APPENDIX B

Upper Calapooia River Watershed Analysis
Surface Erosion Assessment

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August 1998

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METHODS

The assessment of surface erosion for the Upper Calapooia Watershed Administrative Unit (WAU) was performed following the methodology of the Surface Erosion Module of the Washington Forest Practices Board Standard Methodology for Conducting Watershed Analysis, Version 4.0 (WFPB, 1997). The analysis focused on two general sources of surface erosion: 1) hillslope surface erosion, including harvest units and landslide scars; and 2) logging roads.

Hillslope Surface Erosion

The potential for surface erosion was evaluated using data obtained from the Natural Resources Conservation Service (NRCS) Soil Survey for Linn County (Langridge, 1987) and the United States Forest Service (USFS) Soil Resource Inventory (SRI; Willamette National Forest, 1994). Surface Erosion Map Units (SEMUs) were constructed based on the soil type, parent material, texture, depth and fine material content of the soil. Although "erosion hazard" ratings are provided by both the NRCS soil survey and SRI, such ratings have proven ineffective at predicting the actual surface erosion from logging in other WAUs. For this reason, the SEMUs are used for the erosion potential assessment. Differences in the characteristics listed above influence the amount and type of material delivered to stream channels via overland flow as well as the production of sediment from forest road surfaces. The extent of surface erosion has been found to be more a function of the nature and proximity of harvest and site preparation activities to surface drainage ways, and for this assessment is evaluated primarily through field inspection at a sample of recent land use sites distributed throughout the SEMUs.

The natural background sediment delivery rate was estimated using the soil creep methodology (WFPB, 1997). The WAU was subdivided into seven subbasins **(Map B1)** to allow comparisons of sediment contributions and land use impacts at various points along the stream network. The minimum drainage area required for channel initiation was approximated for each subbasin based on field observations. Geographical Information Systems (GIS) was then used to delineate the stream network and calculate the total stream length within each subasin based on the minimum contributing area. Soil depth, bulk density and coarse material content was approximated using average values associated with the most extensive dominant soil group in each subbasin. The accuracy of the estimated background delivery rate was evaluated through a comparison with average annual suspended sediment yields observed in nearby basins. Calculations and detailed information on the physical characteristics used to estimate background sediment yield is provided in Attachment B1.

Logging and related activity comprise the dominant land use in the Upper Calapooia WAU and were the primary focus of this analysis. Three levels of inspection were used to identify surface erosion: 1) inspection of aerial photographs; 2) reconnaissance from driving by; and 3) field inspection of recently harvested units. The location of timber harvest that occurred during the last five to six years was compiled from ownership records and vegetation age maps **(Map B3).** Field data sheets from the hillslope surface erosion inspections are provided in Attachment B2.

Based on the mass wasting photo inventory, some landslide scars may take as much as ten years or more to re-vegetate (Appendix A). Numerous large landslides occurred in 1996, therefore, surface erosion from landslide scars was perceived to be a potentially important source of fine sediment.

Sediment delivery from landslides scars was evaluated using a procedure based on the Universal Soil Loss Equation (USLE) that is designed specifically for forest lands (Dissmeyer and Foster, 1984). The surface area, cover, slope and delivery of a subset of recent landslide scars was obtained as part of the landslide inventory (Appendix A). These landslide scars were subdivided by mass wasting map unit (MWMU) and SEMU, and the sediment delivery from each scar was assessed using the USLE-based procedure. These data were used to generate an estimate of the average sediment yield per acre of landslide scar in each MWMU/SEMU combination.

Annual landslide scar sediment yield estimates for each subbasin were developed by extrapolating the estimated landslide scar sediment yield rate to the total acreage of unvegetated landslide scars in each subbasin. For the purpose of this evaluation, it is assumed that all scars delivering sediment to stream channels via mass wasting deliver an equivalent proportion of sediment generated via surface erosion. Attachment B3 contains a description of all co-effcients used to develop estimates of the landslide scar erosion rate, and the complete landslide scar erosion calculation spreadsheets.

Non-forestry land uses, including rural residential and light grazing occur in limited areas along the valley bottom in the westernmost portion of the WAU. Because of the limited area involved the impacts of non-forestry activities were not investigated.

Road Surface Erosion

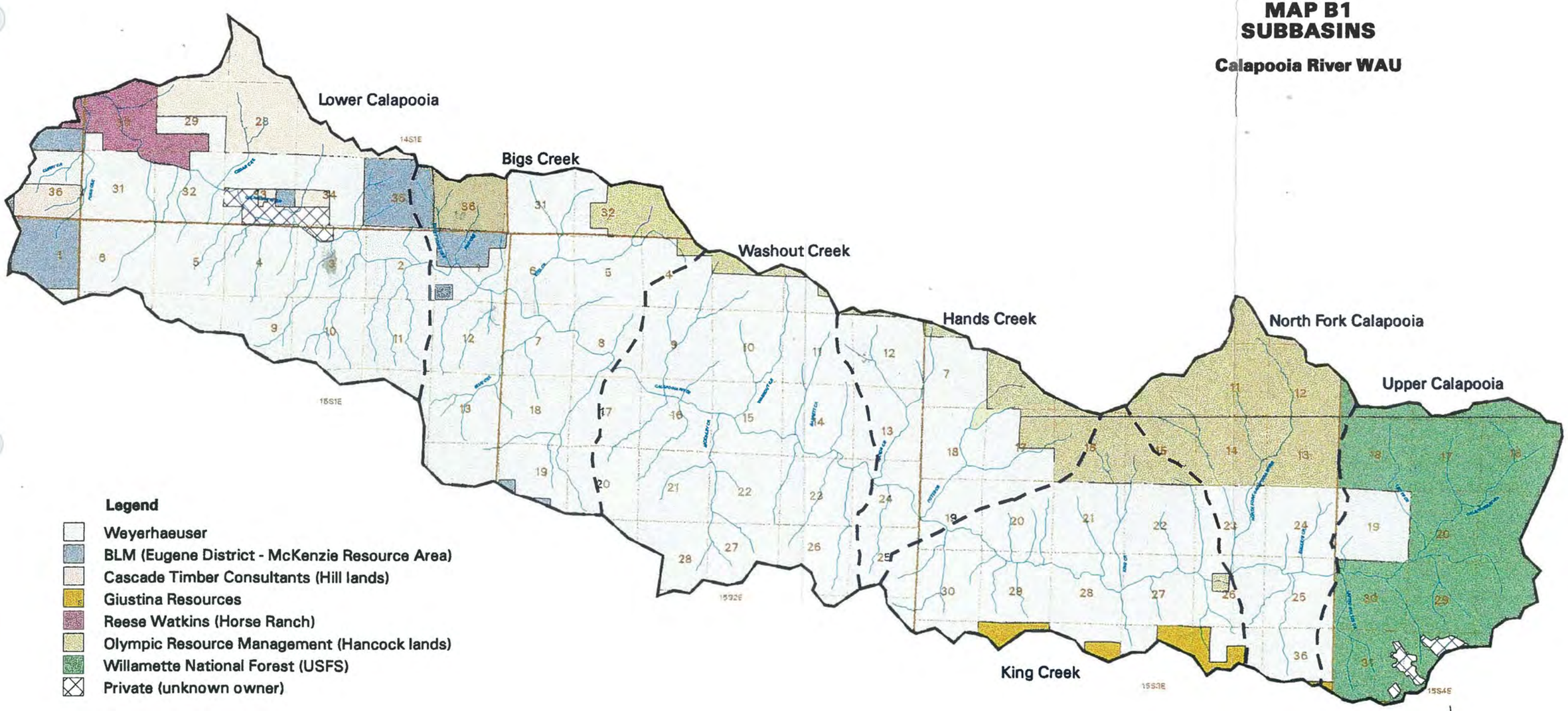
Two general sources of road sediment delivery were assessed. Sediment delivery resulting from traffic use and runoff from exposed road surfaces was evaluated using a modified version of the standard road erosion model provided in the Manual (WFPB, 1997). The numerous refinements and modifications of the model are described in Attachment B4.

In addition, fluvial erosion and gullying resulting from erosion of fill below unprotected culvert outfalls or diversion of streamflow down road surfaces and inboard ditches was quantified based on the field observations. The length, average width and average depth of each gully encountered was measured and used to calculate the approximate volume of material that had been eroded at each site. The total eroded volume was modified based on the average proportion of coarse soil material for the SEMU in which the gully occurred in, to better reflect the contribution of fine sediment.

A complete inventory of the driveable road network was conducted by Weyerhaueser in May 1997. Site specific data on traffic rates, surface material, cover, road configuration and delivery was collected for over 2900 road segments. This data was spot checked by the Surface Erosion Analyst in May 1998.

MAP B1
SUBBASINS

Calapooia River WAU



Legend

- Weyerhaeuser
- BLM (Eugene District - McKenzie Resource Area)
- Cascade Timber Consultants (Hill lands)
- Giustina Resources
- Reese Watkins (Horse Ranch)
- Olympic Resource Management (Hancock lands)
- Willamette National Forest (USFS)
- Private (unknown owner)

1 : 90000

1 inch = 7500 feet

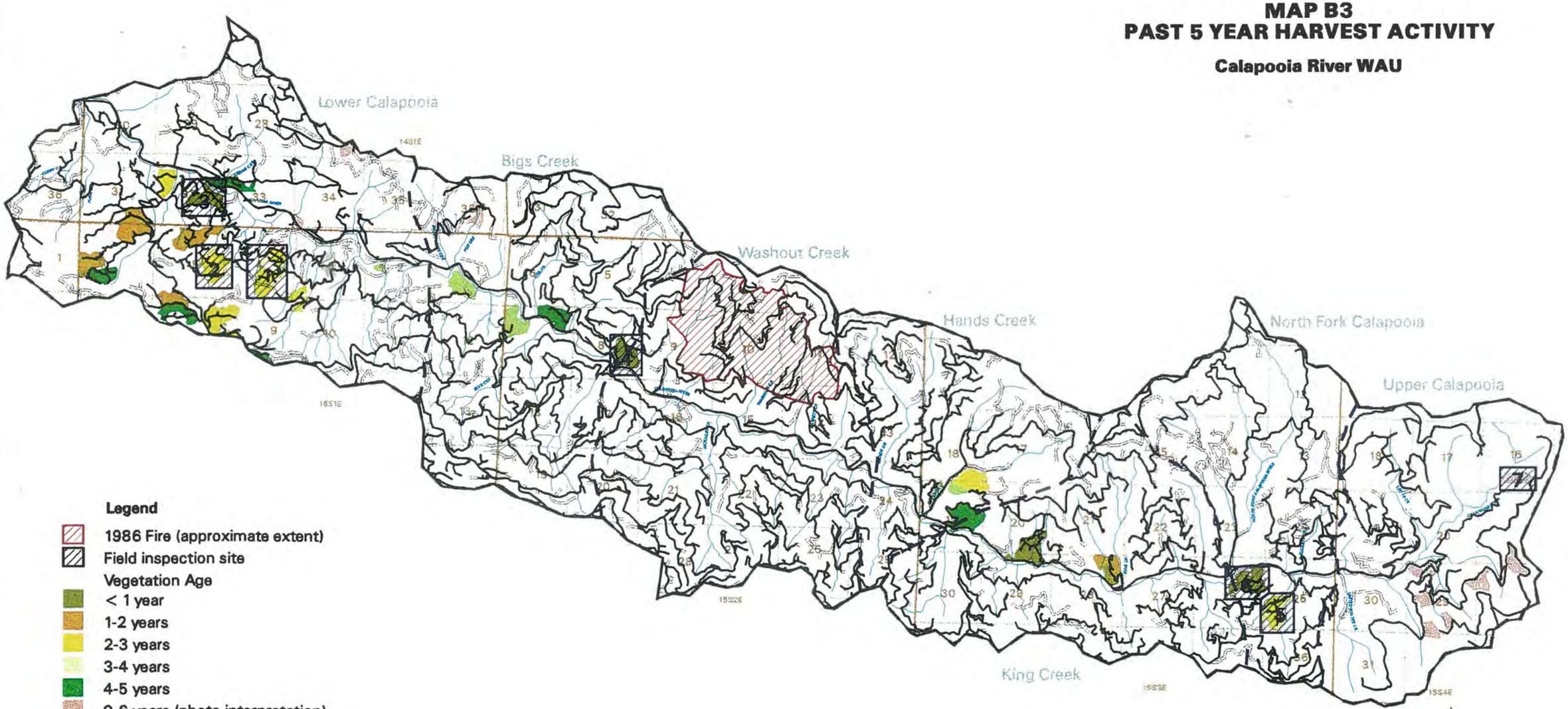
Map B1 Subbasins

Weyerhaeuser

DATE: 08/18/98

MAP B3
PAST 5 YEAR HARVEST ACTIVITY

Calapooia River WAU



Legend

- 1986 Fire (approximate extent)
- Field inspection site

Vegetation Age

- < 1 year
- 1-2 years
- 2-3 years
- 3-4 years
- 4-5 years
- 0-6 years (photo interpretation)

- Driveable roads
- Abandoned/overgrown roads

1:90000

1 inch = 7500 feet

Map B3 Past 5 Year Harvest Activity

Weyerhaeuser

DATE: 08/18/98

For moderate to heavily used roads, traffic is frequently a major determinant of sediment production (Reid and Dunne, 1984). Sediment delivery was modeled for both existing use and under a scenario in which all mainline and primary/secondary roads were assumed to have high use to assess the influence of traffic rate on sediment production in the Calapooia River WAU. Complete inventory data and road sediment delivery calculations are provided in Attachment B5 Road hazard ratings were developed by comparing road sediment contributions from surface erosion and gullying to natural background sediment delivery rates. In subbasins with moderate or high hazard ratings, the model output was examined in detail to identify the specific road segments and characteristics responsible for producing the majority of the sediment.

Turbidity Sampling

Because suspended sediment is usually the primary source of sediment in forest streams in the Pacific Northwest, turbidity can be used as a surrogate for suspended sediment concentrations (MacDonald et al., 1991). Turbidity samples were collected throughout the WAU, and at four sites on the Calapooia River downstream of the WAU to assess conclusions relative to sediment contributions from various management activities and natural background rates. Water samples were collected during a rain event on 29 May 1998.

ANALYSIS AND RESULTS

Overview of Native Soils and Soil Erosion Potential

The combined NRCS soil survey and Soil Resource Inventory (SRI) delineates over 30 detailed soil units, often differentiated by fairly subtle distinctions. Soils within the WAU range from moderately deep to deep (2 - 4.5 ft; 0.6 - 1.4m) and are typically well drained, readily allowing infiltration of rainfall and snowmelt inputs. The mineral soil is normally covered with a continous layer of organic duff and litter 1 to 2 in (2.5-5 cm) thick, except where removed by land clearing (roadcuts, agricultural areas, construction) or intense fires. Soils in the Calapooia WAU were divided into five SEMUs **(Map B2)**.

SEMU 1 is located in the western-most portion of the WAU. This map unit contains soils derived from sedimentary or tuffaceous parent materials formed on ancient earthflows. Soils in SEMU 1 are generally deeper than 3.3 ft (1 m), with a high clay content (up to 30%), and contain little coarse material. Because of the gentle slopes and high clay content (high soil cohesion), the erosion potential is low except on short, steep slopes immediately adjacent to incised stream channels. SEMU 1 generally corresponds to the Honeygrove-Peavine-Apt NRCS map unit.

SEMU 2 consists primarily of soils of the Harrington series associated with basalt outcrops. These soils are moderately-deep (<0.9m; 3 ft) gravelly loams, containing 30 to 50 percent gravel and cobbles. The erosion potential is moderate

SEMU 3 is the most extensive soil group in the WAU. SEMU 3 occupies valley sideslopes and frequently old slump areas along the Calapooia mainstem. Soils are predominantly cobbly loams of the Kinney series, formed from volcanic ash mixed with colluvium derived from tuffaceous rocks. Depths may exceed 3.2 feet (1 m). The coarse material content is approximately 30 percent. The erosion potential is moderate to high on steep, stream adjacent sideslopes and inner gorges.

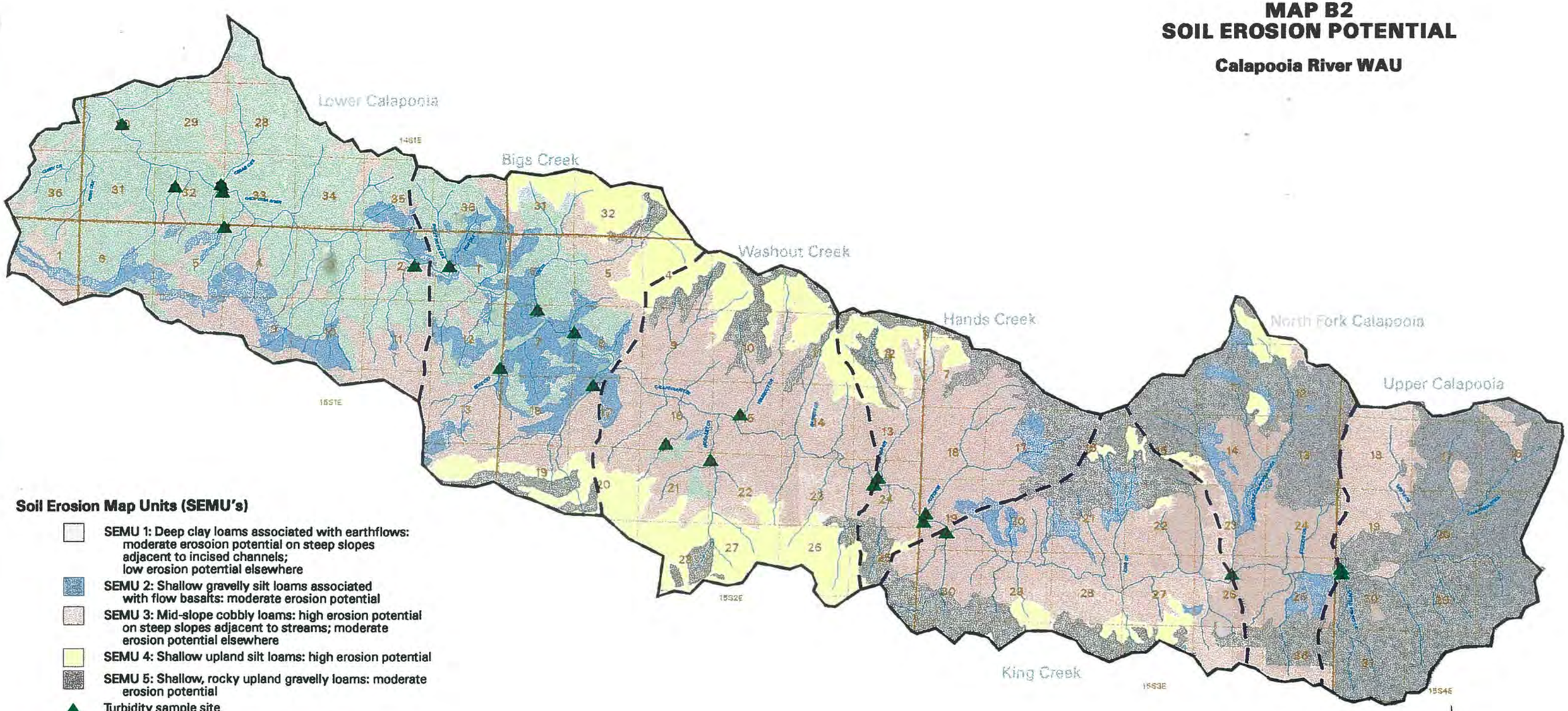
SEMUs 4 and 5 occupy ridgetops along the WAU drainage divide. Both are moderately-deep silt loams formed from colluvium derived from igneous rock. These two map units are differentiated primarily by the coarse material content of the soil. SEMU 4, in the middle of the WAU, is dominated by soils of the Keel series, with less than 10 percent coarse material content, and a high erosion potential. SEMU 5 is dominated by soils of the Hummington series and SRI unit 201, and contains up to 50 percent coarse fragments. The erosion potential for SEMU 5 is moderate.

Natural Background Sediment Delivery

The natural background sediment delivery rate varied by subbasin from 13.5 to 29.7 tons/mi^2 per year (5.7-12.6 tonnes/km^2/yr), averaging 22.5 tons/mi^2 per year (9.6 tonnes/km^2) for the entire basin (Table B1). Background sediment production is highest in the Lower Calapooia subbasin where soils are deep and contain little coarse material. Despite the relatively gentle slopes, the creep rate on the old earthflow topography is presumed to at least equal the rate in other subbasins. Background sediment production is lowest in the Upper Calapooia subbasin where soils are thin and coarse.

MAP B2
SOIL EROSION POTENTIAL

Calapooia River WAU



Soil Erosion Map Units (SEMU's)

- SEMU 1: Deep clay loams associated with earthflows: moderate erosoion potential on steep slopes adjacent to incised channels; low erosion potential elsewhere
- SEMU 2: Shallow gravelly silt loams associated with flow basalts: moderate erosion potential
- SEMU 3: Mid-slope cobbly loams: high erosion potential on steep slopes adjacent to streams; moderate erosion potential elsewhere
- SEMU 4: Shallow upland silt loams: high erosion potential
- SEMU 5: Shallow, rocky upland gravelly loams: moderate erosion potential
- Turbidity sample site

1:90000

1 inch = 7500 feet

Map B2 Soil Erosion Potential

Weyerhaeuser

DATE: 08/18/98

Table B1 Physical characteristics and estimated natural background sediment delivery rate for subbasins in the Calapooia River WAU.

Subbasin	Drainage Area (mi^2)	Channel length (mi)	Mean soil depth (ft)	Soil Creep rate (in/yr)	Estimated Background Sediment Delivery ($tons/mi^2/yr$)
Lower Calapooia	18.8	61	4.0	0.08	29.8
Bigs Creek	13.4	47	3.7	0.08	28.8
Washout Creek	14.7	48	3.3	0.08	20.3
Hands Creek	7.7	24	4.0	0.08	19.8
King Creek	10.8	37	3.3	0.08	18.6
N. F. Calapooia	9.1	32	3.3	0.08	18.9
Upper Calapooia	10.5	36	3.0	0.08	13.5
Total	85.0	285			22.5

Annual sediment yields reported for several tributaries of the Bull Run River in north central Oregon ranged from 22 to 72 $tons/mi^2$ per year (USGS, 1998). Estimated sediment yields for the Calapooia River WAU are generally within this range, although higher elevation subbasins with thin, coarse soils produce slightly less sediment. Total suspended sediment yields are expected to be higher than estimated inputs from soil creep developed for this assessment, because streams also receive sediment inputs from other processes such as mass wasting that contribute substantial amounts of sediment (Appendix A), but were not assessed as part of the background sediment production estimate.

Hillslope Surface Erosion and Sediment Delivery

Contributing Land Use Activities

The location and age of units harvested within the past five years are depicted on Map B3. Units harvested on the Weyerhaueser ownership between 1993 and 1998 are classified according to age. Recent harvest units located on other ownerships were identified using vegetation age class maps. Areas with vegetation in the 0-6 year age class are assumed to have been harvested since 1992. Most forestry activities involve clearcut harvest of second-growth timber utilizing ground based and/or cable logging methods. Site preparation is generally limited to mechanical, with some piling and burning. Harvest units on the USFS ownership in the eastern part of the basin appear to have been broadcast burned.

Seven recent harvest units were inspected in the field (Table B2; Map B3). Four of the field inspection sites are predominantly within SEMU 1, and logged using a combination of ground-based and cable systems. Based on observations at Site 3, initial soil disturbance associated with logging in this SEMU is minimal. However, some delivery of sediment via overland flow was observed where yarding or site preparation activities have exposed patches of soil immediately adjacent to surface drainage ways. Revegetation in SEMU 1 is rapid, as evidenced by the absence of exposed soil in units older than one year, thus sediment contributions from this source are expected to be minimal.

Table B2 Summary of observations at surface erosion field inspection sites in the Calapooia WAU, May 1998.

						Surface Cover (%)			Evidence of:	
Site #	**SEMU**	**Year cut**	**Harvest method[1]**	**Site Prep**	**Slope**	**Mineral Soil**	**Slash/ duff**	**Veg**	**Surface flow**	**Sed. Delivery**
1	1,2,3	1995	GB/C	spot burn	<30	0	40	90	No	No
2	1,2,3	1995	GB/C	spot burn	<30	<5	30	90	No	No
3	1	1997	GB	pile/ spot burn	<20	10	30	75	Yes	Yes
4	1,2	1997	C	none	30-60	10	30	75	No	No
5	3	1995	C	spot burn	20-60	<5	20	90	No	No
6	3	1997	C	spot burn	40-60	20	60	20	Yes	No
7	5	1996	C	Broad cast burn	>60	15	55	30	Yes	No

GB=Ground-based C=Cable

Two field inspection sites were located within SEMU 3 (Table B2). Both sites were logged using cable yarding systems and then spot burned. At site 6, which was harvested in 1997, soils were exposed on approximately 20 percent of the harvest unit, and there was some evidence of surface flow where ditch relief culverts delivered road-runoff onto side slopes. Concentrated flows quickly dispersed and infiltrated on hillslopes, and no delivery to stream channels was observed.

The final field inspection site was located on the USFS ownership at the eastern end of the WAU (Table B2; Map B3) in SEMU 5. Inspection site 7 had been cable yarded and broadcast burned. Skid trail surfaces were armored with gravel, indicating that overland flow and surface erosion had occurred. However, because skid trails were oriented obliquely to the slope, no delivery of fine sediment to the stream network was observed.

No recent harvest has occurred in SEMU 4, therefore the potential for surface erosion in this map unit was assessed using aerial photographs. In 1986, a major fire occurred and extensive areas of bare soil were observed on the 1987 aerial photos. Surface erosion reportedly increased following the fire, requiring more frequent ditch cleaning (Proctor, pers. comm. 1998). In 1998 slopes had revegetated and no areas of ongoing erosion were observed.

Landslide Scar Erosion

A number of unvegetated landslide scars dating from the 1996 storm event and several scars from earlier mass wasting episodes up to ten years of age were identified as a potential source of fine sediment due to post-failure surface erosion. Estimated landslide scar erosion rates varied by SEMU and MWMU, and ranged from approximately 19 to over 87 tons per acre per year under bare soil conditions (Table B3). Increasing surface soil cover on the slide scars to 30 percent reduces the estimated annual seiment yield rate by approximately 70 percent.

Table B3 Summary of estimated landslide scar surface erosion rates for selected MWMU and SEMU in the Calapooia WAU.

MWMU	SEMU	Number of sites	Estimated average annual soil loss with 0% surface cover (tons/ac)	Estimated average annual soil loss with 30% surface cover (tons/ac)
1	1	1	54.0	16.2
	2	4	32.6	9.8
	3	23	23.4	9.8
	4	8	44.7	13.4
	5	11	18.9	5.7
2	1	1	50.6	15.2
	2	1	27.1	8.1
	4	2	45.2	13.6
3	3	2	86.5	25.6
7	1	4	76.2	22.9
	3	26	30.9	9.3
	4	4	81.5	24.5
	5	4	31.9	9.6

Extrapolating these landslide scar erosion rates to unvegetated landslide scars less than ten years old identified in the complete mass wasting landslide inventory suggests that this source of erosion contributes from 1.6 to 300 tons of sediment per year for the subbasins identified in the Calapooia WAU (Table B4).

Table B4 Estimated total annual landslide scar erosion by subbasin in the Calapooia WAU.

Subbasin	Estimated total landslide scar sediment yield (tons/mi^2/yr)	Increase over estimated natural background sediment yield (%)
Lower Calapooia	1.8	6
Bigs Creek	4.6	16
Washout Creek	9.7	48
Hands Creek	8.6	43
King Creek	26.4	142
N. F. Calapooia	No slides identified	–
Upper Calapooia	0.2	1
Total	6.9	31

Only the King Creek subbasin had an increase in sediment production greater than 50 percent, the increase required to cause a detectable response. The estimated landslide scare erosion in the King Creek subbasin was 142 percent of the background rate. This high increase resulted from surface erosion on the exposed portions of two large landslides in MWMU 3. These were the only recent MWMU 3 landslides identified in the landslide inventory, yet they accounted for over 40 percent of the total estimated landslide scare erosion.

Conclusions and Hazard Ratings

The field inspections, drive-by reconnaissance and air photo analysis all indicate that surface erosion associated with timber harvest activities is limited and that delivery of sediment via hillslope surface erosion in the Calapooia River WAU is minimal under current management practices. Erosion can result when soils are exposed immediately adjacent to surface drainageways. Although erosion observed from this situation was limited, because of the high erosion potential on steep, stream adjacent slopes and the high proportion of fine materials, the hazard of significant contributions is considered moderate in SEMUs 1, 3 and 4.

No sediment delivery was observed at field inspection sites in SEMUs 2 and 5. The high proportion of coarse fragments leads to rapid armoring of exposed soil surfaces, and field observations suggest that normal logging practices conducted in accordance with existing state regulations is adequate to prevent widespread surface erosion impacts. This supports the assignment of a low hazard rating for contemporary forestry activities within SEMUs 2 and 5

.

The landslide scar erosion modeling indicates that surface erosion of unvegetated MWMU 3 can contribute over 100 percent of the natural backgournd sediment yield. Landslide scars in this MWMU are rare but often large an dchronically active. These landslides are therefore considered to have a high surface erosion hazard.

Road Surface Erosion

The Calapooia River WAU contains an extensive network of logging roads **(Map B5)**. The primary access route is the USFS maintained 2820 road which parallels the mainstem Calapooia River for most of its length. The first six miles of this road are paved. Other important access routes include the Mohawk Mainline along the southwest edge of the WAU and the Giustina mainline to the southeast.

There are approximately 645 total miles of road in the Calapooia River WAU, resulting in an average road density of 7.6 miles/mile^2. Road densities are generally high (>5.0 mi/mi^2), except for the Upper Calapooia subbasin (Table B5). Approximately 20 percent of the roads in the basin are mapped as abandoned. Abandoned roads mapped for this assessment include both roads that have been "put to bed" in accordance with ODF regulations as well as roads that are currently inaccessible due to washouts. The majority of abandoned roads visited no longer appear to contribute sediment via surface flow. However, in at least two instances, large gullies had formed due to fluvial erosion at plugged stream crossings on abandoned roads.

Table B5 Road density by subbasin in the Calapooia River WAU.

Subbasin	Drainage Area (mi^2)	Active Road Density (mi/mi^2)	Total Road Density including active and abandoned (mi/mi^2)
Lower Calapooia	18.8	4.3	6.1
Bigs Creek	13.4	5.4	6.7
Washout Creek	14.7	6.4	7.3
Hands Creek	7.7	4.9	6.6
King Creek	10.8	5.6	6.4
N.F. Calapooia	9.1	4.3	5.8
Upper Calapooia	10.5	3.7	4.2
Total	85.0	6.2	7.6

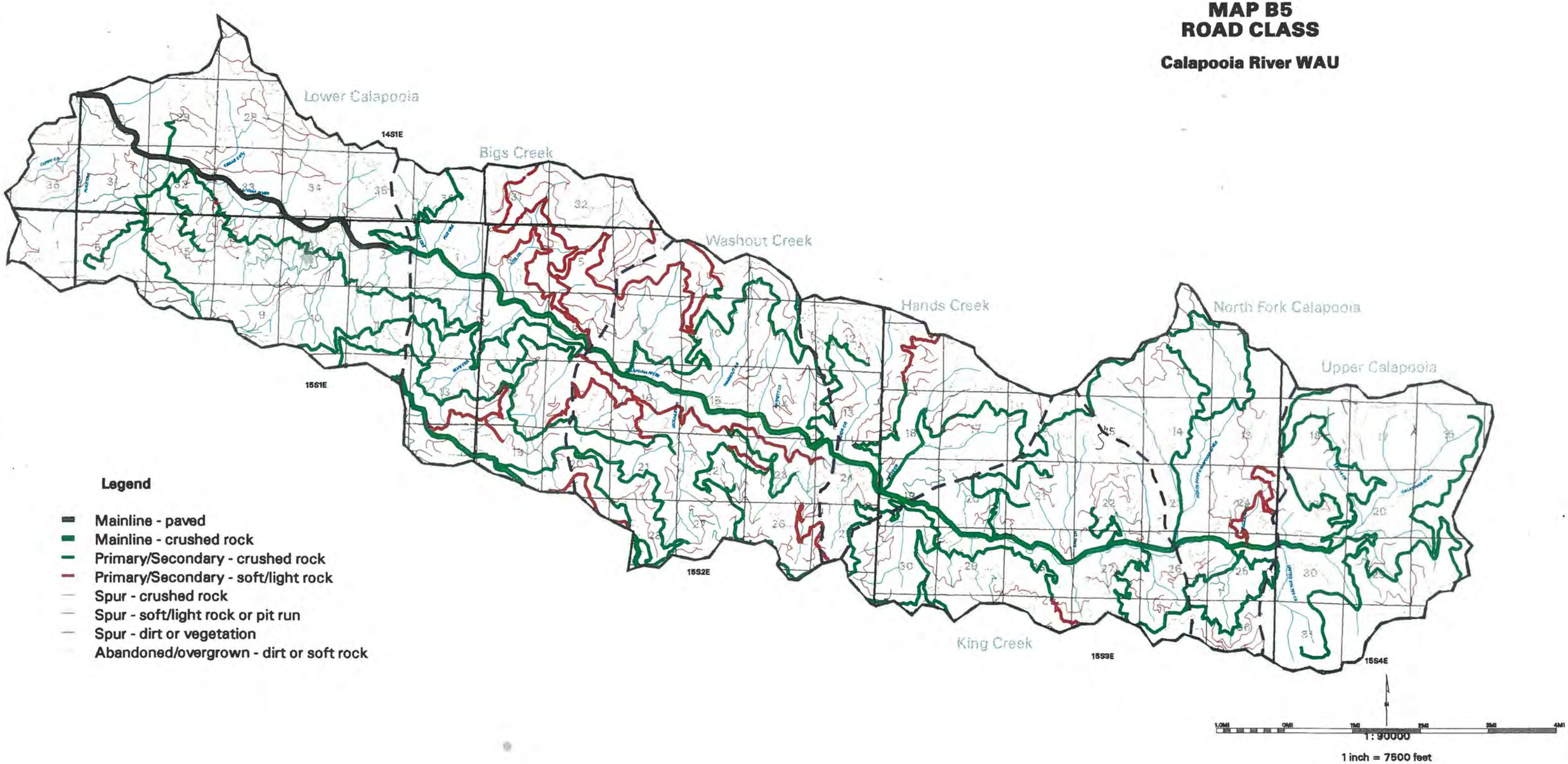
Evaluation of Road Surface Erosion

A complete field inventory of all driveable roads in the Calapooia River WAU was conducted to improve the estimates of sediment yield generated by the model. The majority of roads have rock surfaces and receive light to moderate use (Map B5). In general, roads are well maintained and in good condition. However, the Calapooia mainline, which parallels the river and is frequently within 200 feet of the channel, is severely potholed in places. This road also recieves the heaviest traffic.

Under existing traffic conditions, road surface erosion delivers an estimated 986 tons (1085 metric tonnes) of sediment per year to channels in the Calapooia River WAU. The contributions vary by subbasin, amounting to increases of 23 to 81 percent over the estimated background sediment yield (Table B6). Sediment yield increases of this magnitude are potentially detectable and may impact aquatic resources.

MAP B5
ROAD CLASS

Calapooia River WAU



Legend

- Mainline - paved
- Mainline - crushed rock
- Primary/Secondary - crushed rock
- Primary/Secondary - soft/light rock
- Spur - crushed rock
- Spur - soft/light rock or pit run
- Spur - dirt or vegetation
- Abandoned/overgrown - dirt or soft rock

Map B5 Road Class

Weyerhaeuser

DATE: 08/18/98

Figure B1 Sediment contributions by road prism component for driveable, non-stream adjacent roads in the Calapooia River WAU.

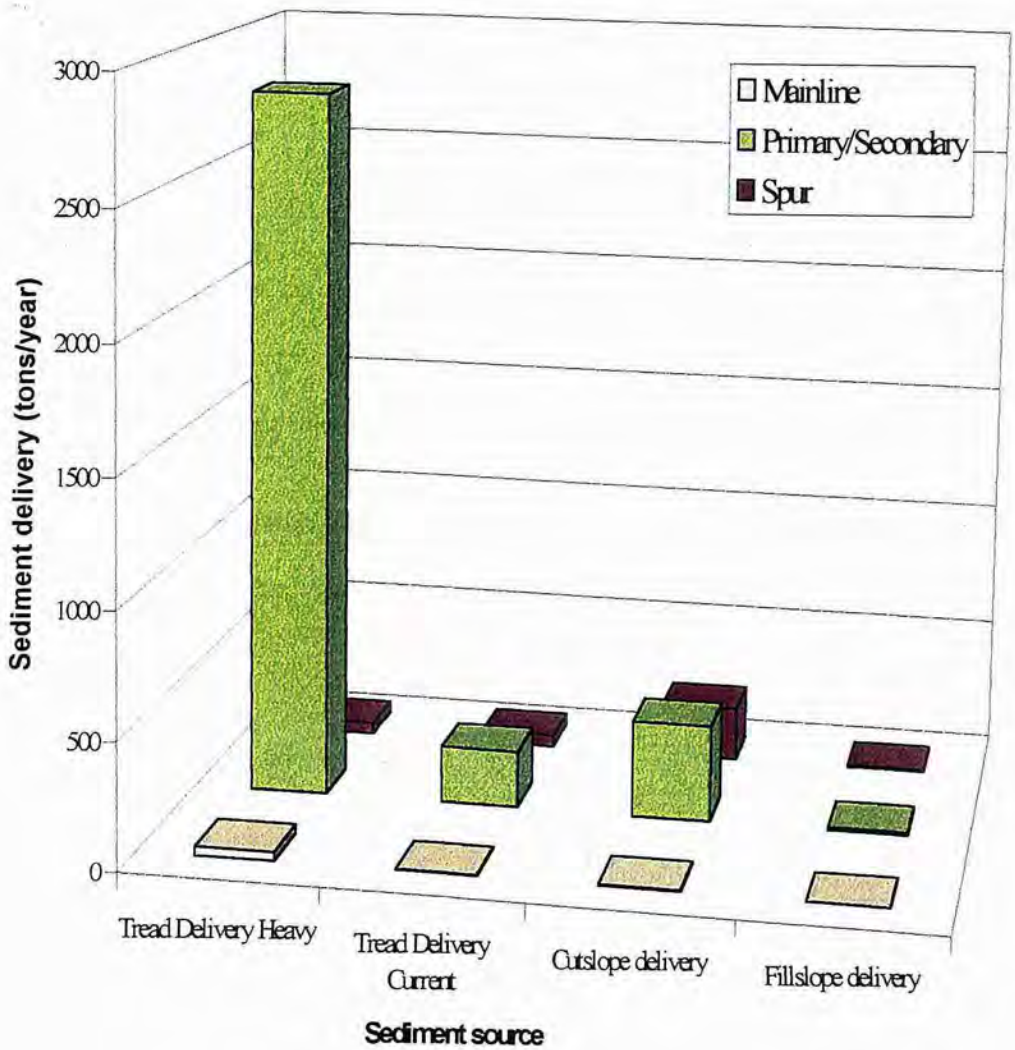


Table B6 Estimated annual background and road-related sediment inputs in the Calapooia River WAU.

Subbasin	Natural Background sediment yield (tons/mi²/yr)	Road Surface Input Rate (tons/ mi²/yr)	Road Erosion Hazard Rating	Increase over background (%)	Observed Gully Inputs (tons/mi²/ yr)[1]	Increase over background (%)	Gully Haza Rating
Lower Calapooia	29.8	6.9	Low	23%	ND[2]	ND[2]	
Bigs Creek	28.8	19.0	Mod	66%	26.5	92%	Mod
Washout Creek	20.3	16.3	Mod	81%	ND[2]	ND[2]	
Hands Creek	19.8	11.7	Mod	59%	111.6	564%	High
King Creek	18.6	12.2	Mod	66%	ND[2]	ND[2]	
N. F. Calapooia	18.9	9.3	Low	49%	ND[2]	ND[2]	
Upper Calapooia	13.5	5.1	Low	38%	46.0	341%	High
Total	22.5	11.6	Mod	52%	1697	52%	High

[1] Assumes all sediment entered in one yer.
[2]ND=No data; no gullies were identified and measured during field reconnaissance.

The source of sediment delivered to streams from roads varied depending on their position. Erosion of road tread surfaces on the stream adjacent portions of the Calapooia mainline, 600 and 700 roads have the highest rate of sediment delivery. On mid-slope and ridge-top roads under existing conditions, unvegetated cutslope surfaces contribute the majority (67%) of the fine sediment (Figure B1). Despite the high traffic rate, mainline roads other than USFS 2820 (the Calapooia mainline) contributed only small amounts of sediment because of their ridgetop position and limited extent (Map B5).

Under the high traffic use scenario, mainline, primary and secondary roads in the basin are assumed to experience heavy traffic. Under this scenario, tread surfaces contribute over 80 percent of the total road sediment yield (Figure B1). Cut and fillslope delivery are unchanged from existing conditions. The model indicates that high traffic rates could result in substantially higher sediment yields than either background or existing conditions (Figure B2), with increases ranging from 63 to almost 350 percent. While this scenario is unlikely to occur under current operations, the modeling facilitates an evaluation of potential impacts and development of road hazard calls.

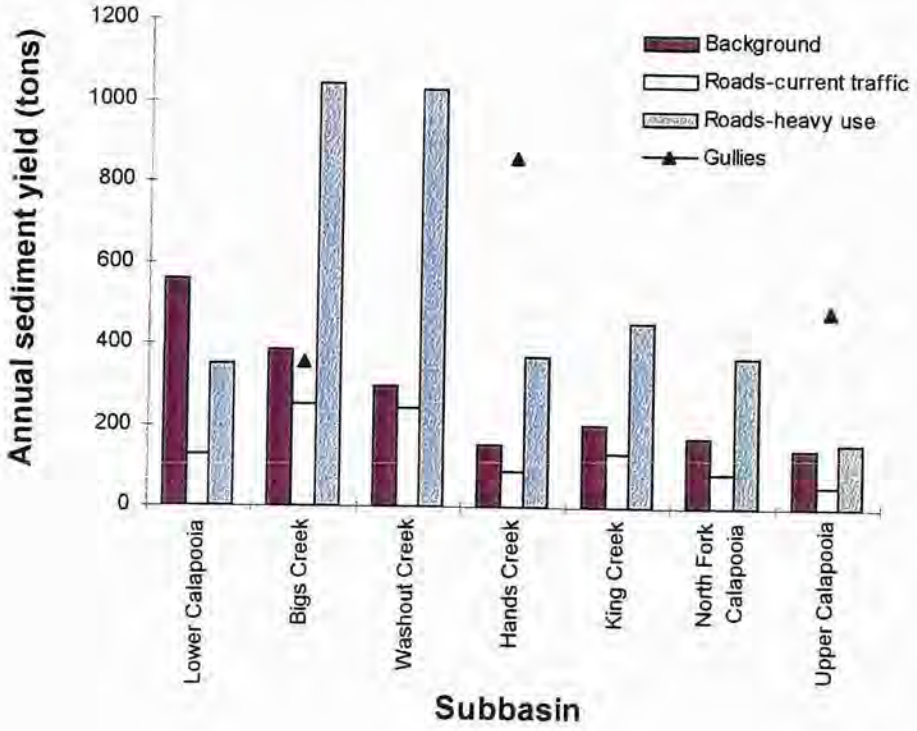


Figure B2 Comparison of annual road related sediment inputs with estimated natural background sediment yield, Calapooia River WAU.

Gully Erosion

A second major sediment source associated with construction of logging roads in mountainous terrain is the creation of gullies. Sediment budget studies in the Pacific Northwest indicate that gully erosion may account for up to 68 percent of the total sediment input, including that generated by mass wasting (Kelsey et al, 1981). Gullies most commonly originate where overlong inboard ditchlines release flow onto erodible fill or hillslopes, or where blocked stream crossing or ditch relief culverts divert flow onto road tread surfaces. Drainage structures on crowned or insloped roads where the road climbs on the approach and through the crossing have a high "diversion potential" (Weaver and Hagans, 1994).

A number of gullies were noted in the Calapooia WAU, particularly in the Bigs, Washout and Hands Creek subbasins. Gullies identified during reconnaissance surveys by the Surface Erosion Analyst delivered a total of approximately 1697 tons of sediment to streams in the Calapooia WAU. At sites encountered on abandoned roads, sediment delivery may have occurred over a number of years. However, there was also evidence of gully erosion at numerous other sites that had been rapidly repaired. Because this survey is incomplete and because delivery volumes could not be generated at sites that had been repaired, the actual magnitude of fine sediment contributions from gully erosion probably exceeds the observed contribution. Evidence from the gullies encountered suggests that fine sediment contributions from this source may far exceed annual background sediment inputs (Figure B2).

Road Erosion Hazard Ratings

The hazard ratings for road-related erosion in the Calapooia River WAU were developed by comparing road inputs to natural background sediment delivery. Sediment inputs from road surface erosion under current traffic rates were less than 100 percent in all cases, leading to the assignment of low to moderate hazard ratings. Further analysis of sediment inputs for individual road segments under both existing conditions and the high traffic scenario identified specific roads with relatively high input rates, and was used to distinguish the portion of the road (i.e. tread, cuslope or fill slope) generating the majority of the sediment. Road Segment Erosion units (RSEs) were developed to account for the different input processes, and are presented on Map B6.

Road Segment Erosion unit 1 consists of portions of the Calapooia mainline located within 200 feet of the channel in all subbasins. Tread surface erosion from this road accounted for 10 to 20 percent of the total sediment delivery in each subbasin. The high traffic rate and proximity to the stream are responsible for the relatively high rate of sediment delivery.

Road Segment Erosion unit 2 includes the stream adjacent portions of the 600 and 700 roads along Potts Creek and the North Fork Calapooia respectively. These older roads were located within 50 feet of the stream channel for much of their length, and had high sediment delivery rates from the tread and cutslopes. In addition, sections of both of these roads are level with or below the current stream elevation, and thus have a high diversion potential.

Road Segment Erosion unit 3 consists of road systems that were identified as having high sediment input rates from cutslopes under existing conditions. The majority of the road systems with high cutbank inputs were located in SEMU 3, and were particularly common in the Bigs and Washout Creek subbasins where steep slopes result in high, steep cutbanks **(Map B6)**.

Road Segment Erosion unit 4 includes roads that had high rates of tread surface sediment yield under the heavy use model scenario (Map B6). Sediment delivery rates on roads identified as having a high erosion hazard under this scenario ranged from 11.4 to 23.7 tons per mile. Examination of the data suggest that these high erosion rates were due to high delivery on the 2400, 2600 and 3000 road systems, where from 27 to 39 percent of the road surface runoff was routed directly to a stream channel. On the 700 and 3100 roads, delivery rates were much lower, thus the high sediment yields are suspected to be a function of thinner, more erodible surfacing in these cases.

Road Segment Erosion unit 5 includes existing gullies encountered during field reconnaissance as well as sites noted to have a high diversion potential. Specific conditions at mapped sites are described in Attachment B6. Since the reconnaissance survey did not cover the complete road network it is likely that numerous other sites that belong in RSE unit 5 exist within the WAU. Existing gullies included in RSE unit 4 delivered sediment amounting to over 500 percent of the annual background yield within an individual subbasin (Table B6), and thus both existing gullies and sites with a high diversion potential are considered to have a high hazard.

Log culverts encountered during the inventory are also depicted on Map B6. Because of their age and generally poor condition, log culverts have a high risk of collapse that can lead to either diversion and gully erosion as at RSE unit 4 Site 2 or mass wasting (Appendix A).

TURBIDITY SAMPLING

Turbidity was analyzed for a total of 26 water samples collected within or directly downstream of the Calapooia WAU during a single storm event (Table B7). Turbidity values were low, ranging from 1.5 to 15.5 NTU. A recent review concluded that the ability of salmonid fishes to find and capture food is impaired at turbidities in the range of 25 to 70 NTU (Lloyd et al, 1987).

Table B7 Summary of turbidity values measured in and immediately downstream of the Calapooia WAU between 0930 and 1630 on 29 May 1998.

Stream Name	Site #	Turbidity (NTU)	Stream Name	Site #	Turbidity (NTU)
Unnamed Trib	1	1.0	Calapooia River above Blue and Bigs Creeks	14	1.8
United States Creek	2	1.0	Bigs Creek	15	4.6
Upper Calapooia River	3	1.5	Sweet Home Creek	16	15.5
N.F. Calapooia	4	2.0	Calapooia River below 3700 road junction	17	2.1
Calapooia River above Potts Creek	5	1.1	Calapooia River above Cedar Creek	18	3.3
Potts Creek	6	1.5	Cedar Creek	19	16.0
Calapooia River above Hands Creek	7	1.3	Unnamed Trib	20	3.8
Hands Creek	8	1.9	Unnamed Trib	21	5.6
Washout Creek	9	2.5	Calapooia River below Highway Bridge	22	3.8
McKinley Creek	10	1.3	Calapooia River near McClun Wayside[1]	23	3.4
Unnamed Trib	11	1.4	Calapooia River above 228 bridge at Holley[1]	24	7
Unnamed Trib	12	9.3	Calapooia River at Crawfordsville[1]	25	9
Blue Creek	13	4.3	Calapooia River at Brownsville[1]	26	12.6

[1]Sample site located outside of Calapooia River WAU.

Sample site locations within the Calapooia WAU are depicted on Map B2. Turbidity in tributary streams varied from 1 NTU to 16 NTUs. The spatial variability of turbidity values observed in the tributary streams on 29 May 1998 is probably much lower than the temporal variability of turbidity throughout the WAU. Activities observed within the various subbasins immediately before and after the sampling, such as Placer mining, or major road maintenance, could be responsible for the variation between tributaries. However, there is no data available to confirm this hypothesis.

Turbidity in the mainstem Calapooia River generally increased moving downstream. While the contribution of agricultural activities within the WAU was not assessed, it is interesting to note that the highest mainstem turbidities were observed downstream of the WAU, where the Calapooia River enters a wide valley bottom, and agricultural and grazing become the dominant landuse.

CONFIDENCE IN WORK PRODUCTS

Hillslope Erosion

Confidence in the estimates of background erosion generated using the soil creep model are moderate. Although estimated rates were within the range of suspended sediment yields measured in nearby basins, the soil creep model does not incorporate estimates of fine sediment delivered via mass wasting or bank erosion, and involves the use of numerous assumptions and simplifications (e.g. soil depth, drainage network length, creep rate).

Confidence in watershed-scale conclusions related to recent logging operations is high. No evidence of significant hillslope erosion was observed in the WAU, either on recent aerial photographs or during the field inspections of recently harvested units. In several cases, field inspections were conducted during heavy rainfall when soils were probably near saturation and erosion would be most active.

Confidence in the landslide scar erosion values are moderate. A model specifically developed for forested lands was applied, and k-factor values were modified by SEMU. However, only a small subset of slides was used to develop the average erosion rates, and for some MWMU/SEMU combinations the sample size consisted of only one or two slides. Few of the slides were visited in the field to validate cover and delivery calls.

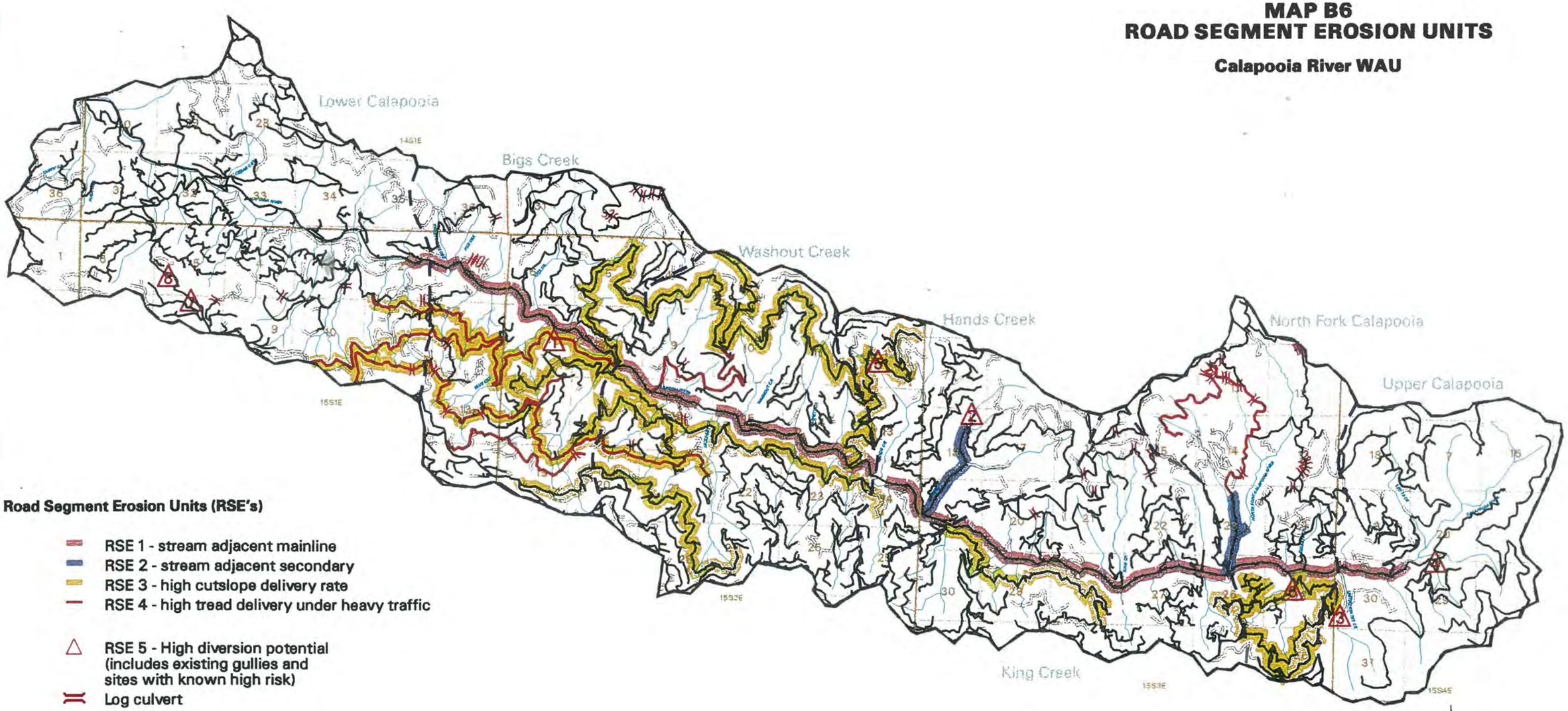
Road Erosion

The description of road surface conditions and delivery percentages are considered to be quite accurate due to the complete coverage of the road inventory and general agreement with road condition descriptions at sites field checked by the Surface Erosion Analyst. The model was refined by calibrating the traffic co-efficiants with data from a similar basin and by using subbasin specific soils data. However, hazard ratings depend on the accuracy of both road and background input rates, neither of which have been validated by field sampling within the WAU, thus the overall confidence is only fair.

Confidence in the gully hazard rating and ability to indentify sites with a high diversion potential is high. Measured gullies occurred at sites with high diversion potential, and generally contributed substantially more than 100 percent of the estimated annual background sediment. However, confidence in the map of sites within RSE unit 4 is low, because information on diversion potential and existing gullies was not collected as part of the complete road inventory, so more sites probably exist within the WAU.

MAP B6
ROAD SEGMENT EROSION UNITS

Calapooia River WAU



Road Segment Erosion Units (RSE's)

- RSE 1 - stream adjacent mainline
- RSE 2 - stream adjacent secondary
- RSE 3 - high cutslope delivery rate
- RSE 4 - high tread delivery under heavy traffic
- △ RSE 5 - High diversion potential (includes existing gullies and sites with known high risk)
- Log culvert
- Driveable roads
- Abandoned/overgrown roads

1.0MI 0MI 1MI 2MI 3MI 4MI

1 : 90000

1 inch = 7500 feet

Map B6 Road Segment Erosion Units

Weyerhaeuser

DATE: 08/18/98

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ATTACHMENT B1

CALCULATION OF NATURAL BACKGROUND SEDIMENT YIELD

ESTIMATED NATURAL BACKGROUND SEDIMENT PRODUCTION

FILE: d:\r2_swm\projects\calapooia\report\attb2.xls
DATE: 6/14/98
PROJ. CALAPOOIA WATERSHED ANALYSIS
BY: Sue Madsen, Beak Consultants

Subbasin	Drainage area (mi^2)	Channel length m	Dominant Soil Type	Avg Soil Depth m	Creep Rate (m/yr)	Bulk Density	Coarse material fraction	Background Sediment Yield (metric tonnes/yr)	Background Sediment Yield (tons/yr)	Background rate (metric tonnes/mi^2/yr)
Lower Calapooia	18.8	98,165	Peavine	1.2	0.002	1.2	10%	509	560	29.8
Bigs Creek	13.4	75,635	Peavine /Kinney	1.2	0.002	1.2	20%	351	387	28.8
Washout Creek	14.7	77,244	Kinney/Keel	1.0	0.002	1.1	20%	272	299	20.3
Hands Creek	7.7	38,622	Kinney/Keel	1.0	0.002	1.1	20%	138	152	19.8
King Creek	10.8	59,543	Kinney /Hummington	1.2	0.002	1.0	36%	183	201	18.6
N.F. Calapooia	9.1	51,496	Hummington/Kinney	1.2	0.002	1.0	36%	156	172	18.9
Upper Calapooia	10.5	57,934	Hummington	1.0	0.002	1.0	45%	129	142	13.5

Notes:

Background rate (tonnes/yr)=(Length x 2) x Depth x Creep Rate x Bulk Density x (1-% Coarse)

Channel lengths were calculated based on an average contributing area of 20 acres for the Lower Calapooia subbasin, and 10 acres for for all other subbasins.

Data on soil properties was obtained from the NRCS Soil Survey of Linn County (Landridge 1987)

ATTACHMENT B2

HILLSLOPE EROSION FIELD DATA SHEETS

SURFACE EROSION FIELD FORM

WAU: CALAPOOIA
Subbasin: LOWER CALAPOOIA
Surveyor: SWM
Date: 5/18/98
Location: OFF ROAD 3831B - SITE #1 T15S R1E, NE 1/4 S4
Landform: ANCIENT DEEP SEATED SLIDE, MMMU?
Parent Material: TUFFACEOUS COLLUVIUM, EARTHFLOW
SEMU: 1 - DEAVINE SOILS COMPLEX

Activity: Tractor Harvest | Highlead Harvest | Fire | Grazing | ORV | Other | Undisturbed

Site Prep: Broadcast Burn | Mechanical | None | Other

MAYBE SPOT BURN? NO EVIDENCE OF PILES, TOO PATCHY FOR BROADCAST

Date: AGE = 2-3 YRS

Evidence of Surface Erosion? Yes | No

Type of Erosion: Sheetwash | Rill | Gully | Other

% of Area Affected: < 1% EXPOSED SOIL

Depth: N/A

Size of Material: FINE SILT/CLAY

Slope: < 30% (%)

Delivered to Channel? Yes | No

Comments:

WALK UP EASTERN EDGE ALONG CHANNEL (PHOTO 9, 10). SIDESLOPE TO CHANNEL < 30%. LITTLE BARE GROUND W/IN UNIT, + NO EVIDENCE OF DELIVERY TO STREAM. SOILS FINE TEXTURE, VERY ERODIBLE. EXPOSED ON ROAD CUTS (PHOTO 11); SED MOVING THROUGH DITCH. SHOULD PROBABLY CAREFULLY SEED ALL EXPOSED AREAS IN THIS SEMU. MATERIAL HAS BEEN DELIVERED VIA DITCH LINES TO SMALL EMPHEMERAL CHANNEL IN CENTER OF UNIT, BUT DOES NOT REACH PERENNIAL STREAM FROM THERE. (AND WILL NOT). DIFFICULT TO DETERMINE HARVEST METHOD, AS THERE ARE NO DISCERNABLE SKID TRAILS. PROBABLY TRACTOR, BASED ON SLOPES

AA - STEVE CAFFERATA
(GROUND BASED

SURFACE EROSION FIELD FORM

WAU: CALAPOOIA
Subbasin: LOWER CAL
Surveyor: SWM
Date: 5/18/98
Location: UNIT 2a SITE #2 - E½ OF SECTION 5 T15S R1E
Landform: OLD DEEPSEATED
Parent Material: EARTH FLOW, TUFFACEOUS BR. SOIL VERY DEEP
SEMU: /

Activity: Tractor Harvest ? CONFIRM; NO EVIDENCE, BUT ESTIMATE BASED ON SLOPE | Highlead Harvest w/SOME CABLE | Fire | Grazing | ORV | Other | Undisturbed

Site Prep: Broadcast Burn | Mechanical | None | Other

GROUND BASED ACCORDING TO CAPPERATA 6/18/98 SWM

Date: AGE 2-3 YRS

Evidence of Surface Erosion? Yes | No

Type of Erosion: Sheetwash | Rill | Gully | Other | NA

% of Area Affected: <5

Depth:

Size of Material: FINESILT/CLAY

Slope: 30-50 (%)

Delivered to Channel? Yes | No

Comments:

WALK UP SMALL STREAM IN CENTER OF UNIT - NO BUFFER (UP TO 15)
LITTLE OR NO EXPOSED SURFACE, EVEN WHERE SLOPES ARE LOCALLY
STEEP (30-50%). RODENT ACTIVITY PRIMARY CAUSE. SURPRISED
NO PROTECTION ON THIS STREAM - NEW SINCE HARVEST?
SITE PREP BY BURNING, THOUGH APPEARS PATCHY; NO EVIDENCE OF PILING OR
TRACTOR ACTIVITES. STEEPER PORTIONS APPEAR TO HAVE BEEN CABLED

SURFACE EROSION FIELD FORM

WAU: CALAPOOIA
Subbasin: LOWER CAL
Surveyor: SWM
Date: 5/20/98
Location: 14S 1E S32 E1/2 - SITE #3
Landform: OLD DEEP-SEATED EARTHFLOW
Parent Material: SILT/CLAY LOAM SOILS, DEEP, TUFFACEOUS SEDIMENTARY
SEMU: 1

Activity: (Tractor Harvest) Highlead Harvest Fire Grazing ORV (Other) Undisturbed

GROUND BASED (CAFFERATA 6/18/98)

Site Prep: Broadcast Burn (Mechanical) None (Other) PILE + BURN

Date: AGE <1 YR

Evidence of Surface Erosion? (Yes) No

Type of Erosion: (Sheetwash) Rill Gully Other

% of Area Affected: 10%

Depth: N/A

Size of Material: SILT

Slope: VARIABLE <30 (%)

Delivered to Channel? (Yes) No

Comments:

UNIT APPEARS TO HAVE BEEN LOGGED W/ RUBBER TIRE SKIDDER, THEN PILED + BURNED. FAIRLY HIGH AMOUNT OF MINERAL SOIL EXPOSED (40-70%) PARTICULARLY IN LOWER WEST CORNER BELOW ROAD. SEDIMENT IS DELIVERED TO CHANNEL ONLY WHERE AREAS NEAR EPHEMERAL STREAMS ARE EXPOSED (W/IN ~ 25'). EQUIPMENT HAS DEPOSITED MATERIAL IN FLOW PATHS IN SOME CASES, CAUSING WATER TO FLOW ACROSS EXPOSED SOIL OR CUT THROUGH DEPOSIT. SEE PHOTOS. UPPER PORTION OF UNIT HAS BEEN CABLE LOGGED, W/ NO PILING OR EVIDENCE OF TRACTOR ACTIVITY

SURFACE EROSION FIELD FORM

WAU: CALAPOOIA
Subbasin: BIGS / WASHOUT
Surveyor: SWM
Date: 5/18/98
Location: SITE #4
Landform: STEEP MT SIDESLOPE TO ALMOST INNER GORGE ALONG 300 ROAD
Parent Material: VOLCANOCLASTIC
SEMU: 3 (SOME 2)

Activity: Tractor Harvest | ~~Highlead Harvest~~ CABLE | Fire | Grazing | ORV | Other | Undisturbed

Site Prep: Broadcast Burn | Mechanical | None | Other

Date: < 1 YR OLD

Evidence of Surface Erosion? Yes | No

Type of Erosion: Sheetwash | Rill | Gully | Other

% of Area Affected: MUCH OF AREA BELOW 3000N ROAD (~40-50%), BUT LITTLE OF OVERALL UNIT.

Depth: ~~GULLIES~~ RILLS 6-10" DEEP FROM CONCENTRATED ROAD RUNOFF

Size of Material: SILT / SM. GRAVEL

Slope: 42 (%)

Delivered to Channel? Yes | No

Comments:

CUT TO CHANNEL BELOW ROAD 3000N. SURF ERO OF FILL SLOPE (PHOTO 16)
GULLIES ON STEEP CUT SLOPE, SUR EROSION + HIGH DP. (PHOTO 17)
GULLIES BELOW PERCHED CULVERTS (2m x 2m) - PHOTO 18 WHERE CULVERTS
Q ONTO HILLSIDE (SLOPE > 70%). SIGNIFICANT EROSION, EVEN OF UNHARVESTED
BANK (PHOTO 20).

ENTERED UNIT FROM 3060 ROAD - NO EVIDENCE OF SURFACE FLOW. APPEARS
TO HAVE BEEN CABLE HARVESTED - IS QUITE STEEP, BUT NO WELL DEFINED
SKID TRAILS. DOESN'T APPEAR TO HAVE HAD ANY SITE PREP TO DATE

SURFACE EROSION FIELD FORM

WAU: CALAPOOIA
Subbasin: N.F. CAL
Surveyor: SWM
Date: 5/19/96
Location: T15S 3E SEC 25 NW – SITE # 5
Landform: ANCIENT DEEP SEATED?
Parent Material: VOLCANIC LASTIC; ASH?
SEMU: 3

Activity: (Tractor Harvest) (~~Highlead~~ CABLE Harvest) Fire Grazing ORV Other Undisturbed

Site Prep: Broadcast Burn Mechanical None (Other) ?
NO EVIDENCE OF BURN, OR PILES
MAY BE SOME KIND OF MECHANICAL OR HAND TREATMENT

Date: AGE 2-3 YRS

Evidence of Surface Erosion? Yes (No)

Type of Erosion: Sheetwash Rill Gully Other

% of Area Affected: <5%

Depth: N/A

Size of Material: N/A

Slope: VARIABLE (%)

Delivered to Channel? Yes (No)

Comments:
~~TRAVERSED~~ WALKED EASTERN BOUNDARY ALONG STREAM. ONLY POTENTIAL SED SOURCE IS HIGH EXPOSED BANK NEAR LOWER LANDING (PHOTO 1,2) - SITE IS W/IN 200 FT OF STREAM, + SLOPES DOWN TOWARD IT. NO EVIDENCE OF EXTENSIVE DELIVERY HOWEVER. NO BARE AREAS ON SIDESLOPE EVEN WHERE THEY EXCEED 80%. NO DELIVERY THRU RMZ
ALSO WALKED DOWN SMALL UNBUFFERED STREAM IN CENTER OF UNIT. NO EXPOSED AREAS OR EVIDENCE OF DE-STABILIZED BANKS

SURFACE EROSION FIELD FORM

WAU: CALAPOOIA
Subbasin: N.F. CAL
Surveyor: SWM
Date: 5/19/98
Location: T15SR3E S26 NE - SITE #6
Landform: VALLEY SIDESLOPE; DEEPSEATED ?
Parent Material: ASH? VOLCANICLASTIC - SOILS RED, DEEP, HIGH SILT/CLAY
SEMU: 3

Activity: Tractor Harvest | Highlead Harvest (LOOKS LIKE CABLE UNIT) | Fire | Grazing | ORV | Other | Undisturbed

Site Prep: ~~Broadcast Burn~~ SPOT | Mechanical | None | Other

Date: < 1 YR

Evidence of Surface Erosion? Yes | No

Type of Erosion: Sheetwash | Rill | Gully | Other

% of Area Affected: 20 (INCLUDING CUT BANKS)

Depth: DIFFICULT TO DETERMINE

Size of Material: SILT

Slope: VARIABLE (%)

Delivered to Channel? Yes | No
TO EPHEMERAL, NON-FISH BEARING

Comments:

RECENTLY HARVESTED + BURNED UNIT. BURN PATCHY, BUT HAS EXPOSED SOIL IN SOME PLACES. NUMEROUS CUT BANKS + BURNED AREAS CONTRIBUTE FINES TO EPHEMERAL CHANNELS. MATERIAL WILL EVENTUALLY GET TO STREAM. POTENTIAL SOLUTIONS. SEED CUTBANKS IN THIS P.M. ASAP. WATCH TO MAKE SURE GREEN UP OCCURS QUICKLY. AS NOTED IN OTHER UNITS, THERE ARE SOME STEEP DITCHES W/A HIGH POTENTIAL FOR DIVERSION. OF PARTICULAR CONCERN HERE W/ ABUNDANT SM. SLASH + MOBILE SEDIMENT. THAT COULD BLOCK CULVERTS LEADING TO GULLY EROSION

SURFACE EROSION FIELD FORM

WAU: CALAPOOIA
Subbasin: UPPER CAL
Surveyor: SWM
Date: 5/19/98
Location: USFS CC OFF 520 RD - MILE 2.4 - SITE # 7
Landform: STEEP MT SIDESLOPE (STRAIGHT)
Parent Material: IGNEOUS - BASALT / ANDESITE COLLUVIUM
SEMU: 5

Activity: Tractor Harvest ~~Highlead Harvest~~ CABLE YARD ? Fire Grazing ORV Other Undisturbed

Site Prep: Broadcast Burn Mechanical None Other

Date: ? ✓ w/USFS : 6 YRS OLD (SWM / [illegible])

Evidence of Surface Erosion? Yes No

Type of Erosion: Sheetwash Rill Gully Other

% of Area Affected: 15

Depth: < 2cm

Size of Material: SILT / SAND

Slope: > 70 (%)

Delivered to Channel? No Yes No

Comments:

BURN HAS EXPOSED ~ 40-50 % MINERAL SOIL. CABLE SKID TRAILS ARE ALSO VISIBLE (PHOTO 28). SOME EVIDENCE THAT SHEETWASH EROSION HAS OCCURRED (ARMORING OF EXPOSED AREAS), HOWEVER SKID TRAILS SHOW NO EVIDENCE OF GULLY DEVELOPMENT, + NO BUILD UP OF EXCESS FINES WAS OBSERVED IN CHANNEL AT BOTTOM OF UNIT (PHOTO 29). NO CURRENT FLOW. YARDING TRACKS ARE OBLIQUE TO HILLSLOPE + DO NOT CROSS CHANNELS

ATTACHMENT B3

LANDSLIDE SCAR EROSION MODELING

Landslide Scar Erosion Modeling Notes

Landslide scar erosion was calculated using a version of the Universal Soils Loss Equation (USLE) modified for use on forested sites (Dissmeyer and Foster 1984). The procedure uses the following equation to predict surface and rill erosion:

Soil Loss (tons/acre)=RKLSCP

R= rainfall erosivity index. Values for the R factor were obtained from the RUSLE computer program (SWCS 1992).

K=soil erodibility index. Values for the K factor corresponding to the dominant soil type in each SEMU were obtained from the Soil Survey of Linn County Area (Landridge 1987).

LS=hillslope length/slope factor. Values for the LS factor were obtained from the RUSLE computer program (SWCS 1992) by plugging in the landslide scar length and slope as measured in the field.

C=Cropping Management factor. Values for the C factor were obtained frm Dissmeyer and Foster (1984). Landslide cover was assumed to be zero based on field and air photo evaluation. Surface erosion under surface cover of 30% grass was also modeled to investigate the value of seeding slide scars.

P=erosion control practice factor. Values for the P factor were obtained frm Dissmeyer and Foster (1984). It was assumed that no erosion control practices (e.g. terracing) were applied to the slide scars.

Field data was obtained for 39 slide scars that delivered sediment to streams. Average values of the LS and proportion of sediment delivered to the channel for each combination of MWMU/SEMU were calculated from the field data. These average values were applied to the remainder of slides identified in the landslide inventory to estimate the total annual sediment delivery from landslide scar erosion for each subbasin. The mass wasting inventory revealed that slides in the Calapooia River WAU often do not quickly revegetate (Appendix A). However, because surface armoring may reduce surface erosion even in the absence of vegetation, only new slides identified on the 1997 photo set were assumed to deliver sediment.

Slide #	SUBBASIN	MWMU	SEMU	COVER (%)	R	K	SLOPE (%)	LS	C (0%Cover)	C (30%Cover)	P	SOIL LOSS WITH NO COVER (tons/ac/yr)	SOIL LOSS WITH 30% COVER (tons/ac/yr)	SCAR AREA (acres)	% DEL	SEDIMENT YIELD WITH NO COVER (tons/yr)	SEDIMENT YIELD WITH 30% COVER (tons/yr)
364	Bigs Cr	1	2		55	0.15		7.8	0.45	0.135	1	28.96	8.69	0.01	79	0.20	0.06
399	Bigs Cr	1	2		55	0.15		7.8	0.45	0.135	1	28.96	8.69	0.04	79	0.81	0.24
362	Bigs Cr	1	3		55	0.12		7.8	0.45	0.135	1	23.17	6.95	0.04	79	0.65	0.20
397	Bigs Cr	1	3		55	0.12		7.8	0.45	0.135	1	23.17	6.95	0.85	79	15.63	4.69
401	Bigs Cr	1	3		55	0.12		7.8	0.45	0.135	1	23.17	6.95	0.28	79	5.21	1.56
406	Bigs Cr	1	3		55	0.12		7.8	0.45	0.135	1	23.17	6.95	0.07	79	1.30	0.39
410	Bigs Cr	1	3		55	0.12		7.8	0.45	0.135	1	23.17	6.95	0.21	79	3.91	1.17
367	Bigs Cr	1	4		55	0.25		7.8	0.45	0.135	1	48.26	14.48	0.04	79	1.36	0.41
375	Bigs Cr	2	1		55	0.28		7.3	0.45	0.135	1	50.59	15.18	0.07	100	3.60	1.08
373	Bigs Cr	7	1		55	0.28		11	0.45	0.135	1	76.23	22.87	0.07	87	4.72	1.42
363	Bigs Cr	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.04	87	1.01	0.30
366	Bigs Cr	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.01	87	0.25	0.08
398	Bigs Cr	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.07	87	2.02	0.61
400	Bigs Cr	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.21	87	6.07	1.82
402	Bigs Cr	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.04	87	1.01	0.30
407	Bigs Cr	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.14	87	4.05	1.21
408	Bigs Cr	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.21	87	6.07	1.82
409	Bigs Cr	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.07	87	2.02	0.61
411	Bigs Cr	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.02	87	0.51	0.15
365	Bigs Cr	7	4		55	0.25		11	0.45	0.135	1	68.06	20.42	0.01	87	0.53	0.16
686	Hands Cr	1	3	<30	55	0.12	80	13.3	0.45	0.135	1	39.50	11.85	0.35	10	1.37	0.41
379	Hands Cr	1	3		55	0.12		7.8	0.45	0.135	1	23.17	6.95	0.07	79	1.30	0.39
690	Hands Cr	1	5	<30	55	0.1	78	5.8	0.45	0.135	1	14.36	4.31	0.11	80	1.23	0.37
380	Hands Cr	1	5		55	0.1		7.8	0.45	0.135	1	19.31	5.79	0.07	79	1.09	0.33
413	Hands Cr	1	5		55	0.1		7.8	0.45	0.135	1	19.31	5.79	0.16	79	2.44	0.73
377	Hands Cr	3	3		55	0.12		29.1	0.45	0.135	1	86.43	25.93	0.21	90	16.61	4.98
378	Hands Cr	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.11	87	3.03	0.91
688	Hands Cr	7	5	<30	55	0.1	78	16	0.45	0.135	1	39.60	11.88	0.37	70	10.28	3.08
691	Hands Cr	7	5	<30	55	0.1	75	18.4	0.45	0.135	1	45.54	13.66	0.59	100	27.01	8.10
696	Hands Cr	7	5	<30	55	0.1	70	6.2	0.45	0.135	1	15.35	4.60	0.04	100	0.58	0.17
381	Hands Cr	7	5		55	0.1		11	0.45	0.135	1	27.23	8.17	0.04	87	0.84	0.25
675	King Cr	1	2	<30	55	0.15	75	11.7	0.45	0.135	1	43.44	13.03	0.17	90	6.76	2.03
666	King Cr	1	3	<30	55	0.12	70	14	0.45	0.135	1	41.58	12.47	0.22	20	1.85	0.55
680	King Cr	1	3	<30	55	0.12	65	10.4	0.45	0.135	1	30.89	9.27	0.03	100	1.01	0.30
708	King Cr	1	3	<30	55	0.12	80	2.3	0.45	0.135	1	6.83	2.05	0.01	90	0.04	0.01
716	King Cr	1	3	<30	55	0.12	89	9.9	0.45	0.135	1	29.40	8.82	0.11	90	2.83	0.85
717	King Cr	1	3	<30	55	0.12	88	6	0.45	0.135	1	17.82	5.35	0.06	80	0.79	0.24
383	King Cr	1	3		55	0.12		7.8	0.45	0.135	1	23.17	6.95	0.04	79	0.65	0.20
392	King Cr	1	3		55	0.12		7.8	0.45	0.135	1	23.17	6.95	0.14	79	2.61	0.78
393	King Cr	1	3		55	0.12		7.8	0.45	0.135	1	23.17	6.95	0.02	79	0.33	0.10
394	King Cr	1	3		55	0.12		7.8	0.45	0.135	1	23.17	6.95	0.11	79	1.95	0.59
395	King Cr	1	3		55	0.12		7.8	0.45	0.135	1	23.17	6.95	0.14	79	2.61	0.78
385	King Cr	1	4		55	0.25		7.8	0.45	0.135	1	48.26	14.48	0.04	79	1.36	0.41
667	King Cr	1	5	<30	55	0.1	74	11.6	0.45	0.135	1	28.71	8.61	0.07	100	1.99	0.60
672	King Cr	1	5	<30	55	0.1	82	13.4	0.45	0.135	1	33.17	9.95	0.15	80	3.93	1.18
673	King Cr	1	5	<30	55	0.1	86	5.3	0.45	0.135	1	13.12	3.94	0.03	100	0.38	0.11
382	King Cr	1	5		55	0.1		7.8	0.45	0.135	1	19.31	5.79	0.01	79	0.14	0.04
709	King Cr	3	3	<30	55	0.12	82	29.13	0.45	0.135	1	86.52	25.95	2.97	90	230.91	69.27
669	King Cr	7	3	<30	55	0.12	78	11	0.45	0.135	1	32.67	9.80	0.09	100	3.10	0.93

Slide #	SUBBASIN	MWMU	SEMU	COVER (%)	R	K	SLOPE (%)	LS	C (0%Cover)	C (30%Cover)	P	SOIL LOSS WITH NO COVER (tons/ac/yr)	SOIL LOSS WITH 30% COVER (tons/ac/yr)	SCAR AREA (acres)	% DEL	SEDIMENT YIELD WITH NO COVER (tons/yr)	SEDIMENT YIELD WITH 30% COVER (tons/yr)
674	King Cr	7	3	<30	55	0.12	70	5.6	0.45	0.135	1	16.63	4.99	0.09	100	1.54	0.46
701	King Cr	7	3	<30	55	0.12	85	17	0.45	0.135	1	50.49	15.15	0.22	90	9.93	2.98
711	King Cr	7	3	<30	55	0.12	68	2.2	0.45	0.135	1	6.53	1.96	0.01	100	0.06	0.02
714	King Cr	7	3	<30	55	0.12	70	10.5	0.45	0.135	1	31.19	9.36	0.19	80	4.74	1.42
715	King Cr	7	3	<30	55	0.12	79	10.1	0.45	0.135	1	30.00	9.00	0.19	100	5.59	1.68
384	King Cr	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.01	87	0.25	0.08
371	Lower Calapooia	1	1		55	0.28		7.8	0.45	0.135	1	54.05	16.22	0.14	79	6.08	1.82
414	Lower Calapooia	1	2		55	0.15		7.8	0.45	0.135	1	28.96	8.69	0.02	79	0.41	0.12
361	Lower Calapooia	2	2		55	0.15		7.3	0.45	0.135	1	27.10	8.13	0.04	100	0.96	0.29
360	Lower Calapooia	7	1		55	0.28		11	0.45	0.135	1	76.23	22.87	0.04	87	2.36	0.71
370	Lower Calapooia	7	1		55	0.28		11	0.45	0.135	1	76.23	22.87	0.02	87	1.18	0.35
372	Lower Calapooia	7	1		55	0.28		11	0.45	0.135	1	76.23	22.87	0.32	87	21.24	6.37
387	Upper Calapooia	1	5		55	0.1		7.8	0.45	0.135	1	19.31	5.79	0.04	79	0.54	0.16
386	Upper Calapooia	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.04	87	1.01	0.30
636	Washout Cr	1	3	<10	55	0.12	76	5.1	0.45	0.135	1	15.15	4.54	0.02	100	0.29	0.09
640	Washout Cr	1	3	<10	55	0.12	70	7.7	0.45	0.135	1	22.87	6.86	0.04	100	0.87	0.26
651	Washout Cr	1	3	<30	55	0.12	74	3.3	0.45	0.135	1	9.80	2.94	0.01	70	0.05	0.02
396	Washout Cr	1	3		55	0.12		7.8	0.45	0.135	1	23.17	6.95	0.14	79	2.61	0.78
403	Washout Cr	1	3		55	0.12		7.8	0.45	0.135	1	23.17	6.95	0.13	79	2.44	0.73
405	Washout Cr	1	3		55	0.12		7.8	0.45	0.135	1	23.17	6.95	0.11	79	1.95	0.59
606	Washout Cr	1	4	<30	55	0.25	68	5.5	0.45	0.135	1	34.03	10.21	0.13	20	0.88	0.26
607	Washout Cr	1	4	<30	55	0.25	55	5.2	0.45	0.135	1	32.18	9.65	0.03	100	1.02	0.31
612	Washout Cr	1	4	<30	55	0.25	72	6.3	0.45	0.135	1	38.98	11.69	0.06	90	2.06	0.62
720	Washout Cr	1	4	<30	55	0.25	75	4.7	0.45	0.135	1	29.08	8.72	0.03	100	0.86	0.26
730	Washout Cr	1	4	<30	55	0.25	70	12.7	0.45	0.135	1	78.58	23.57	0.44	70	24.47	7.34
390	Washout Cr	1	4		55	0.25		7.8	0.45	0.135	1	48.26	14.48	0.04	79	1.36	0.41
610	Washout Cr	1	5	<30	55	0.1	49	3	0.45	0.135	1	7.43	2.23	0.02	90	0.12	0.04
615	Washout Cr	1	5	<30	55	0.1	88	9.5	0.45	0.135	1	23.51	7.05	0.06	80	1.21	0.36
634	Washout Cr	1	5	<30	55	0.1	86	4.3	0.45	0.135	1	10.64	3.19	0.02	70	0.13	0.04
731	Washout Cr	2	4	<30	55	0.25	75	7.3	0.45	0.135	1	45.17	13.55	0.03	100	1.56	0.47
635	Washout Cr	7	3	<30	55	0.12	77	8	0.45	0.135	1	23.76	7.13	0.04	80	0.72	0.22
638	Washout Cr	7	3	<30	55	0.12	80	6.1	0.45	0.135	1	18.12	5.44	0.05	100	0.86	0.26
725	Washout Cr	7	3	<30	55	0.12	66	2.9	0.45	0.135	1	8.61	2.58	0.01	100	0.09	0.03
726	Washout Cr	7	3	<30	55	0.12	70	20.5	0.45	0.135	1	60.89	18.27	0.74	10	4.49	1.35
388	Washout Cr	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.14	87	4.05	1.21
389	Washout Cr	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.04	87	1.01	0.30
391	Washout Cr	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.14	87	4.05	1.21
404	Washout Cr	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.07	87	2.02	0.61
412	Washout Cr	7	3		55	0.12		11	0.45	0.135	1	32.67	9.80	0.01	87	0.25	0.08
718	Washout Cr	7	4	<30	55	0.25	72	17.5	0.45	0.135	1	108.28	32.48	0.47	100	51.22	15.37
724	Washout Cr	7	4	<30	55	0.25	77	13.2	0.45	0.135	1	81.68	24.50	0.51	70	29.39	8.82
368	Washout Cr	7	4		55	0.25		11	0.45	0.135	1	68.06	20.42	0.04	87	2.11	0.63

ATTACHMENT B4

DEVIATIONS FROM STANDARD METHODOLOGY

1) The surface erosion assessment included an evaluation of landslide scar erosion conducted using a procedure based on Universal Soil Loss Equation (USLE) developed specifically for forested lands (Dissmeyer and Foster 1984).

2) Input data for the road surface erosion model was based on a complete inventory of the driveable road network in the Calapooia WAU performed in May 1997.

3) Separate calculations of sediment yields were performed for the cutslope, tread and fillslope portions of each segment. These separate estimates allowed an evaluation of the primary sediment production and delivery process (i.e. raw cutbanks delivering to inboard ditches; sediment piping through tread surfaces; ravel from bare fill slopes).

4) Traffic factors were modified based on the results of a calibration of calculated sediment yield estimates with field studies that measured actual sediment fluxes from road surfaces, in combination with specific traffic rates (Clark 1986).

5) The effects of traffic yield on sediment were assessed for both current conditions and under heavy use. This allows an assessment of the relative sensitivity of various road segments to traffic, and facilitates identification of segments that would most benefit from major upgrades prior to the resumption of logging activity.

6) The amount of fine sediment that could be supplied via piping of underlying soil materials through road tread and ballast surfaces was modified by subtracting the average proportion of coarse material contained in the dominant soil type for each SEMU.

7) The potential magnitude of gully erosion associated with flow diversions at stream crossings or outflow of overlong ditch lines onto unarmoured fill slopes was approximated by calculating the total volume of sediment eroded at gully sites (lengthxwidthxdepth) encountered during field reconnaissance, minus the coarse material portion of the dominant soil in the SEMU occupied by the gully.