EXECUTIVE SUMMARY

Watershed Analysis for Mendocino Redwood Company's Ownership in the Navarro River Watershed

This report presents the results of a watershed analysis performed by Mendocino Redwood Company (MRC) on their ownership[1] in the Navarro River watershed. The MRC ownership in the Navarro River watershed is considered the Navarro watershed analysis unit (WAU). This section presents a brief overview of the watershed and the watershed analysis process followed by MRC. More specific information is found in the individual modules of this report.

The Navarro River is on the 303(d) list as sediment and temperature impaired and a total maximum daily load (TMDL) has been developed for sediment and temperature reduction in the river (NCRWQCB, 2000). The Navarro River and its tributaries support populations of coho salmon and steelhead trout, two fisheries of concern in northern California. For this reason MRC conducted a watershed analysis to assist in their efforts to reduce non-point source pollution, evaluate current and past land management practices and establish a baseline for monitoring of watershed conditions over time. The watershed analysis will also be used to identify needs for site-specific management planning and restoration in the watershed to reduce impacts to aquatic resources and potentially to improve fish and aquatic habitat conditions.

MRC's approach to the Navarro River watershed analysis was to perform resource assessments of mass wasting, surface and point source erosion (roads/skid trails), hydrology, fish habitat, riparian condition and stream channel condition. Mass wasting, riparian condition and surface and point source erosion modules address the hillslope hazards. The fish habitat and stream channel condition modules address the vulnerability of aquatic resources. Prescriptions are developed to address the issues and processes identified in the watershed analysis. Finally, monitoring is suggested to determine the efficacy of the prescriptions to protect sensitive aquatic resources. The monitoring will provide the feedback for MRC's adaptive management approach to resource conservation.

The Navarro WAU is separated into two separate management units by MRC, Navarro West and Navarro East (see Navarro WAU Base Maps A and B). Much of the data was summarized and presented by these administrative units.

RESULTS

Mass Wasting

A total of 1220 shallow-seated landslides (debris slides, torrents, or flows) were identified and characterized in the Navarro WAU, 578 in Navarro West and 642 in Navarro East. A total of 270 deep-seated landslides (rockslides or earth flows) were mapped in the Navarro WAU, 187 in Navarro West and 83 in Navarro East. Of the 1220 shallow-seated landslides in the Navarro WAU, 759 are determined to be road-associated. This is approximately 62% of the total number of shallow-seated landslides.

[1] It must be emphasized that only the Mendocino Redwood Company ownership is analyzed in the watershed.

A total of 2,189,000 tons of mass wasting sediment delivery was estimated for the time period 1969-2000 in the Navarro WAU. This equates to 750 tons/sq. mi./yr. Of the total estimated amount, 258,500 tons (12% of total) occurred from 1969-1981, 441,600 tons (20% of total) occurred from 1982-1987, and 1,492,000 tons (68% of total) occurred in the 1988-2000 time period (Table A-5). A total of approximately 84,000 tons was delivered into Navarro West in 1995 by the Floodgate slide, which is 4% of the total delivery from 1969-2000 and 6% of the total amount delivered from 1988-2000 in the whole Navarro WMU. The sediment delivery was a result of a deep-seated rockslide that was not caused by forest management practices (Sownma-Bawcom, 1996).

Relatively large amounts of sediment delivered from 1988-2000 compared to earlier time periods results from several factors, including high rain fall events during this time frame, two sets of aerial photographs analyzed during this time, and field work done in the summer of 1999. Consequently more landslides where found in the 1988-2000 period than the other periods.

The landscape was partitioned into six Mass Wasting Map Units (MWMU) representing general areas of similar geomorphology, landslide processes, and sediment delivery potential for shallow-seated landslides (Map A-2). The total sediment delivered from non-road related slides in MWMU 1, 2, and 3 was 81%, while MWMU 4 delivered 19% of the total non-road related delivery.

Surface and Point Erosion (Roads/Skid Trails)

It was determined that there are 617 miles of truck roads in the Navarro WAU (skid trails not included). This represented a road density of 7.3 miles of road per square mile. In the Navarro WAU 276 controllable erosion sites have high treatment immediacy and 466 controllable erosion sites have moderate treatment immediacy. In addition to these controllable erosion sites 610 culverts or crossings in the Navarro WAU have a diversion potential. These diversion potential sites need to be considered a high priority for road improvement as they can represent a significant potential fluvial erosion hazard. The culvert size analysis has determined that 260 culverts are potentially too small to pass the 50 year flood and an additional 276 culverts potentially will not pass the 100 year flood.

Roads in the MRC ownership in the Navarro WAU are estimated to generate, on average, 490 tons/mi^2/yr of sediment from road-associated surface and point source erosion. This represented 520 tons/mi^2/yr and 450 tons/mi^2/yr of estimated sediment delivery from Navarro East and Navarro West respectively (Table ES1 a & b).

Table ES-1(a) Road Associated Surface and Point Source Erosion Estimates by Planning Watershed for the Navarro East, MRC ownership.

Planning Watershed	**MRC Owned Acres**	**Surface Erosion (tons/yr)**	**Point Source Erosion (tons/yr)**	**Total Road Assoc. Erosion (tons/yr)**	**Road Assoc. Erosion Rate (tons/sq mi/yr)**
Dutch Henry Creek	4625	709	1537	2246	311
North Fork Indian Creek	1729	187	535	721	267
John Smith Creek	2080	569	2108	2678	824
Lower South Branch Navarro River	3988	532	287	819	131
Middle South Branch Navarro	6095	1359	3576	4935	518
Little North Fork Navarro River	6423	1648	5905	7553	753
Upper South Branch Navarro River	4807	1090	700	1790	238
Navarro East Totals (rounded)	***30,000***	***6,000***	***14,500***	***21,000***	***450***

Table ES-1(b) Road Associated Surface and Point Source Erosion Estimates by Planning Watershed for the Navarro West, MRC ownership.

Planning Watershed	MRC Owned Acres	Surface Erosion (tons/yr)	Point Source Erosion (tons/yr)	Total Road Assoc. Erosion (tons/yr)	Road Assoc. Erosion Rate (tons/sq mi/yr)
Rancheria Creek	742	542	930	1472	1270
Flynn Creek	2874	397	75	472	105
Floodgate Creek	704	67	8	75	68
Hendy Woods	998	585	757	1341	860
Lower Navarro River	4583	1149	433	1582	221
Middle Navarro River	4641	1328	649	1978	273
North Fork Navarro River	3943	1310	637	1947	316
Ray Gulch	2982	896	5573	6470	1389
Upper Navarro River	2925	991	3547	4538	993
Mill Creek	429	96	27	123	184
Navarro West Totals (rounded)	***25000***	***7500***	***13000***	***20000***	***520***

The future potential for point source erosion was evaluated in the Navarro WAU. This potential erosion or controllable erosion was identified during the road inventory during 1998-2000. A total of 1,103,723 cubic yards of controllable erosion was identified in the Navarro WAU (Table ES-2).

Table ES-2. Controllable Erosion by Treatment Immediacy for the Navarro WAU.

	Controllable Erosion Treatment Immediacy (yd^3)				
Location	**High**	**Moderate**	**Low**	**None**	**Undetermined**
Navarro East	221958	80573	194689	21715	10
Navarro West	96836	378072	102429	1164	53
Navarro WAU Total	***318794***	***458645***	***297118***	***22879***	***63***
Percent of total	29%	42%	27%	2%	<1%

In the Navarro WAU the majority of the forested portion of what is now the MRC ownership was harvested using tractor based yarding during the 1940s, 1950s and 1960s. This high level of skid trail construction and use is estimated to contribute a high level of sediment delivery. In general, skid trail sediment delivery rates were higher in Navarro East during the 1940s and 1950s than Navarro West. Navarro East has a more consistent skid trail sediment delivery rate for the duration of that time period than Navarro West.

Hydrology

Using the peak flow record from 1952-1998, the flood of record for the Navarro River is 1955 (64,500 cfs) considered to be greater than a 50 year event for the Navarro River. Throughout the last 50 years in the Navarro WAU there have been numerous large flood events. There have been 4 events >20 year recurrence (1955, 1965, 1974, and 1993 water years) and an additional 4 events > 10 year recurrence (1970, 1982, 1986, and 1996 water years). In the last decade alone there have been 2 storms greater than a 10 year recurrence (1993 and 1995), 5 storms greater than a 5 year recurrence (1993, 1995(3 events) and 1998) and 8 storms greater than a 2 year recurrence. This indicates a high number of large storms occurring within the last decade. The high occurrence of these large storms in the last decade suggests that the Navarro WAU has been subjected to stressful hydrologic conditions, possibly creating a greater incidence of landslides, road failures or surface erosion than previous decades. These flood events have

the capacity to re-shape river or stream channels and transport large sediment loads. The meteorological events that created these large floods also can be assumed to be a major contributor to the erosion and mass wasting delivered to the watercourses in the WAU.

Riparian Function

The riparian function assessment is divided into two groups: 1) the potential of the riparian stand to recruit large woody debris (LWD) to the stream channel along with the level of concern about current LWD conditions in the stream, and 2) a canopy closure and stream temperature assessment.
Our analysis showed a need for large woody debris in most of the channel segments of the Navarro WAU due to past stream clearing, historic harvest and low riparian recruitment potentials. Channel segments with LWD levels that are well below targets will need to be a priority for future recruitment and restoration work. Riparian LWD recruitment potential in the Navarro WAU is moderate to low. Currently, the majority of the streams have a deficient LWD quality rating, with the remainder being marginal. None of the major streams in the Navarro WAU received an on target LWD quality rating.

Stream temperatures for the tributary watercourses in the lower portion of the Navarro River, in Navarro West, are all "on target" (see module for description). Further, the small tributaries of the mainstem Navarro River in Navarro West are "on target" for stream temperatures. The mainstem of the Navarro River does not provide water temperatures compatible for salmonid summer rearing. The proximity and size of the mainstem of the Navarro River allows limited ability for streamside vegetation to affect stream temperatures for the Navarro River.

The North Fork of the Navarro River, both the South and North Branches exhibit stream temperatures that are either marginal or deficient to support salmonids. The North Fork of the Navarro River, a.k.a. Navarro East, is further inland and has higher air temperatures. Therefore, higher stream water temperatures should be expected. However, the stream shade quality is either marginal or deficient in the North Fork of the Navarro River (Navarro East). This suggests a need for improvement in stream shading to assist in maintaining more appropriate stream temperatures for aquatic organisms.

Stream Channel Condition

Baseline information on the stream channels of the Navarro WAU was collected and reported (see Stream Channel Condition module). Individual channel segments were categorized into geomorphic units using the baseline stream channel information, topography the channel segments are found in, position in the drainage network, and gradient/confinement classes. Seven stream geomorphic units were established to represent the range of channel conditions and sensitivities to input factors of coarse and fine sediment and LWD (Table ES-3).

Table ES-3. Stream Geomorphic Units and Sensitivities for the Navarro WAU.

Stream Geomorphic Unit	Channel Sensitivity		
	Coarse Sediment	Fine Sediment	LWD
Geomorphic Unit I. Estuarine Channels of the Navarro River.	Low	Moderate	Low
Geomorphic Unit II. Low Gradient, Confined Channels of the Navarro River.	Moderate	Moderate	Moderate
Geomorphic Unit III. Confined and Moderately Confined Low Gradient Channel Segments in the Navarro River Watershed.	Moderate	Moderate	High
Geomorphic Unit IV. Confined Low Gradient Channel Segments of Small Tributary Streams in the Navarro River Watershed.	High	Moderate	High
Geomorphic Unit V. Channel Migration/Avulsion Channel Segments in the Navarro River Watershed.	Moderate	Low	High
Geomorphic Unit VI. Moderate Gradient Confined Transport Segments.	Moderate	Low	Moderate
Geomorphic Unit VII. High Gradient Transport Segments.	Low	Low	Low

Fish Habitat Assessment

The anadromous fish species inhabiting the Navarro River WAU are steelhead trout (*Oncorhynchus mykiss*), coho salmon (*O. kisutch*) and Pacific lamprey (*Lampetra tridentata*). Non-anadromous species include sculpin (*Cottus spp.),* threespine stickleback (*Gasterosteus aculeatus*), California roach (*Lavinia symmetricus*), and Sacramento sucker (*Castomus occidentalis*). On MRC's property there are approximately 63 stream miles of habitat being utilized by coho and 95 stream miles of habitat being utilized by steelhead in the Navarro River watershed.

Habitat typing data indicated that spawning habitat was fair to good throughout most of the Navarro WAU. However, permeability data indicated areas with poor quality spawning gravel, especially in the North Branch North Fork Navarro River. Reduction of erosion rates should increase the quality of spawning gravel in the Navarro River WAU. Throughout most of the Navarro WAU, summer rearing and over-wintering habitat is limited by a lack of large woody debris and deep pools. Land management activities that promote woody debris recruitment and reduce pool filling (caused by erosion) should directly increase the quality of rearing habitat in the Navarro WAU.

Sediment Input Summary

The average estimated sediment input for the past thirty-two years for the Navarro WAU is 1300 tons/square mile/year. The Navarro WAU is broken down into two areas Navarro West and Navarro East for sediment inputs. Sediment inputs over the last thirty two years in Navarro West have come from hillslope mass wasting (25%), road mass wasting (23%), road surface and point source erosion (49%) and to a lesser extent skid trail erosion (3%). In Navarro East sediment inputs came from hillslope mass wasting (9%), road mass wasting (61%), road surface and point source erosion (27%), and to a lesser extent skid trail erosion (3%).

Road associated erosion is the dominant sediment contributing process in the Navarro WAU. The road associated mass wasting and surface and point source erosion combined accounts for 88% of the

estimated sediment inputs in the Navarro East. In Navarro West road associated mass wasting and surface and point source erosion combined accounted for 72% of the sediment input. Mass wasting from roads accounts for 61% of the sediment inputs in the Navarro East. While in Navarro West mass wasting associated with roads accounted for 23% of the sediment input.

Land Management Prescriptions

The following prescriptions were specifically prepared for use in the Navarro WAU. These prescriptions are meant to help address issues to aid in the stewardship of aquatic resources of the Mendocino Redwood Company ownership in the Navarro WAU. The prescriptions are meant to be used in addition to the current California Forest Practice Rules and company policies. At the time of the publication of this watershed analysis MRC's forest management policies are governed by interim guidelines prior to the issuance of a Habitat Conservation Plan and Natural Community Conservation Plan (HCP/NCCP). Once the HCP/NCCP is approved, the conservation strategies set forth in these documents will become the company policies. A prescription is only presented if it deviates from or adds clarification to these policies.

Mass Wasting

Mass wasting map unit 1 – Inner gorge or steep streamside slopes adjacent to low gradient watercourses

MWMU 1 Road placement, construction, and management:

- New road construction in MWMU 1 will not occur unless it is the only access available. If new road construction must occur it will only be to gain entry in and out of MWMU 1 and construction developed with the approval of a California Registered Geologist. The exception is when the road is the best alternative.
- Seasonal roads (roads subjected to annual use) in MWMU 1, including newly constructed roads and re-opened existing roads, will have the surface armored with rock.
- Temporary roads (roads only used periodically, every few years or decades) in MWMU 1 will be storm-proofed (such as suggested in Weaver and Hagans, 1994) prior to the winter period and the surface stabilized with grass seed, mulch, or other cover product.
- Any road that is within MWMU 1 will not have winter period heavy truck or log hauling traffic unless armored with a rock surface.
- The slopes of the inner gorge or the first 50 feet, whichever is longer, will be an equipment exclusion zone (EEZ) except for designated crossings and existing truck roads.

MWMU 1 timber harvest*:*

- MWMU 1 will receive no harvest on inner gorge slopes unless approved by a California Registered Geologist. On other areas (non-inner gorge slopes) within MWMU 1 in addition to the riparian protections set as company policy timber harvest must retain a minimum of 50% overstory canopy dispersed evenly across the slopes.
- The MWMU 1 protections will extend from the edge of the watercourse transition line up to the break in slope of the inner gorge and 25 feet of additional slope distance after the break in slope of the inner gorge.
- For those areas that do not have well defined inner gorge topography in MWMU 1 timber harvest must retain 50% overstory canopy[2].
- The area directly adjacent to the break in slope of the inner gorge will retain those trees with a root mass that maintains the stability of that slope break.

[2] Only trees greater than 30 feet in height count towards canopy measurement.

- Trees within 10 feet of the bankfull channel will be retained, except for redwood clumps. At least 50% of a redwood clump must be retained with emphasis on leaving the trees most likely to deliver to the stream in this 10 foot zone.

Mass wasting map unit 2 – Inner gorge or steep streamside slopes adjacent to moderate to high gradient watercourses

Road construction, placement or management:

- Alternatives to road construction or road use, such as cable yarding, helicopter yarding or alternative road placement, will be pursued in MWMU 2.
- New road construction in MWMU 2 will not occur unless it is the only access available. If new road construction must occur it will only be to gain entry in and out of MWMU 2 and construction developed with the approval of a California Registered Geologist. The exception is when the road is the best alternative.
- The slopes of the inner gorge or the first 50 feet, whichever is longer, will be an equipment exclusion zone (EEZ) except for designated crossings and existing truck roads.

Timber Harvest:

- MWMU 2 will receive no harvest on inner gorge slopes unless approved by a California Registered Geologist. On other areas (non-inner gorge slopes) within MWMU 2 in addition to the riparian protections set as company policy timber harvest must retain a minimum of 50% overstory canopy (see footnote page vi) dispersed evenly across the slopes.
- Trees within 10 feet of the bankfull channel will be retained, except for redwood clumps. At least 50% of a redwood clump must be retained with emphasis on leaving the trees most likely to deliver to the stream in this 10 foot zone.

Mass wasting map unit 3 – Steep dissected terrain

Forester will utilize available resources for identification of unstable areas or areas with predicted slope instability. These include Map A-1 of Mass Wasting Assessment for the Navarro WAU, Division of Mines and Geology landslide maps (if available), or past Timber Harvest Plans.

Forester will walk the ground of this unit prior to prescribing operations. If upon field review the unit is confirmed to meet the definition of MWMU 3 and a significant risk of sediment delivery is identified the following guidelines apply:

- No road or landing construction activity will occur in areas identified in the field as having a significant likelihood of sediment delivery to a watercourse from mass wasting unless a site-specific assessment is conducted and operations approved by a California Registered Geologist.
- Harvest operations must retain at least 50% of the overstory canopy (see footnote page vi) unless a site-specific assessment is conducted and operations approved by a California Registered Geologist.

Rockslides

No harvest or new road construction will occur on active portions of rockslides with a risk for sediment delivery unless approved by a California Registered Geologist.

Roads

John Smith Creek, Ray Gulch, Upper Navarro, Little North Fork Navarro River, Rancheria Creek and Hendy Woods planning watersheds had the highest rates of road associated erosion. In all of these cases the roads in the planning watersheds had a high amount of point source erosion. This probably indicates older legacy roads that are having a high amount of culvert or landing failures or inappropriate drainage creating gully erosion. These planning watersheds with a high rate of erosion should be considered priorities for erosion control work when considering work in a watershed context (i.e. "buttoning-up the entire watershed").

High and Moderate Erosion Hazard Roads

The roads with a high erosion hazard rating should be given special attention for maintenance or erosion control. These roads should be considered high priority roads for rock surface, improved and increased road drainage relief, design upgrades or decommissioning.

The moderate erosion hazard roads should be given similar attention, but not as high a priority as the high erosion hazard roads.

Masonite Road (M Road)

A management plan has been developed for the Masonite road, across all watersheds (not just the Navarro WAU). The plan presents a prioritization of where road restoration work should occur and a timeline and process for that restoration.

High and moderate treatment immediacy sites for roads in the Navarro WAU

The high treatment immediacy controllable erosion sites will be the highest priority for erosion control, upgrade, or modifications to existing design. These sites will be scheduled for repair based on operational considerations of harvest scheduling, proximity and availability of equipment, magnitude of the problem, and accessibility to the site.

The moderate treatment immediacy controllable erosion sites will be the next highest priority (relative to the high treatment immediacy sites) for erosion control, upgrade, or modifications to existing design. The moderate treatment immediacy sites will typically be addressed when in close proximity to high treatment immediacy sites.

It is recommended that road site corrections attempt to follow the order of treatment immediacy as presented in Appendix B.

Diversion potential sites along roads in the Navarro WAU

These diversion potential sites will be a high priority for correction. These sites will be scheduled for repair based on operational considerations of harvest scheduling, proximity and availability of equipment, magnitude of the problem, and accessibility to the site. It is very likely that these sites will be addressed when in close proximity to high treatment immediacy sites.

It is recommended that road site corrections attempt to follow the order these diversion potential sites are presented in Appendix B.

Undersized culverts in the Navarro WAU

The 260 culverts that will not pass the 50 year flood will be visited in the field and a determination will be made if the culverts are indeed under-sized (identification of under-sized culverts was done by an office-based evaluation that could be inaccurate). If after field review the culverts are found to be under-sized it will be a high priority for replacement to a watercourse crossing structure that will pass the 100-year flood.

The 16 culverts that will not pass the 100 year flood will be visited in the field and a determination will be made if the culverts are indeed under-sized for this sized flood event (identification of under-sized culverts was done by an office-based evaluation that could be inaccurate). If after field review the culverts are found to be under-sized for the 100 year flood it will be a moderate priority for replacement to a watercourse crossing structure that will pass the 100-year flood. Typically the upgrade will occur once the culvert has reached the end of its operational life.

The field review will consist of determining the cross section area of the bankfull channel and comparing it the cross sectional area of the culvert in question. A rule of thumb is that to pass the 100 year flood the culvert opening area needs to be 3 times as large as the bankfull channel cross section area (Cafferata, Spittler, and Wopat, 2000).

Fish passage barriers from culverts in the Navarro WAU

There are 3 known culverts that are fish passage barriers Bridge Creek, Camp Creek and an unnamed tributary below John Smith Creek. In the case of Bridge Creek and Camp Creek a bridge should be built at the watercourse crossing. The unnamed tributary below John Smith Creek will be evaluated for appropriate watercourse crossing design for fish passage.

Other fish migration barriers likely exist and need to be investigated over time.

Riparian

Large woody debris recruitment

The company policies for streamside stand retention are considered to be appropriate at this time for LWD recruitment. Monitoring of LWD recruitment will be done to determine if this is correct.

In the interim MRC will promote attempts to place LWD in stream channels to provide habitat structure. The stream locations with high instream LWD demand should be considered the highest priority for LWD placement. The moderate instream LWD demand segments would be next.

When planning for instream LWD placement the following major streams in the Navarro WAU are recommended for a higher level of consideration, due to instream LWD demands and coho salmon habitat improvement:

Little North Fork Navarro River
John Smith Creek
South Branch North Fork Navarro River
Flynn Creek
Marsh Gulch
Murray Gulch

Stream Shade

The company policies for streamside canopy and riparian management are considered to be appropriate at this time.

The 2 river reaches with unnaturally low canopy, the North Branch North Fork Navarro from approximately John Smith Creek downstream to the crossing at highway 128, and the South Branch. North Fork Navarro from Malcom's bridge downstream to the confluence with the North Branch will have the following considerations for canopy improvement:

- Tree planting along the river for restoration of riparian vegetation should be emphasized.
- Restoration harvest within the AMZ will not remove trees providing effective shade.
- Stream temperatures will be monitored to determine if temperatures are lowering as canopy grows in over time.

Monitoring

Aquatic resources monitoring will be conducted in the Navarro WAU. This monitoring is to assist Mendocino Redwood Company to assess impacts to aquatic resources associated with past or future timber harvest and related forest management activities in the Navarro WAU. The monitoring suggested in this plan is monitoring that MRC across all its lands including the Navarro WAU. However, other monitoring efforts not mentioned here may be conducted by MRC in the Navarro WAU. Currently a comprehensive monitoring plan is being developed for the MRC lands. Once that plan is finalized it will supercede the monitoring presented here.

Monitoring Plan Goals:

- Test the efficacy of the Navarro WAU prescriptions to address impacts to aquatic resources from timber harvest and related forest management activities.
- To assess long term channel conditions. Are current and future forest management practices inhibiting, neutralizing or promoting stream channel conditions for aquatic habitat?

A monitoring report will be produced each year that monitoring is conducted in the Navarro WAU. The report will cover the monitoring and analysis that has occurred up to that year; if no monitoring is conducted in a given year than no report will be produced. The goal will be to have a report completed by February of the year following the monitoring. Table ES-4 summarizes some of the monitoring to be conducted in the Navarro WAU over time.

Table ES-4. Monitoring Matrix for Mendocino Redwood Company Lands Including the Navarro Watershed Analysis Unit.

Monitoring Objectives	**Reasoning, Comments**	**Technique**
1. Determine effectiveness of measures to reduce management created mass wasting.	Management created mass wasting is significant contributor of sediment delivery.	Evaluation of mass wasting following a large storm event or after approximately 20 years.
2. Determine effectiveness of erosion control practices on high and moderate surface erosion hazard roads and landings.	Roads provide sediment delivery in the Navarro WAU.	Evaluation of watercourse crossings, landings, and road lengths for erosion evaluation.
3. Determine in-stream large woody debris amounts over time.	Large woody debris is needed for stream channel and aquatic habitat improvement in the Navarro WAU.	Stream LWD inventories and mapping of LWD designation areas in select stream reaches and long term channel monitoring sites.
4. Determine if stream temperatures are staying within properly functioning range for salmonids.	Stream temperature can be a limiting factor for salmonid growth and survival.	Stream temperature probes and assessment conducted in strategic locations.
5. Determine if fine sediment in stream channels is creating effects deleterious to salmonid reproduction.	Many forest practices can produce high fine sediment amounts. Need to ensure fine sediments are not impacting salmonid reproduction.	Permeability measurements on select stream reaches (bulk gravel samples if necessary).
6. Determine long-term channel morphology changes from coarse sediments.	Channel morphology can be altered from sediment increases, possibly affecting aquatic habitat.	Thalweg profiles and cross section surveys on select stream reaches.
7. Determine presence and absence of fish species in Class I watercourses.	Management practices and resource protections can affect distribution of aquatic organisms.	Electro-fishing and snorkeling observations at select locations to determine species composition and presence.

Navarro River Watershed
Watershed Analysis Unit

Navarro River Watershed Overview

Pacific Ocean

John Smith Creek 113.50061
Little No. Fork Navarro River 113.50060
Dutch Henry Creek 113.50062
Fly Creek 113.50035
Rav Gulch 113.50076
Lower Navarro River 113.50077
North Fork Navarro River 113.50074
Lower So. Branch Navarro River 113.50052
Middle So. Branch Navarro Riv 113.50051
Upper South Branch Navarro Riv. 113.50050
Floodgate Creek 113.50072
Middle Navarro River 113.50073
Mill Creek 113.50070
North Fork Indian Creek 113.50041
Upper Navarro River 113.50071
Handy Woods 113.50043
Lower Indian Creek 113.50042
Upper Indian Creek 113.50040
Rancheria Creek 113.50020
Con Creek 113.50033
Ham Canyon 113.50022
Robinson Creek 113.50032
Soda Creek 113.50031
Hayrill Creek 113.50021
Anderson Creek 113.50030
Middle Rancheria Creek 113.50016
German Creek 113.50015
Beebe Creek 113.50058
Maple Creek 113.50013
Adams Creek 113.50012
Diamond D Ranch 113.50011
Upper Rancheria Creek 113.50010

Major Streams
Planning Watershed
Navarro River Watershed Boundary

Ocean, Lake, Pond
MRC Ownership

0 4 Miles

August 2002