SECTION B

SURFACE AND POINT SOURCE EROSION
(Roads/Skid Trails)

INTRODUCTION

The surface and point source erosion module examines the past and present soil erosion from roads and skid trails of the Mendocino Redwood Company (MRC) ownership in the Big River watershed, the Big River watershed analysis unit (WAU). This module also provides a hazard assessment of the potential for future surface and point source erosion from roads in the Big River WAU. The road data that is the basis for this analysis was collected by MRC to give a general indication of erosion from roads and skid trails in the WAU prior to a future 100% road inventory of the Big River WAU. The erosion estimates were developed from a combination of field observations and the use of the surface erosion model presented in the Standard Methodology for Conducting Watershed Analysis (Version 4.0, Washington Forest Practices).

Surface erosion is defined as the removal of soil particles from the surface of the soil. Processes such as rill erosion, sheetwash, biogenic transport (animal burrows, treefall, etc.) and ravel are considered surface erosion. Gullies, road crossing washouts, bank erosion and large erosion features created from overland flow of water are considered point source erosion. In contrast, the largest discrete erosion events, landslides, are considered mass wasting (covered in Section A of this watershed analysis).

This module examines road and skid trail associated surface and point source erosion delivering sediment into watercourses. Excessive levels of fine sediments from surface and point source erosion can get trapped in porous streambed gravels; and can increase water turbidity and suspended sediment concentrations. Excessive coarse sediments from point source erosion can adversely affect stream channel morphology. These can reduce the survival of salmonids in their redds or affect habitat needs and physiological characteristics of aquatic organisms. Excessive surface and point source erosion when delivered to a watercourse can also affect other downstream uses such as water supplies, agricultural diversions and recreation users. It is important that best management practices be utilized in forest management operations to minimize the impacts of surface and point source erosion.

SURFACE AND POINT SOURCE EROSION FROM ROADS

Methods

Past, current and potential surface and point source erosion from roads was determined from field observations and a road surface erosion model. The road erosion data presented in this report is based on a sampling of the Big River WAU road network. This analysis is to provide a general characterization of past erosion and future risk of erosion prior to a full road inventory. The field observations yielded a 40% sampling of the Big River WAU road network.

Field observations were collected to achieve a representative sample of roads by planning watershed, hillslope class and use (mainline or secondary roads). All primary haul roads had field observations, the remaining roads were sampled to obtain a representative sample of secondary roads based on hillslope class. The hillslope classes were: 1) low slope, representing the lower 20% of the hillslope between a watercourse and a ridge, 2) mid slope, representing the middle 20-80% portion of a hillslope between a watercourse and a ridge, and 3) top slope, representing the upper 20% of the hillslope near the ridge. Roads adjacent to watercourses typically deliver more erosion than upper slope roads making this segregation for field sampling useful.

The field observations on the roads included gathering data on contributing length, road surface type and vegetative cover on cut- and fill-slopes to aid in surface erosion model calculations. Road surface erosion, defined as sheetwash from the road tread and prism, was not directly measured in the field. The contributing length, the extent of road that delivers erosion to a watercourse, is measured in the field then used for surface erosion calculations. A road prism's contributing length drains water and associated eroded soil into a watercourse. Thus it defines the length of surface erosion of any particular site on the road. The model used to calculate surface erosion from roads is from the Standard Methodology for Conducting Watershed Analysis (Version 4.0, Washington Forest Practices Board) and is described below.

Field observations were also taken of point source erosion sites for road features (watercourse crossings, landings, road fill, etc.) that delivered sediment to a watercourse. Smaller landslides, those that are considered undistinguishable from aerial photographs and road watercourse crossing washouts were also included in the point source erosion sediment delivery estimates. These measurements were used to calculate the volume of point source erosion delivered from the road. The volume of erosion was converted to a weight (in tons) assuming a soil bulk density of 1.35 grams/cubic centimeter (100-lbs/cubic foot).

Future or potential point source erosion observations were collected for high treatment immediacy sites observed during the road sampling. These were sites that appeared to have an immediate need for maintenance to control potential point source erosion. These high treatment immediacy sites should not be considered an all inclusive list of high priority sites for the Big River WAU. Rather, it is a documentation of high treatment immediacy sites observed in our sample of field observed roads.

The potential future point source erosion is called controllable erosion; a term developed by the North Coast Regional Water Quality Control Board for Total Maximum Daily Load (TMDL) purposes. Controllable erosion is defined as soil that could potentially deliver to a watercourse in the next 40 years (the duration of a TMDL), is human created, and can be reasonably controlled by human actions. Typically controllable erosion is a measure of the fill material from a road that could erode if a road feature is not maintained or fails in the next 40 years. Controllable erosion can include bank erosion, gully and road washouts. Controllable erosion does not include sheetwash. The controllable erosion amount is the volume of soil that can be controlled with high design standards for a road feature (i.e. watercourse crossing, side-cast fill, etc.).

Surface erosion from the road surface is influenced by the amount of road traffic (high use mainline, moderate use active secondary, etc.), the type of road surface material, precipitation, width and size of road (the more surface area to erode the more erosion), and vegetative cover (Reid, 1981). Field observations determined the length of a sampled road delivering sediment to a watercourse (contributing length), the road surface material, the percentage of vegetative cover on the cut and fill slopes, and the type of road (mainline or secondary) to aid in the surface erosion calculations. If a landing area was considered to deliver sediment to a watercourse, the dimensions were included in the surface erosion calculations. Typically culverts that drain an inside ditch of a road (cross-drain culverts) put the water and eroded soil on a hillslope and do not deliver to a watercourse. The exception to this is when the cross drain culvert is in close proximity to a watercourse. Near stream cross-drain culverts were included in the surface erosion calculations.

The Standard Methodology for Conducting Watershed Analysis (Version 4.0, Washington Forest Practices Board) provides relationships based on factors to estimate the amount of surface erosion from different road types and conditions. For a complete description of all of the parameters used in calculating surface erosion from roads see the Standard Methodology for Conducting Watershed Analysis (Version 4.0, Washington Forest Practices Board).

The following parameters were used to calculate surface erosion from roads in the Big River WAU. All of the observed roads were assumed to have a base erosion rate of 60 tons/acre/year. This initial value was modified to represent the local road segment by using field-gathered observations and applying them to a factor in the surface erosion calculations. The factors include traffic, cut- and fill-slope vegetation cover, road surface type, and annual precipitation. The resulting equation attempts to model the actual sediment volume contributed by a given road segment. The road tread width was assumed to be 16 feet and 40% of the road prism. The cut- and fill-slopes were assumed to comprise the remaining 60% of the road prism; their dimensions for the surface erosion model were determined by multiplying the tread width by 1.5.

In order to more accurately represent the road conditions considerations were made when applying factors to the surface erosion calculations. The majority of hauling on roads occurs during drier times of the year (i.e. late spring, summer and early fall). Therefore the lowest annual precipitation category is used (<47 in. precipitation annually). Landing areas have a factor of 0.1; these areas receive moderate to high usage only 1-2 times per every 1-2 decades with little to no use in between. A road with at least a 6-inch rocked surface is given a 0.2 factor, a 3 to 6-inch rocked surface is given a 0.5 factor, while a native surface road has a factor of 1. In the rare occurrence of estimating a paved road surface, a 0.03 factor was used.

There were 3 traffic factors used in surface erosion modeling in the Big River WAU: .

1) *Mainline roads with moderate traffic* have a factor of 2; these roads are used for log haul traffic 2-3 times each decade.
2) *Seasonal roads* have a traffic factor of 1.2; these are tributary roads which receive moderate log haul traffic 1-2 years each decade and light traffic the remainder of the time.
3) *Temporary roads* receive a traffic factor of 0.61; these roads receive moderate log haul traffic 1-2 times per every 1-2 decades with little to no use in between.

The result of the surface erosion modeling is added to the total point source erosion that delivered sediment from a given road and presented as tons/year of sediment delivery. To arrive at an estimate of sediment delivery for the roads not observed in the field we extrapolated data from the field checked non-mainline roads. We only used the observations from non-mainline roads for extrapolation because we had field data for all mainline roads within the Big River WAU. The non-field observed roads had the lengths summed into hillslope classes of low, middle and upper slope roads within each planning watershed boundary. The contributing proportion of roads sampled, by hillslope class, was used to estimate the length of road contributing sediment from roads not observed in the field. The surface erosion for the non-field checked roads was modeled by using the extrapolated contributing road length, a traffic factor and a road surface that approximated the same types of road observed in the field. An estimate of point source erosion for the non-field observed roads was calculated by extrapolating the amount of point source erosion by road length and hillslope class to the non-field observed roads.

To calculate relative sediment contributions the tons/year calculations for all roads was totaled by planning watershed and normalized by dividing by the MRC ownership, in square miles, for the planning watershed. The result is an estimate of road surface and point source erosion in tons/square mile/year on MRC lands.

From the estimated sediment delivery information the roads in the Big River WAU are assigned an erosion hazard class. The erosion hazard class is used to classify the roads in the Big River WAU by their current and potential erosion hazard. The erosion hazard class was determined by the amount of erosion a road produced and the likelihood for that erosion to be delivered to a watercourse. High levels of traffic, road surface, proximity to the stream, high past point source erosion, and high modeled surface erosion all were considered when ranking roads for their erosion hazard. The roads with the highest risk of sediment delivery and soil erosion were given a high erosion hazard classification. The roads with medium risk of sediment delivery and soil erosion were given a moderate erosion hazard classification. The roads with the lowest risk of sediment delivery and soil erosion were given a low erosion hazard classification. A description of each erosion hazard classification can be found in the Results and Discussion of this Surface and Point Source Erosion report.

Though MRC has not completed its comprehensive road inventory of Big River, an analysis of roads within the MRC lands in the South Fork Big River watershed has occurred. This analysis was conducted by Pacific Watershed Associates in association with Trout Unlimited and the California Department of Fish and Game. The road assessment documents road conditions and potential point source erosion and suggests methods to improve the road point conditions. This assessment occurred on the majority of the roads within the Russell Brook, Mettick Creek and South Daugherty planning watersheds. The report from this effort is located in the appendix of this section (Appendix B).

Select culverts within the Big River WAU were evaluated for fish passage criteria. The culverts analyzed may not be a complete list of fish passage barriers rather they represent sites which have been identified to date as barriers (either partial or complete barriers). The culverts analyzed are on road crossings of Frykman Gulch, Bull Team Gulch, Boardman Gulch and 2 culverts on Donkey House Gulch. These crossings were analyzed for culvert hydraulics utilizing a computer software program called FISH XING. Other information from fish distribution studies and field reconnaissance of the habitat value were utilized.

Surface and Point Source Erosion from Roads Results and Discussion

Roads within MRC's ownership of the Big River WAU are estimated to generate 320 tons/mi^2/yr of sediment from road-associated surface and point source erosion (Table B-1). South Daugherty Creek and Mettick Creek planning watersheds are estimated to yield 4390 and 4050 tons/year of sediment, respectively; the highest amounts of sediment delivery in the Big River WAU. However, when normalized by area Russell Brook, East Branch North Fork Big River and South Daugherty contribute the highest rates of sediment delivery, 440, 400 and 390 tons/mi^2/yr respectively. This is due to a high density of high use roads within a relatively small area of MRC ownership in these planning watersheds.

Point source erosion was found to be a significant factor for the erosion rates in planning watersheds. The highest proportions of point source erosion come from the East Branch North Fork, Russell Brook and South Daugherty planning watersheds (Table B-1).

It must be noted that an observation of road point source erosion at one point in time does not accurately reflect the characteristics of the road over time. For example, a culvert or road erosion site may have failed several times over its life, but it is not possible to determine that from current observations. Therefore the sediment yield from point source erosion is an estimate that should be interpreted carefully.

Table B-1. Road Associated Surface and Point source Erosion Estimates by Planning Watershed for the Big River WAU.

Planning Watershed	**Total Road Assoc. Erosion (tons/yr)**	**MRC Owned Acres**	**Road Assoc. Erosion Rate (tons/mi^2/yr)**	**Surface Erosion Rate (tons/mi^2/yr)**	**Point Source Erosion Rate (tons/mi^2/yr)**
East Branch North Fork	1580	2527	400	165	235
Lower North Fork	930	2170	270	235	35
Mettick Creek	3140	10294	200	130	70
Rice Creek	440	924	300	290	20
Russell Brook	4050	5926	440	170	270
South Daugherty	4390	7242	390	160	230
Two Log	2000	4275	300	220	80
Big River WAU totals	***16530***	***33,358****	***320***	***190***	***130***

* No road data for Dark Gulch presented, MRC ownership in Big River WAU is 34,060 acres.

A road segment's slope class is an influential parameter of the surface and point source erosion amounts that are delivered to a watercourse. The Big River WAU low slope class roads constitute 55% of all contributing road area (Table B-2). The middle and upper slope class roads compromise 41% and 4%, respectively. The East Branch North Fork planning watershed has the greatest percentage of low slope roads with 75% of all sediment contributing road area coming from the low sloped roads. Erosion rates separated by slope class also demonstrate a greater sediment delivery for low slope class roads. The Big River WAU's low slope class roads deliver 7960 tons/yr., compared to the middle slope class road's 7040 tons/yr. and the upper sloped road's 1530 tons/yr. The erosion rate numbers indicate the importance of monitoring low and mid-sloped roads, particularly the low slope class roads.

Table B-2. Contributing Road Area and Proportion Estimates by Slope Class for Planning Watersheds of Big River WAU.

Planning Watershed	Contributing Road Area (acres) Low-Slope	Percent Roads in Low Slope Class	Contributing Road Area (acres) Mid-Slope	Percent Roads in Middle Slope Class	Contributing Road Area (acres) High-Slope	Percent Roads in Upper Slope Class
East Branch North Fork	6.2	75%	2.0	25%	0.0	0%
Lower North Fork	4.1	48%	4.2	50%	0.1	2%
Mettick Creek	10.4	54%	7.8	38%	0.6	3%
Rice Creek	1.7	65%	0.9	35%	0.0	0%
Russell Brook	5.2	45%	5.6	49%	0.7	6%
South Daugherty	9.4	52%	8.1	45%	0.6	3%
Two Log Creek	6.0	47%	5.3	42%	1.3	11%
Big River WAU:	**43.0**	**55%**	**33.9**	**41%**	**3.3**	**4%**

Table B-3. Surface and Point Source Erosion Estimates by Slope Class for Planning Watersheds of Big River WAU.

Planning Watershed	**Tons/yr**		
	low	middle	upper
East Branch North Fork	930	480	170
Lower North Fork	360	540	30
Mettick Creek	1580	1290	270
Rice Creek	250	180	10
Russell Brook	1320	2250	480
South Daugherty	2710	1290	390
Two Log	810	1010	180
Big River WAU Totals	**7960**	**7040**	**1530**

The erosion rate, though only an estimate, provides a good indicator of where road associated surface and point source erosion issues are currently occurring. However, the timing and amount of road use affects the amount of erosion estimated from a road. If the assumptions on the timing or amount of road used change, the erosion rate estimates may lose their reliability as an indicator of problem areas. Another indicator that can help in interpreting a potential road associated surface or point source erosion risk for sediment delivery is the amount and density of road, and the amount of road that contributes erosion to a watercourse (contributing area). The road density and road surface area totals are presented for each planning watershed in Table B-4 for the Big River WAU.

Road length and road surface area is highest in the Mettick Creek planning watershed (Table B-4). The amount of contributing road area is similar between East Branch North Fork and Lower North Fork, however the road density in Lower North Fork is higher so the contributing road area is of greater concern for the Lower North Fork roads. It should be a goal to lower the contributing road area in the Big River WAU. The Rice Creek planning watershed has a high road density due to a few roads located within a small parcel of MRC land.

Table B-4. Road Surface Areas, Contributing Road Surface Areas, Road Lengths and Road Densities for the Big River WAU.

Planning Watershed	**Road Surface Area (ac)**	**Road Contributing Area (ac)**	**Road Length (miles)**	**Road Density (mi/sq mi)**
East Branch North Fork	54.4	8.3	28.1	7.1
Lower North Fork	59.5	8.4	30.7	9.0
Mettick Creek	202.0	20.2	104.2	6.5
Rice Creek	30.6	2.7	15.8	10.9
Russell Brook	138.3	11.6	71.3	7.7
South Daugherty	156.5	18.1	80.7	7.1
Two Log	98.6	12.6	50.7	7.6
Big River WAU Total	***734.0***	***81.9***	***381.5***	***7.3***

The road erosion hazard classification for each sampled road in the Big River WAU is presented on Map B-1. The categorizing of roads into hazard classes is intended to identify current problem areas, consider reconstruction and prioritize maintenance. The following are the definitions for each road erosion hazard class.

High Road Erosion Hazard Class - These roads have the highest amount of recent deliverable surface erosion to watercourses and a high potential for future deliverable erosion. These roads can be active, abandoned or closed. Often roads in this class are close to watercourses creating a high sediment delivery potential. Erosion is typically due to long contributing road lengths or native surfaces near watercourses: a result of too few waterbars and/or rolling dips or lack of rock surface. Erosion may also be a product of problem areas such as watercrossing wash-outs, poor road drainage, plugged road watercrossings, water diverted down the road surface, culverts not fitted with downspouts, etc. Active roads in this class should get the highest priority for maintenance or improvements. Closed roads in this class will need improvements before opening again. Opening abandoned roads in this class should be avoided.

Moderate Road Erosion Hazard Class - These roads have moderate amounts of recent deliverable surface erosion to watercourses and potential for future deliverable erosion. These roads can be active, abandoned or closed. Erosion problems on roads in this class can usually be handled with good road maintenance. Erosion is typically from problem areas such as poor road drainage, water diverted down the road surface, culverts not fitted with downspouts, and an occasional plugged culvert or watercourse crossing wash-out. Active roads in this class should be a priority for maintenance. Closed or abandoned roads in this class will need some improvements before opening again.

Low Road Erosion Hazard Class - These roads have low amounts of recent deliverable surface erosion to watercourses and low potential for future deliverable erosion. These roads can be active, abandoned or closed. Active roads in this class do not need to be a priority for maintenance. Closed or abandoned roads in this class will need only some improvements before opening again.

A few high treatment immediacy point source erosion sites were identified in the Big River WAU. These were sites observed during the sampling of the road network and are not meant to be interpreted as an all inclusive list for the Big River WAU. The road site numbers and road numbers are found on Map B-1. The road number, site number, amount controllable erosion and description of the site are listed below (Table B-5).

Table B-5. Select High Treatment Immediacy Road Sites within the Big River Watershed Analysis Unit.

Site ID#	Planning Watershed	Controllable Erosion (yd^3)	Description
BL-1	Lower North Fork Big River	5	Plugged culvert
BE-1	East Branch North Fork Big River	40	Gully erosion
BE-2	East Branch North Fork Big River	21	Gully erosion
BE-3	East Branch North Fork Big River	4	Damaged culvert
BE-4	East Branch North Fork Big River	600	Diverted watercourse crossing erosion
BE-5	East Branch North Fork Big River	28	Gully erosion
BE-6	East Branch North Fork Big River	100	Culvert failing
BE-7	East Branch North Fork Big River	138	Gully erosion
BR-1	Russell Brook	6	Gully erosion
BR-2	Russell Brook	5	Watercourse erosion
BM-1	Mettick Creek	1100	Fish barrier, failing culvert
BM-2	Mettick Creek	28	Road slide
BM-3	Mettick Creek	6	Gully erosion
BM-4	Mettick Creek	85	Culvert plugged
BM-5	Mettick Creek	18	Bridge crossing erosion
BM-6	Mettick Creek	26	Road slide
BM-7	Mettick Creek	27	Gully erosion
BM-8	Mettick Creek	32	Gully erosion
BS-1	South Daugherty	710	Road slide
BS-2	South Daugherty	65	Watercourse wash-out
BS-3	South Daugherty	85	Watercourse wash-out
BS-4	South Daugherty	105	Culvert plugged
BS-5	South Daugherty	58	Culvert starting to plug

Fish Passage Barriers

Select culverts within the Big River WAU were evaluated for fish passage criteria. The culverts analyzed may not be a complete list of fish passage barriers rather they represent sites which have been identified to date as barriers (either partial or complete barriers). The culverts analyzed are on road crossings of Frykman Gulch, Bull Team Gulch, Boardman Gulch and 2 culverts on Donkey House Gulch.

Donkey House Gulch

The Donkey House Gulch watershed is comprised of approximately 200 acres of coniferous forest. Potential habitat for steelhead and coho exists in Donkey House Gulch and these species have been found in similar streams nearby. However, a culvert approximately 100 ft upstream of the mouth of Donkey House Gulch is a complete barrier to upstream salmonid migration. A second culvert is present approximately 0.3 miles upstream. Based upon the results of Fish Xing this upper culvert is only a barrier to adult steelhead migration under 7% of potential flows. However, fish must make a 3.5 foot jump from a 1.5 foot deep pool to enter this culvert. It is uncertain what percentage of fish will actually be able to make this jump. The culvert is a complete barrier to juvenile salmonid upstream migration.

Boardman Gulch

The Boardman Gulch watershed is comprised of approximately 750 acres of coniferous forest. Currently, steelhead are present throughout the watershed. There is a road crossing approximately 0.6 miles upstream of the mouth of Boardman Gulch. The crossing consists of a culvert, which is a partial barrier to steelhead upstream migration. Based upon Fish Xing, the culvert is passable under 16% of potential flows by adult steelhead and is completely impassable by juvenile steelhead. Surveys upstream of the culvert have identified steelhead greater than one year of age.

Bull Team Gulch
The Bull Team Gulch watershed is comprised of approximately 300 acres of coniferous forest. Potential habitat for steelhead and coho exists in Bull Team Gulch. However, there is a road crossing (a culvert) approximately 100 feet upstream of the mouth of Bull Team Gulch. The culvert is a complete upstream migration barrier to salmonids. Currently there are no fish species found upstream of the culvert. Juvenile steelhead and coho have been found directly downstream of the culvert.

Frykman Gulch
The Frykman Gulch watershed is comprised of approximately 400 acres of coniferous forest. There is a road crossing (a culvert) approximately 100 feet upstream of the mouth of Frykman Gulch. According to Fish Xing the culvert is only a barrier to upstream adult steelhead migration under 55% of the range of stream discharges up to a 100 year flood. However, fish must make a 3.4 foot jump from a 3 foot deep pool to enter the culvert. It is uncertain what percentage of fish is actually able to make this jump. Electrofishing surveys in 2000, 2001 and 2002 coho above the culvert, in 2002 steelhead were detected. Coho have been found in similar nearby streams. The culvert is a barrier to upstream migration by juvenile salmonids.

Table B-6. Quantity of Habitat Made Available to Salmonids and Quantity of Potential Erosion Controlled from Select Culverts that are Fish Passage Barriers in Big River WAU.

	Quantity of Habitat to Become Available to Salmonids (Stream Miles)		
Stream	Coho	Steelhead	Quantity of Potential Erosion Controlled (Cubic Yards)
Donkey House Gulch	0.5	1	1320
Boardman Gulch*	0	2	900
Frykman Gulch*	0.3	0.6	710
Bull Team Gulch	0.3	0.6	520
Total	1.1	4.2	3450

*Culvert is a partial barrier. See text for details.

SURFACE AND POINT SOURCE EROSION FROM SKID TRAILS

Methods

Skid trail sediment delivery from surface and point source erosion[1] was determined from aerial photograph interpretation and sediment delivery estimates developed in previous MRC watershed analysis (MRC, 1998 and MRC, 2000). Aerial photographs from 1952, 1963, 1972, 1978, 1987 and 2000 were used to identify skid trail activity. The aerial photographs were taken at an altitude that yielded 1:20,000, 1:20,000, 1:20,000, 1:15,840, 1:12,000 and 1:13,000 scales, respectively. The 1952 and 1963 aerial photographs were checked out at the Mendocino County Museum in Willits. The 1972 aerial photographs were checked out at the Mendocino County Assessor's Office in Ukiah. The 1978, 1987 and 2000 aerial photographs are from Mendocino Redwood Company's collection.
The aerial photograph interpretation for skid trail activity consisted of determining the area by density of skid trails (low, moderate, high) for each photo year. Light skid trail density has less than 50 watercourse crossings per square mile or were trails with significant re-vegetation observed in the aerial photograph. Moderate-density skid trail activity is defined as having between 50-100 watercourse crossings per square mile. High-density skid trail activity is defined as having greater than 100 watercourse crossings per square mile.

The amount of sediment delivery from the various densities of skid trail activity was estimated from sediment delivery rates estimated during previous watershed analysis by MRC (MRC, 1998 and MRC, 2000). A combination of surface erosion modeling and field observations of point source erosion from skid trails were used to develop the skid trail estimates. High skid trail density is estimated to contribute 300 tons/square mile/year of sediment. Moderate skid trail density is estimated to contribute 200 tons/square mile/year of sediment, while low skid trail density contributes 50 tons/square mile/year.

For each photo year the area in each skid trail density category was multiplied by the sediment delivery rate for that density. The estimated rate was then assumed to represent the decade previous to the photo year observed (i.e., 1952 photo represent activity in the 1940s).

In the case where aerial photographs were missing from a photo year's collection, we extrapolated the calculated delivery rates within the same planning watershed to the missing area. For the Big River watershed, this occurred with the 1978 aerial photographs. The 1978 aerial photograph collection was missing approximately 2,367 acres from a 33,993-acre total area. Using the proportion of the surveyed acres to total acres we could extrapolate erosion totals for the remaining 2,367 acres.

Surface and Point Source Erosion from Skid Trails Results and Discussion

The skid trail sediment delivery estimate results, by time period, are summarized in Table B-7 and Figure B-1. The estimates should be considered a minimum sediment delivery for skid trails constructed and used in the decade. Undoubtedly, some if not many, sediment delivering skid trails were vegetated enough to be overlooked during the inventory. In particular are those trails constructed or used more than five years prior to the aerial photograph reconnaissance and may not have been observed.

In the Big River WAU the portion that was harvested using tractor based yarding during the 1940s, 1950s and 1960s produced a high level of sediment delivery. This high impact skid trail construction and usage brought high sediment delivery rates on those particular acres. However, the widespread geographic extent of skid trails during the 1970s and 1980s produced the greatest amounts of total skid trail area and

[1] Skid trail mass wasting is analyzed in Section A and Section G of this watershed analysis.

sediment delivered in the Big River WAU. The 1970s brought skid trail use area and sediment delivery peaks on Two Log Creek, Lower North Fork Big River and Rice Creek planning watersheds. The 1980s brought skid trail use area and sediment delivery peaks on the East Branch North Fork Big River, Russell Brook, Mettick Creek and South Daugherty Creek planning watersheds (See Table B-7). Both Martin Creek and Rice Creek planning watersheds had such a small portion of land within the Big River WAU that their results may be considered negligible

In the late 1970s and throughout the 1980s a change in skid trail design altered sediment delivery from skid trails. Skid trails no longer utilized the low-slope trail designs of earlier times and trails were placed along ridges and branched outward. This produced a significant drop in skid trail watercrossings. This "Herringbone pattern" of skid trails affected the designation of low, moderate and high skid trail usage.

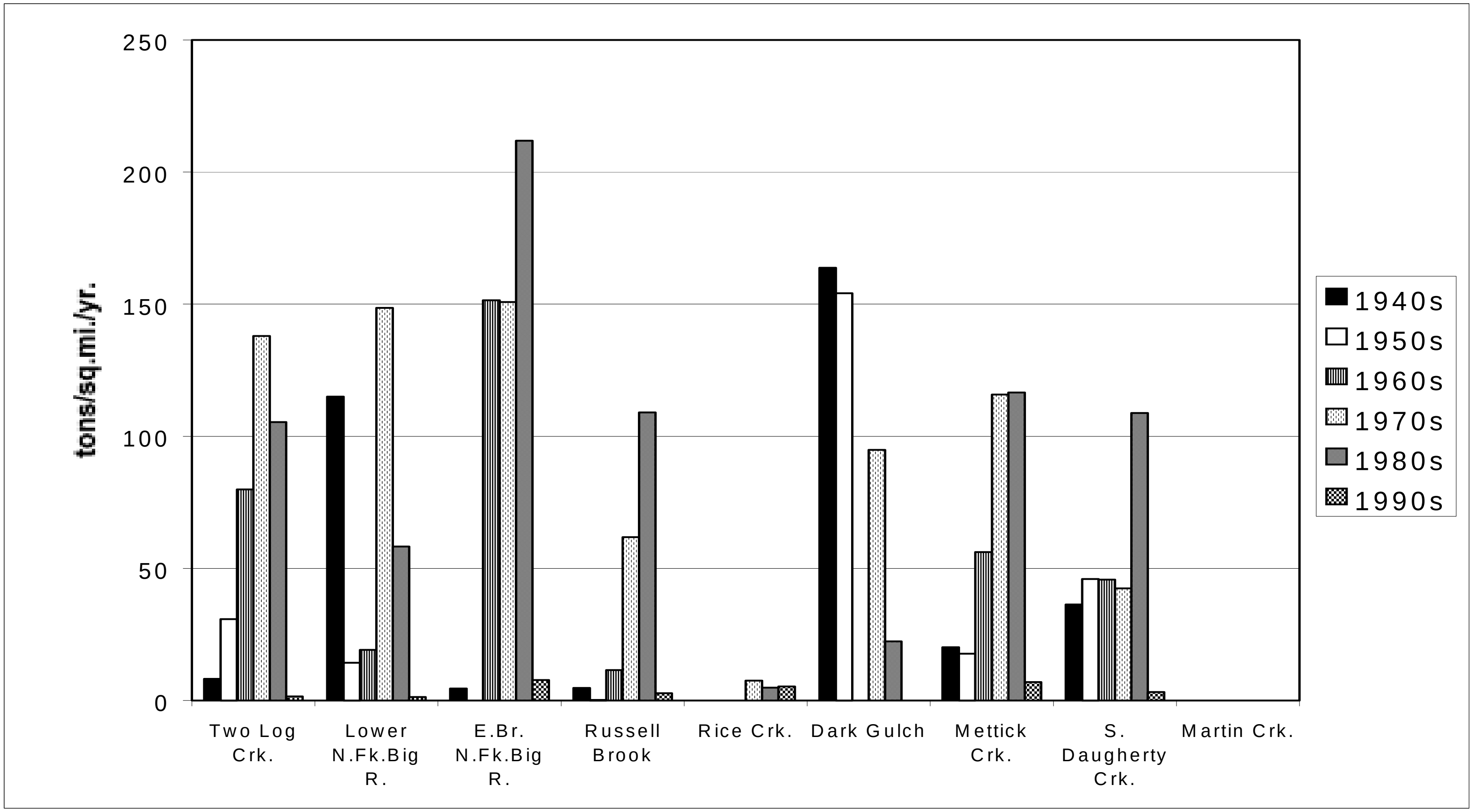
In the 1990s skid trail sediment delivery rates diminished in all watersheds. This is a result of a combination of less harvest activity and stricter regulations on tractor based yarding use. Future skid trail sediment delivery rates will be lower than past rates because California Forest Practice Rules and MRC policy mandate better managed tractor yarding activities. Better erosion control measures are used on skid trails such as increased water bar spacing and a practice by MRC of packing the trails with logging debris (slash), when available, after operations to prevent surface erosion. Furthermore, skid trail operation is limited next to watercourses and prohibited directly in watercourses.

Table B-7. Skid Trail Use and Sediment Delivery Estimates for Big River WAU by Decade.

Planning Watershed	1940s Skid Trail Use Area (acres)	1940s Sediment Delivery (t/mi2/yr)	1950s Skid Trail Use Area (acres)	1950s Sediment Delivery (t/mi2/yr)	1960s Skid Trail Use Area (acres)	1960s Sediment Delivery (t/mi2/yr)	1970s Skid Trail Use Area (acres)	1970s Sediment Delivery (t/mi2/yr)	1980s Skid Trail Use Area (acres)	1980s Sediment Delivery (t/mi2/yr)	1990s Skid Trail Use Area (acres)	1990s Sediment Delivery (t/mi2/yr)	1940s-1990s Avg. Sediment Delivery (t/mi2/yr)
Two Log Crk.	233	8	525	31	1663	80	2379	138	2129	105	133	2	61
Lower N.Fk.Big R.	1038	115	618	14	208	19	1137	149	793	58	57	1	59
E.Br. N.Fk.Big R.	38	5	0	0	1574	151	1538	151	2036	212	390	8	88
Russell Brook	94	5	22	0	1050	11	2756	62	3360	109	317	3	32
Rice Crk.	0	0	0	0	0	0	139	8	89	5	99	5	3
Dark Gulch	326	164	460	154	0	0	283	95	268	22	0	0	73
Mettick Crk.	829	20	845	18	3420	56	5171	116	5490	117	1449	7	56
S. Daugherty Crk.	991	36	1500	46	2120	46	2203	42	3968	109	463	3	47
Martin Crk.	0	0	0	0	0	0	0	0	0	0	0	0	0

Big River Total Tons/Sq.Mi./Yr.
1940s-1990s = 52

Figure B-1. Estimated Skid Trail Sediment Delivery Rate by Watershed and Decade in the Big River WAU.



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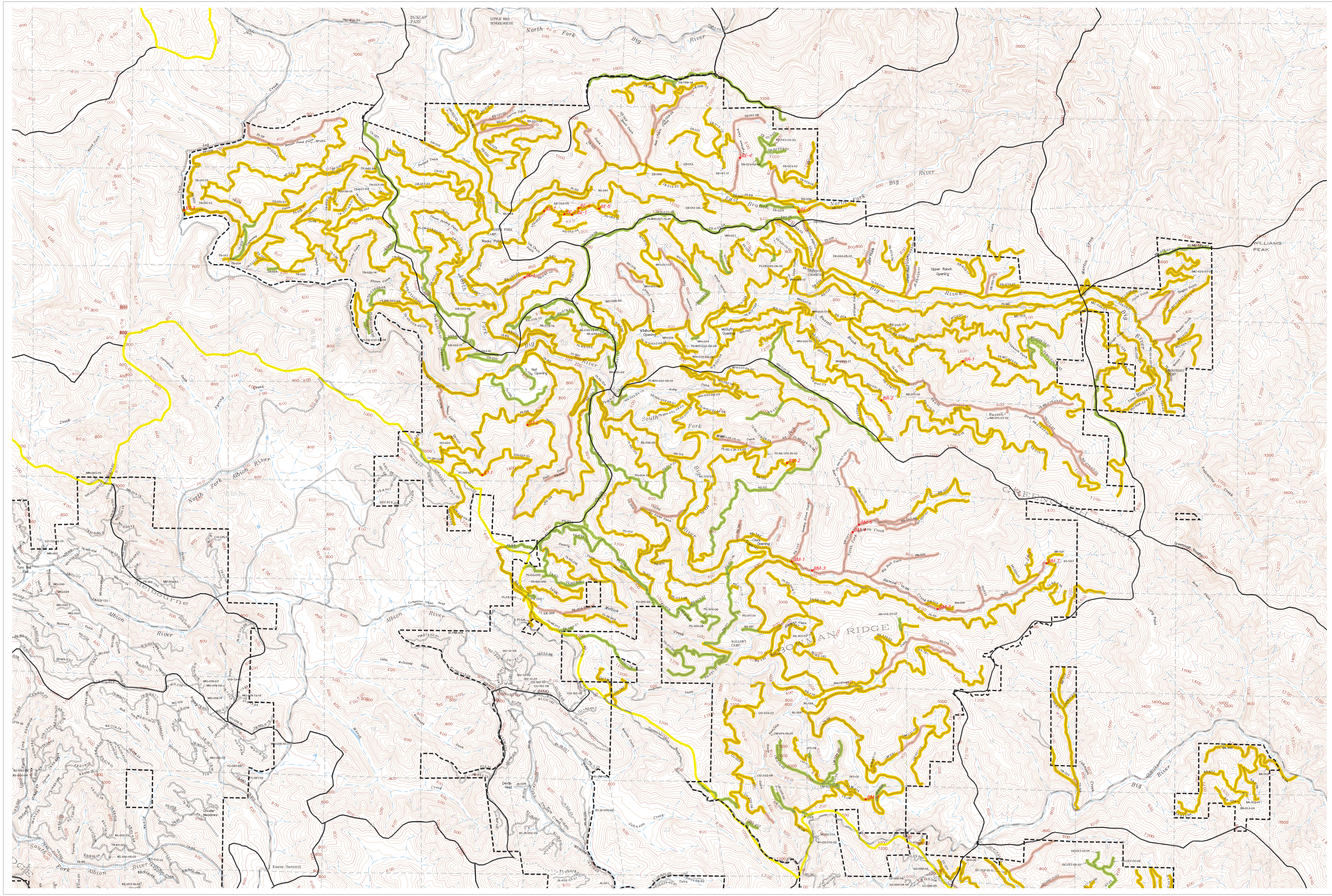


Big River Watershed Analysis Unit

Map B-1 Road Erosion Hazard Classifications

This map presents an erosion hazard rating for the MRC roads and select high treatment immediacy sites. High erosion hazard roads have the highest amount of recent deliverable surface erosion to watercourses and a high potential for future deliverable erosion. Active roads in this class should get the highest priority for maintenance or improvements. Closed roads in this class will need improvements before opening again. Opening abandoned roads in this class should be avoided. Moderate erosion hazard roads have moderate amounts of recent deliverable surface erosion to watercourses and potential for future deliverable erosion. Active roads in this class should be a priority for maintenance. Closed or abandoned roads in this class will need some improvements before opening again. Low Erosion Hazard roads have low amounts of recent deliverable surface erosion to watercourses and low potential for future deliverable erosion. These roads can be active, abandoned or closed. Active roads in this class do not need to be a priority for maintenance. Closed or abandoned roads in this class will need only some improvements before opening again.

Erosion Hazard Rating

- Low
- Moderate
- High
- Known High Treatment Sites
- MRC Ownership
- Planning Watershed Boundary
- Big River Watershed Boundary

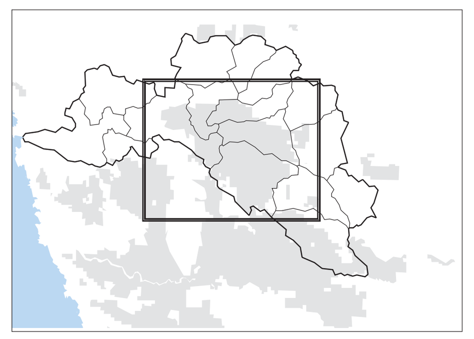
Transportation

- Paved Road
- Rocked Road
- Native Road
- Jeep Trail

Flow Class

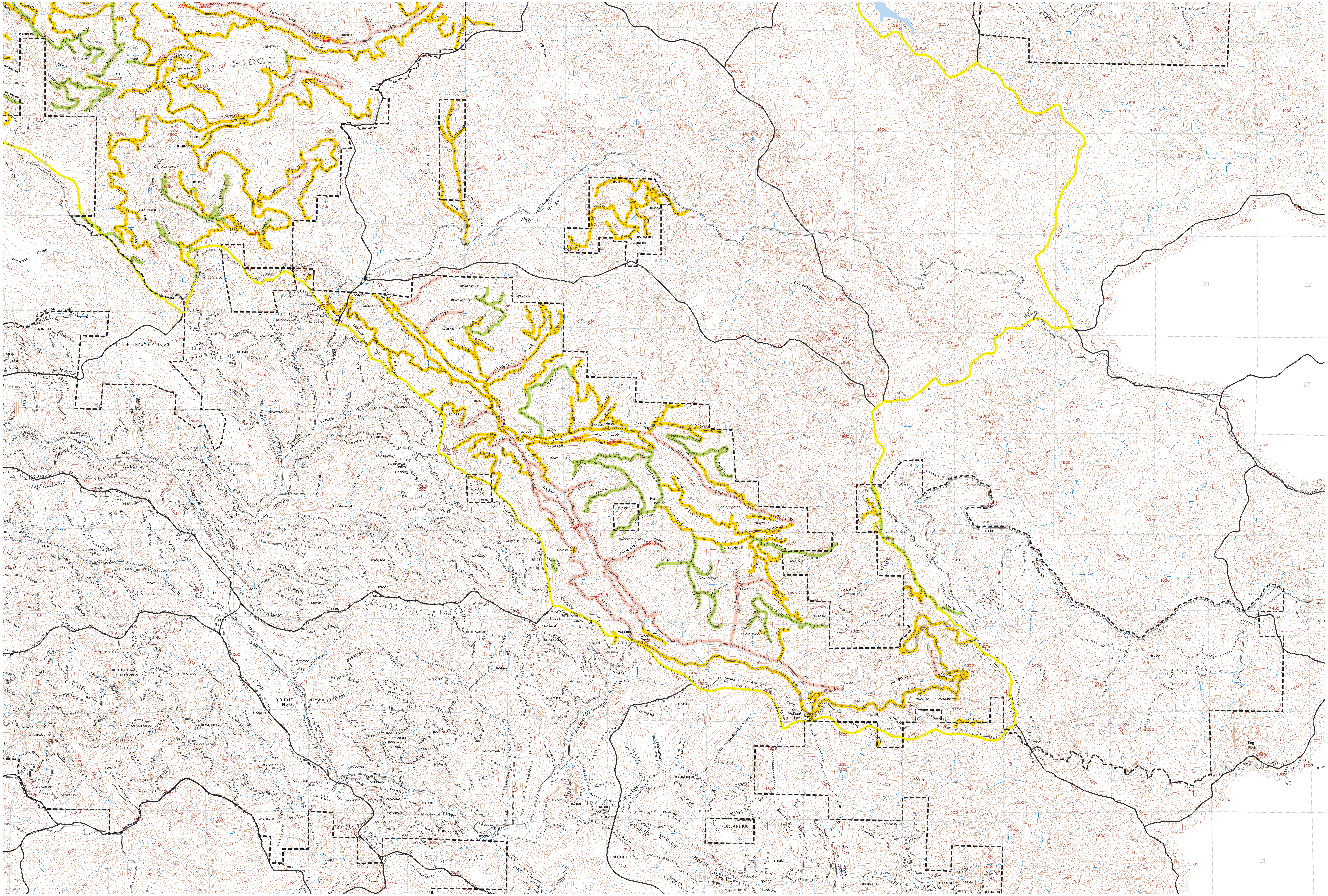
- Class I
- Class II
- Class III

Sheet 1



0 1/2 1 Mile

September 2003



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Big River Watershed Analysis Unit

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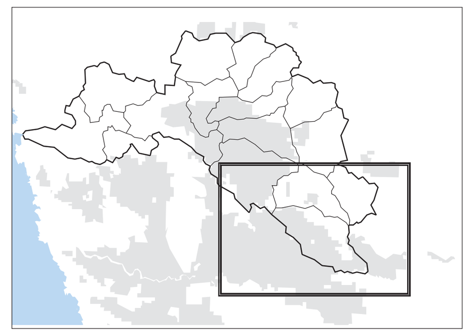
Erosion Hazard Rating
- Low
- Moderate
- High
- Known High Treatment Sites
- MRC Ownership
- Planning Watershed Boundary
- Big River Watershed Boundary

Transportation
- Paved Road
- Rocked Road
- Native Road
- Jeep Trail

Flow Class
- Class I
- Class II
- Class III

Sheet 2



N S E W

0 1/2 1 Mile

September 2003