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APPENDIX C

SEDIMENT DELIVERY CALCULATIONS

NAVARRO RIVER WATERSHED
TECHNICAL SUPPORT DOCUMENT

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APPENDIX C
SEDIMENT DELIVERY CALCULATIONS

This appendix briefly describes many of the calculations Regional Board staff made while computing human-caused sediment delivery in the Navarro Watershed.

C.1 Road Analysis

The length of roads in each use category, as identified in the aerial photo analysis, is presented in Table C-1.

Table C-1: Road Mileage by Category

New Primary	36.9mi
New Secondary	67.4mi
New Rarely Used	10.3mi
Primary	496.8mi
Secondary	973.7mi
Rarely Used	275.8mi
Total Miles	1860.9mi

C.2 Road-Related Gullying

Form: [Basin-Wide Average Stream Crossing Delivery per Mile of Road] [Miles of Road] [Miles of Watershed Area]$^{-1}$ = Road Related Gully Delivery

Example: Indian Creek

(17.9 tons mile^{-1} year^{-1}) (166.2 miles) (39 miles^{2})$^{-1}$ = 90 tons mile^{-2} year^{-1}

C.3 Vineyard Erosion

From: [Acres of Cultivated Vineyards] [Erosion Rate] [Delivery Rate] [Area of Watershed miles^{2}]$^{-1}$ = Rate of Vineyard Related Sediment Yield

Example: Anderson Creek

(1088 acres) (10 tons acre^{-1} year^{-1}) (0.5) (46 miles^{2})$^{-1}$ = 118 tons mile^{-2} year^{-1}

C.4 Road Mass Wasting

Form: [Landslide Delivery] [# Road Miles]$^{-1}$ [10 year RI]$^{-1}$ = Rate of Road Related Mass Wasting Yield

C.5 Road Surface Erosion

Form: [Basic Erosion Rate (tons acre^{-1} year^{-1})] [Traffic/Precipitation Factor (Cover Factor for Ditch/Cutbank) (dimensionless)] [Road Prism Contribution (dimensionless)] [Hydrologic Connectivity (dimensionless)] [Road Width (feet)] [Conversion Factor (acre foot^{-1} mile^{-1})] = Rate of Road Surface Erosion Yield (tons mile^{-1} year^{-1})

In all calculations, road prism and ditch/cutbank contribution was 0.4, hydrologic connectivity was 0.56, ditch/cutbank width was 6 feet, and road width was 21 feet. Other factors that varied are presented in Table C-2.

Example: Existing primary roads in areas receiving greater than 45” annual precipitation

Road Tread: (60 tons acre^{-1} year^{-1}) (4) (0.4) (0.56) (21 ft) (0.1212 ac ft^{-1} mi^{-1})= 137 tons mile^{-1} year^{-1}

Ditch and Cutbank: (60 tons acre^{-1} year^{-1}) (0.37) (0.4) (0.56) (6 ft) (0.1212 ac ft^{-1} mi^{-1})= 3.6 tons mile^{-1} year^{-1}

Total surface erosion yield: (137 + 3.6) tons mile^{-1} year^{-1} = 140.6 tons mile^{-1} year^{-1}

Table C-2
Erosion Rates and Factors used in Calculating Surface Erosion

Category	Basic Erosion Rate (tons/acre/year)	Traffic/Precip. Factor (cover factor for ditch and cutbank)
Primary Roads, <45” annual precip	60	2
Secondary Roads, <45” annual precip	60	1
Rarely Used Roads, >45” annual precip	60	.05
Primary Roads, >45” annual precip	60	4
Secondary Roads, >45” annual precip	60	1
Rarely Used Roads, >45” annual precip	60	.05
New Primary Roads, <45” annual precip	110	2
New Secondary Roads, <45” annual precip	110	1
New Rarely Used Roads, >45” annual precip	110	.05
New Primary Roads, >45” annual precip	110	4
New Secondary Roads, >45” annual precip	110	1
New Rarely Used Roads, >45” annual precip	110	.05
New Ditch and Cutbank	110	.37
Previously existing Ditch and Cutbank	60	.63

C.6 Management Related Mass Wasting

Form: [Rate of Natural Shallow Landslide (from Entrix 1998)] [Management to Natural Ratio] = Management Related Rate

C.7 Stream Crossing Erosion

Navarro road data: 109 stream crossings, average fill volume per crossing = 422 tons.

Data from Furniss et al (1998):

69% (n=266) of stream crossings failed (overtopped culvert).
Of those that failed, 21% had no erosion, 44% eroded 1-25% of their fill, 12% eroded 26-50% of their fill, 10% eroded 51-75% of their fill, and 13% eroded 76-100% of their fill.

Applying data from Furniss et al (1998) to Navarro road data:

69% of 109 = 75 crossings expected to fail

Assume high end of range of fill erosion:
(75)(0.21)(0)(422 tons) + (75)(0.44)(0.25)(422 tons) + (75)(0.12)(0.50)(422 tons) + (75)(0.10)(0.75)(422 tons) + (75)(0.13)(1.0)(422 tons) = 12,133 tons

(Mass of eroded stream crossing fill volume) (total number of stream crossings)$^{-1}$ = (12,133 tons)… …(109 crossings)$^{-1}$ = 111 tons crossing^{-1}

Assuming 10-year recurrence interval storms trigger 69% of stream crossings to fail:
(111tons crossing^{-1}) (10 years)$^{-1}$ = 11.1 tons crossing^{-1} year^{-1}