursue the following BMPs, where consistent with the principles of traffic and employee safety:

1. When possible, slow down snow plow speeds to help decrease sand/snow mix from entering the stream;
2. When possible, use a snow blower to blow additional snow build-up away from the stream channel, when doing so does not endanger snow-slope stability or safe traffic flow;

3. Monitor, maintain and upgrade existing ditch blocks as necessary;
4. Monitor, maintain and upgrade existing sediment catch basins as necessary;
5. Increase the use of chemical deicers and decrease the use of road sand, as long as doing so does not create a safety hazard or cause undue degradation to plant and water quality;
6. Explore revegetating key cut and fill slopes, with a goal of 70% vegetation cover of these areas;
7. Provide post-winter sand removal from the roadway with mechanized pick-up brooms;
8. Improve maintenance records to more accurately estimate the use of road sand and chemicals and to estimate the amount of sand recovered; and
9. Continue to fund and manage the MDT research projects, which will identify the best designs and procedures for minimizing road sand impacts to adjacent bodies of water, and incorporate those findings into additional BMPs.

In addition to the sediment control measures identified above, MDT's Maintenance Division has researched and purchased state-of-the-art winter maintenance snowplow equipment that will soon be available for use on Lolo Pass. This equipment has computer controls to help ensure accuracy and proper distribution of sanding materials, and infrared thermometers to help operators determine the correct materials to use (sand versus liquid deicer). In addition, MDT continues to modify and experiment with aggregate gradations to find appropriate blends of aggregate to apply that will ensure traffic safety while limiting broken windshields and lessening negative impacts to air and water quality. Solid and liquid chemical specifications are strictly specified and controlled to minimize negative impacts to the environment and infrastructure. MDT has developed Best Management Practices (BMPs) for all maintenance activities, included these BMPs in maintenance manuals.

7.3.6 Missoula Conservation District, NRCS

Missoula Conservation District (MCD) and the NRCS have assisted forest landowners in testing and recommending grass seed mixtures that will be most successful at re-vegetating disturbed areas on Upper Lolo’s granitic soils (Comfort 1999, 2001).

Future involvement of the MCD in Upper Lolo will primarily consist of technical assistance and review of any planned culvert replacements on perennial streams, as required under Montana’s Natural Streambed and Land Preservation Act (310 Law).

MCD will actively be involved in restoration planning for the lower portion of the Lolo Creek TMDL planning area, since coordination with numerous small private landowners will be required.

7.4 Implementation Summary

The implementation strategies outlined above were created to help reduce sediment input to the streams of the Upper Lolo TPA. While collaborative efforts among stakeholders will occur in some instances, independent efforts will be occurring as well. DEQ would foster efforts among stakeholders and serve as the facilitator of updated technologies, new data and information and success within the Upper Lolo TPA. The outline below briefly describes the implementation efforts proposed for each stakeholder, with the acknowledgement that additional efforts may be included as new technologies arise.

- **Lolo National Forest:** Major improvements and reclamation to the forest road system.
- **Plum Creek Timber Company:** Major road improvements as outlined in their NFHCP.
- **Montana Department of Transportation:** Implement new mitigation and management strategies (outlined in Section 7.3.5) designed to minimize traction sand input into stream channels. Implement mitigation recommendations as outlined in recent study (Maxim Technologies, 2002). Implement new technologies and management techniques summarized following completion of current research project by Montana State University.
- **Missoula Conservation District:** Continue to work with local stakeholders to provide technical assistance with restoration efforts.
- **DEQ:** Assist with data collection as necessary and feasible. Continue to serve as data storage and analysis facility. Continue to provide information on current water quality standards and new technologies. Serve as liaison and coordinator among stakeholders.

SECTION 8.0
MONITORING PLAN AND ADAPTIVE MANAGEMENT STRATEGY

Monitoring of resource conditions in Upper Lolo are planned by the Lolo National Forest, Montana Department of Transportation and Plum Creek Timber. Planned monitoring is summarized in the following sections.

8.1 Monitoring Plan

As described in Section 7 above, each stakeholder is committing to various degrees of mitigation measures and management changes to help achieve water quality targets. The primary focus of this water quality-monitoring plan can be described by the following objectives:

1. Document water quality trends associated with proposed implementation efforts.
2. Establish additional permanent monitoring sites and collect additional data within the TPA to help better define water quality targets.
3. Monitor progress towards meeting water quality targets.
4. Conduct an adaptive management strategy to fulfill requirements of this WQRP.

This monitoring plan will address the need to evaluate the progress toward meeting or protecting water quality standards and associated beneficial uses (Montana State Law (75-5-703(7) and (9)). The monitoring plan will also address the tracking of specific implementation efforts, much of which is discussed above in Section 7. It is anticipated that the stakeholders will help develop monitoring details and help pursue funding for monitoring and data evaluation. The Upper Lolo Water Quality Protection Monitoring Plan may include, but is not limited to the following:

- Establishment of permanent bench-marked cross-sections whereby channel pattern, dimension and profile can be tracked through time using Rosgen Level II parameters (width/depth ratios, entrenchment ratios and sinuosity) and techniques (Rosgen, 1996).
- Collect additional parameters (V*, pool frequency) as outlined in Section 5.2.1.
- In conjunction with cross-sectional data collection, particle size distribution data would be collected using Wolman pebble count procedures through riffles at the established cross-sections (Wolman, 1954).
- Conduct a road sediment assessment using the Forest Road Survey (FRS) for select watersheds in which recent forest management activities have taken place.
- Monitoring of redds and fine sediment, and associated documentation of the results, should occur on a yearly basis.
- Monitor population status of native salmonid species and report findings to MTDEQ.
- An updated assessment of channel conditions and other geomorphic indicators should be pursued for the whole length of the Lolo Creek Watershed to help determine existing conditions and help track potential future impacts to this important water body and to tie in with future downstream TMDL development.

- Track the effectiveness of BMPs on forest roads and U.S. Highway 12 and other mitigation measures at meeting targets. This could be done by comparing existing in-stream data to data following upgraded practices and mitigation measures.
- The Forest Service currently has a significant amount of stream data on potential reference reaches within the TPA. This information should be incorporated into a database and used to help guide future target setting and evaluation for water bodies in Lolo Creek and elsewhere in the Bitterroot Basin.
- The stakeholders should use data and information to assist the current Clark Fork/Bitterroot model efforts that are being developed.

Watershed monitoring as part of the WQRP will be coordinated between the Lolo National Forest, Plum Creek Timber Company, Montana Department of Transportation, and Montana DEQ. Components of the plan include monitoring trends in levels of surface fines, evaluating the effectiveness of forest road upgrading on spawning gravel composition, implementation monitoring by land managers, and monitoring of other geomorphic and biological variables to be determined by the monitoring partners. These components of the WQRP are discussed in more detail below.

8.2 Implementation monitoring

Tracking progress in implementing watershed restoration actions is planned by watershed land managers. As feasible, Montana DEQ would periodically assist with the compilation of the implementation efforts of the various landowners described below.

Implementation of restoration actions is planned by the Lolo National Forest, Montana Department of Transportation and Plum Creek Timber. Implementation monitoring by Plum Creek Timber will be tracked annually as part of the monitoring commitments in their Native Fish Habitat Conservation Plan (see Section 7.3.3). This will include annual summaries of the length of road upgraded to BMP standards, length of surplus road abandoned, and fish passage barriers corrected.

Should state BMP audits include harvest areas in Upper Lolo Creek, these will be compiled by landowners to serve as future reference in evaluating TMDL success.

The Lolo National Forest plans to continue and increase current monitoring strategies. Monitoring implementation of the Upper Lolo Creek TMDL is proposed as an evolving process, building on what is learned from year-to-year analyses. Some points learned from previous monitoring include:

1. Dimensionless ratios for suspended sediment can aid evaluation of large amounts of previously collected data. However, it is time consuming to compile past data and often stream type information is not available at the monitoring site.
2. Particle size distribution comparison by stream type is able to show trends. Almost all monitoring proposed involves pebble counts in specific stream types and fixed locations.
3. Point bar samples may also prove to be a beneficial form of bedload monitoring.

4. Bedload is an important parameter to consider particularly in granitic landforms such as Upper Lolo; because of direct sampling difficulty little data exist.

8.3 Trend Monitoring of Surface Fines

Annual monitoring of trends in surface fines is planned by the Lolo National Forest at several locations throughout the upper watershed. These sites are shown as open red rings in Figure 10. Information generated from this monitoring will be used in future evaluation of TMDL target attainment. Particle size distributions will be assessed using Wolman pebble counts along riffles in permanent bench-marked stream transects (Wolman 1954) but may be supplanted by other acceptable measures of fines. While the Lolo National Forest will take the lead in this effort, Plum Creek Timber has agreed to assist as necessary in collection of these data. Additionally, it is proposed that MDT explore funding opportunities to monitor surface fines being delivered to the West Fork Lolo Creek from U.S. Highway 12. Methodologies and protocols would mirror the ones being utilized by the other stakeholders. DEQ would work with all stakeholders on monitoring methods and protocols as necessary.

Furthermore, an increase in the number of response reaches and reference reaches are needed in order to adequately judge whether targets are being met. This could be discussed and laid out by the watershed monitoring cooperators following the first year of implementation. To better reflect and utilize reference reach data as it pertains to the Upper Lolo TPA, further stratification of the reference reach data could help draw better conclusions in the future. Some examples are: 1). Stratify by drainage area; 2). Stratify by bank full widths; 3). Stratify by a range of road densities, and 4). Stratify by Rosgen substrate classes. This in turn, would require additional data collection at reference reaches.

8.4 Geomorphic Condition Monitoring

To meet full potential, specific changes need to occur within the stream channel and floodplain. For a stream channel to again become stable, it needs to be able to properly distribute its flow and sediment supply in order to maintain its dimension, pattern and profile without degrading or aggrading. Adjustments occur partially as a result of a change in the stream flow magnitude and/or timing, sediment supply and/or size, direct channel disturbance, and riparian vegetation changes (Rosgen, 1996). Management strategies and additional mitigations outlined in the restoration plan portion of this document would assist in the geomorphic recovery of these segments. It is important to note that "recovery" is defined as "potential for recovery" based on the reference conditions applicable to the streams within the Upper Lolo TPA. Once this recovery is met, sediment loads are expected to reach their expected norm due to efficiency of the system. Putting a time limit on geomorphic recovery can be rather difficult. However, routine measurements of entrenchment ratios, sinuosity and width/depth ratios can show trends over time. These trends can be used to make inferences towards the expected and desired evolutionary stage of the stream channel.

It is suspected that segments of the streams within the Upper Lolo TPA have digressed into an evolutionary stage that is not currently functioning properly. Riggers and Sylte pointed out that stream length has been lost on several streams within the Upper Lolo TPA. In addition to natural recovery, these channels need relief from the chronic excess load that is suspected to be entering their systems. It is anticipated that mitigation efforts outlined in Section 7 would assist in this recovery effort. In order to effectively track the effects of the proposed mitigation measures outlined in this plan, permanent monitoring stations need to be established. As outlined in Section 8.1, bench-marked cross-sections would be established throughout both response and reference reaches. Rosgen Level II and Level III parameters (Rosgen, 1996) would be collected to establish the existing conditions and determine the expected evolutionary stage. Data could then be collected biannually to report and track changes over time and report and departures that may occur.

8.5 Effectiveness Monitoring

As part of the adaptive management and monitoring commitments in the NFHCP, Plum Creek will be measuring trends in spawning gravel quality in East Fork Lolo Creek (treatment watershed) relative to North Fork Granite Creek (control watershed). These sites are shown as solid red dots in Figure 9. Spawning gravel will be collected with a McNeil corer and particle size distributions measured with wet sieving (Schuett-Hames et al. 1994). Plum Creek is specifically evaluating whether or not reducing sediment supply to the East Fork results in a statistically significant improvement in the percentage of fines in spawning gravel relative to a control site. In addition, ongoing MDT research is identifying the maintenance practices and engineering design features that are projected to be most effective in minimizing sand deposition to West Fork Lolo Creek while providing transportation safety. The MDT project may provide implemental practices/design standards for use in the fall of 2003.

8.6 Adaptive Management Strategy

As monitoring data is obtained and evaluated, DEQ in partnership with the stakeholders will adjust load allocations as necessary to meet targets, especially those targets associated with in-stream conditions. Additionally, targets could also be adjusted. These adjustments would take into account new technologies as they arise.

The adaptive management strategies discussed previously (Sections 3.6, 5.2.1, 5.6, and 6.3) are outlined below:

- **Impairment Status:** As discussed in Section 3.6, uncertainties with the current impairment status exist. Therefore, further review and analysis needs to occur in order to adequately address the water quality impairments in the Upper Lolo TPA. Utilization of the approaches discussed in Sections 8.1, 8.2, 8.3, 8.4 and 8.5 would further assist in this effort. An assessment of the impairment status will occur during the 5-year review period of this WQPR.

- **Load Allocations and TMDLs**: As discussed in Sections 6.1 & 6.2, uncertainties exist with the current load allocations and subsequent TMDLs. A starting point enables stakeholders to measure success in the future. It is felt that efforts would be more wisely spent on implementation and monitoring successes, rather than redeveloping loads. However, adjustments in the future could be made as appropriate. These adjustments would occur, if necessary, following the 5-year review of this WQRP.

- **Targets:** In order to set the performance-based targets outlined in Table 13, data from all 5 parameters (pool frequency, V*, entrenchment ratio, width/depth ration, sinuosity) must be collected. These data would be collected at existing sites already established by the Lolo National Forest as well as reference sites (to be determined). Additionally, percent fines data (Section 8.3) would be collected at reference sites. This information would be used to draw better conclusions on the conditions of the reference streams and used for comparison on streams in the Upper Lolo TPA. Percent fines data for Rosgen "E" channel types would be the first priority as the dataset used for the analysis in this WQRP did not contain any "E" channels. Furthermore, a Geographical Information System (GIS) mapping exercise would be conducted to identify Rosgen channel classes within the Upper Lolo TPA. This data could largely be built from existing US Forest Service, Plum Creek Timber and DEQ data. DEQ would lead this exercise.

  The data collection of the in-stream targets (Tables 12 & 13) would aid in an adequate impairment determination. The targets are designed to represent conditions needed for salmonid reproductive success and full beneficial use support. While existing reference data for the parameters in Table 13 do not exist, standard collection methodologies would be used within the Upper Lolo TPA to collect these parameters. Collection would occur at both existing monitoring sites and potential reference reaches within the Upper Lolo TPA. These sites may be identified as more data and knowledge of the area becomes available. At the end of 5 years, an evaluation of BMP implementation, target compliance and beneficial use determinations would be made. At this time, recommendations would be made by MTDEQ to ensure that the goals of this restoration plan are being met. If, at that time, any one goal or target is not being met, an evaluation would be made that would determine one or more of the following:

  - Adjustments to land-use activities;
  - Make changes to original targets;
  - Collect additional data and reevaluate next cycle.

  To ensure reasonable and equitable decisions are made regarding future target and/or management adjustments, DEQ would evaluate and compare both reference and TPA stream data collected under this WQRP with the data collected prior to the development of this plan.

  Additionally, if at the 5-year evaluation period it is found that any or all of the streams within the Upper Lolo TPA are fully supporting beneficial uses, steps would be taken to ensure that management practices and mitigation measures outlined in this WQRP would continue. While favorable management practices would be expected to continue, the level of monitoring outlined in this WQRP could be revised. At this time, the monitoring strategy could be scaled back in both the frequency and intensity. While a downsizing of the monitoring program may or may not take place under these circumstances, enough monitoring would occur to ensure that trends could still be observed. Therefore, ensuring that full beneficial use support remains in place.

- **Restoration Indicators:** Three restoration indicators outlined in section 5.4 need additional explanation:

  Geomorphic indicators: These indicators include such parameters as sinuosity, entrenchment and width depth ratios and other Rosgen Level II parameters. While these indicators are relatively difficult to assess spatially in the pool/riffle channel types, general trends could still be tracked and monitored.

  Sufficient number of age classes of salmonids: Fish population indicators would be set following routine data collection and recommendations of local fisheries biologists.

  Macroinvertebrate indicators: As outlined in DEQ standard protocols, macroinvertebrate collection would be used to identify overall health of the stream as compared to reference conditions. These collections could occur annually at existing monitoring sites and would help indicate aquatic life support.

8.7 Monitoring Strategy/Adaptive Management Summary

Each stakeholder has committed to various levels of monitoring as part of this WQRP. While initial efforts may appear vague, they are expected to become more defined and concise as more information about sediment in the Upper Lolo TPA is collected.

The overlying premise of this monitoring plan is to better understand sediment transport in the Upper Lolo TPA. Continued data collection and analysis of both reference and TPA streams will help towards understanding the impairment status of each stream.

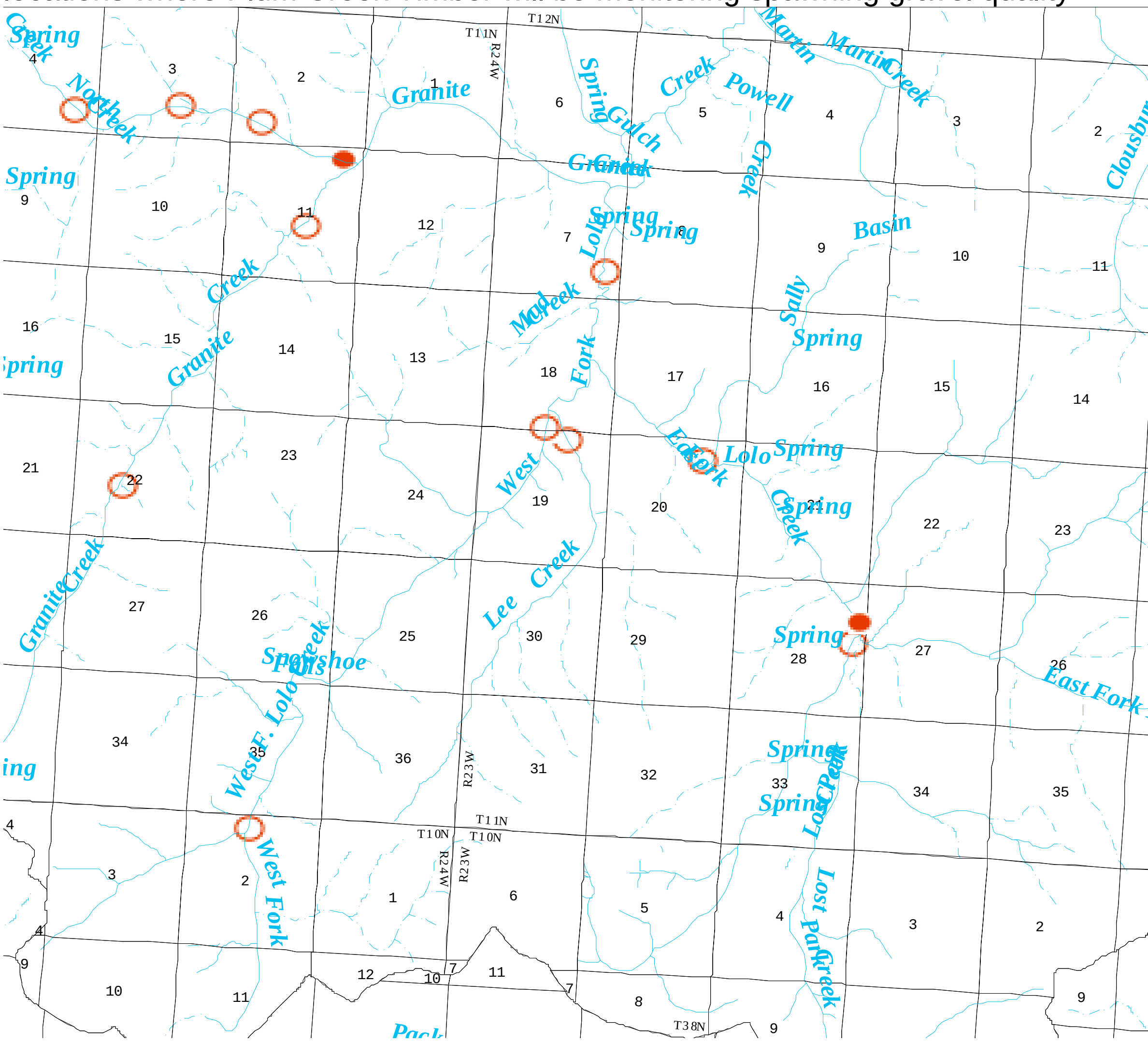
While collaborative efforts among stakeholders will occur in some instances, independent efforts will be occurring as well. As with the implementation strategy outlined in Section 7, DEQ would foster monitoring efforts among stakeholders and serve as the facilitator of updated technologies, new data and information and success within the Upper Lolo TPA. The outline below briefly describes the monitoring efforts proposed for each stakeholder, with the acknowledgement that additional efforts may be included as new technologies arise.

- **Lolo National Forest:** Continue and increase current monitoring activities. This would entail collecting parameters outlined in Table 13 along reference and Upper Lolo TPA impaired streams as feasible. The Lolo N.F. will work with DEQ to collect data and monitor newer parameters such as V*. The Lolo N.F. would also be assisting in geomorphic monitoring as outlined in Section 8.4. Additionally, the Lolo would employ temperature probes in some of the (Granite Creek) Upper Lolo TPA streams as feasible.
- **Plum Creek Timber:** Continue to monitor the effectives of BMPs and mitigation through internal BMP audits. Measure trends in substrate quality through efforts outlined in their NFHCP. Assist the Lolo N.F. with trend monitoring as necessary.
- **Montana Department of Transportation:** Continue research to help identify and utilize the best available technologies and mitigations that would benefit water quality while ensuring public safety.

- **DEQ:** Continue to monitor and track substrate trend over time by collaborating with local stakeholders. Continue to serve as data storage and analysis facility. Continue to provide information on current water quality standards and new technologies. Serve as liaison and coordinator among stakeholders.

Finally, DEQ would assist with both the collection and analysis of monitoring data as necessary and feasible. DEQ would comment on and provide recommendations on any newly developed plans for monitoring in the Upper Lolo TPA. DEQ would compile both stakeholder and DEQ data to analyze trends and make inferences about potential changes to this WQPR at the 5-year evaluation.

Figure 10. Sediment monitoring sites in Upper Lolo. Open rings are locations where the Lolo National Forest will be monitoring trends in surface fines. Closed red dots are locations where Plum Creek Timber will be monitoring spawning gravel quality.



SECTION 9.0
PUBLIC INVOLVEMENT

Montana DEQ initiated this project in May of 1999. On June 23, 1999 forest landowners and agencies first met to discuss restoration planning. Participants included the Lolo National Forest, Plum Creek Timber Company, Missoula County Conservation District, Montana Department of Environmental Quality and the Natural Resources Conservation Service. As an outgrowth of this meeting, technical specialists from the Lolo National Forest and Plum Creek Timber coordinated sediment and culvert inventories in the fall of 1999. Montana Department of Transportation was also contacted and funded an assessment of sediment delivery associated with Highway 12.

In early 2000, the Missoula County Conservation District profiled the Upper Lolo Creek watershed project in their quarterly newsletter.

Additional assessments of Upper Lolo streams were completed in the summer of 2000, and a meeting of watershed stakeholders was held in December 2000. In addition to the initial participants, this meeting included Montana Department of Transportation, Montana Department of Fish, Wildlife and Parks, and the US Environmental Protection Agency.

Additional discussions and meetings between DEQ and the Lolo National Forest, Plum Creek Timber and MDT have transpired throughout 2002. These discussions were designed to get an understanding of future stakeholder involvement with the Upper Lolo TPA.

As for this water quality restoration plan, a one-month public comment period was started on November 28, 2002. A stakeholder comment secession and formal public meeting were held on December 16, 2002. MDEQ reviewed and responded to comments and attempted to incorporate them where possible. Any future significant revisions to this plan or identification of water quality impairment conditions on future 303(d) lists will also undergo public review.

This final document reflects modifications made in response to the written and verbal comments received throughout the public comment period. The written comments and respective responses to those comments are provided in Attachment A.

SECTION 10.0
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APPENDIX A:
DEQ RESPONSES TO WRITTEN PUBLIC COMMENTS

1. Watershed Impairments and Reference Conditions

COMMENT 1a: We understand that DEQ believes the waterbodies in Upper Lolo are not fully supporting their beneficial uses. However, there are several pieces of evidence that suggest beneficial uses may in fact be supported. First, the draft TMDL does not mention an analysis of suspended sediment data collected by the US Forest Service found that the average TSS concentrations in Lost Park Creek were not significantly different than that found in a reference watershed (North Fork Granite Creek). Second, biological data have not been collected that demonstrate that the aquatic communities are in fact impaired. While there is a lot in the way of opinion on the subject, there is in fact no data to support the opinions. Lastly, the existing level of in-stream fines are not significantly different than reference data from streams draining granitic geology in the Bitterroot National Forest and Salmon River Basin. DEQ dismisses this last claim stating that the monitoring data are not extensive enough to know whether or not the streams are similar to reference.

We believe that DEQ could have defensibly argued that these streams are not appreciably different from a reference condition. Since DEQ has not chosen to make this case, we ask that the points listed above be incorporated in the document in terms of a statement of uncertainty regarding the beneficial use support status.

> **DEQ RESPONSE:** This comment has 3 parts. First, total suspended solids (TSS) concentration data was not used in the overall analysis of the existing data because TSS does not directly correlate to the current impairment listings in the Upper Lolo TPA. The current pollutant impairment listing is “siltation”. EPA (1999) defines siltation (or sedimentation) as: *Process of deposition of waterborne or windborne sediment or other material; also refers to the infilling of bottom substrate in a water body by sediment (Siltation).* Additionally, recent studies (Gray et. al, 2000, and USDA, 2001) have concluded that the analytical methodologies used in TSS samples are unreliable and typically result in unacceptably large errors. However, this does not preclude TSS from ever being used in the TMDL process. Existing data, future data collection potential, drainage characteristics and pollutant affects on impaired beneficial uses would dictate the level that TSS may or may not be used in future TMDLs.
>
> Secondly, substantial biological data have been collected for the five streams as documented in the Sufficient Credible Data/Beneficial Use Determinations (SCD/BUD). This biological data is contained in numerous reports including: 10 reports for Granite Cr., 6 reports for Lost Park Cr., 5 documents for Lee Cr., 10 documents for East Fork Lolo Cr., and 5 documents for West Fork Lolo Cr. These reports provide high levels of biological impairment data for each water body. All five waters had data that was more than the minimum needed for sufficient credible data level (see year 2002 SCD/BUD assessments at DEQ/NRIS website) for making impairment determinations.

Thirdly, the original database had 450 data points, the database used in the reference reach analysis had 229 data points, while the impaired streams within the Upper Lolo TPA only had 2 data points. DEQ feels that 2 data points are not sufficient enough to make any "levels of significance" determinations. Given the natural variability that occurs within any particular watershed, it is favorable to increase sampling numbers to increase precision. Basic statistics suggest that by increasing the number of cases per sample, you increase the level of significance and confidence.

Finally, the level of uncertainty surrounding the impairment status was acknowledged in Section 3.6 and the monitoring strategies outlined in Section 8 are designed to better understand the status of the streams in the Upper Lolo TPA.

COMMENT 1b: Section 3.4.4 – There is a sentence that states Lee Creek is limited by natural bed load and increased fines from existing roads based on a personal communication. Given that Lee Creek was found to have very low fine sediment delivery from forest roads (<10% above background), it is difficult to believe that this is a significant limiting factor for the fishery.

DEQ RESPONSE: The statement made in this section does not claim that sediment from roads is the limiting factor affecting fish, but does state that there are increased fines in Lee Creek that are nearly two-times greater than the unroaded North Fork Granite Creek.

COMMENT 1c: Section 3.4.5 –Riggers (1994) is cited as finding that five of six habitat measures have changed significantly from reference conditions. I am not familiar with this document and would like to learn more about what it found. Note that this reference is not listed in the document.

DEQ RESPONSE: The final document has been revised to reflect this comment.

COMMENT 1d: Section 3.5 – The document states that the functioning reference streams were by in large made up of managed drainages. We do not believe this to be an accurate statement.

DEQ RESPONSE: The reference reaches are in fact, made up of managed *and* unmanaged drainages.

COMMENT 1e: Section 3.5 – Other applicable published reference data from fine sediment in granitic streams should be included in this analysis. These include data for the Salmon River Basin in Idaho (Overton et al. 1995) and the Routte National Forest in Colorado (Schnackenbert and MacDonald 1998).

DEQ RESPONSE: While utilizing reference reach data from other regions might be useful, it was felt that local reference reach data from within the same basin (Bitterroot) would be more appropriate.

COMMENT 1f: Section 3.5, Table 5 – We should remove the discussion of "non-functioning" streams on the Bitterroot NF since they really don't relate to this exercise.

DEQ RESPONSE: The purpose of describing reference conditions is to illustrate the characteristics of these two classes of streams, thus showing the differences between potentially impaired streams and those streams that fully support their beneficial uses. Additionally, "non-functioning" has been changed to "non-reference" in the final document.

2. Pollutant Loads and TMDL Allocations

COMMENT 2a: Section 4.3 – I am not sure that the first two paragraphs in this section are particularly helpful for the document. Why are we summarizing a study that compared impacts of roaded vs. unroaded watersheds? I thought the objective of this section was to estimate pollutant loads.

DEQ RESPONSE: The purpose of this section *is* to address pollutant loads. The discussion of road densities and subsequent studies show that sediment production increases as road density increases. Additionally, it links up the rationale for the road restoration activities (closures and obliterations) proposed by stakeholders in Sections 7.3.2 and 7.3.3.

COMMENT 2b: Table 7 [estimates of background (natural) loading] gives a range of natural loading to the Upper Lolo sub-watersheds based on three independent approaches. For example, the estimates for natural loading for the West Fork of Lolo Creek range from 145.9 tons/year to 612 tons/year. Since a "best estimate" of natural loading does not appear to be available for these watersheds, MDT believes that the range of values should be stated in Table 8, rather than the single values that are presently shown.

DEQ RESPONSE: First, all of the table numbers have been updated in the final document, so the draft Table 7 is now Table 10. Table 10 represents estimated (background and natural) loads. Table 11 represents both estimated natural and estimated anthropogenic loads. Finally, the natural "load" was calculated taking the average of the three methods previously outlined in Table 10 and as discussed in Section 4.7.

COMMENT 2c: Page 31, Section 4.4, Stream Crossing Failures on Forest Roads. The last paragraph notes that the stream crossings with "at-risk" fills are not contributing to the current sediment load. The at-risk fills are not part of the calculation however the stream crossings may be contributing surface erosion from the road upslope from the crossing. The current wording is unclear on that point.

DEQ RESPONSE: The Forest Road Survey method assigns a delivery potential to all stream crossings as appropriate. The "at-risk" crossings are at risk of failing and ultimately contributing a large pulse of sediment as compared to the expected current input. These crossings are mentioned because they are a high priority for preventative remediation.

COMMENT 2d: It is not MDT's intent to speculate on the sediment loads that result from other stakeholders' activities. However, since Table 8 states the "Estimated Loads" from all stakeholder activities (including MDT's) as well as a total estimated load, it is important to place MDT's contribution to the total sediment load in an accurate context.

The category "Misc. Upland" on Table 8 is assigned an estimated load of "Negligible". Since the other source categories are Forest Roads, Natural, Culvert Failure, and Highway 12, "Miscellaneous Upland" must encompass sediment sources associated with other forest practices besides roads. Examination of aerial photographs of the West Fork drainage basin reveals a heavy concentration of logged areas and clear cuts. It appears unlikely that this degree of logging activity results in a negligible amount of sediment supplied to the West Fork. A review of the literature on cumulative watershed effects indicates that heavy rain events, especially rain-on-snow events which are common in this area, result in significant erosion of deforested areas such as the logged portions of the Lolo Creek watershed. When the steep slopes and highly erodible granitic terrain of the West Fork drainage basin are taken into account, it is likely that the effects of past and present forest practices on total sediment loads are not negligible. (Appendix E of Ethridge and Heffernan, 2001 (a cited reference in the Draft TMDL) places most of the logged areas in the West Fork drainage in the "High Erosion Hazard" category for these reasons.)

> **DEQ RESPONSE:** It is not inconceivable that forest practices such as timber harvest have had an effect on sediment delivery to streams within the Upper Lolo TPA. Typically, impacts are greatest immediately following ground disturbing activities; before stabilization and recovery occurs. The best available existing data and current studies conducted in the Lolo TPA suggested that vegetative and partial hydrologic recovery have occurred since the most recent disturbance activities and, thus are currently resulting in negligible impacts. Additionally, many of the forestry activities have occurred on segments of the landscape that were not conducive for delivery to stream channels.

COMMENT 2e: Section 6.1, Table 11 – To make Table 11 consistent with Table 12, the Forest Road contribution (existing) for WF Lolo is 19 tons/yr (see also Table 6). The controllable load is a 33% reduction from 19 tons/yr, which would be 12 tons/yr.

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

COMMENT 2f: Page 44, Section 6.1. More information on how the value of 33% as the load reduction factor for the West Fork was determined would be helpful.

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

COMMENT: Page 45, Section 6.2. More information on how the load reduction factors for these streams were determined would be helpful. Also, for clarity in the sentence discussing an estimate of natural background sediment loading, use quotes around the term "low literature estimate" and refer to the table on page 37.

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

COMMENT 2g: Section 6.2, Table 12. The existing load in these tables is not correct. As shown earlier in Table 6, the existing loads are as follows: Granite Creek (96 tons/yr); Lee Creek (9 tons/yr); Lost Park Creek (21 tons/yr); and EF Lolo (53 tons/yr).

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

COMMENT 2h: Section 6.2 – The four-point bullet list below Table 12 also needs to be corrected.

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

COMMENT 2i: Table 4 lists "Highway maintenance and runoff" as probable sources of impairment of Lost Park Creek and East Fork Lolo Creek. Highway 12 only parallels the West Fork of Lolo Creek and is not a contributor of sediment to Lost Park Creek or the East Fork of Lolo Creek. (This comment also applies to Table E-1 on the Executive Summary.)

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

COMMENT 2j Have the mining claims along the ridge between Granite Creek and the West Fork Lolo Creek been considered as potential erosion sources off their tailings/digging piles and disturbance? They are mining for crystals.

> **DEQ RESPONSE:** DEQ was unaware of any crystal mining occurring within the TPA. However based on the location within the watershed and the fashion by which the crystals are being extracted, we suspect that little impact if any water quality impact is occurring to Granite Creek or the West Fork Lolo Creek.

COMMENT 2k: It is inconceivable to us that DEQ proposes that the sediment load from Highway 12 not be included in the TMDL load allocation for West Fork Lolo Creek. The purported justification for this is a low level of certainty about the existing loading estimate. In my reading of the Land and Water report, I do not find their approach unreasonable given the resources provided by MDT. While percentage delivery estimates were based on professional judgment, this does not seem an indefensible approach. There are long stretches of the highway that are well away from the stream which Land and Water assumed to deliver little or no sediment. This seems reasonable. Conversely, there are other segments that are assumed to contribute a high percentage of the sand applied. This also does not seem unreasonable, especially where the creek is a matter of feet from the road, snowplows wing snow directly into the creek, cut slopes are poorly vegetated, ditches route directly to streams, and what sediment control structures do exist are poorly maintained. If you have witnessed this stretch of highway during the spring, it is easy to believe that 20 dump truck loads (~500 tons) are delivered to the stream on an annual basis from highway sanding.

We think that the Land and Water data should be used as the basis for the Highway contribution to the West Fork. Should MDT fund subsequent studies that determine the load is different that originally assumed, they can work with DEQ to revise the load allocation. Two and a half years have passed since Land and Water submitted their report to MDT - two winters that MDT could have improved their loading estimate but have not chosen to do so.

If the Highway 12 load is not included in the load allocation, DEQ and the TMDL process will lose a tremendous amount of credibility in the eyes of the forest products community, as well as others. With MDT being a state agency, they should be a leader in the TMDL program, rather than a follower.

COMMENT 2l: Section 7.3.5 – There is nothing in here about when a load allocation for highway sanding will be developed for WF Lolo.

COMMENT 2m: A major concern to us is the sediment contribution from Montana Highway 12 is not included in the TMDL. It was our understanding that TMDLs must account for all significant sources of sediment and the omission of Montana Highway 12 from the equation is at best puzzling. The contribution from highway sanding and the poorly vegetated right-of-way is without a doubt a significant source, even to a casual observer. Based on initial sediment delivery estimates, highway sanding may exceed the contribution from all forest roads in the planning area combined. The perception would be there is a double standard in how non point source pollution is addressed in the State if Montana Department of Transportation sanding activities are excluded in the TMDL load allocation. We at MWPA are certain that was not the intent of the Department of Environmental Quality and trust that the highway sanding sediment load issue will be addressed in the final TMDL and restoration plan.

COMMENT 2n: In order for the Final TMDL for Upper Lolo Creek to have any credibility, the current best estimate (based on existing reports) of contributions from the Montana Department of Highways must be included. Should additional information or data become available, the TMDL can be revised at a later date. However, to exclude or ignore the obvious, well known by the general public and substantiated in numerous ways, is to cast doubt on the credibility of the entire TMDL that DEQ has worked diligently to produce.

> **DEQ RESPONSE TO COMMENTS 2k-2n:** The final document has been revised to reflect these comments.

COMMENT 2o: Section 4.5 ("Surface Erosion, Sanding, and Maintenance of Highway 12") of the Public Comment Draft, Water Quality Restoration Plan and TMDL for the Upper Lolo Creek TMDL Planning Area states: "From this study [*Land & Water, 2000*], a delivery of ~518 tons/year was projected for the portion of U.S. 12 that lies within the Upper Lolo TPA." This estimate of 518 tons per year is also quoted in Table 8 of the Draft TMDL.

While the Montana Department of Transportation (MDT) acknowledges that the amount of road sand entering the West Fork of Lolo Creek may be substantial, it is also clear that insufficient documentation exists to justify the statement that 518 tons of road sand are entering the creek. Among the uncertainties that make such a numerical estimate impossible at this time are:

a) No adequate estimate exists for the actual amount of road sand that is applied to the TMDL portion of Highway 12 during a typical winter season;

b) Land & Water's assumption that 75% of the road sand that is applied to the entire 32.8 miles of Highway 12 is placed on the first 7.7 miles (Lolo Pass to Lolo Hot Springs) is not correct and inflates the final tonnage estimate considerably;
c) At present, no estimate exists of the amount of road sand that is trapped each year in the eleven sediment catchment basins that MDT constructed in 1995;
d) At present, no estimate exists of the amount of road sand that is trapped and removed by the numerous ditch blocks that MDT installed in 1995 and cleans and replaces annually;
e) Insufficient documentation exists in the Land & Water report to identify the tons per year of road sand delivered into Lolo Creek. In particular, no backup data or documentation is given for the delivery factors (the percentage of the sand applied to the roadway that reaches the creek). In the Land & Water report, 26 out of the 38 roadway segments in the TMDL area were given delivery factors of 50% or greater, with no explanation; and
f) Mathematical errors in the tonnage calculations in the Land & Water report render these numerical estimates highly unreliable.

In contrast, the Draft TMDL document for the Blackfoot Headwaters watershed (which includes the Rogers Pass and Flesher Pass highways) employs a different method to estimate the amount of winter traction sand that reaches the adjacent rivers and streams of that area. When this method is applied to the West Fork Lolo Creek - Highway 12 area, the result is an estimate of 72 tons/year of winter traction sand reaching the West Fork of Lolo Creek. While this alternative estimate is not definitive (nor is the Land & Water estimate), it serves to illustrate the range of values that arise when estimating load tonnages by different methods. Table 8 and the TMDL text should reflect this range of values, (not just the Land & Water estimate) and the fact that the actual numbers are poorly understood. Both the 518-ton and the 72-ton estimate should be considered semi-quantitative. They will be refined by monitoring activities that MDT is presently undertaking to identify the quantities of road sand that are being applied to the roadway and the amount of road sand being recovered by the many sediment trapping devices. These more refined estimates will allow a better estimate of road sand delivery to the West Fork of Lolo Creek, which can then be used in load allocations for this portion of the Upper Lolo Creek TMDL.

DEQ RESPONSE: The Land and Water (2000) semi-quantitative highway sanding estimate is described in Section 4.5 because it provides a publicly published preliminary loading estimate. DEQ anticipates that current estimates of highway sanding will be revised as future studies develop improved load allocations and restoration activities for West Fork Lolo Creek. These more complete and accurate estimates will make possible the setting of more accurate targets and load allocations for highway sanding.

DEQ agrees that improved future estimates will be necessary in developing the final load allocations for West Fork Lolo Creek and proposes to reevaluate these allocations at the five-year review process (see section 8.6). However, until these improved estimates are developed, a reasonable preliminary estimate (or range of estimate) is more useful than either extremely wide bands of quantitative uncertainty or a qualitative estimate of “substantial” traction sand effects.

Finally, DEQ has taken the suggested alternative loading calculation that was applied in the Blackfoot and estimated loading numbers for the West Fork Lolo and U.S. Highway 12. The calculations were adjusted to better represent the West Fork Lolo Creek (i.e. elevation, slope, soil type and highway proximity to the stream channel). This exercise resulted in a reasonable numeric value (425 tons) that is analogous to the one derived from the Land & Water study. However, this method is still an estimate and contains noteworthy levels of uncertainty. DEQ recognizes this uncertainty and acknowledges that the attainment of these loading values is difficult at best. DEQ also recognizes the variability among methodologies and propose that a reasonably tight range would be used to account for that variability. Therefore, the TMDL will utilize a range (425-518 tons) as a starting point for the load allocation from U.S. Highway 12. Recognizing that a starting point provides a baseline by which success could be measured in the future. The final document has been revised to reflect the above comment and this response.

3. Restoration Targets

COMMENT 3a: The draft TMDL proposes a range for the in-stream target based on the upper and lower 90% confidence interval around the mean. For example, for B channel types in Bitterroot reference streams, the mean level of fines was 13%, with a 90% confidence interval of about 2. This means that the mean level of fines could actually be anywhere in that range (11-15%). Statistically speaking, the mean reference condition is being proposed as the target. This is of concern since half the reference streams (or more) could fail to meet the target. We believe that some other statistical measure would make more sense. In EPA's national guidance for setting nutrient criteria, they suggest that the 75th percentile of a reference distribution might be an appropriate measure. For the same B channel type discussed above, the 75th percentile would be a value of 21%. While this still means that 25% of reference streams would fail to meet the target, it seems more appropriate than the 90% CI.

DEQ RESPONSE: A variety of statistical analyses were conducted to try and establish percent fines targets that would best represent reference conditions while still allowing for natural variability. However, given the nature of the available data and the distribution of that data no one analysis proved better than the next for establishing targets.

Therefore the 75th percentile of the reference data was chosen because it was felt that it provided the most achievable targets that best represent reference conditions. This methodology is also the recommended approach by EPA (1999). As more percent fines data is collected, it may be appropriate to adjust the percent fines target, based on an increased understanding of the uncertainty associated with the natural variation of the percent fines target and the sampling methodology. Consequently, the numeric targets presented in this document would be subject to adjustment as additional data and analyses are carried out through an adaptive management approach.

COMMENT 3b: Section 5.2.1 – We are not comfortable with V* as a measure in Upper Lolo Creek. While this was developed for extremely high sediment rainfall-runoff regimes in N. California, but to our knowledge is unproven as a meaningful monitoring tool in the Rockies.

Regarding the other measures (e.g., pool frequency, W/D ratio, Sinuosity, etc.), we also have concerns that these are not appropriate for the context of a TMDL.

> **DEQ RESPONSE:** This comment has two parts. First, while the majority of V* studies have occurred near the west coast, they have not been limited to these areas. Research at the University of Colorado have utilized V* measurements and have recommended that this particular parameter be used for TMDL development. V* is a parameter that has actual studies to back it up, it is practical and works well to show trends over time. Additionally, studies that occurred in northern California occurred in granitic watersheds, which would be applicable to the Upper Lolo basin. Secondly, to meet in-stream targets, specific changes need to occur within the stream channel and floodplain. In order for a stream channel to again become stable, it needs to be able to properly distribute its flow and sediment supply in order to maintain its dimension, pattern and profile without degrading or aggrading. Adjustments occur partially as a result of a change in the stream flow magnitude and/or timing, sediment supply and/or size, direct channel disturbance, and riparian vegetation changes (Rosgen, 1996). Therefore, geomorphic measurements of the channel would help track changes and explain whether a stream is approaching equilibrium, while realizing that its potential would emulate reference conditions.

COMMENT 3c: Page 40, Section 5.2.1, In-Stream Targets. The second sentence of the first paragraph of this section states that numeric targets represent the optimal conditions needed for salmonid reproductive success. If the numeric targets are intended to interpret narrative water quality standards, perhaps the above sentence should be more qualified because as written it could be confusing given the concluding sentence that states it is uncertain whether these targets will meet narrative standards. The first sentence of the second paragraph states that several indicators are most "easily" linked to fish habitat conditions. I suggest the word "closely" as more appropriate in this case than "easily".

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

COMMENT 3d: Page 41, Section 5.2.1.1, In-Stream Target Justification. The second paragraph refers to Section 3.5 and goes on to mention a dataset of 229 streams. In Section 3.5 the reference reach dataset is described as 450 streams. If the 229 are the streams that met the MDEQ "functioning" definition , clarify as such.

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

COMMENT 3e: Section 5.3 – So what that only two years of data are available to characterize the existing condition? How many years of data do you need? Seems like data collected today would characterize the existing condition all by itself.

> **DEQ RESPONSE:** Given the natural variability that occurs, it is favorable to increase sampling numbers to increase precision. Basic statistics suggest that by increasing the number of cases per sample, you increase the level of significance and confidence.

COMMENT 3f: Section 5.4 – In indicator 2, strike the text contained in the bracket at the end of the sentence.

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

COMMENT 3g: Section 5.4.1 – Strike the reference to "upland" targets. Also, we question that actual fish population "targets" should be actually set at some point in the future given the difficulties in measuring this, knowing what an appropriate reference condition is, and the huge number of outside factors that can affect fish populations beyond forest management (e.g., fishing pressure, drought, floods, winter icing, disease, etc.).

> **DEQ RESPONSE:** This comment has 3 parts. First, the final document has been revised to reflect the first part of this comment (strike upland targets). Secondly, as outlined in Section 5.2.1, targets are designed to ensure full beneficial use support. Indicators are not targets. They are designed to show whether targets are being met, properly protecting beneficial uses, and they can show overall in-stream health and condition. Fish are one of the beneficial uses this plan is trying to protect, therefore inferences towards their success seems appropriate. Finally, the streams in the Upper Lolo TPA are not unique in their exposure of outside factors. All streams are subject to natural and climatic variability as well as disease and additional fishing pressures.

COMMENT 3h: Page 42, Section 5.4 Restoration Indicators. Indicator No. 2 will need to be extended into 2003.

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

COMMENT 3i: Page 42, Section 5.4.1 In-Stream Indicator Discussion. Indicator No. 5 was developed to show whether targets listed in Table 9 (should be 12) are being met (add).

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

COMMENT 3j: Section 6.3 – I can help improve this discussion of the Margin of Safety as needed. If EPA will not accept this, the base erosion rates should be adjusted to a less conservative level. Then a lump margin of safety could be added to the TMDL.

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

4. Restoration Strategy and Management Practices.

COMMENT 4a: Page 46, Section 6.4. The second bullet statement could be subject to varying interpretations. A suggested re-wording could be, "Calculated water yield increases will be maintained less than the minimum value expected to produce in channel sediment increases related to scour from increased peak flows." In the second sentence, suggest changing the phase "road density impacts" to "road density values.

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

COMMENT 4b: Section 6.4 – We need to drop the reference to a particular BMP compliance rate. I also have concerns with the second bullet in this list regarding water yield, since it has not been documented as an issue in the analysis area. Regarding future risk, it is covered under Montana's existing BMPs (BMP IV.A.1.h.).

> **DEQ RESPONSE:** This comment has two parts. First, the high compliance level of forestry BMPs is not a numeric target, but rather a management practice that shows compliance by the stakeholders. The 95% BMP application compliance is consistent with the current Statewide BMP audit results. Secondly, water yield increases are mentioned earlier in the document in Section 3.4. Additionally, this final text has been modified to reflect another comment similar to this one.

COMMENT 4c: Page 47, Section 7.1. In the third bullet statement, the Lolo NF as well as Plum Creek has been involved in BMP improvements.

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

5. TMDL Plan Implementation and Monitoring

COMMENT 5a: Section 8 of the document still needs additional work among the landowners and DEQ. Specifically, it is unclear who will do what in regard to monitoring. We also have concerns about the applicability of some of the proposed monitoring metrics (e.g., V*, fish populations, etc.). Regarding adaptive management, it is unclear to us how the monitoring data will be utilized in the future to evaluate success in achieving the TMDL. As was discussed in above, what do we do if despite reducing sedimentation to streams by 50%, the in-stream targets are not met? Are these streams forever impaired? Plum Creek and the Lolo National Forest proposed that if despite reducing human-caused sediment loading by 30-50% (as proposed in the TMDL), the streams do not improve, we believe that it should be concluded that these streams are at their realistic potential, and the in-stream target should be adjusted to the existing condition. This would create a defined endpoint we would support.

> **DEQ RESPONSE:** This comment has four parts:
>
> Lolo National Forest, Plum Creek Timber Company, Montana Department of Transportation, and Montana DEQ will coordinate the watershed monitoring. Section 8 of the final document has been revised to include clarification on the proposed monitoring efforts and how they will be carried out.
>
> The applicability of the proposed monitoring metrics is their correlation to the current impaired beneficial uses as discussed in Section 5.
>
> Data will be stored by DEQ and utilized by the stakeholders to help track changes over time.

As described in Section 5.2.1, in-stream targets are designed to ensure that the impaired waters in the Upper Lolo TPA fully support their beneficial uses. This WQRP/TMDL's desired and required endpoint is to meet water quality narrative and numeric standards that fully support beneficial uses for fisheries and aquatic life. The TMDL in-stream and surrogate targets (V*, fish populations, etc) are estimates of the conditions that would fully support these beneficial uses. Additionally, DEQ does not believe that changes or "endpoints" can necessarily be determined under short timeframes. The purpose of adaptive management is making decisions based on the best current available information, which changes as new technologies arise.

COMMENT 5b: Page 55, Section 8.4. In the middle of the first paragraph is a sentence that notes that management strategies and additional mitigations would assist in the geomorphic recovery of stream segments. This is followed by a sentence that begins, "Once this recovery is met, sediment loads…."

Recognizing that many of the valley bottom roads in the planning area are likely to be permanent features, full recovery of streams' dimension, pattern and profile are unlikely. To anticipate this unlikely recovery with the associated "normalizing" of sediment loads is to set up unrealistic expectations of the public and other agencies. I recommend we acknowledge this limitation and gear our monitoring to both tracking changes over time and defining our potential for recovery.

DEQ RESPONSE: The final document has been revised to reflect this comment.

COMMENT 5c: Can traction sand be identified from natural sediments in the bed on and on the banks of the West Fork Lolo Creek? Is it a different material?

DEQ RESPONSE: To the best of our knowledge, past sanding practices along U.S. Highway 12 utilized a local rock source, but in more recent times, an outside source has been brought in and is being crushed on site. We believe that given the nature of the parent material by which the two sources originate (natural versus current traction sand), that it would be possible to distinguish between them.

6. New Data, Clarifications and Factual Corrections

COMMENT 6a: Section 2.6 – This section focuses of fish species presence/absence and distribution and does not discuss historical fish populations (which is discussed in Section 3.4). You should consider combining these two sections to provide a more comprehensive discussion of what is known about the fishery, both past and present.

DEQ RESPONSE: Sub-Section 2.6 falls under Section 2.0, which is entitled "General Watershed Characteristics", while Section 3.4 falls under "Existing Data and Information". Both are appropriate in the context and organization of the document.

COMMENT 6b: Section 2.6, Paragraph 3 – Paragraph mentions macroinvertebrate data, but I have not seen this data and am not sure if it is available. If it is mentioned in the text here, it implies to me that it has been looked at.

DEQ RESPONSE: Section 2.6 states that the USFS Lolo National Forest has collected macroinvertebrate data on the main stem of Lolo Creek below the Upper Lolo TPA and not within the TPA at this time. The statement is simply stating that no known macroinvertebrate data currently exists within the Upper Lolo TPA.

COMMENT 6c: Section 3.4.1 – This section on references fish data by the Lolo NF, when Plum Creek conducted extensive surveys as part of the development of this TMDL in 1999. The Plum Creek data have been summarized in a technical report, which is contained in the binder of information provided to DEQ.

DEQ RESPONSE: The final document has been revised to reflect this comment.

COMMENT 6d: Section 3.4.2 – There is a statement in this section that fish densities have changed significantly from historic conditions. This should be supported by a reference to actual data, or the sentence removed.

DEQ RESPONSE: The final document has been revised to reflect this comment.

COMMENT 6e: Section 4.4 – The last sentence in the first paragraph should be modified to state that the bottomless arch culvert was installed in the Lost Park drainage in 2002.

COMMENT 6f: Page 30, Section 4.4 Stream Crossing Failures on Forest Roads. The Lost Park Creek replacement has been completed.

DEQ RESPONSE TO COMMENTS 6e & 6f: The final document has been revised to reflect these comments.

COMMENT 6g: Section 5.1 – This section should reference Montana's nonpoint source management plan and Montana Forestry BMPs.

DEQ RESPONSE: This section is intended to convey *general* water quality goals. Specifics and means by which to reach these goals are further discussed in Sections 5.4, 7.1, 7.2, 7.3 and 8.1.

COMMENT 6h: Page 16, Section 3.1 Water Quality problem Statement. Toward the end of the second paragraph, the Lolo NF, as well as Plum Creek, has been bringing old roads up to BMP standards.

DEQ RESPONSE: The final document has been revised to reflect this comment.

COMMENT 6i: In Section 8.6, Phase I, it is not correct to state: "MDT is not currently implementing many of these practices". In fact, MDT has recently begun to implement all of the practices identified in Section 7.3.5. As the result of numerous meetings with MDT maintenance personnel, these practices are now being implemented for the 2002-2003 winter maintenance season on Lolo Pass. In addition, the recently completed study conducted by Maxim

Technologies, Inc. for MDT (TMDL Study, Upper Lolo Creek Watershed), identifies a large number of specific recommendations for better maintenance practices and repairs of existing sediment control features. MDT is presently addressing these recommendations and is planning to conduct the recommended repairs when the weather allows this work.

DEQ RESPONSE: The final document has been revised to reflect this comment.

COMMENT 6j: Section 8.5 (Experimental Research [now Section 8.5 Effectiveness Monitoring]) should be expanded to include the research project that MDT is presently coordinating and funding. This research will identify the engineering design features and maintenance practices that are the most effective at keeping traction sand out of adjacent bodies of water, while maintaining the high standards of safety that are required by the traveling public. This research is in its early stages, but should result in valuable recommendations that MDT could implement as early as the 2003-2004 winter season.

DEQ RESPONSE: The final document has been revised to reflect this comment.

COMMENT 6k: The last paragraph on page 9 suggests that channel sensitivity and fish habitat vulnerability is presented by GCU in Table 1. The data in Table 1 though are physical characteristics.

DEQ RESPONSE: The final document has been revised to reflect this comment.

COMMENT 6l: Page 21, Section 3.4.3 Granite Creek. Re: Thermal modifications in Granite Cr. With the several temperature probes we're running in Upper Lolo we could easily add a couple to Granite Creek and then be able to say something like……"This determination will be confirmed by annual water temperature monitoring for the next XX years in Granite Cr."

DEQ RESPONSE: The final document (Section 8.7) has been revised to reflect this comment.

COMMENT 6m: Page 22, Section 3.4.4 Lee Creek. The latest water yield analysis done for Lee Creek was in 1998. Based on information known at that time the annual water yield increase was 7%. This analysis was for a broad scale "watershed assessment" of upper Lolo Cr. In 1997, the Lolo salvage logged some blown down timber in Lolo Creek but not in Lee Cr. That was the only timber removed from upper Lolo Cr. since the late 1980's. So the 7% value should be accurate depending on what Plum Creek has removed. We haven't kept up with their activities.

The last sentence in this paragraph says that erosion rates from forest roads is nearly two times that of North Fork Granite Creek. North Fork Granite is unroaded so the last sentence may be unclear to folks who don't know that. Could say something like, "because of forest roads, the overall erosion rate in Lee Creek is nearly two times that of the unroaded North Fork Granite Creek."

DEQ RESPONSE: The final document has been revised to reflect this comment.

COMMENT 6n: Page 26, Section 3.6 Water Quality Impairment Summary. The last sentence of the first paragraph refers to section 3.4.4 with regard to Granite Cr. thermal modification impairment. This should be Section 3.4.3.

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

COMMENT 6o: Page 30, Table 6. Estimated sediment delivery. This should be "Table 8." Tables following are also miss-numbered.

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

COMMENT 6p: Page 34, Section 4.5 Surface Erosion, Sanding, and Maintenance of Highway 12. The contribution of the maintenance/sand storage facility is not mentioned. Although it is downstream from the TMDL Planning Area, a reference to it and a notation that it will be addressed in the "Lower" Lolo Creek TMDL may stave of questions and alert MDOT to be thinking about it.

> **DEQ RESPONSE:** The MDT highway 12 maintenance and storage facility is not part of the Upper Lolo TPA and will be addressed in the Lolo Creek TMDL.

COMMENT 6q: Page 35, Section 4.6 Other Minor sediment Sources. The last sentence in the second paragraph notes that water yield modeling has not found changes in runoff patterns that would be detrimental to stream banks. This would include Lee Creek. See also comment relative to page 22.

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

COMMENT 6r: Page 42, first paragraph. In the sentence referring to Table 10 (should be 13), the phrase "were lumped and averaged for visual purposes." would read better as "were summed and averaged for ease of display."

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.

COMMENT 6s: Page 48, Section 7.3.2. The scheduled completion of the Upper Lolo Creek Road reclamation Project EA is now 2003.

> **DEQ RESPONSE:** The final document has been revised to reflect this comment.