BIG RIVER ROAD SEDIMENT SOURCE ASSESSMENT
FINAL REPORT

Prepared for:

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GENERAL INFORMATION

Property Owner:	The Conservation Fund (TCF)
Contact Person:	Scott Kelly, RPF – Project Leader 707-272-4497
Project Location:	T17N, R16W, Sec. 21-23, 25-29, 32-35 T17N, R15W, Sec. 30; T16N R16W, Sec. 3 MDB&M Comptche 7.5' USGS Topographic Quadrangle Mathison Peak 7.5' USGS Topographic Quadrangle Mendocino County, California
Watershed:	Middle Albion River; Upper Albion River; Laguna Creek Mouth of Big River; & Two Log Creek Planning Watersheds Big River Watershed

INTRODUCTION

The purpose of this road based sediment source assessment was to evaluate approximately 48 miles of forest road for erosion and sediment delivery concerns and propose treatments for road upgrades or decommissioning at sites where >10 yds^3 of sediment could potentially reach a watercourse if treatments are not implemented. As directed by TCF staff, this assessment was limited to the portion of the property south of the mainstem of Big River and up to the southern property boundary, an area encompassing over 4,800 acres of timberland, hereafter referred to as the "subject property", and containing approximately 70 miles of forest road. Approximately 22 miles of these roads are within recent or active Timber Harvest Plans (THPs) and were excluded from the assessment at the direction of TCF staff as these have been evaluated during the THP planning and review process. The remaining ~ 48 miles were systematically reviewed as part of this assessment, and are hereafter referred to as the "project roads."

The primary goal of this assessment is to provide a complete inventory of sediment delivery sites associated with the project roads to assist TCF staff with applying for restorative grant funds, and/or as a reference for future road network planning and land management. This project is consistent with TCF goals presented in the Big River and Salmon Creek Forests - Integrated Resource Management Plan (IRMP) to address the protection and enhancement of water quality (TCF, 2009). Consistent with IRMP goals, this assessment has identified several "at risk" road segments where near stream roads may be candidates for decommissioning upon review by TCF forestry staff.

The goal of the proposed road treatments is to minimize road related sediment delivery. Road treatments are consistent with the IRMP (Appendix H: Road Management Plan) where construction of watercourse crossings and road drainage improvements will follow industry standard specifications for low volume forest roads (e.g. PWA, 1994; Weaver and others, 2006). It is commonly known that deleterious quantities of fine grained sediment from road related sources is a common cause of pollution that can degrade the quality of water in watercourses, and adversely affect listed aquatic species or their habitats. Restorative road upgrade work can directly improve habitat conditions by minimizing erosion and sediment delivery to the stream system (PWA, 1994).

This report generally follows guidelines for final reporting of road sediment source assessments as presented in the California Department of Fish and Game (DFG) Habitat Restoration Manual (HRM) (Weaver and others, 2006); specific procedures are described in the *METHODS* section of this report.

REGIONAL SETTING

TCF property reviewed during this assessment is located on slopes of varying aspect and gradient predominately within the Two Log Creek, Laguna Creek, and Mouth of Big River CA Planning Watersheds approximately 4 miles north of Comptche, California (Figures 1 and 2). Elevation ranges from approximately 100 feet along the valley bottom to approximately 800 feet along the ridge top on the southern property boundary. The climate in the region is typical of a Mediterranean climate, with cool wet winters, and warm dry summers. A majority of the precipitation is generated from October to April by a westerly flow of moist air off the Pacific Ocean. Average annual precipitation in the region is approximately 50 inches per year (Goodridge, 1997). Snow provides a relatively insignificant contribution to the hydrologic budget.

Geology

Geologic mapping conducted in the region indicates that the subject sites are underlain by the Coastal Belt Franciscan Complex (Kilbourne, 1983a., 1983b.; Braun and others, 2005). Recent unconsolidated channel deposits composed primarily of sand, silt and gravel are exposed along the active channels along Big River and its larger tributaries. Generally, the Coastal Belt Franciscan consists of greywacke sandstone and shale sequences that display varying degrees of deformation. Shear strength of the bedrock is highly variable and dependent upon the local structure, bedding, and lithology. Field observations on the subject property revealed a range of bedrock conditions from moderately to highly fractured outcrops of thin to massive bedded, hard, competent sandstone to sheared sandstone with relatively low internal strength. The orientation of structural discontinuities was highly variable between localities observed on the subject property; regional characterization of the bedrock structure was beyond the scope of this assessment.

Seismicity

The orientation of the structural grain of the Franciscan complex is controlled by the northwest-southeast trending San Andreas Fault Zone, a right-lateral strike slip fault whose main trace is located offshore approximately 15 miles west of the TCF Big River property. Geologic research indicates the Pacific Plate has been moving north relative to the North American Plate along the San Andreas Fault Zone for the past 30 million years

(Atwater, 1970). The related Maacama Fault Zone trends northwest-southeast down the Ukiah and Willits valleys 15 miles east of the plan area. Based on the most recent documented surface rupture, which occurred in 1906, a probability analysis of the earthquake hazard revealed that the North Coast portion of the San Andreas Fault Zone is capable of producing a magnitude 7.9 earthquake with a 220 year recurrence interval (Petersen and others, 1996).

Soils
The Natural Resource Conservation Service soil survey depicts several soil complexes on the subject property. Formed from the weathering of sedimentary rock, the Irmulco-Tramway complex soils blanket a significant majority of the hillslopes and are characterized by moderate-well drained pale brown loam (Rittiman and Thorson, 2001). Field observations were consistent with the mapped classification. Thickness of the overlying colluvial soil can be highly variable. Generally, colluvium is thin along ridges and upper sideslopes (typically 1-2 feet), and thick (as much as 5-10 feet) within deep swales and local depressions.

Geomorphology
The assessment area is located in steep mountainous terrain where naturally occurring landslides have been identified as a major slope forming process, delivering gravel and wood to the stream system, which provides habitat complexity to populations of aquatic species (Reeves and others, 1995; Swanson and others, 1987). A combination of landsliding, surface erosion, and gully and channel erosion continues to shape the Coast Range Mountains.

Large deep-seated landslides (e.g. translational-rotational landslides and earthflows) commonly occur in the Big River Watershed, some within TCF property, they are generally characterized by a suspended or very slow moving slide mass and deep slide plane extending well into bedrock (Braun and others, 2005). Differential movement within the large slide mass is common where portions of the slide can locally exhibit geomorphic evidence of historical activity while the remaining slide mass appears dormant. A majority of the shallow landslides (e.g. debris slides and flows) occur on slopes over 65% and are concentrated on steep streamside slopes along the outside of meander bends along the mainstem of Big River and its larger tributaries (Braun, 2005). Based on aerial photo analysis most management related shallow landslides originate in cutslopes or fillslopes of roads and skid trails.

METHODS

The methods of this assessment are generally consistent with methods outlined in the DFG HRM (Weaver and others, 2006), and are briefly summarized below.

- Discussions and field review with Scott Kelly, RPF (TCF Project Leader)
- Review of available pertinent maps and literature
- Review of several sets of aerial photographs
- Field reconnaissance and data collection on ~ 48 miles of forest road
- Analysis of the data
  - Culvert sizing
  - Potential sediment delivery estimates
  - Proposed treatment cost estimates
- Quality Assurance / Quality Control
- Preparation of summary maps and report

Initial discussions and field review with Scott Kelly were conducted in December 2009 and January 2010 to identify project goals and refine assessment protocols. Map and aerial photo review of the project roads were conducted at the TCF office in Caspar in December 2009 to identify project road alignments, road construction history, and any anomalous hillslope conditions (e.g. stream diversions, unstable areas). Field data collection was conducted primarily by Christopher Blencowe, RPF (TCF Consultant) from January to March of 2010 under the direct supervision of Elias Steinbuck, PG (TCF Consultant), and involved collection of key site information used to estimate potential sediment delivery volumes and treatment costs. A field form was developed based on recommendations in the DFG HRM to ensure systematic collection of essential field data (Figure 3).

The intention of this assessment was not to document all road related erosion on the subject property, but rather to focus on those areas where a potential for sediment delivery to a watercourse exists. Road erosion that does not have the potential to deliver 10 yds^3 of sediment, but has damaged (or could damage) the road alignment if unmitigated, is summarized by Christopher Blencowe, RPF elsewhere in a summary of road maintenance related issues.

Culvert sizing analysis was conducted using standard empirical methods that incorporate drainage basin attributes and local precipitation data to determine a culvert diameter that would accommodate the 100 year storm event (Cafferata and others, 2004). Analysis of field data to estimate potential sediment delivery volume at watercourse crossings was conducted using repeatable methods where fill slope and dimension data were collected in the field and entered into spreadsheet format during data entry; standard geometric relationships were used to calculate potential sediment delivery volumes (Figure 4). Road surface erosion was estimated over a 10 year period using standard methods and assumptions similar to Weaver and others (2006) as presented in the DFG HRM (Figure 5). Unstable fill volumes were estimated using field measurements and standard geometric relationships.

Treatment costs were determined by estimating a reasonable production rate for each recommended treatment (e.g. per culvert install, per armored fill install, per rolling dip, etc…) based on available literature and experience with similar projects, and applying that to each site; special consideration is always given to complex or high volume sites that may require more equipment time or materials (Figure 6). Often a site will include multiple treatments (e.g. install culvert, stabilize perched fill, and shape the contributing road segment with several rolling dips), however these sites are always mapped and depicted as watercourses as that is the primary pathway for sediment delivery, this is discussed in detail in the *RESULTS* section of this report.

For estimating purposes watercourse crossings were categorically ranked based on relative size (e.g. small, medium, and large for new culverts; small and large for armored fills), and road surfacing was taken into consideration when doing any shaping work (e.g. permanent rocked roads require significant quantities of base rock upon completion of upgrades, seasonal roads do not). Equipment and labor rates were based on TCF supplied current wage rates from similar project work; culvert costs were estimated from up-to-date quotes from local suppliers, rock costs were estimated based on an assumed $50/yd^3 to excavate, sort, and deliver road base or rip-rap from on-site quarries to the project sites.

A concise summary of the essential site data collected in the field and recorded on the original field forms at each site is found in Appendix A and described below.

- **Site id #** - Unique id number recorded on yellow w/white flagging in the field.
- **Site type** - Primary process of potential sediment delivery. Many watercourse crossings also contribute sediment from road erosion or landsliding; however, these are mapped as crossings for the purposes of this assessment.
  - CR - Watercourse Crossing
  - RE - Road Erosion
  - LS - Landslide
- **Road #** - TCF road number where the site is located.
- **PWS** - CA Planning Watershed where the site is located.
  - TL - Two Log Creek
  - LC - Laguna Creek
  - MB - Mouth of Big River
  - MA - Middle Albion River
- **Erosion Problem** - An estimate of the potential sediment delivery volume presented by delivery process (yds^3).
  - Crossing - Computed in the office based on field measurements.
  - Road Erosion - Computed in the office based on field measurements.
  - Landslide - Computed in the field using standard geometric relationships.
- **Problem Description** - Summary of the site conditions and erosion problems.
- **Treatment Immediacy** - Assessment of the urgency to treat the site based on the magnitude of potential delivery and proximity to Class I or II (H, M, L).
- **Proposed Treatment** - Summary of the proposed upgrade or decommissioning. Treatment.

- **Site Specific Cost to Treat -** Estimate based on equipment, labor, and materials. This does not consider logistical time (mob in/out, moving between sites, etc…) or supervision, which can collectively cost between 10-30% of the total project.
- **Cost Effectiveness** - A metric often used for grant funded assessments based on dollars/cubic yard to perform proposed treatments.

Numerous sites, including a majority of the complex or large volume sites, were reviewed in the field by the PG for quality assurance purposes to ensure the assessment data was being collected accurately and no significant sediment sources were being ignored.

RESULTS

The road assessment was conducted on ~ 48 miles of road from December, 2009 to May, 2010 and identified 113 discrete sediment delivery sites where road upgrades or decommissioning is proposed (refer to Figures 1 and 2 for a spatial distribution of the sites, Appendix A for a summary spreadsheet of site data, Appendix B includes all original field forms; Appendix C depicts original mapped locations). A comprehensive discussion of road related erosion and sedimentation problems and standard treatments similar to those proposed herein can be found in the DFG Habitat Restoration Manual (Weaver and others, 2006).

Generally, treatments proposed in this assessment are based on standard design specifications for upgrading or decommissioning low volume forest roads as described in the HRM (Weaver and others, 2006), and consistent with goals presented in the IRMP (TCF, 2009), and predominately include upgrading undersized or poorly functioning watercourse crossings (e.g. installing new culverts sized for the 100-year flow, or installing rock armored fill crossings), excavating and stabilizing unstable fill material, and installing ditch relief culverts or reshaping the road with rolling dips or outsloping to enhance drainage and minimize sediment delivery to the stream system from hydrologically connected road segments.

A review of the assessment data reveals an estimated 18,952 yds^3 of sediment could potentially deliver to the stream network if upgrades are not implemented. An estimated 7,995 yds^3 of sediment is in fill at watercourse crossings, 9,064 yds^3 is estimated from road surface erosion on ~ 8.2 miles of hydrologically connected road segments, and 1,893 yds^3 is estimated from active or potential landslide sites (e.g. perched or cracking fill).

Site data is summarized in Appendix A and mapped as either a watercourse crossing (CR), a road erosion site (RE), or a landslide site (LS). However, a majority of the watercourse crossings also include hydrologically connected road segments that drain to the crossing, and therefore increase the volume estimate and cost estimate to treat that site. It is not practical to identify a crossing as one discrete site, the road erosion leading to the crossing as another discrete site, and the adjacent oversteepened fill yet another site, as all the sediment delivery is essentially to the same point, and the equipment working at the site will implement treatments concurrently. Therefore, when summary data is presented on watercourse crossings, quite a lot more than 7,995 yds^3 of sediment will be displayed because road surface erosion and unstable fill slopes are also included in each crossing estimate. Potential sediment delivery associated with "crossings" is in fact 15,348 yds^3.

In total 88 watercourse crossings were identified for upgrade ranging from minor repair (rock armoring, trash racks, clearing plugged culverts, etc…) to more significant improvements; 25 culvert crossings and 20 rock armored fills are proposed. Proposed road drainage improvements on ~ 8.2 miles of hydrologically connected road include 8 ditch relief culverts, 157 rolling dips, 1,400' of outsloping, 825' of surface rocking, and 98 cross drains on segments proposed for decommissioning. Additionally, 3,400 yds^3 of potentially unstable fill is proposed to be excavated and stabilized.

In several locations it appeared from field observations that road segments could be decommissioned, or crossings excavated and roads converted to temporary status, pending a detailed review of the future harvest and yarding methods in the vicinity of the site by TCF forestry personnel. Treatments for decommissioning or converting a crossing to temporary status generally includes excavating and stabilizing fill from the crossing. Additionally, decommissioning typically involves installing frequent cross drains, and ripping the compacted road surface to enhance infiltration. Consistent with IRMP goals these roads are referred to as "at risk" roads and are summarized by planning watershed in Table 1 below.

Table 1
"At Risk" Roads Proposed for Decommissioning
Sorted by Planning Watershed

Planning Watershed	Road Number	# of Mapped Sites	Length of Road Decomm. (ft.)
Two Log Creek	22100	2	2,000'
	22005	1	950'
	22300	1	100'
	23408	1	500'
	20030.1	3	1,500'
	20030.2	1	800'
	24100	4	1,700'
	24110	1	100'
	24112	1	150'
Laguna Creek	24040	1	250'
	24600	3	2,400'
	N/A[a]	9	1,700'
Total		28	12,150' or 2.3 miles

[a]Legacy road system in the headwaters of Laguna Creek

Many of the road segments presented in Table 1 have good access, would be straightforward and relatively cost effective to decommission, and therefore should be strongly considered for the proposed treatments presented in this assessment subject to review by TCF forestry personnel. Conversely, the legacy road system along the valley bottom in the headwaters of Laguna Creek is quite well vegetated and stable in some locations, or the road bed runs in the active channel in other locations. It is questionable as to whether decommissioning work would be beneficial, despite this the sites were included in the assessment for completeness.

Table 2 presents a summary of the estimated potential sediment delivery volume and cost of proposed treatment by site type and treatment immediacy for all project roads in the assessment area.

Table 2
Summary of Big River Road Sediment Data
Sorted by Site Type and Treatment Immediacy

Site Type	Treatment Immediacy	# of Sites	Potential Sed. Del. Volume (yds^3)	Site Specific Cost to Treat ($)
Crossing[a]	H	6	2,161	45,705
	M	35	6,608	164,541
	L	47	6,579	134,909
	Total CR	**88**	**15,348**	**$ 345,155**
Road Erosion[b]	H	1	403	6,060
	M	4	593	10,232
	L	12	1,606	41,597
	Total RE	**17**	**2,602**	**$ 57,889**
Landslide[c]	H	2	362	6,412
	M	4	449	11,599
	L	2	191	7,810
	Total LS	**8**	**1,002**	**$ 25,821**
Total All	H	9	2,926	58,177
	M	43	7,650	186,372
	L	61	8,376	184,316
	Total All	**113**	**18,952**	**$ 428,865**

[a]Crossing sites commonly include road drainage upgrades on road segments that contribute road erosion to the crossing site, and may include landslide volume as well.
[b]Road erosion sites deliver run-off and sediment to a watercourse, but are not associated with a watercourse crossing; they may include landslide volume as well.
[c]Landslide sites primarily deliver sediment to a watercourse through landsliding.

Construction work proposed in this assessment would likely be completed by licensed contractors with hydraulic excavators, loaders, dozers, graders, water trucks, dump trucks, rollers, compactors, and hand labor. It is assumed that rock would be quarried on the subject property at a cost of $\$50/yd^3$ to excavate, sort, and deliver the material to the site. Culverts and erosion control would be provided by local suppliers of TCF choosing.

Each site was attributed with equipment, labor, and material costs, based on estimates found on Figure 6 to determine a cost estimate for each site. The hours and dollars presented on Figure 6 are only meant to be a starting point for estimating purposes; these were often modified based on site-specific conditions. Table 3 presents a summary of the estimated potential sediment delivery volume and cost of proposed treatment by planning watershed and site type.

Table 3
Summary of Big River Road Sediment Data
Sorted by Planning Watershed and Site Type

PWS	Site Type	# of Sites	Potential Sed. Del. Volume (yds^3)	Site Specific Cost to Treat ($)
Two Log Creek	CR[a]	57	11,255	251,298
	RE[b]	13	2,082	44,334
	LS[c]	6	811	18,011
	Total TL	**76**	**14,148**	**$ 313,643**
Laguna Creek	CR	27	3,398	76,411
	RE	4	520	13,555
	LS	1	60	658
	Total LC	**32**	**3,978**	**$ 90,624**
Mouth of Big River	CR	2	640	13,003
	RE	0	0	0
	LS	1	131	7,152
	Total MB	**3**	**771**	**$ 20,155**
Middle Albion River	CR	2	55	4,443
	RE	0	0	0
	LS	0	0	0
	Total MA	**2**	**55**	**$ 4,443**
Total Big River Project Roads	CR	88	15,348	345,155
	RE	17	2,602	57,889
	LS	8	1,002	25,821
	Total BR	**113**	**18,952**	**$ 428,865**

[a]Crossing sites commonly include road drainage upgrades on road segments that contribute road erosion to the crossing site, and may include landslide volume as well.
[b]Road erosion sites deliver run-off and sediment to a watercourse, but are not associated with a watercourse crossing; they may include landslide volume as well.
[c]Landslide sites primarily deliver sediment to a watercourse through landsliding; they may include secondary road erosion volume as well.

Note that costs are for the site-specific treatments only and do not include logistical costs (which may run ~20% of the total project) such as equipment move-in/move-out, moving equipment between sites, moving culverts around to the sites, final erosion control, and unforeseen circumstances. Additionally the presented cost estimate does not include layout, supervision, and reporting by a qualified professional (which may run ~10% of the total project). Complete project costs are presented in the *SUMMARY* section of this report.

SUMMARY

An assessment of ~ 48 miles of road on TCF property in the Big River Watershed revealed 113 discrete locations where active or potential sediment delivery was noted. An estimated 18,952 yds^3 of potential sediment delivery was inventoried through field based measurements and calculations. Site-specific equipment, labor, and material costs are estimated to be $428,865 to complete the proposed treatments. Table 4 presents a complete project cost estimate including itemized costs to complete the treatments sorted by treatment immediacy, logistical and project management costs, and an estimate of total project cost effectiveness.

<u>Table 4</u>
Complete Project Cost Estimate
Sorted by Treatment Immediacy

Treatment Immediacy	Equipment and Labor	Culverts	Rock	Total Cost
H	$ 31,927	$ 8,000	$ 18,250	$ 58,177
M	$ 92,372	$ 25,500	$ 68,500	$ 186,372
L	$ 85,716	$ 10,100	$ 88,500	$ 184,316
+ Logistics - equip. mob., moving culverts to sites, travel time between sites, erosion control, unforeseen conditions				$ 122,942
+ Project Management - layout, supervision, reporting				$ 61,470
Total Project Cost Estimate				**$ 613,277**
Potential Sediment Savings				18,952 yds^3
Total Project Cost Effectiveness				**$ 32 / yd^3**

REFERENCES

Aerial Photographs

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Maps and Literature

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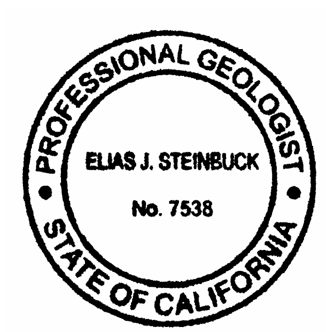
AUTHORITY

This assessment has been conducted in an objective manner and in accord with generally accepted professional practices for this type of work. Subsurface geotechnical exploration was beyond the scope of this report, therefore the conclusions are limited in that regard. Additionally, identification of erosion features can be obscured by dense vegetation and/or prolonged weathering, therefore older features may exist that were not observed on the aerial photographs or identified during the field reconnaissance.

The proposed treatments are based on generally accepted specifications for managing low volume forest and ranch roads in the region; however this does not imply the project roads will not be subjected to rainfall, ground failure, or seismic shaking so intense that culverts and/or road segments will be severely damaged or destroyed regardless of implementation of the proposed treatments.

It is the responsibility of the Project Leader, or his designee, to ensure that the information contained in this assessment is brought to the attention of the contractor in enough detail that the treatments get properly implemented. In the event that site conditions change significantly in the assessment area between the time of this assessment and the time the treatments are implemented, a field visit and supplemental report shall be prepared to document such changes and revise the recommendations.

Please give me a call at 707-357-0520 if you have any questions.



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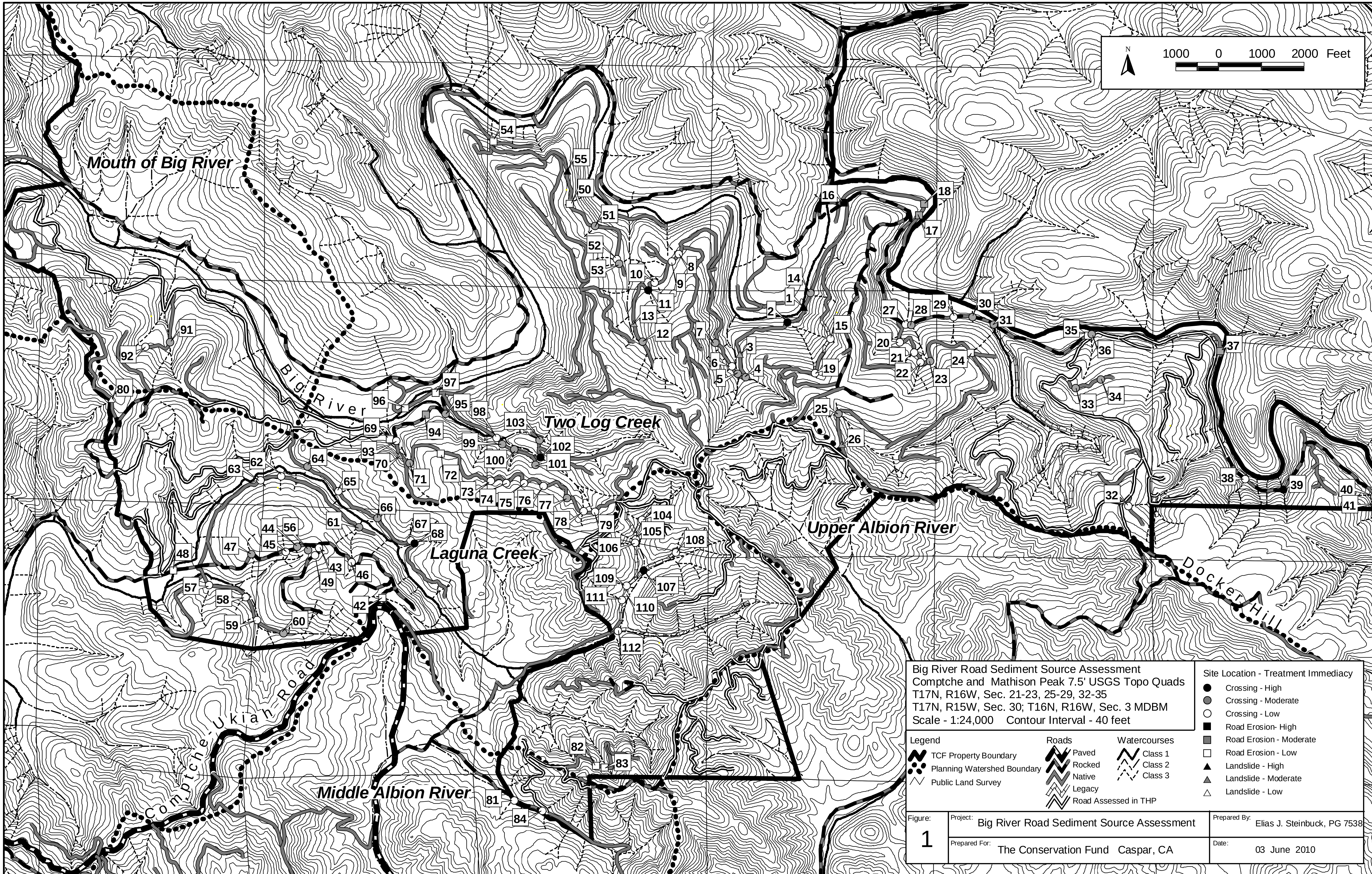

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Mouth of Big River
Big River
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Laguna Creek
Upper Albion River
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Comptche-Ukiah Road
Docker Hill
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Crossing - Moderate
Crossing - Low
Road Erosion- High
Road Erosion - Moderate
Road Erosion - Low
Landslide - High
Landslide - Moderate
Landslide - Low
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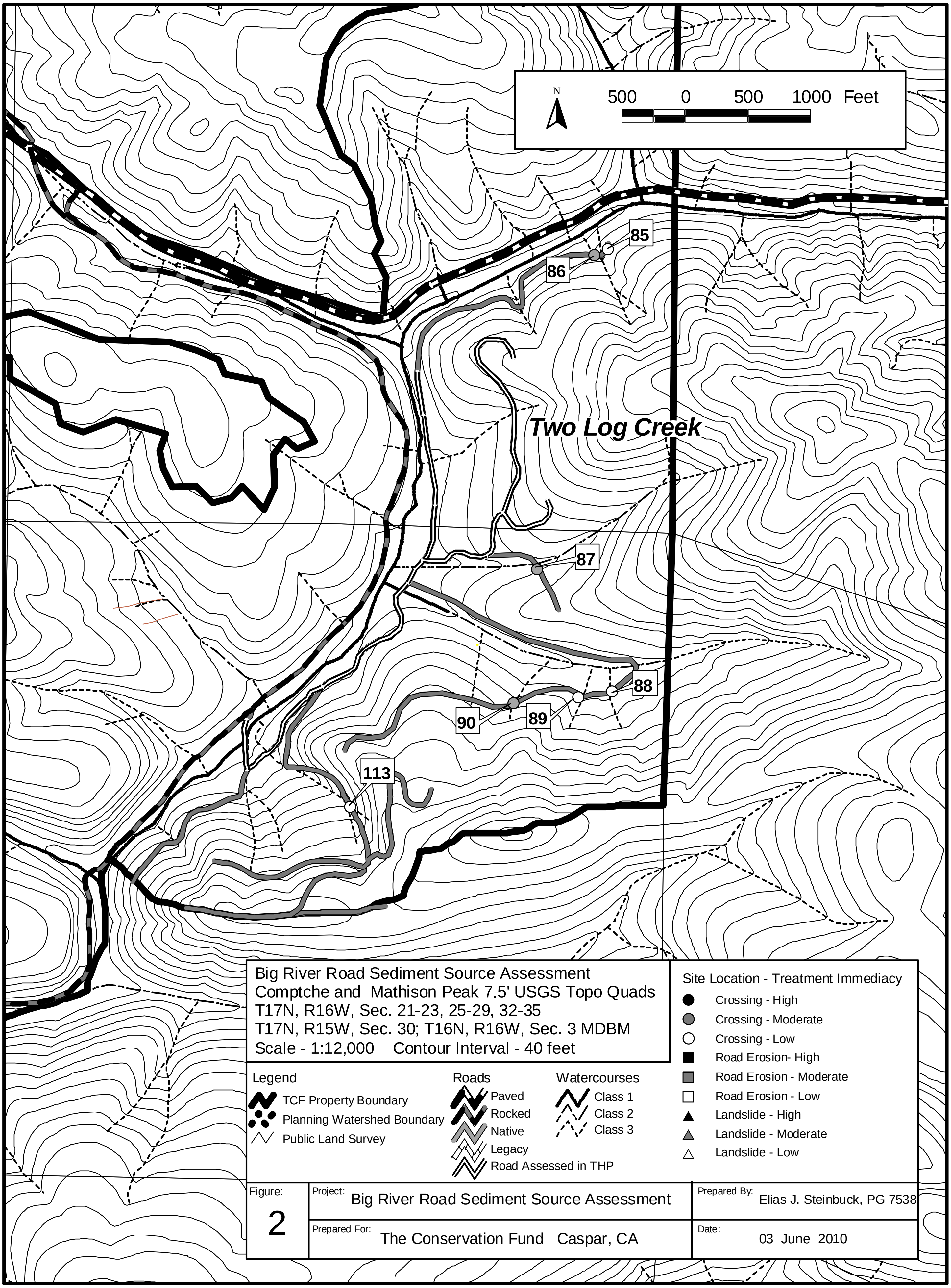
Date:
03 June 2010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Big River Road Sediment Source Assessment
Comptche and Mathison Peak 7.5' USGS Topo Quads
T17N, R16W, Sec. 21-23, 25-29, 32-35
T17N, R15W, Sec. 30; T16N, R16W, Sec. 3 MDBM
Scale - 1:12,000 Contour Interval - 40 feet
Site Location - Treatment Immediacy
Crossing - High
Crossing - Moderate
Crossing - Low
Road Erosion- High
Road Erosion - Moderate
Road Erosion - Low
Landslide - High
Landslide - Moderate
Landslide - Low
Legend
TCF Property Boundary
Planning Watershed Boundary
Public Land Survey
Roads
Paved
Rocked
Native
Legacy
Road Assessed in THP
Watercourses
Class 1
Class 2
Class 3
Figure:
2
Project:
Big River Road Sediment Source Assessment
Prepared By:
Elias J. Steinbuck, PG 7538
Prepared For:
The Conservation Fund Caspar, CA
Date:
03 June 2010

FIGURE 3: Sample Field Form - The Conservation Fund Big River Road Sediment Source Assessment

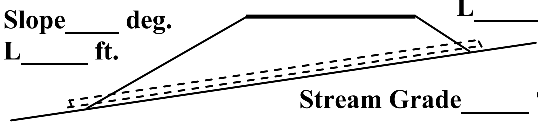
SITE #:	PWS:	Access: □ PU □ ATV □ Foot	Initials:	Date:
	Road #:	Road Surface: □ Rocked □ Native	□ GPS Coord:	

PROBLEM – SED. DEL. POT. H M L

● CROSSING ●

□ Class 1 □ Class 2 □ Class 3 Channel W____ ft.
□ Culvert □ Ford □ Bridge □ Humboldt □ None
Diameter_____ in. x _____ ft.
□ Rusted Out/Damaged
□ Outlet Erosion □ Shotgunned □ Misaligned
□ Diversion Potential
□ High Plug Potential – Plugged_____ %
□ Undersized

Road Width_____ ft.
Inboard Fill Slope____ deg. L_____ ft.
Outboard Fill Slope____ deg. L_____ ft.



Stream Grade_____ %

■ ROAD EROSION ■

□ IBD/Road Surface
Length Undrained______ ft.
□ Steep Road Grade – Rills
Grade______ %
Length______ ft.
□ Run-off Gully
L____ W____ D____ ft.
□ Defective Ditch Relief Culvert
□ Plugged
□ Rusted Out/Damaged
□ Outlet Erosion
□ Shotgunned
□ Undersized

▲ LANDSLIDE ▲

□ Cutslope Failure
L___ W___ D___ ft.
□ Fillslope Failure
L___ W___ D___ ft.
□ Channel Bank Failure
L___ W___ D___ ft.
□ Potential Landslide
L___ W___ D___ ft.
Slope %:_______
Delivery %:_______
Approx. Slide Age
□ Recent (<10 yrs.)
□ Young (10-50 yrs.)
□ Old (>50 yrs.)

Problem Description:

TREATMENT – IMD. H M L

CULVERT CROSSING

□ Clear Culvert
□ Install Critical Dip
□ Install Culvert
Diameter_____ in.
Length _____ ft.
□ Install Downspout
Length _____ ft.
□ Rock Armor
Inlet _____ yds^3
Outlet _____ yds^3
□ Install Trash Rack

FORDS & ARMORED FILLS

□ Install Ford
Ex. Crossing ______ yds^3
□ Install Rock Armored Fill
Rock Armor ______ yds^3
□ 6-12 in. rock armor
□ 12-24 in. rock armor
□ 24-36 in. rock armor

ROAD DRAINAGE

□ Clean Ditch______ ft.
□ Outslope______ ft.
□ Fill Inside Ditch
□ Rolling Dips: #_____
□ Install DRC(s): #_____
Length _____ ft.
□ Road Rock
L_____ x W_____ ft.
□ Rock Line Ditch______ ft.
□ Waterbars: #_____
□ Cross Drains: #_____

EXCAVATION

□ Ex. Crossing ______ yds^3
□ Ex. Landslide ______ yds^3
□ Endhaul ______ yds^3
______ ft.
□ Widen into bank
_____ ft. W
_____ ft. L
□ Ramp Over/Down
_____ ft. H
_____ ft. L

Site Sketch: Depict Problem, Approx. Dimensions, Road and Hillslope Grade (%), Erosion Sources, Treatment

Slope
Cut
Road
Fill
Culvert
Scarp
Landslide
Toe
Spur Ridge
Ditch
Gully
Berm
Watercourse
Spring/Wet Area
Stump/Trees
Outslope
Waterbreak - specify rolling dip, cross drain, or waterbar

Proposed Treatment:

Sediment Savings = Crossing _____ yds^3 + Road Surface Erosion _____ yds^3+ Unstable Fill _____ yds^3 = Total ________ yds^3

□ Data Entered
Initials: date:

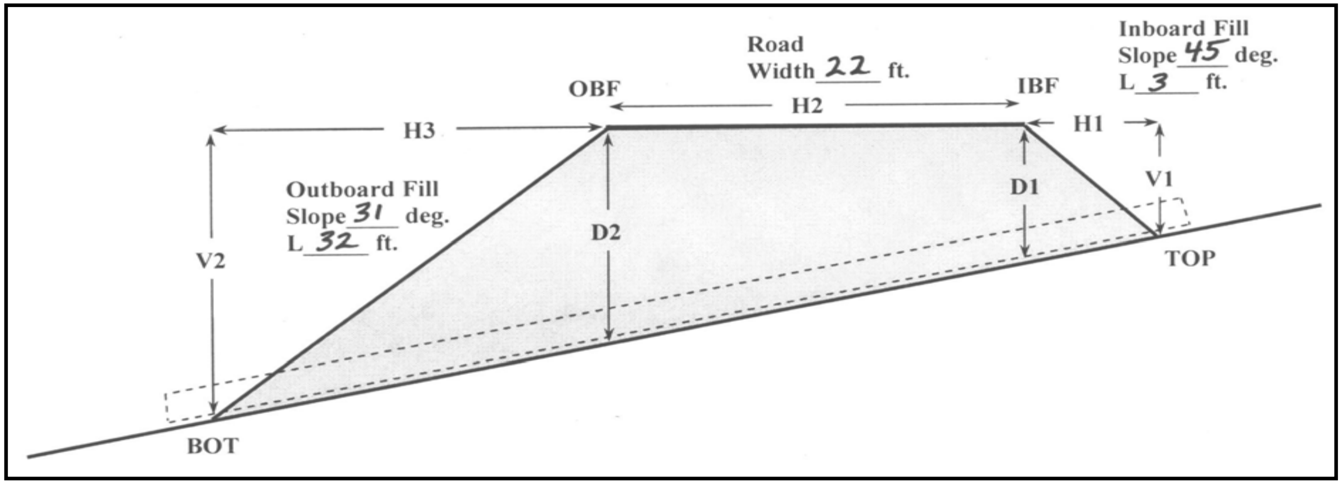
FIGURE 4: Watercourse Crossing Fill Volume Calculator
TCF - Big River Road Sediment Source Assessment

Elias J. Steinbuck, PG
EJS_Fill Volume Calculator_011110.xls

Enter Field Data in Shaded Boxes

Slope IBF	**45**	degrees
Length IBF	**3**	feet
Road Width	**22**	feet
Slope OBF	**31**	degrees
Length OBF	**32**	feet
Channel Width	**2**	feet

Site Number: 2



Calculated Results

Horizontals

H1	2.1	feet
H2	22.0	feet
H3	27.4	feet

Verticals

V1	2.4	feet
V2	-16.4	feet

Fall Rate	-0.3	feet/feet

Depth

D1	2.9	feet
D2	8.9	feet

X-Section Area

XSA1	18.8	sq. ft.
XSA2	137.8	sq. ft.

assumes 1.5:1 sideslopes

Fill Volumes

TOP to IBF	0.5	cubic yards
IBF to OBF	63.8	cubic yards
OBF to BOT	46.7	cubic yards

Total Crossing Fill Volume

111 cubic yards

Modified from: CA DFG, California Salmonid Stream Habitat Restoration Manual, V. II, Ch. X, Fig. X-6, Pg. X-38

FIGURE 5: Road Surface Erosion Calculator | **Elias J Steinbuck, PG**
TCF - Big River Road Sediment Source Assessment | **EJS_Road Erosion Calculator_011110.xls**

Enter Field Data in Shaded Boxes

Site Number: 2

Road Length	**1200**	feet
Road Width	**18**	feet
Erosion Rate	**0.03**	feet/year
Ave. Cut Height	**10**	feet
Ave. Cut Bare Soil	**25**	%

Erosion Rates

Rocked Road	0.02	feet/year
Native Road	0.03	feet/year
Bare Cutbank	0.03	feet/year

Calculated Results

Road Surface

Area	21600	sq. feet
Erosion Rate	0.03	feet/year
Time	10	years
Erosion Volume	240.0	cubic yards

Total Road Surface Erosion Volume

273 cubic yards

Cutbank

Area	3000	sq. feet
Erosion Rate	0.03	feet/year
Time	10	years
Erosion Volume	33.3	cubic yards

Modified from: CA DFG, California Salmonid Stream Habitat Restoration Manual, V. II, Ch. X, Pg. X-34

FIGURE 6: Cost Estimates by Treatment Type — Elias J. Steinbuck, PG

The Conservation Fund - Big River Road Sediment Source Assessment — EJS_TCF Big River Cost Tables 050410.xls

Notes: Time to complete treatments estimated from production rates on similar projects, rates may vary depending on contractor and site conditions

Equiptment and Laborers are estimated in hours, rates are based on simliar recent TCF project rates

Rip-Rap and Road Base estimated at $50/cubic yard to open TCF pits and truck material to the sites, culverts estimated by quote from B&B Industrial

CULVERTS

Small Sized Crossings and DRC's [<50 cubic yards]

	Seasonal Native Road		*Permanent Rocked Road*	
Excavator	4	$ 520	4	$ 520
Dozer	2	$ 190	2	$ 190
Water Truck	2	$ 156	4	$ 312
Grader/Skip	1	$ 87	2	$ 174
Dump Truck	0	$ -	0	$ -
Roller	0	$ -	2	$ 174
Laborer	4	$ 148	4	$ 148
Culvert	24x40	$ 1,000		$ 1,000
Rip-Rap	5	$ 250	5	$ 250
Road Base	0	$ -	20	$ 1,000
Total		***$ 2,351***		***$ 3,768***

Medium Sized Crossings [50 - 250 cubic yards]

	Seasonal Native Road		*Permanent Rocked Road*	
Excavator	10	$ 1,300	10	$ 1,300
Dozer	6	$ 570	6	$ 570
Water Truck	6	$ 468	8	$ 624
Grader/Skip	2	$ 174	4	$ 348
Dump Truck	0	$ -	0	$ -
Roller	2	$ 174	4	$ 348
Laborer	8	$ 296	8	$ 296
Culvert	36x40	$ 1,500		$ 1,500
Rip-Rap	10	$ 500	10	$ 500
Road Base	0	$ -	30	$ 1,500
Total		***$ 4,982***		***$ 6,986***

Large Sized Crossings [250 - 500+ cubic yards]

	Seasonal Native Road		*Permanent Rocked Road*	
Excavator	16	$ 2,080	16	$ 2,080
Dozer	12	$ 1,140	12	$ 1,140
Water Truck	8	$ 624	8	$ 624
Grader/Skip	4	$ 348	8	$ 696
Dump Truck	0	$ -	0	$ -
Roller	6	$ 522	8	$ 696
Laborer	16	$ 592	16	$ 592
Culvert	48x60	$ 2,100		$ 2,100
Rip-Rap	20	$ 1,000	20	$ 1,000
Road Base	0	$ -	50	$ 2,500
Total		***$ 8,406***		***$ 11,428***

ROCK ARMORED FILL CROSSINGS

Small Rock Armored Fill Crossing [<100 cubic yards]

Excavator	4	$ 520
Dozer	2	$ 190
Water Truck	2	$ 156
Grader/Skip	1	$ 87
Dump Truck	0	$ -
Roller	2	$ 174
Laborer	0	$ -
Rip-Rap	20	$ 1,000
Road Base	30	$ 1,500
Total		***$ 3,627***

Large Rock Armored Fill Crossing [>100 cubic yards]

Excavator	6	$ 780
Dozer	4	$ 380
Water Truck	4	$ 312
Grader/Skip	2	$ 174
Dump Truck	0	$ -
Roller	4	$ 348
Laborer	0	$ -
Rip-Rap	40	$ 2,000
Road Base	40	$ 2,000
Total		***$ 5,994***

ROAD SURFACE TREATMENTS

Unstable Fill Excavation [per 100 cubic yards]

	All Roads		
Excavator	5	$ 650	
Dozer	1	$ 95	
Water Truck	1	$ 78	
Grader/Skip	1	$ 87	
Dump Truck*	0	$ -	**add $400 if endhaul*
Roller	0	$ -	
Laborer	0	$ -	
Rip-Rap	0	$ -	
Road Base	0	$ -	
Total		***$ 910***	

Rolling Dip Construction [per 1 dip]

	Seasonal Native Road		*Permanent Rocked Road*	
Excavator	0	$ -	0	$ -
Dozer	2	$ 190	2	$ 190
Water Truck	1	$ 78	2	$ 156
Grader/Skip	1	$ 87	1	$ 87
Dump Truck	0	$ -	0	$ -
Roller	0	$ -	1	$ 87
Laborer	0	$ -	0	$ -
Rip-Rap	0	$ -	0	$ -
Road Base	0	$ -	30	$ 1,500
Total		***$ 355***		***$ 2,020***

Outsloping [per 500' of road length]

	Seasonal Native Road		*Permanent Rocked Road*	
Excavator	0	$ -	0	$ -
Dozer	4	$ 380	6	$ 570
Water Truck	2	$ 156	4	$ 312
Grader/Skip	4	$ 348	4	$ 348
Dump Truck	0	$ -	0	$ -
Roller	2	$ 174	4	$ 348
Laborer	0	$ -	0	$ -
Rip-Rap	0	$ -	0	$ -
Road Base	0	$ -	80	$ 4,000
Total		***$ 1,058***		***$ 5,578***

Rock-Lined Ditch [per 100' of ditch length]

	All Roads	
Excavator	2	$ 260
Dozer	0	$ -
Water Truck	0	$ -
Grader/Skip	1	$ 87
Dump Truck	0	$ -
Roller	0	$ -
Laborer	1	$ 37
Rip-Rap	5	$ 250
Road Base	0	$ -
Total		***$ 634***

	Hourly Rates
Excavator	**$ 130.00**
Dozer	**$ 95.00**
Water Truck	**$ 78.00**
Grader/Skip	**$ 87.00**
Dump Truck	**$ 78.00**
Roller	**$ 87.00**
Laborer	**$ 37.00**