North Coast Integrated Regional Water Management Plan
Proposition 84 Round 1 Implementation Grant

Priority Project Technical Documents: Plans and Specifications

292 - Lower Russian River Water Quality Improvement Project, Sotoyome Resource Conservation District

- 2010 Austin Creek Watershed Sediment Source Assessment, Sonoma County, California
- Sotoyome RCD, Russian River Coastal Tributary Improvement Program QAPP Final Report. 2006; Appendix C

Appendix A

Field observations and treatment recommendations for road related sediment delivery sites

Austin Creek Watershed Sediment Source Assessment Sonoma County, California

Table A1. Field observations and treatment recommendations for road related sediment delivery sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
1	Gray Creek (Upper East Austin Creek)	L	Stream crossing	Road surface only	575	85	Unused logging or fire road. Road bed does not show signs of rilling or active erosion (covered in forest litter). Crossing has a 2" PVC pipe which may be an abandoned water supply line.	1. Outslope road and fill ditch for 575' up left road and install 4 Rolling Dips. 2. Outslope road and fill ditch for 85' up right road.
2	Gray Creek (Upper East Austin Creek)	L	Stream crossing	12	60	1,446	Rarely used native surface road. Stream initiates just upslope of fill crossing in a grassland/swale setting with extensive right approach. Outboard edge of fill is moderately crumbling though heavily vegetated. Overall this site is not a significant sediment source within the watershed.	1. Construct an armored fill crossing using 10 yd3 1-2' rock armor. 2. Outslope road and fill ditch for 1,446' up left road and install 10 rolling dips.
3	Gray Creek (Upper East Austin Creek)	ML	Stream crossing	132	0	65	Culvert set in at shallow (5%) relative to channel grade. Flow from the outlet has gullied the outboard fill face for about 30' to bedrock base. Outboard fill face is littered with terracotta pipe and hog wire.	1. Install an armored fill crossing using 45 yd3 1-3' rock armor.
4	Gray Creek (Upper East Austin Creek)	ML	Stream crossing	12	50	55	Small fill crossing approximately 50' left of site 3. Stream flow contacts road, diverts approximately 15' outside natural channel and gullies 40' down hill slope to adjacent stream channel. Gully appears to be roughly 2'w x 1'd and looks stable.	1. Install an armored fill crossing using 15 yd3 1'-2' rock armor. 2. Outslope road and fill ditch along both road reaches for a total of 105 ft.
5	Gray Creek (Upper East Austin Creek)	ML	Stream crossing	88	15	40	A rusty though not completely rusted out culvert, installed high in the fill and at a fairly shallow (13%) grade, appears to have plugged and overtopped in the past resulting in moderate erosion of the outboard fillslope. What appears to be poorly placed inboard fill armor seems to periodically slough into the inlet, increasing the plug potential. In addition, the existing pipe outlets left of the natural stream axis, resulting in excessive erosion of the left bank, though most sediment delivery has already occurred here. Channel below the pipe outlet has abundant natural armor.	1. Define channel above the inlet by removing up to 6 yd3 of existing armor and sediment. 2. Install a single post trash rack above the culvert inlet.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
6	Gray Creek (Upper East Austin Creek)	L	Stream crossing	Road surface only	25	35	A very small stream channel, about 50' to the left of site 5, crosses the road and down the outboard fill face. The outboard fill face is well armored with local rock but could benefit from more. The strange thing about the existing condition is that the stream channel does not connect with the channel from site 5 but rather veers left and continues parallel down slope.	1. Install an armored fill crossing using 5 yd3 1-2' rock armor.
7	Gray Creek (Upper East Austin Creek)	L	Stream crossing	2	180	100	A small fill crossing with a 6" diameter asbestos pipe in the road bed. The pipe is entirely exposed and is non-functional. Rocky channel bottom both above and below crossing. Stream appears to exhibit minimal ability to erode the road fill.	1. Install an armored fill crossing using 5 yd3 0.5-1' rock armor. 2. Outslope road and fill ditch for 180' up left road and install 1 rolling dip. 3. Outslope road and fill ditch for 100' up right road and install 1 rolling dip.
8	Gray Creek (Upper East Austin Creek)	L	Stream crossing	17	25	45	Two small (1.5 x 0.5 each) streams drain a grassland setting and coalesce above the buried inlet of a non functioning undersized culvert, which is set high in the fill and outside the natural stream axis. Low energy stream with minimal erosion below existing outlet. Road fill prism appears semi-saturated though stable, and short, well vegetated approaches are of little concern.	1. Install an armored fill crossing using 10 yd3 0.5-1.5' rock armor.
9	Gray Creek (Upper East Austin Creek)	L	Ditch relief culvert	Road surface only	0	260	Ditch relief culvert in a grassland setting drains a stable, grassy inboard ditch.	1. Outslope road and fill ditch for 260' up right road and install 2 rolling dips.
10	Gray Creek (Upper East Austin Creek)	M	Stream crossing	6	0	140	Stream drained by 10" asbestos culvert. A 14" diameter ditch relief culvert outlets next to the outlet of the culvert at the crossing. Culvert has high potential to plug and divert flow down the left road reach.	1. Install an armored fill crossing using 10 yd3 1-2' rock armor. 2. Install a rolling dip up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
11	Gray Creek (Upper East Austin Creek)	ML	Ditch relief culvert	Road surface only	630	0	Concentrated road drainage delivers flow and sediment to a completely buried and non-functional ditch relief culvert with downspout. Pipe has been covered by a cutbank failure and flows currently exit the road via the outboard fill face. Pipe seems unnecessary- road drainage can be addressed with rolling dips.	1. Outslope road and fill ditch for 630' up left road and install 4 rolling dips.
12	Gray Creek (Upper East Austin Creek)	M	Stream crossing	Road surface only	85	710	Unused ford crossing; road switches back from upper junkyard area down to Gray Creek. Road crosses Gray Creek and intersects with Gray Creek Road. Large rills down both approaches, however left approach is through-cut and cannot be easily drained.	1. Outslope road/fill ditch for 710' up the right road approach. 2. Install 5 rolling dips up the right road.
13	Gray Creek (Upper East Austin Creek)	M	Stream crossing	23	855	0	Crossing appears to receive very little flow. Smaller (buried) culvert may have drained flow in the past and may have caused the diversion gully to the right. Stream channel looks like a gully above and below the crossing. Treatment immediacy based on connected road length to site.	1. Install a critical dip along the right hinge line. 2. Outslope road and fill ditch for 855' up left road and install 5 rolling dips.
14	Gray Creek (Upper East Austin Creek)	M	Ditch relief culvert	Road surface only	0	800	A non road related upslope gully, possibly from building pad runoff or swimming pool drainage, as well as 800' of road drainage, flows to Gray Creek via a 24" concrete culvert pipe. The upper 500' of contributing road length is paved, while the adjacent 300' of road is rocked with a raveling inboard ditch. Drainage treatments prescribed herein are for road related drainage only- an alternate drainage method upslope of the road should be utilized to minimize gully enlargement, though this is beyond the scope of this assessment.	1. Install an 18"x30' DRC with an 18"x20' downspout approximately 300' right of the site at the contact between paved and rocked surfaces. 2. Outslope road and keep ditch for 300' and install 1 rolling dip right of the site; connect with inboard ditch.
15	Gray Creek (Upper East Austin Creek)	ML	Stream crossing	Road surface only	140	365	Bridge is 20'l x 12'w, bottom is approximately 8' above water. Bridge sits on concrete abutments and does not appear to be constricting stream flow. Road length connecting to the crossing are well rocked and receive moderate use year round.	1. Outslope road and fill ditch for 365' up right road and install 2 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
16	Gray Creek (Upper East Austin Creek)	M	Stream crossing	43	0	1,092	A swale/small stream which exhibits minimal evidence of surface flow. Disconnecting the significant right road approach is likely a more effective means of lowering the potential of outboard fill face erosion than full armored fill installation. A low spot in the road approximately 20' to the left removes the possibility of stream diversion. Treatment immediacy based on contributing road length.	1. Install an armored fill crossing using 25 yd3 1-2' rock armor. 2. Outslope road and fill ditch for 1,092' up right road and install 7 rolling dips.
17	Gray Creek (Upper East Austin Creek)	M	Stream crossing	Road surface only	0	1,485	Very little stream channel morphology both above and below crossing, but springy outflow just above road is creating flow across road. Old, abandoned 18" culvert length is laying in channel below crossing. Small berm across road is keeping flow from diverting down left road reach.	1. Install an armored fill crossing using 20 yd3 1-2' rock armor. 2. Outslope road and fill ditch for 1,485' up right road and install 9 rolling dips.
18	Gray Creek (Upper East Austin Creek)	M	Stream crossing	67	1,080	0	An adequately sized though poorly installed culvert drains a moderately sized creek as well as over 1,000' of steep left road approach. The shotgunned pipe has caused approximately 30 yd3 of past erosion. Below the BOT is a flood plain of very old landing, the stream channel should be defined across this feature (see Site# 68). Class I stream is 75' down channel from BOT.	1. Replace existing culvert with a 48" x 60' long culvert set in at base of fill and at channel grade. Transition channel grade above TOP flag by removing 10 yd3 of material. Store spoils locally. 2. Armor the lower 1/4 of the outboard fill slope with 10 yd3 1-2' rock armor. 3. Install a single post trash rack 4' above culvert inlet in center of channel. 4. Outslope road and fill ditch for 1,080' up left road and install 7 rolling dips. 5. Install a critical dip along right hingeline of crossing.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
19	Gray Creek (Upper East Austin Creek)	ML	Stream crossing	192	240	260	Inlet of culvert is about 30% plugged with branches and sediment. Sediments aggraded about 30' up channel because of shallow culvert slope. Culvert length is short for fill slope and therefore entire outboard fill has failed to outlet leaving near vertical drop from road down to stream channel. Outlet is shotgunned 7' above channel.	1. Replace existing culvert with a 60" x 70' long culvert set in at base of fill and at channel grade. 2. Install a single post trash rack 5' above culvert inlet in center of channel. 3. Outslope road and fill ditch for 240' up left road and install 1 rolling dip. 4. Outslope road and fill ditch for 260' up left road and install 1 rolling dip. *14hours labor and 1hour excavator time for de-watering the stream.
20	Gray Creek (Upper East Austin Creek)	ML	Stream crossing	Road surface only	307	108	A stable ford crossing across Gray Creek with no road fill in the crossing. Approaches, while short, could benefit from drainage structures, though the right approach is through-cut and will likely prove difficult to drain. Upstream of this site approximately 150' is a bank erosion area.	1. Outslope road and fill ditch for 307' up left road and install 2 rolling dips. 2. Outslope road and fill ditch for 108' up right road.
21	Gray Creek (Upper East Austin Creek)	HM	Stream crossing	60	100	85	A small but active stream with an unstable fill crossing is eroding the road prism via a nearly vertical, bare 7' vertical head cut. In the surrounding area the road width is approximately 22' while at the site the road is approximately 15' wide. Upon rebuilding the road the lower 1/4 of the outboard fill face should be armored to retain the 15' width; if a 22' width is desired than 3/4 of the fill face should be armored. Drainage from the low gradient left approach is aiding erosion of the outboard fill face.	1. Excavate TOP to BOT, install a 24" x 70' CMP at channel grade and in the natural stream axis. Armor the lower 1/4 of the fill face with 5 yd3 1-2' rock armor. 2. Outslope road/fill ditch 100' left.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
22	Gray Creek (Upper East Austin Creek)	M	Stream crossing	24	350	160	Actively eroding fill crossing. Eroded outboard fill face has exposed brow logs (3) throughout evacuated area. The lowest most brow log continues to retain fill on both sides of crossing.	1. Install an armored fill crossing using 15 yd3 1-2' rock armor. Note: Keep lowest brow log in place to retain fillslope support. 2. Install 1 rolling dip up right road approach (in swale axis). 3. Install 2 rolling dips up the left road approach.
23	Gray Creek (Upper East Austin Creek)	H	Stream crossing	227	0	250	Actively failing stream crossing. Culvert was set high in fill and short relative to crossing width. Due to inlet being so high in fill, sediments have aggraded up channel for roughly 140'. Outboard fill has eroded back to outlet of culvert. Culvert was aligned so that outlet directs flow towards left bank and is currently eroding that bank. Bottom of culvert is rusted through and when flowing stream runs under culvert. Springy wet swale with toe of older landslide deposit exists about 100' to the right of crossing. Springy swale is depositing flow onto roadbed. *Treatment changed to decommissioning per BB, 3/30/10.	1. Excavate TOP to BOT, establish a 6' channel width and lay back side slopes to stable 2:1 angle (where possible) for decommissioning. Store spoils locally (landing and left approach, and spread up right approach upon departure from area). 2. Armor headcut with 10 yd3 1-1.5' rock armor. 3. Install 4 cross road drains up the right road approach. 4. Cut ditch for 100' across wet swale up right road.
24	Gray Creek (Upper East Austin Creek)	M	Stream crossing	23	95	0	This stream, adjacent to the stream detailed in site 23, is currently diverted to the right and drained by the same culvert pipe. Extensive upstream skidding has resulted in an incised channel with nearly vertical sides. Future erosion estimate is based on expansion of the current channel/gully, primarily from bank lay back as channel incision appears to have reached bedrock. The left approach is very steep, likely too steep for effective drivable road drainage structure installation. *Treatment changed to decommissioning per BB, 3/30/10.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 for decommissioning. Store spoils locally (landing, left road). 2. Install 1 cross road drain up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
24.1	Gray Creek (Upper East Austin Creek)	M	Landslide	60	0	0	Over steepened landing fill perched along the left bank of a class 2 stream. This site is just upstream of site 24. Fill area appears stable, though along with a skid across the stream the channel is being constricted in this area.	1. Pull oversteepened landing fill from START to END flags (40'w x 2'd x 20'l). 2. Stockpile locally on the landing.
25	Gray Creek (Upper East Austin Creek)	No treat	Stream crossing	29	20	30	A partially washed out culverted crossing within a hummocky swale which appears to be a deep seated landslide. The road width at the site has been reduced from 20' to 7' due to wash outs from either past overtopping, too short of a culvert pipe, or both. Check site because crossing is in a deep seated landslide feature. *Treatment changed to No Treat per BB, 3/30/10.	No treatment.
26	Gray Creek (Upper East Austin Creek)	No treat	Stream crossing	6	50	30	Road section passes across a slow moving deep seated landslide feature. Road width has been reduced to roughly 7' and is currently used as more of a trail. Attempts at armoring the outboard fill face with large woody debris have not decreased erosion significantly. Check site because crossing is in a deep seated landslide feature. *Treatment changed to no treat per BB, 3/30/10.	No treatment.
27	Gray Creek (Upper East Austin Creek)	HM	Stream crossing	173	600	30	Culvert receives flow from 2 streams that were made to converge at inboard fill/inlet. Smaller channel to the right is actively eroding about 30' of fill. Main channel has skid along it's left bank. Skid has caused partial stream flow to divert and gully skid for roughly 250'. Culvert bottom is rusted with pin holes. Channel below outlet stair steps over large woody debris and rocky channel bottom. Left road reach has multiple locations where spring flow is emanating from cutbank.	1. Excavate TOP to BOT to replace culvert with a 54" x 50' long culvert set in at channel grade and base of fill. New culvert and roadbed should be placed about 20' down stream from current location and road width can be reduced to 15' wide. This will help to align the two steams above crossing to flow into inlet. 2. Install a single post trash rack 4.5' above inlet. 3. Endhaul spoil up left road to intersection. 4. Outslope road and fill ditch for 600' up left road and install 4 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
28	Thompson Creek (Lower East Austin Creek)	L	Stream crossing	4	60	55	Fairly stable fill crossing on low or no use road high in the watershed. Moderate (3'w x 2'd x 15'l = 4 yd3) gully on the outboard fill face. Channel appears stable above and below road. Short, insignificant approaches do not represent an issue. Overall a pretty benign site.	1. Install an armored fill crossing using 15 yd3 1-2' rock armor.
29	Gray Creek (Upper East Austin Creek)	L	Stream crossing	1	205	15	This is more of a swale than a class 3 stream. Flow is kept in channel across road by a minimal dip in the road. Crossing appears stable with minimal gullying across the road and down the outboard fill face.	1. Install an armored fill crossing using 5 yd3 0.5-1' rock armor. 2. Install 1 rolling dip up the left road approach.
30	Gray Creek (Upper East Austin Creek)	L	Road drainage discharge point	Road surface only	220	0	A very small gully/drainage discharge point has developed due to 220' of road runoff. Site is above Gray Creek Road and contributes flows to a ford crossing across Gray Creek.	1. Install 1 rolling dip on the Doelger-5 Road between gate and site #29.
31	Gray Creek (Upper East Austin Creek)	L	Stream crossing	1	130	46	Minimal stream channel development both above and below the road. Outboard fill face shows minimal gully development.	1. Install an armored fill crossing: 1) Dip the crossing through the stream axis, lowering road a maximum of 2'. 2) At the new outboard edge of fill, excavate a 10' wide keyway tapering to 4' at the base of fill. 3) Place 5 yd3 0.5-1' rock armor on the fillslope and the outer 1/3 of the road tread.
32	Gray Creek (Upper East Austin Creek)	ML	Road drainage discharge point	Road surface only	600	0	Road drainage on a steep, rarely used road which drains directly to a culverted crossing on Gray Creek Road. Road derived sediments can be readily addressed with rolling dips, though the adjacent 150' of left road approach is likely too steep for rolling dip installation.	1. Install 3 rolling dips up the left road approach.
33	Gray Creek (Upper East Austin Creek)	No treat	Stream crossing	Road surface only	25	10	Ford crossing on a seasonal use road which leads to a water tank. Road is significantly dipped through the crossing. Bottom is continuously rocky through the crossing.	No treatment.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
34	Gray Creek (Upper East Austin Creek)	M	Stream crossing	41	275	70	Majority of the left road contribution is a thru-cut. Inboard ditch along left road drains springy hillside that makes ditch active. Where ditch exits road and heads down fill face to stream it is well armored. Outlet of culvert at crossing is oriented towards right bank/road fill and is actively eroding fills. Road bed has been scoured away to roughly 10' wide with majority of that fill being deposited in channel to the left of the outlet.	1. Excavate TOP to BOT to replace culvert with a 60" x 50' long culvert set in at channel grade and base of fill. 2. Install a single post trash rack 5' above inlet.
35	Gray Creek (Upper East Austin Creek)	M	Stream crossing	20	20	500	A diverted stream crossing cutting through a fill crossing on an abandoned road 100' upstream of site #34. While it appears much of the road related erosion has already occurred at this location, a gully is developing which eventually may grow to a significant sediment source.	1. Excavate TOP to BOT, establish 4' channel width and lay back banks to 2:1 angle for decommissioning. 2. Install 3 cross road drains up the right road approach.
36	Gray Creek (Upper East Austin Creek)	M	Stream crossing	3	300	0	Small class 3 stream contacts inboard ditch and diverts down the right road for 100' before exiting the road bed and gullying down the outboard fillface, ultimately connecting with a class 2 stream. The gully on the outboard fill face looks stable with no signs of rilling or gullying down the road bed.	1. Install an armored fill crossing using 10 yd3 of 0.5-1' rock armor. 2. Install 2 rolling dips up the left road approach.
37	Gray Creek (Upper East Austin Creek)	L	Road drainage discharge point	Road surface only	175	0	Approximately 175' of left road contribution enters stream channel via an inboard ditch at the intersection with Gray Creek Road.	1. Install 1 rolling dip up the left road approach.
38	Gray Creek (Upper East Austin Creek)	HM	Stream crossing	Road surface only	150	130	Ford crossing along Gray Creek on the access road to the Colombini's cabin. A concrete apron was built along the downstream hinge of this crossing to provide a base for the ford crossing. The concrete has since worn down, exposing rebar which is pointing in the downstream direction. Approaches are short- the right approach gets contributions from the building pad/roof drainage and the left approach is mostly through cut.	1. Cut exposed rebar to reduce potential threat to fish (2 hrs labor). 2. Install 1 rolling dip up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
39	Gray Creek (Upper East Austin Creek)	HM	Stream crossing	16	975	0	Currently diverted stream crossing which at some point may have been drained by a 24" culvert pipe (as evident from unused pipe on the outboard fill face). Steep left road length has rills and continues with diverted stream flow down to site 40. Future erosion volume is continued road bed incision down to site 40. Upper 350' of left road approach is through cut.	1. Install an armored fill crossing using 25 yd3 of 1-2' rock armor. 2. Install 4 rolling dips up the left road approach. 3. Outslope road and fill ditch for 625'
40	Lawhead Creek (Upper East Austin Creek)	HM	Stream crossing	219	427	25	A fairly large stream crosses a low use road via one 30" culvert and one 36" culvert set in side by side. Both culverts are short, set high in fill and shallow relative to channel grade. Inner gorge road along right bank above crossing occupies portion of natural steam channel. Below outlet he right bank is vertical and actively eroding.	1. Excavate TOP to BOT to replace culvert with a 60" x 70' long culvert set in at channel grade and base of fill. Install a 60" flared inlet to the culvert pipe. 2. Install a single post trash rack 5' above inlet. 3. Outslope road and fill ditch for 427 up left road and install 3 rolling dips. *14hours labor and 1hour excavator time for de-watering the stream.
40.1	Gray Creek (Upper East Austin Creek)	HM	Landslide	7	0	0	Cutbank slide delivering to Lawhead Creek. Material crosses road and delvers to outboard fill slope just to the right of the culvert outlet at site# 40. Currently less than 5 yd3 of sediment delivering to stream. Cutbank is 20'- 25' high and is over steepened at top.	1. Excavate cutbank slide material (18' x 2.5' x 20'). 2. Use material to build dips or push material up spur road near gate.
41	Lawhead Creek (Upper East Austin Creek)	HM	Stream crossing	20	40	0	Older rusted out culvert. Crossing looks to over top during higher flow events and divert down right road reach. Crossing has diversion gully from inlet down right road for 70' and then gully connects to class 2 'Lawhead Creek'. Gully is grassed over and looks stable. Stream flow has also eroded outboard fill above culvert.	1. Install an armored fill crossing using 25 yd3 of 1'-2' rock.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
42	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	67	500	0	Steep bedrock channel above crossing. Stream looks to only flow during large storm events. Inlet of culvert is 50% plugged with talus from cutbank. Three post trash rack exists above inlet. Outlet has a 30' long 1/2 round downspout. Crossing has minimal potential to fail.	1. Outslope road and fill ditch for 500' up left road and install 3 rolling dips. 2. Remove existing 3 post trash rack and install a single post trash rack. 3. Clean inlet (labor). 4. Install a critical dip along right hingeline of crossing.
43	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	40	0	100	Swale/small stream drained by partially plugged culvert with a tri-post trash rack which increases the plug potential. The stream appears to have diverted left in the past, though the diversion gully now appears stable and well vegetated. Culvert has a 1/2 round downspout partially plugged by brush.	1. Clean culvert inlet. 2. Install single post trash rack. 3. Install a critical dip on the left hinge. 4. Outslope road/fill ditch for 100' up right road.
44	Lawhead Creek (Upper East Austin Creek)	L	Ditch relief culvert	Road surface only	150	180	Ditch relief culvert in a swale setting with some flow being contributed from the road/skid above. Culvert is shotgunned approximately 5'. Outboard fill face has been gullied, likely as a result of contributing road lengths. Inlet of culvert pipe is plugged approximately 50% with leaf litter.	1. Clean culvert inlet (labor). 2. Armor below outlet with 5 yd3 0.5-1' rock armor. 3. Outslope road/fill ditch for 180' and install 1 rolling dip up the right road approach. 4. Outslope road/fill ditch for 150' and install 1 rolling dip up the left road approach.
45	Lawhead Creek (Upper East Austin Creek)	M	Stream crossing	27	0	981	Concentrated road drainage and a swale contribute flow to a fill crossing on a small swale. Two redwood trees on the outboard fill face provide natural armor, though a small 1.5'w x 0.5'd gully continues left of the site. The stream alone appears to be low power, though excessive road length and added flow from a nearby swale increases sediment delivery and erosion potential at the site.	1. Install an armored fill crossing using 10 yd3 0.5-1' rock armor. 2. Outslope road/fill ditch for 981' to the right. 3. Install 7 rolling dips up the right approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
46	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	108	0	470	Short culvert set in at shallow angle relative to channel grade. Inlet has a three-post trash rack, outlet has a 1/2 round downspout. Crossing appears to handle very little flow.	1. Clean inlet and install a single post trash rack. 2. Remove downspout, install 5 yd3 0.5-1' rock armor. 3. Install a critical dip along the left hinge line. 4. Outslope road/fill ditch for 470' right. 5. Install 3 rolling dips up right road approach.
47	Lawhead Creek (Upper East Austin Creek)	M	Stream crossing	83	50	1,200	This appears to be an unnecessary crossing on Lawhead Creek. Road crosses creek and terminates shortly at a landing.	1. Excavate TOP to BOT, replace culvert with a 60" x 40' long culvert set in at channel grade and at base of fill. 2. Install a single post trash rack 5' up channel from inlet. 3. Outslope road and fill ditch for 1,200' and install 8 rolling dips up the right road approach. *14hours labor and 1hour excavator time for de-watering the stream.
48	Lawhead Creek (Upper East Austin Creek)	M	Stream crossing	14	485	0	Currently diverted stream crossing. Flow diverts down right road for 375' before exiting down outboard fillslope into Lawhead Creek. Gully down road bed appears stable and does not appear to have experienced flow in quite some time.	1. Install an armored fill crossing using 10 yd3 0.5-1' rock armor. 2. Outslope road/fill ditch for 485' up the left road approach and install 3 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
49	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	3	475	0	Fairly active, steep stream intersects an inner-gorge road and diverts to the right (some flow also goes to the left on a nearly flat segment of road). Ideally this entire road could be decommissioned, however if upgrading the road is desired an armored fill crossing is appropriate in this location. Future erosion estimate is based on expansion of the existing diversion gully. Immediacy reflects current diversion and contributing road length in an inner gorge setting.	1. Install an armored fill crossing using 10 yd3 0.5-1.5' rock armor. 2. Outslope road/fill ditch for 475' left. 3. Install 3 rolling dips up the left road approach.
50	Lawhead Creek (Upper East Austin Creek)	M	Stream crossing	161	100	265	Three 24" culverts stacked 2 at the bottom and 1 above in Lawhead Creek. Bottom 2 culverts are plugged with sediment. Inlet section of upper culvert has separated. Steam is currently flowing sub-surface of culverts.	1. Replace culvert with a 60" x 60' long culvert set in at base of fill and at channel grade. Install a 60" diameter flared inlet to the culvert pipe. 2. Install a single post trash rack 5' up channel from inlet. 3. Outslope left road for 100'. 4. Outslope right road for 265' and install 2 rolling dips. *14hours labor and 1hour excavator time for de-watering the stream.
51	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	52	300	50	Two 36" rusted culverts sit side by side at base of fill and at channel grade. Upon rebuild road will have to be raised to accommodate lager culvert and this may create diversion potential to the right. Check CMP calls for a 84" culvert which the crossing can't accommodate. Install 60" culver pipe with flared inlet per DKH, 3/30/10.	1. Replace culvert with a 60" x 50' long culvert set in at base of fill and at channel grade. Install a 60" diameter flared inlet to the culvert pipe. 2. Install a single post trash rack 5' up channel from inlet. 3. Outslope left road for 300'. 4. Install 2 rolling dips up the left road approach. *14hours labor and 1hour excavator time for de-watering the stream.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
52	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	7	50	0	Currently diverted stream crossing with a three post trash rack. Inlet is somewhat open but accumulated sediments above the trash rack has caused flow to divert to the right approximately 185'.	1. Install an armored fill crossing using 10 yd3 0.5-1.5' rock armor.
53	Lawhead Creek (Upper East Austin Creek)	ML	Landslide	18	225	0	This fill failure is on an inner gorge road along Lawhead Creek, a main tributary of Gray Creek. Excavation activities at this site may overlap the "TOP" area of site #40, located directly downstream.	1. Excavate START to END, transition channel above inlet of adjacent stream crossing (site #40); store spoils locally.
54	Lawhead Creek (Upper East Austin Creek)	HM	Stream crossing	174	355	50	Culvert undersized and rusted through, but set in at base of fill. Inlet is about 80% plugged with sediments. Outlet of culvert is a confluence with another class II stream. Left road approach is deeply gullied from diverted stream flow 200' up road.	1. Replace culvert with a 60" x 50' long culvert set in at base of fill and at channel grade. 2. Install a single post trash rack 5' up channel from inlet. 3. Armor lower 1/4 of outboard fill face with 10 yd3 of 1'-2' rock. 4. Outslope left road for 355' and install 2 rolling dips. *14hours labor and 1hour excavator time for de-watering the stream.
55	Lawhead Creek (Upper East Austin Creek)	M	Stream crossing	19	1,570	0	A small, rusted out pipe on an unused road at the confluence of 2 streams. Flow periodically diverts down right road, resulting in moderate gullying of the road surface (2'w x 1'd x 50'l past gully). With landowner approval road should be decommissioned. Immediacy reflects significant left road approach.	1. Install an armored fill crossing using 10 yd3 1-2' rock armor. 2. Outslope road/fill ditch for 1570' up left road approach. 3. Install 11 rolling dips up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
56	Lawhead Creek (Upper East Austin Creek)	M	Stream crossing	122	50	50	Old, somewhat failing Humboldt crossing. Roadbed doesn't show deformation, but logs on outboard edge of fill are rotten. Stream looks to flow infrequently and minimally. Stream flow appears to bypass Humboldt logs, cross the roadbed and gully down the outboard edge of fill on the right hingeline. Check site evaluation: Channel has natural steep change in slope at crossing and makes a sharp right turn below the crossing. Site is near geologic contact between sandstone and serpentine/blue schist. See cutbank on "B. Balala-2" road- may need armor above TOP flag?	1. Install an armored fill crossing using 20 yd3 1-3' rock armor.
57	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	15	20	500	A low power stream intersects an abandoned road. A small (less than 2 vertical feet) headcut has developed at the outboard edge of the road. Several fairly large redwood stumps at the base of the fillslope provide good natural armor. The right approach contributes 300' of flow with an additional 200' of spur road contributing flows.	1. Install an armored fill crossing using 15 yd3 0.5-1.5' rock armor. 2. Install 2 rolling dips on adjacent right road and 1 on the spur road. 3. Outslope road/fill ditch for 300' up the right road approach.
58	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	1	750	360	Swale above road which barely develops into a class 3 stream below. Gully down outboard fillface is likely due to left road contribution and not from surface flow through the swale.	1. Install an armored fill crossing using 5 yd3 0.5-1.5' rock armor. 2. Outslope road/fill ditch for 750' up the left road approach and 360' up the right road approach. 3. Install 5 rolling dips left and 2 rolling dips right.
59	Lawhead Creek (Upper East Austin Creek)	L	Stream crossing	24	60	100	A small, low power stream intersects the road via a fill crossing. Approaches are short and the outboard fill face is well vegetated.	1. Install an armored fill crossing using 15 yd3 0.5-1.5' rock armor. 2. Outslope road/fill ditch for 60' to the left and 100' right.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
60	Lawhead Creek (Upper East Austin Creek)	L	Stream crossing	1	50	350	Minimal channel development above and below crossing, though channel is "V" shaped. Small gully (0.5'w x 1'd) exists down the outboard fill face, though it is mossy and vegetated.	1. Install an armored fill crossing using 5 yd3 0.5-1.5' rock armor. 2. Outslope road/fill ditch for 350' up right road approach. 3. Install 2 rolling dips up the right road approach.
61	Lawhead Creek (Upper East Austin Creek)	L	Other (swale)	3	150	50	A headwall swale developing into a class 3 stream below the road. A springy left approach with added flow from a swale located left of the site combine to form a small (2'w x 1'd x 20'l) gully. Future erosion estimate based on continued expansion of the gully up the left approach.	1. Install 1 rolling dip in the axis of the swale located left of the site. 2. Outslope road/fill ditch for 150' left of site.
62	Lawhead Creek (Upper East Austin Creek)	L	Stream crossing	1	360	30	Minimal channel development both above and below crossing. Minimal (0.5'w x 1'd) older rill down the outboard fill face for 20'. Redwoods growing on the outboard fillface look to be supporting the slope.	1. Install an armored fill crossing using 5 yd3 0.5-1.5' rock armor. 2. Outslope road/fill ditch for 360' up the left road approach and install 2 rolling dips.
63	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	6	1,200	0	Twin rusted out 18" diameter pipes drain an active stream and 1200' of steep left road approach. Upon upgrade the left road approach can likely be lowered if necessary. Currently there is very little fill left in the crossing. Ideally this site and associated road approach could be decommissioned (with landowner approval). Flows could potentially divert onto B. Balala 2.1 Road given a large enough precipitation event.	1. Excavate TOP to BOT, lay back banks to 4:1 where possible, establish 6' channel for ford crossing. Pull back right bank below BOT. 2. Install 8 rolling dips up the left road approach.
64	Gray Creek (Upper East Austin Creek)	M	Landslide	36	0	1,000	Continuous cracks exist along the outboard edge of the road about 150' upslope from a class 3 stream on an inner gorge slope. Area does not appear to have experienced recent movement. Hill slope below slump is densely vegetated with straight trees.	1. Excavate unstable fill from START to END flags (100'w x 2'd x 12'l). 2. Endhaul spoils up the right road. 3. Outslope road/fill ditch for 250' of B. Balala 2.3 Road and 750' of B. Balala 2 Road. 4. Install 2 rolling dips up B. Balala 2.3 Road and 5 rolling dips up B. Balala 2 Road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
65	Gray Creek (Upper East Austin Creek)	L	Other (swale)	Road surface only	15	430	A headwall swale above an overgrown, abandoned road. This is barely a site, though it appears some road related flow potentially intercepts the swale axis. The swale likely becomes a class 3 stream below the road, though full visual inspection of this area is limited by thick vegetation. With landowner approval this road is a good candidate for decommissioning.	1. Install an armored fill crossing using 5 yd3 0.5-1' rock armor. 2. Install 3 rolling dips up the right road approach. 3. Outslope road/fill ditch for 430' up the right road approach.
66	Gray Creek (Upper East Austin Creek)	ML	Stream crossing	39	80	300	This stream has been heavily impacted above the culverted crossing. Woody debris including fencing material, metal debris, and a make shift pond (irrigation use?) are all in the channel upstream of the site. The crossing itself appears to be of little concern, especially considering the non road related impacts to this stream. While the pipe is rusty, it is not rusted out, though when it is eventually replaced a 24" diameter CMP should be used.	1. Clean the culvert inlet. 2. Install 1 rolling dip left and 2 rolling dips right. 3. Outslope road/fill ditch for 80' left and 300' right.
66.1	Gray Creek (Upper East Austin Creek)	M	Stream crossing	180	1,500	0	Culvert looks oversized for stream dimensions. Culvert bottom appears rusty but not rusted through. Culvert set in shallow relative to channel grade. Culvert currently has a 40' long 1/2 round well functioning downspout that is well anchored and delivers flow to bottom of the fillslope. Minimal diversion potential to the right.	1. Install a single post trash rack above the inlet. 2. Outslope road/fill ditch for 1,500' up the left road. 3. Install 10 rolling dips left. 4. Install a critical dip along the left hingeline at the crossing. 5. As a low priority, replace the existing downspout with a 36" x 50' full round downspout.
66.2	Gray Creek (Upper East Austin Creek)	ML	Ditch relief culvert	Road surface only	500	0	Left road length is from site #66.1 down to intersection with Gray Creek Road. Road length delivers to ditch relief culvert on Gray Creek Road. You can no longer drive up 2.4 Road from Gray Creek Road because cutbank is too high and there is a dormant deep seated landslide at intersection that could be reactivated if road were cut into it.	1. Outslope road and fill ditch for 500' up 2.4 Road and install 2 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
67	Gray Creek (Upper East Austin Creek)	L	Stream crossing	2	200	100	Partially washed out crossing, diffuse channel morphology above and below the road. Springy approaches add to flow.	1. Install an armored fill crossing using 10 yd3 0.5-1.5' rock armor. 2. Outslope road/fill ditch for 100' right and 200' left. 3. Install 1 rolling dip left.
68	Gray Creek (Upper East Austin Creek)	HM	Stream crossing	82	0	0	This is the lower extent of site #18. Stream flow travels across a meadow/flood plain via an active gully before entering Gray Creek. The flood plain area appears to have been used as a landing or staging area for timber harvest activities. As a result, the channel/gully appears to have incised to base level in places though the banks are nearly vertical and bare. In addition, a 4' vertical headcut continues to advance upstream through the remaining fill. There are abundant local spoil storage locations and straight-forward access to the area.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes 2:1 for decommissioning. Store spoils locally.
69	Gray Creek (Upper East Austin Creek)	M	Bank erosion	150	200	200	A 400' long section of road which parallels N. Balala Road lower on the hill slope along the left bank of Gray Creek. This redundant, unused section of road is unnecessary and not required for access to the property. Gray Creek is actively scouring below the outboard fill in many sections resulting in fill failures.	1. Pull outboard fill along the entire length of this spur road where stream flow is currently or could potentially undercut the road fill. 2. Stockpile fill along the cutbank. Decommission outslope with dozer. 3. Install 5 cross road drains along road bed.
70	Gray Creek (Upper East Austin Creek)	M	Bank erosion	9	0	200	This bank erosion site is at a natural erosion bend in Gray Creek approximately 100' left of site #20, a ford crossing. Stream flow is undercutting the road bed, and a near-vertical section of road fill may eventually erode into Gray Creek. The road alignment may need to be moved in 3-5' upon excavation (will need to remove a large Bay tree at inside portion of turn).	1. Pull back vertical portion of bank to stable 2:1 angle for 50'; will likely need to move road in 3-5'. Store spoils locally. 2. Armor bend in channel with 10 yd3 2' armor. 3. Install 1 rolling dip up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
73	Gray Creek (Upper East Austin Creek)	M	Stream crossing	15	65	30	When Gray Creek Road was upgraded about 7 years ago, this site was not receiving much flow because the stream above was (and is) diverted- site was upgraded as an armored fill. Upon implementation of sites detailed in this assessment, stream flow will be put back into natural channel above (site #39), and this site will get much more flow. The outboard fill face is minimally armored, but with year-round road use this site should have culverted stream flow.	1. Excavate the crossing from TOP to BOT, install a 24" x 30' CMP. Attach a 24" x 20' full-round downspout. 2. Armor the outboard fillface with 5 yd3 0.5-1' rock armor. 3. Install a critical dip on the left hinge.
74	Thompson Creek (Lower East Austin Creek)	ML	Stream crossing	7	220	15	Small wooded stream crossing in otherwise grassland setting. Minimal armor placed at outboard edge of road (about 0.5-1' rock). Base of outboard fill is about another 15' down slope. Sidewalls of channel are near vertical from the outboard edge of the road down to the BOT.	1. Install an armored fill crossing using 15 yd3 1-2' rock armor. 2. Install 2 rolling dips up the left road approach. 3. Outslope road/fill ditch for 220' up the left road.
75	Thompson Creek (Lower East Austin Creek)	ML	Stream crossing	5	15	5	A small fill crossing which may have diverted to the right in the past, though now a minor gully through the fill prevents the possibility of diversion. A large Bay tree adjacent to the channel at the outboard edge of the road is providing natural armor. If possible this tree should remain post upgrade. It is possible some flow diverted to this crossing from site 76 in the past.	1. Install an armored fill crossing using 10 yd3 0.5-1.5' rock armor. If at all possible retain the Bay tree on the outboard edge of fill.
76	Thompson Creek (Lower East Austin Creek)	L	Stream crossing	15	100	50	Minimal armor placed at the outboard edge of the road. Stream channel has incised through the outboard fill face for 25' down to the BOT. A large (approximately 3' diameter) boulder at the BOT may have been part of placed armor.	1. Install an armored fill crossing using 20 yd3 of 1-2' rock armor. 2. Outslope road/fill ditch for 100' up left road approach. 3. Install 1 rolling dip up left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
77	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	64	100	445	Not sure if crossing was pulled or washed out. Remaining road fill on both banks near vertical. Left bank fill dimensions are 25'w x 1.5'd x 3'l, right bank dimensions are 50'w x 4'd x 8'l. The right bank width is substantially greater because a spur road travels along the bank (see sketch). The right road is also along an outside meander in the creek which appears to be actively scouring the road fill.	1. Lay back left and right banks (road fill) to 2:1 (where possible along the right bank pull as much of the vertical fill as possible). 2. Rebuild the road bed to act as a ford crossing for quad use (2 hours each excavator, dozer and labor). 3. Outslope road and fill ditch for 100' left and 445' right. 4. Install 1 rolling dip to the left and 3 rolling dips to the right. *14hours labor and 1hour excavator time for de-watering the stream.
78	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	3	0	325	A partially washed out fill crossing on a section of road now used primarily as a trail. Beyond this site, the road width narrows to almost single track width. Installation of cross road drains up the right road approach may not be possible with standard size equipment. Some fill has already washed away exposing a brow log at the previous edge of fill. A small upslope gully exists approximately 30' left of the site.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes 2:1 for decommissioning. Spoil on road to right of site. 2. Install 4 cross road drains on the right road approach.
79	Gilliam Creek (Lower East Austin Creek)	No treat	Stream crossing	5	0	0	If not for the presence of brow logs (6 total remaining), this would appear to be merely a game trail. The entire road bed is gone along the left approach, and the remaining right road is approximately 1-2' wide. The remaining brow logs should probably not be removed as they appear to be supporting what little fill remains. As these logs continue to rot they will slowly mitigate the input of sediment into the stream. Opening this area for equipment access will likely stimulate erosion.	No treatment.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
80	Gilliam Creek (Lower East Austin Creek)	No treat	Stream crossing	89	50	100	A nearly washed away crossing, rotten wood across the stream may be an old bridge or failed brow logs. Approaches almost fully washed away. Right side of crossing is bedrock- some sediment overburden but excavation of this bank will be slow, tedious and likely unnecessary with 2:1 bank angle being impossible (this is reflected in complexity and production rate at site). Access to this area will be expensive and time consuming, and most erosion has already occurred, hence low immediacy. *No treat per BB, 3/30/10.	No treatment.
81	Gilliam Creek (Lower East Austin Creek)	No treat	Stream crossing	3	10	120	Above the road this is more of a swale than a developed class 3 stream. Approximately 60% of the outboard fill face has eroded. Area appears stable for now, though the road bed will likely continue to erode. Minimal road width remaining on either approach. *no treat per BB, 3/30/10.	No treatment.
82	Gilliam Creek (Lower East Austin Creek)	No treat	Stream crossing	5	20	100	Fill crossing on a small stream. The road width has been reduced to a single-track trail on both approaches. Access to this site will be difficult and expensive. *No treat per BB, 3/30/10.	No treatment.
83	Gilliam Creek (Lower East Austin Creek)	No treat	Stream crossing	9	30	0	Washed out crossing, no real road width left to get equipment in to the site as fill on approaches is washed out. Some remaining fill could be pulled, though it will be difficult to work around the mature Bay trees. Left bank is approximately 17'w x 1.5'd x 3'l, right bank is 20'w x 2'd x 4'l. *No treat per BB, 3/30/10.	No treatment.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
84	Gilliam Creek (Lower East Austin Creek)	No treat	Stream crossing	62	0	25	A terminal landing with what appears to be mining gear left at the site. Two streams are cutting through what remains of the fill. What appear to be mine tailings are stockpiled on the inboard side of the landing. Large woody debris and various scrap metal has been placed in the stream axis. Access to this area is poor- most of the road fill has washed away, including 6 washed out crossings. Check site because treatment will require extensive road reconstruction and is likely cost prohibitive. *No treat per BB, 3/30/10.	No treatment.
85	Gilliam Creek (Lower East Austin Creek)	No treat	Stream crossing	3	30	0	Second of two streams crossing a landing/mining area. Stream doesn't look to have been crossed to make a road. Banks are vertical, approximately 2' tall, and appear stable. There are mature fir trees in and around the creek.	No treatment.
86	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	6	290	10	A small stream crosses a narrow, low use road. Nearly flat right road approach may allow diversion given large enough precipitation event, though this is unlikely. Immediacy based on fairly significant left approach length and vicinity of Gilliam Creek (located approximately 200' downstream).	1. Install an armored fill crossing using 15 yd3 0.5-1.5' rock armor. 2. Install 2 rolling dips up the left road approach. 3. Outslope road/fill ditch for 290' up left road.
87	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	1	0	135	Minimal stream channel morphology above and below the road. Road switches back and crosses channel 50' upstream of this site. Minimal road fill at the crossing.	1. Install a critical dip at the crossing. 2. Install 1 rolling dip up the right road approach.
88	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	1	300	0	Road crosses stream channel with no real drainage structure. Stream appears to flow minimally and infrequently. Minor dip in the road on the right hingeline is keeping flow within the natural channel area. Stream appears to bifurcate below the outboard fill face with the majority of flows going toward site #87.	1. Install an armored fill crossing using 5 yd3 of 0.5-1.5' rock armor. Define channel below fill to concentrate flows toward site #87. 2. Install 2 rolling dips up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
89	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	73	500	0	A near-origin stream crosses a fill area located at the outside bend of a switch back on a rarely used, narrow road. While this crossing should be excavated, layback of the left bank may impede on the existing roadbed. May potentially need armor on the left bank after excavation. No adequate stockpile locations in the area and will likely have to endhaul spoils approximately 1200' up the left road approach. There is piping through the fill, no evidence of overland flow through the crossing during site check (1/27/10). Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate TOP to BOT, establish a 4' channel width and layback side slopes to stable 2:1 angle. Haul spoils 1200' to the left to the intersection with Gilliam 1 Road. 2. Install 3 rolling dips up the left road approach. 3. Outslope road/fill ditch for 500' up left road approach.
90	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	170	625	220	Large stacked logs beyond the outboard edge of the road and down to the base of the fillslope indicate this crossing may be a Humboldt. A non functional, detached 18" diameter culvert pipe was observed on the outboard fillface. The channel above the road appears incised. Road fill through the crossing appears stable, primarily due to Humboldt logs.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to 2:1 for decommissioning. Store spoils locally. 2. Install 3 cross road drains up the right road approach and 8 up the left road approach.
91	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	5	1,350	5	A partially washed out fill crossing on an unnecessary road which parallels Gilliam Road (above). Below Gilliam 1 Road is a low-gradient bench area which appears to be acting as a depositional setting. While the crossing itself displays moderate erosion potential, most of the sediment in transport will likely never make it to the main stream system (hence low immediacy). In addition, near surface bedrock in the channel suggests stream incision in complete, though bank erosion will continue. Approximately 1000' of Gilliam 1 Road, proposed for decommissioning, and 350' of Gilliam Road, proposed for upgrade, are connected.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle for decommissioning. Excavate an additional 5 yd3 of perched sediment from the left bank below the BOT. Store spoils locally on the road bed. 2. Install 14 cross road drains up the left approach on Gilliam 1 Road. 3. Install 2 rolling dips on Gilliam Road. 4. Outslope road/fill ditch for 350' of contributing portion of Gilliam Road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
92	Gilliam Creek (Lower East Austin Creek)	ML	Landslide	278	0	0	Very old road/skid travels along the right bank of a class 2 stream. Road fill is constricting the natural channel width and causing scour along both banks. Near the left edge of the site (near the "START" flag), the road travels steeply uphill and intersects a swale/class 3 stream. This stream development area has created a 2'w x 1'd x 60'l gully which delivers to the class 2 stream. Moderate Low treatment immediacy due to slow erosion rate, accessability to site, and road opening cost.	1. Pull back the outboard fill from START to END flags (300'w x 2.5'd x 10'l = 278 yd3 (1.2) = 334 yd3 total). Store spoils along cutbank. 2. Install 2 cross road drains along steep skid near START flag. Place one of these drainage structures in the axis of the swale to limit potential diversion.
93	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	162	0	0	This is the lower extent of the stream detailed in site #90. Abundant large woody debris and fill in the channel. A 14' headcut is migrating upstream from the confluence with a larger class 2 stream. This entire area (encompassing sites 92-94) has been heavily impacted by past industrial logging activities. Road approaches appear to be long gone, though evidence of skid roads in the area is abundant. There was overland flow at the site during 1-27-10 site checking visit eroding through the fill at the crossing creating a rill (1' W x 0.6" D x 70'L) resulting in <2 yd3 of delivery. Moderate Low treatment immediacy due to slow erosion rate, accessability to site, and road opening cost.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle where possible. Spoil locally as much as possible, haul remainder to non-delivering location.
94	Gilliam Creek (Lower East Austin Creek)	ML	Landslide	125	200	200	Very old landing/road fill exists along the right bank of a class 2 stream. Fillslope is near vertical and appears to be constricting flow. Large logs present within fill. The combination of sites 92, 93 and 94 appear to be the cause of aggraded sediments in the channel. The left bank opposite this site may have had a road at some point, though little evidence remains and this area may not be accessible for treatment.	1. Excavate oversteepened outboard landing fill from START to END flags (140'w x 4'd x 12'l = 249 yd3 (1.2) = 290 yd3 total). 2. Install 2 cross road drains up the left approach and 2 cross road drains up the right approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
95	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	29	40	35	A partially washed out fill crossing with abundant woody debris in the fill. Surrounding area appears heavily skidded. Short, springy approaches will not require additional treatment. Low treatment immediacy due to slow erosion rate, accessability to site, and road opening cost.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle. Store spoils locally.
96	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	Road surface only	550	50	Crossing area is too old to tell whether it was pulled, a failed bridge (planks on right bank), or if it has always been a ford crossing. Area to the right of the crossing is broad and flat and is said to have been previously used as a mill site. Natural channel banks are currently too steep for an adequate ford crossing, even for quad use only.	1. Lay back both left and right banks to stable 4:1 angle to construct a ford crossing for quad use. Store spoils locally. 2. Outslope road/fill ditch for 550' up the right road approach. 3. Install 4 rolling dips up the right road approach. *14hours labor and 1hour excavator time for de-watering the stream.
97	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	2	40	400	A previously decommissioned road currently used as a pedestrian/bicycle trail. Very little fill remains at the crossing. This stretch of trail is desired for quad access by State Park's personnel- currently almost accessible though tread is a bit narrow on the approaches. This crossing could also be dipped out and function as a ford crossing, though the approaches still need to be widened to allow for quad access.	1. Install an armored fill crossing to be used for quad access: note no dozer time allotted as road was previously decommissioned. 2. Outslope road/fill ditch for 40' left and 400' right. 3. Install 3 rolling dips up the right road approach.
98	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	Road surface only	60	150	Pulled crossing on previously decommissioned road. Crossing appears 100% pulled- remaining fill (side slopes) looks stable. State Park personnel would like to access this area by quads. A possible alternative to armored fill installation is use of a small quad-use bridge.	1. Install an armored fill crossing using 40 yd3 1-3' rock armor. 2. Outslope road/fill ditch for 60' of left road approach and 150' of right road approach. 3. Install 1 rolling dip up the right road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
99	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	4	35	320	Previously decommissioned crossing, though left bank is too steep and moderately erodible. Some fill material appears to have settled below the outboard fillface and may be put into transport given a large enough precipitation event. Future erosion estimate is based on gully enlargement through remaining fill and input from the oversteepened left bank. A very steep skid up the natural hill slope above the right road approach may be adding some flow to the site. A low spot on the right road approach may partially disconnect road surface flows from the right, but a large enough storm event may result in flows from the right approach delivering to the site.	1. Construct an armored fill crossing using 10 yd3 1-2' rock armor (for quad access). 2. Outslope road/fill ditch for 35' left and 320' right. 3. Install 2 rolling dips up the right road approach. 4. Install 1 cross road drain up the skid above the right road approach.
100	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	3	30	250	Springy, wet stream crossing. Road fill appears stable with large Bay and Redwood trees providing natural stabilization (no need to add additional armor to fill area). Right road approach is springy for 60'- flow beyond is confined to an inboard ditch and drained via a functioning waterbar.	1. Outslope road/keep ditch for adjacent 60' of right road. Install 1 rolling dip to drain road surface only. 2. Outslope road/fill ditch for 190' up right road approach; install 1 rolling dip.
101	Gilliam Creek (Lower East Austin Creek)	ML	Landslide	44	0	250	A slide-prone environment including a large, deep seated past failure which has impacted Gilliam Creek. Currently the road related instability will not fully deliver, though future undercutting of previously deposited material will increase the delivery potential at this site. Some road related failure has already occurred via mass wasting or gullying by surface flows. Check site to determine delivery percentage and spoils management.	1. Excavate unstable road fill (90'w x 3'd x 25'l). Leave enough road width to access area beyond via quad. Haul spoils to the right approximately 1,000' to the vicinity of the road intersection. 2. Outslope road/fill ditch for 250' right. 3. Install 2 rolling dips up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
102	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	Road surface only	40	60	Pulled crossing on previously decommissioned road. State Park personnel would like to access this area via quad. Side slopes appear stable.	1. Install an armored fill crossing using 5 yd3 1-2' rock armor. 2. Outslope road/fill ditch for 40' up the left road approach to allow quad access. 3. Install 1 rolling dip up the right road approach.
103	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	Road surface only	50	100	A pulled crossing on a previously decommissioned road, exposed bedrock in "stair step" style channel. Remaining fill (side slopes) appears stable. State Park personnel would like to upgrade this section for quad access. While an armored fill is proposed at this location, a small, quad-use bridge may be a better option.	1. Install an armored fill crossing using 10 yd3 1-2' rock armor. 2. Outslope road/fill ditch for 50' up left road approach and 100' up the right road approach.. 3. Install 1 rolling dip up the right road approach.
104	Gilliam Creek (Lower East Austin Creek)	ML	Road drainage discharge point	2	110	250	Low gradient partially grassed over road approaches in swale setting contribute flow to a small (2' x 0.5') apparently stable gully. Portions of contributing road and through cut of "meadow trail" (no fill) and likely cannot be effectively drained, though overall this site is of little concern. Future erosion estimate form possible gully expansion.	1. Install 1 rolling dip along left approach and 1 rolling dip along right approach.
105	Gilliam Creek (Lower East Austin Creek)	M	Stream crossing	31	600	0	Bedrock stream channel above road. Stream diverts down right road for 25' before exiting onto outboard fill. Stream is still with in natural hingeline of steam valley. Stream has potential to divert further down right road as it has done in the past.	1. Install an armored fill crossing using 15 yd3 of 1'-2' rock. Install crossing on lower right hinge line of crossing, where flow is currently exiting road (because this is a shorter fill slope). 2. Outslope road and fill ditch for 600' up left road and install 4 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
106	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	29	170	30	Mostly stable fill crossing with bedrock exposed in channel 15' below bottom of fill slope. Steam confluence with detailed at site# 105.	1. Install an armored fill crossing using 10 yd3 of 0.5'-1.5' rock. 2. Outslope road and fill ditch for 170' up left road and install 1 rolling dip.
107	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	74	730	0	Stream channel has aggraded for 60' up channel from inboard road with coluvial sediments. Channel is bedrock at TOP flag. Minimal signs of surface flow on road bed and down outboard fill. Two large (4' diameter) Redwood trees on outboard fill seem to be helping to support fill.	1. Excavate crossing from TOP to BOT with 4' channel width for decommissioning. 2. Install an armored fill crossing using 10 yd3 of 1'-2' rock for quad access. 3. Spoil locally 4. Outslope road and fill ditch for 700' up left road and install 5 rolling dips.
108	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	12	425	20	Small stable fill crossing on small low power creek. May at one point have had diversion potential but outboard half of right approach is outsloped back into crossing and making diversion unlikely.	1. Install an armored fill crossing using 10 yd3 of 0.5'-1.5' rock for quad access. 2. Spoil locally 3. Outslope road and fill ditch for 425' up left road and install 3 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
109	Gilliam Creek (Lower East Austin Creek)	M	Stream crossing	36	250	20	Culvert inlet is pretty much buried but small evacuated area allows the inlet to capture some of the flow. Crossing appears to overtop during high flows, though there is minimal gully development on the road surface. Culvert is set shallow relative to channel grade.	1. Replace existing culvert with a 24" x 50' culvert pipe set in at channel grade and in the natural stream axis. Store spoils locally. 2. Armor the outboard fillslope with 5 yd3 1-2' rock armor. 3. Install a single post trash rack approximately 2.5' above the culvert inlet. 4. Install 5 yd3 1-2' rock armor along the right bank below the outlet. 5. Outslope road/fill ditch for 200' up the left road approach. 6. Install 1 rolling dip up the left road approach.
110	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	3	500	0	Small near origin stream intersects unused road. Very little future erosion likely. Extensive road opening costs involved in accessing this site.	1. Install an armored fill crossing using 5 yd3 0.5-1.5' rock armor. 2. Outslope road/fill ditch for 500' up left road approach. 3. Install 3 rolling dips up the left road approach.
111	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	4	100	65	Two swales converge on the road and begin to develop into a class 3 stream below. Minimal channel development below road and minimal rilling on the outboard fillslope. Another spur road is located 40' down slope from the site.	1. Excavate crossing from TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle. 2. Store spoils locally. 3. Install an armored fill crossing using 5 yd3 of 0.5-1.5' rock armor (for quad use). 4. Outslope road/fill ditch for 100' up the left road approach and for 65' up the right approach. 5. Install 1 rolling dip up left approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
112	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	3	100	0	Small stream intersecting abandoned road approximately 100' downstream of site 111. Left approach is well vegetated.	1. Excavate TOP to BOT, establish a 4' channel width and lay back banks to 2:1 for decommissioning. Store spoils locally. 2. Install 1 cross road drain up the left road approach.
113	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	88	200	110	Older fill crossing with flows diverting to the right approximately 30' before exiting onto the outboard fillslope and reconnecting with the natural stream channel. Gully on the both the road bed and fillslope appear somewhat stable but will continue to erode the fill in the long term future. Older diversion gullies exist further down the right road approach. Skid road to the right of the crossing contributes sediment via 50' long stable gully. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes 2:1 for decommissioning. 2. Store spoils locally. 3. Install 3 cross road drains up the left road approach. 2. Install 2 cross road drains up the skid road to the right of the crossing.
114	Gilliam Creek (Lower East Austin Creek)	ML	Landslide	36	130	0	An active landslide poised to deliver to Gilliam Creek. The overall setting appears to be a large, deep seated feature which has slumped in the past and is likely a function of regional geology rather than entirely a result of road construction. Approximately half the road bed is already gone, and the remaining tread may be too narrow for a standard size excavator. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate START to END, stockpile down the right road approach. 40'x1.5'x20' 2. Install 2 cross road drains up the left road approach.
115	Gilliam Creek (Lower East Austin Creek)	ML	Landslide	45	200	0	The majority of the road fill has already failed into Gilliam Creek, though some material remains in the upper portion of the evacuated area.	1. Excavate remaining road fill from START to END flags. 40'x1.5'x20' 2. Store spoils locally. 3. Install 3 cross road drains up the left road approach. *1hour dozer time to fill in crossing for equipment access to site# 113.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
116	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	68	320	0	A nearly washed out crossing with some fill remaining in the channel and steep banks in the vicinity of Gilliam Creek. Channel makes a hard turn to the right below the BOT, though this appears natural. This stream may have diverted to the right well upstream by a skid in the past. Abundant woody debris in the fill. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 for decommissioning. 2. Store spoils locally. 3. Install 4 cross road drains up the right road approach. *1hour dozer time to fill in crossing for equipment access to site# 113.
117	Gilliam Creek (Lower East Austin Creek)	ML	Other (gully)	71	150	55	It appears the stream detailed in site 116 was diverted well upstream of Tater Knoll Road. This diverted flow has resulted in a very long, large gully down the hillside which crosses the road and continues to Gilliam Creek. Check site because the upper most portion of this channel has yet to be fully investigated, though it is likely that this area still receives some flow during large storm events and will continue to erode the fill. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to 2:1 for decommissioning. Store spoils locally. 2. Install 2 cross road drains up the left road approach. *1hour dozer time to fill in crossing for equipment access to site# 113.
118	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	8	70	0	Partially washed out crossing with some fill remaining. Banks appear mostly stable below the road prism, though they could be laid back further. Approaches are short and insignificant. Stream appears to have diverted in the past, leaving an inactive gully. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle for decommissioning. Spoil locally. 2. Install 1 cross road drain up the left road approach. *1hour dozer time to fill in crossing for equipment access to site# 113.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
119	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	33	350	40	Stream flow is actively headcutting into the road fill, almost to the inboard portion of the road. Side slopes are oversteepened and will continue to erode as stream erodes to the natural channel. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate crossing from TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 for decommissioning. Store spoils locally. 2. Install 5 cross road drains up the left road approach. *1hour dozer time to fill in crossing for equipment access to site# 113.
120	Gilliam Creek (Lower East Austin Creek)	No treat	Landslide	0	0	0	This is a very large past failure, likely far more than what would be road related. Most erosion has already occurred. While this site is ugly, it is beyond the scope of the current road related erosion assessment. However, the presence of this feature will likely severely limit access options to sites located beyond.	No treatment.
121	Upper Austin Creek	M	Stream crossing	20	300	200	The road and crossing are on the right bank of Austin Creek. It is likely that during a 100-year storm event (and potentially lesser events) this area is submerged. Culvert appears undersized, though upstream about 200' the same stream is culverted under "King's Ridge Road." Crossing and immediate road lengths look to be at the toe of an old, stable landslide feature.	1. Replace culvert with 24" x 40' pipe set in at channel grade. 2. Armor the lower 1/4 of the outboard fillface with 5 yd3 1-2' rock armor. 3. Install 1 rolling dip left and 1 rolling dip right.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
122	Upper Austin Creek	ML	Bank erosion	56	0	0	The road is built adjacent to Austin Creek, and a natural bend in the channel is undercutting the outside edge (right bank), destabilizing the road fill. A 100'w x 6'l section of the bank/outboard fillface is being affected, though road surface drainage does not appear to be an issue. The overall location of the road is problematic, as it appears to be built on a flood plain, within the 100-year storm high flow zone. Armoring the bank will help deflect stream flow, though properly sized armor is essential to eliminate the potential of armor being put into transport by the stream. A gabion structure may be the preferred treatment. This site, while a clear erosional feature, demonstrates lower immediacy with respect to sediment input because of the setting within the flood zone. Current armor volume estimate assumes 2 layers of 2-3' rock armor.	Final treatments based on check site evauation: 1. Excavate a 100'w x 5'd x 6'l (111 yd3 *1.2 = 134 yd3) area on the right bank of Austin Creek (removing perched material and laying back bank to stable 2:1). Excavate a keyway 100'w x 2'd x 2'l at the base of fill (additional 15 yd3 *1.2 = 18 yd3). place 120 yd3 2-3' rock armor in keyway and 6-8' up the right bank to buttress the fill and deflect stream energy. 2. Store spoils on the flat area near site #123 (left approximately 100' to the left).
123	Upper Austin Creek	No treat	Stream crossing	63	0	0	Bedrock stream channel above and below the crossing, and culvert appears to be set at the base of fill. Bedrock visible on cutbank exposure and on road bed on left hinge line. Area below outlet is well armored with 2-3' rock armor down to Austin Creek. Not enough road fill for a critical dip.	No treatment. Check CMP indicates culvert is properly sized
124	Upper Austin Creek	ML	Road drainage discharge point	1	100	83	Road drainage with swale contribution exits the road via a small gully directly into Austin Creek. While this is not a huge issue the flow could be easily dispersed with the installation of 1 rolling dip in the axis of the swale.	1. install 1 rolling dip left of the site in the axis of the swale. 2. Place 5 yd3 of 0.5'- rock armor on the outboard fillface over a 20'w x 20'l section at the outlet of the dip.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
125	Upper Austin Creek	M	Ditch relief culvert	1	250	0	A 60% plugged ditch relief culvert drains the roadbed and a springy inboard ditch. Minimal rilling from the pipe outlet down to Austin Creek. A second 12" ditch relief culvert exists approximately 100' up the left road approach, draining the same springy inboard ditch and hillside.	1. Replace both existing ditch relief culverts with 18"x30' ditch relief culverts. 2. Outslope road/retain ditch for 250' left. 3. Install 1 rolling dip up the left road approach.
126	Upper Austin Creek	M	Stream crossing	27	135	0	An adequately sized though mostly flat culvert drains a stream which has been skidded across approximately 150' upstream of the crossing. The skid has decommissioned itself and requires no treatment. Left of the crossing is a slumping, springy cutbank. At the crossing, the pipe appears at or very near bedrock, so while it is low gradient across the road (increasing plug potential) it may well be installed as deep as possible. Pipe is mildly shotgunned onto bedrock. The main issue at this site is diversion to the right.	1. Install a critical dip on the left hinge of the crossing. 2. Install a single post trash rack above the inlet. 3. Install 1 18"x20' ditch relief culvert at the springy slump to the left of the site. 4. Install 1 rolling dip to the left (drain road surface only- do not connect to ditch).
127	Upper Austin Creek	ML	Stream crossing	41	0	100	This stream crossing may be a gully from "King's Ridge Road," above. No clear channel morphology below the road, slumped grassland hill slope above the road. The pipe appears to be set in shallow relative to channel grade.	1. Replace culvert pipe with a 24" x 60' pipe set in at channel grade. 2. Armor lower 1/4 of outboard fillface with 5 yd3 1-2' rock armor. 3. Install a critical dip along the left hinge line.
128	Upper Austin Creek	ML	Stream crossing	5	0	330	The road is built across the flood plain here, and the pipe at the crossing is low gradient as a result of the setting. The stream goes subsurface, filtering into alluvial gravels 20' below the road prior to it's confluence with Austin Creek. A break in slope approximately 50' to the right of the crossing causes sediment to deposit on the flood plain prior to reaching this stream crossing. It will require a fairly large precipitation event for either the road approach or stream crossing to deliver sediments to Austin Creek.	1. Install a critical dip on the left hinge of the crossing. 2. Install 2 rolling dips up the right road approach. 3. Clean pipe outlet of leaf litter and sediment (1 hr/labor).

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
129	Upper Austin Creek	ML	Stream crossing	Road surface only	815	50	Ford crossing on Austin Creek, with no real road fill on either approach as the road bed is located on the flood plain. The left approach is connected to the creek approximately 150' from the current active channel on a flood plain. Flow from Austin Creek rarely occupies the area where sediments are being deposited.	1. Outslope road/fill ditch for 815' up the left approach. 2. Install 5 rolling dip up the left road.
130	Upper Austin Creek	M	Stream crossing	75	115	260	Stream drained by adequately sized though flat culvert pipe in decent condition. Some sediment is aggrading above the inlet due to low gradient installation angle. Oversteepened right bank above the inlet, though the presence of a power pole just to the right of the culvert and power lines above increase the complexity of treatment at the site. Low gradient approaches, and stream appears to have diverted to the right in the past, resulting in a past diversion gully 30' to the right of the crossing. The inboard ditch delivers from both approaches. The pipe is shotgunned but overall the stream doesn't appear very high power. The entire area is hummocky and shows abundant signs of past skidding.	1. Excavate TOP to BOT, replace the existing culvert pipe with a 24" x 60' culvert set in at the base of fill and in the natural stream axis. Note: It may not be possible to excavate all the way to the TOP due to the power lines and pole. 2. Armor the outboard fill slope with 5 yd3 of 0.5-1.5' rock armor. 3. Install 1 rolling dip up the right road approach. 4. Install a critical dip on the right hinge. 5. Outslope road and fill ditch for 115' left and 260' to the right.
131	Upper Austin Creek	M	Stream crossing	71	50	0	Short, newly installed plastic, double walled culvert set in shallow (compared to channel grade). Outlet of the culvert directs flow onto a 30' length of gullying outboard fillslope. The channel above the inlet appears to be incising through a hummocky landslide feature. Sediments have been deposited at the inlet, which is approximately 10% plugged.	1. Excavate TOP to BOT, replace existing culvert pipe with a 24" x 60' culvert set at the base of fill and in the natural stream axis. 2. Armor the lower 1/4 of the outboard fillslope with 5 yd3 0.5-1.5' rock armor. 3. Install a single post trash rack above the inlet. 4. Install a critical dip on the right hinge line.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
132	Upper Austin Creek	ML	Stream crossing	33	100	100	Older steel culvert, short and shallow relative to channel grade, in the center of a dipped road. Crossing appears to receive minimal flow, with minimal gully development below the outlet for 20'.	1. Excavate TOP to BOT, replace existing pipe with a 24" x 50' long culvert. 2. Armor the lower 1/4 of the outboard fillslope with 3 yd3 1-2' rock armor.
133	Upper Austin Creek	M	Stream crossing	42	130	50	A small stream with an undersized, flat plastic pipe installed high in the fill. Road flow from the right currently bypasses the adjacent site (#134) and exits the roadway here via a 1'w x 1'd x 20'l gully. Treatment of site 134 will address this problem. Increased complexity at the site due to overhead power lines.	1. Excavate TOP to BOT, replace culvert with 24" x 60' culvert pipe at the base of fill and in the natural stream axis. 2. Install 1 rolling dip up the left road approach. 3. Outslope road/fill ditch for 130' left.
134	Upper Austin Creek	HM	Stream crossing	49	0	200	An 18" wooden box culvert with a rotten-out bottom. This drainage structure has been in place for a long time, and the area appears stable, but most likely the crossing will ultimately fail due to the condition of the culvert. Outlet is high in the fill and flow on the outboard fill slope has gullies down to bedrock.	1. Excavate TOP to BOT, replace the existing culvert with a 24" x 60' culvert set at the base of fill and in the natural stream axis. 2. Outslope road/fill ditch for 200' up the right road. 3. Install 1 rolling dip up the right road approach.
135	Upper Austin Creek	ML	Stream crossing	80	200	100	The culvert at this crossing, while apparently properly sized, is short, shallow and high in the fill. Sediments appear to have aggraded as much as 18' upstream above the inlet. The crossing overall appears stable, though there is minimal gully development below the outlet for 20' to the BOT.	1. Excavate TOP to BOT, replace the existing culvert with a 24" x 60' culvert pipe set at the base of fill and in the natural stream axis. Stockpile spoils locally. 2. Install a single post trash rack. 3. Outslope road/fill ditch for 200' up the left road approach. 4. Install 1 rolling dip right and 1 rolling dip left.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
136	Upper Austin Creek	HM	Stream crossing	50	100	570	Two 2.5'w x 0.75'd streams coalesce directly above the inlet of an 18" plastic culvert pipe set at a low gradient (compared to the natural channel gradient) and high in the fill. This hummocky area appears to be the toe of an old slide or slump. A springy grassland portion of the watershed above the contributing right approach should be drained by a ditch relief culvert in addition to road surface drainage treatments. A minimum 30" diameter culvert pipe should be used at this location. Increased complexity due to overhead power lines.	1. Excavate TOP to BOT, replace culvert with 30" x 50' culvert pipe set at the base of fill and in the natural stream axis. 2. Define the channel below the BOT for 20'. 3. Install a single post trash rack 30" above the inlet. 4. Install 2 18" x 30' ditch relief culverts up the right road approach. 5. Install 4 rolling dips right and 1 left. 6. Outslope road/keep ditch for 570' right. 7. Outslope road/fill ditch for 100' left.
137	Upper Austin Creek	M	Stream crossing	210	250	350	Culvert bottom is rusty but not quite rusted through, and the short pipe is set high in the fill and flat relative to the natural stream grade. Sediments have aggraded up the channel behind the inlet for 20'. The pipe outlet is shotgunned approximately 5'. Channel has bedrock steps above and below the crossing. An old gully feature with no apparent flow exists left of the crossing above the road. An abandoned road is located below the crossing approximately 40' downstream. This crossing is approximately 80% washed out.	1. Excavate TOP to BOT, replace the existing culvert with a 48" x 50' culvert pipe set at the base of fill and in the natural stream axis. 2. Install an "I" beam trash rack above the inlet. 3. Remove perched lobe of sediment to the right of the inlet. 4. Outslope road/fill ditch for 250' left and 350' right. 5. Install 1 rolling dip left and 2 rolling dips right. *14hours labor and 1hour excavator time for de-watering the stream.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
138	Upper Austin Creek	ML	Ditch relief culvert	1	40	100	A wooden box culvert in a springy swale drains 140' of road with additional inputs from two small streamlets within the swale. Below this site is an abandoned, heavily gullied road which should be decommissioned. Currently flow is directed into a large gully on this lower road which, after decommissioning work, will not be an issue.	1. Replace existing ditch relief culvert with an 18" x 20' ditch relief culvert. 2. Install an 18" x 10' downspout. 3. Outslope road/retain ditch for 100' right and 40' left. 4. Install 1 rolling dip up the right approach.
139	Upper Austin Creek	M	Ditch relief culvert	9	50	200	Old wooden box culvert currently drains 200' of right road approach (up to the stream detailed as site #140). The culvert outlets onto a lower abandoned road, and has developed a significant (3'w x 2'd x 200'l) gully down the inboard road. Most likely this gully was developed by diverted flow from the stream at site 140.	1. Replace the ditch relief culvert at the site with an 18" x 30' culvert pipe. Orient the outlet to direct flow onto the abandoned roadbed below, not into the gully. 2. Install 1 rolling dip up the right road approach. Connect to the inboard ditch.
140	Upper Austin Creek	HM	Stream crossing	23	0	550	This crossing is located on the left side of a springy, grassy hillside, and may be at the toe of an older, stable landslide feature. The inboard ditch up the right road approach is flowing. This crossing may have failed in the past, resulting in a dramatic gully down the abandoned roadbed located below and to the right (see site 139).	1. Excavate TOP to BOT, replace the existing culvert with a 24" x 40' culvert pipe set in at the base of fill and in the natural stream axis. 2. Install a single post trash rack above the inlet. 3. Install a critical dip along the left hinge line. 4. Outslope road/keep ditch for 450' to the right. 5. Install 3 rolling dips to the right and 1 up the driveway to Bette Campbell's house. 6. Install 2 18" x 40' ditch relief culverts up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
141	Upper Austin Creek	M	Stream crossing	79	120	0	Flowing class ll steam near Betty Campbell's driveway. Channel above crossing looks artificially incised. Area may have been altered to build home site. Outlet shotgunned 3' on the bouldery channel bottom. Steam makes a left turn shortly after outlet. Area looks stable. Check Site= see if 60" or 54" culvert can fit at crossing. Difficult to install a critical dip.	Per check site evaluation 6/2/10: 1. Replace culvert with a 48" x 40' long culvert, set in at channel grade. 2. Install a flared inlet. 3. Install a trash rack. 4. Armor lower 3/4 of outboard fill with 20 yds3 of 1'-2' rock (reuse existing where possible).
142	Upper Austin Creek	M	Stream crossing	24	390	0	Two diverted flowing Class II streams merge and continue to flow down the inboard ditch to site 143. The 2'x 1' deep up road stream flows through a meadow before hitting the road and making a 90 degree turn and running for 50' down the inboard ditch. A 3' headcut migrating at the 90 degree turn into the ditch, which appears stable and is armored with native bed load material. The second stream bifurcates from the flow at site 143 approximately 125' from the inboard road. Minimal channel development above. Evidence of overland flow at fill crossing with a 2'w x 1'd x 45'l gully to confluence with flow from site 143.	1. Excavate TOP to BOT, install a 36" x 40' CMP at the base of fill and in the natural stream axis. 2. Add a trash rack above the inlet. 3. Armor headcut at 1st stream with 5 yd3 1-2' rock armor. 4. Transition excavation from BOT through the LES. 5. Install 2 rolling dips to the left (with 20' outlet at 5% to the right in the meadow). 6. Outslope road/keep ditch for 390' to the left.
143	Upper Austin Creek	ML	Stream crossing	27	30	35	Culvert looks to be at grade and channel bottom. Culvert set in at slightly oblique angle to natural channel at outlet. Not much scour below outlet due to shallow soils and presence of bedrock.	1. Install a trash rack. 2. Install 5 yds3 of 2' rock along right bank below outlet.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
144	Upper Austin Creek	ML	Stream crossing	18	585	0	An 18" culvert drains a small stream in an oak woodland setting. The pipe is short with the outlet set high in the fill, which has developed a moderate (2'w x 1'd scour from the pipe outlet to the BOT. Left road contribution is springy along the inboard ditch, and it is almost through cut but can be outsloped. Approximately 360' of abandoned spur road (UAC Spur 5.1) intersects with the left approach and is actively delivering flow to the inboard ditch. Very little road fill along this road.	1. Excavate TOP to BOT, install a 24" x 40' CMP at the base of fill and in the natural stream axis. 2. Add a trash rack above the inlet. 3. Install a critical dip along the right hingeline. 4. Outslope road/keep ditch for 200' to the left. 5. Install 3 rolling dip up left road. 6. Install an 18" x 40' ditch relief culvert up the left road to drain the inboard ditch.
145	Upper Austin Creek	HM	Stream crossing	19	165	0	Small, dry class 3 stream with 165' of contributing springy ditch flow crosses through 12" culvert pipe with concrete lining on first segment. Undersized pipe is set high in the fill (approximately 4' above the BOT) with woody debris at the outlet, where outlet erosion has caused channel incision.	1. Excavate TOP to BOT, install a 24" x 40' CMP at the base of fill and in the natural stream axis. Armor the outboard fillface with 10 yd3 1-2' rock armor. 2. Add a trash rack above the inlet. 3. Install a critical dip along the right hingeline. 4. Outslope road/keep ditch for 165' to the left. 5. Remove 2'w x 1'd berm for 30' left.
146	Upper Austin Creek	M	Stream crossing	42	300	50	Undersized culvert, high in the fill and shallow relative to natural channel grade, drains a small bedrock stream. A 2'w x 0.5'd x 17'l gully on the outboard fillface appears stable. Treatment immediacy based on the left road contribution, where road drainage has resulted in 2 gullies off the outboard edge of the road.	1. Excavate TOP to BOT, install a 24" x 40' CMP at the base of fill and in the natural stream axis. 2. Add a trash rack above the inlet. 3. Install 2 rolling dips to the left. 4. Outslope road/keep ditch for 300' left. Clean ditch for 300' left. 5. Install 2 18"x30' ditch relief culverts, each with an 18" x 20' downspout.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
147	Upper Austin Creek	HM	Stream crossing	176	150	100	Flowing class 2 stream in grassy oak woodland setting. Small class 3 tributary enters approximately 100' above the inlet. The 18" diameter pipe currently in place at the site is undersized with a significant rust line, and outlets into an older box culvert at the base of fill. A 0.5'w x 1'd x 20'l gully has formed on the outboard fillslope from left road approach contributions. A temporary spoil storage area is located at the turn out up the left road.	1. Excavate TOP to BOT, replace existing culvert with 30" x 70' culvert pipe set in at the base of fill and in the natural stream axis. 2. Install a trash rack above the inlet. 3. Install 1 rolling dip to the left. 4. Outslope road/retain ditch for 100' right and 130' to the left.
148	Upper Austin Creek	HM	Road drainage discharge point	15	800	15	Gully down the outboard fillface and hillside delivers sediments to the flood plain of Austin Creek. Excessive left road approach (600') and 200' of abandoned spur road have developed a gully down the inboard road. Collected road runoff exits road at small rolling dip.	1. Install 3 cross road drains up the abandoned spur road. 2. Cut inboard ditch for 400' from gully up the left road. 3. Install 2 18" x 40' ditch relief culverts. 4. Outslope road/keep ditch for 500' and install 3 rolling dips.
149	Upper Austin Creek	HM	Landslide	37	210	0	Past and potential cutbank failure. Right lateral scarp is currently incising with flows and contributing to Austin Creek via the inboard ditch. Head scarp is over steepened with root mass perched at top approximately 50'. Rilling, slumping and gullying down the face of the cutbank failure with vegetated areas of more stability. Evidence of failure on the outboard fillface with 2 brow logs remaining spanning a 6' void space. Two points of delivery include 1) at the bridge crossing (site 150) and 2)at the culverted crossing to the right of the slide (site 175). Future erosion estimate is based on the continued failure on the cutbank with no attempted mitigation to reduce failure. Need to address road drainage and continued maintenance. Slide has taken out the road in the past.	1. Install 1 rolling dip up the left road approach. 2. Outslope road/keep ditch for 210' to the left. 3. Cut inboard ditch for 75' to the right to site 175. 4. Inslope road with defined inboard ditch through the failure area (approximately 155'). *Long term maintenance: Excavate slide material from road and ditch on an ongoing, as needed basis to keep road open. Store spoils at the turn out near site 147 (to the left) or on the landing in between.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
150	Upper Austin Creek	ML	Stream crossing	Road surface only	50	450	A 50' long and 10' wide steel flat car bridge with wooden decking. Base of bridge is approximately 13' above water level. Posted signs on both approaches declare bridge to be unsafe. No sign of slumping or cracks at bridge ends or below- bridge appears to be set on natural hillslope.	1. Install 2 rolling dips up the right road approach.
151	Upper Austin Creek	M	Stream crossing	39	50	0	Very small class 3 culverted crossing. Pipe is undersized and has high plug potential due to rocky terrain. Pipe is set shallow to natural channel grade and is high in the fill, with the shotgunned outlet incising through the outboard fillface. Armored fill will serve as critical dip for site 152.	1. Remove existing culvert and install an armored fill crossing using 20 yd 1.5'- rock armor (gather locally). 2. Store spoils beyond site 153. 3. Re-rock 90' of road through crossing.
152	Upper Austin Creek	M	Stream crossing	8	400	0	Culvert in a slumping cutbank/hillside setting in what may be a sandstone/serpentine contact. Culvert has a high potential to plug with colluvial sediments from an unstable hillside above. Probably cannot fit a larger culvert at this location due to near surface bedrock. Left inboard ditch is actively flowing and eroding.	1. Outslope road/keep ditch for 400' up the left road. 2. Install 2 rolling dips up the left road approach. 3. Install 2 18" x 30' ditch relief culverts up the left road approach. 4. Install a critical dip on right hingeline
153	Upper Austin Creek	M	Stream crossing	17	0	40	Abandoned short spur road leaves Upper Austin Creek Road and heads down the hill to a summer (ford) crossing on Austin Creek. Road appears to have been dipped to constrain flow within the channel.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 for decommissioning. 2. Store spoils locally along the left road approach.
154	Upper Austin Creek	M	Stream crossing	18	230	0	A very small flowing class 2 stream in very steep terrain. Channel is down to bedrock and boulder bed substrate. Culvert is set high in the fill and shotgunned, however very large armor placed around and below the outlet protect from future erosion to Austin Creek via road below.	1. Install a critical dip along the right hingeline. 2. Install 1 18" x 40' ditch relief culvert to the left. 3. Clean/cut ditch for 230' left.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
155	Upper Austin Creek	ML	Stream crossing	26	100	0	Minimal stream valley development on hillside above the road. Crossing is close to intersection with spur road, below. Flow outlets culvert at site and shortly enters another culvert, below. Both sites should be treated simultaneously.	1. Excavate TOP to BOT, replace pipe with 24" x 30' culvert at the base of fill and in natural stream axis. 2. Armor outboard fillface with 10 yd3 1-2' rock armor. 3. Install a trash rack above the pipe inlet. 4. Install a critical dip along the right hingeline. 5. Install a rolling dip at the intersection with spur road (to the left).
156	Upper Austin Creek	M	Stream crossing	7	50	180	A fill crossing on a very small, dry class 3 stream in very rocky and steep terrain. Outlet erosion on the outboard fillface is less than 5 yd3. The majority of flow and sediment transport is deposited along the inboard road with minor evidence of rilling/sheet flow across the road to an outboard fillface gully. Note: no rock volume called for as armor is available locally in the vicinity of sites 151 and 152.	1. Build an armored fill crossing: Create a broad rolling dip (maximum depth 1'), excavate a keyway 10'w at new outboard edge of the road tapering to 4'w at the base of fill. Set 15 yd3 0.5-1' rock to armor the outboard fillface and 1/3 of the road width. Note: Generate rock armor locally, in the vicinity of sites 151 and 152.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
157	Upper Austin Creek	M	Stream crossing	37	0	60	Crossing appears to have overtopped in the past. Bedrock channel above the inlet. Short, flat culvert has been smashed into an oval shape. Area below the outlet has been well armored down to the BOT. Slight diversion potential exists to the left. Left side of outboard fillface is oversteepened and will likely fail in the future. Future erosion based on crossing failure as well as left bank collapse below the BOT.	1. Excavate TOP to BOT, replace existing culvert with 24" x 40' pipe set at base of fill and in natural stream axis. 2. Armor the lower 1/4 of the outboard fillface with 5 yd3 1-2' rock armor. 3. Install a single post trash rack above the inlet. 4. Install a critical dip along the left hingeline. 5. Pull back the left bank along the outboard fillface (15'w x 15'l x 2'd = 17 yd3).
158	Upper Austin Creek	ML	Ditch relief culvert	2	50	180	A rusty ditch relief culvert, crushed at the outlet, drains a springy hillslope and a mildly insloped road. Drainage has resulted in the development of a gully on the outboard fillface. A low gradient bench 40' below the outlet causes some sediment to settle out prior to reaching Austin Creek.	1. Replace ditch relief culvert at the site with an 18" x 20' pipe. 2. Outslope road/retain ditch for 180' right and 50' left. 3. Install 1 rolling dip up the right road approach.
159	Upper Austin Creek	M	Ditch relief culvert	1	400	60	Small pipe with crushed outlet draining to low gradient bench prior to flowing into Austin Creek. Steep left approach has abundant sediment accumulation in ditch (road is mildly insloped). Increased complexity due to near surface bedrock, which may make effective dip installation problematic.	1. Replace ditch relief culvert at the site with an 18"x30' pipe. 2. Install 1 18"x30' ditch relief culvert up the left approach. 3. Outslope road/retain ditch for adjacent 100' left. 4. Outslope road/fill ditch for 300' (beyond bend in road). 5. Install 3 rolling dips up the left road approach.
160	Upper Austin Creek	M	Stream crossing	38	50	0	An adequately sized culvert set in shallow relative to stream channel grade. Outlet is high in the fill but the outboard fillface is well armored. Bedrock channel just above the inlet.	1. Install a critical dip along the left hingeline. 2. Install a trash rack above the inlet.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
161	Upper Austin Creek	HM	Stream crossing	123	400	135	Several small streams coalesce above an undersized pipe which appears to be set at or very near bedrock. An unused and partially washed out spur road "horseshoes" around the crossing (see sketch). This horseshoe section should be decommissioned and the main crossing upgraded. Below the outlet of the pipe the base of an adjacent landing is being undercut, though full excavation of this area may result in over steepening of the landing fill. To address this situation, Upper Austin Creek Road should be moved in approximately 15' to get the pipe outlet away from the left bank and to allow for a stable 2:1 outboard fillface rebuild. The left bank should be armored. The landing to the left of the site can act as an equipment/material staging area as well as a temporary spoil storage location.	1. Excavate TOP to BOT, replace existing pipe with a 30" x 60' culvert pipe set in at the base of fill and in the natural stream axis. 2. Move road in approximately 15' to get outlet away from undercut left bank and to achieve proper 2:1 rebuild angle of outboard fillface. 3. Install an "I" beam style trash rack above the culvert inlet. 4. Armor the left undercut bank (base of landing) with 5 yd3 2-3' rock armor. 5. Install 2 18"x30' ditch relief culverts up the left road approach. 6. Outslope road/retain ditch for 400' to the left. 7. Outslope road/fill ditch for 135' up the right road approach. 8. Install 1 rolling dip to the right and 3 to the left.
162	Upper Austin Creek	HM	Stream crossing	1	0	50	Two small streams (dimensions totaling 2x1) coalesce on the road bed, resulting in an active head cut which is migrating into the fill prism. This site is adjacent to site #161 on a short "horseshoe" shaped section of abandoned spur road. The area is open and easily accessible, and treatment of this site will be fast and straight forward during upgrade of site 161.	1. Excavate TOP to BOT, establish a 4' channel width and lay back sideslopes to stable 2:1 angle for decommissioning. 2. Install 1 cross road drain to the right.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
163	Upper Austin Creek	HM	Stream crossing	22	250	800	Newly installed culvert set onto bedrock and at grade. Crossing does not look to be a fish barrier. Fill slopes are near vertical, but inlet armored with a wing wall. Treatment immediacy is based upon road contribution. Left road has an 18" ditch relief culvert about 200' from site that is receiving diverted flow from site# 164. Check CMP suggest an 84" culvert, but I don't think that will fit here. Only other alternative would be to install a bridge.	1. Outslope right road and fill ditch for 800' and install 5 rolling dips. 2.Install 1 rolling dip up left road.
164	Upper Austin Creek	HM	Stream crossing	24	285	0	A small stream has plugged the small, flat culvert currently at crossing. Flow travels 30' to the right before exiting via a 12" ditch relief culvert. This road is directly above Austin Creek and may be a full bench road on bedrock. Culvert is shotgunned but outlets onto bedrock and may be set as deep as possible. Treatment immediacy due to diversion, connected road length, and proximity to Austin Creek.	1. Excavate crossing from TOP to BOT to replace culvert with a 24" x 30' long culvert set in at channel grade. 2. Install a 24" x 10' long full round downspout. 3. Armor lower 3/4 of outboard fill face with 5yds3 of 1'-2' rock. 4. Install a critical dip along right hingeline of crossing. 5. Outslope road and fill ditch for 100' along left road and install 1 Rolling Dip. 6. Install a 18" x 30' long ditch relief culvert at intersection.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
165	Upper Austin Creek	HM	Stream crossing	512	380	0	Multiple flood terraces above crossing indicate high sediment transport and that crossing has failed in the past. Fill directly below outlet is well armored, but side slopes are actively failing. Culvert is high in fill and set shallow relative to channel grade. Stream is currently flow at TOP flag and at base of armor below outlet. Armor around outlet can be re-used.	1. Excavate crossing from TOP to BOT and replace culvert with a 36" x 70' long culvert, set in at channel grade. 2. Install a trash rack. 3. Armor lower 1/4 of outboard fillslope with 15 yds3 of 1'-2' rock. Can re-use armor below outlet for some of the volume. 4. Install a critical dip along right hingeline. 5. Outslope left road and fill ditch for 380' and install 2 rolling dips.
166	Upper Austin Creek	HM	Stream crossing	387	195	0	Small, flat, short culvert with 1/2 round downspout drains stream with abundant woody debris in the channel. Part of the outboard fillface is armored, while the unarmored portion is oversteepened (>50 degrees), bare, and actively eroding into the stream channel. Diversion potential to the right. Approach is steep and connected via the inboard ditch.	1. Excavate TOP to BOT, replace pipe with 24"x90' culvert set at the base of fill and in the natural stream axis. Clean woody debris from channel as much as possible above the TOP. 2. Armor the lower 1/4 of the outboard fillface with 20 yd3 2'- rock armor. 3. Install a trash rack above the culvert inlet. 4. Install a critical dip along the right hingeline. 5. Outslope road/fill ditch for 195' up the right road approach. 6. Install 1 rolling dip up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
167	Upper Austin Creek	HM	Stream crossing	147	1,500	0	Culvert set shallow relative to channel grade. Pipe is short and set high in the fill. Outlet is shotgunned about 6' over the outboard fillface, with fill failing around the bedrock scour area beneath the outlet.	1. Excavate TOP to BOT, replace culvert with 24" x 60' pipe set in at channel grade and in the natural stream axis. 2. Armor the outboard fillface with 10 yd3 1-2' rock armor. 3. Install a trash rack above the inlet. 4. Outslope road/retain ditch for 1500' up left road approach. 5. Install 10 rolling dips left. 6. Install 3 18"x30' ditch relief culverts up the left road approach. 7. Clean/cut/define ditch where needed up the left road approach.
168	Upper Austin Creek	No treat	Stream crossing	0	0	0	Ford crossing on Austin Creek. No road fill along either road length. Road travels along flood plain of Austin Creek.	No treatment.
169	Upper Austin Creek	No treat	Stream crossing	Road surface only	20	0	Short channel length (~50') above the road. Stream comes down hill and intersects road on flood plain of Red Slide Creek. No road fill here. Site is near property gate.	No treatment.
170	Upper Austin Creek	L	Stream crossing	0	300	0	Unused ford crossing on Austin Creek. Left road approach is completely grassed over, though springy and wet. Right road approach is on flood plain of Austin Creek until site# 261.	1. Install 4 cross road drains along left road length.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
171	Upper Austin Creek	M	Stream crossing	83	850	0	Ford crossing on Austin Creek. Both left road approaches are grassed over. Approximately 250' of road travels along the bank of a class 2 creek, which appears to have the potential to erode the outboard fillface for about 150' (see sketch).	1. Pull back upper 150' of outboard fill along the left road approach where class 2 stream is undermining the road fill. 2. Install 3 cross road drains along this 150' stretch. 3. Install 4 cross road drains along 600' stretch of other left road approach. 4. Install 4 cross road drains along spur road off of left road.
172	Upper Austin Creek	L	Landslide	Road surface only	450	80	This appears to be an on-going slow failure of some road fill as well as native material in a swale setting between Upper Austin Creek Road and Austin Creek. Several scarp/tension crack features are visible on the partially washed out road bed. While some surface flow is apparent, no clear bed and bank morphology exists. Near surface bedrock in the vicinity of the site. Check site evaluation 2/18/10: Natural slide feature, no treat.	1. Install 6 cross road drains along left road reach.
173	Upper Austin Creek	HM	Stream crossing	107	0	655	Washed out stream crossing on abandoned section of road. Almost all of the left approach is gone. Road fill slope along both banks are near vertical. Area shows signs of recent shallow fill failures. Right road approach is completely grassed over.	1. Excavate remaining fills on both banks. 2. Spoil along right road. 3. Install 8 cross road drain up right road.
174	Upper Austin Creek	M	Stream crossing	26	0	150	Old abandoned road just below drive road. Crossing is just below site# 138. Stream is currently diverted into old wooden box culvert. Significant stable gully from outlet down hillside. Gully is about 15' to the left of natural channel. Older gully exists at inlet from diverted flow from site# 140.	1. Excavate crossing from TOP to BOT for decommission by laying fill slope back to 2:1 angle. 2. Spoil locally. 3. Install 2 cross road drains up right road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
175	Upper Austin Creek	HM	Stream crossing	18	20	0	A 60% plugged culvert drains directly into Austin Creek. Main problem here is cutbank slides to the left of the site have been excavated and sidecast into the flow path of this stream. Also, the culvert is set high in fill and is creating an active gully.	1. Replace culvert with a 24" x 30' long culverts set in at channel grade. 2. Armor lower 3/4 of outboard fill slope with 10yds3 of 1'-2' rock. 3. Install a trash rack.
176	Upper Austin Creek	M	Stream crossing	Road surface only	250	470	Ford crossing on (seasonal use spur) Austin Creek. Majority of left road is on minimal slope. Right reach is very spring, but because of seasonal use no ditch is needed.	1. Outslope road and fill ditch for 250' up left road and install 1 rolling dip. 2. Outslope road and fill ditch for 470' up right road and install 3 rolling dips.
177	Upper Austin Creek	M	Stream crossing	14	230	0	A small stream (just below site# 154) is diverted 40' to the right before being drained by a 12" culvert. Although the stream is diverted there is near surface bedrock in the ditch and in channel below the road and current culvert location seems appropriate.	1. Replace culvert with a 24" x 30' long culvert set in at channel grade. 2. Install a critical dip along right hingeline. 3. Outslope road and fill ditch for 230' up left road and install 1 rolling dip.
178	Upper Austin Creek	M	Stream crossing	10	100	0	Inlet of culvert is 20% plugged with rocks that were placed around inlet and from rock lined channel above. Crossing is just below site# 155. Culvert is shallow and short. Gully beyond outlet is rocked lined. Armored fill is called for because road is seasonal use.	1. Install an armored fill crossing using 10yds3 of 1'-2' rock. 2. Outslope road and fill ditch for 100' up left road.
179	Upper Austin Creek	L	Stream crossing	1	0	75	Short road terminates at water infrastructure in creek. Small amount (1yds3) of perched sediment on right bank could be removed.	1. Excavate 1yds3 of perched material from right bank. 2. Spoil locally.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
180	Upper Austin Creek	HM	Stream crossing	10	0	80	Small class 3 culverted crossing. Undersized pipe set high in the fill and shallow relative to channel grade. Single post trash rack installed to the right of the inlet. Some road surface rilling from site 181 contributes to the crossing. Outlet is shotgunned but directs flows to large boulders, limiting outboard fillface erosion.	1. Install an armored fill crossing: Create broad dip through crossing, lowering road a maximum of 2'. At new outboard edge of road excavate a keyway 10' wide tapering to 4' at the base of fill. Set 15 yd3 of 0.5-1' rock armor on outboard fillface and 1/3 into road bed. Generate rock armor locally (additional 1 hour/each dozer and excavator to gather local armor). 2. Outslope road/retain ditch for 80' to the right (site 181).
181	Upper Austin Creek	ML	Stream crossing	9	0	60	Rocky stream channel above and below the crossing. Culvert appears to be set well relative to natural channel grade. Stream channel stair steps down hillside. Plumbing parallel to channel on left bank, likely outside influence of treatment area.	1. Install an armored fill at the crossing: Remove the existing culvert, create a broad dip through the crossing. At the new outboard edge of the road, create a 10'w keyway tapering to 4' at the base of fill. Set 10 yd3 1-2' rock armor, available locally, to armor the outboard fillface and the outer 1/3 of the road tread. At a minimum the site should have a critical dip for diversion protection. 2. Outslope road/fill ditch for 60' up the right approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
182	Upper Austin Creek	M	Stream crossing	12	80	60	Small fill crossing with minimal road fill. Roadbed is outsloped, and stream flow is currently gullying (2'w x 1'd) down a rocky outboard fillslope. Stream flow above the road comes from multiple areas, so it is best to create a very broad dip through the crossing area and align the axis approximately 25' down the left road approach from the current location. An 80' spur road to the left provides access to a spring box.	1. Install an armored fill crossing: Create a broad dip through the crossing area, lowering the road to a maximum 2' depth. Align the axis of the dip 25' down the left road to capture multiple channels. At the new outboard edge of the road create a 20'w keyway tapering to 4' at the base of fill. Armor the outboard fillface and the outer 1/3 of the road tread with 25 yd3 1-2' rock armor. 2. Outslope road/fill ditch for 80' along spur road located left of the site to the spring box.
183	Upper Austin Creek	HM	Landslide	60	0	80	Deep seated landslide in grassland setting with Spur 5 cutting through feature above channel initiation of 2'w x 1'd class 2 stream (20' below the road). Landslide is active and will continue to slump onto road from above and fail below, delivering to the stream. No treatment to the feature is cost effective, nor will it mitigate continued movement. Best treatment is to dewater the feature and road. Future erosion includes continued delivery to the stream by existing gullies (combined) enlarging through the feature plus some loss of the roadbed. Road will continue to require maintenance to keep open as slide continues to move.	1. Outslope road/retain ditch for 80' to the right (to site 183.1). 2. Install 1 rolling dip up the right road approach between sites 183 and 183.1 to more stable ridge between 2 near origin streams.
183.1	Upper Austin Creek	HM	Landslide	6	0	320	Part of the same landslide detailed in site 183. Failure on outboard edge of road delivers to the stream initiation point approximately 20' below the road. Future erosion includes continued enlargement of the gully above the channel initiation point. As stated in description of #183, no realistic mitigation of the slide movement is possible but hydrologic ally disconnecting the right road approach will result in decreasing the gully enlargement.	1. Outslope road/retain ditch for 320' right. 2. Install 2 rolling dips up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
184	Upper Austin Creek	ML	Stream crossing	Road surface only	220	0	Low gradient stream channel crosses roadbed with very little gradient change. Tree branches have fallen into channel above the road and caused some flow to divert down the right road reach.	1. Use dozer to dip out the ford crossing into a broader dip down the right road reach to capture any diverted flow. 2. Outslope road/fill ditch for 220' and install 1 rolling dip up the right road approach.
185	Upper Austin Creek	ML	Spring	25	150	400	Springy, slumped grassland setting. Left and right road reaches converge in a swale that develops into a class 3 stream below. Both road approaches are grassed over. Future erosion is outboard fillface failure through the swale, though there appears to be minimal chance of it failing.	1. Outslope road/fill ditch for 150' up the left road approach and 400' up the right road approach. 2. Install 1 rolling dip to the left and 2 rolling dips right.
186	Upper Austin Creek	M	Stream crossing	6	0	0	Near origin class 3 stream in grassland setting. Outboard fillface is slumping and cracking due to hummocky nature of hillside. Fill crossing with small sediment fan above the inboard road. Diversion potential in either direction.	1. Install an armored fill crossing: Create a broad dip through the crossing, lowering the road a maximum of 2'. Excavate a keyway 10'w at the new outboard edge of the road tapering to 4' at the base of fill. Set 15 yd3 0.5-1' rock to armor the keyway including the outer 1/3 of the roadbed and the outboard fillface. If possible generate rock locally. 2. Spoil locally.
187	Upper Austin Creek	ML	Stream crossing	27	0	75	Culverted crossing in a grassland setting. Culvert has been set in shallow relative to channel grade, though it appears properly sized. Entire grassland setting is slumping. Outboard road on right side of outlet is experiencing an accelerated failure rate due to the shotgunned pipe outlet.	1. Armor below the outlet and the outboard road to the right of the culvert with 10 yd3 1-2' rock armor; generate locally. 2. Outslope road/fill ditch for 75' up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
188	Upper Austin Creek	H	Stream crossing	6	2,100	0	Flowing class 2 stream with undersized though otherwise good condition culvert. Channel is incised above the crossing with tight meanders and large 1-3' boulder steps. Channel grade is much gentler below the crossing. Pipe is set okay in the fill and in line with the channel axis. Not much fill at the crossing. Very long left road length contributes to the site, hence high treatment immediacy.	1. Excavate TOP to BOT, remove existing culvert pipe. 2. Create ford crossing by dipping out the crossing and laying back the sideslopes to 4:1 (wherever possible). Spoil locally. 3. Outslope road/retain ditch for 1000' to the left. 4. Install 14 rolling dips up the left road approach.
189	Upper Austin Creek	M	Stream crossing	2	80	0	Culverted stream crossing with completely buried culvert inlet. Stream flow currently diverts 20' outside natural channel and gullies for 60' before reentering the natural channel. Minimal road fill, road is outsloped.	1. Install an armored fill crossing: Create a broad dip through the crossing, lowering the road a maximum of 2'. At new outboard edge of the road excavate a 10'w keyway tapering to 4' at the base of fill. Set 10 yd3 of locally generated rock armor to armor the outboard fillface and the outer 1/3 of the road. Store spoils locally.
190	Upper Austin Creek	M	Stream crossing	2	1,200	0	Intermittently flowing Class ll stream on abandoned road. Flow goes subsurface through washed out crossing. Very little road fill here. Long road length but majority is grown over.	1. Remove culvert and install an Armored fill crossing using local rock. 2. Outslope road and fill ditch for 1,000' up left road and install 8 rolling dips.
191	Upper Austin Creek	HM	Spring	Road surface only	1,700	0	Virtually all of the portions of spur 5 road (from site# 180 on one portion and 188 on the other portion) connects to this ditch relief culvert. A ditch has been cut across tool yard to concentrate flow from road lengths to inlet. Treatment immediacy is due to road length.	1. Outslope road and fill ditch for 500' up road to site# 188 and install 2 rolling dips. 2. Outslope road and fill ditch for 1,700' up road to site# 180 and install 8 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
192	Upper Austin Creek	M	Ditch relief culvert	3	240	0	Excessive road drainage through small, low gradient ditch relief culvert. Abundant woody debris placed in gully below the outlet (pipe has short 1/2 round downspout). This debris limits full visual inspection of gully base, but expansion seems likely. Sideslopes are steep and could be laid back. Road is insloped with prominent berm at outboard edge of road. A small diverted stream (site 193) is contributing to ditch flow. Several small past diversion gullies up the left approach.	1. Clear woody debris from outboard fillface, lay back side slopes to 2:1 angle (where possible). Store spoils locally. 2. Place 5 yd3 0.5'- rock armor on gully base. 3. Replace ditch relief culvert at the site with an 18"x40' culvert. 4. Install 1 18"x30' ditch relief culvert up the left approach. 5. Outslope road/retain ditch for 240' up the left road approach and remove berm. 5. Install 2 rolling dips up the left approach.
193	Upper Austin Creek	M	Stream crossing	17	60	0	Stream currently diverted into the inboard ditch and connected to a ditch relief culvert at site 192. Abandoned road prism above crossing is causing erodible step in channel.	1. Excavate TOP to BOT, replace existing culvert pipe with a 24" x 50' culvert at the base of fill and in the natural stream axis. Store spoils locally. 2. Install a trash rack above the inlet. 3. Install a critical dip along the right hingeline. 4. Outslope road/remove ditch and remove outboard berm for 60' up the left road approach.
194	Upper Austin Creek	ML	Ditch relief culvert	Road surface only	180	0	Ditch relief culvert drains a springy, slumping hillslope above. Older abandoned road above has been almost entirely washed away by past stream diversions coming down the Upper Austin Creek Spur 7 Road.	1. Outslope road/retain ditch for 130' up the left approach to site 195. 2. Remove berm for 120' left.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
195	Upper Austin Creek	M	Stream crossing	48	65	0	Culvert is short but not shotgunned. Streamflow beyond outlet appears to be meandering through fill though area looks stable for 30' down from outlet. Channel then has a 6' near vertical headcut.	1. Replace culvert with 24" x 50' culvert set at channel grade and in natural stream axis. 2. Endhaul spoils. 3. Install a trash rack above the inlet. 4. Install a critical dip along the right hingeline.
196	Upper Austin Creek	HM	Stream crossing	167	125	0	A fairly large stream with a small tributary just upstream of the TOP, where a water supply line is located next to a 2' diameter redwood. A small quarry pit is located to the right on the inboard road with a small spoil pile stockpiled near the pipe inlet. Culvert pipe is 1/2 plugged at the inlet with a rusted base and it appears flow is starting to headcut into the road width. In addition, the pipe is small, short and high in the fill and installed at a shallow angle relative to channel grade. The road approach is steep and insloped, and the springy ditch overflows onto the road bed. A diverted stream (site 197) is adding significant flow to this ditch. The outboard fillface is heavily vegetated, but appears to be gullied by streamflow with oversteepened banks. Diversion potential will be addressed through installation of a critical dip at site 195.	1. Excavate TOP to BOT, replace existing pipe with a 36"x60' culvert set in at the base of fill and in the natural stream axis. Store spoils locally. 2. Install a trash rack above the inlet. 3. Outslope road/retain ditch for 125' to the left. 4. Clean ditch for 125' left. 5. Install 1 rolling dip up the left road approach.
197	Upper Austin Creek	HM	Stream crossing	76	410	0	Streamflow currently diverted into the inboard ditch and flowing to site 196. Original channel below the road has been skidded, most likely to access rock outcrop adjacent to the BOT flag. Flow emerges in original channel at BOT.	1. Install a 24" x 60' culvert set at the base of fill and in the natural stream axis. 2. Install a trash rack above the inlet. 3. Install a critical dip along the right hingeline. 4. Outslope road/retain ditch for 410' up the left road. 5. Install 2 18"x35' ditch relief culverts up the left road approach. 6. Install 2 rolling dips up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
198	Upper Austin Creek	HM	Ditch relief culvert	3	1,381	0	Ditch flow to small plastic pipe above springy swale/class 3 stream initiation. Small, well vegetated gully may expand if site is left untreated. Cutbank above left approach is springy and slumpy. Approximately 581' of Upper Austin Creek Road delivers to this site, of which approximately 240' is through cut and will be problematic to drain. Approximately 800' of Upper Austin Creek Spur 9 Road is hydrologically connected to this site as well.	1. Replace the ditch relief culvert at the site with an 18"x30' pipe. 2. Install 1 18"x30' ditch relief culvert up the left road approach. 3. Outslope road/retain ditch for 300' of non through cut portion of left approach. 4. Install 2 rolling dips up the left approach and remove berm for 100'. 5. On Upper Austin Creek Spur 9 Road, outslope road/fill ditch for 800' and install 5 rolling dips.
199	Upper Austin Creek	HM	Stream crossing	150	115	90	Steep active stream with abundant water supply infrastructure above and below crossing. A pond has been built in the channel 20' above inlet of culvert. Inlet of culver is a box 36" concrete culvert and outlet is a round 48" concrete culvert. Culvert is short and set shallow relative to channel grade. Half round downspout at outlet is not helping much to transport flow.	1. Excavate crossing from TOP to BOT to replace culvert with a 36" x 60' long culvert, set in at channel grade. Will need to rebuild plumbing infrastructure upon rebuild of crossing (4hrs labor). 2. Install trash rack. 3. Outslope road, fill ditch for 90' up left road. 4. Outslope road, fill ditch for 110' up right road.
200	Upper Austin Creek	ML	Stream crossing	39	0	50	Crossing is about 40' down slope from another culverted crossing (grassy hillslope between). Difficult to determine the true BOT as slope to the left is associated with the outboard fill of site 199 and the slope to the right is a hummocky landslide feature. Note: this crossing may be a good candidate for an armored fill with landowner approval.	1. Excavate TOP to BOT, replace culvert with 24"x40' culvert pipe set at the base of fill and in the natural stream axis. 2. Install a critical dip along the left hingeline.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
201	Upper Austin Creek	M	Stream crossing	11	0	350	Inlet of the culvert is about 80% plugged with sediment. Shallow fill at crossing be result in difficulty installing a 24" culvert. Steep right road approach may make critical dip installation problematic. This site is a good candidate for an armored fill crossing, with landowner approval.	1. Excavate TOP to BOT, replace existing culvert with 24"x40' culvert pipe set in at the base of fill and in the natural stream axis. 2. Install a critical dip on the left hingeline. 3. Install a trash rack above the inlet. 4. Outslope road/fill ditch for 350' up the right road approach. 5. Install 2 rolling dips up the right road approach.
202	Upper Austin Creek	M	Stream crossing	7	0	40	A small near origin stream high in the watershed is eroding through the fill of a low to no use road. Above the road the stream morphology is diffuse, with several small channels flowing through a springy-swale setting. The presence of a large water storage tank at the end of this road (100' left of the site) suggests landowner necessity of this road. Otherwise this would be a good decommissioning candidate. Access will be challenging, as the road is very steep (40% +) to the right of the site. In the absence of the large water tank this road would likely be considered a skid due to the steep angle, narrow width, and relatively little amount of road fill.	1. Install an armored fill crossing: Create a broad dip through the crossing, lowering the road a maximum of 2'. At the new outboard edge of the road, create a 15'w keyway tapering to 4' at the base of fill. Place 15 yd3 0.5-1.5' rock to armor the outboard fillface and the outer 1/3 of the road width. If at all possible save the oak tree on the outboard fillface.
203	Upper Austin Creek	M	Road drainage discharge point	4	0	250	Approximately 250' of through cut road length exits road bed and gullies to the headwall area of a class 3 stream. Road bed is moderately rilled. A completely plugged 8" PVP pipe under the road bed may be draining the upper pasture area.	1. Outslope road/ and cut ditch for 250' (towards the lower fence) up the right road approach. 2. Where the ditch exits the road (above class 3 stream) build a 10'w x 2'd x 20'l sediment catchment basin. 3. Dip road to funnel flow to the basin. 4. Place rock armor on the outlet of the basin down to the stream.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
204	Upper Austin Creek	L	Road drainage discharge point	2	80	340	Some road drainage and abundant building pad runoff drains to the very top of a well vegetated swale. The adjacent building appears to be fairly new, and the bare dirt entering the swale via rills and small gullies may be stabilized by natural vegetation before long. Also, this site is high enough in the watershed that most fine sediment will likely be retained in the swale's vegetation prior to reaching the stream initiation point. Future erosion estimate based on expansion of numerous rills/small gullies.	1. Install 1 cross road drain to the left and one to the right. Make the drain to the right parallel to the ridge, essentially a long, broad berm. 2. If area is still bare during implementation seed and straw all bare soil. 3. Install 1 rolling dip on main (rocked) road between site 203 and the house.
205	Upper Austin Creek	M	Road drainage discharge point	15	700	0	Flows from a midslope road (475') and a ridge nose skid (225') have resulted in a fairly large gully, which appears to connect downstream with a stream detailed in site 167 and 206. The gully appears somewhat stable- future erosion estimate based on continues migration of the headcut into the road.	1. Layback gully headcut and perched fill at the outboard edge of the road to 2:1, spoil locally. 2. Install 3 rolling dips up the left road approach (past the landing to the gate). 3. Outslope road/fill ditch for 475' up the left road approach. 4. Install 3 cross road drains on the skid road up the ridge nose.
206	Upper Austin Creek	ML	Stream crossing	3	100	0	Small fill crossing. Very little cutbank where road crosses stream. Area looks to be toe of old landslide feature. Stream channel deeply incised below the road.	1. Install an armored fill crossing using 5 yd3 1-2' rock armor. 2. Install 1 rolling dip up the left road approach.
207	Upper Austin Creek	HM	Stream crossing	62	450	0	Stream crossing in hummocky grassland setting. Stream channel appears to define right hingeline of landslide feature. Near vertical fillslope beyond culvert outlet. The 10" diameter asbestos culvert pipe is too short, set high in the fill, and is 60% plugged. Bedrock channel above the inlet. Difficult to determine the natural channel below the outlet- used stump on left bank as best indicator.	1. Install an Armored fill crossing 15' top width and 4' bottom wide using 10yds of 1'-2' rock. 2. Outslope road/fill ditch for adjacent 450' of left road approach. Do not outslope across grassland area. 3. Install 3 rolling dips left.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
208	Upper Austin Creek	HM	Landslide	134	20	0	Perched fill on the right hinge of site 207, this future fill failure is located on a ridge nose with bedrock visible 4-8' below the ground surface. Proceeding out the ridge nose the fill thickens to as much as 24' before tapering to natural hillslope at a 2' diameter oak tree (END flag). Some excavation/erosion volume may overlap with site 207. Right approach, while technically not connected to the site, is ponding water on the roadbed due to berm at the outboard edge of the road.	1. Excavate all unstable fill off of ridge nose between START and END flags (75'w x 4'd x 12'l = 134(1.2) = 161 yd3). 2. Incorporate spoils into outsloping road to the left of site 207. 3. Pull berm located to the right of the site which is currently causing water to pond on the road surface.
209	Upper Austin Creek	HM	Stream crossing	55	30	0	This culverted crossing is completely buried and functioning as a fill crossing. Stream currently diverts to the right for 30' before gullying down the hillslope (3'w x 1'd x 50'l). Fractured bedrock at the bottom of corrugated metal siding (used as downspout) indicates stable BOT location.	1. Excavate TOP to BOT, replace existing pipe with 24" x 40' culvert set at the base of fill and in the natural stream axis. 2. Armor the outboard fillface with 10 yd3 1.5'- rock armor. 3. Install a trash rack above the inlet. 4. Install a critical dip along the right hingeline.
210	Upper Austin Creek	M	Landslide	107	40	0	Unstable fill to the right of the diversion gully (site 209). Fill failure will deliver directly to stream channel below, though some sediment may be retained on the natural hillslope.	1. Excavate unstable road fill between START and END flags (40'w x 4'd x 20'l = 119(1.2) = 143 yd3. 2. Haul spoils 1000' to the landing up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
211	Upper Austin Creek	H	Other (gully)	925	0	800	Overflow culvert drains pond (and watershed above) outside of natural stream channel. Over flow has caused a massive (100' x 25' x 100') gully that intersects small class ll stream valley. Overflow continues down stream channel, it has completely eroded though one road full crossing and is currently eroding through another (see site# 212 & 213). Overflow has cause natural stream valley walls to erode for about 500' down to site# 195. Two long steep skid roads account for right road contribution which have no waterbars and used year-round.	1. Remove culvert and back fill area to prevent pond flow from entering gully below. 2. Install an 30" diameter overflow pipe within natural channel area (about 140' down left road from current culvert). Install 20' long section under road along pond and then install a 110' long downspout down to natural stream channel. Culvert will need to be installed under lowest road to allow access. 3. Install an elbow to outlet to orient flow down natural channel. 4. Install 10 waterbars up right roads/skids.
212	Upper Austin Creek	HM	Other (gully)	891	105	0	Lower extent of site 211, where flow from the pond combines with flow from a small stream (with road surface contributions) and has gullied through old spur roads. Future erosion estimates include left bank (100'w x 12'l to 1:1 = 267 yd3), right bank (50 yd3 inaccessible for treatment + 50'w x 23'l x 10'd = 426 yd3, to be excavated) and 2 sediment lobes totaling approximately 150 yd3 in the channel. Check site feedback: realistic excavation amount will be lower than original 1330 yd3 estimate; determine spoils management based on landowner input (likely use to further buttress dam); keep immediacy the same (HM) as channel will not be fully dewatered.	1. Excavate unstable fill from the left bank, laying back to 2:1 wherever possible (70'w x 12'l = 374 yd3). 2. Excavate unstable fill from right bank where accessible (50'w x 23'l x 10'd = 426 yd3); may be best accessed from site 213 (downstream). 3. Endhaul spoils to stockpile location up left road (determine with landowner input- possibly at base of dam). 4. Install 1 cross road drain up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
213	Upper Austin Creek	H	Stream crossing	98	40	0	Partially washed out stream crossing with large overturned stump in the middle of the old road in the center line of the channel. Currently a short 18" asbestos culvert is draining the majority of the flow. The culvert is actively eroding the outboard fillface, which appears to consist of fine grained sediment and large woody debris. Right bank is actively slumping, with 3-5' vertical displacement. Right bank failure is mostly due to excessive flow from site 211, but could be part of a larger deep-seated feature.	1. Excavate TOP to BOT, establish a 5' channel width and layback sideslopes to 2:1. 2. Endhaul spoils, location to be determined with landowner input.
214	Upper Austin Creek	HM	Landslide	454	250	0	Currently failing outboard fillface along the left bank of a class 2 stream. Road was built along the nose of a ridge between 2 channels. Fill failure is likely due to increased flows from the diverted pond flow detailed in site 211. Right hinge of failure is at the BOT of site 213.	1. Excavate the outboard fillface from START to END flags (150'w x 4'd x 20'l). 2. Stockpile 134 yd3 along the ridge nose and endhaul 400 yd3 approximately 1000' to location yet to be determined (will identify with landowner input).
215	Upper Austin Creek	ML	Stream crossing	4	30	130	More of a springy wet swale above road, that develops into a class lll stream below. Crossing is currently being drained by an 8" PVC pipe. Right road length is a through cut for 100'.	1. Install an armored fill crossing using 15yds3 of 1'-2' rock. 2. Install 1 rolling dip above through cut.
216	Upper Austin Creek	M	Stream crossing	14	230	250	Small stream, which has incised through past slump deposits. Future erosion based on possible gully through road and bank collapse down stream.	1. Install an armored fill crossing using 10 yds3 of 1'-2' rock. 2.Outslope left road and fill ditch for 230' and install 1 rolling dip. 3. Outslope right road and fill ditch fro 250' and install 2 rolling dips. 4. Layback side slopes to 2:1 for 25' below armored fill.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
217	Upper Austin Creek	M	Ditch relief culvert	Road surface only	615	0	Ditch relief culvert draining diverted stream flow from site# 218, 265' of Spur 9 road, and 350' of spur 9.1 roads. Upper 100' of spur 9 road looks to travel across toe of slow moving deep seated landslide and is insloped due to rotational movement of feature. Spur 9.1 travels up to water tank.	1. Along spur 9 road outslope road and fill ditch for 265' and install 2 rolling dips (one just below intersection and one at site). 2. Along spur 9.1 road outslope road and fill ditch for 350' and install 2 rolling dips.
218	Upper Austin Creek	M	Stream crossing	12	120	0	Springy swale that develops into a class lll stream below road. Spring flow is currently diverted down inboard ditch for 265' to site# 217.	1. Install an armored fill crossing using 15 yds3 of 1'-2' rock. 2. Outslope left road and fill ditch for 120'.
219	Upper Austin Creek	M	Spring	Road surface only	200	0	Dry swale above road that develops into a class lll stream below road. When swale is wet, spring flow diverts down inboard ditch and ultimately to site# 217	1. Install an armored fill crossing using 15 yds3 of 1'-2' rock. 2. Outslope left road and fill ditch for 200' and install 1 rolling dip.
220	Upper Austin Creek	HM	Stream crossing	39	225	0	Small stream diverted for 80' before gullying down natural hillslope to Austin Creek. Future erosion based on continued gully expansion.	1. Install an armored fill crossing using 20 yds3 of 1'-2' rock. 2. Outslope left road and fill ditch for 225' and install 2 rolling dip.
221	Upper Austin Creek	H	Stream crossing	32	200	0	This is one of at least 3 streams that are currently diverted into inboard ditch (not sure how many because property boundary is 60' up left road from site). Creek flow exits inboard ditch 100' down right road via 18" culvert and has created a large (40' x 20') gully down nose of spur ridge.	1. Excavate crossing from TOP to BOT to install a 24" x 40' long culvert, set in at channel grade. 2. Install a 30' long full round downspout to outlet. 3. Install a trash rack. 4. Install a critical dip along right hingeline. 5. Outslope left road and keep ditch for 60' (property boundary).

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
222	Upper Austin Creek	HM	Stream crossing	63	0	450	Culverted crossing currently diverts flow into older mature gully. Inlet of culvert is an 8" concrete culvert and outlet is a 10" plastic culvert. Culvert is on lower hingeline of springy swale.	1. Replace culvert with 24" x 50' long culvert. Install outlet in natural channel to the right of current outlet. 2. Install 20' long full round downspout to outlet. 3. Install a trash rack. 4. Install a critical dip along left hingeline. 5. Install an 18" x 30' long ditch relief culvert 50' up right road to drain springy swale. 6. Outslope right road and fill ditch for 450' and install 3 rolling dips.
223	Upper Austin Creek	M	Ditch relief culvert	3	0	305	Small ditch relief culvert drains 305' of road and springy inboard ditch. A gully has developed down outboard fill face below outlet.	1. Replace culvert with an 18" x 30' long ditch relief culvert. 2. Install an 18" x 30' long ditch relief culvert up right road approach. 3. Outslope right road and keep ditch for 305' and install 2 rolling dips.
224	Upper Austin Creek	M	Stream crossing	60	0	115	A small but active stream has incised through unstable slide material upslope before being drained by a flat, short, small culvert. Flow from a previously plugged ditch relief culvert to the right (site#223) has gullied through road fill and delivered to the outlet of this site.	Per check site evaluation 6/2/10: 1. Install an armored fill: Lower road surface 1', at the new outboard edge of the road excavate a 15' wide keyway tapering to 4' wide at the base of fill. Place 20 yd3 1-2' rock armor on the keyway and outer 1/3 of the roadbed. Store spoils locally. 5. Outslope right road and fill ditch for 115' and install 1 rolling dip.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
225	Upper Austin Creek	M	Landslide	52	0	30	Entire road length from site# 224 to 226 looks to travel across an older slow moving toe of a landslide. One continuous scarp exists along outboard fill from site# 224 to 226. Hillslope undulates below scarp to confluence of both class ll streams. Trees growing on toe of slide above road look relatively straight. Cutbank all along swale is weeping.	1. Pull back outboard fill from start (site# 226) to end (site# 224) flags. 35' x 2' x 20' 2. Endhaul spoil up right road to intersection
226	Upper Austin Creek	M	Stream crossing	17	0	30	Stream channel above road looks to be incising through toe of older slow moving landslide feature. Stream drains into small culvert that looks to plug frequently and thereby divert flow down to site# 227.	1. Remove existing culvert. 2. Install an armored fill crossing using 20 yds3 of 1'-2' rock.
227	Upper Austin Creek	M	Spring	3	25	80	A small plastic pipe which appears to have plugged in the past drains a very springy, slumpy hillslope. Approximately 40' left of the current culvert is either a diversion gully or beheaded natural stream channel. This low point along the road is currently getting road surface flow from the landing to the left and road to the right. Most inboard ditch flow goes to inlet of pipe.	1. Replace pipe with an 18" x 30' long ditch relief culvert with a 10' long full round downspout. 2. Pull back steep left fillslope and spoil on landing. 3. Cut inboard ditch from inlet 90' up right road and 20' up left road.
228	Upper Austin Creek	M	Stream crossing	26	60	120	Culverted crossing in grassland setting. Right road approach is very springy and wet. Ditch relief culvert on right approach is currently draining springy cutbank. Outlet of ditch relief culvert gullies for 70' to the stream. Culvert at crossing is shallow and short. Length of culvert has caused outboard fill failure around outlet. Culvert is separated.	1. Remove existing culvert at crossing and install an armored fill using 15yds3 of 1'-2' rock. 2. Inslope road and cut ditch for 100' up right road to drain springy hillslope. 3. Plug ditch relief culvert that is currently draining springy hillslope.
229	Upper Austin Creek	M	Stream crossing	12	0	435	There is 435' of road, 180' of which is located within the property boundary, delivers to a small stream. Road is unnecessarily wide here and rock costs can be reduced by removing 80yds3 from outboard fill, essentially moving road in 10'.	1. Move road in by excavating outboard fill (80yds3). 2. Spoil down left road. 3. Install an armored fill crossing using 15yds3 of 1.5' rock. 4. Outslope road and fill ditch for 100' up right road and install 1 rolling dip.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
230	Upper Austin Creek	M	Ditch relief culvert	3	0	270	Ditch relief culvert at intersection with Spur 6 road. Culvert is mostly just draining 30' of springy inboard ditch. From outlet flow gullies hillside for 60' down to Austin Creek.	1. Outslope road and cut ditch for 30' from inlet and then outslope road and fill ditch for another240'. 2. Install 2 rolling dips. 3. Replace culvert with an 18' x 30' ditch relief culvert.
231	Upper Austin Creek	M	Stream crossing	3	450	60	Ford crossing on Austin Creek. Left road has on ditch relief culvert (concrete 10") that has a gully from outlet for 70' down to Austin Creek. Cutbank is springy and road gets minimal use.	1. Outslope and cut ditch for 450'. 2. Install two 18" x 30' long ditch relief culverts. 3. Install 3 rolling dips.
232	Upper Austin Creek	ML	Stream crossing	18	0	150	Lower extent of stream detailed at site# 165. Culvert set on bedrock. Check CMP indicates that culvert is oversized for 100 year storm event. Ford crossing on Austin Creek is 50' to the left, hence no critical dip is needed. Site# 165 culvert is about 50' up channel from this site, hence not trash rack is needed.	1. Outslope road, fill ditch and remove berm for 150' up right road and install 1 rolling dip.
233	Upper Austin Creek	M	Road drainage discharge point	Road surface only	270	120	Springy cutbanks place flow onto roadbed where it is currently rilling road surface. Minimal road fill at site.	1. Outslope road and cut ditch for 270' up left road, install two 18" x 30' long ditch relief culverts, and install 2 rolling dips. 2. Outslope road and cut ditch for 120' up right road, install an 18" x 30' long ditch relief culvert, and install 1 rolling dip.
234	Upper Austin Creek	ML	Stream crossing	24	75	225	A fairly short (15') bridge on a 10' x 2' stream. Well armored fill slopes are 8' apart, which are mildly impeding the channel. Check CMP program indicates that only a 48" culvert is need for a 100 year storm event. Future erosion is based on fill slope layback under bridge.	1. Outslope road, keep or cut ditch for 225' and install 3 rolling dips up right road. 2. Install an 18" x 30' long ditch relief culvert along right road. 3. Outslope road, fill ditch for 75' up left road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
235	Upper Austin Creek	ML	Stream crossing	7	0	180	Small springy stream channel comes down grassy slumping swale and diverts down left road to minimal water bar. Cutbank down past water bar continues to be springy and wet. Eight inch PVC pipe at gate drains springy cutbank.	1. Install an armored fill crossing using 10yds3 of 1'-2' rock. 2. Replace 8" PVC pipe with an 18" x 30' ditch relief culvert. 3. Outslope road and retain ditch for 180' up right road and install 1 rolling dip.
236	Upper Austin Creek	ML	Stream crossing	4	30	0	Stream channel above road looks more gully like than a stream. Steam may be on right hingeline of deep seated landslide feature. Outboard fill and hillslope below outlet are near vertical due to scour by Austin Creek.	1. Replace culvert with a 24" x 20' long culvert. 2. Install a 10' full round downspout. 3. Install a single post trash rack. 4. Install a critical dip on right hingeline of crossing.
237	Upper Austin Creek	M	Stream crossing	8	170	0	Small but active steam with undersized culvert. Past diversion to the right suggest past plugging of inlet. Main problem here is possible diversion.	1. Replace culvert with a 24" x 30' long culvert set in at channel grade. 2. Install a single post trash rack. 3. Install a critical dip along right hingeline of crossing. 4. Outslope road and fill ditch for 170' up left road and install 1 rolling dip. 5. Define channel from swale 25' from the left to new inlet.
238	Upper Austin Creek	ML	Stream crossing	3	65	0	Very little road fill here. Road travels along flood plain of Austin Creek. Small stream flow contacts road and diverts down right road for 40' and then enters Austin Creek. No signs of rilling on roadbed. Outboard fill looks stable.	1. Install an armored fill crossing using 15yds3 of 1'-2' rock.
239	Upper Austin Creek	ML	Stream crossing	Road surface only	15	175	Ford crossing on Austin Creek at confluence with large tributary. Left approach has been occupied by stream in the past but is on flood plain, so it doesn't not require treatment.	1. Install 1 rolling dip up right road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
240	Upper Austin Creek	HM	Road drainage discharge point	Road surface only	750	50	Low point along road length. Road is straddled by two class l steams (road occupies nose of ridged between). Minimal gully on either side of road that deliver to Austin Creek. Left road length was taken beyond property boundary to drainage break.	1. Outslope road and fill ditch for 750' up left road and install 5 rolling dips.
241	Upper Austin Creek	M	Stream crossing	7	700	0	Small stream intersects road and has developed a 2.5' vertical scarp at outboard which is actively headcutting back into road fill. Small cross road drain to the right prevents diversion. Road is a good candidate for decommission.	1. Install an armored fill crossing at site using 15yds3 of 1.5' rock. 2. Outslope left road and fill ditch for 700' and install 5 rolling dips.
242	Upper Austin Creek	M	Stream crossing	46	100	0	Partially washed out fill crossing on abandoned road. Area des have some trees growing within fill but stream flow is still eroding area. Steam looks to only flow during large storm events.	1. Excavate crossing and install an armored fill using 20yds3 of 1'-2' rock. Extra dozer time to rebuild road. 2. Outslope left road and fill ditch for 100' and install 1 rolling dip.
243	Upper Austin Creek	ML	Ditch relief culvert	Road surface only	250	0	Ditch relief culvert drains inboard ditch of Kings ridge road and the Tyrrell driveway. Driveway is mildly outsloped with no ditch but tire ruts are keeping flow on road. Culvert outlet mildly shotgunned.	1. Outslope Tyrrell driveway and install 2 rolling dips.
244	Upper Austin Creek	ML	Stream crossing	30	0	35	Stream crossing near residence out building. Building is on outboard edge of left bank and fill is somewhat crowding stream channel. Culvert is set in somewhat shallow relative to channel grade but doesn't seem to be an issue. A fairly stable 2' headcut exists about 15' down channel from outlet and could migrate up channel destabilizing crossing. If crossing were to fail stream flow could occupy housing area.	1. Install trash rack above inlet. 2. Install critical dip along left hingeline. 3. Install 5yds3 of 1'-2' rock armor at headcut below outlet.
245	Upper Austin Creek	M	Stream crossing	4	30	500	Two small streams which appear to be near origin in open grassland setting, deliver flows to inboard ditch before exiting road into natural channel. Road appears to have very little fill. Future erosion is based on expansion of partially armored channel.	1. Install an armored fill crossing using 10yds3 of 1.5' rock. 2. Cut ditch for 75' to capture flow. 3. Outslope right road and fill ditch for 440' and install 3 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
246	Upper Austin Creek	No treat	Spring	2	80	100	Broad springy wet swale occupied by toe of ancient deep-seated landslide feature. Spring infrastructure exists here that is capturing flow and piping it to water tanks off site. Surface spring flow currently saturating roadbed and exiting down 25' long outboard fill face at two locations. About 30' down slope from bottom of road fill toe of landslide ends and drops steeply for about 20' to where class ll stream channel initiates.	No Treatment. Because site/road is on toe of ancient deep-seated landslide feature that is slowing eroding, therefore any treatment here could accelerate natural process.
247	Upper Austin Creek	ML	Stream crossing	3	0	300	Rarely used road crosses minimally developed channel. Stream below road is offset from natural channel by 25'. This can be addressed by making a very broad dip and centering the low point to connect both channels. Currently flows are diverting left before rilling off outboard fill.	1. Install an armored fill crossing using 15yds3 of 1.5' rock. Be sure to build a broad dip to encompass all flow. 2. Outslope right road and fill ditch for 300' and install 2 rolling dips.
248	Upper Austin Creek	ML	Spring	2	25	165	Springy swale above road develops into a class lll stream below. Minimal incision down short outboard fill. Road approaches are grassy.	1. Install an armored fill crossing using 5yds3 of 0.5'-1.5' rock. 2. Outslope right road and fill ditch for 165' and install 1 rolling dip.
249	Upper Austin Creek	ML	Stream crossing	1	0	350	Impacted (woody debris and skid influence) stream through large deep seated slide bifurcates above road and coalesces on a steep road/skid which occupies the natural channel. Skid prism continues to occupy stream channel below crossing.	1. Decommission crossing by excavating from TOP to BOT with a 4' channel width and laying slopes back 2:1 2. Spoil locally. 3. Install 1 cross road drain up left road. 4. Outslope right road and fill ditch for 300' and install 2 rolling dips.
250	Upper Austin Creek	No treat	Stream crossing	Road surface only	100	0	Steam crossing on left hingeline of (active) slow moving deep seated landslide. Left road approach is grassed over and continues beyond property boundary. No right road exists any longer. 300' width of landslide feature has completely removed any sign of road. See field map.	No Treatment.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
251	Upper Austin Creek	M	Ditch relief culvert	7	0	720	Road drainage from 590' of native road surface, leading past water tanks, combines with 130' of rocked Tyrrell Driveway to drain to a 12" culvert. Additionally the spill way from the outlet is connected to the pond. These combined flows travel 110' through a well rocked ditch before gulling down 60' of un-rocked hillslope, and into a class ll stream. Future erosion is based upon gully expansion. The pond, while increasing erosion potential, is not a road related site and therefore is not considered as part of the treatment prescription.	1. Outslope Tyrrell Spur 1.1 road for 590' and install 4 rolling dips.
252	Upper Austin Creek	M	Landslide	88	0	0	Landing below house and pond. Somewhat continuous tension scarp (no real vertical displacement) exists from Armored pond outflow channel for 50' along edge of landing. Landowner has mulched fill face so it is difficult to determine how active this slide feature is. Thickness of mulch is inhibiting plant growth on fill face.	1. Excavate slumping landing fill from START to END flags. 50' x 2' x 30'. 2. Endhaul spoil (landowner probably does not want spoils in their backyard) down to Upper Austin Creek road or across Kings Ridge Road to large flat area (not on Tyrrell property).
253	Upper Austin Creek	M	Stream crossing	54	200	25	Lower extent of same stream as site# 244. Culvert is undersized and rusted through with a 4' deep scour hole below shotgunned outlet. Left road approach was paved many years ago and is mostly covered with gravels with some grass growing on it. Road access is to propane tanks for residents. Kings Ridge road may deliver additional flow to this site.	1. Excavate crossing from TOP to BOT to replace culvert with a 30" x 50' long culvert, set in at channel grade. 2. Armor lower 1/4 of outboard fill slope with 5 yds3 of 1'-2' rock. 3. Install a trash rack.
254	Upper Austin Creek	ML	Road drainage discharge point	Road surface only	500	0	Road drainage delivers to flood plain of Austin Creek at intersection with Upper Austin Creek Road.	1. Outslope left road and fill ditch for 500' and install 3 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
255	Upper Austin Creek	ML	Stream crossing	58	160	0	Newly installed culvert. Bedrock channel above inlet. Outlet looks high in fill with remnants of older culvert below. Flood plain of Austin Creeks is about 60' down channel from crossing. Plugged ditch relief culvert up right road, near drainage break, is causing inboard ditch to pool with water.	1. Install 10 yds3 of 1'-2' rock armor below outlet. 2. Install a critical dip along left hingeline of crossing. 3. Outslope road fill ditch for 160' up left road and install 1 rolling dip.
256	Upper Austin Creek	ML	Stream crossing	30	340	115	Bedrock channel above inlet. Inlet of culvert is 20% plugged with sediment. Outlet is set on bedrock. Crossing is about 100' upslope from Austin Creek flood plain. Outboard fills on both sides of crossing are near vertical and should be pulled back.	1. Install a trash rack. 2. Excavate oversteepened fill on both sides of outlet (10' x 2' x 8')2 3. Outslope right road and fill ditch for 115'. 4. Outslope left road and fill ditch for 340' and install 2 rolling dips.
257	Upper Austin Creek	M	Stream crossing	39	710	200	Fairly large stream, near confluence with Austin Creek. Drained by flat, short, culvert. Though culvert is oversized for 100 year storm event. Up stream from inlet area is aggraded with sediments due to presence of skids and channel incision by stream bifurcating around toe of pale-landslide deposit. Flow is currently emerging at base of bay tree 20' down stream of culvert outlet (BOT).	1. Excavate stored sediments above inlet. 65' x 1.5' x 15' 2. Spoil locally 3. Install a trash rack 4. Outslope road, fill ditch for 200' up right road and install 1 rolling dip. 5. Outslope road, fill ditch for 425' up left road and install 3 rolling dips. 6. Install 4 cross road drains up skid road (above crossing on left bank).
258	Upper Austin Creek	M	Bank erosion	223	100	0	Short spur road takes off at Site# 257 and travels along left bank of class ll stream . Stream banks on either side are near vertical and actively being scoured. Banks on the average are about 10' tall. Given the geologic setting, stream may just be incising through toe of old landslide deposit, hence moderate treatment immediacy.	1. Lay back both left and right banks from START (BOT flag of site# 257) to END flag (near flood plain of Austin Creek). 2(200') x 1.5' x 10' 2. Spoil locally.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
259	Upper Austin Creek	HM	Stream crossing	69	40	200	Culvert looks to out of alignment of natural stream channel. Flow from outlet is scouring toe of older deep seated landslide feature. Hillslope along left road length is springy grassland that is currently slumping onto road and rill roadbed to outlet of culvert. Three cut logs were placed below outlet to act as energy dissipaters.	1. Replace culvert with a 42" x 40' long culvert. Excavate crossing to set new outlet between two redwood stumps (with living saplings) to the right of current outlet. 2. Install a trash rack. 3. Outslope road and full ditch for 200 up right road and install 1 rolling dip. 4. Inslope road and cut ditch for 40' up left road. Connect ditch to inlet of culvert.
260	Upper Austin Creek	M	Stream crossing	44	25	585	What appears to be a fairly new and adequately sized (though short) culvert. Crossing drains a mainly 4' x1' stream, with several small tributaries for a combined dimension of 6' x 1'. Outboard fill is steep but short. A knob just above inlet (10') appears to deflect some flows but may be a natural feature of the stream. True base of fill is hard to determine as this appears to be the flood plain of Austin Creek. Very low gradient on left approach may allow diversion, so critical dip recommended.	1.Install trash rack. 2. build up left approach to act as a critical dip. 3. Outslope road, fill ditch for 585' and install 4 rolling dips.
261	Upper Austin Creek	ML	Road drainage discharge point	Road surface only	40	250	Low point along road length on flood plain of Austin Creek. Right road length delivers sediments to site.	1. Outslope road and fill ditch for 250' up right road and install 1 rolling dip.
262	Gilliam Creek (Lower East Austin Creek)	M	Stream crossing	130	40	0	Majority of stream crossing is washed out, with remnants of the crushed culvert buried under fill at the stream bottom. Past diversion gullies exist down right road. Bedrock exposed along right bank under remaining road fill. Left bank is near vertical. Equipment will only be able to access left bank unless crossing is rebuilt. Future erosion estimate is both banks collapsing, while excavation amount is based only on left bank.	1. Excavate remaining fill along left road approach (35'w x 5'd x 10'l). 2. Stockpile locally along cutbank.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
263	Gilliam Creek (Lower East Austin Creek)	HM	Stream crossing	34	200	200	An active stream diverts 150' down a steep road (essentially a skid). Actively incising gully as large as 5'w x 3'd (in places) reenters natural channel before flowing to site 262. Approximately 200' of left road is connected via the low point where the gully reenters natural stream channel. The right approach is very steep (>40%) but could benefit from cross road drains. Excavation estimate from STREAM profile, future erosion estimate from potential gully expansion.	1. Access site via ridge nose skid approximately 250' left of site 262. Fill gully by pulling the outboard fill material into the void space to access crossing. 2. Excavate TOP to BOT, establish 4' channel width and lay back side slopes to 2:1 wherever possible. Spoil locally down the left road approach. 3. Install 2 cross road drains right and 3 cross road drains left.
264	Gilliam Creek (Lower East Austin Creek)	ML	Road drainage discharge point	8	360	0	Approximately 360' of left road drainage exits road and occupies older stabilized gully. Gully travels roughly 200' to Gilliam Creek. Majority of roadbed is grassed over and covered with tan oak leaf litter.	1. Install 3 rolling dips up the left road approach.
265	Gilliam Creek (Lower East Austin Creek)	L	Landslide	67	250	0	Failing outboard fillface along mainstem of Gilliam Creek. Past failure has already delivered some sediment to Gilliam Creek, and future erosion estimate is based on the remainder of the fill failing, with some fill being retained above the channel. Low treatment immediacy due to slow release of sediments at site.	1. Excavate perched road fill (60'w x 15'l x 1.5'd), stockpile on the inboard road (leaving trail width suitable for quad access) and up the left road approach. 2. Install 2 rolling dips up the left road approach.
266	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	38	200	10	Partially washed out stream crossing, with channel "stair stepping" through road fill. Some smaller redwoods are growing in the aggraded fill above the inboard road. Stream has cut through most of the fill and has scoured around to the right hinge line leaving a lobe of fill on the left to be excavated. Moderate Low treatment immediacy due to slow release of sediments at site.	1. Install an armored fill: 1) Dip road surface, lowering road 2' max. 2) At the new outboard edge of the road, excavate a keyway 30' wide tapering to 4' wide at the base of fill. 3) Place 25 yd3 2'- rock armor on the outboard fillface and the outer 1/3 of the road width. 2. Install 1 rolling dip up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
267	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	15	10	10	The road occupies the channel of Gilliam Creek at this site, traveling approximately 200' along the left bank before being lost among very thick brush. Most fill has already eroded, but oversteepened bare banks are poised to deliver. Abundant woody debris and aggraded sediment in the channel, but only 40' seeps realistically treatable due to access constraints. Future erosion estimate based on layback of 2' tall (average) bank- possibly more if aggraded sediments in channel mobilize. 3/29/10: Access to sites on the other side of Gilliam Creek will likely be via Gilliam 2.1 Road (previously assumed to be a decom road). Determine plan of action for right approach (upgrading of skid?) with input from Danny Hagans and State Park personnel. 6/2/10: Additional hours and material per check site evaluation with DKH, TZ and BB	1. At bare/near vertical bank adjacent to site 266, excavate 40'w x 3'l unstable bank to 4:1 angle (33 yd3 total) to create a Ford crossing. Store spoils up left road beyond site 266. Per check site evaluation 6/2/10: 1. 5 additional hrs/excavator for excavationg ford crossing (no dozer). 2. 3 hrs/excavator for channel realignment. 3. 2 hrs/road opening through cutbank slides. 4. 2 hrs excavator, 10 yd3 2' rock armor to build "sill" at ford crossing. 5. 40 hrs/labor and 40 hrs/excavtor for layout and construction of connecting trail on right bank to upper skid road.
268	Gilliam Creek (Lower East Austin Creek)	HM	Stream crossing	162	780	75	Plugged almost nonfunctional pipe on a small creek high in the watershed. Biggest issue here is the significantly insloped left approach which has resulted in the development of a gully on the left road. The outboard fillface has been heavily covered by brush, though it is likely the gully continues down the fillface. Abundant sediments in the channel below the crossing appear to have derived from the road surface and been deposited by road drainage. These sediments will mobilize again given a large enough precipitation event. Approximately 350' of native surfaced left approach extends beyond the watershed boundary but is connected to this site. Higher complexity at this site due to underground utility vault located next to pipe inlet.	1. Excavate TOP to BOT, replace pipe with 24" x 60' culvert pipe set at the base of fill and in the natural stream axis. 2. Install a trash rack above the pipe inlet. 3. Outslope road/fill ditch for 780' up the left road approach. 4. Install 5 rolling dips left. 5. Use up to 50 yd3 of spoil materials to build up the right approach to further protect against diversion potential. Haul the remainder of spoils to the meadow area 350' to the right.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
269	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	Road surface only	100	1,935	Minimal if any road fill here. Small, near source, class 3 stream confluences with another larger class 3 stream at site. Right road length continues along/as left bank of stream and is well outsloped. Road travels along left bank of stream for 750' and then continues for another 285' as a through cut road up to the nose of a ridge. Left road does slope down to site but is near flat, therefore stream could meander along road length. Moderate low treatment immediacy because there is not much that can be done to disperse road drainage.	1. Install a critical dip at confluence of both streams. 2. Outslope left road and fill ditch for 100'.
270	Lower East Austin Creek	M	Stream crossing	9	830	0	Short length of channel development above the road. This stream appears not to have flowed in recent years. Stream crosses road via minimal water bar. Clump of redwoods growing on the outboard fillface. Treatment immediacy due to significant contributing road length.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to 2:1 for decommissioning. Spoil locally. 2. Install 9 cross road drains up the left road approach.
271	Lower East Austin Creek	HM	Stream crossing	45	420	0	Stream diverted into inboard ditch. Infrastructure (shack, water tank) in channel will have to be moved for implementation. Future erosion based on expansion of diversion gully.	1. Excavate TOP to BOT, establish a 4' channel width and layback side slopes to 2:1 for decommissioning. Determine final BOT location after water tanks and shack have been moved. 2. Install 6 cross road drains up the left approach.
272	Lower East Austin Creek	HM	Stream crossing	32	0	450	Stream channel with aggraded sediment about 20' above inlet. Inlet is about 90% plugged with sediment. Culvert short in the fill and set almost flat. Stream looks to frequently divert down left road.	1. Excavate crossing from TOP to BOT with a 4' channel width for decommission. 2. Spoil locally. 3. Install 6 cross road drains up right road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
273	Lower East Austin Creek	HM	Stream crossing	21	0	450	Plugged non-functional pipe in small stream with significant right approach .	1. Excavate crossing from TOP to BOT with a 4' channel width and side slope 2:1 for decommission. 2. Spoil locally. 3. Install 6 cross road drains up right road.
274	Lower East Austin Creek	M	Stream crossing	27	100	640	Flat area that may have been a landing or mill site. Stream is currently flowing above the TOP flag, no flow downstream of road fill. At higher flows stream looks to flow over road, but with minimal incision.	1. Excavate crossing from TOP to BOT with a 4' channel width and side slopes 2:1 for decommission. 2. Spoil locally. 3. Install 2 cross road drains up left road and 8 up the right.
275	Lower East Austin Creek	HM	Stream crossing	25	0	370	Stream diverted ~60' to plugged non-functional and undersized pipe high in the fill set axis of nearby swale. Active headcut eroding road. Future erosion based on cumulative gully expansion from diversion point.	1. Excavate crossing from TOP to BOT with a 4' channel width and side slopes 2:1 for decommission. 2. Spoil locally. 3. Install 3 cross road drains up right road and 1 on left in axis of swale
276	Lower East Austin Creek	M	Stream crossing	86	30	300	Fill crossing with a Bay tree growing out of OBF about 5' down from OBR. Minimal incision across roadbed and down fillslope. Stream currently flowing at BOT flag.	1. Excavate crossing from TOP to BOT with a 4' channel width and side slopes 2:1 for decommission. 2. Spoil locally. 3. Install 4 cross road drains up right road.
277	Lower East Austin Creek	M	Stream crossing	52	0	310	Fill crossing with mild diversion potential to left	1. Excavate crossing from TOP to BOT with a 4' channel width and side slopes 2:1 for decommission. 2. Spoil locally. 3. Install 3 cross road drains on right road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
278	Lower East Austin Creek	HM	Stream crossing	8	60	10	Inlet of culvert is 90% plugged because culvert was set in flat and caused sediment to aggrade above inlet. At higher flows stream flows across road and has incised through fill (along left side of culvert) back into middle of the road. Mau be a Humboldt crossing below culvert. Outlet is spilling flow onto large log parallel to channel.	1. Excavate crossing from TOP to BOT with a 4' channel width and side slopes 2:1 for decommission. 2. Spoil locally.
279	Lower East Austin Creek	M	Stream crossing	11	250	10	Small creek gullying through fill. Low point in road left of crossing (where flow exits road but ultimately intersects channel. Left approach therefore connected through low point.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle for decommissioning. 2. Install 3 cross road drains on left.
280	Lower East Austin Creek	M	Stream crossing	27	0	200	Small stream with bedrock channel bottom in grassland setting. Stream flowed this year and deposited sediments onto roadbed. Stream continued down left road.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle for decommissioning. 2. Install 2 cross road drains on right.
281	Lower East Austin Creek	M	Stream crossing	34	0	105	Diverted stream at fill crossing combines with flows from diverted flow from site #280 on right to gully down OBF.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle for decommissioning. 2. Install 1 cross road drain on right.
282	Lower East Austin Creek	M	Stream crossing	Road surface only	370	600	Broad open flat swale with a picnic bench on right bank of stream. No road fill here.	1. Install 8 cross road drains up right road and 4 on left.
283	Lower East Austin Creek	ML	Road drainage discharge point	Road surface only	0	500	Right road length delivers to flood plain of East Austin Creek.	1. Install 6 cross road drains up the right road approach.
284	Bearpen Creek (Upper Austin Creek)	L	Stream crossing	1	0	50	Swale above the road developing into a class 3 stream below. Surface flow from right road and swale definitely concentrate on road and rill down the left approach and outboard fillface.	1. Install an armored fill crossing using 5 yd3 1-2' rock armor (more like a rolling dip in swale axis with rocked outlet).

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
285	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	6	250	65	Entire area shows evidence of past and present instability. The adjacent road section to this stream crossing is very springy and has a skid road above adding to erosion concerns below. Removal of much material may excite landslide and dewatering is best recommendation. Decommissioning the skid road located above will help to disperse water.	1. Construct an armored fill at the site. 1) Create a broad dip through the crossing, lowering the road a maximum of 2'. 2) At the new outboard edge of fill, excavate a keyway 10' wide and tapering to 4' wide at the base of fill. Place 10 yd3 on the outboard fillface and the outer 1/3 of the road. 2. Outslope road for 75 and remove ditch. 3. Cut ditch from farthest streamlet to left for 150'. 4. Decommission skid road above by installing 5 cross road drains. 5. Install 1 rolling dip along left road.
286	Bearpen Creek (Upper Austin Creek)	L	Stream crossing	7	130	10	Newly upgraded crossing for recent THP. Three humboldt logs have been left in road fill to facilitate flow across dipped out road. No distinct headcut/knick point below Humboldt logs. Large (3-4') boulders and bedrock exist just downstream from the ends of the logs. Approximately 65' of left road is saturated due to springy cutbank.	1. Cut ditch from stream up the left road approach 65' to capture cutbank spring flow.
287	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	Road surface only	400	10	Recently upgraded crossing due to THP (feature is alternately known as THP crossing 4.2). A 12" culvert was removed and an armored fill crossing was installed. Armor at the outboard fillface is up to 3' in diameter. Hillslope above the road appears to be the toe of an ancient landslide. Left road approach is outsloped.	1. Install 2 rolling dips up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
288	Bearpen Creek (Upper Austin Creek)	HM	Road drainage discharge point	3	0	560	Flows are concentrated in ditch and road runoff from gentle inslope. A gully is enlarged for 50' and cutbank is raw and oozing into ditch in headwaters of class 3 stream, which appears to initiate approximately 50' below the road. Hillside material is very gooey, but some bedrock is apparent in the ditch.	1. Outslope 125' from landing above site and install 1 rolling dip. 2. Install 2 additional rolling dips above the landing. 3. Armor cutbank with 5 yd3 2'-riprap. 4. Armor ditch 2'w x 50'l with 0.5'-rock armor.
289	Bearpen Creek (Upper Austin Creek)	L	Road drainage discharge point	Road surface only	360	0	Off road drain delivers to class 2 stream, minimal rilling within road drain. Left road length is already outsloped where possible.	1. Install 2 rolling dips up the left road approach.
290	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	65	225	30	Road surface appears to have been recently shaped during timber harvesting. Minimal rolling dip on left approach and road is outsloped. Minimal critical dip/rolling dip on the right hingeline. Critical dip at the inboard road could still allow stream flow to divert to the right. Culvert bottom is rusted but not rusted through. Culvert is short and shallow, but the outboard fillface is well armored. This crossing corresponds to THP crossing 5.4.	1. Install an armored fill crossing: 1) Dip the road through the crossing. 2) At eh new outboard edge of the road excavate a 10' wide keyway tapering to 4' wide at the base of fill. 3) Place 30 yd3 1-2' rock armor on the outboard fillface and the outer 1/3 of the road. 2. Install 1 rolling dip up the left road approach.
291	Bearpen Creek (Upper Austin Creek)	HM	Road drainage discharge point	2	450	0	There are 2 locations of sediment input from poorly installed road drainage structures. The class 2 stream is very close to the road here and the outboard fillface is very steep. The road is steep, though rolling dip installation should be attempted with ditch relief culverts as well to drain the springy hillside.	1. Install 3 18" x 30' ditch relief culverts up the left road approach. 2. Install 3 rolling dips left. 3. Outslope road/retain ditch 450' left, clean/cut 300' of this ditch.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
292	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	19	420	0	Culvert inlet about 30% crushed. Culvert bottom rusted though not yet rusted through. Culvert pipe is set in shallow relative to the channel grade. Single post trash rack above the inlet. Left road length is springy for adjacent 80' left of the stream up to a minor rolling dip. Left road is outsloped where possible. This crossing corresponds to THP crossing 5.3.	1. Remove existing culvert pipe (1 hr excavator). 2. Install an armored fill crossing: 1) Dip road through crossing. 2) At the new outboard edge of the road, excavate a 10' wide keyway tapering to 4' at the base of the fill. 3) Place 10 yd3 1-2' rock armor on the outboard fillface and the outer 1/3 of the road. 3. Cut the ditch from the stream 80' left. 4. Install 2 rolling dips up the left road approach.
293	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	229	1,335	0	Large crossing in close proximity to main stem Bearpen (<500'). The culvert is not at base of fill which has caused aggraded sediment above the inlet and a deep plunge pool at outlet. The stream is undercutting natural hillside on the left near outlet but proper extension and rebuild angle should eliminate that issue. Site #294 acts as a critical dip and stream cannot divert out of swale.	1. Excavate from TOP to BOT and replace culvert at base of fill with a 54" x 60' long culvert. 2. Install a trash rack 3. Install 9 rolling dips up left approach. 4. Spoil locally. *14hours labor and 1hour excavator time for de-watering the stream.
294	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	Road surface only	40	600	Newly re-armored fill crossing on low gradient class 2 stream. Crossing has 3 18" concrete culvert sections placed vertically at the outboard road to buttress the road fill. Area appears stable. Right road approach is outsloped wherever possible.	1. Install 4 rolling dips up the right road approach.
295	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	57	500	0	Culvert may be undersized but concrete culvert is short and set shallow relative to channel grade, but 25' length of OBF has been armored with 0.5'-1' rock. Single pole trash rack above inlet. See THP crossing #4.	1. Replace with an armored fill crossing using 20 yd3 of 1'-2' rock. 2. Install 3 rolling dips up left road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
296	Bearpen Creek (Upper Austin Creek)	M	Landslide	70	0	0	Vertical OBF due to undercutting of large stream and perched fill on inner gorge road. Past landsliding has already entered sediment into the stream system and more will likely deliver. There is room to excavate cutbank and move road in during treatment.	1. Excavate road fill for 95'w x 2'deep x 10'long on average 2. Move road in as necessary
297	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	20	1,750	245	Twin 24" culverts set in concrete wing walls (inlet and outlet) drain flows from a fairly active 5' x 1' stream. Little fill and seasonal road use indicate this site is a great candidate for a ford crossing. Extensive left approach (including approximately 1000' of spur road) rationale for increased treatment immediacy. Crossing has overtopped in the past. Well vegetated skid up right bank above inlet may be impeding natural channel width but appears stable and should be left alone.	1. Excavate concrete and twin pipes, layback sideslopes 4:1 for ford crossing and establish a 5' channel width through center line. 2. Endhaul concrete scraps and culverts and place spoils locally. 3. Install 5 rolling dips left and 1 on right approach. 4. Outslope 750' of left approach. 5. Install 12 cross road drains up skid trail to left.
298	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	10	0	0	Older crossing 35' downstream from Site #297. Crossing most likely washed out and then was pulled and newer road alignment is now at Site #297. a 7' tall step has been armored (with 2'-3' rock) within channel to keep channel grade up through Site #297. Mossy vertical fillslopes remain on both left and right banks that could be laid back to 2:1 to reduce potential future erosion.	1. Layback remaining fillslope on both left and right banks. 2. Spoil locally.
299	Bearpen Creek (Upper Austin Creek)	M	Other (swale)	1	15	600	Site is located in a headwall swale with a Class III stream becoming defined of OBF. Minor gullying occurs across road from disperse swale drainage and springy cutbank. The OBF is small but slumped and covered with transported road sediment.	1. Armor OBF with 5 yd3 of riprap. 2. Install 4 rolling dips on right approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
300	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	22	20	1,750	Springy swale in a possible ancient landslide toe above road. Landslide feature continues below road. Stream flow is transported across road via a shallow rolling dip. Stream flow is actively rilling OBF in multiple areas. Majority of right road length exceeds 20% and more or less travels down ridge. Road has been outsloped where possible and has minimal rolling dips and off road drains.	1. Install an armored fill crossing using 25 yd3 of 0.5-1.5' rock. 2. Install 11 rolling dips up right road. 3. Crown road where needed along steeper sections.
301	Bearpen Creek (Upper Austin Creek)	M	Spring	Road surface only	0	100	Springy hillside with Stream initiation just below OBF. Transported road sediments fill channel which may be exacerbated from occasional diversion of Site #300. Future erosion is solely based on chronic road surface delivery .	1. Create a broad dip at site. 2. Breach berm and install 1 rolling.
302	Bearpen Creek (Upper Austin Creek)	M	Ditch relief culvert	1	0	2,840	Excessive road drainage combined with building pad runoff drains to crushed and plugged ditch relief culvert, where a vegetated 2' x 1' x 50' gully is expanding before entering a Class III stream. The upper most 950' is rocked, with remainder paved. Approximately 540' right of site is a low gradient meadow with abundant camp infrastructure. No treatments seem applicable in this congested area or the connected paved approach.	1. Replace culvert at site with 18" x 30' ditch relief culvert. 2. Install 2, 18" x 30' long ditch relief culverts up right approach between site and main camp area. 3. Install 7 rolling dips on upper most 950' of unpaved road (adjacent to Site #301, in water tank area). 4. Outslope road and fill ditch where possible on unpaved section. 5. Repave road surface at ditch relief culvert locations (3) 5'x15'=225'
303	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	6	0	465	Small seasonal stream with 40% plugged culvert. Small fill prism here and critical pipe will not fit. This culvert also receives flow from nearly 465' of grassy ditch and vegetated hillside.	1. Excavate from TOP to BOT, and replace with 24" x 40' long culvert. 2. Install 4, 18" x 40' long ditch relief culverts on right approach. 3. Repave road surface (4)5'x15'=300'
304	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	35	200	0	Minimal stream valley or flow delivers to culvert. Minimal channel development below outlet as well.	1. Excavate from TOP to BOT and replace culvert with a 24" x 50' long culvert set in at channel grade. 2. Repave road surface 15'x15'=225'

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
305	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	31	0	625	Flow diverted from original channel emerges at base of large Bay tree before draining through 80% plugged 18" culvert. Some flow emerges on cutbank down left road. Best solution here is to replace lower pipe (left) at current flow axis and cut ditch from past channel in case upslope improvements result in stream re-occupying the paleochannel, which is vegetated and dry. See sketch for additional information.	1. At lower left of the 2 pipes excavate from TOP to BOT. 2. Replace with a 24" x 60' long culvert at base of fill. 3. Cut ditch for 40' right of site. 4. Install 2, 18" x 30' long ditch relief culverts up right road approach. 5. Repave road surface at stream crossing 15'x15'=225' 6. Repave road surface at 2 ditch relief culvert locations (2) 5'x15'=150'
306	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	473	1,975	75	Culvert installed in 2003. Looks to be at base of fill and at channel grade. Single post trash rack above inlet. Upper portion of left road, near site #305 has springy wet cutbanks. Upper stretch of road is paved for 735' and then well rocked for the rest of the length. Some sections of the road length are through cut.	1. Replace trash rack with a galvanized post. 2. Install 1 18' x 40' ditch relief culvert below Site #305. 3. Install 1 18' x 50' ditch relief culvert 100' down road from first and just before through cut. 4. Install 1 18' x 40' ditch relief culvert beyond switchback. 5. Install 5 rolling dips along rocked section of road.
307	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	54	565	0	Culvert is high in the fill and not at channel grade. The stream is currently plunging and undercutting fill. Site has recently n=been upgraded but not up to current standards. Old erosion features present. The entire road length is springy and 2 ditch relief culverts are installed to help relieve stream crossing but more would be beneficial. See THP site C3.6 for additional information.	1.Excavate from TOP to BOT an replace with a 24" x 60' long culvert at base of fill. 2. Armor 3/4 of OBF with 20 yd3 of rip rap. 3. Install a critical dip on right hinge. 4. Install 2 ditch relief culverts (18" x 40' long each) on left approach. 5. Install 4 rolling dips on left approach. 6. Spoil locally.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
308	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	154	375	0	Fairly new 96" culvert on a large tributary of Bearpen Creek. Possible fish passage issue at 18" drop off to concrete apron below pipe outlet. Otherwise pipe appears adequately sized and in good condition. Both the inboard and outboard fillfaces appear to be well armored with rip rap up to 3 feet in diameter. While diversion potential exists to the right, a spur road adjacent to the site prohibits the installation of a critical dip, as diverted flows would erode this spur road. If check site evaluation determines this site is a fish passage issue, increase treatment immediacy.	1. Outslope road/retain ditch for 375' to the left. 2. Install 1 18" x 30' ditch relief culvert up the left road approach. 3. Install 2 rolling dips up the left road approach. 4. Install a single post I-beam style trash rack above pipe inlet.
309	Bearpen Creek (Upper Austin Creek)	L	Stream crossing	15	257	0	Steep seasonal stream with pipe installed at low angle relative to the natural channel grade. Some aggraded sediments above inlet as well as forest litter. Appears to be room to place a pipe deeper in the fill, but care must be taken to ensure the outlet is not placed in the high water zone. Chronic road delivery occurs at the outboard fillface.	1. Excavate TOP to BOT, replace existing culvert pipe with 24" x 40' pipe set in near the base of fill and in the natural stream axis, but above the high water line of creek into which the pipe will drain. Store spoils locally. Armor the outboard fillface with 5 yd3 1-2' rock armor. 2. Install a single post trash rack above the inlet. 3. Install a critical dip along the right hingeline. 4. Install 1 rolling dip up the left road approach.
310	Bearpen Creek (Upper Austin Creek)	No treat	Stream crossing	Road surface only	0	165	Steel bridge across Bearpen Creek. Bridge is 14' wide, 50' long and bottom of bridge is 14' above the stream. Bridge has been installed over an older log spanner bridge. Steel "I" beam abutments are behind older wood pile abutments. Area appears stable. The right approach has a springy inboard ditch, flowing at the time of assessment, which enters Bearpen Creek at a gently sloped ditch-out. Current right approach is longer than stated (up to site 309) but will be cut off at stated length with a critical dip at site 309.	No treatment.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
311	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	131	450	300	Significant tributary of Bearpen Creek drained by an undersized partially (1/3) plugged culvert pipe. A skid up the right bank leads to a partially washed out landing with 2 smaller tributaries. Check site to determine possible access to this area and to determine most appropriate TOP location (i.e. pull back skid for entire 200'?) and proper future erosion estimate. There is a mild break in slope on the right road approach but road would benefit from a rolling dip along this section.	1. Excavate TOP to BOT, replace pipe with a 36" x 60' culvert set at the base of fill and in the natural stream axis. Armor the outboard fillface with 20 yd3 1-2' rock armor. 2. Install an I beam style trash rack above the pipe inlet. 3. Install 2 18" x 40' ditch relief culverts up the left road approach. 4. Install 2 rolling dips up the right road approach and 3 left. 5. Pending check site review, spoil locally.
312	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	50	0	350	A 1' x 2' wooden box culvert, which appears rotten and separated between the slats. Culvert is set high in the fill and shallow relative to the natural channel grade. It appears the landowner has been placing slash on the fill below the outlet. The channel above the inlet is choked with rotten fir trees. Doesn't appear the stream has received flow this year.	1. Excavate TOP to BOT, replace existing pipe with a 24" x 50' culvert pipe set in at the base of fill and in the natural stream axis. Armor outboard fillface with 10 yd3 1-2' rock armor. 2. Install a trash rack above the inlet. 3. Install a critical dip on the left hingeline. 4. Install 1 rolling dip up the right road approach.
313	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	34	0	0	Old log stringer bridge across mainstem Bearpen Creek with trestle on top. Top abutments appear stable, but right bank upstream is being cut into by stream deflection. Armoring here may stabilize hillside and bridge. Approximately 50' further upstream the stream carves through the natural hillside and may over time undermine the year around access road. Both cutbanks are bare and stream channel is being pinched by the abutments.	Per check site evaluation 6/2/10: 1. Excavate a 30'w x 2'd x 2'l keyway along the right bank. Endhaul spoils. 2. Place 25 yd3 3' rock armor in keyway and 1/2 way up the right bank. Additional labor and excavtor time to manage water during work.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
314	Bearpen Creek (Upper Austin Creek)	M	Landslide	34	0	50	It is hard to tell if this is solely a fill failure or in part the result of bank erosion from the mainstem of Bearpen Creek. Surface flows from the roadbed appear to be compromising the already loose road fill. Armor has been placed periodically at the base of fill on the right bank of Bearpen Creek, with this failure site located at an unarmored section.	Per check site evaluation 6/2/10: 1. Excavate a 30'w x 2'd x 2'l keyway, endhaul spoils on landing to the left. 2. Place 20 yd3 2-3' rock armor at the base of fill (in keyway) and up the right bank.
315	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	210	0	50	Right bank crowded by landing fill from inlet for 80' up the channel, but looks stable. This area is off the property, therefore not assessed. Culvert outlet is shotgunned 6' and therefore is not only set in shallow relative to channel grade. Culvert is sized properly for the 100yr storm event.	1. Install a single post trash rack above the pipe inlet. 2. Install 20yds3 of 2'-3' rock armor below outlet. * No critical dip required as per DKH.
316	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	10	175	0	Very small stream (dry) flows to an 80% plugged cement culvert before dissipating on the flood plain above Bearpen Creek very close to the confluence with Austin Creek.	1. Excavate TOP to BOT, replace pipe with 24" x 30' culvert set at the base of fill and in the natural stream axis. Note: May not need to raise the road to accommodate pipe if culvert excavation is deep enough. 2. Install an 18" x 40' ditch relief culvert up the left road approach. 3. Repave road at stream corssing 12'x15'=180' 4.Repave road at ditch relief culvert installation 5'x15'=75'
317	Bearpen Creek (Upper Austin Creek)	L	Stream crossing	1	75	0	Small seasonal stream deposits in ditch and travels to the right down a low gradient, bare ditch. Site is located near the flood plain of mainstem Bearpen Creek and could easily be placed in the natural axis. Upslope drainage may be disturbed but this area is unavailable for investigation, as it is off the project property.	1. Install an armored fill crossing using 5 yd3 0.5-1' rock armor. 2. Outslope road/fill ditch for 75' of left road approach.
318	Bearpen Creek (Upper Austin Creek)	L	Ditch relief culvert	Road surface only	0	280	A 12" ditch relief culvert drains King's Ridge Road. Inlet of pipe is plugged with leaf litter. Bottom of pipe is rusty but not rusted through.	1. Clean inlet of pipe.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
319	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	80	0	450	Culvert is short and set high in the fill, which has resulted in significant erosion of the outboard fillface. Stream appears to currently flow primarily on bedrock, though this is difficult to determine for sure as brush and fallen trees obscure the view of the fillface. A small gully has developed near the outboard edge of the road as a result of the steep right approach with poor drainage structures. The presence of near surface bedrock and a buried water line may make installation of a steeper gradient culvert pipe problematic.	1. Excavate TOP to BOT, replace pipe with 30" x 50' culvert set at the base of fill and in the natural stream axis. Armor the outboard fillface with 15 yd3 1-2' rip rap. 2. Install a critical dip along the left hingeline of the crossing. 3. Install 2 rolling dips up the right road approach (one in the axis of the swale located approximately 85' to the right).
320	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	16	0	350	Two small streamlets, moderately developed in a swale setting high in the watershed, diverts down the left road before exiting the roadbed via several small rills on the OBF. True Class III stream development in swale below the road. Approach moderately outsloped, but could benefit from rolling dips. Right road can be lowered to allow armored fill installation.	1. Install an armored fill crossing: Create a broad dip and lower road 2' max, establish keyway on OBF 16' wide at new OBR tapering to a 4' at base of fill. Set 15 yd3 of 2' minus riprap in keyway 1\3 into road. 2. Spoil locally. 3. Install 2 rolling dips up right road approach.
321	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	105	500	175	Culvert bottom rusted. Culvert outlet looks to be at base of fill. Old skid road crosses stream above inlet and has aggradded channel for 60'. Trash rack present. Minimal critical dip at CLP but stream could still divert down lower road if lower occupied IBR on right road.	1. Excavate from TOP to BOT and replace with a 24" x 70' long culvert set in a channel grade (ensure removal of skid fill from above current inlet). 2. Install a trash rack. 3. Install a critical dip on right higeline. 4. Install 2 rolling dips up left road. 5. Install 1 rolling dip along upper right road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
322	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	162	420	245	A large pipe in good condition draining a healthy stream. Some stored sediment above the pipe inlet, but overall a good looking crossing. Twin T-stake trash racks should be replaced with a single post I-beam style trash rack. The main problematic issue here is an emergent spring 115' up the right road approach. This flow has created a small gully on the outboard fillface at the crossing, though it can be easily cut off by installation of a ditch relief culvert.	1. Install an I-beam style trash rack above the culvert inlet. 2. Cut a ditch at the inboard edge of the road for 10' beneath the emergent spring located 115' right of the site. 3. Install an 18" x 30' ditch relief culvert 105' to the right of the crossing. 4. Place 2 yd3 1.5' rock armor below the outlet of the ditch relief culvert on the flat bench uphill of the redwood tree cluster. 5. Install 2 rolling dips to the right and 3 to the left.
323	Bearpen Creek (Upper Austin Creek)	L	Stream crossing	3	40	100	Minimal stream valley morphology both above and below fill crossing. Mature Redwood tree growing in center of stream just above road. Roadbed has been dipped and outsloped through crossing. Minimal rilling down OBF.	1. Install an armored fill crossing using 5 yd3 of 0.5'-1.5' riprap.
324	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	74	335	110	Large stream with a 4' diameter culvert and 2 steep road approaches eroding the outboard fillface. The culvert causes a 3' plunge onto bedrock due to high and short placement. The outlet has rust holes and will need to be replaced within the next 10 years. Two waterbars currently provide temporary relief from road drainage.	1. Excavate TOP to BOT, replace existing pipe with a 48"x60' culvert set at the base of fill and in the natural stream axis. Armor the outboard fillface with 15 yd3 2'- rock armor. Stockpile locally. 2. Outslope road/fill ditch for 110' to the right and 335' to the left. 3. Install 2 rolling dips left and one right.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
325	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	1	0	20	An armored fill crossing on an active stream adjacent to a culverted crossing (#326, located to the right). Current armored fill is functioning okay, but the armor could be arranged better to prevent diversion to the left and to key in the larger pieces of rock below the road. Current critical dip on the left hinge is functional. Currently the crossing appears passable on a quad, rough in a 4x4 truck, and likely impassable in a logging haul truck. Future erosion estimate is based on scouring around the upstream armor.	1. Rebuild armored fill, moving the larger armor currently at the inboard road to the outboard fillface and transitioning the armor on the approaches to a more drivable (while still functional) design.
326	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	69	15	1,500	Inlet of culvert is slightly crushed. Single pole trash rack has been installed above the inlet. Culvert appears to be at or near the channel grade. Minimal critical dip on the left hinge, though a more robust structure should be installed to ensure diversion potential is minimized. Extensive 1,500' right approach could be outsloped and get rolling dips, though near surface bedrock may make dip installation problematic in places.	1. Excavate TOP to BOT, replace culvert pipe with 30" x 60' pipe set at channel grade and in the natural stream axis. 2. Install critical dip along the left hinge line. 3. Install trash rack above the inlet. 4. Outslope road/fill ditch for 1,500' to the right. 5. Install 10 rolling dips up right road approach.
327	Bearpen Creek (Upper Austin Creek)	L	Landslide	14	0	0	Perched landing fill above a class 3 stream. Fill has several wide tension cracks and abundant large woody debris.	1. Pull perched fill for 75' wide x 10' long. Spoil locally.
328	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	101	70	100	Two streams coalesce above an adequately sized though far too short and rusty culvert. Outboard fillface is nearly vertical, mostly bare and unarmored. Springy right approach and a skid road up the right bank above the inlet.	1. Excavate TOP to BOT, replace pipe with a 30" x 50' culvert set at the base of fill and in the natural stream axis. Armor the outboard edge of fill with 25 yd3 1-2' rock armor. 2. Cut an inboard ditch 40' to the right to drain the springy area and armor ditch with up to 5 yd3 0.5'-rock. 3. Stockpile locally.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
329	Bearpen Creek (Upper Austin Creek)	L	Stream crossing	9	5	85	Small near-origin stream drained by small high in the fill culvert. Stream is currently dry, but upstream swale is seeping. Stream flow must fill scour area before reaching inlet.	1. Install an armored fill crossing: 1) Dip the road surface through the crossing, lowering the road a maximum of 2'. 2) Excavate a keyway 15' wide at the new outboard edge of fill, tapering to 4' wide at the base of fill. 3) Place 5 yd3 0.5-1.5' rock armor on the outboard fillface and the outer 1/3 of the road tread.
330	Bearpen Creek (Upper Austin Creek)	ML	Spring	6	0	0	Emergent spring on landslide face. Flow (some of which is being captured for spring box use) has been diverted down the left road for 30' before gullying down outboard fill. Spring flow is constant and not subject to fluctuations like a stream. Some of the flow dissipates onto roadbed below while some ultimately flows back into natural channel.	Per chack site evaluation 6/2/10: 1. Using hand labor, dip slide material to direct flow into natural channel below to reduce diversion potential. 2. Install 1 cross road drain to the left and 1 cross road drain to the right.
331	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	49	40	30	Recently installed armored fill crossing with failed outboard fill and steep perched fill. There is stream flow 40' above inboard road and 75' below road and several yds3 of road fill in channel. Crossing could be stabilized by rebuilding armored fill at greater depth and lowering the road. Road fill in channel and steep side slopes should be removed.	1. Rebuild armored fill crossing reusing existing 2'-3' rock and importing an additional 25 yds3 of 0.5'-1.5' rock. 2. Excavate 20yds3 of fill from outboard fill face. Per check site evaluation 6/2/10: do not excavate channel (only outboard fillface).
332	Gilliam Creek (Lower East Austin Creek)	L	Spring	Road surface only	450	0	Headwall swale location with Class III stream initiating below the lower road. The cutbank is springy with ponded water on the inboard road and hydrophilic vegetation covering the road surface for nearly 20 feet. Minimal erosion occurring across duff covered road and hillside.	1. Construct a wide and deep cross road drain at spring. 2. Rip left road, install 9 cross road drains.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
333	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	8	0	150	Currently diverted stream near the North fork of Gilliam Creek. Flow gullies down the left road approach to a culverted crossing (site #334). Mild break in slope on right road approach at a swale, but drainage structures will be beneficial. Access to this area will be a challenge.	1. Install an armored fill: 1) Dip the road surface through the crossing, lowering the road 2' maximum. 2) At the new outboard edge of the road, excavate a 10'w keyway tapering to 4' at the base of fill. 3) Place 15 yd3 1.5'- rock armor on the outboard fillface and the outer 1/3 of the road width. 2. Install 1 rolling dip up the right road approach.
334	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	2	70	100	Culverted stream crossing on the North fork of Gilliam Creek, high in the watershed. Two diverted streams are currently eroding the outboard fillface. The road is duff covered, though diversion gullies are bare and appear active during heavy storms.	1. Excavate TOP to BOT, establish a 5' channel width and layback side slopes to 4:1 angle for a stable ford crossing. Spoil locally. 2. Install 1 rolling dip up the right road approach. * 1 hour excavator and 1 hour dozer time to rebuild crossing to access sites further out road.
335	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	20	0	85	Fill crossing just upstream of site 334 with some flow currently diverted and gullying through the fill at site 334. Road is essentially an inner gorge skid above the North fork of Gilliam Creek. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle for decommissioning. 2. Install 1 cross road drain to the right. * 1 hour dozer time to rebuild crossing to access sites# 341.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
336	Gilliam Creek (Lower East Austin Creek)	L	Landslide	37	0	0	Failed road fill on inner gorge road next to the north fork of Gilliam Creek. Most of fill looks to have already failed. Creek side redwoods partially stabilize toe, but stream is actively undercutting already loose fill. Access will be tough, as tread is reduced to approximately 6.5' in places. Failure continues left bend in the road, but it may not be prudent to excavate beneath the cutbank slide, as a future sediment delivery issue may develop. Much of the road related erosion has already occurred, and what remains may be full-bench, possibly bedrock. Moderate Low treatment immediacy due to age of feature, accessability to site, and road opening cost.	1. Excavate 140'w x 2'd x 6'l section of loose fill, working around existing trees. Specific excavation limits will be determined during check site evaluation and/or layout process. Leave/establish wide enough tread for quad access. 2. Determine spoil management during check site evaluation- likely will have to haul majority of spoils, but may not have adequate access for full size dump truck. Per BB check site eval 6/2/10: stockpile locally, determine limits of excavation during layout.
337	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	39	25	50	Small stream that has delivered abundant sediment to Gilliam Creek and will continue to do so. Bedrock in channel and redwoods on the hillslopes are good markers of limits of excavation. Removal of all fill will be difficult due to access constraints and steep topography.	1. Install an armored fill: 1) Dip the road surface through the crossing, lowering the road 2' maximum. 2) At the new outboard edge of the road, excavate a 10'w keyway tapering to 4' at the base of fill. 3) Place 25 yd3 1.5'- rock armor on the outboard fillface and the outer 1/3 of the road width. 2. Excavate an additional 50 yd3 from the right road prism.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
338	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	111	375	40	Small stream headcutting through the fill on an abandoned road. Access will be tough, with cutbank and road fill slides to deal with as long as washed out crossings (site 337). Small past fill failure approximately 85' up the left approach. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Install an armored fill: 1) Dip the road surface through the crossing, lowering the road 2' maximum. 2) At the new outboard edge of the road, excavate a 14'w keyway tapering to 4' at the base of fill. 3) Place 20 yd3 1.5'- rock armor on the outboard fillface and the outer 1/3 of the road width. 2. Outslope road/fill ditch through past fill failure (approximately 80' of outsloping). 3. Install 3 rolling dips up the left road approach. * 1 hour excavator and 1 hour dozer time to rebuild crossing to access sites further out road.
339	Gilliam Creek (Lower East Austin Creek)	L	Other (swale)	1	200	0	Headwall swale with class 3 stream initiating below the road. Small duff covered gully through the road fill.	1. Rip left approach and install 5 cross road drains, with one at the swale that is wide and broad.
340	Gilliam Creek (Lower East Austin Creek)	ML	Landslide	1	0	400	Four hundred feet of right road (from nose of ridge) travels to where stream has washed away any signs of where road went from here. Height of road relative to stream makes it unlikely that road crossed the stream. Road may have switched back here and continued downhill. Slide face and roadbed are dense with small trees and appear stable. What vertical fill remains has a low probability of delivering to the stream.	1. Install 6 cross road drains up the right road approach.
341	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	70	120	0	Washed out Humboldt crossing. One log remains in center of channel. Remaining fillslopes are near vertical and mossed over.	1. Realistically, equipment will only be able to access the left bank. Excavate 40'w x 2'd x 12'l and spoil locally. 2. Install 2 cross road drains up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
342	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	21	800	60	Small stream currently diverted and gullying through the fill. Minimal channel development above the road. Steep left road approach adds to erosion at the outboard fillface.	1. Excavate TOP to BOT, establish a 4' channel width and layback side slopes to stable 2:1 angle for decommission. Spoil locally. 2. Install 11 cross road drains left rand 1 right.
343	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	6	100	0	Small stream currently diverted right when flowing. There are large diversion gullies to the right approach and failing outboard fill. The stream axis is low gradient and duff covered, but right road surface is bare.	1. Excavate TOP to BOT, establish 4' channel width and layback side slopes to stable 2:1 angle. Spoil locally. 2. Install 2 cross road drains left.
344	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	32	370	0	Small but active stream currently diverted and gulling through the fill. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate TOP to BOT, establish 4' channel width and layback side slopes to stable 2:1 angle. Spoil locally. 2. Install 5 cross road drains left.
345	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	14	1,260	0	What was thought to have been a long aggraded crossing with a steep and long outboard fillface has shown to be a road traveling across a broad bedrock step. Bedrock stream bottom observed 2' below the outboard road. Stream is currently flowing in the natural axis, but has the potential to divert and has diverted in the past. Treatment immediacy primarily due to extensive left road approach.	1. Excavate TOP to BOT, establish 5' channel width and layback side slopes to stable 2:1 angle. Spoil locally up the left road approach. 2. Install 16 cross road drains left. Near the top of the road, at the intersection, the road crosses a swale. Make sure to install a cross road drain on the lower hinge of the swale. 3. Outslope road and fill ditch for 1,260' up left road.
346	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	40	0	125	Likely skid road ending at the confluence of 2 streams. Most fill has eroded down to site 345, but bare, vertical slopes remain. No road to the left and the right road is duff covered with many small trees, with overall difficult access for equipment.	1. Excavate 30'w x 3'd to remove remaining fill from both crossings. Spoil locally.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
347	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	7	50	500	Small stream high in the watershed with brushy road approaches. The stream has eroded through the outboard fillface and will continue to do so. Bare, vertical side slopes are exposed, but channel does not appear to see regular flow.	1. Excavate TOP to BOT, establish a 4' channel width and layback side slopes to stable 2:1 angle for decommissioning. Spoil locally. 2. Install 7 cross road drains up the right road approach.
348	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	4	15	0	Small stream high in the watershed with vegetated road approaches. The current 4'w x 2'd outboard fillface gully appears well vegetated.	1. Excavate TOP to BOT, establish a 4' channel width and layback side slopes to stable 2:1 angle for decommissioning. Spoil locally.
349	Bearpen Creek (Upper Austin Creek)	M	Spring	9	0	280	Springy hillside drained by plugged and separated concrete pipe. Abundant emergent flow on hill approximately 80' to the right of the site.	1. Replace pipe at the site with a 18" x 30' ditch relief culvert. 2. Install an 18" x 30' ditch relief culvert 80' up the right approach of the site. 3. Outslope road/retain ditch for 80' to the right. 4. Clean/cut ditch for 80' up the right road approach. 5. Outslope road/fill ditch for 200' (to the gate). 6. Install 2 rolling dips up the right road approach.
350	Bearpen Creek (Upper Austin Creek)	ML	Other (swale)	Road surface only	550	0	Broad swale near ridge with class 3 stream initiating approximately 50' below the road. The 550' right approach is wide, 90% bare and only partially outsloped. The cutbank as the site is springy, and flow travels diagonally across the road surface into a swale. The outboard fillface is bare and crumbling.	1. Install 4 rolling dips up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
351	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	54	0	575	Steep stream with emergent spring approximately 50' to the right. The culvert pipe currently in use at the stream is larger than necessary but installed at a low angle relative to channel grade, partially plugged and high in the fill. Extensive springy approach is already mostly outsloped, but could be enhanced. An additional emergent spring exists on the cutbank up the right road approach approximately 450'.	1. Excavate TOP to BOT, replace pipe with a 24" x 50' pipe set in at the base of fill and in the natural stream axis. Armor the outboard fillface with 20 yd3 1-2' rock armor. 2. Install a trash rack above the inlet. 3. Install a critical dip along the left hingeline. 4. Cut ditch 50' to the right. 5. Outslope road/fill ditch for 400' between emergent springs. 6. Install an 18" x 30' ditch relief culvert 450' to the right of the crossing. 7. Outslope road/retain ditch for 125' right of ditch relief culvert installation. 8. Install 4 rolling dips to the right of the site.
352	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	148	0	385	Steep and narrow swale with seasonal stream which currently flows subsurface through the site. The culvert is relatively flat and more than 50% plugged. Bedrock is present in the area (for excavation boundaries). The right road approach is steep, outsloped and appears full bench-installation of drainage structures along this stretch appears problematic. The left road is narrow with a steep outboard fillface.	1. Excavate TOP to BOT, replace existing culvert with 24" x 60' pipe set at the base of fill and in the natural stream axis. Lower road surface 2 feet. Armor the outboard fillface with 5 yd3 1-2' rock armor. Spoil locally. 2. Install a trash rack above the inlet. 3. Install a critical dip along the left hingeline.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
353	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	367	50	750	Steep bedrock stream with adequately sized culvert which is high in the fill and at a low angle relative to the channel grade. Outlet is shotgunned and a scour hole has developed below on the outboard fillface. Hillslope ravel is plugging the pipe (rather than sediments aggrading above the pipe inlet). Extensive right approach nicely outsloped though could benefit from rolling dips. A flared inlet will help reduce plug potential due to extra sediment from natural hillslope ravel. An emergent spring located 125' to the right should be drained by a ditch relief culvert.	1. Excavate TOP to BOT, replace existing culvert with a 30" x 90' pipe set at the base of fill and in the natural stream axis. Install a 30" diameter flared inlet at the pipe inlet. Armor the outboard fillface with 15 yd3 1-2' rock armor. 2. Install a trash rack above the inlet. 3. Install 5 rolling dips up the right road approach. 4. Install 1 18" x 30' ditch relief culvert 125' to the right.
354	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	325	0	125	Nearly flat culvert with an 80% plugged inlet drains a large, swift stream. The stream has overtopped in the past, washing out nearly all of the outboard fillface (now vegetated) leaving a 10' road width. Site also receives flow from a large spring located 50' to the right. Disconnecting the spring from the site will reduce saturated fill area.	1. Excavate TOP to BOT, replace existing culvert with a 30" x 80' pipe set at the base of fill and in the natural stream axis. Armor the lower 3/4 of the outboard fillface with 45 yd3 2'- rock armor. 2. Install a critical dip along the left hingeline. 3. Install a trash rack above the pipe inlet. 4. Install an 18" x 40' width relief culvert at the spring located 50' to the right.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
355	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	36	0	150	Several streams coalesce above the road, diverting into an active gully before crossing the road at a plugged, non functional pipe. This write up pertains soley to the crossing- check site to determine proper treatments to the diverted upslope area. It seems that the most appropriate approach is to leave flow in the current orientation, pull back the right bank of the gully and put in an oversized pipe to accommodate all flow. Future erosion includes crossing failure plus 2'x0.5'x150' gully expansion.	1. Excavate TOP to BOT, replace pipe with a 30" x 50' culvert set at the base of fill. 2. Install a critical dip along the left hingeline. 3. Clean/cut ditch for 150' to the right. 4. Outslope road/keep ditch 150' to the right. 5. Install 1 rolling dip up the right road approach. 6. Pull back oversteepened gully sides wherever possible (additional 2 hrs/excavator for access and excavation time, 5 yd3 excavation volume). Work spoils into critical dip/pipe replacement backfill.
356	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	46	0	175	Thick sediment cone above the inlet indicates upslope instability and could induce culvert failure/plugging if not removed from the natural channel. Stream has overtopped in the past, resulting in large gullies down the outboard fillface. Outlet erosion from the shotgunned pipe is evident as well.	1. Install an armored fill crossing: 1) Create a broad dip through the crossing, lowering the road a maximum of 2'. 2) At the new outboard edge of the road, excavate a 10' wide keyway, tapering to 4' wide at the base of fill. 3) Place 15 yd3 0.5-1.5' rock armor on the outboard fillface and the outer 1/3 of the road. 2. Install 1 rolling dip on the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
357	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	163	345	815	Flowing stream with extensive and very steep right road approach drained by rusty, likely undersized pipe set in at the base of fill. Flow is piping around the culvert. Also, emergent spring on the cutbank to the right in a past failure zone is pumping significant amounts of flow onto the road bed, which is eroding down both the inboard and outboard fillfaces. Minimum 30" diameter pipe for replacement.	1. Excavate TOP to BOT, replace pipe with a 30" x 60' culvert set at the base of fill. Armor the outboard fillface with 5 yd3 1-2' rock armor. 2. Install a trash rack above the inlet. 3. Clean/cut ditch for 100' to the right through springy failure zone. Armor ditch with 5 yd3 0.5'-. 4. Outslope road/keep ditch 150' to the right. 5. Install 6 rolling dips up the right road and 2 up the left road approach.
358	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	18	80	0	Two crossings at this site- the upper is an 18" concrete pipe set high in the fill, lower is a 24" plastic pipe with shotgunned outlet with near surface bedrock at the crossing. The area is adjacent to the Camp Cazadero ball field and cabins, and it appears building pad and field-related runoff more than road drainage are at work here. Stream appears to be diverted from what was previously the natural channel (where infrastructure now is) approximately 200' upstream from the crossing.	1. Replace each pipe with a 24" x 30' pipe. Set lower in the fill than at present if possible. 2. Install a critical dip along the right hingeline.
359	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	20	110	100	Over 170' of aggraded sediment (much of which is likely road rock from the main camp area) above the inlet. This may be a natural depositional setting. The flow is currently subsurface through the crossing and emerges at the base of fill. Culvert appears to plug often and stream has overtopped more than once, leaving large gullies on the outboard fillface. FE based on gully expansion.	Per check site evaluation 6/2/10: 1. Add 20 yd3 1-2' rock armor to the outlet area/outboard fillface. 2. Enhance the critical dip and armor dip outlet (into natural channel) with 10 yd3 0.5-1.5' rock armor. 3. Replace trash rack above the inlet.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
360	Upper Austin Creek	No treat	Spring	10	0	60	Emergent spring at an abandoned mine is saturating existing tailings pile, which is currently acting as a landing. Flow then enters the adjacent creek upstream of site 361. A natural swale exists below the landing, but it seems like the current set up is least disruptive. Check site to determine necessity of treatment with respect to presence of mine tailings. Future erosion estimates based on gully expansion and possible failing of oversteepened landing edge.	No treatment.
361	Upper Austin Creek	L	Stream crossing	22	140	165	Culvert is oversized for the stream and placed on bedrock. Mine tailings cover the right slope above the inlet and periodically deliver to the channel. Without major mine remediation little can be done to stop delivery. Adjacent cutbanks are both springy. Left approach is rocky with very little fine grained sediment delivering, but the right road has developed gully and both the road surface and cutbank appear composed of fine material.	1. Outslope/fill ditch 165' of right approach. 2. Install 1 rolling dip to the right.
362	Upper Austin Creek	ML	Stream crossing	1	0	300	Small stream flowing across nearly full bench bedrock road with well built, stable armored fill on the outboard fillface. The channel may have experienced debris torrent(s) in the past, as evidenced by abundant cobbles within a sediment cone at the inboard edge of the road. Slight possibility of diversion to the left, and the crossing could benefit from additional dipping out of the road surface. Flow from emergent spring on the right approach concentrates on the road bed before delivering to the stream at the crossing.	1. Dip road through the crossing to reduce diversion potential. 2. Install an 18" x 30' ditch relief culvert at the emergent spring on the right road approach. 3. On the lower road (below the spring), install 1 rolling dip and apply road rock though the axis. 4. Outslope road/fill ditch for 300' to the right. 5. Install 2 rolling dips up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
363	Upper Austin Creek	ML	Other (swale)	2	0	100	Headwall swale developing into class 3 stream below the road. Small headcut at the top of a 3'w x 2'd x 15'l gully eroding into the outboard fillface. Past fill failure with gullied face that doesn't appear to be delivering located to the left before a terminal landing. Low percentage of fine grained sediment- the road surface is comprised mostly of gravel to cobbles.	1. Excavate 12 yd3 through the road prism. Layback sideslopes to 2:1 for decommissioning. Stockpile up either approach. 2. Install 1 cross road drain up the right road.
364	Upper Austin Creek	ML	Stream crossing	3	10	80	Headwall swale on the right hinge of a large landslide develops into a class 3 stream below the road. No drainage structure exists at the site. A minimal critical dip along the left hingeline prevents diversion.	1. Install an armored fill crossing using 25 yd3 1-2' rock armor.
365	Upper Austin Creek	ML	Stream crossing	34	40	0	Small stream drained by crushed though partially functional culvert set high in the fill, flat, and with a shotgunned outlet. Short left approach with diversion potential to the right.	1. Install an armored fill crossing using 10 yd3 0.5-1.5' rock armor. 2. Remove berm for 40' to the left.
366	Upper Austin Creek	M	Stream crossing	2	60	15	Channel above the road is offset (to the right) of the channel below the road. Roadbed has a hump where the upper channel meets the road, indicating deposition of the material. Stream has diversion potential to the right.	1. Install an armored fill crossing using 25 yd3 1-2' rock armor.
367	Upper Austin Creek	M	Stream crossing	8	275	0	Small stream diverts for a short while down the right road approach before exiting the road via several smaller gullies on the outboard fillface. Lower road will also need drainage structures.	1. Install an armored fill crossing using 10 yd3 1.5'- rock armor. 2. Install 2 rolling dips up the right road approach.
367.1	Upper Austin Creek	HM	Stream crossing	35	500	0	Older landslide deposit has diverted covered skid road and diverted stream flow out of it's natural channel. Not sure if landslide was natural occurrence or a result of legacy logging practices. Outboard toe of landslide is actively being headcut by stream flow. Historic channel exists about 15' to the left of current flow. Potential for extreme erosion due to active gullying down hillside and beyond profile.	1. Excavate stream crossing from TOP to BOT to establish flow back into natural channel. 2. Spoil locally 3. Install 6 cross road drains up left road/skid.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
368	Upper Austin Creek	M	Ditch relief culvert	3	265	40	Springy hillside above road in forested setting. Spring flow has gullied down the outboard fillface in two places to the left of the current ditch relief culvert. Pipe inlet is 90% plugged with sediment due to slumping above. Abandoned road below the outlet of the ditch relief culvert.	1. Outslope road and cut a ditch for adjacent 100' up the left road. 2. Outslope road, fill ditch for remaining 165' left. 3. Replace ditch relief culvert at site with 18" x 20' pipe and install a 40' downspout. 4. Cut ditch for 45' along the right road approach.
369	Upper Austin Creek	M	Stream crossing	6	550	60	Stream diverted left at road, then drained in gully across lower road before confluence with a larger class 2 stream. It appears the only realistic place to put the stream across the road is between 2 fairly large trees on the outboard edge of the road. A hose in the creek is adding flow from an unknown upslope source (spring?). Higher complexity due to need to work between trees. Also near surface bedrock may prevent installation of keyway at proper keyway.	1. Install an armored fill between the trees using 10 yd3 1.5'- rock armor. Likely will not be able to lower road too much due to tree roots. Use stored sediments located to the right (on the outboard road) to build up left road to prevent diversion. 2. Outslope road/fill ditch for 60' to the right. 3. Install 6 cross road drains up skid road to the left of site.
370	Upper Austin Creek	M	Stream crossing	31	70	30	Area appears to be the toe of an old landslide feature. Site is an abandoned roadbed below site 369. Stream flow is piping out of cutbank and is offset to the right (25') from the channel above. This is probably more of an influence of landslide material than road building. Flow is moderately headcutting through fill.	1. Cut ditch for 30' along left road approach from the base of upper fillface (site 369) to "J" fir tree, where flow is piping from cutbank. 2. Excavate TOP to BOT, establish a 4' channel width and lay back sideslopes to 2:1 for decommissioning. Spoil locally.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
371	Upper Austin Creek	M	Road drainage discharge point	28	240	0	A springy meadow drains onto the road, travelling 240' before exiting the road via an active gully and delivering to a class 2 stream. A lower skid road parallels the current road with a past, dewatered, stable gully from previous stream diversion. This is where the flow should go, as the gully here has cut down to bedrock and sideslopes appear fairly stable. Near surface bedrock on the roadbed may lead to problems installing road drainage treatments.	1. Approximately 35-40' up the right road approach from the current gully, install an 18"x30' ditch relief culvert with an 18"x10' downspout to direct flow into past gully. 2. Install 1 rolling dip at ditch relief culvert to prevent road drainage from bypassing ditch relief culvert. 3. Cut ditch 200' to the left. 4. Outslope road, retain ditch for 100' left from the new pipe location to the through cut portion of the road.
372	Upper Austin Creek	HM	Stream crossing	82	1,050	0	Two small streams above the road connect to the inboard ditch and divert down the right road approach. Minimal rilling down the right road from stream diversion. Treatment immediacy based on significant right road approach.	1. Excavate TOP to BOT, install a 24" x 70' culvert pipe at the base of fill and in the natural stream axis. Armor the outboard fillface with 40 yd3 1-2' rock armor. 2. Install a critical dip on the right hingeline. 3. Outslope road, fill ditch for 1050' and remove berm for 300'. 4. Install 7 rolling dips up the left approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
373	Upper Austin Creek	M	Stream crossing	27	160	0	Several small channels (totaling 3'w x 1'd) coalesce in the inboard ditch before diverting to the right in the same ditch. This area may also be handling flows from another diverted stream, site 372 located left.	1. Excavate TOP to BOT, install a 24" x 40' culvert at the base of fill and in the natural stream axis. Armor the lower 3/4 of the outboard fillface with 10 yd3 1-2' rock armor. 2. Install a trash rack above the inlet. 3. Install a critical dip along the right hingeline. 4. Outslope road, fill ditch for 160' to the left. 5. Install 1 rolling dip up the left road approach.
374	Upper Austin Creek	M	Stream crossing	8	150	0	Small fill crossing in steep grassland setting. Minimal stream flow at the crossing. No real rill or gully across the road but the outboard fillface appears to have experienced erosion in the past.	1. Install an armored fill crossing using 10 yd3 of 1-2' rock armor. 2. Outslope road, fill ditch for 150' up the left road approach. 3. Install 1 rolling dip up the left road.
375	Upper Austin Creek	ML	Stream crossing	60	30	460	Stream has essentially self decommissioned through a fill crossing. Channel has incised to what appears to be the natural base level. Banks are steep and bare in places, though do not appear extremely erosional. A slump/past landslide on the natural hillslope approximately 40' upstream appears to be more of a sediment production issue than the road, though this appears to be a natural feature. Future erosion estimate from continued raveling of the banks.	1. Lay back banks to 2:1 and store spoils locally. 2. Install 2 cross road drains between the site and the landing. 3. Install 2 rolling dips to the right of the landing. No equipment hours were added to rebuild crossing to access site#'s 376-379 because of their low treatment immediacy.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
376	Upper Austin Creek	L	Stream crossing	352	0	520	Washed out crossing on what may be Class I stream. Stream channel looks to be at grade. Only fill remaining is along right bank. 1.5' vertical scarps exist about 15' back into road and abandoned skid/road travels along right bank for 100'. See sketch for additional information. Low treatment immediacy due to equipment access issues regarding the rebuilding of site# 375.	1. Excavate from Start to End flags 2. Spoil half the spoils locally and endhaul the other half tor road shaping 3. Install 3 cross road drains up spur road and 4 up right road. Note: Additional time will be needed to rebuild crossing to access sites beyond *14hours labor and 1hour excavator time for de-watering the stream.
377	Upper Austin Creek	L	Other (swale)	12	30	20	Small but steep swale directs flow to headcut at OBF, where 4'w x 3'd gully is eroding what remains of a long abandoned road. Access to this area will be difficult as several washed out crossing to the right must be restored to allow equipment to get in here. Low treatment immediacy due to equipment access issues regarding the rebuilding of site# 375 and 376	1. Excavate 24 yd3 through axis of swale and from banks. 2. Store spoils locally.
378	Upper Austin Creek	L	Landslide	94	0	300	Unstable fill on OBF of long abandoned road. Spring and swale contributions from upslope helping to saturate fill. Access to this area will be tough, with washed out crossings and cutbank slides to contend with fillface itself is well vegetated, but tension cracks on road surface indicate instability. Low treatment immediacy due to equipment access issues regarding the rebuilding of site# 376	1. Excavate 70'w x 3'd x 12'long of unstable material from OBF 2. Store spoils locally along cutbank. 3. Install 4 cross road drains up right approach, with 1 in axis of small swale near right hinge of failure.
379	Upper Austin Creek	L	Stream crossing	20	0	0	Washed out crossing. Stream channel at grade with right bank oversteepened (55 degree). Fillslope is grassy and looks relatively stable. Low treatment immediacy due to equipment access issues regarding the rebuilding of site#375 and 376.	1. Pull back right bank from Start to End (site #378) flags to a 2:1 stable slope 2. Spoil locally.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
380	Upper Austin Creek	L	Stream crossing	39	100	30	Washed out crossing. Stream is actively eroding down to natural channel grade. Fillslopes are near vertical and bare with no scarps observed beyond fillslopes. Low treatment immediacy due to equipment access issues regarding the rebuilding of site#375.	1. Excavate crossing from TOP to BOT with 5' channel width. 2. Lay back sideslopes 2:1 for decommission. 3. Spoil locally. 4. Install 1 cross road drain up left road.
381	Upper Austin Creek	No treat	Stream crossing	Road surface only	60	0	Road crosses creek where two 4x1 streams coalesce. Stream has diverted down right road in the past, resulting in a gully which has left ~2' of walkable road surface. Stream has now incised to the point of near natural channel grade and another diversion seems highly unlikely.	No treatment.
382	Upper Austin Creek	ML	Stream crossing	3	0	210	Small stream flows across road before dissipating in campsite area, flow then coalesces and enters Austin Creek through Site #383 downstream ~80'.	1. Construct an armored fill crossing using 10 yd3 of 1.5' minus rock 2. Install 1 rolling dip up left approach.
383	Upper Austin Creek	ML	Stream crossing	4	60	20	Short spur road that leads to cabin. Stream currently flows under stack of 20' long logs than area that is armored with 4"-6" rock. Low gradient slope from road to Class I stream.	1. Construct an armored fill crossing using 20 yd3 of 0.5'-1.5' rock 2. Install 1 rolling dip up left approach.
384	Upper Austin Creek	ML	Road drainage discharge point	Road surface only	175	170	Low point along road length. Road is about 25' away from Austin Creek. Minimal rills from OBR down to creek. No real room to install rolling dips.	1. Outslope and fill ditch for 175' up left and 170 up right.
385	Upper Austin Creek	ML	Stream crossing	9	5	0	Stream flowing down past and future cutbank slide diverts to the right before exiting OBF via several small gullies and rills. Point where stream hits road is essentially a break in slope with dual diversion potentials, though currently flow is going to the right. Due to unstable natural setting, likely difficult to keep a dip through road here.	1. Install an armored fill crossing with 10 yd3 of 1.5' minus rock.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
386	Upper Austin Creek	ML	Stream crossing	4	0	40	Eight inch PVC pipe drains currently flowing stream. Stream travels down landslide deposit that may be active. Crossing is roughly 7' up slope from class 1 steam, hence the call for larger rock diameter for armor.	1. Install an armored fill crossing using 20yds3 of 1'-3' rock.
387	Upper Austin Creek	No treat	Stream crossing	9	140	85	Ford crossing across mainstem Upper Austin Creek. Crossing itself is stable but large cutbank failure on north side of channel is a natural sediment production feature. Rills and gullies on slide face will continue to expand and deliver sediment to creek. Future erosion from slide face from gully expansion. Left road approach is somewhat ugly (rills and springy cutbank), but vicinity to large slide suggests no treatment is required here.	No treatment.
408	Branscomb Creek (Lower East Austin Creek)	HM	Stream crossing	11	0	920	Small stream and excessive road approach drained by undersized, flat, plugged pipe set high in the fill. At some point a road or skid may have occupied the channel above and below current road. Unnecessary spur to the right with emergent spring could be decommissioned. Perched fill on the right bank below the BOT should be laid back. Treatment immediacy based primarily on connected road approach.	1. Remove existing pipe. 2. Install an armored fill using 15 yd3 1.5'- rock armor. 3. Excavate 10 yd3 from right bank below the BOT. 4. Outslope road/fill ditch for 900' up the right road approach (begin after benches at Julie Andrews' overlook). 5. Install 6 rolling dips up the right road. 6. Install 3 cross road drains up the spur to the right.
409	Branscomb Creek (Lower East Austin Creek)	HM	Ditch relief culvert	4	0	900	This is a large broad swale with a class 3 stream initiating below the road. The ditch relief culvert drains the swale and long, steep road approach. A gully has developed on the road surface and delivers directly to the inlet. Another gully has formed from the outlet to the class 3 stream, below. Simple road drainage treatments will help a lot.	1. Outslope/fill ditch for 900' of right road approach. 2. Install 5 rolling dips up the right road approach. 3. Rock road through the swale and up right approach for 60' (900 ft2 total). 4. Armor the outboard fillface at the swale axis with 5 yd3 1.5'- rock armor.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
410	Branscomb Creek (Lower East Austin Creek)	M	Stream crossing	12	0	1,045	Small stream hits the road and diverts left before gullying through outboard fillface back into the natural channel. Very steep right road approach, through cut in places, with near surface bedrock. It appears the best solution is to leave the stream in the inboard ditch for 30' and build an armored fill crossing at the current flow alignment. Treatment immediacy based on connected road approach.	1. Cut an inboard ditch for 30' to connect upper and lower channels. 2. Install an armored fill crossing with 15 yd3 1-2' rock armor. 3. Outslope road/fill ditch (where possible) for 1000' up the right road. 4. Install 9 rolling dips up the right road approach.
411	Branscomb Creek (Lower East Austin Creek)	M	Stream crossing	3	175	0	Small stream crossing with chunks of cement used as armor on small outboard fillface. Minimal gully developed through road surface, but right approach delivers directly to the site.	1. Install an armored fill crossing using 5 yd3 0.5-1.5' rock armor. 2. Install 1 rolling dip on the left road approach. 3. Outslope/fill ditch up the left road approach for 175'.
412	Branscomb Creek (Lower East Austin Creek)	ML	Stream crossing	4	40	10	Small stream intersects the road. Some attempt has been made to armor the outboard fillface with wood and scrap concrete, but a proper armored fill should be installed.	1. Install an armored fill using 5 yd3 1.5'- rock armor.
413	Branscomb Creek (Lower East Austin Creek)	M	Stream crossing	6	220	100	Ford crossing over Branscomb Creek (Lower East Austin Creek). Ford itself appears stable, but a fairly significant swale on the left approach is adding flows which are gullying down the adjacent 50' of left road approach. No effective option to get swale flow across road prior to the ford.	1. Pull up to 5 yd3 off left approach of the ford. 2. Cut an inboard ditch at the inboard road for 50' left of the ford to connect the swale to the creek. Armor ditch with 5 yd3 0.5'- rock armor. 3. Outslope road/fill ditch for 200' up the left road and 100' up the right road. 4. Install 1 rolling dip to the right and 2 left.
414	Branscomb Creek (Lower East Austin Creek)	L	Stream crossing	4	40	45	Well developed stream 100' up-channel and just below the road, but flat and filled in channel directly above the road. No gully developed through the road or on the outboard fillface. Both approaches are outsloped.	1. Install an armored fill crossing using 5 yd3 0.5-1.5' rock armor.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
415	Branscomb Creek (Lower East Austin Creek)	HM	Stream crossing	3	400	0	Near origin stream with a 100% plugged culvert. Stream currently crosses the road and erodes the outboard fillface. Some concrete blocks have been placed on the outboard fillface, though an insufficient amount. Road width is currently 7' from inboard to outboard road and may be difficult for vehicle access.	1. Install an armored fill crossing: Create a broad dip, excavate keyway, and place 10 yd4 of 0.5'-1.5' rock. 2. Rebuild to at least a 10' road width. 3. Outslope left road where possible. 4. Install 3 rolling dips on left approach.
416	Branscomb Creek (Lower East Austin Creek)	HM	Stream crossing	5	845	0	Small but active stream drained by armored fill which appears to have been installed after a headcut had migrated about 1/2 way into the fill prism, reducing the current road width to 6'. A swale to the left may be flow diverted from above or meadow drainage. Either way, a rocked dip should suffice for a drainage structure at the swale. Left road approach has changes in grade which may reverse grade (hard to tell), but left approach should be treated in entirety. The road beyond this site is accessible only by quad or walking due to narrow width at the crossing.	1. Install an armored fill crossing with 13 yd3 1.5'- rock armor. Establish 12' (minimum) road width. 2. At the swale to the left, install a rolling dip, apply 500 ft2 road rock and place 2 yd3 1.5'- rock armor on the outboard fillface. 3. Outslope road/fill ditch for 845' to the left. 4. Install 5 (additional) rolling dips up left road approach.
417	Branscomb Creek (Lower East Austin Creek)	HM	Stream crossing	2	350	0	Small near origin stream diverts to right and a large gully has developed. Above site there is a large meadow and several streamlets connect to road and likely drain past this site and into gully. Simple treatments could reduce much fine sediment input.	1. Install an armored fill crossing: Create a broad dip, excavate a keyway, and place 10 yd3 of 0.5'-1.5' rock. 2. Outslope 350' of left approach. 3. Install 2 rolling dips on left approach.
418	Branscomb Creek (Lower East Austin Creek)	M	Stream crossing	5	200	25	Two small streams coalesce at the plugged inlet of an undersized, non functional pipe. Gully has headcut through the fill into the road tread, exposing the pipe. Approaches are partially vegetated. Large oak tree at the outboard edge of the road should be saved.	1. Install an armored fill crossing using 10 yd3 1.5'- rock armor. Remove old pipe, save oak tree on outboard fillface. 2. Outslope road/fill ditch for 200' up the left road approach. 3. Install 1 rolling dip up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
419	Branscomb Creek (Lower East Austin Creek)	L	Stream crossing	2	0	415	Stream through a grassland swale meets road and mainly dissipates at the grade change. Defining channel axis will reduce the risk of gully development and will lower the amount of saturated meadow area currently being impacted by wild boar. The right road approach is steep in segments and bare, but outsloping and the installation rolling dips appears possible.	1. Install 2 small armored fill crossings in the stream axis: create broad dips, excavate a shallow keyway and place 5 yd3 1'- rock armor at each crossing. 2. Outslope/fill ditch for 415' up the right (Yellow Trail Road) approach. 3. Install 3 rolling dips up the right road.
420	Lower East Austin Creek	No treat	Other (swale)	Road surface only	625	0	Steep, rocky road crosses a swale, combines with road flow and ultimately dissipates on a large, flat bench which was used as a mill site at some point. Below this bench, a small class 3 stream develops and flows to East Austin Creek. While this road is nasty and a maintenance issue (if drivability is desired), it is very likely no road related sediment evacuates the depositional bench to impact East Austin Creek.	No treatment.
421	Branscomb Creek (Lower East Austin Creek)	ML	Spring	1	350	0	Main access route to spring/pump house for the property. Approximately 350' of wide, bare road delivers to a small gully developed across a small landing where water tanks reside. Gully enlargement will be minimal over time and delivery to the lower class 3 stream may only occur during extremely large storm events. Outboard fillface is self armored with redwood roots.	1. Outslope the left road approach for 350'. 2. Install 2 rolling dips up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
422	Branscomb Creek (Lower East Austin Creek)	HM	Stream crossing	164	340	0	Small stream with plugged, non-functional culvert. Very steep left approach and gullied skid contributing flows. Abundant fine grained sediment accumulated in creek from road drainage issues above. This sediment will mobilize as the gully progresses through the fill. Currently the stream diverts down the right road before gullying through the outboard fillface back to the natural channel. Water tanks and a well located approximately 350' to the right. This road needs to be accessible by truck, but the turn at the crossing is very tight and the road approach is extremely steep. Complexity reflects tight conditions and tricky rebuild.	1. Excavate TOP to BOT; remove outboard fillface of skid above inlet, remove stored sediments in channel, remove outboard fillface of main road above the BOT (narrow width to 10'). 2. Lower left approach 3-4' (if possible) to lessen grade. 3. Build an armored fill crossing at the site with 10 yd3 1.5'- rock armor. 4. Outslope road/fill ditch for 100' up left road. 5. Install 2 cross road drains up the skid.
423	Branscomb Creek (Lower East Austin Creek)	ML	Stream crossing	20	10	0	Two small streams, which may be drainage gullies from a pond on the neighbor's property (above), coalesce just below the outboard fillface after gullying through the fill. Future erosion estimate from gully enlargement. Excavation estimate includes removing sediment from between the two channels.	1. Excavate fill from both channels and from the area between the channels, establish the confluence of the streams at the current outboard fillface, lay back side slopes to 2:1, spoil to the right.
424	Branscomb Creek (Lower East Austin Creek)	M	Stream crossing	4	115	100	Stream in oak grassland setting with a large gully developed down the outboard fillfae. Sideslopes are grassy but vertical. Some armor has been placed to reduce headcutting, but is temporary. Road approaches grassed over, road apparently not used.	1. Excavate TOP to BOT, establish 2:1 sideslopes. 2. Install 2 cross road drains on the left road approach and 2 on the right.
425	Branscomb Creek (Lower East Austin Creek)	ML	Spring	Road surface only	425	15	Emergent spring above the road combines with road surface flow to contribute flows to a swale which then turns to a stream approximately 75' below the road. Almost no fill at the crossing.	1. Dip the crossing (5 yd3) with bulldozer. 2. Install 5 cross road drains up the left road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
426	Branscomb Creek (Lower East Austin Creek)	M	Stream crossing	76	190	0	Wide swale with class lll stream and plugged culvert on left hinge of swale. Meadow drains onto road surface 20' to the left of crossing, travels to right hingeline, and down outboard fill. Outboard fill is packed with trash. Gully development delivers sediments to stream.	1. Install an armored fill crossing using 20yds3 of 0.5'-1.5' rock armor. Excavate keyway plus material to BOT. 2. Endhaul spoils. 3. Cut ditch for 20' up left road to drain springy hillside. 4. Install 1 rolling dip along left road approach.
427	Branscomb Creek (Lower East Austin Creek)	No treat	Stream crossing	76	200	0	Stream has gullied through unused road and is dumping sediment into mainstem Branscomb Creek. Site is an older freature that will slowly contribute sediment to stream over time. Property line is 100' up the left road, with a cutbank slide approximately 100' beyond the property line.	No treat (due to severe access constraints) per check site evaluation DKH/TZ/BB 6/2/10
428	Branscomb Creek (Lower East Austin Creek)	No treat	Bank erosion	120	0	0	Old mill area in upper Branscomb Creek where inner gorge road is failing into the creek. Ten foot tall slumps are vertical and bare. Road surface is lumpy and duff covered with saw logs present.	No treat (due to access constraints) per check site evaluation 6/2/10 DKH/BB/TZ
429	Branscomb Creek (Lower East Austin Creek)	L	Stream crossing	4	0	25	Filled in swale with a class lll stream eroding through fill. Area currently used as mill site and extra water storage. Landowner may not want to treat. Future erosion based on gully enlargement along right bank.	1. Layback stream channel sideslope to 2:1 where possible. 2. Endhaul spoil.
430	Branscomb Creek (Lower East Austin Creek)	L	Stream crossing	42	210	75	Creek gullying through road at confluence with Brandscomb creek. This crossing should be decommissioned with additional material removed from the left bank below BOT. Check site to determine spoils management and necessity of trail rebuild.	Per check site evaluation 6/2/2010: 1. Using hand labor, lower road surface/define channel, excavate a 15' wide keyway tapering to 4' wide at the base of fill. Install an armored fill crossing using 10 yd3 0.5-1.5' rock armor.
431	Branscomb Creek (Lower East Austin Creek)	No treat	Stream crossing	5	60	25	Crossing was either pulled or washed out a long time ago. A small amount of fill may exist within old crossing, but due to stableness of area excavation does not seem necessary.	No treatment.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
432	Branscomb Creek (Lower East Austin Creek)	No treat	Other (gully)	1	110	0	Gully along grassy, no use, road. Gully has developed from diverted stream flow at site# 414, above. Once this site is treated, gully will receive less flow.	No treatment.
450	Upper East Austin Creek	M	Stream crossing	Road surface only	240	750	Ford crossing on East Austin Creek. Majority of left road in a through cut with one off road drain where a rolling dip could be installed. Crossing itself looks good. Right road contribution is off of property, hence no treatments for this road length.	1. Install 1 rolling dip at off road drain location. 2. rock remaining road length for rolling dip down to ford crossing.
451	Upper East Austin Creek	M	Stream crossing	6	0	185	Small stream valley development in grassland setting. Steam currently diverted down left inboard ditch to site# 453. Inboard ditch looks stable and not actively eroding. Future erosion volume based upon ditch enlargement.	1. Install an armored fill crossing using 10yds of 0.5'-1.5' rock. 2. Outslope road and retain ditch for 185' up left road.
452	Upper East Austin Creek	M	Stream crossing	6	0	150	Minimal stream valley development, above road, in grassland setting. Stream flow currently diverted down left inboard ditch and connected to site# 453. Future erosion volume based upon ditch enlargement.	1. Install an armored fill crossing using 10yds of 0.5'-1.5' rock. 2. Outslope road and retain ditch for 150' up left road.
453	Upper East Austin Creek	M	Stream crossing	12	250	150	Culverted stream crossing in grassland setting. Culvert looks to be at base of fill and at channel grade, as evident by bedrock step below outlet. Culvert looks adequately sized.	1. Install trash rack. 2. Outslope road and retain ditch for 150' up right road. 3. Outslope road and retain ditch for 250' up left road and install 1 rolling dip to drain road and cutbank.
454	Upper East Austin Creek	M	Stream crossing	9	0	310	Minimal stream development above road, in grassland setting. Stream currently diverted down left road for 230' to site# 455. Minimal rilling in ditch from diverted flow .	1. Install armored fill crossing using 15yds3 of 1'-2' rock 2. Outslope road and retain ditch for 310' up right road and install 1 rolling dip to drain road and cutbank.
455	Upper East Austin Creek	M	Stream crossing	10	0	230	Small stream flows onto road, deposits gravelly sediments on inboard road, and flow continues down left inboard ditch for 265' to site# 456. Future erosion based on ditch enlargement.	1. Install armored fill crossing using 10yds3 of 0.5'-1.5' rock 2. Outslope road and retain ditch for 260' up right road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
456	Upper East Austin Creek	M	Stream crossing	45	0	265	Looks to be oversized culvert for steam channel area. Stream looks to have incised through old landslide deposit. Banks of stream below outlet are near vertical and still sluffing. These could be pulled back to 2:1 angle to reduce sediment input. Minimal diversion potential. Future erosion volume and potential are based upon sluffing banks below culvert outlet.	1. Install a single post trash rack above inlet. 2. Pull back both left and right banks below outlet to 2:1 slope angle. 3. Spoil locally 4. Install 5yds3 of 1'-2' rock below outlet. 5. Install a critical dip along left hingeline of crossing. 6. Outslope road and retain ditch for 265' along right road reach.
457	Upper East Austin Creek	HM	Stream crossing	60	100	160	Fill crossing is moderately active eroding back into road fill at outboard road. Landowner has installed (sparse) rock and tires to armor fill. Stream banks below road are near vertical and sluffing into stream.	1. Install armored fill crossing using 20yds3 of 1'-2' rock. 2. Pull back both left and right banks to 2;1 angle for 50' down channel from bottom of armored fill area. 3. Spoil locally. 4. Outslope road and retain ditch for 160' up right road. 5. Outslope road and retain ditch for 100' up left road.
458	Upper East Austin Creek	M	Landslide	93	100	0	Road is about 25' up slope from Austin Creek on outside meander. Stream flow currently below bedrock bank but at higher flows, stream is actively eroding hillslope and road fill above. Most of the outboard fill looks to have already been eroded. Not much can be done to move road in or pull remaining fills without reducing road width and restricting vehicle traffic.	1. P ull what remaining fill (that cam be excavated) from START to END flags. 2. Endhaul spoil to use for road shaping. 3. Inslope road for 100' across face of slide area.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
459	Upper East Austin Creek	M	Stream crossing	33	210	120	Newly installed double walled culvert. Looks to be set in at channel grade. Looks to be old road fill on left bank from outlet for 30' down channel. Fill is near vertical and sluffing into channel..Old roadbed just upslope from current road.	1. Install a single post trash rack. 2. Pull back right road from outlet for 30' down channel (30x3x6). Spoil locally. 3. Outslope road and retain ditch for 120' up right road. 4. Outslope road and retain ditch for 210' up left road and install 1 rolling dip.
460	Upper East Austin Creek	M	Stream crossing	10	0	200	Minimal stream channel development above road. No road fill on abandoned roadbed above currently used road. Grassland setting. Landowner has placed a 3' boulder at outboard fill to armor fill slope.	1. Install an armored fill crossing using 15yds3 of 1'-2' rock. 2. Outslope road and retain ditch for 200' up right road length.
461	Upper East Austin Creek	M	Stream crossing	Road surface only	300	600	Ford crossing on "Devils Creek" . Crossing itself looks good, just the road approaches need treatment	1. Outslope road and retain ditch for 600' up right road length and install 3 rolling dips. 2. Outslope road and retain ditch for 300' up left road length and install 1 rolling dips.
462	Upper East Austin Creek	ML	Stream crossing	4	0	100	Looks to be a naturally aggraded stream channel above road. Partial flow diverts down left road to low spot, while the rest of the flow travels across road and continues down natural channel.	1. Install an armored fill crossing using 5yds3 of 0.5'-1.5' rock armor. 2. Outslope road and retain ditch for 100' up right road.
463	Upper East Austin Creek	HM	Ditch relief culvert	15	170	260	Ditch relief culvert drains right and left road approaches, as well as two swales. Road contribution is gullying outboard fill at site. Ditch flow is piping through the fill next to the culvert.	1. Replace culvert with a 18"x20' long culvert. 2. Install an 18"x30' long ditch relief culvert up right road approach. 3. Outslope road and retain ditch for 200' up right road and 2 rolling dips. 4. Outslope road and retain ditch for 170' up left road and install 1 rolling dip. 5. Cut inboard ditch for 200' to new culvert inlet.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
464	Upper East Austin Creek	M	Stream crossing	5	190	0	Low gradient class lll stream currently diverted 70' to the right where road is failing.. The road approach is gentle but bare.	1. Install an armored fill crossing using 15yds3 of 0.5'-1.5' rock. 2. Outslope road and retain ditch for 190' up left road.
465	Upper East Austin Creek	ML	Road drainage discharge point	Road surface only	375	150	Road surface drainage exits road and flows across short, well vegetated flood plain before entering East Austin Creek.	1. Outslope road and fill ditch for 375' up left road and install 3 rolling dips. 2. Outslope road and retain ditch for 150' up right road. 3. Install 1 cross road drain on skid below road.
466	Upper East Austin Creek	M	Stream crossing	5	110	110	Small stream with drainage structure across road. Non channel definition across road but a small gully has developed down outboard fill.	1. Install an armored fill crossing using 10yds3 of 0.5'-1.5' rock. 2. Outslope road and retain ditch for 110' up left road. 3. Outslope road and retain ditch for 110' up right road.
467	Upper East Austin Creek	M	Stream crossing	57	215	170	Small stream drains across road. Two small gullies on outboard fill appear to be the result of road and stream contribution.	1. Install an armored fill crossing using 20yds3 of 1'-2' rock. 2. Outslope road and retain ditch for 215' up left road and install 1 rolling dip. 3. Outslope road and retain ditch for 170' up right road and install 1 rolling dip.
468	Upper East Austin Creek	M	Road drainage discharge point	Road surface only	150	850	Excessive road length contributes road surface runoff to East Austin Creek via bedrock gully down 13' long hillslope.	1. Outslope road/retain ditch for 850' to the right and 150' to the left. 2. Install 5 rolling dips to the right.
469	Upper East Austin Creek	ML	Stream crossing	24	50	0	Field estimates consider culvert to be adequately sized for observed channel size. Culvert Q program suggests a 48" culvert diameter for the 100yr storm event. Not enough fill at site to accommodate this large of a culvert, hence an armored fill is recommended.	1. Install an armored fill crossing using 15yds3 of 1'-2' rock.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
470	Upper East Austin Creek	L	Stream crossing	Road surface only	200	274	Ford crossing on East Austin Creek. Crossing itself is fine. Left road length is on a flood plain with no real fill.	1. Install 1 rolling dip along the right road length.
471	Upper East Austin Creek	H	Landslide	69	0	200	Road fill slide being undercut by creek flow with road drainage actively contributing to 4' vertical scarp at the outboard edge of the road. Future erosion based on slide expansion through remaining prism (39 yd3) plus delivery of 30 yd3 of perched toe material. Check site- effective treatment will be difficult due to location of road with respect to an erosional bend in the creek. Broken water line visible to left on slide face may have contributed to this failure.	Per office discussion 6/4/10 (GM,TZ): 1. 14 hr/labor, 2 hr excavator to manage water during work. 2. Excavate a 25'w x 2'd x 2'l keyway at the base of fill. Pull material upslope to rebuild outboard fillface. 3. Armor the base of fill and approximately 1/2 way up the fillface with 50 yd3 3' diameter rock armor. 4. Outslope road/fill ditch for 200' up right road approach. 5. Install 1 rolling dip to the right.
472	Upper East Austin Creek	M	Stream crossing	36	70	600	Stream is currently diverted above the house. Dip in roadbed below the house is most likely the historic channel. House was probably built on the alluvial fan of the stream. The culvert (and stream flow) currently aligned just outside of the left hingeline of the crossing. Flow from the outlet gullies down the hillside for about 70' before reoccupying the natural channel area. Profile done to align new culvert pipe with original channel area. Check site: determine if area is indeed natural channel or older evacuated area of past landslide.	1. Replace culvert: install new outlet to drain into the natural channel, right of current outlet. May be underground infrastructure. 2. Outslope road/retain ditch for 600' to the right. 3. Install 3 rolling dips up right road approach.
473	Upper East Austin Creek	M	Stream crossing	27	0	460	Small, steep stream intersects road and diverts 25' to the left before gullying down the outboard fillslope and ultimately reoccupying the natural channel.	1. Install an armored fill with 25 yd3 1-2' rock armor. Leave stream in current alignment and capture flow with a very broad dip through the crossing. 2. Outslope road, fill ditch for 460' to the right. 3. Install 3 rolling dips up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
474	Upper East Austin Creek	M	Ditch relief culvert	24	560	0	Currently a 4'w x 4'd x 80'l gully begins at the culvert outlet and continues for 80' before entering the axis of the swale. Gully will likely continue to enlarge despite past attempts to armor with brush.	1. Outslope road/retain ditch for 560' up the left road. 2. Install 3 rolling dips to drain the road surface only. 3.Install 3 18" x 30' ditch relief culverts up the left road approach.
475	Upper East Austin Creek	M	Other (gully)	10	450	0	Road drainage and swale contribution exits road in a mostly vegetated gully, though portions of the bare sideslopes continue to ravel.	1. Install 2 18" x 30' ditch relief culverts up the left road. 2. Outslope road/retain ditch for 450' to the left. 3. Install 3 rolling dips up the left road approach.
476	Lower East Austin Creek	M	Stream crossing	36	150	0	Stream has not been active for quite sometime. Valley bottom covered in leaf litter. Ditch relief culvert on right hinge of crossing currently receives 700' of left road flow which has caused a 3'w x 3'd gully down hillside to intersect with the road below.	1. Install an armored fill crossing using 10 yd3 0.5-1.5' rock armor. 2. Outslope road, retain ditch for 150' up the left road approach.
477	Lower East Austin Creek	M	Stream crossing	12	250	0	Small stream intersects the road and diverts to the right. Road drainage gullies into natural channel. Bare, steep, raveling cutbank on left should be drained by dips as small slides may plug ditch relief culverts.	1. Install an armored fill crossing using 15 yd3 of 1-2' rock armor. 2. Outslope road, retain ditch for 250' of left road. 3. Install 2 rolling dips to the left. Connect to ditch.
478	Lower East Austin Creek	ML	Stream crossing	1	0	560	Continuation of stream flow from site 476. Roadbed is on the flood plain of East Austin Creek, with very little fill. It is likely only possible to install 2 rolling dips up the right road because of a broad turn.	1. Install an armored fill crossing using 10 yd3 1-2' rock armor. 2. Install 2 rolling dips up the right road (below the broad turn.
479	Lower East Austin Creek	L	Stream crossing	Road surface only	60	215	Large ford across East Austin Creek near the confluence with Gray Creek. Right approach travels across a flood plain and could benefit from a rolling dip, though high flow in the creek may wash out this road segment. Steep left approach previously upgraded.	1. Install 1 rolling dip up the right road approach.

2010 Austin Creek Watershed
Sediment Source Assessment
Sonoma County, California

PWA Report No. 10086601
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Sotoyome Resource Conservation District
Contract #ACWRP-001

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1 PROJECT SUMMARY

Austin Creek is a tributary to the Russian River. The Austin Creek Watershed Sediment Source Assessment Project (ACWA) area is located in the central coast region of Sonoma County, California, west of the town of Healdsburg and north of the town of Cazadero. The project involved assessing road related erosion and sediment delivery on public and private land in 3 subwatersheds of the Austin Creek watershed: Upper Austin Creek subwatershed, Lower East Austin Creek subwatershed, and Upper East Austin Creek subwatershed.

Using field inventories and data analysis, PWA identified a total of 446 sites along approximately 55.13 mi of roads with the potential to deliver sediment to streams within the project area. Approximately 12.21 mi of the assessed roads are located on public lands (BLM and State Parks) and 42.92 mi are located on private landholdings. Of the 446 inventoried sites, we recommend that 421 sites be treated for erosion control and erosion prevention. We estimate that treating these sites will prevent the episodic, primarily storm-driven delivery of approximately 18,680 yd^3 of sediment to salmonid streams in the Austin Creek watershed in the coming decades. In addition to individual, problematic erosion sites, field crews measured approximately 30.86 mi of road surfaces and/or ditches (representing nearly 56% of the total inventoried road mileage) currently draining to stream channels, either directly or via gullies. We recommend treating 30.39 mi of these road reaches to disperse road surface runoff and diminish chronic sediment delivery to the mainstem and tributaries of Austin Creek. We estimate that implementing the recommended road drainage treatments will prevent delivery of approximately 25,460 yd^3 of fine sediment to the stream system during the next decade alone. The estimated cost for implementing all recommended erosion control and erosion prevention treatments for the 2010 Austin Creek watershed assessment area is $2,241,240.

The expected benefit of completing the erosion control and erosion prevention treatments recommended in this report lies in the reduction of long-term sediment delivery to Austin Creek, an important watershed for coho salmon and steelhead production in Sonoma County, California. This assessment includes a prioritized plan of action for cost-effective erosion prevention and erosion control, which, when implemented and employed in combination with protective land-use practices, can be expected to significantly contribute to the long-term improvement of water quality and salmonid habitat in the watershed. With this prioritized plan of action, entities interested in the sustainability of the watershed and preservation of salmonid habitat can advance efforts to obtain funding and implement the road related erosion remediation plan for the ACWA area.

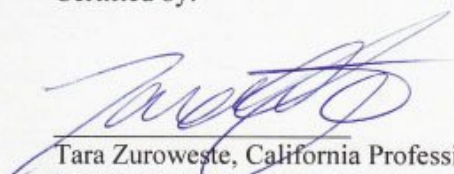
2 CERTIFICATION AND LIMITATIONS

This report, entitled *2010 Austin Creek Watershed Sediment Source Assessment, Sonoma County, California,* was prepared under the direction of a licensed professional geologist at Pacific Watershed Associates Inc. (PWA), and all information herein is based on data and information collected by PWA staff. Sediment-source inventory and analysis for the project, as well as erosion control treatment prescriptions, were similarly conducted by or under the responsible charge of a California licensed professional geologist at PWA.

The interpretations and conclusions presented in this report are based on a study of inherently limited scope. Observations are qualitative, or semi-quantitative, and confined to surface expressions of limited extent and artificial exposures of subsurface materials. Interpretations of problematic geologic and geomorphic features (such as unstable hillslopes) and erosion processes are based on the information available at the time of the study and on the nature and distribution of existing features.

The recommendations included in this report are professional opinions derived in accordance with current standards of professional practice, and are valid as of the submittal date. No other warranty, expressed or implied, is made. PWA is not responsible for changes in the conditions of the property with the passage of time, whether due to natural processes or to the works of man, or changing conditions on adjacent areas. Furthermore, to ensure proper applicability to existing conditions, the information and recommendations contained in this report shall be reevaluated after a period of no more than 3 years, and it is the responsibility of the landowner to ensure that no recommendations are inappropriately applied to conditions on the property that have changed since the recommendations were developed. Finally, PWA is not responsible for changes in applicable or appropriate standards beyond our control, such as those arising from changes in legislation or the broadening of knowledge, which may invalidate any of our findings.

Certified by:



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3 INTRODUCTION

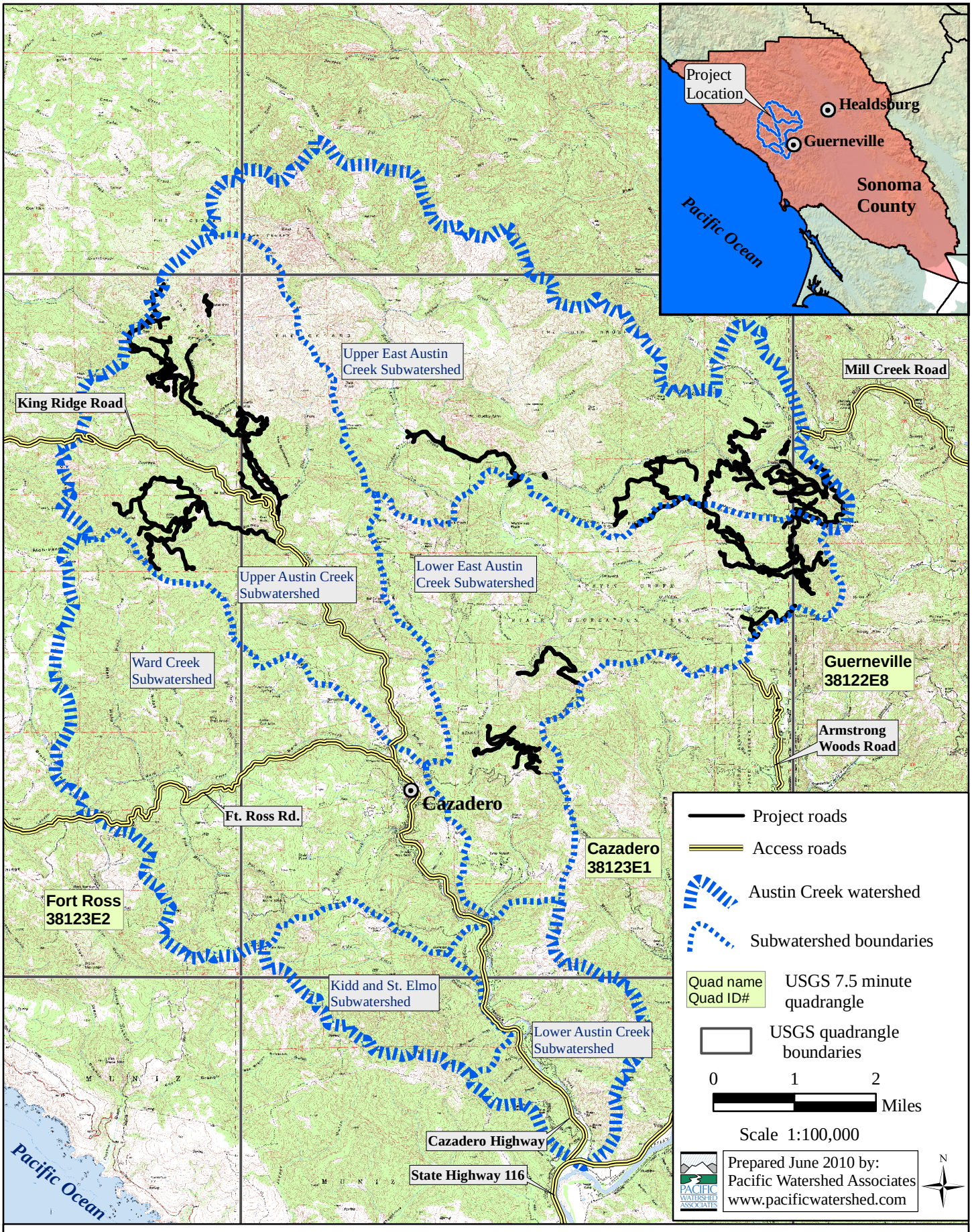
One of the most important watershed management elements of long-term restoration and maintenance of both water quality and fish habitat is the reduction of future impacts from upland erosion and sediment delivery. Sediment delivery to stream channels from roads and road networks has been extensively documented, and is recognized as a significant impediment to the health of salmonid habitat (Furniss et al., 1991; Higgins et al., 1992; Harr and Nichols, 1993; Flosi et al., 1998; NMFS, 2000, 2001; Cafferata et al., 2007). Unlike many watershed improvement and restoration activities, erosion prevention through "storm-proofing" rural, ranch, and forest roads provides immediate benefits to the streams and aquatic habitat of a watershed (Weaver and Hagans, 1994, 1999; Weaver et al., 2006). It measurably diminishes the impact of road related erosion on the biological productivity of the watershed's streams, and allows future storm runoff to cleanse the streams of accumulated coarse and fine sediment, rather than allowing continued sediment delivery from managed areas.

The Austin Creek Watershed Sediment Source Assessment (ACWA) project area is located in the central coast region of Sonoma County, California, west of the town of Healdsburg and north of the town of Cazadero (Map 1). Austin Creek is a major tributary of the Russian River. Its watershed encompasses an area of approximately 68.7 mi^2 and includes about 175 mi of blue line stream based on USGS 7.5-minute quadrangle data (USGS 1979, 1997, 1998a, b). Roads assessed for this project are located in 3 subwatersheds of Austin Creek: Upper Austin Creek, Lower East Austin Creek, and Upper East Austin Creek subwatersheds.[1]

Current land use in the Austin Creek watershed includes timber harvesting, quarrying, gravel mining, and rural development. Historically, the watershed supported extensive logging as well as magnesite mining. The watershed is dominantly vegetated with coniferous forests, but there are zones of grassland and oak woodland in the upper areas. With the exception of the Austin Creek State Recreation Area and the Bureau of Land Management Properties (CDFG, 2002), all landholdings in the watershed are privately owned.

In order to improve fisheries in the Russian River and Austin Creek, CDFG has designated mapping and treating all active and potential sediment sources in the watersheds as a top priority, focusing specifically on roads systems (CDFG, 2002). In the CDFG Coho Salmon Recovery Strategy, recommendations for Austin Creek and its tributaries include assessment, prioritization, and treatment of sources of excess sediment. The Draft Russian River Basin Fisheries Restoration Plan (CDFG, 2002, p. 99) notes that road building is the most detrimental human activity in terms of accelerated erosion in the basin. Reasons given for the detrimental effects of roads include the fact that the slopes at which most roads are built tend to inhibit the natural dispersal of water, thereby concentrating runoff and creating gullies and landslides. In addition, road networks have created drastic changes in the natural drainage patterns of the watershed by increasing the area of impervious surfaces and diverting water to follow roads rather than natural

[1] These subwatershed designations are consistent with previous work by Laurel Marcus and Associates (2005).



Map 1. Location of the 2010 Austin Creek Watershed Sediment Source Assessment, Sonoma County, California (Guerneville, Cazadero, and Fort Ross 7.5-minute quadrangles; USGS, 1997, 1998a, b).

patterns. The purpose of the 2010 Austin Creek Watershed Sediment Source Assessment Project is to evaluate road related sources of erosion and sediment delivery on both private and public roads in the watershed, and develop a prioritized plan of action to reduce sediment delivery to the mainstem and tributaries of Austin Creek. This project builds upon previous efforts of large road improvement projects within the Austin Creek basin. This includes road improvement work completed in the Gray Creek, Ward Creek, and Lower East Austin Creek subwatersheds (Pacific Watershed Associates, 1999, 2002, 2004, 2007).

In this report, we provide results of the field assessment and data analysis, and a detailed plan of action for implementing erosion control and erosion prevention treatments to reduce road related erosion in the project area. All treatment prescriptions follow guidelines described in the *Handbook for Forest and Ranch Roads* (Weaver and Hagans, 1994), as well as *Parts IX* and *X* of the California Department of Fish and Game *Salmonid Stream Habitat Restoration Manual* (Taylor and Love, 2003; Weaver et al., 2006). Assessment data are summarized in Tables 1-5; Maps 1, 2, 3a-h, 4a-h, and Appendix A. Projected requirements for heavy equipment and estimated project costs are provided in Tables 6 and 7. Construction and installation instructions for the recommended erosion control and erosion prevention treatments are provided in Appendixes B. For an overview of terminology and techniques used in road related erosion assessments, see Section 12: Supplementary Information.

4 FIELD DESCRIPTION OF THE ASSESSMENT AREA

4.1 Location and Travel Directions to the Field Area

The project area is located in the central coast region of Sonoma County, California, west of the town of Healdsburg and north of the town of Cazadero (Map 1). The Gualala River and Russian Gulch watersheds separate the project area from the Pacific Coast. Roads assessed for the project are located in 3 subwatersheds of the Austin Creek watershed: Upper Austin Creek, Upper East Austin Creek, and Lower East Austin Creek.

To access the Upper Austin Creek subwatershed project area, take River Road (State Highway 116) west through Monte Rio and turn north onto Cazadero Highway at the confluence of Austin Creek and the Russian River. Travel approximately 6 mi along Cazadero Highway to the town of Cazadero, and then veer to the right onto King Ridge Road. Project roads in the Upper Austin Creek subwatershed area are located on both sides of King Ridge Road approximately 6 mi north of the town of Cazadero. Project roads in the Lower East Austin Creek subwatershed can be accessed from the town of Guerneville (located along State Highway 116) on Armstrong Woods Road or Old Cazadero Road. To reach project roads in the Upper East Austin Creek area, travel west from Healdsburg on Westside Road for approximately 1.5 mi to Mill Creek Road, and then take Mill Creek Road west approximately 8.2 mi to Gray Creek Road.

4.2 Climate, Terrain, and Local Geology

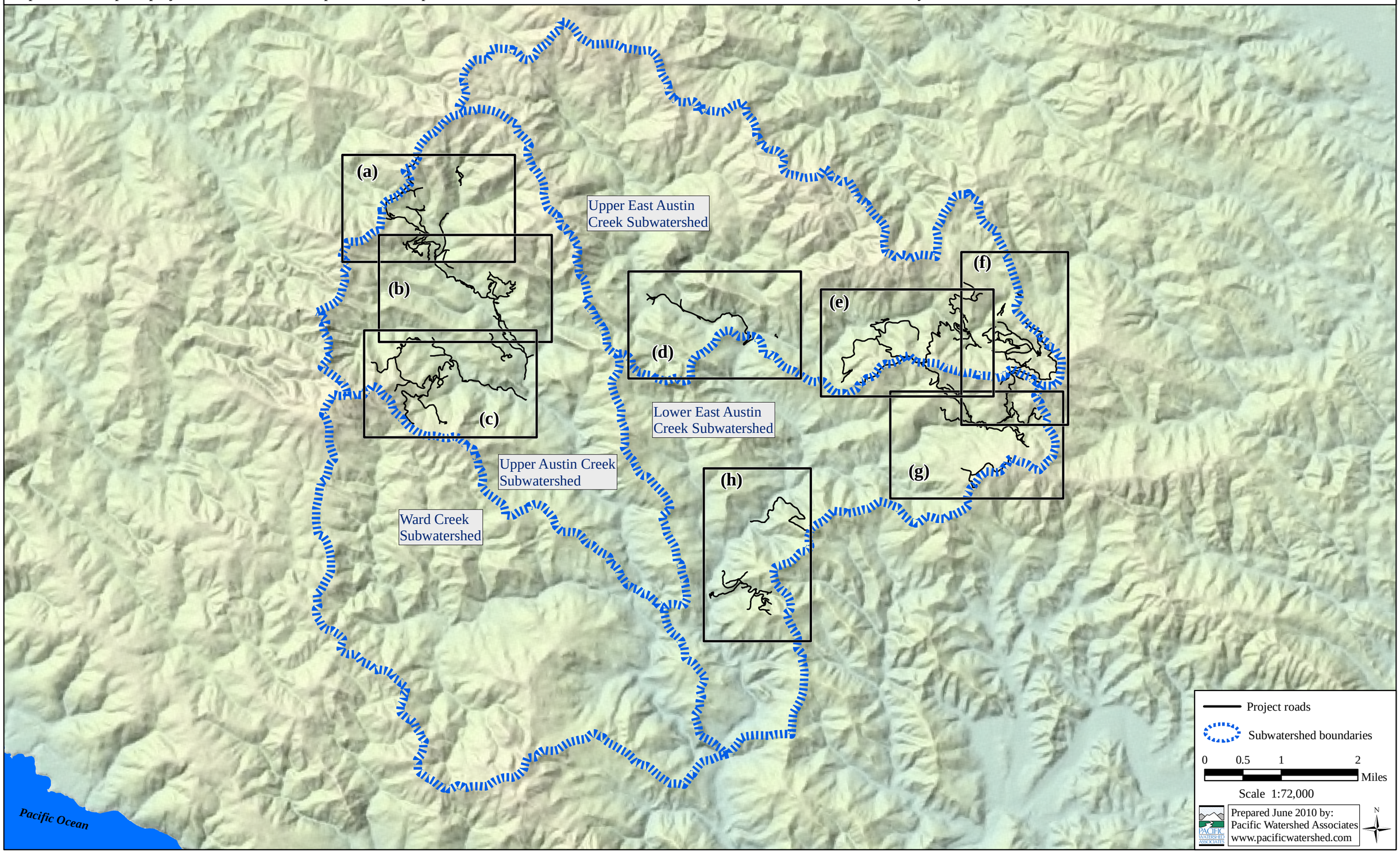
Central coast of California in the area of the Austin Creek watershed experiences a Mediterranean-type climate with warm, dry summers, and cool, wet winters with occasional intense rainstorms. Mean annual precipitation in the Austin Creek watershed is approximately 59.2 in., based on California Department of Water Resources rain gauges in Vanado and the surrounding area.[2] Most rainfall occurs between November and April, with the eastern part of the watershed receiving about 20 more inches of rainfall per year on average than the western edge of the watershed (Laurel Marcus and Associates, 2005). Snow accumulation is rare on average, but occasional damaging snowstorms occur in the area, including as recently as 1974 (Laurel Marcus and Associates, 2005). The temperate climate and abundant rainfall in the watershed support expansive forests of Redwood and Douglas fir, with varying amounts of Tanoak and Bay, and zones of grassland and oak woodlands.

The geology of the Austin Creek basin is complex, with many dynamic forces shaping a constantly evolving landscape. The steep terrain of the 68.7 mi^2 Austin Creek watershed is primarily an effect of coastal tectonic uplift. Splays of the roughly north-south oriented San Andreas Fault system, which is located just west of the project area, dissect the watershed. The Jurassic-Cretaceous Franciscan Formation, a mixed assortment of sedimentary and metamorphic lithologies formed during the tectonic evolution of the California coast, is the primary geologic formation underlying the Austin Creek watershed (Blake et al., 2002). The highly erodible Franciscan graywacke and mélange unit (KJfs) underlies approximately 42% of the total watershed area (Laurel Marcus and Associates, 2005). Additional rock units of the Franciscan Formation include greenstone, metabasalt, sandstones of varying ages, serpentinite, and small outcrops of silica-carbonates (hydrothermally altered serpentinites). In the Upper Austin Creek subwatershed, exposures of serpentinite blocks (sp) are prominent, along with various units of the Franciscan Formation. The underlying geology of the Upper East Austin Creek subwatershed is primarily Eocene- to Cretaceous-age sandstone (TKfs). In contrast, the dominant rock types in the Lower Austin Creek subwatershed (near the confluence with the Russian River) consist of Jurassic-Cretaceous Franciscan metabasalts (KJfmg) and resilient Great Valley Sequence conglomerates (KJgvc). Surficial Quaternary aged landslide deposits (Qls) are widespread in the Austin Creek watershed, especially in the lower watershed (Blake et al., 2002; Laurel Marcus and Associates, 2005.)

Elevations in the watershed range from 95 ft to approximately 2,300 ft (USGS, 1997, 1998a, 1998b). Unsurfaced roads in the project area traverse a range of elevations from ridgetops to the inner gorges of streams, including Upper Austin Creek, East Austin Creek, Gray Creek, Gilliam Creek and Bearpen Creek and several small unnamed tributaries (Maps 2, 3a-h, 4a-h). Of significance for salmonid habitat, the extensive construction of roads for timber harvesting in this area of steep terrain, erodible geologic substrate, and high rainfall (including occasional intense winter storms) has resulted in high rates of erosion and sediment delivery from road networks to stream channels. The lower tributaries within the basin alternately traverse gorges with steep, unstable slopes and high rates of erosion, and low gradient areas that facilitate sediment

[2] Rainfall data acquired from: http://www.krisweb.com/krisrussian/krisdb/webbuilder/ws_c.htm

Map 2. Index map for project areas detailed in Maps 3a-h and Maps 4a-h. Austin Creek Watershed Sediment Source Assessment, Sonoma County, California.



deposition and accumulation. Whereas salmonid populations have evolved and flourished with the natural processes of rainfall and erosion in the area, the impact of anthropogenically induced erosion from resource management and road construction has resulted in accelerated sediment delivery to streams and a degradation of salmonid habitat in this important watershed.

4.3 Road Networks in the Project Area

Roads inventoried in the ACWA area are categorized as maintained, abandoned, or decommissioned.

Maintained roads show some evidence for recent maintenance (e.g. brushing, culvert cleaning, recent rocking, etc). Maintained year-round use roads in the ACWA project area are surfaced with locally developed aggregate for surface rock, and have culverted drainage structures at most stream crossings. Although these roads have been maintained for landowner and public access, the majority are insufficiently drained, with infrequent ditch relief culverts and minimal road shaping to improve drainage. Currently, maintained roads in the project area include long reaches from which concentrated runoff from the erosion of road surfaces, ditches, and cutbanks is draining directly into the stream system.

Abandoned roads show no evidence for recent maintenance and are usually overgrown to varying degrees. Along many designated abandoned roads in the project area, PWA observed problems typical of outdated land use management practices, including use of Humboldt crossings and poorly designed fill crossings; undersized culverts; diverted streams or streams with developing diversion problems; and long stretches of hydrologically connected[3] road reaches adjacent to stream crossings.

Decommissioned roads are those that have been determined by the landowner to be unnecessary for future use, and therefore treated to protect local hydrology and hillslope stability, and permanently closed. Decommissioned roads are typically treated by removing road fill from stream crossings; relocating excavated fill material to stable, long-term storage locations; and decompacting, obliterating, or otherwise hydrologically disconnecting the former road surface from the stream system.

4.3.1 Roads in the Upper Austin Creek subwatershed

Approximately 26.8 mi of roads were assessed within the Upper Austin Creek subwatershed, all of which are on private property. Daily traffic use for most roads is minimal as the majority are used for residential access, and appear only passable by 4WD vehicles. There are short abandoned spur roads on some properties, most likely originally constructed to support logging. A 2 mi long road reach in the Bearpen Creek subbasin of Upper Austin Creek receives relatively higher use by cars and delivery trucks, and portions are paved.

[3] Hydrologically connected describes sites or road segments from which eroding sediment is delivered to stream channels (Furniss et al., 2000). See also Section 12 (Supplementary Information).

4.3.2 Roads in the Lower East Austin Creek subwatershed

Approximately 15.2 mi of roads were assessed with the Lower East Austin Creek subwatershed, of which the majority (~11.7 mi) are on State Parks property. Private roads in the area are primarily used for recreational purposes (e.g., hiking, ATV use), and some provide access to potable water infrastructure. Most of the project roads on State Parks property are abandoned roads in the Gilliam Creek subbasin that are being considered either for decommissioning or conversion to trails. This assessment project follows through on earlier work to assess and treat road related erosion on State Parks property in Austin Creek (Pacific Watershed Associates, 1999), effectively finalizing the assessment of all roads on State Parks property in the watershed.

4.3.3 Roads in the Upper East Austin Creek subwatershed

Approximately 13.2 mi of roads were assessed in the Upper East Austin Creek subwatershed, all of which are on private property. The majority of the roads are for residential access and receive minimal daily traffic. In 2002, a 4.8 mi portion of Gray Creek Road was upgraded to PWA road drainage standards, with outsloping, rolling dips, and culverts or ford crossings sized for the 100-year peak storm flow (Pacific Watershed Associates, 2002). For this project, PWA staff assessed spur roads leading off Gray Creek Road, effectively finalizing the assessment of all roads within the Gray Creek subbasin of the Upper East Austin Creek subwatershed.

5 FIELD TECHNIQUES AND DATA COLLECTION

The ACWA project consists of two distinct elements: (1) a complete field inventory of all current and potential road related erosion sources along approximately 55.13 mi of road; and (2) the development of a prioritized plan of action for cost-effective erosion control and erosion prevention treatments in the watershed. All project elements were completed under the direction of a PWA licensed professional geologist.

To facilitate the field inventory, GIS data layers provided by Sotoyome RCD were combined with NAIP imagery (CaSIL, 2008) and 10 m contour interval layers to produce field maps at a 1:6,000 scale. These maps were used to document the locations of inventoried sites, and to ground truth the location and configuration of mapped road segments in the field. Roads that were not identified on any of the provided layers but were located in the field were also mapped, and were included in the field inventory. The GIS roads layer was then modified based on ground truthing, and used in the development of the final project maps.

PWA conducted a field inventory of all identified road segments, and assessed all road related erosion sites showing evidence of past or potential sediment delivery to the stream system. Because the purpose of the inventory was to quantify the potential magnitude of impacts of road related erosion on fish-bearing streams, we excluded any site or road reach showing evidence for

erosion (past, current, or potential) that did not also show evidence for current or potential sediment delivery to a stream.

Inventoried sites for this assessment primarily consist of stream crossings, potential and existing landslides related to the road system, gullies below ditch relief culverts, and various discharge points (e.g., swales, roadside gullies, low spots in the road, berm breaches) for uncontrolled road surface and/or inboard ditch runoff.[4] For each site identified as a potential sediment source, PWA staff plotted its location on a GIS-generated map with a 1:6,000 scale NAIP imagery base; collected a GPS waypoint using a GPS map 60Cx handheld GPS unit (where possible based on satellite reception); and recorded a series of field observations including: (1) detailed site description; (2) nature and magnitude of existing and potential erosion problems; (3) likelihood of erosion or slope failure; (4) length of hydrologically connected road surface associated with the site; and (5) treatments needed for prevention or elimination of future sediment delivery. The data collected for each site also includes an evaluation of *treatment immediacy* based on the potential or likelihood of sediment delivery from the site to a stream channel, and the level of urgency for addressing erosion problems at that location. Stream crossing sites were additionally evaluated for potential fish barrier problems.

For each existing or possible problem site in the project area, PWA field staff evaluated the potential for erosion and sediment delivery, and collected field measurements (width, depth, and length of the potential erosion area) to derive sediment volume. For most stream crossings, PWA field crews used tape and clinometer surveys to develop longitudinal profiles and cross sections of the site. These data were used to calculate road fill and potential sediment delivery volumes with the STREAM computer program. This proprietary software, developed by PWA, provides accurate and reproducible estimates of: (1) the potential volume of erosion at a stream crossing, whether over time or during any possible catastrophic, storm-generated washout; (2) excavation volumes associated with culvert installation, culvert replacement, or complete decommissioning of a stream crossing; and (3) backfill volumes associated with culvert installation or replacement. In addition, field crews measured the lengths of hydrologically connected road to derive estimates for chronic sediment delivery. The roadbed, ditch, and cutbank of hydrologically connected road reaches were inspected and each road reach assigned to 1 of 5 rates of chronic road surface lowering/cutbank retreat based on the level of road usage, types of surfacing materials, soil competency, vegetative cover, and observed evidence of surface erosion in progress. Chronic sediment production from hydrologically connected road reaches was calculated on a decadal basis, using the empirical formulas:

<u>For unpaved roads:</u>
(measured length) x (25 ft average width, including cutbanks and ditches) x (0.1-0.3 ft average lowering of the road and ditch/cutbank retreat per decade).

<u>For paved roads:</u>
(measured length) x (10 ft average width) x (0.1-0.3 ft average cutbank or ditch retreat per decade).

[4] Detailed definitions of sediment delivery sites are provided in Section 12.

Where new or replacement stream crossing culverts are recommended for installation, culverts are sized to convey the 100-year peak storm flow.[5] PWA staff calculated the necessary culvert sizes using either (1) the Rational Method (Dunne and Leopold, 1978), for drainage areas less than 80 acres; or (2) the empirical equations of the USGS Magnitude and Frequency Method (Wannanan and Crippen, 1977) for drainage areas equal to or larger than 80 acres. These culvert sizing calculations were used for stream crossings where the field-estimated bankfull channel dimensions were greater than approximately 3 ft by 1 ft in cross sectional area.[6]

In the final phase of the project, PWA personnel analyzed the inventory results to develop cost-effective erosion control and erosion prevention prescriptions, as well as a prioritized plan of action for the project area. Using field observations, data analyses, and information about realistic needs for future road use from the various landowners, PWA staff assigned a treatment designation of either "upgrade" or "decommission" for each treatment site.[7] These designations are intended to provide the landowner with prescriptions and estimated costs for storm-proofing treatment sites and hydrologically connected road segments, and are PWA's best recommendations for the most efficient and cost-effective methods to accomplish this goal.

6 RESULTS

The purpose of the field assessment was to identify and quantify all locations that either are currently eroding and delivering sediment to streams in the project area, or show a potential to do so in the future. We did not inventory any on-going or potential erosion sites identified in the field that did not also show evidence for sediment delivery to a stream. Although such sites may impact road or trail maintenance, they do not represent a threat to water quality or fish habitat, and therefore were not applicable to this project.

6.1 Summary of Field Data and Analyses

PWA field crews identified a total of 446 sites and approximately 30.86 mi of hydrologically connected road surfaces with the potential to deliver sediment to streams in the Austin Creek assessment area (Maps 3a-h; Tables 1a, 1b; Appendix A). We recommend that 421 of these sites and 30.39 mi of the connected road segments be treated for erosion control and erosion prevention (Table 1a). Field data show that treating the 421 sites will prevent the future episodic delivery of approximately 18,680 yd^3 of sediment to streams in the Austin Creek watershed, and that treating the 30.39 mi of connected road segments could prevent delivery of approximately

[5] The *100-year peak storm flow* for a location is the discharge that has a 1% probability of occurring at that location during any given year.

[6] For stream channels with cross sectional areas of 3 ft^2 or smaller, PWA follows the recommendations outlined in the California Department Fish and Game *Salmonid Stream Habitat Restoration Manual* and defaults to a minimum culvert size of 24 in.

[7] See Section 12 for additional information on road upgrading and decommissioning.

25,460 yd^3 of fine sediment during the next decade alone (Table 2). The total estimated sediment delivery for the sites and road reaches recommended for treatment account for 98% of the total identified volume of potential sediment delivery from all identified sites and connected road surfaces within the project area.

Table 1a. Inventory results for sediment delivery sites and hydrologically connected road segments, 2010 Austin Creek Watershed Sediment Source Assessment, Sonoma County, California.

Sources of sediment delivery	Sediment delivery sites		Hydrologically connected roads adjacent to sites		Total length of roads surveyed for project (mi)
	Inventoried (#)	Recommended for treatment (#)	Inventoried (mi)	Recommended for treatment (mi)	
Stream crossings	341	322	23.69	23.40	-
Ditch relief culverts	24	24	2.49	2.49	-
Landslides	28	27	0.94	0.94	-
Springs	13	11	0.87	0.83	
Road drainage discharge points	22	22	1.90	1.90	-
Bank erosion	5	4	0.13	0.13	-
Other[a]	13	11	0.84	0.70	-
Total	**446**	**421**	**30.86**	**30.39**	**55.13**

[a]*Other* sources of sediment delivery are specified in Table 1b, and include 5 gullies and 8 swales.

Table 1b. Sediment delivery sites included in the "Other" category in Table 1a and Maps 2a-h and 3a-h, 2010 Austin Creek Watershed Sediment Source Assessment, Sonoma County, California.

Site #	"Other" sediment delivery sites	Recommended for treatment (Y/N)
61	Swale	Y
65	Swale	Y
117	Gully	Y
211	Gully	Y
212	Gully	Y
299	Swale	Y
339	Swale	Y
350	Swale	Y

Table 1b—cont. Sediment delivery sites included in the "Other" category in Table 1a and Maps 2a-h and 3a-h, 2010 Austin Creek Watershed Sediment Source Assessment, Sonoma County, California.

Site #	"Other" sediment delivery sites	Recommended for treatment (Y/N)
363	Swale	Y
377	Swale	Y
420	Swale	N
432	Gully	N
475	Gully	Y

Table 2. Estimated future sediment delivery for sites and road surfaces recommended for treatment, 2010 Austin Creek Watershed Sediment Source Assessment, Sonoma County, California.

Sources of sediment delivery	Estimated future sediment delivery (yd^3)	Percent of total
1. Episodic sediment delivery from road related erosion sites (indeterminate time period)		
Stream crossings	14,055	75 %
Landslides	2,065	11 %
Ditch relief culverts	80	<1 %
Springs	45	<1 %
Bank erosion sites	440	2 %
Road drainage discharge points	80	<1 %
Other sites[a]	1,915	10 %
Total episodic sediment delivery	**18,680**	**100%**
2. Chronic sediment delivery from road surface erosion (estimated for a 10 yr period)[b]		
Total chronic sediment delivery	**25,460**	

Note: Twenty five (25) sites were identified as 'No Treat' within the project area (19 stream crossings, 1 landslide, 2 springs, 1 bank erosion, 1 gully, and 1 swale). Total future erosion for these sites is estimated to be 870 yd^3 (495 yd^3 episodic sediment delivery volume and 375 yd^3 chronic sediment delivery volume).

[a]*Other* sources of sediment delivery are specified in Table 1b, and include: 7 swales and 4 gullies.

[b]Sediment delivery for rocked and native surface roads is calculated for a 10 yr period. It assumes a combined width of 25 ft for the road, ditch, and cutbank contributing area, and 1 of 5 empirical values for road surface lowering and cutbank retreat based on field analyses by PWA staff: (1) 0.1 ft/10 yr (low rating); (2) 0.15 ft/10 yr (moderate-low rating); (3) 0.2 ft/10 yr (moderate rating); (4) 0.25 ft/10yr (high-moderate rating); and (5) 0.3 ft/10yr (high rating).

PWA recommends treatment for 322 stream crossings in the Austin Creek assessment area, which account for 75% of all treatment sites (Table 1a). Inventoried stream crossing sites include 143 crossings with culverts, 142 fill (unculverted) crossings, 8 pulled or decommissioned crossings, 5 Humboldt crossings, 5 bridges, 8 armored fill, and 22 ford crossings (Appendix A). We project that approximately 14,055 yd^3 of future road related sediment delivery will originate from the 322 stream crossings if they are left untreated, which is approximately 75% of total future episodic sediment delivery from sites recommended for treatment in the ACWA project area (Table 2).

PWA identified 29 stream crossings on maintained and unmaintained roads that have drainage structures not sufficiently designed for the 100-year peak storm flow (Table 3). Furthermore, of the total 341 inventoried stream crossings, 175 have the potential to divert in the future and 61 streams are currently diverted. Of the 143 existing culverts at stream crossings, 111 have a moderate or high potential to become plugged by sediment and debris (Table 3).

Table 3. Erosion problems at stream crossings, 2010 Austin Creek Watershed Sediment Source Assessment, Sonoma County, California.

Stream crossing problem	# Inventoried	Percent of total[a]
Stream crossings with diversion potential	175	51 %
Stream crossings currently diverted	61	18 %
Crossings with culverts likely to plug[b]	111	33 %
Crossings with culverts that are currently undersized[c]	29	8%

[a]From Table 1a, total stream crossings inventoried = 341.
[b]Culvert plug potential is moderate to high.
[c]Culverts in stream channels larger than 3 ft x 1 ft that are too small to convey the calculated 100-year peak storm flow.

Ditch relief culverts were inventoried if they showed the potential to deliver future, site-specific erosion, or were currently functioning as conduits for delivery of road surface sediment. PWA recommends treatment for all 24 inventoried ditch relief culvert sites in the ACWA area (Table 1a). Ditch relief culverts represent less than 1% of all treatment sites, with a projected potential sediment delivery of 80 yd^3 (Table 2).

Field crews identified a total of 27 road related landslides that require treatment: 20 potential road fill landslides, 3 potential landing fill failure, 2 slow moving deep-seated features, and 2 cutbank slides. The total estimated sediment delivery from landslides is 2,065 yd^3, which is approximately 11% of the total future episodic sediment delivery from recommended treatment sites in the ACWA project area.

PWA inventoried 13 springs that exhibit the potential for sediment delivery, 11 of which are recommended for treatment. Springs account for less than 1% of all treatment sites. Total estimated future sediment delivery from the 11 springs recommended for treatment is 45 yd^3.

Discharge points for road surface drainage are locations along poorly drained road segments where accumulated concentrated flow from road surface/ditch/cutbank erosion exits the road to be delivered to a stream. The accumulation and subsequent discharge of large quantities of road surface runoff frequently results in the erosion of a length of native hillside or fillslope between the road and the receiving stream channel. In addition, these sites are also commonly found along streamside roads in close proximity to a stream channel. All 22 discharge points identified in the ACWA area are recommended for treatment. Estimated site-specific future sediment delivery from these sites totals 80 yd^3, less than 1% of the total future episodic sediment delivery from recommended treatment sites.

A bank erosion site is the result of stream erosion at the base of road fill, as compared to a landslide site that includes other kinds of hillslope mechanisms. PWA recommends treatment for 3 of the 4 inventoried bank erosion sites in the ACWA area. Estimated future sediment delivery for these sites is 440 yd^3 which accounts for 2% of the total future episodic sediment delivery from recommended treatment sites in the ACWA project area.

PWA field staff identified an additional 13 'other' sediment delivery sites (swales or gullies), 11 of which require treatment (Tables 1a, 1b). Estimated site-specific future sediment delivery from these sites totals 915 yd^3, which is about 10% of the estimated future episodic sediment delivery for the project area.

PWA field crews measured approximately 30.86 mi of road surfaces and/or ditches (representing 56% of the total ~55 mi of inventoried roads) currently draining to stream channels, either directly or via gullies (Table 1a). Based on assessments PWA has conducted over the last 2 decades in many similar forested watersheds, this represents a high connectivity value. Our field data show that approximately 30.39 mi of hydrologically connected road reaches are feasible to treat, which could prevent a substantial volume (>25,000 yd^3) of fine sediment from being delivered to stream channels in the ACWA area over the next decade (Table 2).

Of the 421 inventoried sites that we recommend for treatment, we designate 78 with priority ratings of high or high-moderate: 64 upgrade sites and 14 decommission sites (Maps 4a-h; Tables 4a, 4b; Appendix A). The potential episodic sediment delivery (over an indeterminate time period) for the 78 sites is approximately 8,545 yd^3, which is about 46% of the projected episodic sediment delivery for the project area. There are a total of 7.85 mi of hydrologically connected road segments associated with these sites, which, we project, could deliver an additional 7,560 yd^3 of sediment to streams in the ACWA area during the next decade.

Table 4a. Treatment immediacy ratings for sediment delivery sites and associated lengths of hydrologically connected road.

Treatment immediacy	Treatment sites				Estimated future sediment delivery from inventoried erosion sites[b]		Estimated future sediment delivery from road, ditch, and cutbank surfaces[c]	
	Upgrade sites	Road length (mi)[a]	Decommission sites	Road length (mi)[a]	Volume (yd^3)	Relative percentage	Volume (yd^3)	Relative percentage
High	2 Stream crossings 1 Landslide; 1 Other	0.63	2 Stream crossings	0.05	1,360	7%	625	3%
High-moderate	47 Stream crossings 5 Landslides 4 Road drainage discharge points 3 Ditch relief culverts; 1 Spring	6.47	10 Stream crossings 1 Landslide 1 Other	0.70	7,185	39%	6,935	27%
Subtotal	*64 sites*	*7.10*	*14 sites*	*0.75*	*8,545*	*46%*	*7,560*	*30%*
Moderate	101 Stream crossings 12 Ditch relief culverts 7 Landslides; 4 Springs; 5 Road drainage discharge points 1 Bank erosion; 2 Other	10.53	16 Stream crossings 2 Bank erosion 1 Landslide	1.18	5,410	29%	9,610	38%
Moderate-Low	76 Stream crossings 8 Road surface discharge points 6 Ditch relief culverts 3 Springs; 2 Landslides 1 Bank erosion; 1 Other	5.65	20 Stream crossings 5 Landslides; 2 Springs 1 Road drainage discharge point 2 Other	1.73	3,800	20%	5,935	23%
Subtotal	*229 sites*	*16.18*	*49 sites*	*2.91*	*9,210*	*49%*	*15,545*	*61%*
Low	39 Stream crossings 4 Road drainage discharge points 3 Landslides, 2 Other 3 Ditch relief culverts	2.62	9 Stream crossings 2 Landslides 1 Spring, 2 Other	0.83	925	5%	2,355	9%
Subtotal	*51 sites*	*2.62*	*14 sites*	*0.83*	*925*	*5%*	*2,355*	*9%*
Total	**344 upgrade sites[d]**	**25.9**	**77 decom sites[e]**	**4.49**	**18,680**	**100%**	**25,460**	**100%**

[a]*Road length* refers to hydrologically connected road reaches adjacent to recommended treatment sites.
[b]Episodic sediment delivery for road related sites (indeterminate time period).
[c]Chronic sediment delivery from adjacent hydrologically connected roads and cutbanks (estimated for a 10 yr period).
[d]Upgrade sites (344 total): 265 stream crossings, 24 ditch relief culverts, 21 road drainage discharge points, 18 landslides, 8 springs, 2 bank erosion sites, and 6 other sites.
[e]Decommission sites (77 total): 57 stream crossings, 9 landslides, 3 springs, 2 bank erosion sites, 1 road surface discharge point, and 5 other sites.

Table 4b. Individual upgrade and decommission sites listed by treatment immediacy, 2010 Austin Creek Watershed Sediment Source Assessment, Sonoma County, California.

Site type	Upgrade site ID #	Decommission site ID #
High treatment immediacy		
Stream crossing	#188, 221	#23, 213
Landslide	#471	
Other	#211	
High-moderate treatment immediacy		
Stream crossing	#21, 27, 38-41, 54, 134, 136, 140, 145, 147, 161, 163-167, 175, 180, 196, 197, 199, 207, 209, 220, 222, 259, 268, 297, 300, 306, 312, 326, 328, 352-355, 357, 372, 408, 415-417, 422, 457	#68, 162, 173, 263, 271-273, 275, 278, 367.1
Landslide	#40.1, 149, 183, 183.1, 208	#214
Road drainage discharge points	#148, 240, 288, 291	
Ditch relief culvert	#198, 409, 463	
Spring	#191	
Other		#212
Moderate treatment immediacy		
Stream crossing	#10, 12, 13, 16-18, 22, 34, 36, 45, 47, 48, 50, 55, 56, 66.1, 73, 105, 109, 121, 126, 130, 131, 133, 137, 141, 142, 146, 151, 152, 154, 156, 157, 160, 176-178, 182, 186, 189, 190, 193, 195, 201, 202, 216, 218, 224, 226, 228, 229, 231, 237, 241, 242, 245, 253, 257, 260, 290, 292, 293, 303-305, 311, 315, 319-322, 331, 351, 359, 366, 367, 369, 373, 374, 410, 411, 413, 418, 426, 450-456, 459-461, 464, 466, 467, 472, 473, 476, 477	#24, 35, 153, 171, 174, 262, 270, 274, 276, 277, 279, 280-282, 370, 424
Ditch relief culvert	#14, 125, 139, 159, 192, 217, 223, 230, 251, 302, 368, 474	
Landslide	#64, 201, 225, 252, 296, 314, 458	#24.1
Road drainage discharge point	#203, 205, 233, 371, 468	
Spring	#219, 227, 301, 349	
Bank erosion	#70	#69, 258
Other	#299, 475	

(continued on next page)

Table 4b—cont. Individual upgrade and decommission sites listed by treatment immediacy, 2010 Austin Creek Watershed Sediment Source Assessment, Sonoma County, California.

Site type	Upgrade site ID #	Decommission site ID #
Moderate-low treatment immediacy		
Stream crossing	#3-5, 15, 19, 20, 42, 43, 46, 49, 51, 52, 57, 58, 63, 66, 74, 75, 77, 107, 108, 127-129, 132, 135, 143, 144, 150, 155, 181, 184, 187, 200, 206, 215, 232, 234-236, 238, 239, 244, 247, 255, 256, 266, 267, 269, 285, 287, 294, 295, 307, 308, 313, 316, 324, 325, 333, 334, 337, 338, 356, 358, 362, 364, 365, 382, 383, 385, 386, 412, 462, 469, 478	#89, 90, 93, 113, 116, 118, 119, 249, 298, 335, 341-348, 375, 423
Road drainage discharge points	#32, 104, 124, 254, 261, 264, 384, 465	#283
Ditch relief culvert	#11, 66.2, 138, 158, 194, 243	
Spring	#185, 248, 421	#330, 425
Landslide	#53, 101	#92, 94, 114, 115, 340
Bank erosion	#122	
Other	#350	#117, 363
Low treatment immediacy		
Stream crossing	#1, 2, 6-8, 28, 29, 31, 59, 60, 62, 67, 76, 86-88, 96-100, 102, 103, 106, 110, 111, 179, 284, 286, 309, 317, 323, 329, 361, 414, 419, 430, 470, 479	#78, 91, 95, 112, 170, 376, 379, 380, 429
Road surface discharge points	#30, 37, 204, 289	
Landslide	#265, 327, 336	#172, 378
Ditch relief culvert	#9, 44, 318	
Spring		#332
Other	#61, 65	#339, 377

We assign moderate or moderate-low priorities to 278 sites (229 upgrade sites and 49 decommission sites), which include a total of about 19 mi of associated hydrologically connected road reaches. Estimated future sediment delivery for the 278 sites is approximately 9,210 yd^3. We project that the hydrologically connected road segments adjacent to these sites could deliver approximately 15,545 yd^3 of sediment to the stream system during the next 10 years. We assign a low priority to 65 sites (51 upgrade sites and 14 decommission sites), which have a total of 3.4 mi of associated hydrologically connected road segments. Estimated potential sediment delivery for the sites is approximately 925 yd^3, with an additional 2,355 yd^3 of sediment projected to be delivered from the road reaches during the coming decade.

6.2 Unusually Problematic or Complex Sites

Of the 421 inventoried sites in the project area, 80 sites are particularly noteworthy for their limited accessibility and/or relatively high complexity to treat. Sites deserving specific mention include 55 sites with access problems and 25 that would benefit more from abandonment than attempted treatments using heavy equipment.

6.2.1 Sites with restricted access in the Gilliam Creek area

Roads within the Gilliam Creek area (a subbasin of the Lower East Austin Creek area), have long been abandoned by previous landowners and have since experienced a number of landslide and stream crossing washout events that have left the area with very few access points in which to treat the remaining potential sediment sources. Site #77 and #96-103 are on a previously decommissioned road (Maps 3f, 3g). These sites will have to be temporarily upgraded in order to access sites further along the alignment (Site# 74-78, 86-95, and 113-119). Although the landowner of the adjacent property has given verbal approval to allow heavy equipment access through his property, treating these sites is not feasible because it will require that the equipment be transported ("lowboyed") approximately 30 mi, and then driven ("walked in") an additional ~2 mi.

Equipment access to sites #107-112, 333-335, and 339-341 is restricted because of a hillslope debris slide at site# 120 and a road fill failure at site #336 (Map 3f). The landowner of the adjacent property has verbally committed to allowing equipment to access these sites through his property, which will be the only way to potentially access these sites for treatment.

In order to access to sites #337, 338, and 342-346, it will be necessary to temporarily rebuild stream crossing site #267 as well as reopen an old skid road (Map 3g). It is possible that these sites could be accessed from the property along the road to the east of site #345, but owner of that property is not involved in this assessment project, and therefore it is currently unknown if an alternate access route will be possible.

6.2.2 Sites determined to be infeasible to treat throughout the project area ("no treat" sites)

Our field data show that 25 sites are either infeasible or not cost-effective to treat, that is, are "no treat" sites (Maps 4a-h). For example, our data suggest it is not cost-effective to treat sites #79-85 in the Gilliam Creek subbasin of the Lower East Austin Creek subwatershed (Map 3g). These sites are located along an old mining trail that has mostly deteriorated, and the cost to rebuild the roadbed in order to treat the sites would be excessive relative to amount of sediment savings achieved.

We recommend against treating sites #25 and 26, small stream crossings on the toe of a moderately stable deep-seated landslide in the Upper East Austin Creek subwatershed (Map 3e). Field observations show that little road fill remains at either crossing, but it is possible that excavating either one of these sites could stimulate movement of the toe of the landslide and stimulate greater sediment production than what currently exists at these sites.

Site#120 is a past hillslope debris slide that has completely taken out the roadbed for roughly 150 ft (Map 3g). This site was analyzed for this project mainly to help the landowner evaluate access issues for the property. The following 15 sites are not recommended for treatment because they are characterized by very low erosion potential with minimal site specific future erosion volume, and/or minimal road length connected to site to warrant any treatment: site #30, 123, 168, 169, 246, 250, 310, 360, 381, 387, 420, 427, 428, 431, 432 (Maps 3a-c, 3e, 3h, 4a-c, 4e, 4h; Appendix A).

7 RECOMMENDED TREATMENTS

PWA recommends 23 different types of erosion control and erosion prevention treatments for the ACWA project area. The treatments are organized into 2 categories (site-specific treatments and road surface treatments), and include both upgrading and decommissioning measures (Table 5). In addition to the treatment summaries in Table 5, detailed treatment information for each site is also provided in Appendix A and in the assessment database. Overviews of construction and installation techniques for the recommended treatments are provided in Appendix B.

Stream crossing treatments are primarily implemented to reduce the risk of catastrophic failure and sediment delivery resulting from road fill erosion or stream diversion along road surfaces. Recommended treatments for stream crossings include: (1) constructing a total of 63 critical dips to prevent diversions at streams with diversion potential; (2) installing 8 culverts at currently unculverted stream crossings, 2 of which will require downspouts; (3) replacing 69 undersized or damaged culverts, 5 of which will required flared inlets, and 2 of which will require downspouts; (4) constructing 135 armored fill or ford crossings; (5) excavating approximately 16,259 yd^3 of fill material, primarily at stream crossings and fillslopes; (6) installing approximately 845 yd^3 of rock armor to stabilize stream crossing fillslopes, ditches, and headcuts; (7) implementing 5 miscellaneous site-specific treatments such as removing rebar from armored ford, rebuilding armored fill crossing, installing a sediment catchment basin to capture road runoff, and removing woody debris from non-fish bearing stream channels above culvert crossings. In addition, installing a trash rack is required for 79 stream crossing culverts.

Road treatments are designed to control road drainage by reshaping the roadbed, dispersing road surface runoff onto stable slopes and preventing delivery of concentrated runoff to streams. Upgrading treatments to redirect flow include outsloping the road, insloping the road, installing rolling dips, installing ditch relief culverts, cutting ditches, and removing berms. Road surface erosion is curtailed by adding road rock, which fortifies the surface and reduces production of fine sediment. For road decommissioning, frequent cross-road drains and in-place outsloping are proposed to direct water off road and skid trail surfaces.

Table 5. Recommended erosion control and erosion prevention treatments, Austin Creek Watershed Sediment Source Assessment Project, Sonoma County, California.

Treatment type			No.	Comments
Site specific treatments	Stream crossing treatments	Culvert (install)	8	Install a culvert at an unculverted fill
		Culvert (replace)	69	Replace an undersized, poorly installed, or worn out culvert
		Culvert (clean/clear)	7	Remove sediment or debris from the culvert
		Downspout	7	Install to prevent erosion at stream crossing culvert outlets
		Flared Inlet	5	Install flared inlet to increase culvert capacity
		Trash rack	79	Install at culvert inlets to prevent plugging
		Armored fill or rocked ford (wet) crossing	135	Install rocked ford crossings (7) and armored fill crossings (128) using 1,640 yd^3 of rock armor.
		Critical dip	63	Install to prevent stream diversions
		Rock (armor)	61	At 61 sites, add a total of 845 yd^3 of rock armor on inboard and outboard stream crossing fillslopes, ditches, and headcuts
		Soil excavation	285	At 285 sites, excavate and remove a total of 16,259 yd^3 of sediment, primarily at fillslopes and stream crossings
		Miscellaneous treatments	5	Miscellaneous treatments at 5 site-specific locations
Road surface treatments	Road drainage structures	Ditch relief culvert (install or replace)	82	Install (65) or replace (17) ditch relief culverts to improve road surface drainage.
		Ditch relief culvert downspout	7	Install to prevent erosion at ditch relief culvert outlets
		Rolling dip	702	Install to improve road drainage.
		Cross road drain	333	Install to improve drainage on decommission roads
	Road shaping treatments	Outslope road and remove ditch	161	At 161 locations, outslope road and remove ditch for a total of 71,356 ft of road to improve road surface drainage
		Outslope road and retain ditch	65	At 65 locations, outslope road and retain ditch for a total of 20,130 ft of road to improve road surface drainage
		Inslope road	4	At 4 locations, inslope road for a total of 395 ft to improve road surface drainage.
		Crown road	1	At 1 location, crown road for a total of 700 ft of road to improve road surface drainage.
		Berm (remove)	9	At 9 locations, remove a total of 1,120 ft of berm to improve road surface drainage.
		Clean or cut ditch	33	At 33 locations, clean or cut ditch for a total of 5,040 ft
	Other	Paving	14	Repave a total of 1,605 ft^2 of road at 4 stream crossings, and 10 ditch relief culvert installations
		Road rock (for road surfaces)	265	At 265 locations, use a total of 5,317 yd^3 of road rock to rock the road surface at 48 stream culvert installations, 8 critical dip locations, 20 DRC installations, 70 rolling dips, 12,635 ft of outslope and remove ditch, 17,260 ft of outslope and retain ditch, 255 ft of inslope road, 700 ft of crowned road, 28 armored fills and 3 other site-specific locations.

Road treatments in the project area include: (1) removing a total of approximately 1,120 ft of outboard road berm; (2) cleaning/cutting 5,040 ft of ditch; (3) outsloping a total of 91,486 ft of

road (outsloping and retaining ditch for 20,130 ft; outsloping and removing ditch for 71,356 ft; (4) insloping a total of 395 ft of road; (5) crowing the roadbed for 700 ft; (6) installing 702 rolling dips; (7) installing 333 cross road drains; (8) installing 65 ditch relief culverts; (9) replacing 17 ditch relief culvert; and (10) adding a total of approximately 5,317 yd^3 of road rock at 265 locations; (11) repaving approximately 1,650 ft^2 of road surface at 14 locations.

Once the road shaping and road drainage structures have been constructed, moderate to high use sections of the road will need to be watered and recompacted as a final road treatment. Following the completion of all construction and road rocking, bare soil areas should be seeded with native grasses appropriate for the area. In addition, bare soil areas should be mulched with weed-free straw where necessary to prevent sediment delivery to nearby gullies or streams.

8 HEAVY EQUIPMENT AND LABOR REQUIREMENTS

Equipment needs for erosion control treatments in the assessment area are detailed in the project database and summarized, based on immediacy, in Table 6. Most treatments require the use of heavy equipment, e.g., excavator, bulldozer, grader, and water truck. Some hand labor is required at sites needing downspouts, new culverts or culvert repairs, or for applying seed and mulch to ground disturbed during construction. Equipment needs are reported as equipment times, in hours, to treat all sites and road segments. These estimates only include the time needed for the actual treatment work, and do not include additional construction activities such as opening roads, staging materials at work sites, traveling between sites, final grading, or spreading road rock, straw, and mulch. Equipment and labor hours in addition to those listed in Table 6 are further explained in Section 9.

Table 6. Estimated heavy equipment and labor requirements based on treatment immediacy, 2010 Austin Creek Watershed Sediment Source Assessment, Sonoma County, California.

Treatment immediacy	# of sites	Excavated volume[a] (yd^3)	Excavator (hr)	Bulldozer (hr)	Dump truck (hr)	Backhoe (hr)	Water truck (hr)	Labor (hr)
High or high-moderate	78	10,035	495	779	49	108	151	688
Moderate or moderate-low	278	12,818	908	1,376	37	230	325	1,348
Low	65	1,412	116	195	8	0	59	65
Total	**421**	**24,265**	**1,519**	**2,350**	**94**	**338**	**535**	**2,101**

Note: Equipment and labor times do not include hours necessary for opening roads, traveling between sites, transporting culverts, spreading road rock, and spreading straw and mulch.

[a]Excavated volume includes material permanently removed and stored as well as material excavated and reused for backfilling upgraded stream crossings.

PWA estimates that erosion control and erosion prevention remediation in the ACWA project area will require 1,519 hr of excavator time and 2,350 hr of bulldozer time (Table 6). An excavator and bulldozer will not be needed at all treatment sites, and some treatment sites will require one but not the other. Dump truck operators will require 94 hr to transport excavated spoil material to disposal sites and to import clean backfill. Backhoe operators will require 338 hr to install ditch relief culverts and other site specific needs. Approximately 535 hr of water truck time will be needed for applying water to dry soils during road-drainage treatment implementation, and for backfilling excavations at stream crossings and ditch relief culverts. Finally, approximately 2,101 hours of labor time will be required for various tasks, including culvert installation or replacement.

9 ESTIMATED COSTS

The estimated total cost to implement the recommended erosion control and erosion prevention treatments for the ACWA project is $2,241,240 (Table 7). Approximately $528,148, or 24% of the total, is for the purchase of rock and culvert materials. A total of $398,462, or 18% of the total project cost, is projected for detailed project planning and management, on-site equipment operator instruction and supervision, establishing effectiveness monitoring measures, and post-project analysis and reporting. Costs detailed in Table 7 also include expenses for the use of lowboy trucks to haul construction equipment to and from the work area (footnote "f"); truck/trailer time for delivering straw mulch and culverts to work sites (footnote “g”); time required by a motor grader and water truck to create a “finished” grade to banks, ditches, and road surfaces following rough construction by other equipment (footnote “h”); and labor time for spreading straw mulch and seed (footnote “i”).

Most of the treatments listed in this plan are not complex or difficult for equipment operators with experience in road upgrading and decommissioning operations on forestlands. The costs in Table 7 are assumed reasonable if work is performed by experienced outside contractors, and there is no added overhead for contract administration and pre- and post-project surveying. The use of inexperienced operators or the wrong combination of heavy equipment would require additional technical oversight and supervision in the field, as well as an escalation of the costs to implement the work. To help insure success of the project, it is imperative that only the most experienced and reliable heavy equipment operators be employed under the supervision of a professional geologist, and that the project coordinator is on-site full time at the beginning of the project and intermittently after equipment operations have begun.

Table 7. Estimated equipment times and costs to implement erosion control and erosion prevention treatments, 2010 Austin Creek Watershed Sediment Source Assessment.

Cost category[a]		Cost rate[b] ($/hr)	Estimated Project Times			Total estimated costs[e] ($)
			Treatment[c] (hr)	Logistics[d] (hr)	Total (hr)	
Move in, move out[f]	Excavator	110	40	--	40	4,400
	Bulldozer	110	40	--	40	4,400
	Grader	110	40	--	40	4,400
	Loader	110	40	--	40	4,400
	Roller	110	40	--	40	4,400
	Water Truck	110	40	--	40	4,400
	Truck/trailer	80	40	--	40	3,200
Road opening	Excavator	185	40	--	40	7,400
Heavy equipment for site-specific treatments[g]	Excavator	185	1,517	455	1972	364,820
	Bulldozer	165	994	298	1292	213,180
	Dump truck	110	94	28	122	13,420
	Backhoe	125	10	3	13	1,625
	Roller	125	35	11	46	5,750
	Water truck	100	225	68	293	29,300
	Truck / trailer	80	87	26	113	9,040
	Loader	165	41	12	53	8,745
Heavy equipment for road drainage treatments[h]	Excavator	185	2	1	3	555
	Bulldozer	165	1,356	407	1763	290,895
	Backhoe	125	328	98	426	53,250
	Roller	125	191	57	248	31,000
	Water truck	100	504	151	655	65,500
	Grader	165	88	26	114	18,810
Laborers[i]		50	2,369	711	3080	154,000
Rock costs (includes trucking for 6,209 yd^3 of road rock and 2,485 yd^3 of riprap)						350,370
Culvert materials costs (2,750' of 18", 2,370' of 24", 730' of 30", 340' of 36", 40' of 42", 210' of 48", 110' of 54", and 390' of 60", including costs for couplers, elbows, and trash racks)						177,778
Mulch, seed, and planting materials for 13.5 acres of disturbed ground[j]						17,740
Supervision, coordination, layout, and reporting[k]						398,462
Estimated sediment savings: 44,140 yd^3					**Total Estimated Costs:**	**$2,241,240**

(Continued on next page.)

Table 7—continued.

[a]Costs excluded from the list are for tools and miscellaneous materials, and variable administration and contracting expenses, and.

[b]Heavy equipment costs include operator and fuel. Costs listed are estimates for favorable local private sector equipment rental and labor rates.

[c]Treatment times refer to equipment hours expended explicitly for erosion control and erosion prevention work at all project sites and roads.

[d]Logistics times for heavy equipment (30%) include all equipment hours expended for opening access to sites on maintained and abandoned roads, travel time for equipment to move from site to site, and conference times with equipment operators to convey treatment prescriptions and strategies. Logistic times for laborers (30%) include estimated daily travel time to project area.

[e]Total estimated project costs for equipment rental and labor are based on private sector rates. Materials costs are subject to change.

[f]Lowboy hauling costs area based on 6 hauls (1 to move in and 1 to move out) at 3.3 hr/ trip, for each of the 3 subwatersheds. Lowboy hours are for transporting excavator, bulldozer, grader, roller, and loader.

[g]An additional 36 hr of loader time are added for loading of culverts onto truck and trailer. A total of 51hr of truck and trailer time are added for delivering culverts and straw to sites.

[h]An additional 194 hr of water truck time and 88 hr of grader time are added for final grading and spreading road rock.

[i]An additional 258 hr of labor time are added for spreading straw mulch and seeding. This includes 51 hr of labor for initial delivery of straw to sites.

[j]Seed costs are based on 475 lb of erosion control seed per acre at $19.93/lb. Straw needs are 679 bales per acre at $6.95/bale.

[k]Supervision time includes detailed layout (flagging, etc) prior to equipment arrival, training of equipment operators, supervision during equipment operations, supervision of labor work, and post-project documentation and reporting.

10 CONCLUSIONS

This assessment is a comprehensive evaluation of road related erosion and sediment delivery to streams along a total of approximately 55.13 mi of maintained, seasonal, and abandoned, roads in Austin Creek watershed, Sonoma County, California. It provides field data to identify and quantify currently observable and possible future sources of sediment and erosion along roads on both private and publicly owned properties

An integral part of this assessment is a prioritized plan of action for cost-effective erosion control and erosion prevention for the assessment area. When implemented and employed in combination with protective land use practices, the treatment prescriptions outlined in this report

may be expected to significantly contribute to the long-term protection and improvement of water quality and salmonid habitat in the Austin Creek watershed.

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12 SUPPLEMENTARY INFORMATION: TERMINOLOGY AND TECHNIQUES USED IN ROAD RELATED EROSION ASSESSMENTS

12.1 Sources of Road Related Erosion

Sources for erosion and sediment delivery are divided into two categories: (1) sediment from specific treatment sites, and (2) sediment from the surfaces of road segments of varying lengths—and their associated cutbanks and inboard ditches—that are hydrologically connected to streams.

Site-specific erosion is termed *episodic* because it is projected to occur during storm events that may occur over an indeterminate time. Some sites, such as unstable fillslope landslides on steep hillslopes, may show evidence for imminent failure, erosion, and sediment delivery. But typically, individual sites can only be evaluated in terms of their likelihood to fail during the next severe storm or runoff event, with plans designed to prevent erosion and sediment delivery as a result of that eventuality.

In contrast to site-specific episodic erosion, erosion from road surfaces is termed *chronic* because it occurs on an on-going basis, during every rainfall event that results in surface runoff. Chronic road surface erosion is primarily dependent on the level of road usage, the erodibility of the road surface, the steepness of the road, and the amount of surface runoff that is collected, concentrated, and discharged from the road. PWA provides estimates of chronic erosion and sediment delivery for a 10-year period, based on empirical calculations for fine sediment generation from hydrologically connected road surfaces and associated bare cutbanks and ditches (Weaver et al., 2006). The amount of fine sediment delivered to stream channels from these eroding road surfaces can be substantial over time, and in many watersheds may represent the greater detriment to fish habitat and the aquatic ecosystem.

12.1.1 Site-specific erosion sources

Stream crossings

A stream crossing is the location where a road crosses a stream channel (Weaver and Hagans, 1994). Drainage structures used in stream crossings include bridges, fords, armored fills, culverts, and a variety of temporary crossing structures. When they erode, sediment delivery from stream crossings is always assumed to be 100%, because any sediment eroded from the crossing site is delivered directly to the stream (Furniss et al., 1997; Weaver et al., 2006). The size of the stream affects the rate of sediment mobilization and movement, but any sediment delivered to small ephemeral streams will eventually be transported to downstream fish-bearing stream channels. Because of this, it is important to identify all stream crossings and evaluate the potential for erosion and sediment delivery from the site.

Common features of stream crossings that lead to erosion problems include (1) fill crossings without culverts, (2) crossings with undersized culverts, (3) crossings with culverts susceptible to

being plugged, (4) crossings with culvert outlet erosion, (5) crossings with logs or debris buried in the fill intended to convey streamflow (i.e., *Humboldt crossings*), (5) crossings with a potential for stream diversion, and (6) crossings that have currently diverted streams.

A *fill crossing* is a stream crossing without a culvert or other drainage structure to carry the flow through the road prism. At such sites, stream flow either crosses the road and flows over the fillslope, or is diverted down the road via the inboard ditch. Most fill crossings are located at small Class II or III streams[8] that only have flow during larger runoff events. *Armored fill crossings* and *ford crossings* are designed to be functional, unculverted stream crossings. A properly constructed armored fill crossing is based on a site-specific design, using a mix of riprap-sized rock to minimize erosion while allowing the stream to flow across the road prism (Weaver et al., 2006). A ford crossing may use rock armor to stabilize the roadway, but the road is built essentially on the natural streambed and fill is not used.

Humboldt crossings are constructed from logs or woody debris, usually laid parallel to flow, which are then covered with fill. Humboldt crossings are susceptible to plugging, gullying, and washout during storm flows (Weaver et al., 2006). Older Humboldt log crossing structures beneath more recently installed culverts are often found in rural northern California road networks.

Large volumes of erosion may occur at stream crossings when culverts are too small for the drainage area and storm flows exceed culvert capacity, or when culverts become plugged by sediment and debris. In these instances, flood runoff will spill across the road, allowing erosion of the stream crossing fill and development of a *washout crossing*. Washout crossings will remain highly problematic as the streambed and banks continue to erode and adjust to a stable grade.

Serious erosion problems may also occur where a stream crossing has a *diversion potential*. Stream diversions occur at stream crossings that are unculverted, or have culverts that plug during a flood event, allowing water to spill out onto the road surface or into the ditch, and flow down the road and onto adjacent hillslopes or into nearby stream channels. When this occurs, the roadbed, hillslope, and/or stream channel that receives the diverted flow may become deeply gullied or destabilized. Road and hillslope gullies can develop and enlarge quickly and deliver large quantities of sediment to stream channels (Hagans et al., 1986; Furniss et al., 1997). Streamflow that is diverted onto steep or unstable slopes may also trigger hillslope landslides and large debris flows.

To be considered adequately sized, culverts at stream crossings must have the capacity to convey a 100-year peak storm flow with sediment and organic debris in transport (USDA Forest Service, 2000; Weaver et al., 2006). In areas where large woody debris may lodge against the culvert,

[8] In general, Class I streams are waterways containing viable or restorable fish habitat, or are the source of domestic water supplies. Class II streams are those that support non-fish aquatic species. Class III streams are defined as channels with a defined bed and banks and showing evidence for sediment transport. Class IV streams are man-made watercourses.

trash racks should be installed slightly upstream from culvert inlets as an additional precaution against plugging. Substandard stream crossing culverts include those that are not large enough to convey a 100-year flow, or are installed at too low of a gradient through the stream crossing fill. Installing a culvert at a shallower grade than the natural upstream channel will cause sediment and debris to be deposited at and immediately upstream of the culvert inlet, which promotes plugging and decreases the culvert's capacity to carry streamflow. The outdated practice of installing culverts at insufficiently low gradients was once employed as a cost-cutting measure, because it requires a shorter length of pipe to convey flow through the road. In the long run, however, this practice often proves detrimental to erosion control and maintenance efforts because it allows the culvert to discharge water onto unconsolidated road fill rather than into the preexisting stream channel, resulting in pronounced erosion of the outboard, downstream fill face.

Landslides

Landslides with the potential to fail during periods of intense and prolonged rainfall events are identified in the field by tension cracks, scarps showing vertical displacement, corrective regrowth on trees (i.e., pistol butt trees) and perched, hummocky fill indicating surface instability. As a standard practice, PWA maps all existing and potential landslides observed in the field, but only inventories those that are associated with roads and show a potential to deliver sediment to a watercourse. Types of landslides in a road related erosion assessment typically include (1) road fill failures, (2) landing fill failures, (3) hillslope debris slides, and (4) deep-seated, slow landslides. The majority of treatable landslides in an assessment area are often the result of failure of unstable fill and sidecast material from earlier road construction. Preemptive excavation of small, current or potential landslides is an effective technique for erosion control, achieved by removing the unstable material and redepositing it in a stable, designated location either at or near the treatment site. Conversely, large, deep-seated landslides are usually found to be technically infeasible to treat.

Ditch relief culverts

A *ditch relief culvert* (DRC) is a plastic, metal, or concrete pipe installed beneath the road surface to convey flow from an inside road ditch to an area beyond the outer edge of the road fill. When properly spaced, DRCs limit the quantity of water available to cause erosion at any single location, allowing flow to disperse and reducing the likelihood of gullies forming at their outlets. It is sometimes necessary to install downspouts or rock armor at DRC outlets to further dissipate energy and prevent erosion.

Discharge points for road surface, cutbank, and ditch erosion

Unpaved road surfaces, and their associated cutbanks and inboard ditches, are major sources for erosion and delivery of fine sediment to stream channels. For paved roads, ditches, cutbanks, and unpaved turnouts may still represent active sediment sources. Road surface, cutbank, and ditch erosion is termed "chronic" because it occurs throughout the year, and may include one or more of the following processes: (1) mechanical pulverizing and wearing down of road surfaces by vehicular traffic; (2) erosion of unpaved road surfaces by rainsplash and runoff during periods of wet weather; (3) erosion of inboard ditches by runoff during wet weather; and (4) erosion of

cutbanks by dry ravel, rainfall, slope failures, and brushing/grading practices. *Discharge points for road surface, cutbank, and ditch erosion* are locations where sediment-laden flow from poorly drained road/cutbank/ditch segments exits the roadway to be delivered into the stream system. Discharge points are often in the form of roadside gullies or waterbars, but on some low gradient or streamside roads may simply be low spots where concentrated flow exits the road and is delivered directly to a stream without gully formation.

Additional site-specific sediment sources

Additional, less frequent sources of sediment delivery that may be found in an assessment area include:

Point source springs. Point source springs refer to sites where spring flow is entering the roadbed and causing erosion. Flow from multiple springs may become concentrated along a road with inadequate drainage structures, creating roadside gullies or fillslope failures.

Sites of bank erosion. Bank erosion sites refer to locations of streambank erosion caused or exacerbated by emplacement of a nearby road.

Swales. Swales are channel-like depressions that only carry minor flow during periods of extreme rainfall.

Channel scour. Channel scour refers to the widening or deepening of stream channels as a result of increased flow levels.

Non-road related upslope gullies. These are sites of focused runoff that form upslope from a roadway, and may exacerbate erosion at the roadway or contribute sediment to the system during high discharge.

12.1.2 Evaluation of hydrologically connected road segments

PWA measures the lengths of hydrologically connected road segments adjacent to sediment delivery sites, such as on either side of a stream crossing, ditch relief culvert, or discharge point, to derive an estimate for total potential sediment delivery from connected road surfaces in the project area. In addition, because the adjacent hydrologically connected road segments contribute to the overall erosion and sediment delivery problem at a site, PWA considers the treatment site and adjacent road segments as a unit when estimating future sediment delivery and developing treatment prescriptions for that location.

12.2 Overview of Storm-proofing Roads (Road Upgrading and Decommissioning)

Forest and rural roads may be storm-proofed by one of two methods: upgrading or decommissioning (Weaver and Hagans, 1994, 1999; Weaver et al., 2006). Upgraded roads are kept open, and are inspected and maintained. Their drainage facilities and fills are designed or treated to accommodate the 100-year peak storm flow. Conversely, properly decommissioned roads are closed and no longer require maintenance. Whether through upgrading or decommissioning, the goal of storm-proofing is to make the road as "hydrologically invisible" as possible, that is, to reduce or prevent future sediment delivery to the local stream system. A well-designed storm-proofed road includes specific characteristics (see table, next page), all proven to contribute to long-term improvement and preservation of watershed hydrology and aquatic habitat.

12.2.1 Road upgrading

Road upgrading involves a variety of treatments used to make a road more resilient to large storms and flood flows. The most important of these include upgrading stream crossings (especially culvert upsizing to accommodate the 100-year peak storm flow and debris in transport, and treatments to correct or prevent stream diversion); removing unstable sidecast and fill materials from steep slopes; and applying road drainage techniques (e.g., installing ditch relief culverts, removing berms, constructing rolling dips, insloping or outsloping the road) to improve dispersion of surface runoff. Road upgrading often also includes adding road rock or riprap as needed to fortify roads and crossings. The treatments are fully described by Weaver et al. (2006).

Installing rolling dips

Rolling dips are installed on low- to moderate-gradient, hydrologically connected roads to disperse surface runoff and discharge it onto the native hillslope below the road. Rolling dips may extend from the inboard edge to the outboard edge of a road prism, or just on the roadbed, and are constructed at intervals as needed to control erosion (typically 100, 150, or 200 ft). They are effective in reducing year-round ("chronic") sediment delivery from road surfaces, and are designed to be easily drivable and not impede vehicular traffic.

Road shaping

Road shaping changes the existing geometry or orientation of the road surface, and is accomplished through insloping (sloping the road toward the cutbank), outsloping (sloping the road toward the outside edge), or crowning (creating a high point near the center axis of the road so that it slopes both inward and outward). Like rolling dips, road shaping is used to prevent uncontrolled delivery of road surface runoff by dispersing it into the inside ditch or onto the hillslope below the road. This is also effective in preventing the formation of gullies at the edge of the road, and localized slope instability below the road. Road shaping is almost always used in concert with rolling dips to disperse surface runoff.

Characteristics of storm-proofed roads (*from* Weaver et al., 2006).

Storm-proofed stream crossings

- All stream crossings have a drainage structure designed for the 100-year peak storm flow (with debris).
- Stream crossings have no diversion potential (functional critical dips are in place).
- Stream crossing inlets have low plug potential (trash barriers installed).
- Stream crossing outlets are protected from erosion (extended beyond the base of fill; dissipated with rock armor).
- Culvert inlet, outlet, and bottom are open and in sound condition.
- Undersized culverts in deep fills (greater than backhoe reach) have emergency overflow culvert.
- Bridges have stable, non-eroding abutments and do not significantly restrict 100-year flood flow.
- Fills are stable (unstable fills are removed or stabilized).
- Road surfaces and ditches are "hydrologically disconnected" from streams and stream crossing culverts.
- Class I stream crossings meet CDFG and NMFS fish passage criteria (Taylor and Love, 2003).

Storm-proofed fills

- Unstable and potentially unstable road and landing fills are excavated or structurally stabilized.
- Excavated spoil is placed in locations where it will not enter a stream.
- Excavated spoil is placed where it will not cause a slope failure or landslide.

Road surface drainage

- Road surfaces and ditches are "hydrologically disconnected" from streams and stream crossing culverts.
- Ditches are drained frequently by functional rolling dips or ditch relief culverts.
- Outflow from ditch relief culverts does not discharge to streams.
- Gullies (including those below ditch relief culverts) are dewatered to the extent possible.
- Ditches do not discharge (through culverts or rolling dips) onto active or potential landslides.
- Decommissioned roads have permanent drainage and do not rely on ditches.
- Fine sediment contributions from roads, cutbanks, and ditches are minimized by utilizing seasonal closures and implementing a variety of surface drainage techniques including berm removal, road surface shaping (outsloping, insloping, or crowning), road surface decompaction, and installing rolling dips, ditch relief culverts, waterbars, and/or cross-road drains to disperse road surface runoff and reduce or eliminate sediment delivery to the stream.

Installing ditch relief culverts

A ditch relief culvert is a drainage structure (usually an 18 in. pipe) installed across a road prism to move water and sediment from the inboard ditch so that it can be dispersed on native hillslope downslope from the road. Ditch relief culverts are used to drain ditch flow on roads that are too steep for rolling dips or outsloping, as well as at sites with excessive flow from springs or seepage from cutbanks.

Excavating unstable fillslope

The fillslope, the sloping part of the road between its outboard edge and the natural ground surface below, may fail or show signs of potential failure. As a preventative measure, unstable fillslope sediment is excavated and relocated (endhauled or pushed) to a permanent, stable spoil disposal site.

Upgrading stream crossings

Techniques used to remediate road related erosion at a stream crossing are dependent on the size of the stream channel, and specific physical characteristics at the crossing site. Class I and large stream crossings may require a bridge, or, if their banks are small or low gradient, a ford crossing may be suitable, particularly if seasonal use is anticipated. A common approach to upgrading moderate-sized crossings of Class II and III streams is to construct a culverted fill crossing capable of withstanding the 100-year flood flow. Techniques for upgrading small and moderate-size stream crossings include:

Installing or replacing culverts. A culvert capable of withstanding the 100-year peak storm flow is installed or replaced in the fill crossing. Culverts on non fish-bearing streams are placed at the base of fill, in line and on grade with the natural stream channel upstream and downstream of the crossing site. Backfill material, free of woody debris, is compacted in 0.5-1.0 ft thick lifts until 1/3 of the diameter of the culvert has been covered. At sites where fillslopes are steeper than 2:1, or where eddying currents might erode fill on either side of the inlet, rock armor is applied as needed.

Installing an armored fill. Armored fills are installed on smaller stream crossings with relatively small fill volume, but where debris torrents are common, channel gradients are steep, or inspection and maintenance of a culverted crossing is impossible or unlikely to occur. The roadbed is heavily rocked and a keyway at the base of the outboard fillslope is excavated and backfilled with interlocking rock armor of sufficient size to resist transport by stream flow. Armored fill crossings are constructed with a dip in the axis of the crossing to prevent diversion of the stream flow, and focus the flow over the part of the fill that is most densely armored.

Installing secondary structures. A variety of secondary structures may be used to increase the function of small stream crossings by allowing uninterrupted stream flow, decreasing plugging, and controlling erosion. Where a culvert has been improperly installed too high in the fill, a *downspout* may be added to its outlet to release the flow close to the ground surface, rather than letting it cascade from the height of the culvert. *Rock armor* may be used to buttress steep fillslopes, as well as to prevent erosion of inboard or outboard fillslopes by eddying currents. A *trash rack* placed in the channel above a culvert inlet will trap debris and reduce plugging. To prevent stream diversion should the culvert become plugged or its

capacity exceeded, a *critical dip* (essentially a rolling dip constructed on the down-road hingeline of the fill) may be installed to ensure that stream flow will be directed across the road and back into the natural channel. Finally, an *overflow culvert* may be a necessary addition at a culverted crossing where, because of site conditions, plugging or capacity exceedence of the primary culvert is anticipated.

12.2.2 Road decommissioning

In essence, decommissioning is “reverse road construction,” although complete topographic obliteration of the roadbed is not usually required to achieve cost-effective erosion prevention. In most cases, serious erosion problems are confined to a few, isolated locations along a road (perhaps 10% to 20% of the full road network to be decommissioned) where stream crossings need to be excavated, unstable sidecast on the downslope side of a road or landing needs to be removed before failure, or the road crosses unstable terrain and the entire road prism must be removed. But typically, lengths of road beyond the extent of individual treatment sites usually require simpler, permanent improvements to surface drainage, such as surface decompaction, additional cross-road drains, and/or partial outsloping. As with road upgrading, the heavy equipment techniques used in road decommissioning have been extensively field tested and are widely accepted (Weaver and Sonnevil, 1984; Weaver et al., 1987, 2006; Harr and Nichols, 1993; Weaver and Hagans, 1994).

Road ripping or decompaction

Road ripping is a technique in which the surface of a road or landing is disaggregated or "decompacted" to a depth of at least 18 in. using mechanical rippers. This action reduces or eliminates surface runoff and usually enhances revegetation.

Installing cross-road drain

Cross-road drains (also called “deep waterbars”) are large ditches or trenches excavated across a road or landing surface to provide drainage and prevent runoff from traveling along, or pooling on, the former road bed. They are typically installed at 50, 75, 100 or 200 ft intervals, or as necessary at springs and seeps. In some locations (e.g., streamside zones), partial outsloping may be used instead of cross-road drain construction.

In-place stream crossing excavation (IPRX)

IPRX is a decommissioning treatment used for roads or landings that are built across stream channels. The fill (including the culvert or Humboldt log crossing) is completely excavated and the original streambed and side slopes are exhumed. Excavated spoil is stored at nearby, stable locations where it will not erode. In some cases, this may necessarily be as far as several hundred feet, or more, from the crossing. An IPRX typically involves more than simply removing a culvert, as the underlying and adjacent fill material must also be removed and stabilized. As a final measure, the sides of the channel may be cut back to slopes of 2:1, and mulched and seeded for erosion control.

Exported stream crossing excavation (ERX)

ERX is a decommissioning treatment in which stream crossing fill material is excavated and the spoil is hauled off-site for storage (the act of moving spoil material off-site is called “endhauling”). This procedure is necessary when large, stable storage areas are not available at or near the excavation site. It is most efficient to use dump trucks to endhaul the spoil material.

In-place outsloping (IPOS)

IPOS (also called "pulling the sidecast") calls for excavation of unstable or potentially unstable sidecast material along the outside edge of a road prism or landing, and placement of the spoil on the roadbed against the corresponding, adjacent cutbank or within several hundred feet of the site. As a further decommissioning measure, the spoil material is placed against the cutbank to block vehicular access to the road.

Export outsloping (EOS)

EOS is a technique comparable to IPOS, except that spoil material is moved off-site to a permanent, stable storage location. EOS is required when it is not possible to place spoil material against the cutbank, e.g., where the road prism is narrow or where there are springs along the cutbank. EOS usually requires dump trucks to endhaul the spoil material. This technique is used for both decommissioning and upgrading roads, but as the roadbed is partially or completely removed, EOS is more commonly used for decommissioning.

12.3 Determining Treatment Immediacy and Cost-Effectiveness

Identifying *treatment immediacy* is an integral part of an assessment used to prioritize sites prior to implementation. Treatment immediacy is a professional evaluation of how important it is to quickly perform erosion control or erosion prevention work. It is defined as "high," "moderate," or "low," and represents the urgency of treating the site before it erodes or fails. An evaluation of treatment immediacy is based on the following criteria: (1) *erosion potential*, or whether there is a low, moderate, or high likelihood for future erosion at a site; (2) *sediment delivery*, which is an estimate of the sediment volume projected to be eroded from a site and delivered to a nearby stream; and (3) the value or sensitivity of downstream resources being protected. Generally, sites that are likely to erode or fail in a normal winter, and are expected to deliver significant quantities of sediment to a stream channel, are rated as having high treatment immediacy.

The *erosion potential* of a site is a professional evaluation of the likelihood that erosion will occur during a future storm, based on local site conditions and field observations. It is a subjective probability estimate, expressed as "low," "moderate," or "high," and not an estimate of how much erosion is likely to occur. The volume of sediment projected to erode and reach stream channels is described by *sediment delivery*, which plays a significant role in determining the treatment immediacy for a site. The larger the volume of potential future sediment delivery to a stream, the more important it becomes to closely evaluate the need for treatment.

From this assessment, treatment immediacy and *cost-effectiveness* may be analyzed, along with the client's transportation needs, to prioritize treatment sites or locations for implementation. *Cost-effectiveness* is not only a necessary consideration for environmental protection and restoration projects for which funding may be limited, but is also an accepted and well-documented tool for prioritizing potential treatment sites in an area (Weaver and Sonnevil, 1984; Weaver and Hagans, 1999). A quantitative estimate for cost-effectiveness is determined by dividing the cost of accessing and treating a site by the volume of sediment prevented from being delivered to local stream channels. The resulting value, or *sediment savings*, provides a comparison of cost-effectiveness among sites, and an average for the entire project area. For example, if the cost to develop access and treat an eroding stream crossing is projected to be $5000, and the treatment will potentially prevent 500 yd^3 of sediment from reaching the stream channel, the predicted cost-effectiveness for that site would be $5000/500$yd^3$, or $10/$yd^3$.

PWA further evaluates cost-effectiveness for an entire assessment area by organizing sites into logistical groups based on similar requirements for heavy equipment and materials, and addressing these as a unit to minimize expenses. Furthermore, although sites and road segments with the lowest immediacy ratings are placed last on the list for treatment, it is sometimes possible to treat these sites once the project is underway, as opportunities to cost-effectively treat low-immediacy sites often arise when heavy equipment is already located nearby to perform maintenance or restoration at higher-immediacy sites.

12.4 References for Supplementary Information

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Appendix A

Field observations and treatment recommendations for road related sediment delivery sites

Austin Creek Watershed Sediment Source Assessment
Sonoma County, California

Table A1. Field observations and treatment recommendations for road related sediment delivery sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
1	Gray Creek (Upper East Austin Creek)	L	Stream crossing	Road surface only	575	85	Unused logging or fire road. Road bed does not show signs of rilling or active erosion (covered in forest litter). Crossing has a 2" PVC pipe which may be an abandoned water supply line.	1. Outslope road and fill ditch for 575' up left road and install 4 Rolling Dips. 2. Outslope road and fill ditch for 85' up right road.
2	Gray Creek (Upper East Austin Creek)	L	Stream crossing	12	60	1,446	Rarely used native surface road. Stream initiates just upslope of fill crossing in a grassland/swale setting with extensive right approach. Outboard edge of fill is moderately crumbling though heavily vegetated. Overall this site is not a significant sediment source within the watershed.	1. Construct an armored fill crossing using 10 yd3 1-2' rock armor. 2. Outslope road and fill ditch for 1,446' up left road and install 10 rolling dips.
3	Gray Creek (Upper East Austin Creek)	ML	Stream crossing	132	0	65	Culvert set in at shallow (5%) relative to channel grade. Flow from the outlet has gullied the outboard fill face for about 30' to bedrock base. Outboard fill face is littered with terracotta pipe and hog wire.	1. Install an armored fill crossing using 45 yd3 1-3' rock armor.
4	Gray Creek (Upper East Austin Creek)	ML	Stream crossing	12	50	55	Small fill crossing approximately 50' left of site 3. Stream flow contacts road, diverts approximately 15' outside natural channel and gullies 40' down hill slope to adjacent stream channel. Gully appears to be roughly 2'w x 1'd and looks stable.	1. Install an armored fill crossing using 15 yd3 1'-2' rock armor. 2. Outslope road and fill ditch along both road reaches for a total of 105 ft.
5	Gray Creek (Upper East Austin Creek)	ML	Stream crossing	88	15	40	A rusty though not completely rusted out culvert, installed high in the fill and at a fairly shallow (13%) grade, appears to have plugged and overtopped in the past resulting in moderate erosion of the outboard fillslope. What appears to be poorly placed inboard fill armor seems to periodically slough into the inlet, increasing the plug potential. In addition, the existing pipe outlets left of the natural stream axis, resulting in excessive erosion of the left bank, though most sediment delivery has already occurred here. Channel below the pipe outlet has abundant natural armor.	1. Define channel above the inlet by removing up to 6 yd3 of existing armor and sediment. 2. Install a single post trash rack above the culvert inlet.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
6	Gray Creek (Upper East Austin Creek)	L	Stream crossing	Road surface only	25	35	A very small stream channel, about 50' to the left of site 5, crosses the road and down the outboard fill face. The outboard fill face is well armored with local rock but could benefit from more. The strange thing about the existing condition is that the stream channel does not connect with the channel from site 5 but rather veers left and continues parallel down slope.	1. Install an armored fill crossing using 5 yd3 1-2' rock armor.
7	Gray Creek (Upper East Austin Creek)	L	Stream crossing	2	180	100	A small fill crossing with a 6" diameter asbestos pipe in the road bed. The pipe is entirely exposed and is non-functional. Rocky channel bottom both above and below crossing. Stream appears to exhibit minimal ability to erode the road fill.	1. Install an armored fill crossing using 5 yd3 0.5-1' rock armor. 2. Outslope road and fill ditch for 180' up left road and install 1 rolling dip. 3. Outslope road and fill ditch for 100' up right road and install 1 rolling dip.
8	Gray Creek (Upper East Austin Creek)	L	Stream crossing	17	25	45	Two small (1.5 x 0.5 each) streams drain a grassland setting and coalesce above the buried inlet of a non functioning undersized culvert, which is set high in the fill and outside the natural stream axis. Low energy stream with minimal erosion below existing outlet. Road fill prism appears semi-saturated though stable, and short, well vegetated approaches are of little concern.	1. Install an armored fill crossing using 10 yd3 0.5-1.5' rock armor.
9	Gray Creek (Upper East Austin Creek)	L	Ditch relief culvert	Road surface only	0	260	Ditch relief culvert in a grassland setting drains a stable, grassy inboard ditch.	1. Outslope road and fill ditch for 260' up right road and install 2 rolling dips.
10	Gray Creek (Upper East Austin Creek)	M	Stream crossing	6	0	140	Stream drained by 10" asbestos culvert. A 14" diameter ditch relief culvert outlets next to the outlet of the culvert at the crossing. Culvert has high potential to plug and divert flow down the left road reach.	1. Install an armored fill crossing using 10 yd3 1-2' rock armor. 2. Install a rolling dip up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
11	Gray Creek (Upper East Austin Creek)	ML	Ditch relief culvert	Road surface only	630	0	Concentrated road drainage delivers flow and sediment to a completely buried and non-functional ditch relief culvert with downspout. Pipe has been covered by a cutbank failure and flows currently exit the road via the outboard fill face. Pipe seems unnecessary- road drainage can be addressed with rolling dips.	1. Outslope road and fill ditch for 630' up left road and install 4 rolling dips.
12	Gray Creek (Upper East Austin Creek)	M	Stream crossing	Road surface only	85	710	Unused ford crossing; road switches back from upper junkyard area down to Gray Creek. Road crosses Gray Creek and intersects with Gray Creek Road. Large rills down both approaches, however left approach is through-cut and cannot be easily drained.	1. Outslope road/fill ditch for 710' up the right road approach. 2. Install 5 rolling dips up the right road.
13	Gray Creek (Upper East Austin Creek)	M	Stream crossing	23	855	0	Crossing appears to receive very little flow. Smaller (buried) culvert may have drained flow in the past and may have caused the diversion gully to the right. Stream channel looks like a gully above and below the crossing. Treatment immediacy based on connected road length to site.	1. Install a critical dip along the right hinge line. 2. Outslope road and fill ditch for 855' up left road and install 5 rolling dips.
14	Gray Creek (Upper East Austin Creek)	M	Ditch relief culvert	Road surface only	0	800	A non road related upslope gully, possibly from building pad runoff or swimming pool drainage, as well as 800' of road drainage, flows to Gray Creek via a 24" concrete culvert pipe. The upper 500' of contributing road length is paved, while the adjacent 300' of road is rocked with a raveling inboard ditch. Drainage treatments prescribed herein are for road related drainage only- an alternate drainage method upslope of the road should be utilized to minimize gully enlargement, though this is beyond the scope of this assessment.	1. Install an 18"x30' DRC with an 18"x20' downspout approximately 300' right of the site at the contact between paved and rocked surfaces. 2. Outslope road and keep ditch for 300' and install 1 rolling dip right of the site; connect with inboard ditch.
15	Gray Creek (Upper East Austin Creek)	ML	Stream crossing	Road surface only	140	365	Bridge is 20'l x 12'w, bottom is approximately 8' above water. Bridge sits on concrete abutments and does not appear to be constricting stream flow. Road length connecting to the crossing are well rocked and receive moderate use year round.	1. Outslope road and fill ditch for 365' up right road and install 2 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
16	Gray Creek (Upper East Austin Creek)	M	Stream crossing	43	0	1,092	A swale/small stream which exhibits minimal evidence of surface flow. Disconnecting the significant right road approach is likely a more effective means of lowering the potential of outboard fill face erosion than full armored fill installation. A low spot in the road approximately 20' to the left removes the possibility of stream diversion. Treatment immediacy based on contributing road length.	1. Install an armored fill crossing using 25 yd3 1-2' rock armor. 2. Outslope road and fill ditch for 1,092' up right road and install 7 rolling dips.
17	Gray Creek (Upper East Austin Creek)	M	Stream crossing	Road surface only	0	1,485	Very little stream channel morphology both above and below crossing, but springy outflow just above road is creating flow across road. Old, abandoned 18" culvert length is laying in channel below crossing. Small berm across road is keeping flow from diverting down left road reach.	1. Install an armored fill crossing using 20 yd3 1-2' rock armor. 2. Outslope road and fill ditch for 1,485' up right road and install 9 rolling dips.
18	Gray Creek (Upper East Austin Creek)	M	Stream crossing	67	1,080	0	An adequately sized though poorly installed culvert drains a moderately sized creek as well as over 1,000' of steep left road approach. The shotgunned pipe has caused approximately 30 yd3 of past erosion. Below the BOT is a flood plain of very old landing, the stream channel should be defined across this feature (see Site# 68). Class I stream is 75' down channel from BOT.	1. Replace existing culvert with a 48" x 60' long culvert set in at base of fill and at channel grade. Transition channel grade above TOP flag by removing 10 yd3 of material. Store spoils locally. 2. Armor the lower 1/4 of the outboard fill slope with 10 yd3 1-2' rock armor. 3. Install a single post trash rack 4' above culvert inlet in center of channel. 4. Outslope road and fill ditch for 1,080' up left road and install 7 rolling dips. 5. Install a critical dip along right hingeline of crossing.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
19	Gray Creek (Upper East Austin Creek)	ML	Stream crossing	192	240	260	Inlet of culvert is about 30% plugged with branches and sediment. Sediments aggraded about 30' up channel because of shallow culvert slope. Culvert length is short for fill slope and therefore entire outboard fill has failed to outlet leaving near vertical drop from road down to stream channel. Outlet is shotgunned 7' above channel.	1. Replace existing culvert with a 60" x 70' long culvert set in at base of fill and at channel grade. 2. Install a single post trash rack 5' above culvert inlet in center of channel. 3. Outslope road and fill ditch for 240' up left road and install 1 rolling dip. 4. Outslope road and fill ditch for 260' up left road and install 1 rolling dip. *14hours labor and 1hour excavator time for de-watering the stream.
20	Gray Creek (Upper East Austin Creek)	ML	Stream crossing	Road surface only	307	108	A stable ford crossing across Gray Creek with no road fill in the crossing. Approaches, while short, could benefit from drainage structures, though the right approach is through-cut and will likely prove difficult to drain. Upstream of this site approximately 150' is a bank erosion area.	1. Outslope road and fill ditch for 307' up left road and install 2 rolling dips. 2. Outslope road and fill ditch for 108' up right road.
21	Gray Creek (Upper East Austin Creek)	HM	Stream crossing	60	100	85	A small but active stream with an unstable fill crossing is eroding the road prism via a nearly vertical, bare 7' vertical head cut. In the surrounding area the road width is approximately 22' while at the site the road is approximately 15' wide. Upon rebuilding the road the lower 1/4 of the outboard fill face should be armored to retain the 15' width; if a 22' width is desired than 3/4 of the fill face should be armored. Drainage from the low gradient left approach is aiding erosion of the outboard fill face.	1. Excavate TOP to BOT, install a 24" x 70' CMP at channel grade and in the natural stream axis. Armor the lower 1/4 of the fill face with 5 yd3 1-2' rock armor. 2. Outslope road/fill ditch 100' left.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
22	Gray Creek (Upper East Austin Creek)	M	Stream crossing	24	350	160	Actively eroding fill crossing. Eroded outboard fill face has exposed brow logs (3) throughout evacuated area. The lowest most brow log continues to retain fill on both sides of crossing.	1. Install an armored fill crossing using 15 yd3 1-2' rock armor. Note: Keep lowest brow log in place to retain fillslope support. 2. Install 1 rolling dip up right road approach (in swale axis). 3. Install 2 rolling dips up the left road approach.
23	Gray Creek (Upper East Austin Creek)	H	Stream crossing	227	0	250	Actively failing stream crossing. Culvert was set high in fill and short relative to crossing width. Due to inlet being so high in fill, sediments have aggraded up channel for roughly 140'. Outboard fill has eroded back to outlet of culvert. Culvert was aligned so that outlet directs flow towards left bank and is currently eroding that bank. Bottom of culvert is rusted through and when flowing stream runs under culvert. Springy wet swale with toe of older landslide deposit exists about 100' to the right of crossing. Springy swale is depositing flow onto roadbed. *Treatment changed to decommissioning per BB, 3/30/10.	1. Excavate TOP to BOT, establish a 6' channel width and lay back side slopes to stable 2:1 angle (where possible) for decommissioning. Store spoils locally (landing and left approach, and spread up right approach upon departure from area). 2. Armor headcut with 10 yd3 1-1.5' rock armor. 3. Install 4 cross road drains up the right road approach. 4. Cut ditch for 100' across wet swale up right road.
24	Gray Creek (Upper East Austin Creek)	M	Stream crossing	23	95	0	This stream, adjacent to the stream detailed in site 23, is currently diverted to the right and drained by the same culvert pipe. Extensive upstream skidding has resulted in an incised channel with nearly vertical sides. Future erosion estimate is based on expansion of the current channel/gully, primarily from bank lay back as channel incision appears to have reached bedrock. The left approach is very steep, likely too steep for effective drivable road drainage structure installation. *Treatment changed to decommissioning per BB, 3/30/10.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 for decommissioning. Store spoils locally (landing, left road). 2. Install 1 cross road drain up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
24.1	Gray Creek (Upper East Austin Creek)	M	Landslide	60	0	0	Over steepened landing fill perched along the left bank of a class 2 stream. This site is just upstream of site 24. Fill area appears stable, though along with a skid across the stream the channel is being constricted in this area.	1. Pull oversteepened landing fill from START to END flags (40'w x 2'd x 20'l). 2. Stockpile locally on the landing.
25	Gray Creek (Upper East Austin Creek)	No treat	Stream crossing	29	20	30	A partially washed out culverted crossing within a hummocky swale which appears to be a deep seated landslide. The road width at the site has been reduced from 20' to 7' due to wash outs from either past overtopping, too short of a culvert pipe, or both. Check site because crossing is in a deep seated landslide feature. *Treatment changed to No Treat per BB, 3/30/10.	No treatment.
26	Gray Creek (Upper East Austin Creek)	No treat	Stream crossing	6	50	30	Road section passes across a slow moving deep seated landslide feature. Road width has been reduced to roughly 7' and is currently used as more of a trail. Attempts at armoring the outboard fill face with large woody debris have not decreased erosion significantly. Check site because crossing is in a deep seated landslide feature. *Treatment changed to no treat per BB, 3/30/10.	No treatment.
27	Gray Creek (Upper East Austin Creek)	HM	Stream crossing	173	600	30	Culvert receives flow from 2 streams that were made to converge at inboard fill/inlet. Smaller channel to the right is actively eroding about 30' of fill. Main channel has skid along it's left bank. Skid has caused partial stream flow to divert and gully skid for roughly 250'. Culvert bottom is rusted with pin holes. Channel below outlet stair steps over large woody debris and rocky channel bottom. Left road reach has multiple locations where spring flow is emanating from cutbank.	1. Excavate TOP to BOT to replace culvert with a 54" x 50' long culvert set in at channel grade and base of fill. New culvert and roadbed should be placed about 20' down stream from current location and road width can be reduced to 15' wide. This will help to align the two steams above crossing to flow into inlet. 2. Install a single post trash rack 4.5' above inlet. 3. Endhaul spoil up left road to intersection. 4. Outslope road and fill ditch for 600' up left road and install 4 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
28	Thompson Creek (Lower East Austin Creek)	L	Stream crossing	4	60	55	Fairly stable fill crossing on low or no use road high in the watershed. Moderate (3'w x 2'd x 15'l = 4 yd3) gully on the outboard fill face. Channel appears stable above and below road. Short, insignificant approaches do not represent an issue. Overall a pretty benign site.	1. Install an armored fill crossing using 15 yd3 1-2' rock armor.
29	Gray Creek (Upper East Austin Creek)	L	Stream crossing	1	205	15	This is more of a swale than a class 3 stream. Flow is kept in channel across road by a minimal dip in the road. Crossing appears stable with minimal gullying across the road and down the outboard fill face.	1. Install an armored fill crossing using 5 yd3 0.5-1' rock armor. 2. Install 1 rolling dip up the left road approach.
30	Gray Creek (Upper East Austin Creek)	L	Road drainage discharge point	Road surface only	220	0	A very small gully/drainage discharge point has developed due to 220' of road runoff. Site is above Gray Creek Road and contributes flows to a ford crossing across Gray Creek.	1. Install 1 rolling dip on the Doelger-5 Road between gate and site #29.
31	Gray Creek (Upper East Austin Creek)	L	Stream crossing	1	130	46	Minimal stream channel development both above and below the road. Outboard fill face shows minimal gully development.	1. Install an armored fill crossing: 1) Dip the crossing through the stream axis, lowering road a maximum of 2'. 2) At the new outboard edge of fill, excavate a 10' wide keyway tapering to 4' at the base of fill. 3) Place 5 yd3 0.5-1' rock armor on the fillslope and the outer 1/3 of the road tread.
32	Gray Creek (Upper East Austin Creek)	ML	Road drainage discharge point	Road surface only	600	0	Road drainage on a steep, rarely used road which drains directly to a culverted crossing on Gray Creek Road. Road derived sediments can be readily addressed with rolling dips, though the adjacent 150' of left road approach is likely too steep for rolling dip installation.	1. Install 3 rolling dips up the left road approach.
33	Gray Creek (Upper East Austin Creek)	No treat	Stream crossing	Road surface only	25	10	Ford crossing on a seasonal use road which leads to a water tank. Road is significantly dipped through the crossing. Bottom is continuously rocky through the crossing.	No treatment.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
34	Gray Creek (Upper East Austin Creek)	M	Stream crossing	41	275	70	Majority of the left road contribution is a thru-cut. Inboard ditch along left road drains springy hillside that makes ditch active. Where ditch exits road and heads down fill face to stream it is well armored. Outlet of culvert at crossing is oriented towards right bank/road fill and is actively eroding fills. Road bed has been scoured away to roughly 10' wide with majority of that fill being deposited in channel to the left of the outlet.	1. Excavate TOP to BOT to replace culvert with a 60" x 50' long culvert set in at channel grade and base of fill. 2. Install a single post trash rack 5' above inlet.
35	Gray Creek (Upper East Austin Creek)	M	Stream crossing	20	20	500	A diverted stream crossing cutting through a fill crossing on an abandoned road 100' upstream of site #34. While it appears much of the road related erosion has already occurred at this location, a gully is developing which eventually may grow to a significant sediment source.	1. Excavate TOP to BOT, establish 4' channel width and lay back banks to 2:1 angle for decommissioning. 2. Install 3 cross road drains up the right road approach.
36	Gray Creek (Upper East Austin Creek)	M	Stream crossing	3	300	0	Small class 3 stream contacts inboard ditch and diverts down the right road for 100' before exiting the road bed and gullying down the outboard fillface, ultimately connecting with a class 2 stream. The gully on the outboard fill face looks stable with no signs of rilling or gullying down the road bed.	1. Install an armored fill crossing using 10 yd3 of 0.5-1' rock armor. 2. Install 2 rolling dips up the left road approach.
37	Gray Creek (Upper East Austin Creek)	L	Road drainage discharge point	Road surface only	175	0	Approximately 175' of left road contribution enters stream channel via an inboard ditch at the intersection with Gray Creek Road.	1. Install 1 rolling dip up the left road approach.
38	Gray Creek (Upper East Austin Creek)	HM	Stream crossing	Road surface only	150	130	Ford crossing along Gray Creek on the access road to the Colombini's cabin. A concrete apron was built along the downstream hinge of this crossing to provide a base for the ford crossing. The concrete has since worn down, exposing rebar which is pointing in the downstream direction. Approaches are short- the right approach gets contributions from the building pad/roof drainage and the left approach is mostly through cut.	1. Cut exposed rebar to reduce potential threat to fish (2 hrs labor). 2. Install 1 rolling dip up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
39	Gray Creek (Upper East Austin Creek)	HM	Stream crossing	16	975	0	Currently diverted stream crossing which at some point may have been drained by a 24" culvert pipe (as evident from unused pipe on the outboard fill face). Steep left road length has rills and continues with diverted stream flow down to site 40. Future erosion volume is continued road bed incision down to site 40. Upper 350' of left road approach is through cut.	1. Install an armored fill crossing using 25 yd3 of 1-2' rock armor. 2. Install 4 rolling dips up the left road approach. 3. Outslope road and fill ditch for 625'
40	Lawhead Creek (Upper East Austin Creek)	HM	Stream crossing	219	427	25	A fairly large stream crosses a low use road via one 30" culvert and one 36" culvert set in side by side. Both culverts are short, set high in fill and shallow relative to channel grade. Inner gorge road along right bank above crossing occupies portion of natural steam channel. Below outlet he right bank is vertical and actively eroding.	1. Excavate TOP to BOT to replace culvert with a 60" x 70' long culvert set in at channel grade and base of fill. Install a 60" flared inlet to the culvert pipe. 2. Install a single post trash rack 5' above inlet. 3. Outslope road and fill ditch for 427 up left road and install 3 rolling dips. *14hours labor and 1hour excavator time for de-watering the stream.
40.1	Gray Creek (Upper East Austin Creek)	HM	Landslide	7	0	0	Cutbank slide delivering to Lawhead Creek. Material crosses road and delvers to outboard fill slope just to the right of the culvert outlet at site# 40. Currently less than 5 yd3 of sediment delivering to stream. Cutbank is 20'- 25' high and is over steepened at top.	1. Excavate cutbank slide material (18' x 2.5' x 20'). 2. Use material to build dips or push material up spur road near gate.
41	Lawhead Creek (Upper East Austin Creek)	HM	Stream crossing	20	40	0	Older rusted out culvert. Crossing looks to over top during higher flow events and divert down right road reach. Crossing has diversion gully from inlet down right road for 70' and then gully connects to class 2 'Lawhead Creek'. Gully is grassed over and looks stable. Stream flow has also eroded outboard fill above culvert.	1. Install an armored fill crossing using 25 yd3 of 1'-2' rock.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
42	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	67	500	0	Steep bedrock channel above crossing. Stream looks to only flow during large storm events. Inlet of culvert is 50% plugged with talus from cutbank. Three post trash rack exists above inlet. Outlet has a 30' long 1/2 round downspout. Crossing has minimal potential to fail.	1. Outslope road and fill ditch for 500' up left road and install 3 rolling dips. 2. Remove existing 3 post trash rack and install a single post trash rack. 3. Clean inlet (labor). 4. Install a critical dip along right hingeline of crossing.
43	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	40	0	100	Swale/small stream drained by partially plugged culvert with a tri-post trash rack which increases the plug potential. The stream appears to have diverted left in the past, though the diversion gully now appears stable and well vegetated. Culvert has a 1/2 round downspout partially plugged by brush.	1. Clean culvert inlet. 2. Install single post trash rack. 3. Install a critical dip on the left hinge. 4. Outslope road/fill ditch for 100' up right road.
44	Lawhead Creek (Upper East Austin Creek)	L	Ditch relief culvert	Road surface only	150	180	Ditch relief culvert in a swale setting with some flow being contributed from the road/skid above. Culvert is shotgunned approximately 5'. Outboard fill face has been gullied, likely as a result of contributing road lengths. Inlet of culvert pipe is plugged approximately 50% with leaf litter.	1. Clean culvert inlet (labor). 2. Armor below outlet with 5 yd3 0.5-1' rock armor. 3. Outslope road/fill ditch for 180' and install 1 rolling dip up the right road approach. 4. Outslope road/fill ditch for 150' and install 1 rolling dip up the left road approach.
45	Lawhead Creek (Upper East Austin Creek)	M	Stream crossing	27	0	981	Concentrated road drainage and a swale contribute flow to a fill crossing on a small swale. Two redwood trees on the outboard fill face provide natural armor, though a small 1.5'w x 0.5'd gully continues left of the site. The stream alone appears to be low power, though excessive road length and added flow from a nearby swale increases sediment delivery and erosion potential at the site.	1. Install an armored fill crossing using 10 yd3 0.5-1' rock armor. 2. Outslope road/fill ditch for 981' to the right. 3. Install 7 rolling dips up the right approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
46	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	108	0	470	Short culvert set in at shallow angle relative to channel grade. Inlet has a three-post trash rack, outlet has a 1/2 round downspout. Crossing appears to handle very little flow.	1. Clean inlet and install a single post trash rack. 2. Remove downspout, install 5 yd3 0.5-1' rock armor. 3. Install a critical dip along the left hinge line. 4. Outslope road/fill ditch for 470' right. 5. Install 3 rolling dips up right road approach.
47	Lawhead Creek (Upper East Austin Creek)	M	Stream crossing	83	50	1,200	This appears to be an unnecessary crossing on Lawhead Creek. Road crosses creek and terminates shortly at a landing.	1. Excavate TOP to BOT, replace culvert with a 60" x 40' long culvert set in at channel grade and at base of fill. 2. Install a single post trash rack 5' up channel from inlet. 3. Outslope road and fill ditch for 1,200' and install 8 rolling dips up the right road approach. *14hours labor and 1hour excavator time for de-watering the stream.
48	Lawhead Creek (Upper East Austin Creek)	M	Stream crossing	14	485	0	Currently diverted stream crossing. Flow diverts down right road for 375' before exiting down outboard fillslope into Lawhead Creek. Gully down road bed appears stable and does not appear to have experienced flow in quite some time.	1. Install an armored fill crossing using 10 yd3 0.5-1' rock armor. 2. Outslope road/fill ditch for 485' up the left road approach and install 3 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
49	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	3	475	0	Fairly active, steep stream intersects an inner-gorge road and diverts to the right (some flow also goes to the left on a nearly flat segment of road). Ideally this entire road could be decommissioned, however if upgrading the road is desired an armored fill crossing is appropriate in this location. Future erosion estimate is based on expansion of the existing diversion gully. Immediacy reflects current diversion and contributing road length in an inner gorge setting.	1. Install an armored fill crossing using 10 yd3 0.5-1.5' rock armor. 2. Outslope road/fill ditch for 475' left. 3. Install 3 rolling dips up the left road approach.
50	Lawhead Creek (Upper East Austin Creek)	M	Stream crossing	161	100	265	Three 24" culverts stacked 2 at the bottom and 1 above in Lawhead Creek. Bottom 2 culverts are plugged with sediment. Inlet section of upper culvert has separated. Steam is currently flowing sub-surface of culverts.	1. Replace culvert with a 60" x 60' long culvert set in at base of fill and at channel grade. Install a 60" diameter flared inlet to the culvert pipe. 2. Install a single post trash rack 5' up channel from inlet. 3. Outslope left road for 100'. 4. Outslope right road for 265' and install 2 rolling dips. *14hours labor and 1hour excavator time for de-watering the stream.
51	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	52	300	50	Two 36" rusted culverts sit side by side at base of fill and at channel grade. Upon rebuild road will have to be raised to accommodate lager culvert and this may create diversion potential to the right. Check CMP calls for a 84" culvert which the crossing can't accommodate. Install 60" culver pipe with flared inlet per DKH, 3/30/10.	1. Replace culvert with a 60" x 50' long culvert set in at base of fill and at channel grade. Install a 60" diameter flared inlet to the culvert pipe. 2. Install a single post trash rack 5' up channel from inlet. 3. Outslope left road for 300'. 4. Install 2 rolling dips up the left road approach. *14hours labor and 1hour excavator time for de-watering the stream.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
52	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	7	50	0	Currently diverted stream crossing with a three post trash rack. Inlet is somewhat open but accumulated sediments above the trash rack has caused flow to divert to the right approximately 185'.	1. Install an armored fill crossing using 10 yd3 0.5-1.5' rock armor.
53	Lawhead Creek (Upper East Austin Creek)	ML	Landslide	18	225	0	This fill failure is on an inner gorge road along Lawhead Creek, a main tributary of Gray Creek. Excavation activities at this site may overlap the "TOP" area of site #40, located directly downstream.	1. Excavate START to END, transition channel above inlet of adjacent stream crossing (site #40); store spoils locally.
54	Lawhead Creek (Upper East Austin Creek)	HM	Stream crossing	174	355	50	Culvert undersized and rusted through, but set in at base of fill. Inlet is about 80% plugged with sediments. Outlet of culvert is a confluence with another class II stream. Left road approach is deeply gullied from diverted stream flow 200' up road.	1. Replace culvert with a 60" x 50' long culvert set in at base of fill and at channel grade. 2. Install a single post trash rack 5' up channel from inlet. 3. Armor lower 1/4 of outboard fill face with 10 yd3 of 1'-2' rock. 4. Outslope left road for 355' and install 2 rolling dips. *14hours labor and 1hour excavator time for de-watering the stream.
55	Lawhead Creek (Upper East Austin Creek)	M	Stream crossing	19	1,570	0	A small, rusted out pipe on an unused road at the confluence of 2 streams. Flow periodically diverts down right road, resulting in moderate gullying of the road surface (2'w x 1'd x 50'l past gully). With landowner approval road should be decommissioned. Immediacy reflects significant left road approach.	1. Install an armored fill crossing using 10 yd3 1-2' rock armor. 2. Outslope road/fill ditch for 1570' up left road approach. 3. Install 11 rolling dips up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
56	Lawhead Creek (Upper East Austin Creek)	M	Stream crossing	122	50	50	Old, somewhat failing Humboldt crossing. Roadbed doesn't show deformation, but logs on outboard edge of fill are rotten. Stream looks to flow infrequently and minimally. Stream flow appears to bypass Humboldt logs, cross the roadbed and gully down the outboard edge of fill on the right hingeline. Check site evaluation: Channel has natural steep change in slope at crossing and makes a sharp right turn below the crossing. Site is near geologic contact between sandstone and serpentine/blue schist. See cutbank on "B. Balala-2" road- may need armor above TOP flag?	1. Install an armored fill crossing using 20 yd3 1-3' rock armor.
57	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	15	20	500	A low power stream intersects an abandoned road. A small (less than 2 vertical feet) headcut has developed at the outboard edge of the road. Several fairly large redwood stumps at the base of the fillslope provide good natural armor. The right approach contributes 300' of flow with an additional 200' of spur road contributing flows.	1. Install an armored fill crossing using 15 yd3 0.5-1.5' rock armor. 2. Install 2 rolling dips on adjacent right road and 1 on the spur road. 3. Outslope road/fill ditch for 300' up the right road approach.
58	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	1	750	360	Swale above road which barely develops into a class 3 stream below. Gully down outboard fillface is likely due to left road contribution and not from surface flow through the swale.	1. Install an armored fill crossing using 5 yd3 0.5-1.5' rock armor. 2. Outslope road/fill ditch for 750' up the left road approach and 360' up the right road approach. 3. Install 5 rolling dips left and 2 rolling dips right.
59	Lawhead Creek (Upper East Austin Creek)	L	Stream crossing	24	60	100	A small, low power stream intersects the road via a fill crossing. Approaches are short and the outboard fill face is well vegetated.	1. Install an armored fill crossing using 15 yd3 0.5-1.5' rock armor. 2. Outslope road/fill ditch for 60' to the left and 100' right.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
60	Lawhead Creek (Upper East Austin Creek)	L	Stream crossing	1	50	350	Minimal channel development above and below crossing, though channel is "V" shaped. Small gully (0.5'w x 1'd) exists down the outboard fill face, though it is mossy and vegetated.	1. Install an armored fill crossing using 5 yd3 0.5-1.5' rock armor. 2. Outslope road/fill ditch for 350' up right road approach. 3. Install 2 rolling dips up the right road approach.
61	Lawhead Creek (Upper East Austin Creek)	L	Other (swale)	3	150	50	A headwall swale developing into a class 3 stream below the road. A springy left approach with added flow from a swale located left of the site combine to form a small (2'w x 1'd x 20'l) gully. Future erosion estimate based on continued expansion of the gully up the left approach.	1. Install 1 rolling dip in the axis of the swale located left of the site. 2. Outslope road/fill ditch for 150' left of site.
62	Lawhead Creek (Upper East Austin Creek)	L	Stream crossing	1	360	30	Minimal channel development both above and below crossing. Minimal (0.5'w x 1'd) older rill down the outboard fill face for 20'. Redwoods growing on the outboard fillface look to be supporting the slope.	1. Install an armored fill crossing using 5 yd3 0.5-1.5' rock armor. 2. Outslope road/fill ditch for 360' up the left road approach and install 2 rolling dips.
63	Lawhead Creek (Upper East Austin Creek)	ML	Stream crossing	6	1,200	0	Twin rusted out 18" diameter pipes drain an active stream and 1200' of steep left road approach. Upon upgrade the left road approach can likely be lowered if necessary. Currently there is very little fill left in the crossing. Ideally this site and associated road approach could be decommissioned (with landowner approval). Flows could potentially divert onto B. Balala 2.1 Road given a large enough precipitation event.	1. Excavate TOP to BOT, lay back banks to 4:1 where possible, establish 6' channel for ford crossing. Pull back right bank below BOT. 2. Install 8 rolling dips up the left road approach.
64	Gray Creek (Upper East Austin Creek)	M	Landslide	36	0	1,000	Continuous cracks exist along the outboard edge of the road about 150' upslope from a class 3 stream on an inner gorge slope. Area does not appear to have experienced recent movement. Hill slope below slump is densely vegetated with straight trees.	1. Excavate unstable fill from START to END flags (100'w x 2'd x 12'l). 2. Endhaul spoils up the right road. 3. Outslope road/fill ditch for 250' of B. Balala 2.3 Road and 750' of B. Balala 2 Road. 4. Install 2 rolling dips up B. Balala 2.3 Road and 5 rolling dips up B. Balala 2 Road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
65	Gray Creek (Upper East Austin Creek)	L	Other (swale)	Road surface only	15	430	A headwall swale above an overgrown, abandoned road. This is barely a site, though it appears some road related flow potentially intercepts the swale axis. The swale likely becomes a class 3 stream below the road, though full visual inspection of this area is limited by thick vegetation. With landowner approval this road is a good candidate for decommissioning.	1. Install an armored fill crossing using 5 yd3 0.5-1' rock armor. 2. Install 3 rolling dips up the right road approach. 3. Outslope road/fill ditch for 430' up the right road approach.
66	Gray Creek (Upper East Austin Creek)	ML	Stream crossing	39	80	300	This stream has been heavily impacted above the culverted crossing. Woody debris including fencing material, metal debris, and a make shift pond (irrigation use?) are all in the channel upstream of the site. The crossing itself appears to be of little concern, especially considering the non road related impacts to this stream. While the pipe is rusty, it is not rusted out, though when it is eventually replaced a 24" diameter CMP should be used.	1. Clean the culvert inlet. 2. Install 1 rolling dip left and 2 rolling dips right. 3. Outslope road/fill ditch for 80' left and 300' right.
66.1	Gray Creek (Upper East Austin Creek)	M	Stream crossing	180	1,500	0	Culvert looks oversized for stream dimensions. Culvert bottom appears rusty but not rusted through. Culvert set in shallow relative to channel grade. Culvert currently has a 40' long 1/2 round well functioning downspout that is well anchored and delivers flow to bottom of the fillslope. Minimal diversion potential to the right.	1. Install a single post trash rack above the inlet. 2. Outslope road/fill ditch for 1,500' up the left road. 3. Install 10 rolling dips left. 4. Install a critical dip along the left hingeline at the crossing. 5. As a low priority, replace the existing downspout with a 36" x 50' full round downspout.
66.2	Gray Creek (Upper East Austin Creek)	ML	Ditch relief culvert	Road surface only	500	0	Left road length is from site #66.1 down to intersection with Gray Creek Road. Road length delivers to ditch relief culvert on Gray Creek Road. You can no longer drive up 2.4 Road from Gray Creek Road because cutbank is too high and there is a dormant deep seated landslide at intersection that could be reactivated if road were cut into it.	1. Outslope road and fill ditch for 500' up 2.4 Road and install 2 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
67	Gray Creek (Upper East Austin Creek)	L	Stream crossing	2	200	100	Partially washed out crossing, diffuse channel morphology above and below the road. Springy approaches add to flow.	1. Install an armored fill crossing using 10 yd3 0.5-1.5' rock armor. 2. Outslope road/fill ditch for 100' right and 200' left. 3. Install 1 rolling dip left.
68	Gray Creek (Upper East Austin Creek)	HM	Stream crossing	82	0	0	This is the lower extent of site #18. Stream flow travels across a meadow/flood plain via an active gully before entering Gray Creek. The flood plain area appears to have been used as a landing or staging area for timber harvest activities. As a result, the channel/gully appears to have incised to base level in places though the banks are nearly vertical and bare. In addition, a 4' vertical headcut continues to advance upstream through the remaining fill. There are abundant local spoil storage locations and straight-forward access to the area.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes 2:1 for decommissioning. Store spoils locally.
69	Gray Creek (Upper East Austin Creek)	M	Bank erosion	150	200	200	A 400' long section of road which parallels N. Balala Road lower on the hill slope along the left bank of Gray Creek. This redundant, unused section of road is unnecessary and not required for access to the property. Gray Creek is actively scouring below the outboard fill in many sections resulting in fill failures.	1. Pull outboard fill along the entire length of this spur road where stream flow is currently or could potentially undercut the road fill. 2. Stockpile fill along the cutbank. Decommission outslope with dozer. 3. Install 5 cross road drains along road bed.
70	Gray Creek (Upper East Austin Creek)	M	Bank erosion	9	0	200	This bank erosion site is at a natural erosion bend in Gray Creek approximately 100' left of site #20, a ford crossing. Stream flow is undercutting the road bed, and a near-vertical section of road fill may eventually erode into Gray Creek. The road alignment may need to be moved in 3-5' upon excavation (will need to remove a large Bay tree at inside portion of turn).	1. Pull back vertical portion of bank to stable 2:1 angle for 50'; will likely need to move road in 3-5'. Store spoils locally. 2. Armor bend in channel with 10 yd3 2' armor. 3. Install 1 rolling dip up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
73	Gray Creek (Upper East Austin Creek)	M	Stream crossing	15	65	30	When Gray Creek Road was upgraded about 7 years ago, this site was not receiving much flow because the stream above was (and is) diverted- site was upgraded as an armored fill. Upon implementation of sites detailed in this assessment, stream flow will be put back into natural channel above (site #39), and this site will get much more flow. The outboard fill face is minimally armored, but with year-round road use this site should have culverted stream flow.	1. Excavate the crossing from TOP to BOT, install a 24" x 30' CMP. Attach a 24" x 20' full-round downspout. 2. Armor the outboard fillface with 5 yd3 0.5-1' rock armor. 3. Install a critical dip on the left hinge.
74	Thompson Creek (Lower East Austin Creek)	ML	Stream crossing	7	220	15	Small wooded stream crossing in otherwise grassland setting. Minimal armor placed at outboard edge of road (about 0.5-1' rock). Base of outboard fill is about another 15' down slope. Sidewalls of channel are near vertical from the outboard edge of the road down to the BOT.	1. Install an armored fill crossing using 15 yd3 1-2' rock armor. 2. Install 2 rolling dips up the left road approach. 3. Outslope road/fill ditch for 220' up the left road.
75	Thompson Creek (Lower East Austin Creek)	ML	Stream crossing	5	15	5	A small fill crossing which may have diverted to the right in the past, though now a minor gully through the fill prevents the possibility of diversion. A large Bay tree adjacent to the channel at the outboard edge of the road is providing natural armor. If possible this tree should remain post upgrade. It is possible some flow diverted to this crossing from site 76 in the past.	1. Install an armored fill crossing using 10 yd3 0.5-1.5' rock armor. If at all possible retain the Bay tree on the outboard edge of fill.
76	Thompson Creek (Lower East Austin Creek)	L	Stream crossing	15	100	50	Minimal armor placed at the outboard edge of the road. Stream channel has incised through the outboard fill face for 25' down to the BOT. A large (approximately 3' diameter) boulder at the BOT may have been part of placed armor.	1. Install an armored fill crossing using 20 yd3 of 1-2' rock armor. 2. Outslope road/fill ditch for 100' up left road approach. 3. Install 1 rolling dip up left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
77	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	64	100	445	Not sure if crossing was pulled or washed out. Remaining road fill on both banks near vertical. Left bank fill dimensions are 25'w x 1.5'd x 3'l, right bank dimensions are 50'w x 4'd x 8'l. The right bank width is substantially greater because a spur road travels along the bank (see sketch). The right road is also along an outside meander in the creek which appears to be actively scouring the road fill.	1. Lay back left and right banks (road fill) to 2:1 (where possible along the right bank pull as much of the vertical fill as possible). 2. Rebuild the road bed to act as a ford crossing for quad use (2 hours each excavator, dozer and labor). 3. Outslope road and fill ditch for 100' left and 445' right. 4. Install 1 rolling dip to the left and 3 rolling dips to the right. *14hours labor and 1hour excavator time for de-watering the stream.
78	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	3	0	325	A partially washed out fill crossing on a section of road now used primarily as a trail. Beyond this site, the road width narrows to almost single track width. Installation of cross road drains up the right road approach may not be possible with standard size equipment. Some fill has already washed away exposing a brow log at the previous edge of fill. A small upslope gully exists approximately 30' left of the site.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes 2:1 for decommissioning. Spoil on road to right of site. 2. Install 4 cross road drains on the right road approach.
79	Gilliam Creek (Lower East Austin Creek)	No treat	Stream crossing	5	0	0	If not for the presence of brow logs (6 total remaining), this would appear to be merely a game trail. The entire road bed is gone along the left approach, and the remaining right road is approximately 1-2' wide. The remaining brow logs should probably not be removed as they appear to be supporting what little fill remains. As these logs continue to rot they will slowly mitigate the input of sediment into the stream. Opening this area for equipment access will likely stimulate erosion.	No treatment.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
80	Gilliam Creek (Lower East Austin Creek)	No treat	Stream crossing	89	50	100	A nearly washed away crossing, rotten wood across the stream may be an old bridge or failed brow logs. Approaches almost fully washed away. Right side of crossing is bedrock- some sediment overburden but excavation of this bank will be slow, tedious and likely unnecessary with 2:1 bank angle being impossible (this is reflected in complexity and production rate at site). Access to this area will be expensive and time consuming, and most erosion has already occurred, hence low immediacy. *No treat per BB, 3/30/10.	No treatment.
81	Gilliam Creek (Lower East Austin Creek)	No treat	Stream crossing	3	10	120	Above the road this is more of a swale than a developed class 3 stream. Approximately 60% of the outboard fill face has eroded. Area appears stable for now, though the road bed will likely continue to erode. Minimal road width remaining on either approach. *no treat per BB, 3/30/10.	No treatment.
82	Gilliam Creek (Lower East Austin Creek)	No treat	Stream crossing	5	20	100	Fill crossing on a small stream. The road width has been reduced to a single-track trail on both approaches. Access to this site will be difficult and expensive. *No treat per BB, 3/30/10.	No treatment.
83	Gilliam Creek (Lower East Austin Creek)	No treat	Stream crossing	9	30	0	Washed out crossing, no real road width left to get equipment in to the site as fill on approaches is washed out. Some remaining fill could be pulled, though it will be difficult to work around the mature Bay trees. Left bank is approximately 17'w x 1.5'd x 3'l, right bank is 20'w x 2'd x 4'l. *No treat per BB, 3/30/10.	No treatment.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
84	Gilliam Creek (Lower East Austin Creek)	No treat	Stream crossing	62	0	25	A terminal landing with what appears to be mining gear left at the site. Two streams are cutting through what remains of the fill. What appear to be mine tailings are stockpiled on the inboard side of the landing. Large woody debris and various scrap metal has been placed in the stream axis. Access to this area is poor- most of the road fill has washed away, including 6 washed out crossings. Check site because treatment will require extensive road reconstruction and is likely cost prohibitive. *No treat per BB, 3/30/10.	No treatment.
85	Gilliam Creek (Lower East Austin Creek)	No treat	Stream crossing	3	30	0	Second of two streams crossing a landing/mining area. Stream doesn't look to have been crossed to make a road. Banks are vertical, approximately 2' tall, and appear stable. There are mature fir trees in and around the creek.	No treatment.
86	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	6	290	10	A small stream crosses a narrow, low use road. Nearly flat right road approach may allow diversion given large enough precipitation event, though this is unlikely. Immediacy based on fairly significant left approach length and vicinity of Gilliam Creek (located approximately 200' downstream).	1. Install an armored fill crossing using 15 yd3 0.5-1.5' rock armor. 2. Install 2 rolling dips up the left road approach. 3. Outslope road/fill ditch for 290' up left road.
87	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	1	0	135	Minimal stream channel morphology above and below the road. Road switches back and crosses channel 50' upstream of this site. Minimal road fill at the crossing.	1. Install a critical dip at the crossing. 2. Install 1 rolling dip up the right road approach.
88	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	1	300	0	Road crosses stream channel with no real drainage structure. Stream appears to flow minimally and infrequently. Minor dip in the road on the right hingeline is keeping flow within the natural channel area. Stream appears to bifurcate below the outboard fill face with the majority of flows going toward site #87.	1. Install an armored fill crossing using 5 yd3 of 0.5-1.5' rock armor. Define channel below fill to concentrate flows toward site #87. 2. Install 2 rolling dips up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
89	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	73	500	0	A near-origin stream crosses a fill area located at the outside bend of a switch back on a rarely used, narrow road. While this crossing should be excavated, layback of the left bank may impede on the existing roadbed. May potentially need armor on the left bank after excavation. No adequate stockpile locations in the area and will likely have to endhaul spoils approximately 1200' up the left road approach. There is piping through the fill, no evidence of overland flow through the crossing during site check (1/27/10). Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate TOP to BOT, establish a 4' channel width and layback side slopes to stable 2:1 angle. Haul spoils 1200' to the left to the intersection with Gilliam 1 Road. 2. Install 3 rolling dips up the left road approach. 3. Outslope road/fill ditch for 500' up left road approach.
90	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	170	625	220	Large stacked logs beyond the outboard edge of the road and down to the base of the fillslope indicate this crossing may be a Humboldt. A non functional, detached 18" diameter culvert pipe was observed on the outboard fillface. The channel above the road appears incised. Road fill through the crossing appears stable, primarily due to Humboldt logs.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to 2:1 for decommissioning. Store spoils locally. 2. Install 3 cross road drains up the right road approach and 8 up the left road approach.
91	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	5	1,350	5	A partially washed out fill crossing on an unnecessary road which parallels Gilliam Road (above). Below Gilliam 1 Road is a low-gradient bench area which appears to be acting as a depositional setting. While the crossing itself displays moderate erosion potential, most of the sediment in transport will likely never make it to the main stream system (hence low immediacy). In addition, near surface bedrock in the channel suggests stream incision in complete, though bank erosion will continue. Approximately 1000' of Gilliam 1 Road, proposed for decommissioning, and 350' of Gilliam Road, proposed for upgrade, are connected.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle for decommissioning. Excavate an additional 5 yd3 of perched sediment from the left bank below the BOT. Store spoils locally on the road bed. 2. Install 14 cross road drains up the left approach on Gilliam 1 Road. 3. Install 2 rolling dips on Gilliam Road. 4. Outslope road/fill ditch for 350' of contributing portion of Gilliam Road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
92	Gilliam Creek (Lower East Austin Creek)	ML	Landslide	278	0	0	Very old road/skid travels along the right bank of a class 2 stream. Road fill is constricting the natural channel width and causing scour along both banks. Near the left edge of the site (near the "START" flag), the road travels steeply uphill and intersects a swale/class 3 stream. This stream development area has created a 2'w x 1'd x 60'l gully which delivers to the class 2 stream. Moderate Low treatment immediacy due to slow erosion rate, accessability to site, and road opening cost.	1. Pull back the outboard fill from START to END flags (300'w x 2.5'd x 10'l = 278 yd3 (1.2) = 334 yd3 total). Store spoils along cutbank. 2. Install 2 cross road drains along steep skid near START flag. Place one of these drainage structures in the axis of the swale to limit potential diversion.
93	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	162	0	0	This is the lower extent of the stream detailed in site #90. Abundant large woody debris and fill in the channel. A 14' headcut is migrating upstream from the confluence with a larger class 2 stream. This entire area (encompassing sites 92-94) has been heavily impacted by past industrial logging activities. Road approaches appear to be long gone, though evidence of skid roads in the area is abundant. There was overland flow at the site during 1-27-10 site checking visit eroding through the fill at the crossing creating a rill (1' W x 0.6" D x 70'L) resulting in <2 yd3 of delivery. Moderate Low treatment immediacy due to slow erosion rate, accessability to site, and road opening cost.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle where possible. Spoil locally as much as possible, haul remainder to non-delivering location.
94	Gilliam Creek (Lower East Austin Creek)	ML	Landslide	125	200	200	Very old landing/road fill exists along the right bank of a class 2 stream. Fillslope is near vertical and appears to be constricting flow. Large logs present within fill. The combination of sites 92, 93 and 94 appear to be the cause of aggraded sediments in the channel. The left bank opposite this site may have had a road at some point, though little evidence remains and this area may not be accessible for treatment.	1. Excavate oversteepened outboard landing fill from START to END flags (140'w x 4'd x 12'l = 249 yd3 (1.2) = 290 yd3 total). 2. Install 2 cross road drains up the left approach and 2 cross road drains up the right approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
95	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	29	40	35	A partially washed out fill crossing with abundant woody debris in the fill. Surrounding area appears heavily skidded. Short, springy approaches will not require additional treatment. Low treatment immediacy due to slow erosion rate, accessability to site, and road opening cost.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle. Store spoils locally.
96	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	Road surface only	550	50	Crossing area is too old to tell whether it was pulled, a failed bridge (planks on right bank), or if it has always been a ford crossing. Area to the right of the crossing is broad and flat and is said to have been previously used as a mill site. Natural channel banks are currently too steep for an adequate ford crossing, even for quad use only.	1. Lay back both left and right banks to stable 4:1 angle to construct a ford crossing for quad use. Store spoils locally. 2. Outslope road/fill ditch for 550' up the right road approach. 3. Install 4 rolling dips up the right road approach. *14hours labor and 1hour excavator time for de-watering the stream.
97	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	2	40	400	A previously decommissioned road currently used as a pedestrian/bicycle trail. Very little fill remains at the crossing. This stretch of trail is desired for quad access by State Park's personnel- currently almost accessible though tread is a bit narrow on the approaches. This crossing could also be dipped out and function as a ford crossing, though the approaches still need to be widened to allow for quad access.	1. Install an armored fill crossing to be used for quad access: note no dozer time allotted as road was previously decommissioned. 2. Outslope road/fill ditch for 40' left and 400' right. 3. Install 3 rolling dips up the right road approach.
98	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	Road surface only	60	150	Pulled crossing on previously decommissioned road. Crossing appears 100% pulled- remaining fill (side slopes) looks stable. State Park personnel would like to access this area by quads. A possible alternative to armored fill installation is use of a small quad-use bridge.	1. Install an armored fill crossing using 40 yd3 1-3' rock armor. 2. Outslope road/fill ditch for 60' of left road approach and 150' of right road approach. 3. Install 1 rolling dip up the right road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
99	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	4	35	320	Previously decommissioned crossing, though left bank is too steep and moderately erodible. Some fill material appears to have settled below the outboard fillface and may be put into transport given a large enough precipitation event. Future erosion estimate is based on gully enlargement through remaining fill and input from the oversteepened left bank. A very steep skid up the natural hill slope above the right road approach may be adding some flow to the site. A low spot on the right road approach may partially disconnect road surface flows from the right, but a large enough storm event may result in flows from the right approach delivering to the site.	1. Construct an armored fill crossing using 10 yd3 1-2' rock armor (for quad access). 2. Outslope road/fill ditch for 35' left and 320' right. 3. Install 2 rolling dips up the right road approach. 4. Install 1 cross road drain up the skid above the right road approach.
100	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	3	30	250	Springy, wet stream crossing. Road fill appears stable with large Bay and Redwood trees providing natural stabilization (no need to add additional armor to fill area). Right road approach is springy for 60'- flow beyond is confined to an inboard ditch and drained via a functioning waterbar.	1. Outslope road/keep ditch for adjacent 60' of right road. Install 1 rolling dip to drain road surface only. 2. Outslope road/fill ditch for 190' up right road approach; install 1 rolling dip.
101	Gilliam Creek (Lower East Austin Creek)	ML	Landslide	44	0	250	A slide-prone environment including a large, deep seated past failure which has impacted Gilliam Creek. Currently the road related instability will not fully deliver, though future undercutting of previously deposited material will increase the delivery potential at this site. Some road related failure has already occurred via mass wasting or gullying by surface flows. Check site to determine delivery percentage and spoils management.	1. Excavate unstable road fill (90'w x 3'd x 25'l). Leave enough road width to access area beyond via quad. Haul spoils to the right approximately 1,000' to the vicinity of the road intersection. 2. Outslope road/fill ditch for 250' right. 3. Install 2 rolling dips up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
102	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	Road surface only	40	60	Pulled crossing on previously decommissioned road. State Park personnel would like to access this area via quad. Side slopes appear stable.	1. Install an armored fill crossing using 5 yd3 1-2' rock armor. 2. Outslope road/fill ditch for 40' up the left road approach to allow quad access. 3. Install 1 rolling dip up the right road approach.
103	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	Road surface only	50	100	A pulled crossing on a previously decommissioned road, exposed bedrock in "stair step" style channel. Remaining fill (side slopes) appears stable. State Park personnel would like to upgrade this section for quad access. While an armored fill is proposed at this location, a small, quad-use bridge may be a better option.	1. Install an armored fill crossing using 10 yd3 1-2' rock armor. 2. Outslope road/fill ditch for 50' up left road approach and 100' up the right road approach.. 3. Install 1 rolling dip up the right road approach.
104	Gilliam Creek (Lower East Austin Creek)	ML	Road drainage discharge point	2	110	250	Low gradient partially grassed over road approaches in swale setting contribute flow to a small (2' x 0.5') apparently stable gully. Portions of contributing road and through cut of "meadow trail" (no fill) and likely cannot be effectively drained, though overall this site is of little concern. Future erosion estimate form possible gully expansion.	1. Install 1 rolling dip along left approach and 1 rolling dip along right approach.
105	Gilliam Creek (Lower East Austin Creek)	M	Stream crossing	31	600	0	Bedrock stream channel above road. Stream diverts down right road for 25' before exiting onto outboard fill. Stream is still with in natural hingeline of steam valley. Stream has potential to divert further down right road as it has done in the past.	1. Install an armored fill crossing using 15 yd3 of 1'-2' rock. Install crossing on lower right hinge line of crossing, where flow is currently exiting road (because this is a shorter fill slope). 2. Outslope road and fill ditch for 600' up left road and install 4 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
106	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	29	170	30	Mostly stable fill crossing with bedrock exposed in channel 15' below bottom of fill slope. Steam confluence with detailed at site# 105.	1. Install an armored fill crossing using 10 yd3 of 0.5'-1.5' rock. 2. Outslope road and fill ditch for 170' up left road and install 1 rolling dip.
107	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	74	730	0	Stream channel has aggraded for 60' up channel from inboard road with coluvial sediments. Channel is bedrock at TOP flag. Minimal signs of surface flow on road bed and down outboard fill. Two large (4' diameter) Redwood trees on outboard fill seem to be helping to support fill.	1. Excavate crossing from TOP to BOT with 4' channel width for decommissioning. 2. Install an armored fill crossing using 10 yd3 of 1'-2' rock for quad access. 3. Spoil locally 4. Outslope road and fill ditch for 700' up left road and install 5 rolling dips.
108	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	12	425	20	Small stable fill crossing on small low power creek. May at one point have had diversion potential but outboard half of right approach is outsloped back into crossing and making diversion unlikely.	1. Install an armored fill crossing using 10 yd3 of 0.5'-1.5' rock for quad access. 2. Spoil locally 3. Outslope road and fill ditch for 425' up left road and install 3 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
109	Gilliam Creek (Lower East Austin Creek)	M	Stream crossing	36	250	20	Culvert inlet is pretty much buried but small evacuated area allows the inlet to capture some of the flow. Crossing appears to overtop during high flows, though there is minimal gully development on the road surface. Culvert is set shallow relative to channel grade.	1. Replace existing culvert with a 24" x 50' culvert pipe set in at channel grade and in the natural stream axis. Store spoils locally. 2. Armor the outboard fillslope with 5 yd3 1-2' rock armor. 3. Install a single post trash rack approximately 2.5' above the culvert inlet. 4. Install 5 yd3 1-2' rock armor along the right bank below the outlet. 5. Outslope road/fill ditch for 200' up the left road approach. 6. Install 1 rolling dip up the left road approach.
110	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	3	500	0	Small near origin stream intersects unused road. Very little future erosion likely. Extensive road opening costs involved in accessing this site.	1. Install an armored fill crossing using 5 yd3 0.5-1.5' rock armor. 2. Outslope road/fill ditch for 500' up left road approach. 3. Install 3 rolling dips up the left road approach.
111	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	4	100	65	Two swales converge on the road and begin to develop into a class 3 stream below. Minimal channel development below road and minimal rilling on the outboard fillslope. Another spur road is located 40' down slope from the site.	1. Excavate crossing from TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle. 2. Store spoils locally. 3. Install an armored fill crossing using 5 yd3 of 0.5-1.5' rock armor (for quad use). 4. Outslope road/fill ditch for 100' up the left road approach and for 65' up the right approach. 5. Install 1 rolling dip up left approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
112	Gilliam Creek (Lower East Austin Creek)	L	Stream crossing	3	100	0	Small stream intersecting abandoned road approximately 100' downstream of site 111. Left approach is well vegetated.	1. Excavate TOP to BOT, establish a 4' channel width and lay back banks to 2:1 for decommissioning. Store spoils locally. 2. Install 1 cross road drain up the left road approach.
113	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	88	200	110	Older fill crossing with flows diverting to the right approximately 30' before exiting onto the outboard fillslope and reconnecting with the natural stream channel. Gully on the both the road bed and fillslope appear somewhat stable but will continue to erode the fill in the long term future. Older diversion gullies exist further down the right road approach. Skid road to the right of the crossing contributes sediment via 50' long stable gully. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes 2:1 for decommissioning. 2. Store spoils locally. 3. Install 3 cross road drains up the left road approach. 2. Install 2 cross road drains up the skid road to the right of the crossing.
114	Gilliam Creek (Lower East Austin Creek)	ML	Landslide	36	130	0	An active landslide poised to deliver to Gilliam Creek. The overall setting appears to be a large, deep seated feature which has slumped in the past and is likely a function of regional geology rather than entirely a result of road construction. Approximately half the road bed is already gone, and the remaining tread may be too narrow for a standard size excavator. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate START to END, stockpile down the right road approach. 40'x1.5'x20' 2. Install 2 cross road drains up the left road approach.
115	Gilliam Creek (Lower East Austin Creek)	ML	Landslide	45	200	0	The majority of the road fill has already failed into Gilliam Creek, though some material remains in the upper portion of the evacuated area.	1. Excavate remaining road fill from START to END flags. 40'x1.5'x20' 2. Store spoils locally. 3. Install 3 cross road drains up the left road approach. *1hour dozer time to fill in crossing for equipment access to site# 113.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
116	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	68	320	0	A nearly washed out crossing with some fill remaining in the channel and steep banks in the vicinity of Gilliam Creek. Channel makes a hard turn to the right below the BOT, though this appears natural. This stream may have diverted to the right well upstream by a skid in the past. Abundant woody debris in the fill. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 for decommissioning. 2. Store spoils locally. 3. Install 4 cross road drains up the right road approach. *1hour dozer time to fill in crossing for equipment access to site# 113.
117	Gilliam Creek (Lower East Austin Creek)	ML	Other (gully)	71	150	55	It appears the stream detailed in site 116 was diverted well upstream of Tater Knoll Road. This diverted flow has resulted in a very long, large gully down the hillside which crosses the road and continues to Gilliam Creek. Check site because the upper most portion of this channel has yet to be fully investigated, though it is likely that this area still receives some flow during large storm events and will continue to erode the fill. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to 2:1 for decommissioning. Store spoils locally. 2. Install 2 cross road drains up the left road approach. *1hour dozer time to fill in crossing for equipment access to site# 113.
118	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	8	70	0	Partially washed out crossing with some fill remaining. Banks appear mostly stable below the road prism, though they could be laid back further. Approaches are short and insignificant. Stream appears to have diverted in the past, leaving an inactive gully. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle for decommissioning. Spoil locally. 2. Install 1 cross road drain up the left road approach. *1hour dozer time to fill in crossing for equipment access to site# 113.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
119	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	33	350	40	Stream flow is actively headcutting into the road fill, almost to the inboard portion of the road. Side slopes are oversteepened and will continue to erode as stream erodes to the natural channel. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate crossing from TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 for decommissioning. Store spoils locally. 2. Install 5 cross road drains up the left road approach. *1hour dozer time to fill in crossing for equipment access to site# 113.
120	Gilliam Creek (Lower East Austin Creek)	No treat	Landslide	0	0	0	This is a very large past failure, likely far more than what would be road related. Most erosion has already occurred. While this site is ugly, it is beyond the scope of the current road related erosion assessment. However, the presence of this feature will likely severely limit access options to sites located beyond.	No treatment.
121	Upper Austin Creek	M	Stream crossing	20	300	200	The road and crossing are on the right bank of Austin Creek. It is likely that during a 100-year storm event (and potentially lesser events) this area is submerged. Culvert appears undersized, though upstream about 200' the same stream is culverted under "King's Ridge Road." Crossing and immediate road lengths look to be at the toe of an old, stable landslide feature.	1. Replace culvert with 24" x 40' pipe set in at channel grade. 2. Armor the lower 1/4 of the outboard fillface with 5 yd3 1-2' rock armor. 3. Install 1 rolling dip left and 1 rolling dip right.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
122	Upper Austin Creek	ML	Bank erosion	56	0	0	The road is built adjacent to Austin Creek, and a natural bend in the channel is undercutting the outside edge (right bank), destabilizing the road fill. A 100'w x 6'l section of the bank/outboard fillface is being affected, though road surface drainage does not appear to be an issue. The overall location of the road is problematic, as it appears to be built on a flood plain, within the 100-year storm high flow zone. Armoring the bank will help deflect stream flow, though properly sized armor is essential to eliminate the potential of armor being put into transport by the stream. A gabion structure may be the preferred treatment. This site, while a clear erosional feature, demonstrates lower immediacy with respect to sediment input because of the setting within the flood zone. Current armor volume estimate assumes 2 layers of 2-3' rock armor.	Final treatments based on check site evauation: 1. Excavate a 100'w x 5'd x 6'l (111 yd3 *1.2 = 134 yd3) area on the right bank of Austin Creek (removing perched material and laying back bank to stable 2:1). Excavate a keyway 100'w x 2'd x 2'l at the base of fill (additional 15 yd3 *1.2 = 18 yd3). place 120 yd3 2-3' rock armor in keyway and 6-8' up the right bank to buttress the fill and deflect stream energy. 2. Store spoils on the flat area near site #123 (left approximately 100' to the left).
123	Upper Austin Creek	No treat	Stream crossing	63	0	0	Bedrock stream channel above and below the crossing, and culvert appears to be set at the base of fill. Bedrock visible on cutbank exposure and on road bed on left hinge line. Area below outlet is well armored with 2-3' rock armor down to Austin Creek. Not enough road fill for a critical dip.	No treatment. Check CMP indicates culvert is properly sized
124	Upper Austin Creek	ML	Road drainage discharge point	1	100	83	Road drainage with swale contribution exits the road via a small gully directly into Austin Creek. While this is not a huge issue the flow could be easily dispersed with the installation of 1 rolling dip in the axis of the swale.	1. install 1 rolling dip left of the site in the axis of the swale. 2. Place 5 yd3 of 0.5'- rock armor on the outboard fillface over a 20'w x 20'l section at the outlet of the dip.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
125	Upper Austin Creek	M	Ditch relief culvert	1	250	0	A 60% plugged ditch relief culvert drains the roadbed and a springy inboard ditch. Minimal rilling from the pipe outlet down to Austin Creek. A second 12" ditch relief culvert exists approximately 100' up the left road approach, draining the same springy inboard ditch and hillside.	1. Replace both existing ditch relief culverts with 18"x30' ditch relief culverts. 2. Outslope road/retain ditch for 250' left. 3. Install 1 rolling dip up the left road approach.
126	Upper Austin Creek	M	Stream crossing	27	135	0	An adequately sized though mostly flat culvert drains a stream which has been skidded across approximately 150' upstream of the crossing. The skid has decommissioned itself and requires no treatment. Left of the crossing is a slumping, springy cutbank. At the crossing, the pipe appears at or very near bedrock, so while it is low gradient across the road (increasing plug potential) it may well be installed as deep as possible. Pipe is mildly shotgunned onto bedrock. The main issue at this site is diversion to the right.	1. Install a critical dip on the left hinge of the crossing. 2. Install a single post trash rack above the inlet. 3. Install 1 18"x20' ditch relief culvert at the springy slump to the left of the site. 4. Install 1 rolling dip to the left (drain road surface only- do not connect to ditch).
127	Upper Austin Creek	ML	Stream crossing	41	0	100	This stream crossing may be a gully from "King's Ridge Road," above. No clear channel morphology below the road, slumped grassland hill slope above the road. The pipe appears to be set in shallow relative to channel grade.	1. Replace culvert pipe with a 24" x 60' pipe set in at channel grade. 2. Armor lower 1/4 of outboard fillface with 5 yd3 1-2' rock armor. 3. Install a critical dip along the left hinge line.
128	Upper Austin Creek	ML	Stream crossing	5	0	330	The road is built across the flood plain here, and the pipe at the crossing is low gradient as a result of the setting. The stream goes subsurface, filtering into alluvial gravels 20' below the road prior to it's confluence with Austin Creek. A break in slope approximately 50' to the right of the crossing causes sediment to deposit on the flood plain prior to reaching this stream crossing. It will require a fairly large precipitation event for either the road approach or stream crossing to deliver sediments to Austin Creek.	1. Install a critical dip on the left hinge of the crossing. 2. Install 2 rolling dips up the right road approach. 3. Clean pipe outlet of leaf litter and sediment (1 hr/labor).

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
129	Upper Austin Creek	ML	Stream crossing	Road surface only	815	50	Ford crossing on Austin Creek, with no real road fill on either approach as the road bed is located on the flood plain. The left approach is connected to the creek approximately 150' from the current active channel on a flood plain. Flow from Austin Creek rarely occupies the area where sediments are being deposited.	1. Outslope road/fill ditch for 815' up the left approach. 2. Install 5 rolling dip up the left road.
130	Upper Austin Creek	M	Stream crossing	75	115	260	Stream drained by adequately sized though flat culvert pipe in decent condition. Some sediment is aggrading above the inlet due to low gradient installation angle. Oversteepened right bank above the inlet, though the presence of a power pole just to the right of the culvert and power lines above increase the complexity of treatment at the site. Low gradient approaches, and stream appears to have diverted to the right in the past, resulting in a past diversion gully 30' to the right of the crossing. The inboard ditch delivers from both approaches. The pipe is shotgunned but overall the stream doesn't appear very high power. The entire area is hummocky and shows abundant signs of past skidding.	1. Excavate TOP to BOT, replace the existing culvert pipe with a 24" x 60' culvert set in at the base of fill and in the natural stream axis. Note: It may not be possible to excavate all the way to the TOP due to the power lines and pole. 2. Armor the outboard fill slope with 5 yd3 of 0.5-1.5' rock armor. 3. Install 1 rolling dip up the right road approach. 4. Install a critical dip on the right hinge. 5. Outslope road and fill ditch for 115' left and 260' to the right.
131	Upper Austin Creek	M	Stream crossing	71	50	0	Short, newly installed plastic, double walled culvert set in shallow (compared to channel grade). Outlet of the culvert directs flow onto a 30' length of gullying outboard fillslope. The channel above the inlet appears to be incising through a hummocky landslide feature. Sediments have been deposited at the inlet, which is approximately 10% plugged.	1. Excavate TOP to BOT, replace existing culvert pipe with a 24" x 60' culvert set at the base of fill and in the natural stream axis. 2. Armor the lower 1/4 of the outboard fillslope with 5 yd3 0.5-1.5' rock armor. 3. Install a single post trash rack above the inlet. 4. Install a critical dip on the right hinge line.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
132	Upper Austin Creek	ML	Stream crossing	33	100	100	Older steel culvert, short and shallow relative to channel grade, in the center of a dipped road. Crossing appears to receive minimal flow, with minimal gully development below the outlet for 20'.	1. Excavate TOP to BOT, replace existing pipe with a 24" x 50' long culvert. 2. Armor the lower 1/4 of the outboard fillslope with 3 yd3 1-2' rock armor.
133	Upper Austin Creek	M	Stream crossing	42	130	50	A small stream with an undersized, flat plastic pipe installed high in the fill. Road flow from the right currently bypasses the adjacent site (#134) and exits the roadway here via a 1'w x 1'd x 20'l gully. Treatment of site 134 will address this problem. Increased complexity at the site due to overhead power lines.	1. Excavate TOP to BOT, replace culvert with 24" x 60' culvert pipe at the base of fill and in the natural stream axis. 2. Install 1 rolling dip up the left road approach. 3. Outslope road/fill ditch for 130' left.
134	Upper Austin Creek	HM	Stream crossing	49	0	200	An 18" wooden box culvert with a rotten-out bottom. This drainage structure has been in place for a long time, and the area appears stable, but most likely the crossing will ultimately fail due to the condition of the culvert. Outlet is high in the fill and flow on the outboard fill slope has gullies down to bedrock.	1. Excavate TOP to BOT, replace the existing culvert with a 24" x 60' culvert set at the base of fill and in the natural stream axis. 2. Outslope road/fill ditch for 200' up the right road. 3. Install 1 rolling dip up the right road approach.
135	Upper Austin Creek	ML	Stream crossing	80	200	100	The culvert at this crossing, while apparently properly sized, is short, shallow and high in the fill. Sediments appear to have aggraded as much as 18' upstream above the inlet. The crossing overall appears stable, though there is minimal gully development below the outlet for 20' to the BOT.	1. Excavate TOP to BOT, replace the existing culvert with a 24" x 60' culvert pipe set at the base of fill and in the natural stream axis. Stockpile spoils locally. 2. Install a single post trash rack. 3. Outslope road/fill ditch for 200' up the left road approach. 4. Install 1 rolling dip right and 1 rolling dip left.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
136	Upper Austin Creek	HM	Stream crossing	50	100	570	Two 2.5'w x 0.75'd streams coalesce directly above the inlet of an 18" plastic culvert pipe set at a low gradient (compared to the natural channel gradient) and high in the fill. This hummocky area appears to be the toe of an old slide or slump. A springy grassland portion of the watershed above the contributing right approach should be drained by a ditch relief culvert in addition to road surface drainage treatments. A minimum 30" diameter culvert pipe should be used at this location. Increased complexity due to overhead power lines.	1. Excavate TOP to BOT, replace culvert with 30" x 50' culvert pipe set at the base of fill and in the natural stream axis. 2. Define the channel below the BOT for 20'. 3. Install a single post trash rack 30" above the inlet. 4. Install 2 18" x 30' ditch relief culverts up the right road approach. 5. Install 4 rolling dips right and 1 left. 6. Outslope road/keep ditch for 570' right. 7. Outslope road/fill ditch for 100' left.
137	Upper Austin Creek	M	Stream crossing	210	250	350	Culvert bottom is rusty but not quite rusted through, and the short pipe is set high in the fill and flat relative to the natural stream grade. Sediments have aggraded up the channel behind the inlet for 20'. The pipe outlet is shotgunned approximately 5'. Channel has bedrock steps above and below the crossing. An old gully feature with no apparent flow exists left of the crossing above the road. An abandoned road is located below the crossing approximately 40' downstream. This crossing is approximately 80% washed out.	1. Excavate TOP to BOT, replace the existing culvert with a 48" x 50' culvert pipe set at the base of fill and in the natural stream axis. 2. Install an "I" beam trash rack above the inlet. 3. Remove perched lobe of sediment to the right of the inlet. 4. Outslope road/fill ditch for 250' left and 350' right. 5. Install 1 rolling dip left and 2 rolling dips right. *14hours labor and 1hour excavator time for de-watering the stream.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
138	Upper Austin Creek	ML	Ditch relief culvert	1	40	100	A wooden box culvert in a springy swale drains 140' of road with additional inputs from two small streamlets within the swale. Below this site is an abandoned, heavily gullied road which should be decommissioned. Currently flow is directed into a large gully on this lower road which, after decommissioning work, will not be an issue.	1. Replace existing ditch relief culvert with an 18" x 20' ditch relief culvert. 2. Install an 18" x 10' downspout. 3. Outslope road/retain ditch for 100' right and 40' left. 4. Install 1 rolling dip up the right approach.
139	Upper Austin Creek	M	Ditch relief culvert	9	50	200	Old wooden box culvert currently drains 200' of right road approach (up to the stream detailed as site #140). The culvert outlets onto a lower abandoned road, and has developed a significant (3'w x 2'd x 200'l) gully down the inboard road. Most likely this gully was developed by diverted flow from the stream at site 140.	1. Replace the ditch relief culvert at the site with an 18" x 30' culvert pipe. Orient the outlet to direct flow onto the abandoned roadbed below, not into the gully. 2. Install 1 rolling dip up the right road approach. Connect to the inboard ditch.
140	Upper Austin Creek	HM	Stream crossing	23	0	550	This crossing is located on the left side of a springy, grassy hillside, and may be at the toe of an older, stable landslide feature. The inboard ditch up the right road approach is flowing. This crossing may have failed in the past, resulting in a dramatic gully down the abandoned roadbed located below and to the right (see site 139).	1. Excavate TOP to BOT, replace the existing culvert with a 24" x 40' culvert pipe set in at the base of fill and in the natural stream axis. 2. Install a single post trash rack above the inlet. 3. Install a critical dip along the left hinge line. 4. Outslope road/keep ditch for 450' to the right. 5. Install 3 rolling dips to the right and 1 up the driveway to Bette Campbell's house. 6. Install 2 18" x 40' ditch relief culverts up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
141	Upper Austin Creek	M	Stream crossing	79	120	0	Flowing class ll steam near Betty Campbell's driveway. Channel above crossing looks artificially incised. Area may have been altered to build home site. Outlet shotgunned 3' on the bouldery channel bottom. Steam makes a left turn shortly after outlet. Area looks stable. Check Site= see if 60" or 54" culvert can fit at crossing. Difficult to install a critical dip.	Per check site evaluation 6/2/10: 1. Replace culvert with a 48" x 40' long culvert, set in at channel grade. 2. Install a flared inlet. 3. Install a trash rack. 4. Armor lower 3/4 of outboard fill with 20 yds3 of 1'-2' rock (reuse existing where possible).
142	Upper Austin Creek	M	Stream crossing	24	390	0	Two diverted flowing Class II streams merge and continue to flow down the inboard ditch to site 143. The 2'x 1' deep up road stream flows through a meadow before hitting the road and making a 90 degree turn and running for 50' down the inboard ditch. A 3' headcut migrating at the 90 degree turn into the ditch, which appears stable and is armored with native bed load material. The second stream bifurcates from the flow at site 143 approximately 125' from the inboard road. Minimal channel development above. Evidence of overland flow at fill crossing with a 2'w x 1'd x 45'l gully to confluence with flow from site 143.	1. Excavate TOP to BOT, install a 36" x 40' CMP at the base of fill and in the natural stream axis. 2. Add a trash rack above the inlet. 3. Armor headcut at 1st stream with 5 yd3 1-2' rock armor. 4. Transition excavation from BOT through the LES. 5. Install 2 rolling dips to the left (with 20' outlet at 5% to the right in the meadow). 6. Outslope road/keep ditch for 390' to the left.
143	Upper Austin Creek	ML	Stream crossing	27	30	35	Culvert looks to be at grade and channel bottom. Culvert set in at slightly oblique angle to natural channel at outlet. Not much scour below outlet due to shallow soils and presence of bedrock.	1. Install a trash rack. 2. Install 5 yds3 of 2' rock along right bank below outlet.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
144	Upper Austin Creek	ML	Stream crossing	18	585	0	An 18" culvert drains a small stream in an oak woodland setting. The pipe is short with the outlet set high in the fill, which has developed a moderate (2'w x 1'd scour from the pipe outlet to the BOT. Left road contribution is springy along the inboard ditch, and it is almost through cut but can be outsloped. Approximately 360' of abandoned spur road (UAC Spur 5.1) intersects with the left approach and is actively delivering flow to the inboard ditch. Very little road fill along this road.	1. Excavate TOP to BOT, install a 24" x 40' CMP at the base of fill and in the natural stream axis. 2. Add a trash rack above the inlet. 3. Install a critical dip along the right hingeline. 4. Outslope road/keep ditch for 200' to the left. 5. Install 3 rolling dip up left road. 6. Install an 18" x 40' ditch relief culvert up the left road to drain the inboard ditch.
145	Upper Austin Creek	HM	Stream crossing	19	165	0	Small, dry class 3 stream with 165' of contributing springy ditch flow crosses through 12" culvert pipe with concrete lining on first segment. Undersized pipe is set high in the fill (approximately 4' above the BOT) with woody debris at the outlet, where outlet erosion has caused channel incision.	1. Excavate TOP to BOT, install a 24" x 40' CMP at the base of fill and in the natural stream axis. Armor the outboard fillface with 10 yd3 1-2' rock armor. 2. Add a trash rack above the inlet. 3. Install a critical dip along the right hingeline. 4. Outslope road/keep ditch for 165' to the left. 5. Remove 2'w x 1'd berm for 30' left.
146	Upper Austin Creek	M	Stream crossing	42	300	50	Undersized culvert, high in the fill and shallow relative to natural channel grade, drains a small bedrock stream. A 2'w x 0.5'd x 17'l gully on the outboard fillface appears stable. Treatment immediacy based on the left road contribution, where road drainage has resulted in 2 gullies off the outboard edge of the road.	1. Excavate TOP to BOT, install a 24" x 40' CMP at the base of fill and in the natural stream axis. 2. Add a trash rack above the inlet. 3. Install 2 rolling dips to the left. 4. Outslope road/keep ditch for 300' left. Clean ditch for 300' left. 5. Install 2 18"x30' ditch relief culverts, each with an 18" x 20' downspout.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
147	Upper Austin Creek	HM	Stream crossing	176	150	100	Flowing class 2 stream in grassy oak woodland setting. Small class 3 tributary enters approximately 100' above the inlet. The 18" diameter pipe currently in place at the site is undersized with a significant rust line, and outlets into an older box culvert at the base of fill. A 0.5'w x 1'd x 20'l gully has formed on the outboard fillslope from left road approach contributions. A temporary spoil storage area is located at the turn out up the left road.	1. Excavate TOP to BOT, replace existing culvert with 30" x 70' culvert pipe set in at the base of fill and in the natural stream axis. 2. Install a trash rack above the inlet. 3. Install 1 rolling dip to the left. 4. Outslope road/retain ditch for 100' right and 130' to the left.
148	Upper Austin Creek	HM	Road drainage discharge point	15	800	15	Gully down the outboard fillface and hillside delivers sediments to the flood plain of Austin Creek. Excessive left road approach (600') and 200' of abandoned spur road have developed a gully down the inboard road. Collected road runoff exits road at small rolling dip.	1. Install 3 cross road drains up the abandoned spur road. 2. Cut inboard ditch for 400' from gully up the left road. 3. Install 2 18" x 40' ditch relief culverts. 4. Outslope road/keep ditch for 500' and install 3 rolling dips.
149	Upper Austin Creek	HM	Landslide	37	210	0	Past and potential cutbank failure. Right lateral scarp is currently incising with flows and contributing to Austin Creek via the inboard ditch. Head scarp is over steepened with root mass perched at top approximately 50'. Rilling, slumping and gullying down the face of the cutbank failure with vegetated areas of more stability. Evidence of failure on the outboard fillface with 2 brow logs remaining spanning a 6' void space. Two points of delivery include 1) at the bridge crossing (site 150) and 2)at the culverted crossing to the right of the slide (site 175). Future erosion estimate is based on the continued failure on the cutbank with no attempted mitigation to reduce failure. Need to address road drainage and continued maintenance. Slide has taken out the road in the past.	1. Install 1 rolling dip up the left road approach. 2. Outslope road/keep ditch for 210' to the left. 3. Cut inboard ditch for 75' to the right to site 175. 4. Inslope road with defined inboard ditch through the failure area (approximately 155'). *Long term maintenance: Excavate slide material from road and ditch on an ongoing, as needed basis to keep road open. Store spoils at the turn out near site 147 (to the left) or on the landing in between.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
150	Upper Austin Creek	ML	Stream crossing	Road surface only	50	450	A 50' long and 10' wide steel flat car bridge with wooden decking. Base of bridge is approximately 13' above water level. Posted signs on both approaches declare bridge to be unsafe. No sign of slumping or cracks at bridge ends or below- bridge appears to be set on natural hillslope.	1. Install 2 rolling dips up the right road approach.
151	Upper Austin Creek	M	Stream crossing	39	50	0	Very small class 3 culverted crossing. Pipe is undersized and has high plug potential due to rocky terrain. Pipe is set shallow to natural channel grade and is high in the fill, with the shotgunned outlet incising through the outboard fillface. Armored fill will serve as critical dip for site 152.	1. Remove existing culvert and install an armored fill crossing using 20 yd 1.5'- rock armor (gather locally). 2. Store spoils beyond site 153. 3. Re-rock 90' of road through crossing.
152	Upper Austin Creek	M	Stream crossing	8	400	0	Culvert in a slumping cutbank/hillside setting in what may be a sandstone/serpentine contact. Culvert has a high potential to plug with colluvial sediments from an unstable hillside above. Probably cannot fit a larger culvert at this location due to near surface bedrock. Left inboard ditch is actively flowing and eroding.	1. Outslope road/keep ditch for 400' up the left road. 2. Install 2 rolling dips up the left road approach. 3. Install 2 18" x 30' ditch relief culverts up the left road approach. 4. Install a critical dip on right hingeline
153	Upper Austin Creek	M	Stream crossing	17	0	40	Abandoned short spur road leaves Upper Austin Creek Road and heads down the hill to a summer (ford) crossing on Austin Creek. Road appears to have been dipped to constrain flow within the channel.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 for decommissioning. 2. Store spoils locally along the left road approach.
154	Upper Austin Creek	M	Stream crossing	18	230	0	A very small flowing class 2 stream in very steep terrain. Channel is down to bedrock and boulder bed substrate. Culvert is set high in the fill and shotgunned, however very large armor placed around and below the outlet protect from future erosion to Austin Creek via road below.	1. Install a critical dip along the right hingeline. 2. Install 1 18" x 40' ditch relief culvert to the left. 3. Clean/cut ditch for 230' left.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
155	Upper Austin Creek	ML	Stream crossing	26	100	0	Minimal stream valley development on hillside above the road. Crossing is close to intersection with spur road, below. Flow outlets culvert at site and shortly enters another culvert, below. Both sites should be treated simultaneously.	1. Excavate TOP to BOT, replace pipe with 24" x 30' culvert at the base of fill and in natural stream axis. 2. Armor outboard fillface with 10 yd3 1-2' rock armor. 3. Install a trash rack above the pipe inlet. 4. Install a critical dip along the right hingeline. 5. Install a rolling dip at the intersection with spur road (to the left).
156	Upper Austin Creek	M	Stream crossing	7	50	180	A fill crossing on a very small, dry class 3 stream in very rocky and steep terrain. Outlet erosion on the outboard fillface is less than 5 yd3. The majority of flow and sediment transport is deposited along the inboard road with minor evidence of rilling/sheet flow across the road to an outboard fillface gully. Note: no rock volume called for as armor is available locally in the vicinity of sites 151 and 152.	1. Build an armored fill crossing: Create a broad rolling dip (maximum depth 1'), excavate a keyway 10'w at new outboard edge of the road tapering to 4'w at the base of fill. Set 15 yd3 0.5-1' rock to armor the outboard fillface and 1/3 of the road width. Note: Generate rock armor locally, in the vicinity of sites 151 and 152.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
157	Upper Austin Creek	M	Stream crossing	37	0	60	Crossing appears to have overtopped in the past. Bedrock channel above the inlet. Short, flat culvert has been smashed into an oval shape. Area below the outlet has been well armored down to the BOT. Slight diversion potential exists to the left. Left side of outboard fillface is oversteepened and will likely fail in the future. Future erosion based on crossing failure as well as left bank collapse below the BOT.	1. Excavate TOP to BOT, replace existing culvert with 24" x 40' pipe set at base of fill and in natural stream axis. 2. Armor the lower 1/4 of the outboard fillface with 5 yd3 1-2' rock armor. 3. Install a single post trash rack above the inlet. 4. Install a critical dip along the left hingeline. 5. Pull back the left bank along the outboard fillface (15'w x 15'l x 2'd = 17 yd3).
158	Upper Austin Creek	ML	Ditch relief culvert	2	50	180	A rusty ditch relief culvert, crushed at the outlet, drains a springy hillslope and a mildly insloped road. Drainage has resulted in the development of a gully on the outboard fillface. A low gradient bench 40' below the outlet causes some sediment to settle out prior to reaching Austin Creek.	1. Replace ditch relief culvert at the site with an 18" x 20' pipe. 2. Outslope road/retain ditch for 180' right and 50' left. 3. Install 1 rolling dip up the right road approach.
159	Upper Austin Creek	M	Ditch relief culvert	1	400	60	Small pipe with crushed outlet draining to low gradient bench prior to flowing into Austin Creek. Steep left approach has abundant sediment accumulation in ditch (road is mildly insloped). Increased complexity due to near surface bedrock, which may make effective dip installation problematic.	1. Replace ditch relief culvert at the site with an 18"x30' pipe. 2. Install 1 18"x30' ditch relief culvert up the left approach. 3. Outslope road/retain ditch for adjacent 100' left. 4. Outslope road/fill ditch for 300' (beyond bend in road). 5. Install 3 rolling dips up the left road approach.
160	Upper Austin Creek	M	Stream crossing	38	50	0	An adequately sized culvert set in shallow relative to stream channel grade. Outlet is high in the fill but the outboard fillface is well armored. Bedrock channel just above the inlet.	1. Install a critical dip along the left hingeline. 2. Install a trash rack above the inlet.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
161	Upper Austin Creek	HM	Stream crossing	123	400	135	Several small streams coalesce above an undersized pipe which appears to be set at or very near bedrock. An unused and partially washed out spur road "horseshoes" around the crossing (see sketch). This horseshoe section should be decommissioned and the main crossing upgraded. Below the outlet of the pipe the base of an adjacent landing is being undercut, though full excavation of this area may result in over steepening of the landing fill. To address this situation, Upper Austin Creek Road should be moved in approximately 15' to get the pipe outlet away from the left bank and to allow for a stable 2:1 outboard fillface rebuild. The left bank should be armored. The landing to the left of the site can act as an equipment/material staging area as well as a temporary spoil storage location.	1. Excavate TOP to BOT, replace existing pipe with a 30" x 60' culvert pipe set in at the base of fill and in the natural stream axis. 2. Move road in approximately 15' to get outlet away from undercut left bank and to achieve proper 2:1 rebuild angle of outboard fillface. 3. Install an "I" beam style trash rack above the culvert inlet. 4. Armor the left undercut bank (base of landing) with 5 yd3 2-3' rock armor. 5. Install 2 18"x30' ditch relief culverts up the left road approach. 6. Outslope road/retain ditch for 400' to the left. 7. Outslope road/fill ditch for 135' up the right road approach. 8. Install 1 rolling dip to the right and 3 to the left.
162	Upper Austin Creek	HM	Stream crossing	1	0	50	Two small streams (dimensions totaling 2x1) coalesce on the road bed, resulting in an active head cut which is migrating into the fill prism. This site is adjacent to site #161 on a short "horseshoe" shaped section of abandoned spur road. The area is open and easily accessible, and treatment of this site will be fast and straight forward during upgrade of site 161.	1. Excavate TOP to BOT, establish a 4' channel width and lay back sideslopes to stable 2:1 angle for decommissioning. 2. Install 1 cross road drain to the right.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
163	Upper Austin Creek	HM	Stream crossing	22	250	800	Newly installed culvert set onto bedrock and at grade. Crossing does not look to be a fish barrier. Fill slopes are near vertical, but inlet armored with a wing wall. Treatment immediacy is based upon road contribution. Left road has an 18" ditch relief culvert about 200' from site that is receiving diverted flow from site# 164. Check CMP suggest an 84" culvert, but I don't think that will fit here. Only other alternative would be to install a bridge.	1. Outslope right road and fill ditch for 800' and install 5 rolling dips. 2.Install 1 rolling dip up left road.
164	Upper Austin Creek	HM	Stream crossing	24	285	0	A small stream has plugged the small, flat culvert currently at crossing. Flow travels 30' to the right before exiting via a 12" ditch relief culvert. This road is directly above Austin Creek and may be a full bench road on bedrock. Culvert is shotgunned but outlets onto bedrock and may be set as deep as possible. Treatment immediacy due to diversion, connected road length, and proximity to Austin Creek.	1. Excavate crossing from TOP to BOT to replace culvert with a 24" x 30' long culvert set in at channel grade. 2. Install a 24" x 10' long full round downspout. 3. Armor lower 3/4 of outboard fill face with 5yds3 of 1'-2' rock. 4. Install a critical dip along right hingeline of crossing. 5. Outslope road and fill ditch for 100' along left road and install 1 Rolling Dip. 6. Install a 18" x 30' long ditch relief culvert at intersection.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
165	Upper Austin Creek	HM	Stream crossing	512	380	0	Multiple flood terraces above crossing indicate high sediment transport and that crossing has failed in the past. Fill directly below outlet is well armored, but side slopes are actively failing. Culvert is high in fill and set shallow relative to channel grade. Stream is currently flow at TOP flag and at base of armor below outlet. Armor around outlet can be re-used.	1. Excavate crossing from TOP to BOT and replace culvert with a 36" x 70' long culvert, set in at channel grade. 2. Install a trash rack. 3. Armor lower 1/4 of outboard fillslope with 15 yds3 of 1'-2' rock. Can re-use armor below outlet for some of the volume. 4. Install a critical dip along right hingeline. 5. Outslope left road and fill ditch for 380' and install 2 rolling dips.
166	Upper Austin Creek	HM	Stream crossing	387	195	0	Small, flat, short culvert with 1/2 round downspout drains stream with abundant woody debris in the channel. Part of the outboard fillface is armored, while the unarmored portion is oversteepened (>50 degrees), bare, and actively eroding into the stream channel. Diversion potential to the right. Approach is steep and connected via the inboard ditch.	1. Excavate TOP to BOT, replace pipe with 24"x90' culvert set at the base of fill and in the natural stream axis. Clean woody debris from channel as much as possible above the TOP. 2. Armor the lower 1/4 of the outboard fillface with 20 yd3 2'- rock armor. 3. Install a trash rack above the culvert inlet. 4. Install a critical dip along the right hingeline. 5. Outslope road/fill ditch for 195' up the right road approach. 6. Install 1 rolling dip up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
167	Upper Austin Creek	HM	Stream crossing	147	1,500	0	Culvert set shallow relative to channel grade. Pipe is short and set high in the fill. Outlet is shotgunned about 6' over the outboard fillface, with fill failing around the bedrock scour area beneath the outlet.	1. Excavate TOP to BOT, replace culvert with 24" x 60' pipe set in at channel grade and in the natural stream axis. 2. Armor the outboard fillface with 10 yd3 1-2' rock armor. 3. Install a trash rack above the inlet. 4. Outslope road/retain ditch for 1500' up left road approach. 5. Install 10 rolling dips left. 6. Install 3 18"x30' ditch relief culverts up the left road approach. 7. Clean/cut/define ditch where needed up the left road approach.
168	Upper Austin Creek	No treat	Stream crossing	0	0	0	Ford crossing on Austin Creek. No road fill along either road length. Road travels along flood plain of Austin Creek.	No treatment.
169	Upper Austin Creek	No treat	Stream crossing	Road surface only	20	0	Short channel length (~50') above the road. Stream comes down hill and intersects road on flood plain of Red Slide Creek. No road fill here. Site is near property gate.	No treatment.
170	Upper Austin Creek	L	Stream crossing	0	300	0	Unused ford crossing on Austin Creek. Left road approach is completely grassed over, though springy and wet. Right road approach is on flood plain of Austin Creek until site# 261.	1. Install 4 cross road drains along left road length.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
171	Upper Austin Creek	M	Stream crossing	83	850	0	Ford crossing on Austin Creek. Both left road approaches are grassed over. Approximately 250' of road travels along the bank of a class 2 creek, which appears to have the potential to erode the outboard fillface for about 150' (see sketch).	1. Pull back upper 150' of outboard fill along the left road approach where class 2 stream is undermining the road fill. 2. Install 3 cross road drains along this 150' stretch. 3. Install 4 cross road drains along 600' stretch of other left road approach. 4. Install 4 cross road drains along spur road off of left road.
172	Upper Austin Creek	L	Landslide	Road surface only	450	80	This appears to be an on-going slow failure of some road fill as well as native material in a swale setting between Upper Austin Creek Road and Austin Creek. Several scarp/tension crack features are visible on the partially washed out road bed. While some surface flow is apparent, no clear bed and bank morphology exists. Near surface bedrock in the vicinity of the site. Check site evaluation 2/18/10: Natural slide feature, no treat.	1. Install 6 cross road drains along left road reach.
173	Upper Austin Creek	HM	Stream crossing	107	0	655	Washed out stream crossing on abandoned section of road. Almost all of the left approach is gone. Road fill slope along both banks are near vertical. Area shows signs of recent shallow fill failures. Right road approach is completely grassed over.	1. Excavate remaining fills on both banks. 2. Spoil along right road. 3. Install 8 cross road drain up right road.
174	Upper Austin Creek	M	Stream crossing	26	0	150	Old abandoned road just below drive road. Crossing is just below site# 138. Stream is currently diverted into old wooden box culvert. Significant stable gully from outlet down hillside. Gully is about 15' to the left of natural channel. Older gully exists at inlet from diverted flow from site# 140.	1. Excavate crossing from TOP to BOT for decommission by laying fill slope back to 2:1 angle. 2. Spoil locally. 3. Install 2 cross road drains up right road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
175	Upper Austin Creek	HM	Stream crossing	18	20	0	A 60% plugged culvert drains directly into Austin Creek. Main problem here is cutbank slides to the left of the site have been excavated and sidecast into the flow path of this stream. Also, the culvert is set high in fill and is creating an active gully.	1. Replace culvert with a 24" x 30' long culverts set in at channel grade. 2. Armor lower 3/4 of outboard fill slope with 10yds3 of 1'-2' rock. 3. Install a trash rack.
176	Upper Austin Creek	M	Stream crossing	Road surface only	250	470	Ford crossing on (seasonal use spur) Austin Creek. Majority of left road is on minimal slope. Right reach is very spring, but because of seasonal use no ditch is needed.	1. Outslope road and fill ditch for 250' up left road and install 1 rolling dip. 2. Outslope road and fill ditch for 470' up right road and install 3 rolling dips.
177	Upper Austin Creek	M	Stream crossing	14	230	0	A small stream (just below site# 154) is diverted 40' to the right before being drained by a 12" culvert. Although the stream is diverted there is near surface bedrock in the ditch and in channel below the road and current culvert location seems appropriate.	1. Replace culvert with a 24" x 30' long culvert set in at channel grade. 2. Install a critical dip along right hingeline. 3. Outslope road and fill ditch for 230' up left road and install 1 rolling dip.
178	Upper Austin Creek	M	Stream crossing	10	100	0	Inlet of culvert is 20% plugged with rocks that were placed around inlet and from rock lined channel above. Crossing is just below site# 155. Culvert is shallow and short. Gully beyond outlet is rocked lined. Armored fill is called for because road is seasonal use.	1. Install an armored fill crossing using 10yds3 of 1'-2' rock. 2. Outslope road and fill ditch for 100' up left road.
179	Upper Austin Creek	L	Stream crossing	1	0	75	Short road terminates at water infrastructure in creek. Small amount (1yds3) of perched sediment on right bank could be removed.	1. Excavate 1yds3 of perched material from right bank. 2. Spoil locally.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
180	Upper Austin Creek	HM	Stream crossing	10	0	80	Small class 3 culverted crossing. Undersized pipe set high in the fill and shallow relative to channel grade. Single post trash rack installed to the right of the inlet. Some road surface rilling from site 181 contributes to the crossing. Outlet is shotgunned but directs flows to large boulders, limiting outboard fillface erosion.	1. Install an armored fill crossing: Create broad dip through crossing, lowering road a maximum of 2'. At new outboard edge of road excavate a keyway 10' wide tapering to 4' at the base of fill. Set 15 yd3 of 0.5-1' rock armor on outboard fillface and 1/3 into road bed. Generate rock armor locally (additional 1 hour/each dozer and excavator to gather local armor). 2. Outslope road/retain ditch for 80' to the right (site 181).
181	Upper Austin Creek	ML	Stream crossing	9	0	60	Rocky stream channel above and below the crossing. Culvert appears to be set well relative to natural channel grade. Stream channel stair steps down hillside. Plumbing parallel to channel on left bank, likely outside influence of treatment area.	1. Install an armored fill at the crossing: Remove the existing culvert, create a broad dip through the crossing. At the new outboard edge of the road, create a 10'w keyway tapering to 4' at the base of fill. Set 10 yd3 1-2' rock armor, available locally, to armor the outboard fillface and the outer 1/3 of the road tread. At a minimum the site should have a critical dip for diversion protection. 2. Outslope road/fill ditch for 60' up the right approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
182	Upper Austin Creek	M	Stream crossing	12	80	60	Small fill crossing with minimal road fill. Roadbed is outsloped, and stream flow is currently gullying (2'w x 1'd) down a rocky outboard fillslope. Stream flow above the road comes from multiple areas, so it is best to create a very broad dip through the crossing area and align the axis approximately 25' down the left road approach from the current location. An 80' spur road to the left provides access to a spring box.	1. Install an armored fill crossing: Create a broad dip through the crossing area, lowering the road to a maximum 2' depth. Align the axis of the dip 25' down the left road to capture multiple channels. At the new outboard edge of the road create a 20'w keyway tapering to 4' at the base of fill. Armor the outboard fillface and the outer 1/3 of the road tread with 25 yd3 1-2' rock armor. 2. Outslope road/fill ditch for 80' along spur road located left of the site to the spring box.
183	Upper Austin Creek	HM	Landslide	60	0	80	Deep seated landslide in grassland setting with Spur 5 cutting through feature above channel initiation of 2'w x 1'd class 2 stream (20' below the road). Landslide is active and will continue to slump onto road from above and fail below, delivering to the stream. No treatment to the feature is cost effective, nor will it mitigate continued movement. Best treatment is to dewater the feature and road. Future erosion includes continued delivery to the stream by existing gullies (combined) enlarging through the feature plus some loss of the roadbed. Road will continue to require maintenance to keep open as slide continues to move.	1. Outslope road/retain ditch for 80' to the right (to site 183.1). 2. Install 1 rolling dip up the right road approach between sites 183 and 183.1 to more stable ridge between 2 near origin streams.
183.1	Upper Austin Creek	HM	Landslide	6	0	320	Part of the same landslide detailed in site 183. Failure on outboard edge of road delivers to the stream initiation point approximately 20' below the road. Future erosion includes continued enlargement of the gully above the channel initiation point. As stated in description of #183, no realistic mitigation of the slide movement is possible but hydrologic ally disconnecting the right road approach will result in decreasing the gully enlargement.	1. Outslope road/retain ditch for 320' right. 2. Install 2 rolling dips up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
184	Upper Austin Creek	ML	Stream crossing	Road surface only	220	0	Low gradient stream channel crosses roadbed with very little gradient change. Tree branches have fallen into channel above the road and caused some flow to divert down the right road reach.	1. Use dozer to dip out the ford crossing into a broader dip down the right road reach to capture any diverted flow. 2. Outslope road/fill ditch for 220' and install 1 rolling dip up the right road approach.
185	Upper Austin Creek	ML	Spring	25	150	400	Springy, slumped grassland setting. Left and right road reaches converge in a swale that develops into a class 3 stream below. Both road approaches are grassed over. Future erosion is outboard fillface failure through the swale, though there appears to be minimal chance of it failing.	1. Outslope road/fill ditch for 150' up the left road approach and 400' up the right road approach. 2. Install 1 rolling dip to the left and 2 rolling dips right.
186	Upper Austin Creek	M	Stream crossing	6	0	0	Near origin class 3 stream in grassland setting. Outboard fillface is slumping and cracking due to hummocky nature of hillside. Fill crossing with small sediment fan above the inboard road. Diversion potential in either direction.	1. Install an armored fill crossing: Create a broad dip through the crossing, lowering the road a maximum of 2'. Excavate a keyway 10'w at the new outboard edge of the road tapering to 4' at the base of fill. Set 15 yd3 0.5-1' rock to armor the keyway including the outer 1/3 of the roadbed and the outboard fillface. If possible generate rock locally. 2. Spoil locally.
187	Upper Austin Creek	ML	Stream crossing	27	0	75	Culverted crossing in a grassland setting. Culvert has been set in shallow relative to channel grade, though it appears properly sized. Entire grassland setting is slumping. Outboard road on right side of outlet is experiencing an accelerated failure rate due to the shotgunned pipe outlet.	1. Armor below the outlet and the outboard road to the right of the culvert with 10 yd3 1-2' rock armor; generate locally. 2. Outslope road/fill ditch for 75' up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
188	Upper Austin Creek	H	Stream crossing	6	2,100	0	Flowing class 2 stream with undersized though otherwise good condition culvert. Channel is incised above the crossing with tight meanders and large 1-3' boulder steps. Channel grade is much gentler below the crossing. Pipe is set okay in the fill and in line with the channel axis. Not much fill at the crossing. Very long left road length contributes to the site, hence high treatment immediacy.	1. Excavate TOP to BOT, remove existing culvert pipe. 2. Create ford crossing by dipping out the crossing and laying back the sideslopes to 4:1 (wherever possible). Spoil locally. 3. Outslope road/retain ditch for 1000' to the left. 4. Install 14 rolling dips up the left road approach.
189	Upper Austin Creek	M	Stream crossing	2	80	0	Culverted stream crossing with completely buried culvert inlet. Stream flow currently diverts 20' outside natural channel and gullies for 60' before reentering the natural channel. Minimal road fill, road is outsloped.	1. Install an armored fill crossing: Create a broad dip through the crossing, lowering the road a maximum of 2'. At new outboard edge of the road excavate a 10'w keyway tapering to 4' at the base of fill. Set 10 yd3 of locally generated rock armor to armor the outboard fillface and the outer 1/3 of the road. Store spoils locally.
190	Upper Austin Creek	M	Stream crossing	2	1,200	0	Intermittently flowing Class ll stream on abandoned road. Flow goes subsurface through washed out crossing. Very little road fill here. Long road length but majority is grown over.	1. Remove culvert and install an Armored fill crossing using local rock. 2. Outslope road and fill ditch for 1,000' up left road and install 8 rolling dips.
191	Upper Austin Creek	HM	Spring	Road surface only	1,700	0	Virtually all of the portions of spur 5 road (from site# 180 on one portion and 188 on the other portion) connects to this ditch relief culvert. A ditch has been cut across tool yard to concentrate flow from road lengths to inlet. Treatment immediacy is due to road length.	1. Outslope road and fill ditch for 500' up road to site# 188 and install 2 rolling dips. 2. Outslope road and fill ditch for 1,700' up road to site# 180 and install 8 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
192	Upper Austin Creek	M	Ditch relief culvert	3	240	0	Excessive road drainage through small, low gradient ditch relief culvert. Abundant woody debris placed in gully below the outlet (pipe has short 1/2 round downspout). This debris limits full visual inspection of gully base, but expansion seems likely. Sideslopes are steep and could be laid back. Road is insloped with prominent berm at outboard edge of road. A small diverted stream (site 193) is contributing to ditch flow. Several small past diversion gullies up the left approach.	1. Clear woody debris from outboard fillface, lay back side slopes to 2:1 angle (where possible). Store spoils locally. 2. Place 5 yd3 0.5'- rock armor on gully base. 3. Replace ditch relief culvert at the site with an 18"x40' culvert. 4. Install 1 18"x30' ditch relief culvert up the left approach. 5. Outslope road/retain ditch for 240' up the left road approach and remove berm. 5. Install 2 rolling dips up the left approach.
193	Upper Austin Creek	M	Stream crossing	17	60	0	Stream currently diverted into the inboard ditch and connected to a ditch relief culvert at site 192. Abandoned road prism above crossing is causing erodible step in channel.	1. Excavate TOP to BOT, replace existing culvert pipe with a 24" x 50' culvert at the base of fill and in the natural stream axis. Store spoils locally. 2. Install a trash rack above the inlet. 3. Install a critical dip along the right hingeline. 4. Outslope road/remove ditch and remove outboard berm for 60' up the left road approach.
194	Upper Austin Creek	ML	Ditch relief culvert	Road surface only	180	0	Ditch relief culvert drains a springy, slumping hillslope above. Older abandoned road above has been almost entirely washed away by past stream diversions coming down the Upper Austin Creek Spur 7 Road.	1. Outslope road/retain ditch for 130' up the left approach to site 195. 2. Remove berm for 120' left.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
195	Upper Austin Creek	M	Stream crossing	48	65	0	Culvert is short but not shotgunned. Streamflow beyond outlet appears to be meandering through fill though area looks stable for 30' down from outlet. Channel then has a 6' near vertical headcut.	1. Replace culvert with 24" x 50' culvert set at channel grade and in natural stream axis. 2. Endhaul spoils. 3. Install a trash rack above the inlet. 4. Install a critical dip along the right hingeline.
196	Upper Austin Creek	HM	Stream crossing	167	125	0	A fairly large stream with a small tributary just upstream of the TOP, where a water supply line is located next to a 2' diameter redwood. A small quarry pit is located to the right on the inboard road with a small spoil pile stockpiled near the pipe inlet. Culvert pipe is 1/2 plugged at the inlet with a rusted base and it appears flow is starting to headcut into the road width. In addition, the pipe is small, short and high in the fill and installed at a shallow angle relative to channel grade. The road approach is steep and insloped, and the springy ditch overflows onto the road bed. A diverted stream (site 197) is adding significant flow to this ditch. The outboard fillface is heavily vegetated, but appears to be gullied by streamflow with oversteepened banks. Diversion potential will be addressed through installation of a critical dip at site 195.	1. Excavate TOP to BOT, replace existing pipe with a 36"x60' culvert set in at the base of fill and in the natural stream axis. Store spoils locally. 2. Install a trash rack above the inlet. 3. Outslope road/retain ditch for 125' to the left. 4. Clean ditch for 125' left. 5. Install 1 rolling dip up the left road approach.
197	Upper Austin Creek	HM	Stream crossing	76	410	0	Streamflow currently diverted into the inboard ditch and flowing to site 196. Original channel below the road has been skidded, most likely to access rock outcrop adjacent to the BOT flag. Flow emerges in original channel at BOT.	1. Install a 24" x 60' culvert set at the base of fill and in the natural stream axis. 2. Install a trash rack above the inlet. 3. Install a critical dip along the right hingeline. 4. Outslope road/retain ditch for 410' up the left road. 5. Install 2 18"x35' ditch relief culverts up the left road approach. 6. Install 2 rolling dips up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
198	Upper Austin Creek	HM	Ditch relief culvert	3	1,381	0	Ditch flow to small plastic pipe above springy swale/class 3 stream initiation. Small, well vegetated gully may expand if site is left untreated. Cutbank above left approach is springy and slumpy. Approximately 581' of Upper Austin Creek Road delivers to this site, of which approximately 240' is through cut and will be problematic to drain. Approximately 800' of Upper Austin Creek Spur 9 Road is hydrologically connected to this site as well.	1. Replace the ditch relief culvert at the site with an 18"x30' pipe. 2. Install 1 18"x30' ditch relief culvert up the left road approach. 3. Outslope road/retain ditch for 300' of non through cut portion of left approach. 4. Install 2 rolling dips up the left approach and remove berm for 100'. 5. On Upper Austin Creek Spur 9 Road, outslope road/fill ditch for 800' and install 5 rolling dips.
199	Upper Austin Creek	HM	Stream crossing	150	115	90	Steep active stream with abundant water supply infrastructure above and below crossing. A pond has been built in the channel 20' above inlet of culvert. Inlet of culver is a box 36" concrete culvert and outlet is a round 48" concrete culvert. Culvert is short and set shallow relative to channel grade. Half round downspout at outlet is not helping much to transport flow.	1. Excavate crossing from TOP to BOT to replace culvert with a 36" x 60' long culvert, set in at channel grade. Will need to rebuild plumbing infrastructure upon rebuild of crossing (4hrs labor). 2. Install trash rack. 3. Outslope road, fill ditch for 90' up left road. 4. Outslope road, fill ditch for 110' up right road.
200	Upper Austin Creek	ML	Stream crossing	39	0	50	Crossing is about 40' down slope from another culverted crossing (grassy hillslope between). Difficult to determine the true BOT as slope to the left is associated with the outboard fill of site 199 and the slope to the right is a hummocky landslide feature. Note: this crossing may be a good candidate for an armored fill with landowner approval.	1. Excavate TOP to BOT, replace culvert with 24"x40' culvert pipe set at the base of fill and in the natural stream axis. 2. Install a critical dip along the left hingeline.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
201	Upper Austin Creek	M	Stream crossing	11	0	350	Inlet of the culvert is about 80% plugged with sediment. Shallow fill at crossing be result in difficulty installing a 24" culvert. Steep right road approach may make critical dip installation problematic. This site is a good candidate for an armored fill crossing, with landowner approval.	1. Excavate TOP to BOT, replace existing culvert with 24"x40' culvert pipe set in at the base of fill and in the natural stream axis. 2. Install a critical dip on the left hingeline. 3. Install a trash rack above the inlet. 4. Outslope road/fill ditch for 350' up the right road approach. 5. Install 2 rolling dips up the right road approach.
202	Upper Austin Creek	M	Stream crossing	7	0	40	A small near origin stream high in the watershed is eroding through the fill of a low to no use road. Above the road the stream morphology is diffuse, with several small channels flowing through a springy-swale setting. The presence of a large water storage tank at the end of this road (100' left of the site) suggests landowner necessity of this road. Otherwise this would be a good decommissioning candidate. Access will be challenging, as the road is very steep (40% +) to the right of the site. In the absence of the large water tank this road would likely be considered a skid due to the steep angle, narrow width, and relatively little amount of road fill.	1. Install an armored fill crossing: Create a broad dip through the crossing, lowering the road a maximum of 2'. At the new outboard edge of the road, create a 15'w keyway tapering to 4' at the base of fill. Place 15 yd3 0.5-1.5' rock to armor the outboard fillface and the outer 1/3 of the road width. If at all possible save the oak tree on the outboard fillface.
203	Upper Austin Creek	M	Road drainage discharge point	4	0	250	Approximately 250' of through cut road length exits road bed and gullies to the headwall area of a class 3 stream. Road bed is moderately rilled. A completely plugged 8" PVP pipe under the road bed may be draining the upper pasture area.	1. Outslope road/ and cut ditch for 250' (towards the lower fence) up the right road approach. 2. Where the ditch exits the road (above class 3 stream) build a 10'w x 2'd x 20'l sediment catchment basin. 3. Dip road to funnel flow to the basin. 4. Place rock armor on the outlet of the basin down to the stream.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
204	Upper Austin Creek	L	Road drainage discharge point	2	80	340	Some road drainage and abundant building pad runoff drains to the very top of a well vegetated swale. The adjacent building appears to be fairly new, and the bare dirt entering the swale via rills and small gullies may be stabilized by natural vegetation before long. Also, this site is high enough in the watershed that most fine sediment will likely be retained in the swale's vegetation prior to reaching the stream initiation point. Future erosion estimate based on expansion of numerous rills/small gullies.	1. Install 1 cross road drain to the left and one to the right. Make the drain to the right parallel to the ridge, essentially a long, broad berm. 2. If area is still bare during implementation seed and straw all bare soil. 3. Install 1 rolling dip on main (rocked) road between site 203 and the house.
205	Upper Austin Creek	M	Road drainage discharge point	15	700	0	Flows from a midslope road (475') and a ridge nose skid (225') have resulted in a fairly large gully, which appears to connect downstream with a stream detailed in site 167 and 206. The gully appears somewhat stable- future erosion estimate based on continues migration of the headcut into the road.	1. Layback gully headcut and perched fill at the outboard edge of the road to 2:1, spoil locally. 2. Install 3 rolling dips up the left road approach (past the landing to the gate). 3. Outslope road/fill ditch for 475' up the left road approach. 4. Install 3 cross road drains on the skid road up the ridge nose.
206	Upper Austin Creek	ML	Stream crossing	3	100	0	Small fill crossing. Very little cutbank where road crosses stream. Area looks to be toe of old landslide feature. Stream channel deeply incised below the road.	1. Install an armored fill crossing using 5 yd3 1-2' rock armor. 2. Install 1 rolling dip up the left road approach.
207	Upper Austin Creek	HM	Stream crossing	62	450	0	Stream crossing in hummocky grassland setting. Stream channel appears to define right hingeline of landslide feature. Near vertical fillslope beyond culvert outlet. The 10" diameter asbestos culvert pipe is too short, set high in the fill, and is 60% plugged. Bedrock channel above the inlet. Difficult to determine the natural channel below the outlet- used stump on left bank as best indicator.	1. Install an Armored fill crossing 15' top width and 4' bottom wide using 10yds of 1'-2' rock. 2. Outslope road/fill ditch for adjacent 450' of left road approach. Do not outslope across grassland area. 3. Install 3 rolling dips left.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
208	Upper Austin Creek	HM	Landslide	134	20	0	Perched fill on the right hinge of site 207, this future fill failure is located on a ridge nose with bedrock visible 4-8' below the ground surface. Proceeding out the ridge nose the fill thickens to as much as 24' before tapering to natural hillslope at a 2' diameter oak tree (END flag). Some excavation/erosion volume may overlap with site 207. Right approach, while technically not connected to the site, is ponding water on the roadbed due to berm at the outboard edge of the road.	1. Excavate all unstable fill off of ridge nose between START and END flags (75'w x 4'd x 12'l = 134(1.2) = 161 yd3). 2. Incorporate spoils into outsloping road to the left of site 207. 3. Pull berm located to the right of the site which is currently causing water to pond on the road surface.
209	Upper Austin Creek	HM	Stream crossing	55	30	0	This culverted crossing is completely buried and functioning as a fill crossing. Stream currently diverts to the right for 30' before gullying down the hillslope (3'w x 1'd x 50'l). Fractured bedrock at the bottom of corrugated metal siding (used as downspout) indicates stable BOT location.	1. Excavate TOP to BOT, replace existing pipe with 24" x 40' culvert set at the base of fill and in the natural stream axis. 2. Armor the outboard fillface with 10 yd3 1.5'- rock armor. 3. Install a trash rack above the inlet. 4. Install a critical dip along the right hingeline.
210	Upper Austin Creek	M	Landslide	107	40	0	Unstable fill to the right of the diversion gully (site 209). Fill failure will deliver directly to stream channel below, though some sediment may be retained on the natural hillslope.	1. Excavate unstable road fill between START and END flags (40'w x 4'd x 20'l = 119(1.2) = 143 yd3. 2. Haul spoils 1000' to the landing up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
211	Upper Austin Creek	H	Other (gully)	925	0	800	Overflow culvert drains pond (and watershed above) outside of natural stream channel. Over flow has caused a massive (100' x 25' x 100') gully that intersects small class ll stream valley. Overflow continues down stream channel, it has completely eroded though one road full crossing and is currently eroding through another (see site# 212 & 213). Overflow has cause natural stream valley walls to erode for about 500' down to site# 195. Two long steep skid roads account for right road contribution which have no waterbars and used year-round.	1. Remove culvert and back fill area to prevent pond flow from entering gully below. 2. Install an 30" diameter overflow pipe within natural channel area (about 140' down left road from current culvert). Install 20' long section under road along pond and then install a 110' long downspout down to natural stream channel. Culvert will need to be installed under lowest road to allow access. 3. Install an elbow to outlet to orient flow down natural channel. 4. Install 10 waterbars up right roads/skids.
212	Upper Austin Creek	HM	Other (gully)	891	105	0	Lower extent of site 211, where flow from the pond combines with flow from a small stream (with road surface contributions) and has gullied through old spur roads. Future erosion estimates include left bank (100'w x 12'l to 1:1 = 267 yd3), right bank (50 yd3 inaccessible for treatment + 50'w x 23'l x 10'd = 426 yd3, to be excavated) and 2 sediment lobes totaling approximately 150 yd3 in the channel. Check site feedback: realistic excavation amount will be lower than original 1330 yd3 estimate; determine spoils management based on landowner input (likely use to further buttress dam); keep immediacy the same (HM) as channel will not be fully dewatered.	1. Excavate unstable fill from the left bank, laying back to 2:1 wherever possible (70'w x 12'l = 374 yd3). 2. Excavate unstable fill from right bank where accessible (50'w x 23'l x 10'd = 426 yd3); may be best accessed from site 213 (downstream). 3. Endhaul spoils to stockpile location up left road (determine with landowner input- possibly at base of dam). 4. Install 1 cross road drain up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
213	Upper Austin Creek	H	Stream crossing	98	40	0	Partially washed out stream crossing with large overturned stump in the middle of the old road in the center line of the channel. Currently a short 18" asbestos culvert is draining the majority of the flow. The culvert is actively eroding the outboard fillface, which appears to consist of fine grained sediment and large woody debris. Right bank is actively slumping, with 3-5' vertical displacement. Right bank failure is mostly due to excessive flow from site 211, but could be part of a larger deep-seated feature.	1. Excavate TOP to BOT, establish a 5' channel width and layback sideslopes to 2:1. 2. Endhaul spoils, location to be determined with landowner input.
214	Upper Austin Creek	HM	Landslide	454	250	0	Currently failing outboard fillface along the left bank of a class 2 stream. Road was built along the nose of a ridge between 2 channels. Fill failure is likely due to increased flows from the diverted pond flow detailed in site 211. Right hinge of failure is at the BOT of site 213.	1. Excavate the outboard fillface from START to END flags (150'w x 4'd x 20'l). 2. Stockpile 134 yd3 along the ridge nose and endhaul 400 yd3 approximately 1000' to location yet to be determined (will identify with landowner input).
215	Upper Austin Creek	ML	Stream crossing	4	30	130	More of a springy wet swale above road, that develops into a class lll stream below. Crossing is currently being drained by an 8" PVC pipe. Right road length is a through cut for 100'.	1. Install an armored fill crossing using 15yds3 of 1'-2' rock. 2. Install 1 rolling dip above through cut.
216	Upper Austin Creek	M	Stream crossing	14	230	250	Small stream, which has incised through past slump deposits. Future erosion based on possible gully through road and bank collapse down stream.	1. Install an armored fill crossing using 10 yds3 of 1'-2' rock. 2.Outslope left road and fill ditch for 230' and install 1 rolling dip. 3. Outslope right road and fill ditch fro 250' and install 2 rolling dips. 4. Layback side slopes to 2:1 for 25' below armored fill.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
217	Upper Austin Creek	M	Ditch relief culvert	Road surface only	615	0	Ditch relief culvert draining diverted stream flow from site# 218, 265' of Spur 9 road, and 350' of spur 9.1 roads. Upper 100' of spur 9 road looks to travel across toe of slow moving deep seated landslide and is insloped due to rotational movement of feature. Spur 9.1 travels up to water tank.	1. Along spur 9 road outslope road and fill ditch for 265' and install 2 rolling dips (one just below intersection and one at site). 2. Along spur 9.1 road outslope road and fill ditch for 350' and install 2 rolling dips.
218	Upper Austin Creek	M	Stream crossing	12	120	0	Springy swale that develops into a class lll stream below road. Spring flow is currently diverted down inboard ditch for 265' to site# 217.	1. Install an armored fill crossing using 15 yds3 of 1'-2' rock. 2. Outslope left road and fill ditch for 120'.
219	Upper Austin Creek	M	Spring	Road surface only	200	0	Dry swale above road that develops into a class lll stream below road. When swale is wet, spring flow diverts down inboard ditch and ultimately to site# 217	1. Install an armored fill crossing using 15 yds3 of 1'-2' rock. 2. Outslope left road and fill ditch for 200' and install 1 rolling dip.
220	Upper Austin Creek	HM	Stream crossing	39	225	0	Small stream diverted for 80' before gullying down natural hillslope to Austin Creek. Future erosion based on continued gully expansion.	1. Install an armored fill crossing using 20 yds3 of 1'-2' rock. 2. Outslope left road and fill ditch for 225' and install 2 rolling dip.
221	Upper Austin Creek	H	Stream crossing	32	200	0	This is one of at least 3 streams that are currently diverted into inboard ditch (not sure how many because property boundary is 60' up left road from site). Creek flow exits inboard ditch 100' down right road via 18" culvert and has created a large (40' x 20') gully down nose of spur ridge.	1. Excavate crossing from TOP to BOT to install a 24" x 40' long culvert, set in at channel grade. 2. Install a 30' long full round downspout to outlet. 3. Install a trash rack. 4. Install a critical dip along right hingeline. 5. Outslope left road and keep ditch for 60' (property boundary).

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
222	Upper Austin Creek	HM	Stream crossing	63	0	450	Culverted crossing currently diverts flow into older mature gully. Inlet of culvert is an 8" concrete culvert and outlet is a 10" plastic culvert. Culvert is on lower hingeline of springy swale.	1. Replace culvert with 24" x 50' long culvert. Install outlet in natural channel to the right of current outlet. 2. Install 20' long full round downspout to outlet. 3. Install a trash rack. 4. Install a critical dip along left hingeline. 5. Install an 18" x 30' long ditch relief culvert 50' up right road to drain springy swale. 6. Outslope right road and fill ditch for 450' and install 3 rolling dips.
223	Upper Austin Creek	M	Ditch relief culvert	3	0	305	Small ditch relief culvert drains 305' of road and springy inboard ditch. A gully has developed down outboard fill face below outlet.	1. Replace culvert with an 18" x 30' long ditch relief culvert. 2. Install an 18" x 30' long ditch relief culvert up right road approach. 3. Outslope right road and keep ditch for 305' and install 2 rolling dips.
224	Upper Austin Creek	M	Stream crossing	60	0	115	A small but active stream has incised through unstable slide material upslope before being drained by a flat, short, small culvert. Flow from a previously plugged ditch relief culvert to the right (site#223) has gullied through road fill and delivered to the outlet of this site.	Per check site evaluation 6/2/10: 1. Install an armored fill: Lower road surface 1', at the new outboard edge of the road excavate a 15' wide keyway tapering to 4' wide at the base of fill. Place 20 yd3 1-2' rock armor on the keyway and outer 1/3 of the roadbed. Store spoils locally. 5. Outslope right road and fill ditch for 115' and install 1 rolling dip.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
225	Upper Austin Creek	M	Landslide	52	0	30	Entire road length from site# 224 to 226 looks to travel across an older slow moving toe of a landslide. One continuous scarp exists along outboard fill from site# 224 to 226. Hillslope undulates below scarp to confluence of both class ll streams. Trees growing on toe of slide above road look relatively straight. Cutbank all along swale is weeping.	1. Pull back outboard fill from start (site# 226) to end (site# 224) flags. 35' x 2' x 20' 2. Endhaul spoil up right road to intersection
226	Upper Austin Creek	M	Stream crossing	17	0	30	Stream channel above road looks to be incising through toe of older slow moving landslide feature. Stream drains into small culvert that looks to plug frequently and thereby divert flow down to site# 227.	1. Remove existing culvert. 2. Install an armored fill crossing using 20 yds3 of 1'-2' rock.
227	Upper Austin Creek	M	Spring	3	25	80	A small plastic pipe which appears to have plugged in the past drains a very springy, slumpy hillslope. Approximately 40' left of the current culvert is either a diversion gully or beheaded natural stream channel. This low point along the road is currently getting road surface flow from the landing to the left and road to the right. Most inboard ditch flow goes to inlet of pipe.	1. Replace pipe with an 18" x 30' long ditch relief culvert with a 10' long full round downspout. 2. Pull back steep left fillslope and spoil on landing. 3. Cut inboard ditch from inlet 90' up right road and 20' up left road.
228	Upper Austin Creek	M	Stream crossing	26	60	120	Culverted crossing in grassland setting. Right road approach is very springy and wet. Ditch relief culvert on right approach is currently draining springy cutbank. Outlet of ditch relief culvert gullies for 70' to the stream. Culvert at crossing is shallow and short. Length of culvert has caused outboard fill failure around outlet. Culvert is separated.	1. Remove existing culvert at crossing and install an armored fill using 15yds3 of 1'-2' rock. 2. Inslope road and cut ditch for 100' up right road to drain springy hillslope. 3. Plug ditch relief culvert that is currently draining springy hillslope.
229	Upper Austin Creek	M	Stream crossing	12	0	435	There is 435' of road, 180' of which is located within the property boundary, delivers to a small stream. Road is unnecessarily wide here and rock costs can be reduced by removing 80yds3 from outboard fill, essentially moving road in 10'.	1. Move road in by excavating outboard fill (80yds3). 2. Spoil down left road. 3. Install an armored fill crossing using 15yds3 of 1.5' rock. 4. Outslope road and fill ditch for 100' up right road and install 1 rolling dip.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
230	Upper Austin Creek	M	Ditch relief culvert	3	0	270	Ditch relief culvert at intersection with Spur 6 road. Culvert is mostly just draining 30' of springy inboard ditch. From outlet flow gullies hillside for 60' down to Austin Creek.	1. Outslope road and cut ditch for 30' from inlet and then outslope road and fill ditch for another240'. 2. Install 2 rolling dips. 3. Replace culvert with an 18' x 30' ditch relief culvert.
231	Upper Austin Creek	M	Stream crossing	3	450	60	Ford crossing on Austin Creek. Left road has on ditch relief culvert (concrete 10") that has a gully from outlet for 70' down to Austin Creek. Cutbank is springy and road gets minimal use.	1. Outslope and cut ditch for 450'. 2. Install two 18" x 30' long ditch relief culverts. 3. Install 3 rolling dips.
232	Upper Austin Creek	ML	Stream crossing	18	0	150	Lower extent of stream detailed at site# 165. Culvert set on bedrock. Check CMP indicates that culvert is oversized for 100 year storm event. Ford crossing on Austin Creek is 50' to the left, hence no critical dip is needed. Site# 165 culvert is about 50' up channel from this site, hence not trash rack is needed.	1. Outslope road, fill ditch and remove berm for 150' up right road and install 1 rolling dip.
233	Upper Austin Creek	M	Road drainage discharge point	Road surface only	270	120	Springy cutbanks place flow onto roadbed where it is currently rilling road surface. Minimal road fill at site.	1. Outslope road and cut ditch for 270' up left road, install two 18" x 30' long ditch relief culverts, and install 2 rolling dips. 2. Outslope road and cut ditch for 120' up right road, install an 18" x 30' long ditch relief culvert, and install 1 rolling dip.
234	Upper Austin Creek	ML	Stream crossing	24	75	225	A fairly short (15') bridge on a 10' x 2' stream. Well armored fill slopes are 8' apart, which are mildly impeding the channel. Check CMP program indicates that only a 48" culvert is need for a 100 year storm event. Future erosion is based on fill slope layback under bridge.	1. Outslope road, keep or cut ditch for 225' and install 3 rolling dips up right road. 2. Install an 18" x 30' long ditch relief culvert along right road. 3. Outslope road, fill ditch for 75' up left road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
235	Upper Austin Creek	ML	Stream crossing	7	0	180	Small springy stream channel comes down grassy slumping swale and diverts down left road to minimal water bar. Cutbank down past water bar continues to be springy and wet. Eight inch PVC pipe at gate drains springy cutbank.	1. Install an armored fill crossing using 10yds3 of 1'-2' rock. 2. Replace 8" PVC pipe with an 18" x 30' ditch relief culvert. 3. Outslope road and retain ditch for 180' up right road and install 1 rolling dip.
236	Upper Austin Creek	ML	Stream crossing	4	30	0	Stream channel above road looks more gully like than a stream. Steam may be on right hingeline of deep seated landslide feature. Outboard fill and hillslope below outlet are near vertical due to scour by Austin Creek.	1. Replace culvert with a 24" x 20' long culvert. 2. Install a 10' full round downspout. 3. Install a single post trash rack. 4. Install a critical dip on right hingeline of crossing.
237	Upper Austin Creek	M	Stream crossing	8	170	0	Small but active steam with undersized culvert. Past diversion to the right suggest past plugging of inlet. Main problem here is possible diversion.	1. Replace culvert with a 24" x 30' long culvert set in at channel grade. 2. Install a single post trash rack. 3. Install a critical dip along right hingeline of crossing. 4. Outslope road and fill ditch for 170' up left road and install 1 rolling dip. 5. Define channel from swale 25' from the left to new inlet.
238	Upper Austin Creek	ML	Stream crossing	3	65	0	Very little road fill here. Road travels along flood plain of Austin Creek. Small stream flow contacts road and diverts down right road for 40' and then enters Austin Creek. No signs of rilling on roadbed. Outboard fill looks stable.	1. Install an armored fill crossing using 15yds3 of 1'-2' rock.
239	Upper Austin Creek	ML	Stream crossing	Road surface only	15	175	Ford crossing on Austin Creek at confluence with large tributary. Left approach has been occupied by stream in the past but is on flood plain, so it doesn't not require treatment.	1. Install 1 rolling dip up right road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
240	Upper Austin Creek	HM	Road drainage discharge point	Road surface only	750	50	Low point along road length. Road is straddled by two class l steams (road occupies nose of ridged between). Minimal gully on either side of road that deliver to Austin Creek. Left road length was taken beyond property boundary to drainage break.	1. Outslope road and fill ditch for 750' up left road and install 5 rolling dips.
241	Upper Austin Creek	M	Stream crossing	7	700	0	Small stream intersects road and has developed a 2.5' vertical scarp at outboard which is actively headcutting back into road fill. Small cross road drain to the right prevents diversion. Road is a good candidate for decommission.	1. Install an armored fill crossing at site using 15yds3 of 1.5' rock. 2. Outslope left road and fill ditch for 700' and install 5 rolling dips.
242	Upper Austin Creek	M	Stream crossing	46	100	0	Partially washed out fill crossing on abandoned road. Area des have some trees growing within fill but stream flow is still eroding area. Steam looks to only flow during large storm events.	1. Excavate crossing and install an armored fill using 20yds3 of 1'-2' rock. Extra dozer time to rebuild road. 2. Outslope left road and fill ditch for 100' and install 1 rolling dip.
243	Upper Austin Creek	ML	Ditch relief culvert	Road surface only	250	0	Ditch relief culvert drains inboard ditch of Kings ridge road and the Tyrrell driveway. Driveway is mildly outsloped with no ditch but tire ruts are keeping flow on road. Culvert outlet mildly shotgunned.	1. Outslope Tyrrell driveway and install 2 rolling dips.
244	Upper Austin Creek	ML	Stream crossing	30	0	35	Stream crossing near residence out building. Building is on outboard edge of left bank and fill is somewhat crowding stream channel. Culvert is set in somewhat shallow relative to channel grade but doesn't seem to be an issue. A fairly stable 2' headcut exists about 15' down channel from outlet and could migrate up channel destabilizing crossing. If crossing were to fail stream flow could occupy housing area.	1. Install trash rack above inlet. 2. Install critical dip along left hingeline. 3. Install 5yds3 of 1'-2' rock armor at headcut below outlet.
245	Upper Austin Creek	M	Stream crossing	4	30	500	Two small streams which appear to be near origin in open grassland setting, deliver flows to inboard ditch before exiting road into natural channel. Road appears to have very little fill. Future erosion is based on expansion of partially armored channel.	1. Install an armored fill crossing using 10yds3 of 1.5' rock. 2. Cut ditch for 75' to capture flow. 3. Outslope right road and fill ditch for 440' and install 3 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
246	Upper Austin Creek	No treat	Spring	2	80	100	Broad springy wet swale occupied by toe of ancient deep-seated landslide feature. Spring infrastructure exists here that is capturing flow and piping it to water tanks off site. Surface spring flow currently saturating roadbed and exiting down 25' long outboard fill face at two locations. About 30' down slope from bottom of road fill toe of landslide ends and drops steeply for about 20' to where class ll stream channel initiates.	No Treatment. Because site/road is on toe of ancient deep-seated landslide feature that is slowing eroding, therefore any treatment here could accelerate natural process.
247	Upper Austin Creek	ML	Stream crossing	3	0	300	Rarely used road crosses minimally developed channel. Stream below road is offset from natural channel by 25'. This can be addressed by making a very broad dip and centering the low point to connect both channels. Currently flows are diverting left before rilling off outboard fill.	1. Install an armored fill crossing using 15yds3 of 1.5' rock. Be sure to build a broad dip to encompass all flow. 2. Outslope right road and fill ditch for 300' and install 2 rolling dips.
248	Upper Austin Creek	ML	Spring	2	25	165	Springy swale above road develops into a class lll stream below. Minimal incision down short outboard fill. Road approaches are grassy.	1. Install an armored fill crossing using 5yds3 of 0.5'-1.5' rock. 2. Outslope right road and fill ditch for 165' and install 1 rolling dip.
249	Upper Austin Creek	ML	Stream crossing	1	0	350	Impacted (woody debris and skid influence) stream through large deep seated slide bifurcates above road and coalesces on a steep road/skid which occupies the natural channel. Skid prism continues to occupy stream channel below crossing.	1. Decommission crossing by excavating from TOP to BOT with a 4' channel width and laying slopes back 2:1 2. Spoil locally. 3. Install 1 cross road drain up left road. 4. Outslope right road and fill ditch for 300' and install 2 rolling dips.
250	Upper Austin Creek	No treat	Stream crossing	Road surface only	100	0	Steam crossing on left hingeline of (active) slow moving deep seated landslide. Left road approach is grassed over and continues beyond property boundary. No right road exists any longer. 300' width of landslide feature has completely removed any sign of road. See field map.	No Treatment.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
251	Upper Austin Creek	M	Ditch relief culvert	7	0	720	Road drainage from 590' of native road surface, leading past water tanks, combines with 130' of rocked Tyrrell Driveway to drain to a 12" culvert. Additionally the spill way from the outlet is connected to the pond. These combined flows travel 110' through a well rocked ditch before gulling down 60' of un-rocked hillslope, and into a class ll stream. Future erosion is based upon gully expansion. The pond, while increasing erosion potential, is not a road related site and therefore is not considered as part of the treatment prescription.	1. Outslope Tyrrell Spur 1.1 road for 590' and install 4 rolling dips.
252	Upper Austin Creek	M	Landslide	88	0	0	Landing below house and pond. Somewhat continuous tension scarp (no real vertical displacement) exists from Armored pond outflow channel for 50' along edge of landing. Landowner has mulched fill face so it is difficult to determine how active this slide feature is. Thickness of mulch is inhibiting plant growth on fill face.	1. Excavate slumping landing fill from START to END flags. 50' x 2' x 30'. 2. Endhaul spoil (landowner probably does not want spoils in their backyard) down to Upper Austin Creek road or across Kings Ridge Road to large flat area (not on Tyrrell property).
253	Upper Austin Creek	M	Stream crossing	54	200	25	Lower extent of same stream as site# 244. Culvert is undersized and rusted through with a 4' deep scour hole below shotgunned outlet. Left road approach was paved many years ago and is mostly covered with gravels with some grass growing on it. Road access is to propane tanks for residents. Kings Ridge road may deliver additional flow to this site.	1. Excavate crossing from TOP to BOT to replace culvert with a 30" x 50' long culvert, set in at channel grade. 2. Armor lower 1/4 of outboard fill slope with 5 yds3 of 1'-2' rock. 3. Install a trash rack.
254	Upper Austin Creek	ML	Road drainage discharge point	Road surface only	500	0	Road drainage delivers to flood plain of Austin Creek at intersection with Upper Austin Creek Road.	1. Outslope left road and fill ditch for 500' and install 3 rolling dips.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
255	Upper Austin Creek	ML	Stream crossing	58	160	0	Newly installed culvert. Bedrock channel above inlet. Outlet looks high in fill with remnants of older culvert below. Flood plain of Austin Creeks is about 60' down channel from crossing. Plugged ditch relief culvert up right road, near drainage break, is causing inboard ditch to pool with water.	1. Install 10 yds3 of 1'-2' rock armor below outlet. 2. Install a critical dip along left hingeline of crossing. 3. Outslope road fill ditch for 160' up left road and install 1 rolling dip.
256	Upper Austin Creek	ML	Stream crossing	30	340	115	Bedrock channel above inlet. Inlet of culvert is 20% plugged with sediment. Outlet is set on bedrock. Crossing is about 100' upslope from Austin Creek flood plain. Outboard fills on both sides of crossing are near vertical and should be pulled back.	1. Install a trash rack. 2. Excavate oversteepened fill on both sides of outlet (10' x 2' x 8')2 3. Outslope right road and fill ditch for 115'. 4. Outslope left road and fill ditch for 340' and install 2 rolling dips.
257	Upper Austin Creek	M	Stream crossing	39	710	200	Fairly large stream, near confluence with Austin Creek. Drained by flat, short, culvert. Though culvert is oversized for 100 year storm event. Up stream from inlet area is aggraded with sediments due to presence of skids and channel incision by stream bifurcating around toe of pale-landslide deposit. Flow is currently emerging at base of bay tree 20' down stream of culvert outlet (BOT).	1. Excavate stored sediments above inlet. 65' x 1.5' x 15' 2. Spoil locally 3. Install a trash rack 4. Outslope road, fill ditch for 200' up right road and install 1 rolling dip. 5. Outslope road, fill ditch for 425' up left road and install 3 rolling dips. 6. Install 4 cross road drains up skid road (above crossing on left bank).
258	Upper Austin Creek	M	Bank erosion	223	100	0	Short spur road takes off at Site# 257 and travels along left bank of class ll stream . Stream banks on either side are near vertical and actively being scoured. Banks on the average are about 10' tall. Given the geologic setting, stream may just be incising through toe of old landslide deposit, hence moderate treatment immediacy.	1. Lay back both left and right banks from START (BOT flag of site# 257) to END flag (near flood plain of Austin Creek). 2(200') x 1.5' x 10' 2. Spoil locally.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
259	Upper Austin Creek	HM	Stream crossing	69	40	200	Culvert looks to out of alignment of natural stream channel. Flow from outlet is scouring toe of older deep seated landslide feature. Hillslope along left road length is springy grassland that is currently slumping onto road and rill roadbed to outlet of culvert. Three cut logs were placed below outlet to act as energy dissipaters.	1. Replace culvert with a 42" x 40' long culvert. Excavate crossing to set new outlet between two redwood stumps (with living saplings) to the right of current outlet. 2. Install a trash rack. 3. Outslope road and full ditch for 200 up right road and install 1 rolling dip. 4. Inslope road and cut ditch for 40' up left road. Connect ditch to inlet of culvert.
260	Upper Austin Creek	M	Stream crossing	44	25	585	What appears to be a fairly new and adequately sized (though short) culvert. Crossing drains a mainly 4' x1' stream, with several small tributaries for a combined dimension of 6' x 1'. Outboard fill is steep but short. A knob just above inlet (10') appears to deflect some flows but may be a natural feature of the stream. True base of fill is hard to determine as this appears to be the flood plain of Austin Creek. Very low gradient on left approach may allow diversion, so critical dip recommended.	1.Install trash rack. 2. build up left approach to act as a critical dip. 3. Outslope road, fill ditch for 585' and install 4 rolling dips.
261	Upper Austin Creek	ML	Road drainage discharge point	Road surface only	40	250	Low point along road length on flood plain of Austin Creek. Right road length delivers sediments to site.	1. Outslope road and fill ditch for 250' up right road and install 1 rolling dip.
262	Gilliam Creek (Lower East Austin Creek)	M	Stream crossing	130	40	0	Majority of stream crossing is washed out, with remnants of the crushed culvert buried under fill at the stream bottom. Past diversion gullies exist down right road. Bedrock exposed along right bank under remaining road fill. Left bank is near vertical. Equipment will only be able to access left bank unless crossing is rebuilt. Future erosion estimate is both banks collapsing, while excavation amount is based only on left bank.	1. Excavate remaining fill along left road approach (35'w x 5'd x 10'l). 2. Stockpile locally along cutbank.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
263	Gilliam Creek (Lower East Austin Creek)	HM	Stream crossing	34	200	200	An active stream diverts 150' down a steep road (essentially a skid). Actively incising gully as large as 5'w x 3'd (in places) reenters natural channel before flowing to site 262. Approximately 200' of left road is connected via the low point where the gully reenters natural stream channel. The right approach is very steep (>40%) but could benefit from cross road drains. Excavation estimate from STREAM profile, future erosion estimate from potential gully expansion.	1. Access site via ridge nose skid approximately 250' left of site 262. Fill gully by pulling the outboard fill material into the void space to access crossing. 2. Excavate TOP to BOT, establish 4' channel width and lay back side slopes to 2:1 wherever possible. Spoil locally down the left road approach. 3. Install 2 cross road drains right and 3 cross road drains left.
264	Gilliam Creek (Lower East Austin Creek)	ML	Road drainage discharge point	8	360	0	Approximately 360' of left road drainage exits road and occupies older stabilized gully. Gully travels roughly 200' to Gilliam Creek. Majority of roadbed is grassed over and covered with tan oak leaf litter.	1. Install 3 rolling dips up the left road approach.
265	Gilliam Creek (Lower East Austin Creek)	L	Landslide	67	250	0	Failing outboard fillface along mainstem of Gilliam Creek. Past failure has already delivered some sediment to Gilliam Creek, and future erosion estimate is based on the remainder of the fill failing, with some fill being retained above the channel. Low treatment immediacy due to slow release of sediments at site.	1. Excavate perched road fill (60'w x 15'l x 1.5'd), stockpile on the inboard road (leaving trail width suitable for quad access) and up the left road approach. 2. Install 2 rolling dips up the left road approach.
266	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	38	200	10	Partially washed out stream crossing, with channel "stair stepping" through road fill. Some smaller redwoods are growing in the aggraded fill above the inboard road. Stream has cut through most of the fill and has scoured around to the right hinge line leaving a lobe of fill on the left to be excavated. Moderate Low treatment immediacy due to slow release of sediments at site.	1. Install an armored fill: 1) Dip road surface, lowering road 2' max. 2) At the new outboard edge of the road, excavate a keyway 30' wide tapering to 4' wide at the base of fill. 3) Place 25 yd3 2'- rock armor on the outboard fillface and the outer 1/3 of the road width. 2. Install 1 rolling dip up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
267	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	15	10	10	The road occupies the channel of Gilliam Creek at this site, traveling approximately 200' along the left bank before being lost among very thick brush. Most fill has already eroded, but oversteepened bare banks are poised to deliver. Abundant woody debris and aggraded sediment in the channel, but only 40' seeps realistically treatable due to access constraints. Future erosion estimate based on layback of 2' tall (average) bank- possibly more if aggraded sediments in channel mobilize. 3/29/10: Access to sites on the other side of Gilliam Creek will likely be via Gilliam 2.1 Road (previously assumed to be a decom road). Determine plan of action for right approach (upgrading of skid?) with input from Danny Hagans and State Park personnel. 6/2/10: Additional hours and material per check site evaluation with DKH, TZ and BB	1. At bare/near vertical bank adjacent to site 266, excavate 40'w x 3'l unstable bank to 4:1 angle (33 yd3 total) to create a Ford crossing. Store spoils up left road beyond site 266. Per check site evaluation 6/2/10: 1. 5 additional hrs/excavator for excavationg ford crossing (no dozer). 2. 3 hrs/excavator for channel realignment. 3. 2 hrs/road opening through cutbank slides. 4. 2 hrs excavator, 10 yd3 2' rock armor to build "sill" at ford crossing. 5. 40 hrs/labor and 40 hrs/excavtor for layout and construction of connecting trail on right bank to upper skid road.
268	Gilliam Creek (Lower East Austin Creek)	HM	Stream crossing	162	780	75	Plugged almost nonfunctional pipe on a small creek high in the watershed. Biggest issue here is the significantly insloped left approach which has resulted in the development of a gully on the left road. The outboard fillface has been heavily covered by brush, though it is likely the gully continues down the fillface. Abundant sediments in the channel below the crossing appear to have derived from the road surface and been deposited by road drainage. These sediments will mobilize again given a large enough precipitation event. Approximately 350' of native surfaced left approach extends beyond the watershed boundary but is connected to this site. Higher complexity at this site due to underground utility vault located next to pipe inlet.	1. Excavate TOP to BOT, replace pipe with 24" x 60' culvert pipe set at the base of fill and in the natural stream axis. 2. Install a trash rack above the pipe inlet. 3. Outslope road/fill ditch for 780' up the left road approach. 4. Install 5 rolling dips left. 5. Use up to 50 yd3 of spoil materials to build up the right approach to further protect against diversion potential. Haul the remainder of spoils to the meadow area 350' to the right.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
269	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	Road surface only	100	1,935	Minimal if any road fill here. Small, near source, class 3 stream confluences with another larger class 3 stream at site. Right road length continues along/as left bank of stream and is well outsloped. Road travels along left bank of stream for 750' and then continues for another 285' as a through cut road up to the nose of a ridge. Left road does slope down to site but is near flat, therefore stream could meander along road length. Moderate low treatment immediacy because there is not much that can be done to disperse road drainage.	1. Install a critical dip at confluence of both streams. 2. Outslope left road and fill ditch for 100'.
270	Lower East Austin Creek	M	Stream crossing	9	830	0	Short length of channel development above the road. This stream appears not to have flowed in recent years. Stream crosses road via minimal water bar. Clump of redwoods growing on the outboard fillface. Treatment immediacy due to significant contributing road length.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to 2:1 for decommissioning. Spoil locally. 2. Install 9 cross road drains up the left road approach.
271	Lower East Austin Creek	HM	Stream crossing	45	420	0	Stream diverted into inboard ditch. Infrastructure (shack, water tank) in channel will have to be moved for implementation. Future erosion based on expansion of diversion gully.	1. Excavate TOP to BOT, establish a 4' channel width and layback side slopes to 2:1 for decommissioning. Determine final BOT location after water tanks and shack have been moved. 2. Install 6 cross road drains up the left approach.
272	Lower East Austin Creek	HM	Stream crossing	32	0	450	Stream channel with aggraded sediment about 20' above inlet. Inlet is about 90% plugged with sediment. Culvert short in the fill and set almost flat. Stream looks to frequently divert down left road.	1. Excavate crossing from TOP to BOT with a 4' channel width for decommission. 2. Spoil locally. 3. Install 6 cross road drains up right road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
273	Lower East Austin Creek	HM	Stream crossing	21	0	450	Plugged non-functional pipe in small stream with significant right approach .	1. Excavate crossing from TOP to BOT with a 4' channel width and side slope 2:1 for decommission. 2. Spoil locally. 3. Install 6 cross road drains up right road.
274	Lower East Austin Creek	M	Stream crossing	27	100	640	Flat area that may have been a landing or mill site. Stream is currently flowing above the TOP flag, no flow downstream of road fill. At higher flows stream looks to flow over road, but with minimal incision.	1. Excavate crossing from TOP to BOT with a 4' channel width and side slopes 2:1 for decommission. 2. Spoil locally. 3. Install 2 cross road drains up left road and 8 up the right.
275	Lower East Austin Creek	HM	Stream crossing	25	0	370	Stream diverted ~60' to plugged non-functional and undersized pipe high in the fill set axis of nearby swale. Active headcut eroding road. Future erosion based on cumulative gully expansion from diversion point.	1. Excavate crossing from TOP to BOT with a 4' channel width and side slopes 2:1 for decommission. 2. Spoil locally. 3. Install 3 cross road drains up right road and 1 on left in axis of swale
276	Lower East Austin Creek	M	Stream crossing	86	30	300	Fill crossing with a Bay tree growing out of OBF about 5' down from OBR. Minimal incision across roadbed and down fillslope. Stream currently flowing at BOT flag.	1. Excavate crossing from TOP to BOT with a 4' channel width and side slopes 2:1 for decommission. 2. Spoil locally. 3. Install 4 cross road drains up right road.
277	Lower East Austin Creek	M	Stream crossing	52	0	310	Fill crossing with mild diversion potential to left	1. Excavate crossing from TOP to BOT with a 4' channel width and side slopes 2:1 for decommission. 2. Spoil locally. 3. Install 3 cross road drains on right road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
278	Lower East Austin Creek	HM	Stream crossing	8	60	10	Inlet of culvert is 90% plugged because culvert was set in flat and caused sediment to aggrade above inlet. At higher flows stream flows across road and has incised through fill (along left side of culvert) back into middle of the road. Mau be a Humboldt crossing below culvert. Outlet is spilling flow onto large log parallel to channel.	1. Excavate crossing from TOP to BOT with a 4' channel width and side slopes 2:1 for decommission. 2. Spoil locally.
279	Lower East Austin Creek	M	Stream crossing	11	250	10	Small creek gullying through fill. Low point in road left of crossing (where flow exits road but ultimately intersects channel. Left approach therefore connected through low point.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle for decommissioning. 2. Install 3 cross road drains on left.
280	Lower East Austin Creek	M	Stream crossing	27	0	200	Small stream with bedrock channel bottom in grassland setting. Stream flowed this year and deposited sediments onto roadbed. Stream continued down left road.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle for decommissioning. 2. Install 2 cross road drains on right.
281	Lower East Austin Creek	M	Stream crossing	34	0	105	Diverted stream at fill crossing combines with flows from diverted flow from site #280 on right to gully down OBF.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle for decommissioning. 2. Install 1 cross road drain on right.
282	Lower East Austin Creek	M	Stream crossing	Road surface only	370	600	Broad open flat swale with a picnic bench on right bank of stream. No road fill here.	1. Install 8 cross road drains up right road and 4 on left.
283	Lower East Austin Creek	ML	Road drainage discharge point	Road surface only	0	500	Right road length delivers to flood plain of East Austin Creek.	1. Install 6 cross road drains up the right road approach.
284	Bearpen Creek (Upper Austin Creek)	L	Stream crossing	1	0	50	Swale above the road developing into a class 3 stream below. Surface flow from right road and swale definitely concentrate on road and rill down the left approach and outboard fillface.	1. Install an armored fill crossing using 5 yd3 1-2' rock armor (more like a rolling dip in swale axis with rocked outlet).

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
285	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	6	250	65	Entire area shows evidence of past and present instability. The adjacent road section to this stream crossing is very springy and has a skid road above adding to erosion concerns below. Removal of much material may excite landslide and dewatering is best recommendation. Decommissioning the skid road located above will help to disperse water.	1. Construct an armored fill at the site. 1) Create a broad dip through the crossing, lowering the road a maximum of 2'. 2) At the new outboard edge of fill, excavate a keyway 10' wide and tapering to 4' wide at the base of fill. Place 10 yd3 on the outboard fillface and the outer 1/3 of the road. 2. Outslope road for 75 and remove ditch. 3. Cut ditch from farthest streamlet to left for 150'. 4. Decommission skid road above by installing 5 cross road drains. 5. Install 1 rolling dip along left road.
286	Bearpen Creek (Upper Austin Creek)	L	Stream crossing	7	130	10	Newly upgraded crossing for recent THP. Three humboldt logs have been left in road fill to facilitate flow across dipped out road. No distinct headcut/knick point below Humboldt logs. Large (3-4') boulders and bedrock exist just downstream from the ends of the logs. Approximately 65' of left road is saturated due to springy cutbank.	1. Cut ditch from stream up the left road approach 65' to capture cutbank spring flow.
287	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	Road surface only	400	10	Recently upgraded crossing due to THP (feature is alternately known as THP crossing 4.2). A 12" culvert was removed and an armored fill crossing was installed. Armor at the outboard fillface is up to 3' in diameter. Hillslope above the road appears to be the toe of an ancient landslide. Left road approach is outsloped.	1. Install 2 rolling dips up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
288	Bearpen Creek (Upper Austin Creek)	HM	Road drainage discharge point	3	0	560	Flows are concentrated in ditch and road runoff from gentle inslope. A gully is enlarged for 50' and cutbank is raw and oozing into ditch in headwaters of class 3 stream, which appears to initiate approximately 50' below the road. Hillside material is very gooey, but some bedrock is apparent in the ditch.	1. Outslope 125' from landing above site and install 1 rolling dip. 2. Install 2 additional rolling dips above the landing. 3. Armor cutbank with 5 yd3 2'-riprap. 4. Armor ditch 2'w x 50'l with 0.5'-rock armor.
289	Bearpen Creek (Upper Austin Creek)	L	Road drainage discharge point	Road surface only	360	0	Off road drain delivers to class 2 stream, minimal rilling within road drain. Left road length is already outsloped where possible.	1. Install 2 rolling dips up the left road approach.
290	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	65	225	30	Road surface appears to have been recently shaped during timber harvesting. Minimal rolling dip on left approach and road is outsloped. Minimal critical dip/rolling dip on the right hingeline. Critical dip at the inboard road could still allow stream flow to divert to the right. Culvert bottom is rusted but not rusted through. Culvert is short and shallow, but the outboard fillface is well armored. This crossing corresponds to THP crossing 5.4.	1. Install an armored fill crossing: 1) Dip the road through the crossing. 2) At eh new outboard edge of the road excavate a 10' wide keyway tapering to 4' wide at the base of fill. 3) Place 30 yd3 1-2' rock armor on the outboard fillface and the outer 1/3 of the road. 2. Install 1 rolling dip up the left road approach.
291	Bearpen Creek (Upper Austin Creek)	HM	Road drainage discharge point	2	450	0	There are 2 locations of sediment input from poorly installed road drainage structures. The class 2 stream is very close to the road here and the outboard fillface is very steep. The road is steep, though rolling dip installation should be attempted with ditch relief culverts as well to drain the springy hillside.	1. Install 3 18" x 30' ditch relief culverts up the left road approach. 2. Install 3 rolling dips left. 3. Outslope road/retain ditch 450' left, clean/cut 300' of this ditch.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
292	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	19	420	0	Culvert inlet about 30% crushed. Culvert bottom rusted though not yet rusted through. Culvert pipe is set in shallow relative to the channel grade. Single post trash rack above the inlet. Left road length is springy for adjacent 80' left of the stream up to a minor rolling dip. Left road is outsloped where possible. This crossing corresponds to THP crossing 5.3.	1. Remove existing culvert pipe (1 hr excavator). 2. Install an armored fill crossing: 1) Dip road through crossing. 2) At the new outboard edge of the road, excavate a 10' wide keyway tapering to 4' at the base of the fill. 3) Place 10 yd3 1-2' rock armor on the outboard fillface and the outer 1/3 of the road. 3. Cut the ditch from the stream 80' left. 4. Install 2 rolling dips up the left road approach.
293	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	229	1,335	0	Large crossing in close proximity to main stem Bearpen (<500'). The culvert is not at base of fill which has caused aggraded sediment above the inlet and a deep plunge pool at outlet. The stream is undercutting natural hillside on the left near outlet but proper extension and rebuild angle should eliminate that issue. Site #294 acts as a critical dip and stream cannot divert out of swale.	1. Excavate from TOP to BOT and replace culvert at base of fill with a 54" x 60' long culvert. 2. Install a trash rack 3. Install 9 rolling dips up left approach. 4. Spoil locally. *14hours labor and 1hour excavator time for de-watering the stream.
294	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	Road surface only	40	600	Newly re-armored fill crossing on low gradient class 2 stream. Crossing has 3 18" concrete culvert sections placed vertically at the outboard road to buttress the road fill. Area appears stable. Right road approach is outsloped wherever possible.	1. Install 4 rolling dips up the right road approach.
295	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	57	500	0	Culvert may be undersized but concrete culvert is short and set shallow relative to channel grade, but 25' length of OBF has been armored with 0.5'-1' rock. Single pole trash rack above inlet. See THP crossing #4.	1. Replace with an armored fill crossing using 20 yd3 of 1'-2' rock. 2. Install 3 rolling dips up left road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
296	Bearpen Creek (Upper Austin Creek)	M	Landslide	70	0	0	Vertical OBF due to undercutting of large stream and perched fill on inner gorge road. Past landsliding has already entered sediment into the stream system and more will likely deliver. There is room to excavate cutbank and move road in during treatment.	1. Excavate road fill for 95'w x 2'deep x 10'long on average 2. Move road in as necessary
297	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	20	1,750	245	Twin 24" culverts set in concrete wing walls (inlet and outlet) drain flows from a fairly active 5' x 1' stream. Little fill and seasonal road use indicate this site is a great candidate for a ford crossing. Extensive left approach (including approximately 1000' of spur road) rationale for increased treatment immediacy. Crossing has overtopped in the past. Well vegetated skid up right bank above inlet may be impeding natural channel width but appears stable and should be left alone.	1. Excavate concrete and twin pipes, layback sideslopes 4:1 for ford crossing and establish a 5' channel width through center line. 2. Endhaul concrete scraps and culverts and place spoils locally. 3. Install 5 rolling dips left and 1 on right approach. 4. Outslope 750' of left approach. 5. Install 12 cross road drains up skid trail to left.
298	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	10	0	0	Older crossing 35' downstream from Site #297. Crossing most likely washed out and then was pulled and newer road alignment is now at Site #297. a 7' tall step has been armored (with 2'-3' rock) within channel to keep channel grade up through Site #297. Mossy vertical fillslopes remain on both left and right banks that could be laid back to 2:1 to reduce potential future erosion.	1. Layback remaining fillslope on both left and right banks. 2. Spoil locally.
299	Bearpen Creek (Upper Austin Creek)	M	Other (swale)	1	15	600	Site is located in a headwall swale with a Class III stream becoming defined of OBF. Minor gullying occurs across road from disperse swale drainage and springy cutbank. The OBF is small but slumped and covered with transported road sediment.	1. Armor OBF with 5 yd3 of riprap. 2. Install 4 rolling dips on right approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
300	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	22	20	1,750	Springy swale in a possible ancient landslide toe above road. Landslide feature continues below road. Stream flow is transported across road via a shallow rolling dip. Stream flow is actively rilling OBF in multiple areas. Majority of right road length exceeds 20% and more or less travels down ridge. Road has been outsloped where possible and has minimal rolling dips and off road drains.	1. Install an armored fill crossing using 25 yd3 of 0.5-1.5' rock. 2. Install 11 rolling dips up right road. 3. Crown road where needed along steeper sections.
301	Bearpen Creek (Upper Austin Creek)	M	Spring	Road surface only	0	100	Springy hillside with Stream initiation just below OBF. Transported road sediments fill channel which may be exacerbated from occasional diversion of Site #300. Future erosion is solely based on chronic road surface delivery .	1. Create a broad dip at site. 2. Breach berm and install 1 rolling.
302	Bearpen Creek (Upper Austin Creek)	M	Ditch relief culvert	1	0	2,840	Excessive road drainage combined with building pad runoff drains to crushed and plugged ditch relief culvert, where a vegetated 2' x 1' x 50' gully is expanding before entering a Class III stream. The upper most 950' is rocked, with remainder paved. Approximately 540' right of site is a low gradient meadow with abundant camp infrastructure. No treatments seem applicable in this congested area or the connected paved approach.	1. Replace culvert at site with 18" x 30' ditch relief culvert. 2. Install 2, 18" x 30' long ditch relief culverts up right approach between site and main camp area. 3. Install 7 rolling dips on upper most 950' of unpaved road (adjacent to Site #301, in water tank area). 4. Outslope road and fill ditch where possible on unpaved section. 5. Repave road surface at ditch relief culvert locations (3) 5'x15'=225'
303	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	6	0	465	Small seasonal stream with 40% plugged culvert. Small fill prism here and critical pipe will not fit. This culvert also receives flow from nearly 465' of grassy ditch and vegetated hillside.	1. Excavate from TOP to BOT, and replace with 24" x 40' long culvert. 2. Install 4, 18" x 40' long ditch relief culverts on right approach. 3. Repave road surface (4)5'x15'=300'
304	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	35	200	0	Minimal stream valley or flow delivers to culvert. Minimal channel development below outlet as well.	1. Excavate from TOP to BOT and replace culvert with a 24" x 50' long culvert set in at channel grade. 2. Repave road surface 15'x15'=225'

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
305	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	31	0	625	Flow diverted from original channel emerges at base of large Bay tree before draining through 80% plugged 18" culvert. Some flow emerges on cutbank down left road. Best solution here is to replace lower pipe (left) at current flow axis and cut ditch from past channel in case upslope improvements result in stream re-occupying the paleochannel, which is vegetated and dry. See sketch for additional information.	1. At lower left of the 2 pipes excavate from TOP to BOT. 2. Replace with a 24" x 60' long culvert at base of fill. 3. Cut ditch for 40' right of site. 4. Install 2, 18" x 30' long ditch relief culverts up right road approach. 5. Repave road surface at stream crossing 15'x15'=225' 6. Repave road surface at 2 ditch relief culvert locations (2) 5'x15'=150'
306	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	473	1,975	75	Culvert installed in 2003. Looks to be at base of fill and at channel grade. Single post trash rack above inlet. Upper portion of left road, near site #305 has springy wet cutbanks. Upper stretch of road is paved for 735' and then well rocked for the rest of the length. Some sections of the road length are through cut.	1. Replace trash rack with a galvanized post. 2. Install 1 18' x 40' ditch relief culvert below Site #305. 3. Install 1 18' x 50' ditch relief culvert 100' down road from first and just before through cut. 4. Install 1 18' x 40' ditch relief culvert beyond switchback. 5. Install 5 rolling dips along rocked section of road.
307	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	54	565	0	Culvert is high in the fill and not at channel grade. The stream is currently plunging and undercutting fill. Site has recently n=been upgraded but not up to current standards. Old erosion features present. The entire road length is springy and 2 ditch relief culverts are installed to help relieve stream crossing but more would be beneficial. See THP site C3.6 for additional information.	1.Excavate from TOP to BOT an replace with a 24" x 60' long culvert at base of fill. 2. Armor 3/4 of OBF with 20 yd3 of rip rap. 3. Install a critical dip on right hinge. 4. Install 2 ditch relief culverts (18" x 40' long each) on left approach. 5. Install 4 rolling dips on left approach. 6. Spoil locally.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
308	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	154	375	0	Fairly new 96" culvert on a large tributary of Bearpen Creek. Possible fish passage issue at 18" drop off to concrete apron below pipe outlet. Otherwise pipe appears adequately sized and in good condition. Both the inboard and outboard fillfaces appear to be well armored with rip rap up to 3 feet in diameter. While diversion potential exists to the right, a spur road adjacent to the site prohibits the installation of a critical dip, as diverted flows would erode this spur road. If check site evaluation determines this site is a fish passage issue, increase treatment immediacy.	1. Outslope road/retain ditch for 375' to the left. 2. Install 1 18" x 30' ditch relief culvert up the left road approach. 3. Install 2 rolling dips up the left road approach. 4. Install a single post I-beam style trash rack above pipe inlet.
309	Bearpen Creek (Upper Austin Creek)	L	Stream crossing	15	257	0	Steep seasonal stream with pipe installed at low angle relative to the natural channel grade. Some aggraded sediments above inlet as well as forest litter. Appears to be room to place a pipe deeper in the fill, but care must be taken to ensure the outlet is not placed in the high water zone. Chronic road delivery occurs at the outboard fillface.	1. Excavate TOP to BOT, replace existing culvert pipe with 24" x 40' pipe set in near the base of fill and in the natural stream axis, but above the high water line of creek into which the pipe will drain. Store spoils locally. Armor the outboard fillface with 5 yd3 1-2' rock armor. 2. Install a single post trash rack above the inlet. 3. Install a critical dip along the right hingeline. 4. Install 1 rolling dip up the left road approach.
310	Bearpen Creek (Upper Austin Creek)	No treat	Stream crossing	Road surface only	0	165	Steel bridge across Bearpen Creek. Bridge is 14' wide, 50' long and bottom of bridge is 14' above the stream. Bridge has been installed over an older log spanner bridge. Steel "I" beam abutments are behind older wood pile abutments. Area appears stable. The right approach has a springy inboard ditch, flowing at the time of assessment, which enters Bearpen Creek at a gently sloped ditch-out. Current right approach is longer than stated (up to site 309) but will be cut off at stated length with a critical dip at site 309.	No treatment.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
311	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	131	450	300	Significant tributary of Bearpen Creek drained by an undersized partially (1/3) plugged culvert pipe. A skid up the right bank leads to a partially washed out landing with 2 smaller tributaries. Check site to determine possible access to this area and to determine most appropriate TOP location (i.e. pull back skid for entire 200'?) and proper future erosion estimate. There is a mild break in slope on the right road approach but road would benefit from a rolling dip along this section.	1. Excavate TOP to BOT, replace pipe with a 36" x 60' culvert set at the base of fill and in the natural stream axis. Armor the outboard fillface with 20 yd3 1-2' rock armor. 2. Install an I beam style trash rack above the pipe inlet. 3. Install 2 18" x 40' ditch relief culverts up the left road approach. 4. Install 2 rolling dips up the right road approach and 3 left. 5. Pending check site review, spoil locally.
312	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	50	0	350	A 1' x 2' wooden box culvert, which appears rotten and separated between the slats. Culvert is set high in the fill and shallow relative to the natural channel grade. It appears the landowner has been placing slash on the fill below the outlet. The channel above the inlet is choked with rotten fir trees. Doesn't appear the stream has received flow this year.	1. Excavate TOP to BOT, replace existing pipe with a 24" x 50' culvert pipe set in at the base of fill and in the natural stream axis. Armor outboard fillface with 10 yd3 1-2' rock armor. 2. Install a trash rack above the inlet. 3. Install a critical dip on the left hingeline. 4. Install 1 rolling dip up the right road approach.
313	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	34	0	0	Old log stringer bridge across mainstem Bearpen Creek with trestle on top. Top abutments appear stable, but right bank upstream is being cut into by stream deflection. Armoring here may stabilize hillside and bridge. Approximately 50' further upstream the stream carves through the natural hillside and may over time undermine the year around access road. Both cutbanks are bare and stream channel is being pinched by the abutments.	Per check site evaluation 6/2/10: 1. Excavate a 30'w x 2'd x 2'l keyway along the right bank. Endhaul spoils. 2. Place 25 yd3 3' rock armor in keyway and 1/2 way up the right bank. Additional labor and excavtor time to manage water during work.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
314	Bearpen Creek (Upper Austin Creek)	M	Landslide	34	0	50	It is hard to tell if this is solely a fill failure or in part the result of bank erosion from the mainstem of Bearpen Creek. Surface flows from the roadbed appear to be compromising the already loose road fill. Armor has been placed periodically at the base of fill on the right bank of Bearpen Creek, with this failure site located at an unarmored section.	Per check site evaluation 6/2/10: 1. Excavate a 30'w x 2'd x 2'l keyway, endhaul spoils on landing to the left. 2. Place 20 yd3 2-3' rock armor at the base of fill (in keyway) and up the right bank.
315	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	210	0	50	Right bank crowded by landing fill from inlet for 80' up the channel, but looks stable. This area is off the property, therefore not assessed. Culvert outlet is shotgunned 6' and therefore is not only set in shallow relative to channel grade. Culvert is sized properly for the 100yr storm event.	1. Install a single post trash rack above the pipe inlet. 2. Install 20yds3 of 2'-3' rock armor below outlet. * No critical dip required as per DKH.
316	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	10	175	0	Very small stream (dry) flows to an 80% plugged cement culvert before dissipating on the flood plain above Bearpen Creek very close to the confluence with Austin Creek.	1. Excavate TOP to BOT, replace pipe with 24" x 30' culvert set at the base of fill and in the natural stream axis. Note: May not need to raise the road to accommodate pipe if culvert excavation is deep enough. 2. Install an 18" x 40' ditch relief culvert up the left road approach. 3. Repave road at stream corssing 12'x15'=180' 4.Repave road at ditch relief culvert installation 5'x15'=75'
317	Bearpen Creek (Upper Austin Creek)	L	Stream crossing	1	75	0	Small seasonal stream deposits in ditch and travels to the right down a low gradient, bare ditch. Site is located near the flood plain of mainstem Bearpen Creek and could easily be placed in the natural axis. Upslope drainage may be disturbed but this area is unavailable for investigation, as it is off the project property.	1. Install an armored fill crossing using 5 yd3 0.5-1' rock armor. 2. Outslope road/fill ditch for 75' of left road approach.
318	Bearpen Creek (Upper Austin Creek)	L	Ditch relief culvert	Road surface only	0	280	A 12" ditch relief culvert drains King's Ridge Road. Inlet of pipe is plugged with leaf litter. Bottom of pipe is rusty but not rusted through.	1. Clean inlet of pipe.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
319	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	80	0	450	Culvert is short and set high in the fill, which has resulted in significant erosion of the outboard fillface. Stream appears to currently flow primarily on bedrock, though this is difficult to determine for sure as brush and fallen trees obscure the view of the fillface. A small gully has developed near the outboard edge of the road as a result of the steep right approach with poor drainage structures. The presence of near surface bedrock and a buried water line may make installation of a steeper gradient culvert pipe problematic.	1. Excavate TOP to BOT, replace pipe with 30" x 50' culvert set at the base of fill and in the natural stream axis. Armor the outboard fillface with 15 yd3 1-2' rip rap. 2. Install a critical dip along the left hingeline of the crossing. 3. Install 2 rolling dips up the right road approach (one in the axis of the swale located approximately 85' to the right).
320	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	16	0	350	Two small streamlets, moderately developed in a swale setting high in the watershed, diverts down the left road before exiting the roadbed via several small rills on the OBF. True Class III stream development in swale below the road. Approach moderately outsloped, but could benefit from rolling dips. Right road can be lowered to allow armored fill installation.	1. Install an armored fill crossing: Create a broad dip and lower road 2' max, establish keyway on OBF 16' wide at new OBR tapering to a 4' at base of fill. Set 15 yd3 of 2' minus riprap in keyway 1\3 into road. 2. Spoil locally. 3. Install 2 rolling dips up right road approach.
321	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	105	500	175	Culvert bottom rusted. Culvert outlet looks to be at base of fill. Old skid road crosses stream above inlet and has aggradded channel for 60'. Trash rack present. Minimal critical dip at CLP but stream could still divert down lower road if lower occupied IBR on right road.	1. Excavate from TOP to BOT and replace with a 24" x 70' long culvert set in a channel grade (ensure removal of skid fill from above current inlet). 2. Install a trash rack. 3. Install a critical dip on right higeline. 4. Install 2 rolling dips up left road. 5. Install 1 rolling dip along upper right road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
322	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	162	420	245	A large pipe in good condition draining a healthy stream. Some stored sediment above the pipe inlet, but overall a good looking crossing. Twin T-stake trash racks should be replaced with a single post I-beam style trash rack. The main problematic issue here is an emergent spring 115' up the right road approach. This flow has created a small gully on the outboard fillface at the crossing, though it can be easily cut off by installation of a ditch relief culvert.	1. Install an I-beam style trash rack above the culvert inlet. 2. Cut a ditch at the inboard edge of the road for 10' beneath the emergent spring located 115' right of the site. 3. Install an 18" x 30' ditch relief culvert 105' to the right of the crossing. 4. Place 2 yd3 1.5' rock armor below the outlet of the ditch relief culvert on the flat bench uphill of the redwood tree cluster. 5. Install 2 rolling dips to the right and 3 to the left.
323	Bearpen Creek (Upper Austin Creek)	L	Stream crossing	3	40	100	Minimal stream valley morphology both above and below fill crossing. Mature Redwood tree growing in center of stream just above road. Roadbed has been dipped and outsloped through crossing. Minimal rilling down OBF.	1. Install an armored fill crossing using 5 yd3 of 0.5'-1.5' riprap.
324	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	74	335	110	Large stream with a 4' diameter culvert and 2 steep road approaches eroding the outboard fillface. The culvert causes a 3' plunge onto bedrock due to high and short placement. The outlet has rust holes and will need to be replaced within the next 10 years. Two waterbars currently provide temporary relief from road drainage.	1. Excavate TOP to BOT, replace existing pipe with a 48"x60' culvert set at the base of fill and in the natural stream axis. Armor the outboard fillface with 15 yd3 2'- rock armor. Stockpile locally. 2. Outslope road/fill ditch for 110' to the right and 335' to the left. 3. Install 2 rolling dips left and one right.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
325	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	1	0	20	An armored fill crossing on an active stream adjacent to a culverted crossing (#326, located to the right). Current armored fill is functioning okay, but the armor could be arranged better to prevent diversion to the left and to key in the larger pieces of rock below the road. Current critical dip on the left hinge is functional. Currently the crossing appears passable on a quad, rough in a 4x4 truck, and likely impassable in a logging haul truck. Future erosion estimate is based on scouring around the upstream armor.	1. Rebuild armored fill, moving the larger armor currently at the inboard road to the outboard fillface and transitioning the armor on the approaches to a more drivable (while still functional) design.
326	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	69	15	1,500	Inlet of culvert is slightly crushed. Single pole trash rack has been installed above the inlet. Culvert appears to be at or near the channel grade. Minimal critical dip on the left hinge, though a more robust structure should be installed to ensure diversion potential is minimized. Extensive 1,500' right approach could be outsloped and get rolling dips, though near surface bedrock may make dip installation problematic in places.	1. Excavate TOP to BOT, replace culvert pipe with 30" x 60' pipe set at channel grade and in the natural stream axis. 2. Install critical dip along the left hinge line. 3. Install trash rack above the inlet. 4. Outslope road/fill ditch for 1,500' to the right. 5. Install 10 rolling dips up right road approach.
327	Bearpen Creek (Upper Austin Creek)	L	Landslide	14	0	0	Perched landing fill above a class 3 stream. Fill has several wide tension cracks and abundant large woody debris.	1. Pull perched fill for 75' wide x 10' long. Spoil locally.
328	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	101	70	100	Two streams coalesce above an adequately sized though far too short and rusty culvert. Outboard fillface is nearly vertical, mostly bare and unarmored. Springy right approach and a skid road up the right bank above the inlet.	1. Excavate TOP to BOT, replace pipe with a 30" x 50' culvert set at the base of fill and in the natural stream axis. Armor the outboard edge of fill with 25 yd3 1-2' rock armor. 2. Cut an inboard ditch 40' to the right to drain the springy area and armor ditch with up to 5 yd3 0.5'-rock. 3. Stockpile locally.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
329	Bearpen Creek (Upper Austin Creek)	L	Stream crossing	9	5	85	Small near-origin stream drained by small high in the fill culvert. Stream is currently dry, but upstream swale is seeping. Stream flow must fill scour area before reaching inlet.	1. Install an armored fill crossing: 1) Dip the road surface through the crossing, lowering the road a maximum of 2'. 2) Excavate a keyway 15' wide at the new outboard edge of fill, tapering to 4' wide at the base of fill. 3) Place 5 yd3 0.5-1.5' rock armor on the outboard fillface and the outer 1/3 of the road tread.
330	Bearpen Creek (Upper Austin Creek)	ML	Spring	6	0	0	Emergent spring on landslide face. Flow (some of which is being captured for spring box use) has been diverted down the left road for 30' before gullying down outboard fill. Spring flow is constant and not subject to fluctuations like a stream. Some of the flow dissipates onto roadbed below while some ultimately flows back into natural channel.	Per chack site evaluation 6/2/10: 1. Using hand labor, dip slide material to direct flow into natural channel below to reduce diversion potential. 2. Install 1 cross road drain to the left and 1 cross road drain to the right.
331	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	49	40	30	Recently installed armored fill crossing with failed outboard fill and steep perched fill. There is stream flow 40' above inboard road and 75' below road and several yds3 of road fill in channel. Crossing could be stabilized by rebuilding armored fill at greater depth and lowering the road. Road fill in channel and steep side slopes should be removed.	1. Rebuild armored fill crossing reusing existing 2'-3' rock and importing an additional 25 yds3 of 0.5'-1.5' rock. 2. Excavate 20yds3 of fill from outboard fill face. Per check site evaluation 6/2/10: do not excavate channel (only outboard fillface).
332	Gilliam Creek (Lower East Austin Creek)	L	Spring	Road surface only	450	0	Headwall swale location with Class III stream initiating below the lower road. The cutbank is springy with ponded water on the inboard road and hydrophilic vegetation covering the road surface for nearly 20 feet. Minimal erosion occurring across duff covered road and hillside.	1. Construct a wide and deep cross road drain at spring. 2. Rip left road, install 9 cross road drains.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
333	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	8	0	150	Currently diverted stream near the North fork of Gilliam Creek. Flow gullies down the left road approach to a culverted crossing (site #334). Mild break in slope on right road approach at a swale, but drainage structures will be beneficial. Access to this area will be a challenge.	1. Install an armored fill: 1) Dip the road surface through the crossing, lowering the road 2' maximum. 2) At the new outboard edge of the road, excavate a 10'w keyway tapering to 4' at the base of fill. 3) Place 15 yd3 1.5'- rock armor on the outboard fillface and the outer 1/3 of the road width. 2. Install 1 rolling dip up the right road approach.
334	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	2	70	100	Culverted stream crossing on the North fork of Gilliam Creek, high in the watershed. Two diverted streams are currently eroding the outboard fillface. The road is duff covered, though diversion gullies are bare and appear active during heavy storms.	1. Excavate TOP to BOT, establish a 5' channel width and layback side slopes to 4:1 angle for a stable ford crossing. Spoil locally. 2. Install 1 rolling dip up the right road approach. * 1 hour excavator and 1 hour dozer time to rebuild crossing to access sites further out road.
335	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	20	0	85	Fill crossing just upstream of site 334 with some flow currently diverted and gullying through the fill at site 334. Road is essentially an inner gorge skid above the North fork of Gilliam Creek. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate TOP to BOT, establish a 4' channel width and lay back side slopes to stable 2:1 angle for decommissioning. 2. Install 1 cross road drain to the right. * 1 hour dozer time to rebuild crossing to access sites# 341.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
336	Gilliam Creek (Lower East Austin Creek)	L	Landslide	37	0	0	Failed road fill on inner gorge road next to the north fork of Gilliam Creek. Most of fill looks to have already failed. Creek side redwoods partially stabilize toe, but stream is actively undercutting already loose fill. Access will be tough, as tread is reduced to approximately 6.5' in places. Failure continues left bend in the road, but it may not be prudent to excavate beneath the cutbank slide, as a future sediment delivery issue may develop. Much of the road related erosion has already occurred, and what remains may be full-bench, possibly bedrock. Moderate Low treatment immediacy due to age of feature, accessability to site, and road opening cost.	1. Excavate 140'w x 2'd x 6'l section of loose fill, working around existing trees. Specific excavation limits will be determined during check site evaluation and/or layout process. Leave/establish wide enough tread for quad access. 2. Determine spoil management during check site evaluation- likely will have to haul majority of spoils, but may not have adequate access for full size dump truck. Per BB check site eval 6/2/10: stockpile locally, determine limits of excavation during layout.
337	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	39	25	50	Small stream that has delivered abundant sediment to Gilliam Creek and will continue to do so. Bedrock in channel and redwoods on the hillslopes are good markers of limits of excavation. Removal of all fill will be difficult due to access constraints and steep topography.	1. Install an armored fill: 1) Dip the road surface through the crossing, lowering the road 2' maximum. 2) At the new outboard edge of the road, excavate a 10'w keyway tapering to 4' at the base of fill. 3) Place 25 yd3 1.5'- rock armor on the outboard fillface and the outer 1/3 of the road width. 2. Excavate an additional 50 yd3 from the right road prism.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
338	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	111	375	40	Small stream headcutting through the fill on an abandoned road. Access will be tough, with cutbank and road fill slides to deal with as long as washed out crossings (site 337). Small past fill failure approximately 85' up the left approach. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Install an armored fill: 1) Dip the road surface through the crossing, lowering the road 2' maximum. 2) At the new outboard edge of the road, excavate a 14'w keyway tapering to 4' at the base of fill. 3) Place 20 yd3 1.5'- rock armor on the outboard fillface and the outer 1/3 of the road width. 2. Outslope road/fill ditch through past fill failure (approximately 80' of outsloping). 3. Install 3 rolling dips up the left road approach. * 1 hour excavator and 1 hour dozer time to rebuild crossing to access sites further out road.
339	Gilliam Creek (Lower East Austin Creek)	L	Other (swale)	1	200	0	Headwall swale with class 3 stream initiating below the road. Small duff covered gully through the road fill.	1. Rip left approach and install 5 cross road drains, with one at the swale that is wide and broad.
340	Gilliam Creek (Lower East Austin Creek)	ML	Landslide	1	0	400	Four hundred feet of right road (from nose of ridge) travels to where stream has washed away any signs of where road went from here. Height of road relative to stream makes it unlikely that road crossed the stream. Road may have switched back here and continued downhill. Slide face and roadbed are dense with small trees and appear stable. What vertical fill remains has a low probability of delivering to the stream.	1. Install 6 cross road drains up the right road approach.
341	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	70	120	0	Washed out Humboldt crossing. One log remains in center of channel. Remaining fillslopes are near vertical and mossed over.	1. Realistically, equipment will only be able to access the left bank. Excavate 40'w x 2'd x 12'l and spoil locally. 2. Install 2 cross road drains up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
342	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	21	800	60	Small stream currently diverted and gullying through the fill. Minimal channel development above the road. Steep left road approach adds to erosion at the outboard fillface.	1. Excavate TOP to BOT, establish a 4' channel width and layback side slopes to stable 2:1 angle for decommission. Spoil locally. 2. Install 11 cross road drains left rand 1 right.
343	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	6	100	0	Small stream currently diverted right when flowing. There are large diversion gullies to the right approach and failing outboard fill. The stream axis is low gradient and duff covered, but right road surface is bare.	1. Excavate TOP to BOT, establish 4' channel width and layback side slopes to stable 2:1 angle. Spoil locally. 2. Install 2 cross road drains left.
344	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	32	370	0	Small but active stream currently diverted and gulling through the fill. Moderate Low treatment immediacy due to accessability to site and road opening cost.	1. Excavate TOP to BOT, establish 4' channel width and layback side slopes to stable 2:1 angle. Spoil locally. 2. Install 5 cross road drains left.
345	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	14	1,260	0	What was thought to have been a long aggraded crossing with a steep and long outboard fillface has shown to be a road traveling across a broad bedrock step. Bedrock stream bottom observed 2' below the outboard road. Stream is currently flowing in the natural axis, but has the potential to divert and has diverted in the past. Treatment immediacy primarily due to extensive left road approach.	1. Excavate TOP to BOT, establish 5' channel width and layback side slopes to stable 2:1 angle. Spoil locally up the left road approach. 2. Install 16 cross road drains left. Near the top of the road, at the intersection, the road crosses a swale. Make sure to install a cross road drain on the lower hinge of the swale. 3. Outslope road and fill ditch for 1,260' up left road.
346	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	40	0	125	Likely skid road ending at the confluence of 2 streams. Most fill has eroded down to site 345, but bare, vertical slopes remain. No road to the left and the right road is duff covered with many small trees, with overall difficult access for equipment.	1. Excavate 30'w x 3'd to remove remaining fill from both crossings. Spoil locally.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
347	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	7	50	500	Small stream high in the watershed with brushy road approaches. The stream has eroded through the outboard fillface and will continue to do so. Bare, vertical side slopes are exposed, but channel does not appear to see regular flow.	1. Excavate TOP to BOT, establish a 4' channel width and layback side slopes to stable 2:1 angle for decommissioning. Spoil locally. 2. Install 7 cross road drains up the right road approach.
348	Gilliam Creek (Lower East Austin Creek)	ML	Stream crossing	4	15	0	Small stream high in the watershed with vegetated road approaches. The current 4'w x 2'd outboard fillface gully appears well vegetated.	1. Excavate TOP to BOT, establish a 4' channel width and layback side slopes to stable 2:1 angle for decommissioning. Spoil locally.
349	Bearpen Creek (Upper Austin Creek)	M	Spring	9	0	280	Springy hillside drained by plugged and separated concrete pipe. Abundant emergent flow on hill approximately 80' to the right of the site.	1. Replace pipe at the site with a 18" x 30' ditch relief culvert. 2. Install an 18" x 30' ditch relief culvert 80' up the right approach of the site. 3. Outslope road/retain ditch for 80' to the right. 4. Clean/cut ditch for 80' up the right road approach. 5. Outslope road/fill ditch for 200' (to the gate). 6. Install 2 rolling dips up the right road approach.
350	Bearpen Creek (Upper Austin Creek)	ML	Other (swale)	Road surface only	550	0	Broad swale near ridge with class 3 stream initiating approximately 50' below the road. The 550' right approach is wide, 90% bare and only partially outsloped. The cutbank as the site is springy, and flow travels diagonally across the road surface into a swale. The outboard fillface is bare and crumbling.	1. Install 4 rolling dips up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
351	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	54	0	575	Steep stream with emergent spring approximately 50' to the right. The culvert pipe currently in use at the stream is larger than necessary but installed at a low angle relative to channel grade, partially plugged and high in the fill. Extensive springy approach is already mostly outsloped, but could be enhanced. An additional emergent spring exists on the cutbank up the right road approach approximately 450'.	1. Excavate TOP to BOT, replace pipe with a 24" x 50' pipe set in at the base of fill and in the natural stream axis. Armor the outboard fillface with 20 yd3 1-2' rock armor. 2. Install a trash rack above the inlet. 3. Install a critical dip along the left hingeline. 4. Cut ditch 50' to the right. 5. Outslope road/fill ditch for 400' between emergent springs. 6. Install an 18" x 30' ditch relief culvert 450' to the right of the crossing. 7. Outslope road/retain ditch for 125' right of ditch relief culvert installation. 8. Install 4 rolling dips to the right of the site.
352	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	148	0	385	Steep and narrow swale with seasonal stream which currently flows subsurface through the site. The culvert is relatively flat and more than 50% plugged. Bedrock is present in the area (for excavation boundaries). The right road approach is steep, outsloped and appears full bench-installation of drainage structures along this stretch appears problematic. The left road is narrow with a steep outboard fillface.	1. Excavate TOP to BOT, replace existing culvert with 24" x 60' pipe set at the base of fill and in the natural stream axis. Lower road surface 2 feet. Armor the outboard fillface with 5 yd3 1-2' rock armor. Spoil locally. 2. Install a trash rack above the inlet. 3. Install a critical dip along the left hingeline.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
353	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	367	50	750	Steep bedrock stream with adequately sized culvert which is high in the fill and at a low angle relative to the channel grade. Outlet is shotgunned and a scour hole has developed below on the outboard fillface. Hillslope ravel is plugging the pipe (rather than sediments aggrading above the pipe inlet). Extensive right approach nicely outsloped though could benefit from rolling dips. A flared inlet will help reduce plug potential due to extra sediment from natural hillslope ravel. An emergent spring located 125' to the right should be drained by a ditch relief culvert.	1. Excavate TOP to BOT, replace existing culvert with a 30" x 90' pipe set at the base of fill and in the natural stream axis. Install a 30" diameter flared inlet at the pipe inlet. Armor the outboard fillface with 15 yd3 1-2' rock armor. 2. Install a trash rack above the inlet. 3. Install 5 rolling dips up the right road approach. 4. Install 1 18" x 30' ditch relief culvert 125' to the right.
354	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	325	0	125	Nearly flat culvert with an 80% plugged inlet drains a large, swift stream. The stream has overtopped in the past, washing out nearly all of the outboard fillface (now vegetated) leaving a 10' road width. Site also receives flow from a large spring located 50' to the right. Disconnecting the spring from the site will reduce saturated fill area.	1. Excavate TOP to BOT, replace existing culvert with a 30" x 80' pipe set at the base of fill and in the natural stream axis. Armor the lower 3/4 of the outboard fillface with 45 yd3 2'- rock armor. 2. Install a critical dip along the left hingeline. 3. Install a trash rack above the pipe inlet. 4. Install an 18" x 40' width relief culvert at the spring located 50' to the right.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
355	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	36	0	150	Several streams coalesce above the road, diverting into an active gully before crossing the road at a plugged, non functional pipe. This write up pertains soley to the crossing- check site to determine proper treatments to the diverted upslope area. It seems that the most appropriate approach is to leave flow in the current orientation, pull back the right bank of the gully and put in an oversized pipe to accommodate all flow. Future erosion includes crossing failure plus 2'x0.5'x150' gully expansion.	1. Excavate TOP to BOT, replace pipe with a 30" x 50' culvert set at the base of fill. 2. Install a critical dip along the left hingeline. 3. Clean/cut ditch for 150' to the right. 4. Outslope road/keep ditch 150' to the right. 5. Install 1 rolling dip up the right road approach. 6. Pull back oversteepened gully sides wherever possible (additional 2 hrs/excavator for access and excavation time, 5 yd3 excavation volume). Work spoils into critical dip/pipe replacement backfill.
356	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	46	0	175	Thick sediment cone above the inlet indicates upslope instability and could induce culvert failure/plugging if not removed from the natural channel. Stream has overtopped in the past, resulting in large gullies down the outboard fillface. Outlet erosion from the shotgunned pipe is evident as well.	1. Install an armored fill crossing: 1) Create a broad dip through the crossing, lowering the road a maximum of 2'. 2) At the new outboard edge of the road, excavate a 10' wide keyway, tapering to 4' wide at the base of fill. 3) Place 15 yd3 0.5-1.5' rock armor on the outboard fillface and the outer 1/3 of the road. 2. Install 1 rolling dip on the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
357	Bearpen Creek (Upper Austin Creek)	HM	Stream crossing	163	345	815	Flowing stream with extensive and very steep right road approach drained by rusty, likely undersized pipe set in at the base of fill. Flow is piping around the culvert. Also, emergent spring on the cutbank to the right in a past failure zone is pumping significant amounts of flow onto the road bed, which is eroding down both the inboard and outboard fillfaces. Minimum 30" diameter pipe for replacement.	1. Excavate TOP to BOT, replace pipe with a 30" x 60' culvert set at the base of fill. Armor the outboard fillface with 5 yd3 1-2' rock armor. 2. Install a trash rack above the inlet. 3. Clean/cut ditch for 100' to the right through springy failure zone. Armor ditch with 5 yd3 0.5'-. 4. Outslope road/keep ditch 150' to the right. 5. Install 6 rolling dips up the right road and 2 up the left road approach.
358	Bearpen Creek (Upper Austin Creek)	ML	Stream crossing	18	80	0	Two crossings at this site- the upper is an 18" concrete pipe set high in the fill, lower is a 24" plastic pipe with shotgunned outlet with near surface bedrock at the crossing. The area is adjacent to the Camp Cazadero ball field and cabins, and it appears building pad and field-related runoff more than road drainage are at work here. Stream appears to be diverted from what was previously the natural channel (where infrastructure now is) approximately 200' upstream from the crossing.	1. Replace each pipe with a 24" x 30' pipe. Set lower in the fill than at present if possible. 2. Install a critical dip along the right hingeline.
359	Bearpen Creek (Upper Austin Creek)	M	Stream crossing	20	110	100	Over 170' of aggraded sediment (much of which is likely road rock from the main camp area) above the inlet. This may be a natural depositional setting. The flow is currently subsurface through the crossing and emerges at the base of fill. Culvert appears to plug often and stream has overtopped more than once, leaving large gullies on the outboard fillface. FE based on gully expansion.	Per check site evaluation 6/2/10: 1. Add 20 yd3 1-2' rock armor to the outlet area/outboard fillface. 2. Enhance the critical dip and armor dip outlet (into natural channel) with 10 yd3 0.5-1.5' rock armor. 3. Replace trash rack above the inlet.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
360	Upper Austin Creek	No treat	Spring	10	0	60	Emergent spring at an abandoned mine is saturating existing tailings pile, which is currently acting as a landing. Flow then enters the adjacent creek upstream of site 361. A natural swale exists below the landing, but it seems like the current set up is least disruptive. Check site to determine necessity of treatment with respect to presence of mine tailings. Future erosion estimates based on gully expansion and possible failing of oversteepened landing edge.	No treatment.
361	Upper Austin Creek	L	Stream crossing	22	140	165	Culvert is oversized for the stream and placed on bedrock. Mine tailings cover the right slope above the inlet and periodically deliver to the channel. Without major mine remediation little can be done to stop delivery. Adjacent cutbanks are both springy. Left approach is rocky with very little fine grained sediment delivering, but the right road has developed gully and both the road surface and cutbank appear composed of fine material.	1. Outslope/fill ditch 165' of right approach. 2. Install 1 rolling dip to the right.
362	Upper Austin Creek	ML	Stream crossing	1	0	300	Small stream flowing across nearly full bench bedrock road with well built, stable armored fill on the outboard fillface. The channel may have experienced debris torrent(s) in the past, as evidenced by abundant cobbles within a sediment cone at the inboard edge of the road. Slight possibility of diversion to the left, and the crossing could benefit from additional dipping out of the road surface. Flow from emergent spring on the right approach concentrates on the road bed before delivering to the stream at the crossing.	1. Dip road through the crossing to reduce diversion potential. 2. Install an 18" x 30' ditch relief culvert at the emergent spring on the right road approach. 3. On the lower road (below the spring), install 1 rolling dip and apply road rock though the axis. 4. Outslope road/fill ditch for 300' to the right. 5. Install 2 rolling dips up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
363	Upper Austin Creek	ML	Other (swale)	2	0	100	Headwall swale developing into class 3 stream below the road. Small headcut at the top of a 3'w x 2'd x 15'l gully eroding into the outboard fillface. Past fill failure with gullied face that doesn't appear to be delivering located to the left before a terminal landing. Low percentage of fine grained sediment- the road surface is comprised mostly of gravel to cobbles.	1. Excavate 12 yd3 through the road prism. Layback sideslopes to 2:1 for decommissioning. Stockpile up either approach. 2. Install 1 cross road drain up the right road.
364	Upper Austin Creek	ML	Stream crossing	3	10	80	Headwall swale on the right hinge of a large landslide develops into a class 3 stream below the road. No drainage structure exists at the site. A minimal critical dip along the left hingeline prevents diversion.	1. Install an armored fill crossing using 25 yd3 1-2' rock armor.
365	Upper Austin Creek	ML	Stream crossing	34	40	0	Small stream drained by crushed though partially functional culvert set high in the fill, flat, and with a shotgunned outlet. Short left approach with diversion potential to the right.	1. Install an armored fill crossing using 10 yd3 0.5-1.5' rock armor. 2. Remove berm for 40' to the left.
366	Upper Austin Creek	M	Stream crossing	2	60	15	Channel above the road is offset (to the right) of the channel below the road. Roadbed has a hump where the upper channel meets the road, indicating deposition of the material. Stream has diversion potential to the right.	1. Install an armored fill crossing using 25 yd3 1-2' rock armor.
367	Upper Austin Creek	M	Stream crossing	8	275	0	Small stream diverts for a short while down the right road approach before exiting the road via several smaller gullies on the outboard fillface. Lower road will also need drainage structures.	1. Install an armored fill crossing using 10 yd3 1.5'- rock armor. 2. Install 2 rolling dips up the right road approach.
367.1	Upper Austin Creek	HM	Stream crossing	35	500	0	Older landslide deposit has diverted covered skid road and diverted stream flow out of it's natural channel. Not sure if landslide was natural occurrence or a result of legacy logging practices. Outboard toe of landslide is actively being headcut by stream flow. Historic channel exists about 15' to the left of current flow. Potential for extreme erosion due to active gullying down hillside and beyond profile.	1. Excavate stream crossing from TOP to BOT to establish flow back into natural channel. 2. Spoil locally 3. Install 6 cross road drains up left road/skid.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
368	Upper Austin Creek	M	Ditch relief culvert	3	265	40	Springy hillside above road in forested setting. Spring flow has gullied down the outboard fillface in two places to the left of the current ditch relief culvert. Pipe inlet is 90% plugged with sediment due to slumping above. Abandoned road below the outlet of the ditch relief culvert.	1. Outslope road and cut a ditch for adjacent 100' up the left road. 2. Outslope road, fill ditch for remaining 165' left. 3. Replace ditch relief culvert at site with 18" x 20' pipe and install a 40' downspout. 4. Cut ditch for 45' along the right road approach.
369	Upper Austin Creek	M	Stream crossing	6	550	60	Stream diverted left at road, then drained in gully across lower road before confluence with a larger class 2 stream. It appears the only realistic place to put the stream across the road is between 2 fairly large trees on the outboard edge of the road. A hose in the creek is adding flow from an unknown upslope source (spring?). Higher complexity due to need to work between trees. Also near surface bedrock may prevent installation of keyway at proper keyway.	1. Install an armored fill between the trees using 10 yd3 1.5'- rock armor. Likely will not be able to lower road too much due to tree roots. Use stored sediments located to the right (on the outboard road) to build up left road to prevent diversion. 2. Outslope road/fill ditch for 60' to the right. 3. Install 6 cross road drains up skid road to the left of site.
370	Upper Austin Creek	M	Stream crossing	31	70	30	Area appears to be the toe of an old landslide feature. Site is an abandoned roadbed below site 369. Stream flow is piping out of cutbank and is offset to the right (25') from the channel above. This is probably more of an influence of landslide material than road building. Flow is moderately headcutting through fill.	1. Cut ditch for 30' along left road approach from the base of upper fillface (site 369) to "J" fir tree, where flow is piping from cutbank. 2. Excavate TOP to BOT, establish a 4' channel width and lay back sideslopes to 2:1 for decommissioning. Spoil locally.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
371	Upper Austin Creek	M	Road drainage discharge point	28	240	0	A springy meadow drains onto the road, travelling 240' before exiting the road via an active gully and delivering to a class 2 stream. A lower skid road parallels the current road with a past, dewatered, stable gully from previous stream diversion. This is where the flow should go, as the gully here has cut down to bedrock and sideslopes appear fairly stable. Near surface bedrock on the roadbed may lead to problems installing road drainage treatments.	1. Approximately 35-40' up the right road approach from the current gully, install an 18"x30' ditch relief culvert with an 18"x10' downspout to direct flow into past gully. 2. Install 1 rolling dip at ditch relief culvert to prevent road drainage from bypassing ditch relief culvert. 3. Cut ditch 200' to the left. 4. Outslope road, retain ditch for 100' left from the new pipe location to the through cut portion of the road.
372	Upper Austin Creek	HM	Stream crossing	82	1,050	0	Two small streams above the road connect to the inboard ditch and divert down the right road approach. Minimal rilling down the right road from stream diversion. Treatment immediacy based on significant right road approach.	1. Excavate TOP to BOT, install a 24" x 70' culvert pipe at the base of fill and in the natural stream axis. Armor the outboard fillface with 40 yd3 1-2' rock armor. 2. Install a critical dip on the right hingeline. 3. Outslope road, fill ditch for 1050' and remove berm for 300'. 4. Install 7 rolling dips up the left approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
373	Upper Austin Creek	M	Stream crossing	27	160	0	Several small channels (totaling 3'w x 1'd) coalesce in the inboard ditch before diverting to the right in the same ditch. This area may also be handling flows from another diverted stream, site 372 located left.	1. Excavate TOP to BOT, install a 24" x 40' culvert at the base of fill and in the natural stream axis. Armor the lower 3/4 of the outboard fillface with 10 yd3 1-2' rock armor. 2. Install a trash rack above the inlet. 3. Install a critical dip along the right hingeline. 4. Outslope road, fill ditch for 160' to the left. 5. Install 1 rolling dip up the left road approach.
374	Upper Austin Creek	M	Stream crossing	8	150	0	Small fill crossing in steep grassland setting. Minimal stream flow at the crossing. No real rill or gully across the road but the outboard fillface appears to have experienced erosion in the past.	1. Install an armored fill crossing using 10 yd3 of 1-2' rock armor. 2. Outslope road, fill ditch for 150' up the left road approach. 3. Install 1 rolling dip up the left road.
375	Upper Austin Creek	ML	Stream crossing	60	30	460	Stream has essentially self decommissioned through a fill crossing. Channel has incised to what appears to be the natural base level. Banks are steep and bare in places, though do not appear extremely erosional. A slump/past landslide on the natural hillslope approximately 40' upstream appears to be more of a sediment production issue than the road, though this appears to be a natural feature. Future erosion estimate from continued raveling of the banks.	1. Lay back banks to 2:1 and store spoils locally. 2. Install 2 cross road drains between the site and the landing. 3. Install 2 rolling dips to the right of the landing. No equipment hours were added to rebuild crossing to access site#'s 376-379 because of their low treatment immediacy.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
376	Upper Austin Creek	L	Stream crossing	352	0	520	Washed out crossing on what may be Class I stream. Stream channel looks to be at grade. Only fill remaining is along right bank. 1.5' vertical scarps exist about 15' back into road and abandoned skid/road travels along right bank for 100'. See sketch for additional information. Low treatment immediacy due to equipment access issues regarding the rebuilding of site# 375.	1. Excavate from Start to End flags 2. Spoil half the spoils locally and endhaul the other half tor road shaping 3. Install 3 cross road drains up spur road and 4 up right road. Note: Additional time will be needed to rebuild crossing to access sites beyond *14hours labor and 1hour excavator time for de-watering the stream.
377	Upper Austin Creek	L	Other (swale)	12	30	20	Small but steep swale directs flow to headcut at OBF, where 4'w x 3'd gully is eroding what remains of a long abandoned road. Access to this area will be difficult as several washed out crossing to the right must be restored to allow equipment to get in here. Low treatment immediacy due to equipment access issues regarding the rebuilding of site# 375 and 376	1. Excavate 24 yd3 through axis of swale and from banks. 2. Store spoils locally.
378	Upper Austin Creek	L	Landslide	94	0	300	Unstable fill on OBF of long abandoned road. Spring and swale contributions from upslope helping to saturate fill. Access to this area will be tough, with washed out crossings and cutbank slides to contend with fillface itself is well vegetated, but tension cracks on road surface indicate instability. Low treatment immediacy due to equipment access issues regarding the rebuilding of site# 376	1. Excavate 70'w x 3'd x 12'long of unstable material from OBF 2. Store spoils locally along cutbank. 3. Install 4 cross road drains up right approach, with 1 in axis of small swale near right hinge of failure.
379	Upper Austin Creek	L	Stream crossing	20	0	0	Washed out crossing. Stream channel at grade with right bank oversteepened (55 degree). Fillslope is grassy and looks relatively stable. Low treatment immediacy due to equipment access issues regarding the rebuilding of site#375 and 376.	1. Pull back right bank from Start to End (site #378) flags to a 2:1 stable slope 2. Spoil locally.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
380	Upper Austin Creek	L	Stream crossing	39	100	30	Washed out crossing. Stream is actively eroding down to natural channel grade. Fillslopes are near vertical and bare with no scarps observed beyond fillslopes. Low treatment immediacy due to equipment access issues regarding the rebuilding of site#375.	1. Excavate crossing from TOP to BOT with 5' channel width. 2. Lay back sideslopes 2:1 for decommission. 3. Spoil locally. 4. Install 1 cross road drain up left road.
381	Upper Austin Creek	No treat	Stream crossing	Road surface only	60	0	Road crosses creek where two 4x1 streams coalesce. Stream has diverted down right road in the past, resulting in a gully which has left ~2' of walkable road surface. Stream has now incised to the point of near natural channel grade and another diversion seems highly unlikely.	No treatment.
382	Upper Austin Creek	ML	Stream crossing	3	0	210	Small stream flows across road before dissipating in campsite area, flow then coalesces and enters Austin Creek through Site #383 downstream ~80'.	1. Construct an armored fill crossing using 10 yd3 of 1.5' minus rock 2. Install 1 rolling dip up left approach.
383	Upper Austin Creek	ML	Stream crossing	4	60	20	Short spur road that leads to cabin. Stream currently flows under stack of 20' long logs than area that is armored with 4"-6" rock. Low gradient slope from road to Class I stream.	1. Construct an armored fill crossing using 20 yd3 of 0.5'-1.5' rock 2. Install 1 rolling dip up left approach.
384	Upper Austin Creek	ML	Road drainage discharge point	Road surface only	175	170	Low point along road length. Road is about 25' away from Austin Creek. Minimal rills from OBR down to creek. No real room to install rolling dips.	1. Outslope and fill ditch for 175' up left and 170 up right.
385	Upper Austin Creek	ML	Stream crossing	9	5	0	Stream flowing down past and future cutbank slide diverts to the right before exiting OBF via several small gullies and rills. Point where stream hits road is essentially a break in slope with dual diversion potentials, though currently flow is going to the right. Due to unstable natural setting, likely difficult to keep a dip through road here.	1. Install an armored fill crossing with 10 yd3 of 1.5' minus rock.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
386	Upper Austin Creek	ML	Stream crossing	4	0	40	Eight inch PVC pipe drains currently flowing stream. Stream travels down landslide deposit that may be active. Crossing is roughly 7' up slope from class 1 steam, hence the call for larger rock diameter for armor.	1. Install an armored fill crossing using 20yds3 of 1'-3' rock.
387	Upper Austin Creek	No treat	Stream crossing	9	140	85	Ford crossing across mainstem Upper Austin Creek. Crossing itself is stable but large cutbank failure on north side of channel is a natural sediment production feature. Rills and gullies on slide face will continue to expand and deliver sediment to creek. Future erosion from slide face from gully expansion. Left road approach is somewhat ugly (rills and springy cutbank), but vicinity to large slide suggests no treatment is required here.	No treatment.
408	Branscomb Creek (Lower East Austin Creek)	HM	Stream crossing	11	0	920	Small stream and excessive road approach drained by undersized, flat, plugged pipe set high in the fill. At some point a road or skid may have occupied the channel above and below current road. Unnecessary spur to the right with emergent spring could be decommissioned. Perched fill on the right bank below the BOT should be laid back. Treatment immediacy based primarily on connected road approach.	1. Remove existing pipe. 2. Install an armored fill using 15 yd3 1.5'- rock armor. 3. Excavate 10 yd3 from right bank below the BOT. 4. Outslope road/fill ditch for 900' up the right road approach (begin after benches at Julie Andrews' overlook). 5. Install 6 rolling dips up the right road. 6. Install 3 cross road drains up the spur to the right.
409	Branscomb Creek (Lower East Austin Creek)	HM	Ditch relief culvert	4	0	900	This is a large broad swale with a class 3 stream initiating below the road. The ditch relief culvert drains the swale and long, steep road approach. A gully has developed on the road surface and delivers directly to the inlet. Another gully has formed from the outlet to the class 3 stream, below. Simple road drainage treatments will help a lot.	1. Outslope/fill ditch for 900' of right road approach. 2. Install 5 rolling dips up the right road approach. 3. Rock road through the swale and up right approach for 60' (900 ft2 total). 4. Armor the outboard fillface at the swale axis with 5 yd3 1.5'- rock armor.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
410	Branscomb Creek (Lower East Austin Creek)	M	Stream crossing	12	0	1,045	Small stream hits the road and diverts left before gullying through outboard fillface back into the natural channel. Very steep right road approach, through cut in places, with near surface bedrock. It appears the best solution is to leave the stream in the inboard ditch for 30' and build an armored fill crossing at the current flow alignment. Treatment immediacy based on connected road approach.	1. Cut an inboard ditch for 30' to connect upper and lower channels. 2. Install an armored fill crossing with 15 yd3 1-2' rock armor. 3. Outslope road/fill ditch (where possible) for 1000' up the right road. 4. Install 9 rolling dips up the right road approach.
411	Branscomb Creek (Lower East Austin Creek)	M	Stream crossing	3	175	0	Small stream crossing with chunks of cement used as armor on small outboard fillface. Minimal gully developed through road surface, but right approach delivers directly to the site.	1. Install an armored fill crossing using 5 yd3 0.5-1.5' rock armor. 2. Install 1 rolling dip on the left road approach. 3. Outslope/fill ditch up the left road approach for 175'.
412	Branscomb Creek (Lower East Austin Creek)	ML	Stream crossing	4	40	10	Small stream intersects the road. Some attempt has been made to armor the outboard fillface with wood and scrap concrete, but a proper armored fill should be installed.	1. Install an armored fill using 5 yd3 1.5'- rock armor.
413	Branscomb Creek (Lower East Austin Creek)	M	Stream crossing	6	220	100	Ford crossing over Branscomb Creek (Lower East Austin Creek). Ford itself appears stable, but a fairly significant swale on the left approach is adding flows which are gullying down the adjacent 50' of left road approach. No effective option to get swale flow across road prior to the ford.	1. Pull up to 5 yd3 off left approach of the ford. 2. Cut an inboard ditch at the inboard road for 50' left of the ford to connect the swale to the creek. Armor ditch with 5 yd3 0.5'- rock armor. 3. Outslope road/fill ditch for 200' up the left road and 100' up the right road. 4. Install 1 rolling dip to the right and 2 left.
414	Branscomb Creek (Lower East Austin Creek)	L	Stream crossing	4	40	45	Well developed stream 100' up-channel and just below the road, but flat and filled in channel directly above the road. No gully developed through the road or on the outboard fillface. Both approaches are outsloped.	1. Install an armored fill crossing using 5 yd3 0.5-1.5' rock armor.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
415	Branscomb Creek (Lower East Austin Creek)	HM	Stream crossing	3	400	0	Near origin stream with a 100% plugged culvert. Stream currently crosses the road and erodes the outboard fillface. Some concrete blocks have been placed on the outboard fillface, though an insufficient amount. Road width is currently 7' from inboard to outboard road and may be difficult for vehicle access.	1. Install an armored fill crossing: Create a broad dip, excavate keyway, and place 10 yd4 of 0.5'-1.5' rock. 2. Rebuild to at least a 10' road width. 3. Outslope left road where possible. 4. Install 3 rolling dips on left approach.
416	Branscomb Creek (Lower East Austin Creek)	HM	Stream crossing	5	845	0	Small but active stream drained by armored fill which appears to have been installed after a headcut had migrated about 1/2 way into the fill prism, reducing the current road width to 6'. A swale to the left may be flow diverted from above or meadow drainage. Either way, a rocked dip should suffice for a drainage structure at the swale. Left road approach has changes in grade which may reverse grade (hard to tell), but left approach should be treated in entirety. The road beyond this site is accessible only by quad or walking due to narrow width at the crossing.	1. Install an armored fill crossing with 13 yd3 1.5'- rock armor. Establish 12' (minimum) road width. 2. At the swale to the left, install a rolling dip, apply 500 ft2 road rock and place 2 yd3 1.5'- rock armor on the outboard fillface. 3. Outslope road/fill ditch for 845' to the left. 4. Install 5 (additional) rolling dips up left road approach.
417	Branscomb Creek (Lower East Austin Creek)	HM	Stream crossing	2	350	0	Small near origin stream diverts to right and a large gully has developed. Above site there is a large meadow and several streamlets connect to road and likely drain past this site and into gully. Simple treatments could reduce much fine sediment input.	1. Install an armored fill crossing: Create a broad dip, excavate a keyway, and place 10 yd3 of 0.5'-1.5' rock. 2. Outslope 350' of left approach. 3. Install 2 rolling dips on left approach.
418	Branscomb Creek (Lower East Austin Creek)	M	Stream crossing	5	200	25	Two small streams coalesce at the plugged inlet of an undersized, non functional pipe. Gully has headcut through the fill into the road tread, exposing the pipe. Approaches are partially vegetated. Large oak tree at the outboard edge of the road should be saved.	1. Install an armored fill crossing using 10 yd3 1.5'- rock armor. Remove old pipe, save oak tree on outboard fillface. 2. Outslope road/fill ditch for 200' up the left road approach. 3. Install 1 rolling dip up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
419	Branscomb Creek (Lower East Austin Creek)	L	Stream crossing	2	0	415	Stream through a grassland swale meets road and mainly dissipates at the grade change. Defining channel axis will reduce the risk of gully development and will lower the amount of saturated meadow area currently being impacted by wild boar. The right road approach is steep in segments and bare, but outsloping and the installation rolling dips appears possible.	1. Install 2 small armored fill crossings in the stream axis: create broad dips, excavate a shallow keyway and place 5 yd3 1'- rock armor at each crossing. 2. Outslope/fill ditch for 415' up the right (Yellow Trail Road) approach. 3. Install 3 rolling dips up the right road.
420	Lower East Austin Creek	No treat	Other (swale)	Road surface only	625	0	Steep, rocky road crosses a swale, combines with road flow and ultimately dissipates on a large, flat bench which was used as a mill site at some point. Below this bench, a small class 3 stream develops and flows to East Austin Creek. While this road is nasty and a maintenance issue (if drivability is desired), it is very likely no road related sediment evacuates the depositional bench to impact East Austin Creek.	No treatment.
421	Branscomb Creek (Lower East Austin Creek)	ML	Spring	1	350	0	Main access route to spring/pump house for the property. Approximately 350' of wide, bare road delivers to a small gully developed across a small landing where water tanks reside. Gully enlargement will be minimal over time and delivery to the lower class 3 stream may only occur during extremely large storm events. Outboard fillface is self armored with redwood roots.	1. Outslope the left road approach for 350'. 2. Install 2 rolling dips up the left road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
422	Branscomb Creek (Lower East Austin Creek)	HM	Stream crossing	164	340	0	Small stream with plugged, non-functional culvert. Very steep left approach and gullied skid contributing flows. Abundant fine grained sediment accumulated in creek from road drainage issues above. This sediment will mobilize as the gully progresses through the fill. Currently the stream diverts down the right road before gullying through the outboard fillface back to the natural channel. Water tanks and a well located approximately 350' to the right. This road needs to be accessible by truck, but the turn at the crossing is very tight and the road approach is extremely steep. Complexity reflects tight conditions and tricky rebuild.	1. Excavate TOP to BOT; remove outboard fillface of skid above inlet, remove stored sediments in channel, remove outboard fillface of main road above the BOT (narrow width to 10'). 2. Lower left approach 3-4' (if possible) to lessen grade. 3. Build an armored fill crossing at the site with 10 yd3 1.5'- rock armor. 4. Outslope road/fill ditch for 100' up left road. 5. Install 2 cross road drains up the skid.
423	Branscomb Creek (Lower East Austin Creek)	ML	Stream crossing	20	10	0	Two small streams, which may be drainage gullies from a pond on the neighbor's property (above), coalesce just below the outboard fillface after gullying through the fill. Future erosion estimate from gully enlargement. Excavation estimate includes removing sediment from between the two channels.	1. Excavate fill from both channels and from the area between the channels, establish the confluence of the streams at the current outboard fillface, lay back side slopes to 2:1, spoil to the right.
424	Branscomb Creek (Lower East Austin Creek)	M	Stream crossing	4	115	100	Stream in oak grassland setting with a large gully developed down the outboard fillfae. Sideslopes are grassy but vertical. Some armor has been placed to reduce headcutting, but is temporary. Road approaches grassed over, road apparently not used.	1. Excavate TOP to BOT, establish 2:1 sideslopes. 2. Install 2 cross road drains on the left road approach and 2 on the right.
425	Branscomb Creek (Lower East Austin Creek)	ML	Spring	Road surface only	425	15	Emergent spring above the road combines with road surface flow to contribute flows to a swale which then turns to a stream approximately 75' below the road. Almost no fill at the crossing.	1. Dip the crossing (5 yd3) with bulldozer. 2. Install 5 cross road drains up the left road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
426	Branscomb Creek (Lower East Austin Creek)	M	Stream crossing	76	190	0	Wide swale with class lll stream and plugged culvert on left hinge of swale. Meadow drains onto road surface 20' to the left of crossing, travels to right hingeline, and down outboard fill. Outboard fill is packed with trash. Gully development delivers sediments to stream.	1. Install an armored fill crossing using 20yds3 of 0.5'-1.5' rock armor. Excavate keyway plus material to BOT. 2. Endhaul spoils. 3. Cut ditch for 20' up left road to drain springy hillside. 4. Install 1 rolling dip along left road approach.
427	Branscomb Creek (Lower East Austin Creek)	No treat	Stream crossing	76	200	0	Stream has gullied through unused road and is dumping sediment into mainstem Branscomb Creek. Site is an older freature that will slowly contribute sediment to stream over time. Property line is 100' up the left road, with a cutbank slide approximately 100' beyond the property line.	No treat (due to severe access constraints) per check site evaluation DKH/TZ/BB 6/2/10
428	Branscomb Creek (Lower East Austin Creek)	No treat	Bank erosion	120	0	0	Old mill area in upper Branscomb Creek where inner gorge road is failing into the creek. Ten foot tall slumps are vertical and bare. Road surface is lumpy and duff covered with saw logs present.	No treat (due to access constraints) per check site evaluation 6/2/10 DKH/BB/TZ
429	Branscomb Creek (Lower East Austin Creek)	L	Stream crossing	4	0	25	Filled in swale with a class lll stream eroding through fill. Area currently used as mill site and extra water storage. Landowner may not want to treat. Future erosion based on gully enlargement along right bank.	1. Layback stream channel sideslope to 2:1 where possible. 2. Endhaul spoil.
430	Branscomb Creek (Lower East Austin Creek)	L	Stream crossing	42	210	75	Creek gullying through road at confluence with Brandscomb creek. This crossing should be decommissioned with additional material removed from the left bank below BOT. Check site to determine spoils management and necessity of trail rebuild.	Per check site evaluation 6/2/2010: 1. Using hand labor, lower road surface/define channel, excavate a 15' wide keyway tapering to 4' wide at the base of fill. Install an armored fill crossing using 10 yd3 0.5-1.5' rock armor.
431	Branscomb Creek (Lower East Austin Creek)	No treat	Stream crossing	5	60	25	Crossing was either pulled or washed out a long time ago. A small amount of fill may exist within old crossing, but due to stableness of area excavation does not seem necessary.	No treatment.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
432	Branscomb Creek (Lower East Austin Creek)	No treat	Other (gully)	1	110	0	Gully along grassy, no use, road. Gully has developed from diverted stream flow at site# 414, above. Once this site is treated, gully will receive less flow.	No treatment.
450	Upper East Austin Creek	M	Stream crossing	Road surface only	240	750	Ford crossing on East Austin Creek. Majority of left road in a through cut with one off road drain where a rolling dip could be installed. Crossing itself looks good. Right road contribution is off of property, hence no treatments for this road length.	1. Install 1 rolling dip at off road drain location. 2. rock remaining road length for rolling dip down to ford crossing.
451	Upper East Austin Creek	M	Stream crossing	6	0	185	Small stream valley development in grassland setting. Steam currently diverted down left inboard ditch to site# 453. Inboard ditch looks stable and not actively eroding. Future erosion volume based upon ditch enlargement.	1. Install an armored fill crossing using 10yds of 0.5'-1.5' rock. 2. Outslope road and retain ditch for 185' up left road.
452	Upper East Austin Creek	M	Stream crossing	6	0	150	Minimal stream valley development, above road, in grassland setting. Stream flow currently diverted down left inboard ditch and connected to site# 453. Future erosion volume based upon ditch enlargement.	1. Install an armored fill crossing using 10yds of 0.5'-1.5' rock. 2. Outslope road and retain ditch for 150' up left road.
453	Upper East Austin Creek	M	Stream crossing	12	250	150	Culverted stream crossing in grassland setting. Culvert looks to be at base of fill and at channel grade, as evident by bedrock step below outlet. Culvert looks adequately sized.	1. Install trash rack. 2. Outslope road and retain ditch for 150' up right road. 3. Outslope road and retain ditch for 250' up left road and install 1 rolling dip to drain road and cutbank.
454	Upper East Austin Creek	M	Stream crossing	9	0	310	Minimal stream development above road, in grassland setting. Stream currently diverted down left road for 230' to site# 455. Minimal rilling in ditch from diverted flow .	1. Install armored fill crossing using 15yds3 of 1'-2' rock 2. Outslope road and retain ditch for 310' up right road and install 1 rolling dip to drain road and cutbank.
455	Upper East Austin Creek	M	Stream crossing	10	0	230	Small stream flows onto road, deposits gravelly sediments on inboard road, and flow continues down left inboard ditch for 265' to site# 456. Future erosion based on ditch enlargement.	1. Install armored fill crossing using 10yds3 of 0.5'-1.5' rock 2. Outslope road and retain ditch for 260' up right road.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
456	Upper East Austin Creek	M	Stream crossing	45	0	265	Looks to be oversized culvert for steam channel area. Stream looks to have incised through old landslide deposit. Banks of stream below outlet are near vertical and still sluffing. These could be pulled back to 2:1 angle to reduce sediment input. Minimal diversion potential. Future erosion volume and potential are based upon sluffing banks below culvert outlet.	1. Install a single post trash rack above inlet. 2. Pull back both left and right banks below outlet to 2:1 slope angle. 3. Spoil locally 4. Install 5yds3 of 1'-2' rock below outlet. 5. Install a critical dip along left hingeline of crossing. 6. Outslope road and retain ditch for 265' along right road reach.
457	Upper East Austin Creek	HM	Stream crossing	60	100	160	Fill crossing is moderately active eroding back into road fill at outboard road. Landowner has installed (sparse) rock and tires to armor fill. Stream banks below road are near vertical and sluffing into stream.	1. Install armored fill crossing using 20yds3 of 1'-2' rock. 2. Pull back both left and right banks to 2;1 angle for 50' down channel from bottom of armored fill area. 3. Spoil locally. 4. Outslope road and retain ditch for 160' up right road. 5. Outslope road and retain ditch for 100' up left road.
458	Upper East Austin Creek	M	Landslide	93	100	0	Road is about 25' up slope from Austin Creek on outside meander. Stream flow currently below bedrock bank but at higher flows, stream is actively eroding hillslope and road fill above. Most of the outboard fill looks to have already been eroded. Not much can be done to move road in or pull remaining fills without reducing road width and restricting vehicle traffic.	1. P ull what remaining fill (that cam be excavated) from START to END flags. 2. Endhaul spoil to use for road shaping. 3. Inslope road for 100' across face of slide area.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
459	Upper East Austin Creek	M	Stream crossing	33	210	120	Newly installed double walled culvert. Looks to be set in at channel grade. Looks to be old road fill on left bank from outlet for 30' down channel. Fill is near vertical and sluffing into channel..Old roadbed just upslope from current road.	1. Install a single post trash rack. 2. Pull back right road from outlet for 30' down channel (30x3x6). Spoil locally. 3. Outslope road and retain ditch for 120' up right road. 4. Outslope road and retain ditch for 210' up left road and install 1 rolling dip.
460	Upper East Austin Creek	M	Stream crossing	10	0	200	Minimal stream channel development above road. No road fill on abandoned roadbed above currently used road. Grassland setting. Landowner has placed a 3' boulder at outboard fill to armor fill slope.	1. Install an armored fill crossing using 15yds3 of 1'-2' rock. 2. Outslope road and retain ditch for 200' up right road length.
461	Upper East Austin Creek	M	Stream crossing	Road surface only	300	600	Ford crossing on "Devils Creek" . Crossing itself looks good, just the road approaches need treatment	1. Outslope road and retain ditch for 600' up right road length and install 3 rolling dips. 2. Outslope road and retain ditch for 300' up left road length and install 1 rolling dips.
462	Upper East Austin Creek	ML	Stream crossing	4	0	100	Looks to be a naturally aggraded stream channel above road. Partial flow diverts down left road to low spot, while the rest of the flow travels across road and continues down natural channel.	1. Install an armored fill crossing using 5yds3 of 0.5'-1.5' rock armor. 2. Outslope road and retain ditch for 100' up right road.
463	Upper East Austin Creek	HM	Ditch relief culvert	15	170	260	Ditch relief culvert drains right and left road approaches, as well as two swales. Road contribution is gullying outboard fill at site. Ditch flow is piping through the fill next to the culvert.	1. Replace culvert with a 18"x20' long culvert. 2. Install an 18"x30' long ditch relief culvert up right road approach. 3. Outslope road and retain ditch for 200' up right road and 2 rolling dips. 4. Outslope road and retain ditch for 170' up left road and install 1 rolling dip. 5. Cut inboard ditch for 200' to new culvert inlet.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
464	Upper East Austin Creek	M	Stream crossing	5	190	0	Low gradient class lll stream currently diverted 70' to the right where road is failing.. The road approach is gentle but bare.	1. Install an armored fill crossing using 15yds3 of 0.5'-1.5' rock. 2. Outslope road and retain ditch for 190' up left road.
465	Upper East Austin Creek	ML	Road drainage discharge point	Road surface only	375	150	Road surface drainage exits road and flows across short, well vegetated flood plain before entering East Austin Creek.	1. Outslope road and fill ditch for 375' up left road and install 3 rolling dips. 2. Outslope road and retain ditch for 150' up right road. 3. Install 1 cross road drain on skid below road.
466	Upper East Austin Creek	M	Stream crossing	5	110	110	Small stream with drainage structure across road. Non channel definition across road but a small gully has developed down outboard fill.	1. Install an armored fill crossing using 10yds3 of 0.5'-1.5' rock. 2. Outslope road and retain ditch for 110' up left road. 3. Outslope road and retain ditch for 110' up right road.
467	Upper East Austin Creek	M	Stream crossing	57	215	170	Small stream drains across road. Two small gullies on outboard fill appear to be the result of road and stream contribution.	1. Install an armored fill crossing using 20yds3 of 1'-2' rock. 2. Outslope road and retain ditch for 215' up left road and install 1 rolling dip. 3. Outslope road and retain ditch for 170' up right road and install 1 rolling dip.
468	Upper East Austin Creek	M	Road drainage discharge point	Road surface only	150	850	Excessive road length contributes road surface runoff to East Austin Creek via bedrock gully down 13' long hillslope.	1. Outslope road/retain ditch for 850' to the right and 150' to the left. 2. Install 5 rolling dips to the right.
469	Upper East Austin Creek	ML	Stream crossing	24	50	0	Field estimates consider culvert to be adequately sized for observed channel size. Culvert Q program suggests a 48" culvert diameter for the 100yr storm event. Not enough fill at site to accommodate this large of a culvert, hence an armored fill is recommended.	1. Install an armored fill crossing using 15yds3 of 1'-2' rock.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
470	Upper East Austin Creek	L	Stream crossing	Road surface only	200	274	Ford crossing on East Austin Creek. Crossing itself is fine. Left road length is on a flood plain with no real fill.	1. Install 1 rolling dip along the right road length.
471	Upper East Austin Creek	H	Landslide	69	0	200	Road fill slide being undercut by creek flow with road drainage actively contributing to 4' vertical scarp at the outboard edge of the road. Future erosion based on slide expansion through remaining prism (39 yd3) plus delivery of 30 yd3 of perched toe material. Check site- effective treatment will be difficult due to location of road with respect to an erosional bend in the creek. Broken water line visible to left on slide face may have contributed to this failure.	Per office discussion 6/4/10 (GM,TZ): 1. 14 hr/labor, 2 hr excavator to manage water during work. 2. Excavate a 25'w x 2'd x 2'l keyway at the base of fill. Pull material upslope to rebuild outboard fillface. 3. Armor the base of fill and approximately 1/2 way up the fillface with 50 yd3 3' diameter rock armor. 4. Outslope road/fill ditch for 200' up right road approach. 5. Install 1 rolling dip to the right.
472	Upper East Austin Creek	M	Stream crossing	36	70	600	Stream is currently diverted above the house. Dip in roadbed below the house is most likely the historic channel. House was probably built on the alluvial fan of the stream. The culvert (and stream flow) currently aligned just outside of the left hingeline of the crossing. Flow from the outlet gullies down the hillside for about 70' before reoccupying the natural channel area. Profile done to align new culvert pipe with original channel area. Check site: determine if area is indeed natural channel or older evacuated area of past landslide.	1. Replace culvert: install new outlet to drain into the natural channel, right of current outlet. May be underground infrastructure. 2. Outslope road/retain ditch for 600' to the right. 3. Install 3 rolling dips up right road approach.
473	Upper East Austin Creek	M	Stream crossing	27	0	460	Small, steep stream intersects road and diverts 25' to the left before gullying down the outboard fillslope and ultimately reoccupying the natural channel.	1. Install an armored fill with 25 yd3 1-2' rock armor. Leave stream in current alignment and capture flow with a very broad dip through the crossing. 2. Outslope road, fill ditch for 460' to the right. 3. Install 3 rolling dips up the right road approach.

Table A1—cont. Field observations and treatment recommendations for road related sites.

Site #	Subwater-sheds	Treatment immediacy	Problem	Estimated future sediment delivery (yd^3)	Hydrologically connected road length		Comment on problem	Recommended treatments
					Left road/ditch (ft)	Right road/ditch (ft)		
474	Upper East Austin Creek	M	Ditch relief culvert	24	560	0	Currently a 4'w x 4'd x 80'l gully begins at the culvert outlet and continues for 80' before entering the axis of the swale. Gully will likely continue to enlarge despite past attempts to armor with brush.	1. Outslope road/retain ditch for 560' up the left road. 2. Install 3 rolling dips to drain the road surface only. 3.Install 3 18" x 30' ditch relief culverts up the left road approach.
475	Upper East Austin Creek	M	Other (gully)	10	450	0	Road drainage and swale contribution exits road in a mostly vegetated gully, though portions of the bare sideslopes continue to ravel.	1. Install 2 18" x 30' ditch relief culverts up the left road. 2. Outslope road/retain ditch for 450' to the left. 3. Install 3 rolling dips up the left road approach.
476	Lower East Austin Creek	M	Stream crossing	36	150	0	Stream has not been active for quite sometime. Valley bottom covered in leaf litter. Ditch relief culvert on right hinge of crossing currently receives 700' of left road flow which has caused a 3'w x 3'd gully down hillside to intersect with the road below.	1. Install an armored fill crossing using 10 yd3 0.5-1.5' rock armor. 2. Outslope road, retain ditch for 150' up the left road approach.
477	Lower East Austin Creek	M	Stream crossing	12	250	0	Small stream intersects the road and diverts to the right. Road drainage gullies into natural channel. Bare, steep, raveling cutbank on left should be drained by dips as small slides may plug ditch relief culverts.	1. Install an armored fill crossing using 15 yd3 of 1-2' rock armor. 2. Outslope road, retain ditch for 250' of left road. 3. Install 2 rolling dips to the left. Connect to ditch.
478	Lower East Austin Creek	ML	Stream crossing	1	0	560	Continuation of stream flow from site 476. Roadbed is on the flood plain of East Austin Creek, with very little fill. It is likely only possible to install 2 rolling dips up the right road because of a broad turn.	1. Install an armored fill crossing using 10 yd3 1-2' rock armor. 2. Install 2 rolling dips up the right road (below the broad turn.
479	Lower East Austin Creek	L	Stream crossing	Road surface only	60	215	Large ford across East Austin Creek near the confluence with Gray Creek. Right approach travels across a flood plain and could benefit from a rolling dip, though high flow in the creek may wash out this road segment. Steep left approach previously upgraded.	1. Install 1 rolling dip up the right road approach.

Appendix B

Typical drawings (schematic diagrams) showing components of erosion control and erosion prevention treatments, and techniques for construction.

2010 Austin Creek Watershed Sediment Source Assessment Sonoma County, California

No.	Drawing title
1	Typical problems and applied treatments for a non-fish bearing upgraded stream crossing
2	Typical design of a non-fish bearing culverted stream crossing
3	Typical design of a single-post culvert inlet trash rack
4	Typical design for armoring fillslopes
5	General armored fill dimensions
6	Typical armored fill crossing installation
7	Ten steps for constructing a typical armored fill crossing
8	Typical ditch relief culvert installation
9	Typical designs for using road shape to control road runoff (using insloping, outsloping, and crowning)
10	Typical methods for dispersing road surface runoff with waterbars, cross-road drains, and rolling dips
11	Typical road surface drainage by rolling dips
12	Typical sidecast or excavation methods for removing outboard berms on a maintained road
13	Typical excavation of unstable fillslope on an upgraded road
14	Typical problems and applied treatments for a decommissioned stream crossing
15	Typical design for road decommissioning treatments employing export and in-place outsloping techniques
16	Typical excavation of unstable fillslope on a decommissioned road

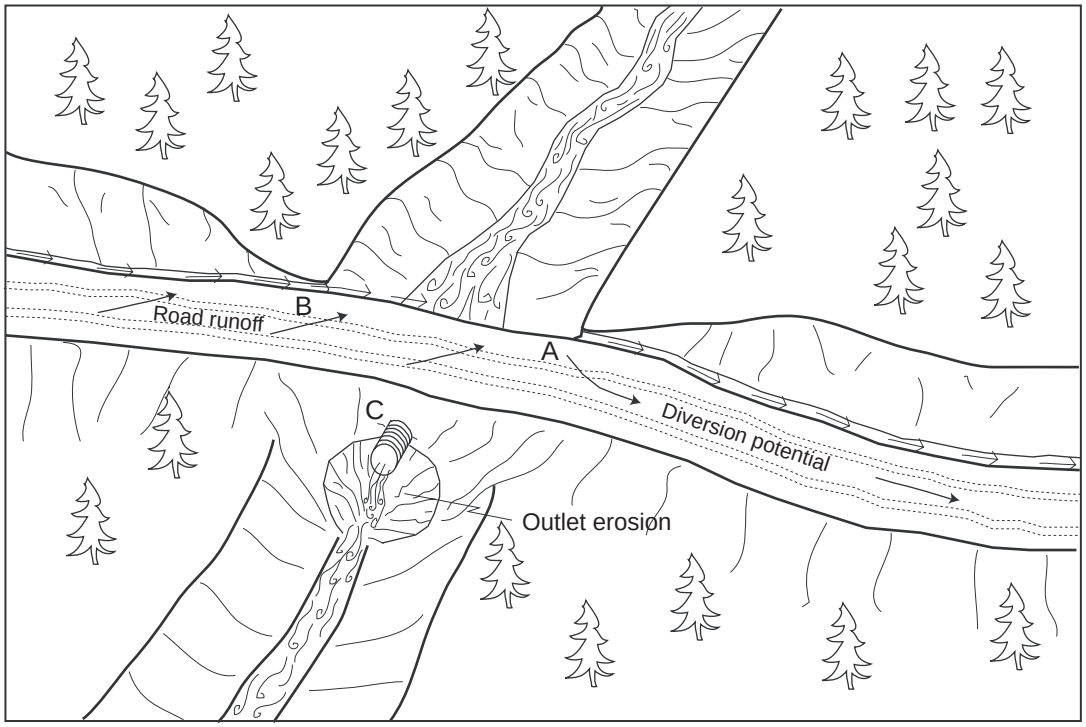
Typical Problems and Applied Treatments for a Non-fish Bearing Upgraded Stream Crossing

Problem condition (before)

A - Diversion potential

B - Road surface and ditch drain to stream

C - Undersized culvert high in fill with outlet erosion

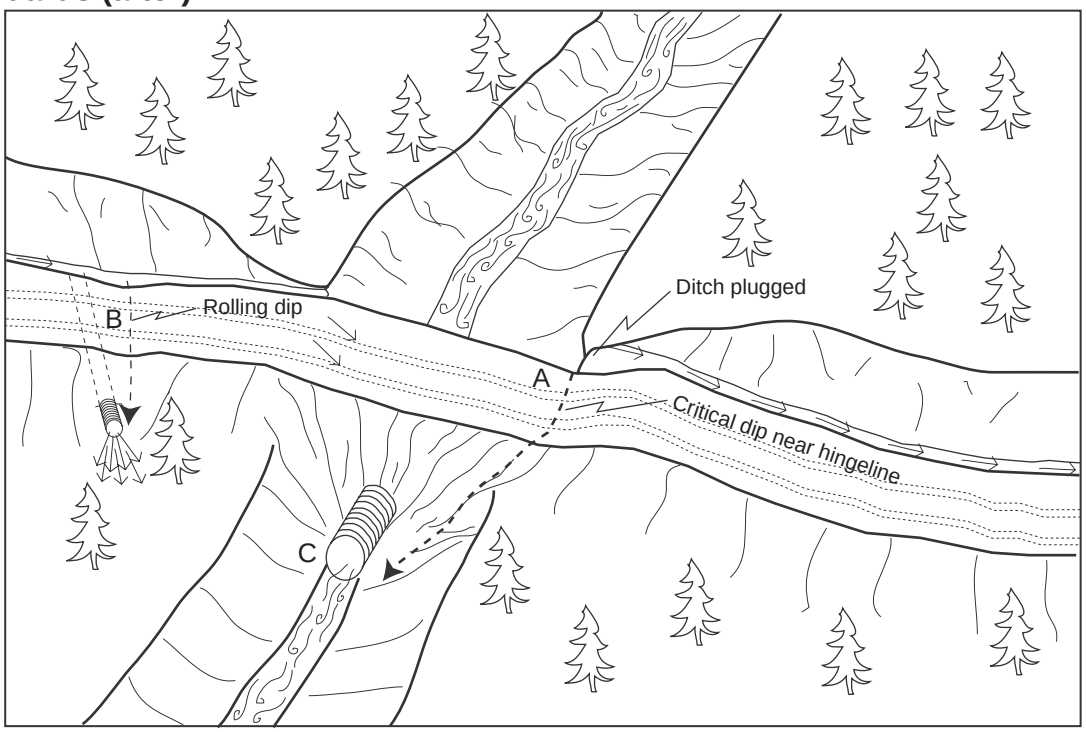


Treatment standards (after)

A - No diversion potential with critical dip installed near hingeline

B - Road surface and ditch disconnected from stream by rolling dip and ditch relief culvert

C - 100-year culvert set at base of fill



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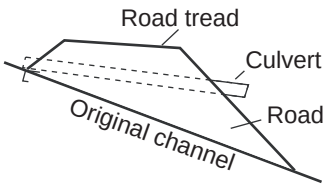
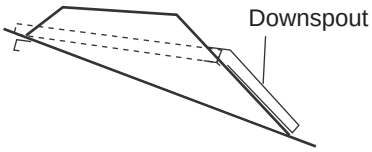
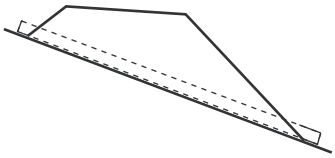
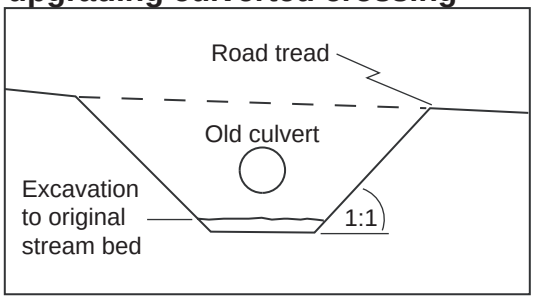
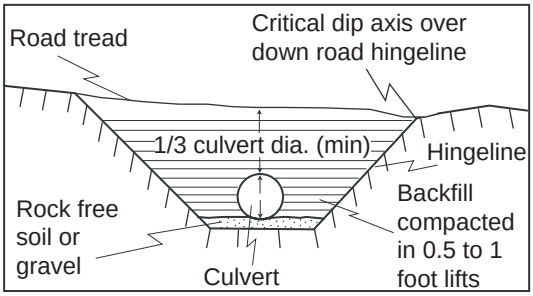
Typical Design of a Non-fish Bearing Culverted Stream Crossing

Existing	Upgraded	Upgraded (preferred)
		
1. Culvert not placed at channel grade. 2. culvert does not extend past base of fill.	1. Culvert not placed at channel grade. 2. Downspout added to extend outlet past road fill.	1. Culvert placed at channel grade. 2. Culvert inlet and outlet rest on, or partially in, the originial streambed.

Excavation in preparation for upgrading culverted crossing



Upgraded stream crossing culvert installation



Note:
Road upgrading tasks typically include upgrading stream crossings by installing larger culverts and inlet protection (trash barriers) to prevent plugging. Culvert sizing for the 100-year peak storm flow should be determined by both field observation and calulations using a procedure such as the Rational Formula.

Stream crossing culvert Installation

1. Culverts shall be aligned with natural stream channels to ensure proper function, and prevent bank erosion and plugging by debris.
2. Culverts shall be placed at the base of the fill and the grade of the original streambed, or downspouted past the base of the fill.
3. Culverts shall be set slightly below the original stream grade so that the water drops several inches as it enters the pipe.
5. To allow for sagging after burial, a camber shall be between 1.5 to 3 incher per 10 feet culvert pipe length.
6. Backfill material shall be free of rocks, limbs or other debris that could dent or puncture the pipe or allow water to seep around pipe.
7. First one end then the other end of the culvert shall be covered and secured.;The center is covered last.
8. Backfill material shall be tamped and compacted throughout the entire process:
   - Base and side wall material will be compacted before the pipe is placed in its bed.
   - Backfill compacting will be done in 0.5 - 1 foot lifts until 1/3 of the diameter of the culvert has been covered. A gas powered tamper can be used for this work.
9. Inlets and outlets shall be armored with rock or mulched and seeded with grass as needed.
10. Trash protectors shall be installed just upstream from the culvert where there is a hazard of floating debris plugging the culvert.
11. Layers of fill will be pushed over the crossing until the final designed road grade is achieved, at a minimum of 1/3 to 1/2 the culvert diameter.

Erosion control measures for culvert replacement

Both mechanical and vegetative measures will be employed to minimize accelerated erosion from stream crossing and ditch relief culvert upgrading. Erosion control measures implemented will be evaluated on a site by site basis. Erosion control measures include but are not limited to:

1. Minimizing soil exposure by limiting excavation areas and heavy equipment distrubance.
2. Installing filter windrows of slash at the base of the road fill to minimize the movement of eroded soil to downslope areas and stream channels.
3. Retaining rooted trees and shrubs at the base of the fill as “anchor” for the fill and filter windrows.
4. Bare slopes created by construction operations will be protected until vegetation can stabilize the surface. Surface erosion on exposed cuts and fills will be minimized by mulching, seeding, planting, compacting, armoring, and/or benching prior to the first rains.
5. Excess or unusable soil will be stored in long term spoil disposal locations that are not limited by factors such as excessive moisture, steep slopes greater than 10%, archeology potential, or proximity to a watercourse.
6. On running streams, water will be pumped or diverted past the crossing and into the downstream channel during the construction process.
7. Straw bales and/or silt fencing will be employed where necessary to control runoff within the construction zone.

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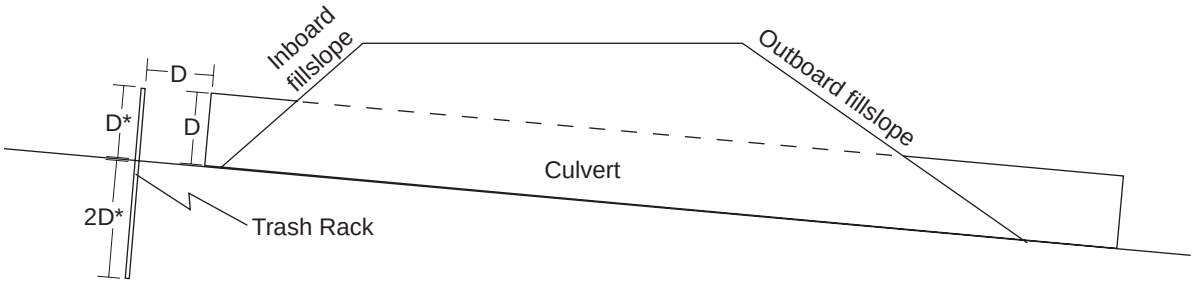
Typical Design of a Single-post Culvert Inlet Trash Rack

Cross section view



D - Culvert diameter

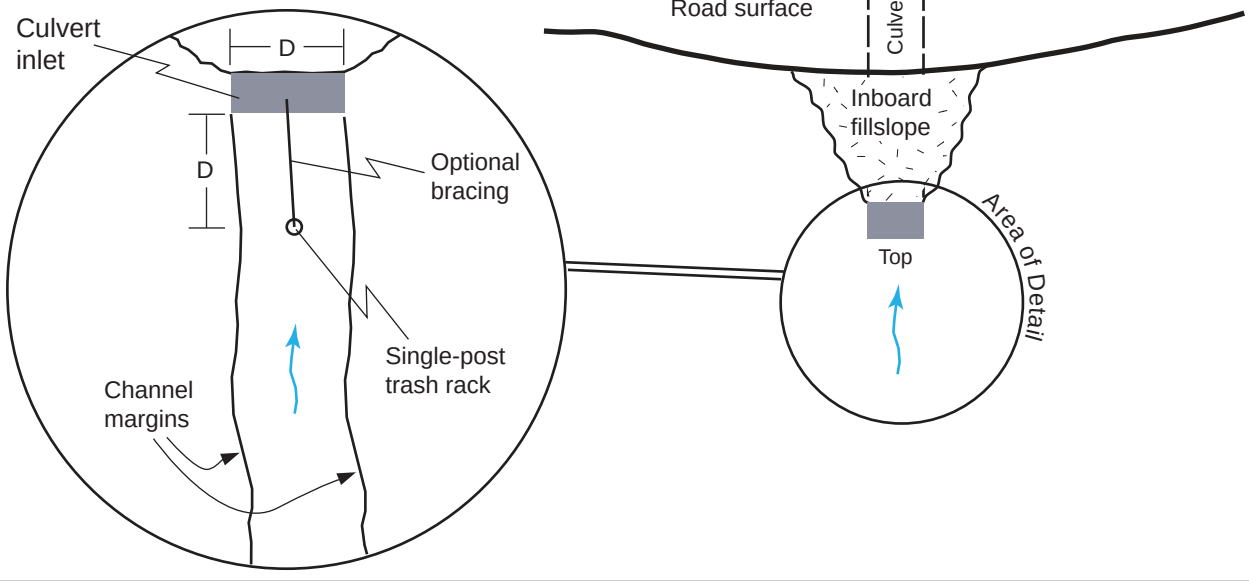
D* - If the culvert is designed for the 100-year peak storm flow, the trash rack height above the streambed should equal D.
If the culvert is undersized, then the trash rack needs to be extended vertically above the streambed to match or exceed the expected headwall height.

Plan view

Notes:

1. Many materials can be used for a single-post trash rack including old railroad track, galvanized pipe, and fence posts.

2. The diameter of single-post trash racks should be sized based on the size of expected woody debris. As a basic rule of thumb, the diameter of the trash rack should be equal to the diameter of the expected woody debris up to 4 inches.



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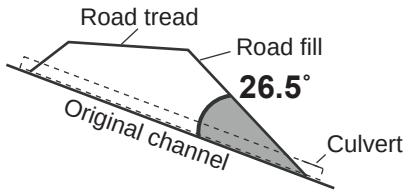
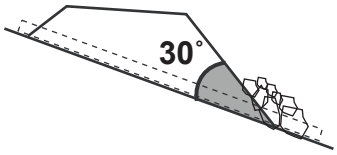
Typical Design of Stream Crossing Fill Armor

Fill angles ≤26.5˚ (2:1)



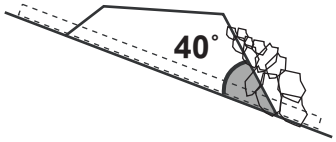
No rock armor needed

Fill angles 26.5˚ - 35˚ (1.5:1)



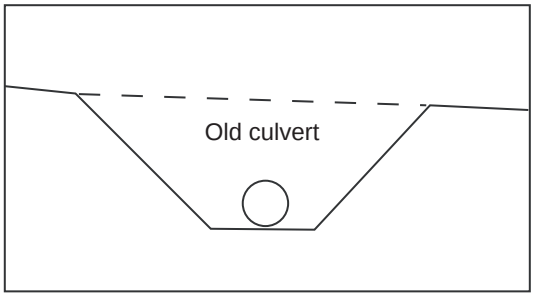
Armor 1/4 up fill face

Fill angles 35˚ - 45˚ (1:1)

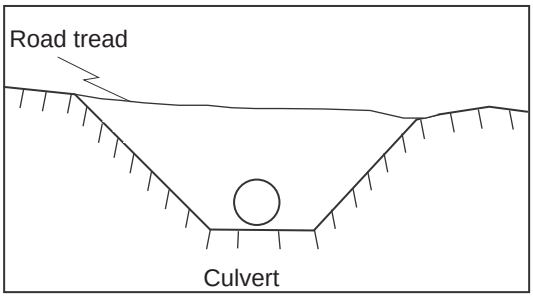


Armor 3/4 way up fill face

Fill angles 26.5˚ - 35˚ (1.5:1)



Fill angles 35˚ - 45˚ (1:1)



Note:
Road upgrading tasks typically include upgrading stream crossings by installing larger culverts and inlet protection (trash barriers) to prevent plugging. Culvert sizing for the 100-year peak storm flow should be determined by both field observation and calculations using a procedure such as the Rational Formula.

Stream crossing culvert Installation

1. Culverts shall be aligned with natural stream channels to ensure proper function, and prevent bank erosion and plugging by debris.
2. Culverts shall be placed at the base of the fill and the grade of the original streambed or downspouted past the base of the fill.
3. Culverts shall be set slightly below the original stream grade so that the water drops several inches as it enters the pipe.
5. To allow for sagging after burial, a camber shall be between 1.5 to 3 incher per 10 feet culvert pipe length.
6. Backfill material shall be free of rocks, limbs or other debris that could dent or puncture the pipe or allow water to seep around pipe.
7. First one end and then the other end of the culvert shall be covered and secured. The center is covered last.
8. Backfill material shall be tamped and compacted throughout the entire process:
   - Base and side wall material will be compacted before the pipe is placed in its bed.
   - Backfill compacting will be done in 0.5 - 1 foot lifts until 1/3 of the diameter of the culvert has been covered. A gas powered tamper can be used for this work.
9. Inlets and outlets shall be armored with rock or mulched and seeded with grass as needed.
10. Trash protectors shall be installed just upstream from the culvert where there is a hazard of floating debris plugging the culvert.
11. Layers of fill will be pushed over the crossing until the final designed road grade is achieved, at a minimum of 1/3 to 1/2 the culvert diameter.

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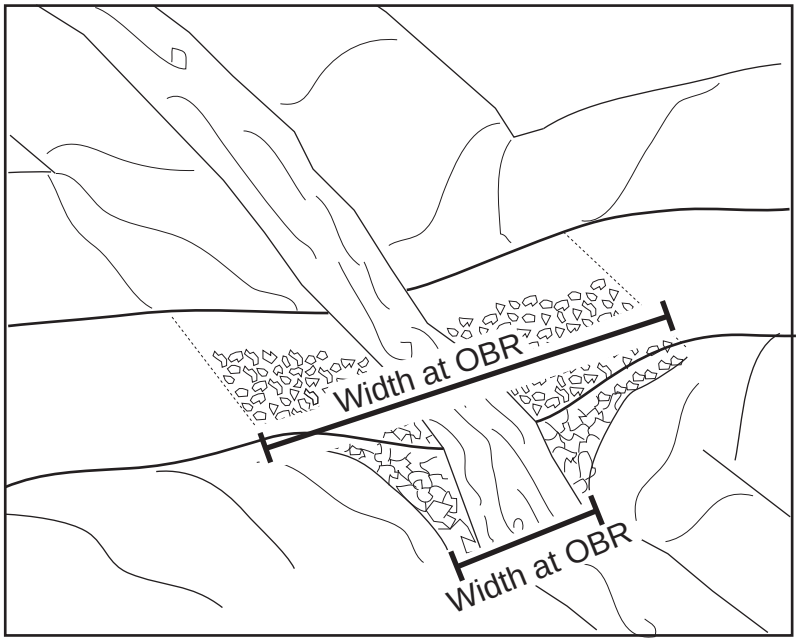
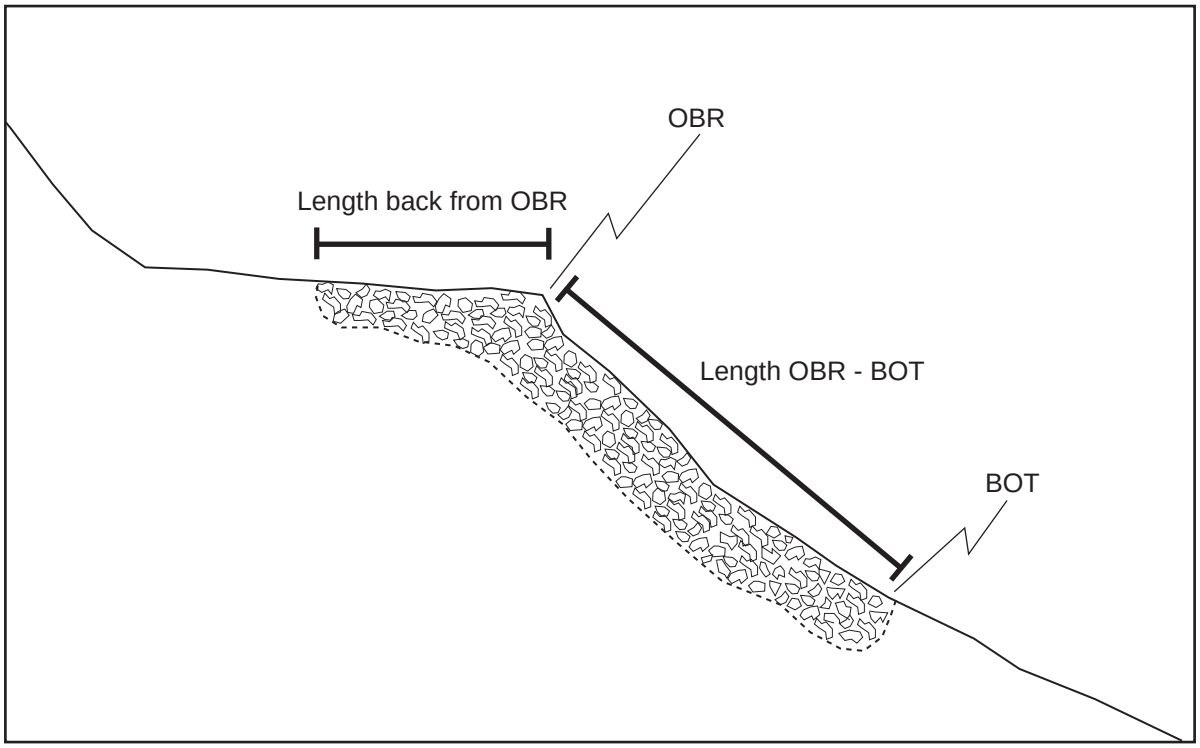
Typical Dimensions Refered to for Armored Fill Crossings

Widths in oblique view



OBR - Outboard edge of road

Lengths in profile view



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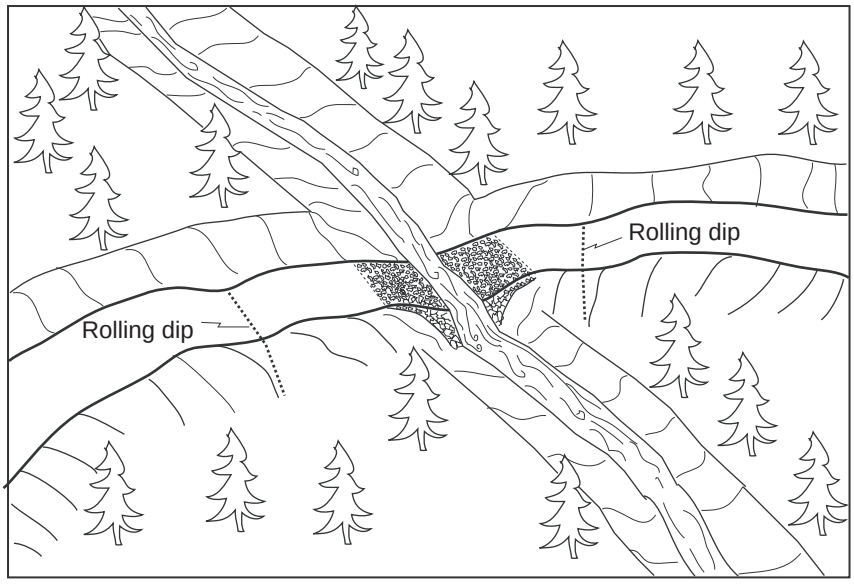
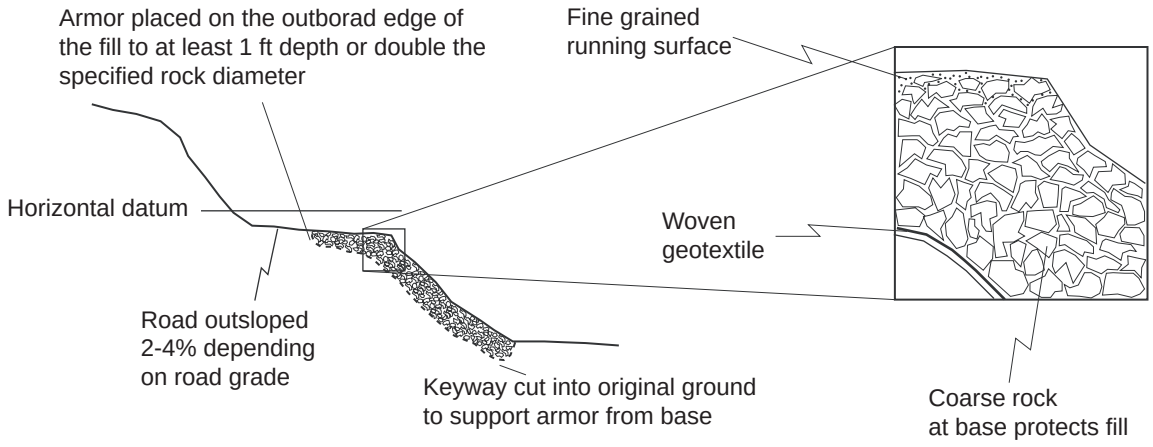
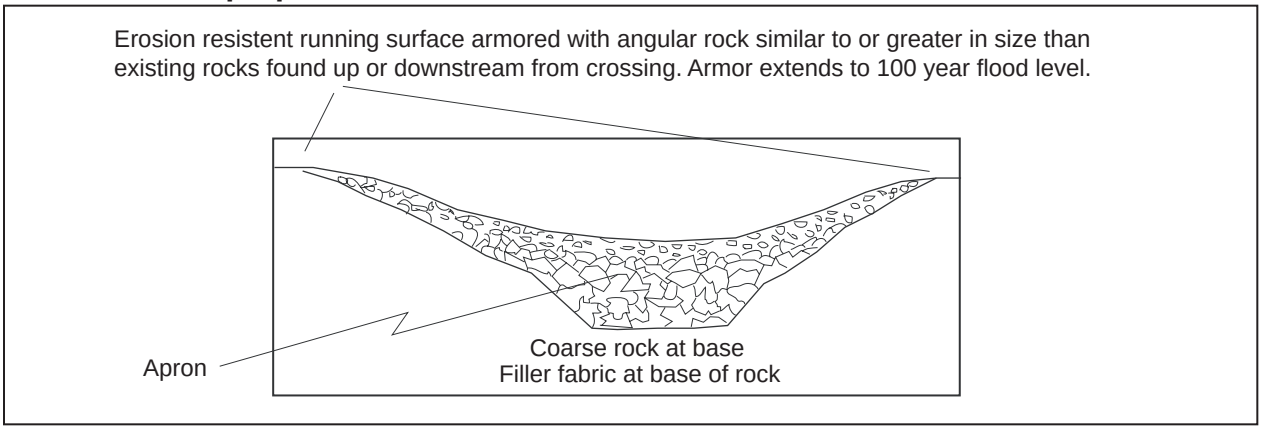
Typical Armored Fill Crossing Installation



Cross section parallel to watercourse



Cross section perpendicular to watercourse



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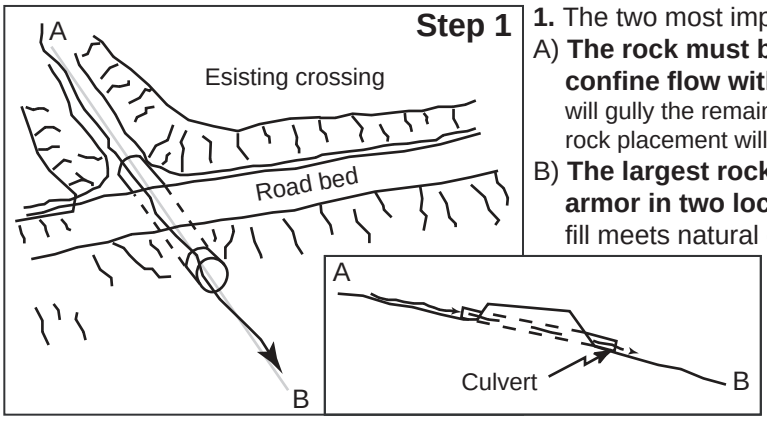
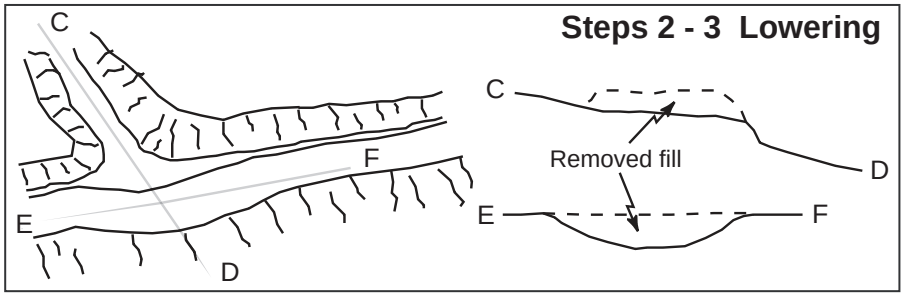
Ten Steps for Constructing a Typical Armored Fill Stream Crossing



1. The two most important points are:

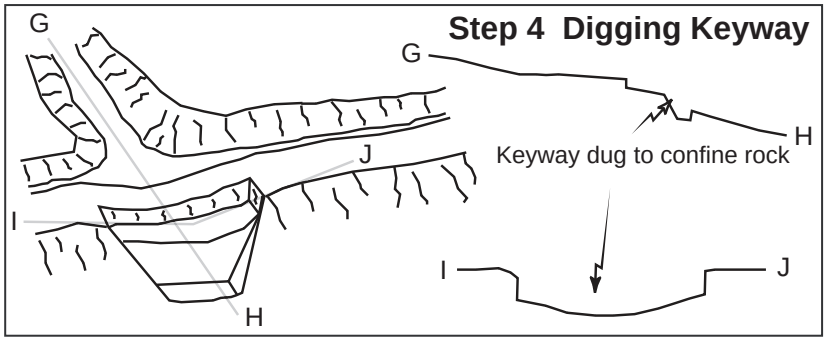
A) **The rock must be placed in a "U" shape across the channel to confine flow within the armored area.** (Flow around the rock armor will gully the remaining fill. Proper shape of surrounding road fill and good rock placement will reduce the likelihood of crossing failure).

B) **The largest rocks must be used to buttress the rest of the armor in two locations:** (i) The base of the armored fill where the fill meets natural channel. (This will butress the armor placed on the outboard fill face and reduce the likelihood of it washing downslope). (ii) The break in slope from the road tread to the outer fill face. (This will butress the fill placed on the outer road tread and will determine the "base level" of the creek as it crosses the road surface).



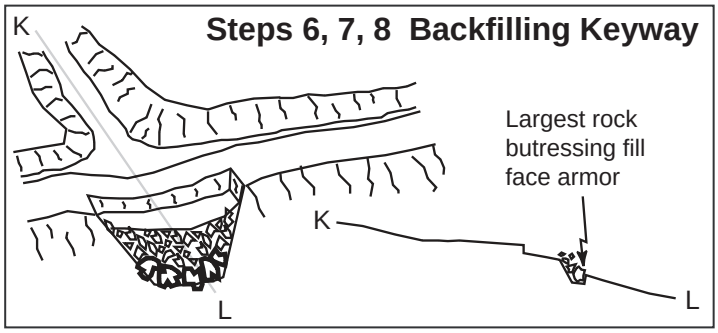
2. Remove any existing drainage structures including culverts and Humboldt logs.

3. Construct a dip centered at the crossing that is large enough to accomodate the 100-year peak storm flow and prevent diversion (C-D, E-F).



4. Dig a keyway (to place rock in) that extends from the outer 1/3 of the road tread down the outboard road fill to the point where outbaord fill meets natural channel (up to 3 feet into the channel bed depending on site specifics) (G-H, I-J).

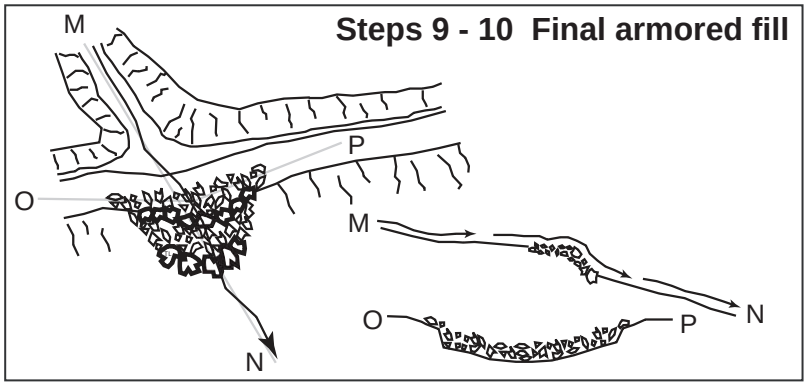
5. Install geofabric (optional) within keyway to support rock in wet areas and to prevent winnowing of the crossing at low flows.



6. Put aside the largest rock armoring to create 2 buttresses in the next step.

7. Create a buttress using the largest rock (as described in the site treatments specifications) at the base of fill. (This should have a "U" shape to it and will define the outlet of the armored fill.)

8. Backfill the fill face with remaining rock armor making sure the final armored area has "U" shape that will accomodate the largest expected flow (K-L).



9. Install a second buttress at the break in slope between the outboard road and the outboard fill face. (This should define the base level of the stream and determine how deep the stream will backfill after construction). (M-N)

10. Back fill the rest of the keyway with the unsorted rock armor making sure the final armored area has a "U" shape that will accommodate the largest expected flow (O-P).

Typical Drawing #7

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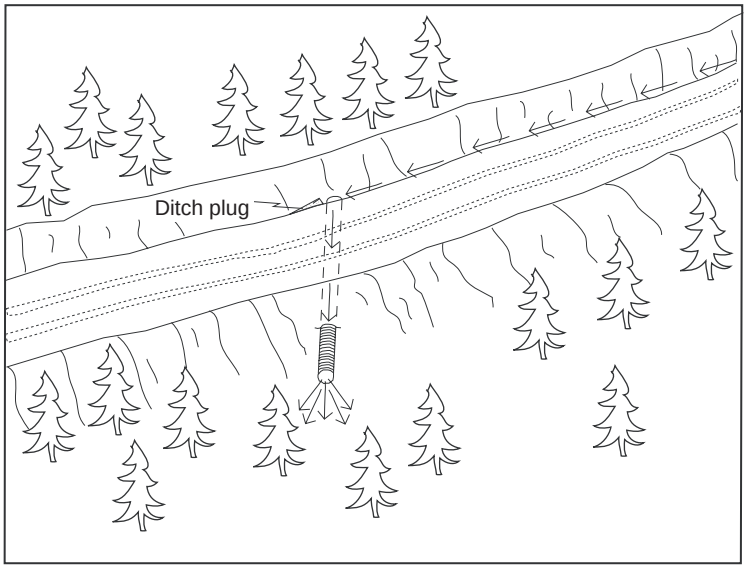
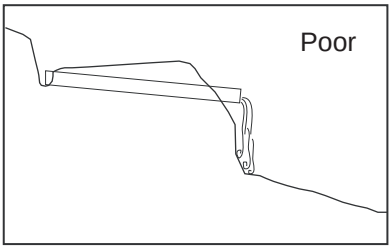
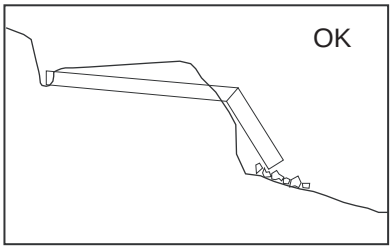
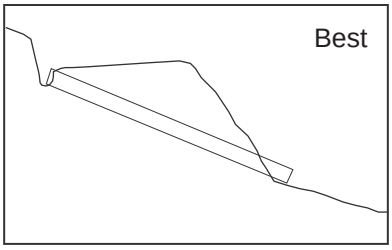
Typical Ditch Relief Culvert Installation









Ditch relief culvert installation

1) The same basic steps followed for stream crossing installation shall be employed.
2) Culverts shall be installed at a 30 degree angle to the ditch to lessen the chance of inlet erosion and plugging.
3) Culverts shall be seated on the natural slope or at a minimum depth of 5 feet at the outside edge of the road, whichever is less.
4) At a minimum, culverts shall be installed at a slope of 2 to 4 percent steeper than the approaching ditch grade, or at least 5 inches every 10 feet.
5) Backfill shall be compacted from the bed to a depth of 1 foot or 1/3 of the culvert diameter, which ever is greater, over the top of the culvert.
6) Culvert outlets shall extend beyond the base of the road fill (or a flume downspout will be used). Culverts will be seated on the natural slope or at a depth of 5 feet at the outside edge of the road, whichever is less.

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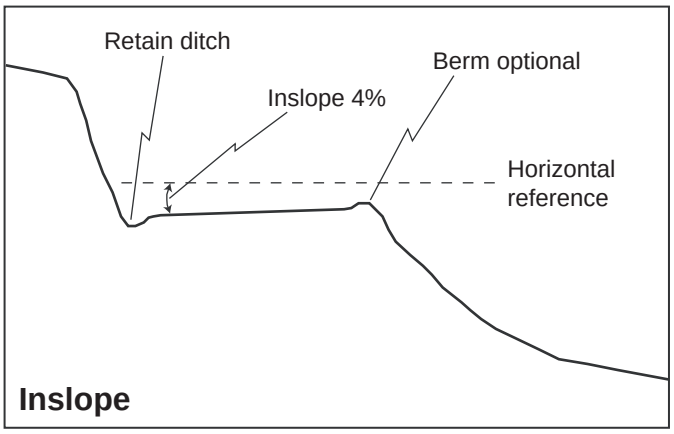
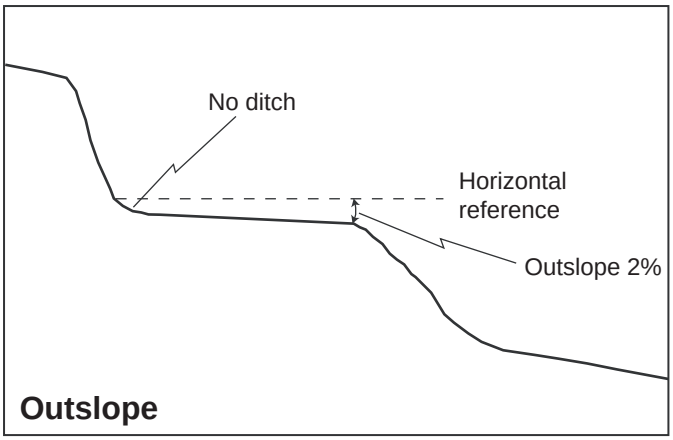
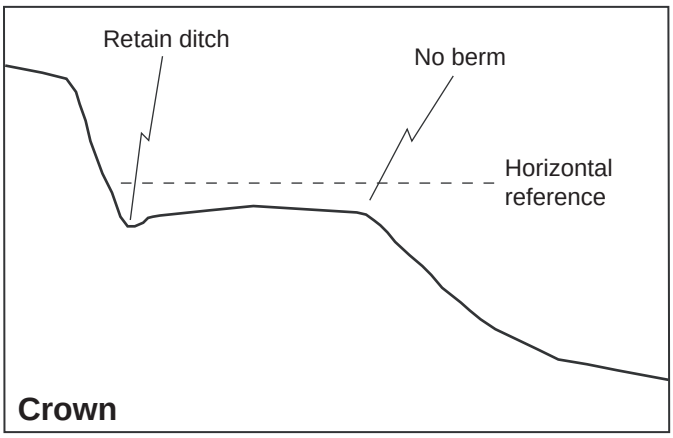
Typical Designs for Using Road Shape to Control Road Runoff







Outsloping Pitch for Roads Up to 8% Grade		
Road grade	**Unsurfaced roads**	**Surfaced roads**
4% or less	3/8" per foot	1/2" per foot
5%	1/2" per foot	5/8" per foot
6%	5/8" per foot	3/4" per foot
7%	3/4" per foot	7/8" per foot
8% or more	1" per foot	1 1/4" per foot

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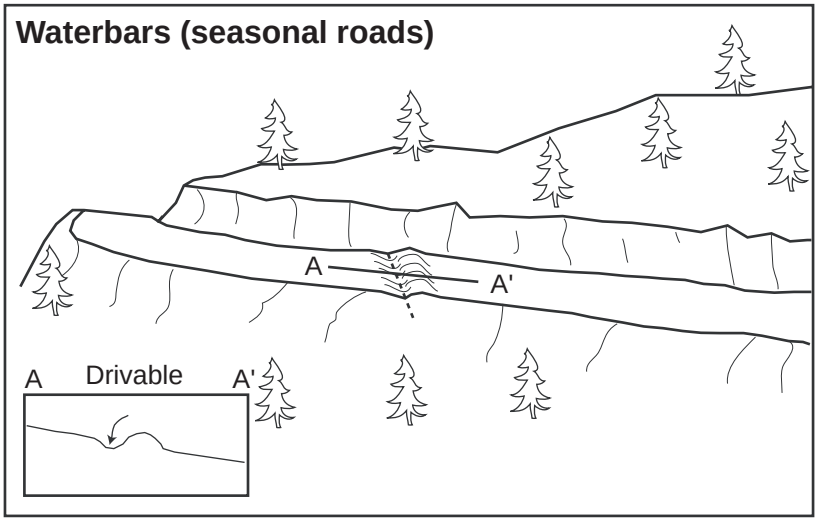
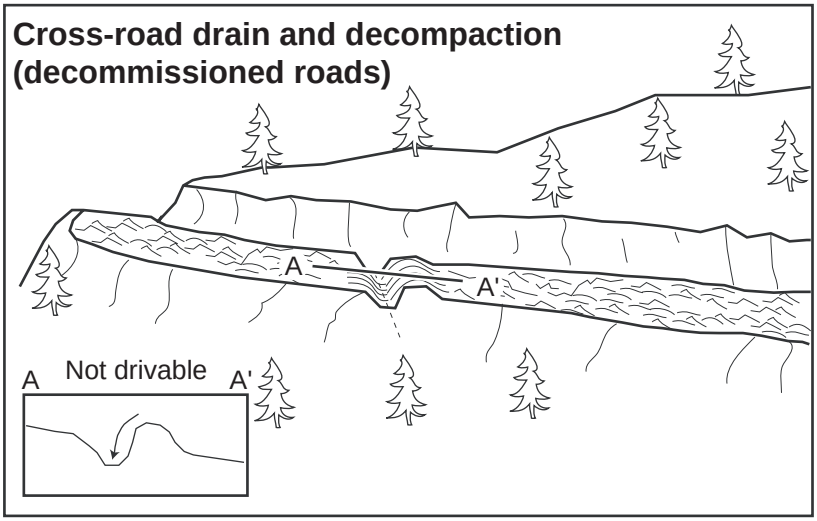
Typical Methods for Dispersing Road Surface Runoff with Waterbars, Cross-road Drains, and Rolling Dips

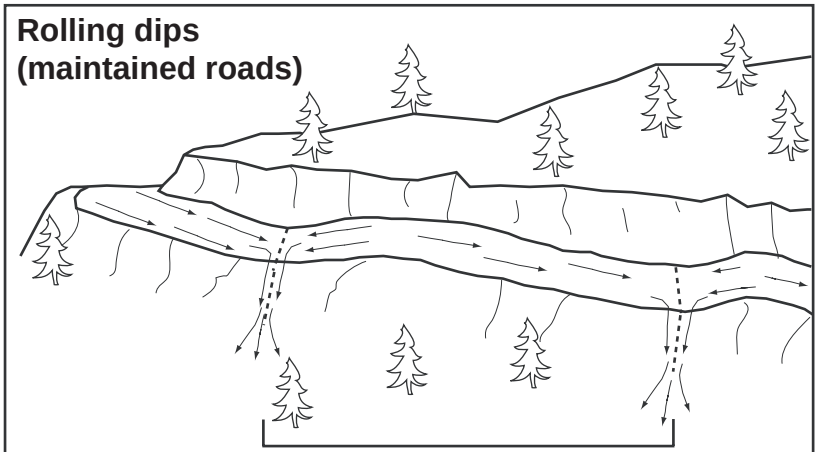
Waterbars (seasonal roads)



Cross-road drain and decompaction (decommissioned roads)



Rolling dips (maintained roads)



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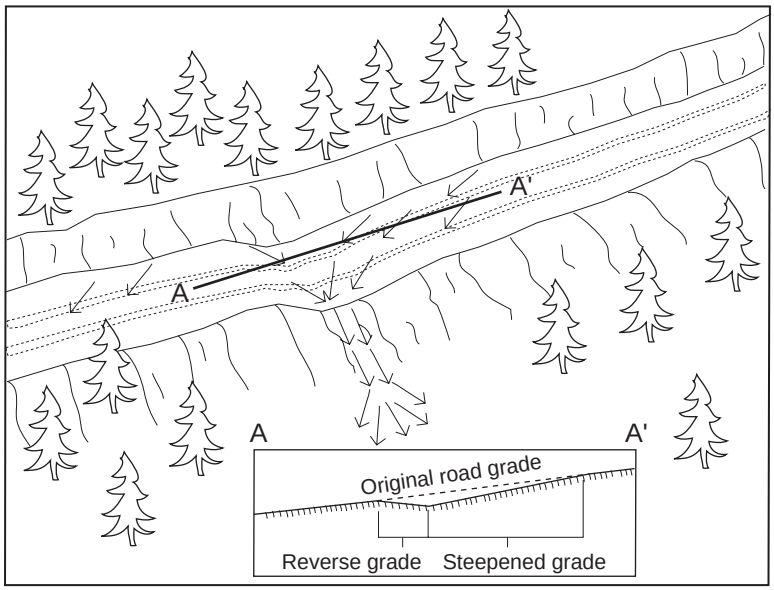
Typical Road Surface Drainage by Rolling Dips



Rolling dip installation:

1. Rolling dips will be installed in the roadbed as needed to drain the road surface.
2. Rolling dips will be sloped either into the ditch or to the outside of the road edge as required to properly drain the road.
3. Rolling dips are usually built at 30 to 45 degree angles to the road alignment with cross road grade of at least 1% greater than the grade of the road.
4. Excavation for the dips will be done with a medium-size bulldozer or similar equipment.
5. Excavation of the dips will begin 50 to 100 feet up road from where the axis of the dip is planned as per guidelines established in the rolling dip dimensions table.
6. Material will be progressively excavated from the roadbed, steepening the grade unitl the axis is reached.
7. The depth of the dip will be determined by the grade of the road (see table below).
8. On the down road side of the rolling dip axis, a grade change will be installed to prevent the runoff from continuing down the road (see figure above).
9. The rise in the reverse grade will be carried for about 10 to 20 feet and then return to the original slope.
10. The transition from axis to bottom, through rising grade to falling grade, will be in a road distance of at least 15 to 30 feet.

Table of rolling dip dimensions by road grade

Road grade %	**Upslope approach distance** (from up road start to trough) ft	**Reverse grade distance** (from trough to crest) ft	**Depth at trough outlet** (below average road grade) ft	**Depth at trough inlet** (below average road grade) ft
<6	55	15 - 20	0.9	0.3
8	65	15 - 20	1.0	0.2
10	75	15 - 20	1.1	0.01
12	85	20 - 25	1.2	0.01
>12	100	20 - 25	1.3	0.01

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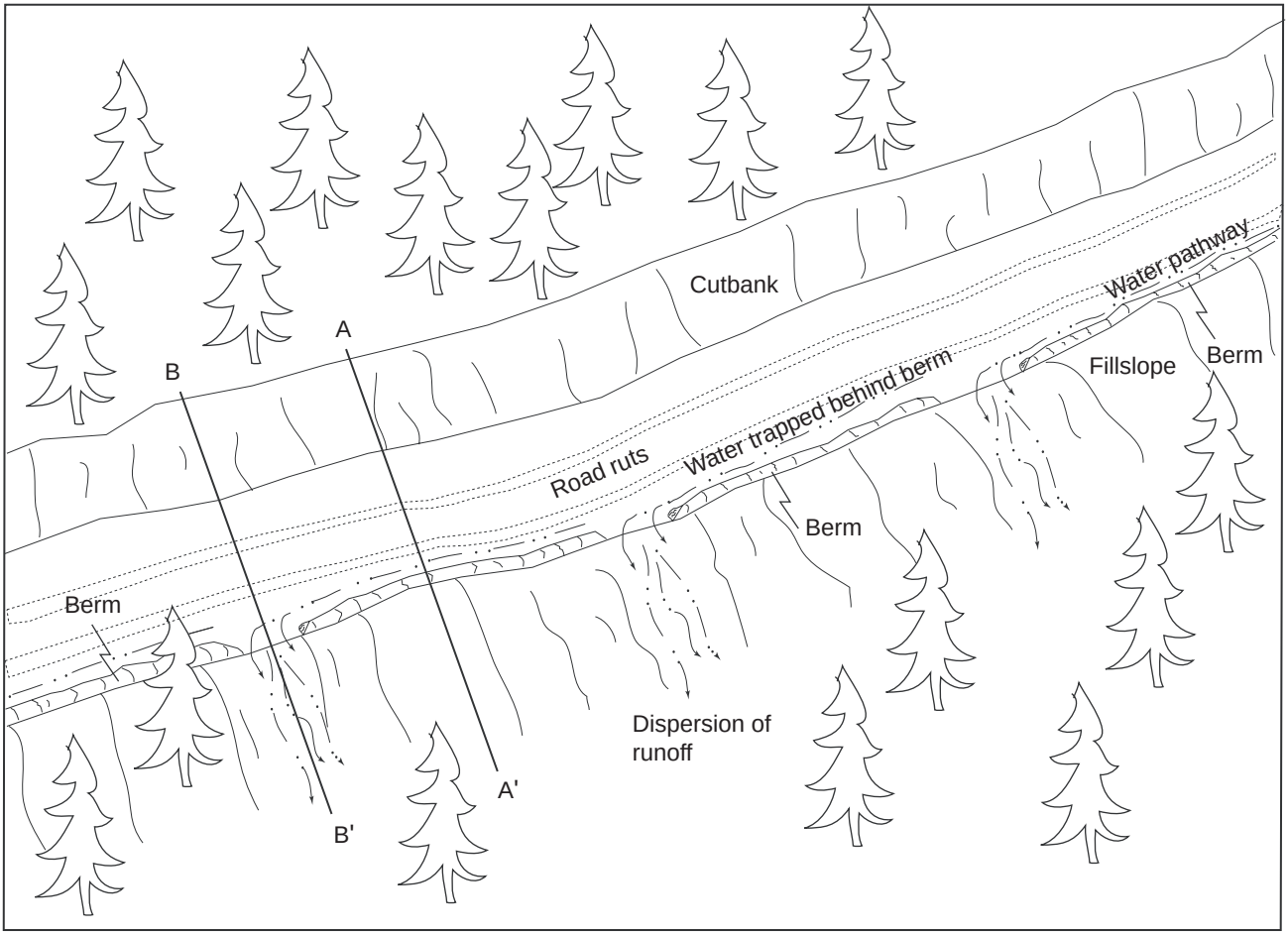
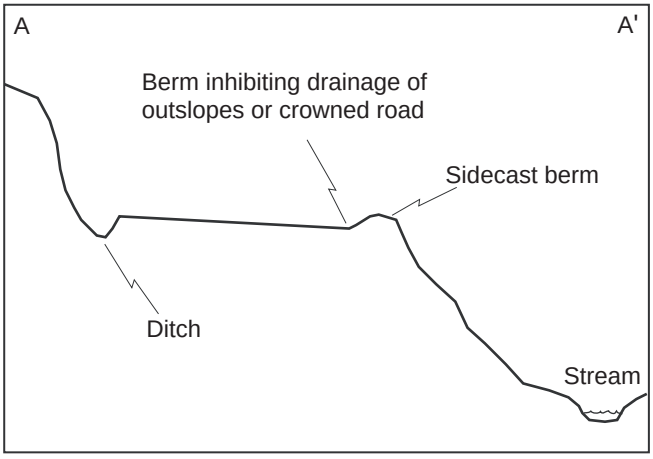
Typical Sidecast or Excavation Methods for Removing Outboard Berms on a Maintained Road

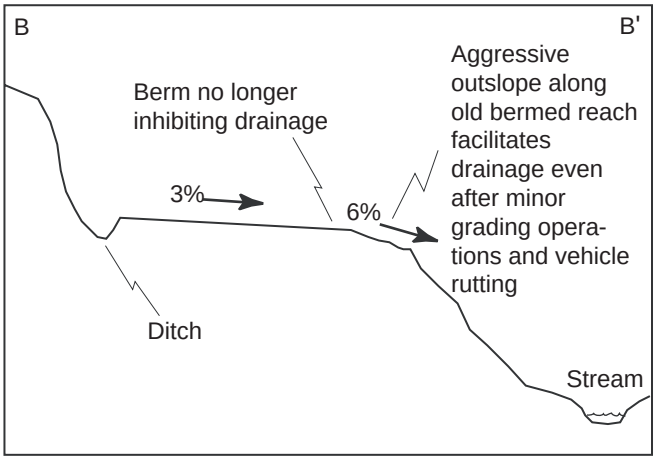
1. On gentle road segments berms can be removed continuously (see B-B').
2. On steep road segments, where safety is a concern, the berm can be frequently breached (see A-A' & B-B') Berm breaches should be spaced every 30 to 100 feet to provide adequate drainage of the road system while maintaining a semi-continuous berm for vehicle safety.



Road cross section between berm breaches



Road cross section at berm breaches



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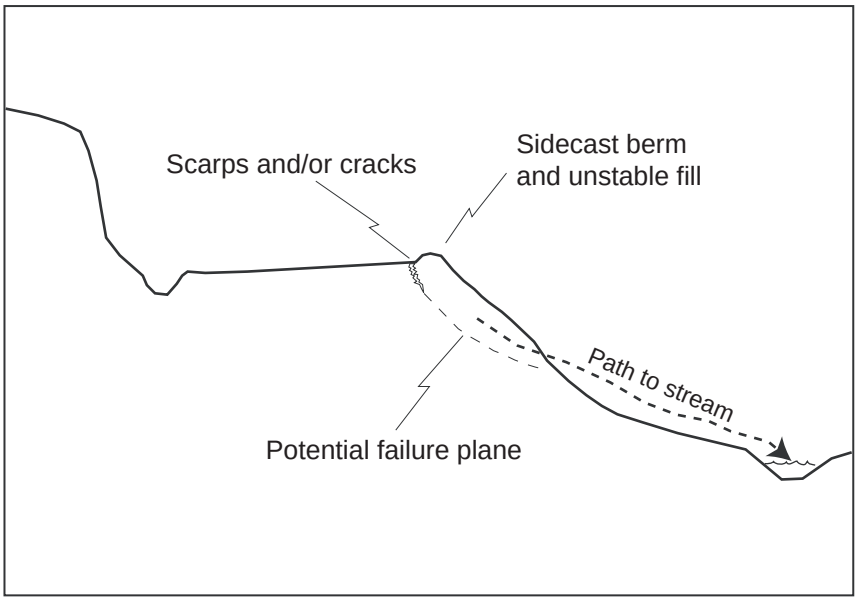
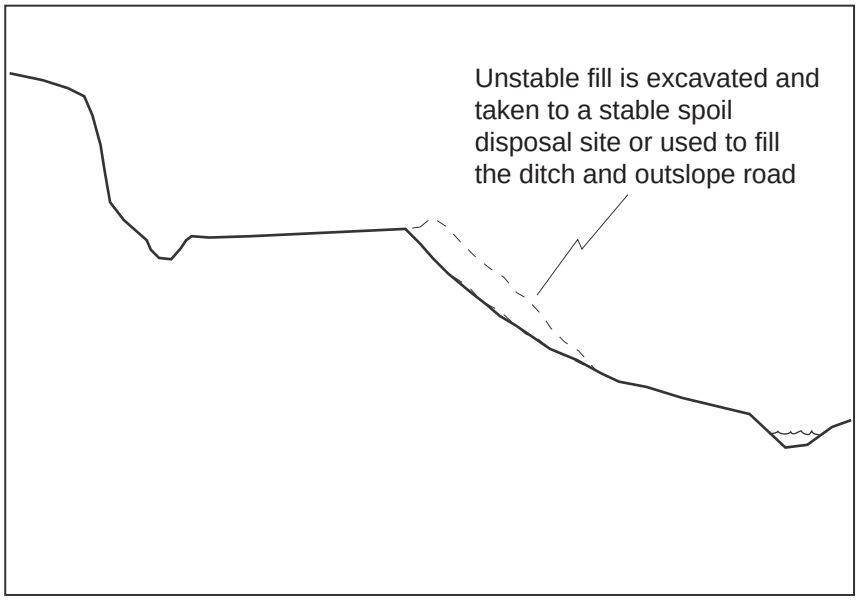
Typical Excavation of Unstable Fillslope on an Upgraded Road

Before



After



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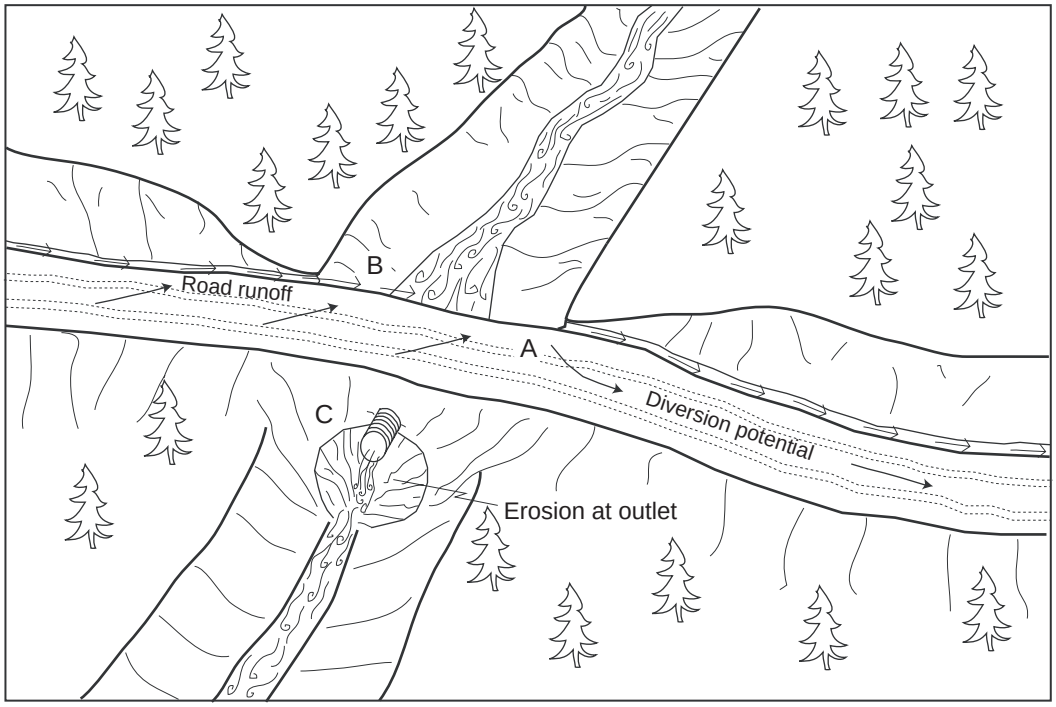
Typical Problems and Applied Treatments for a Decommissioned Stream Crossing

Problem condition (before)

A - Diversion potential

B - Road surface and ditch drain to stream

C - Undersized culvert high in fill with outlet erosion

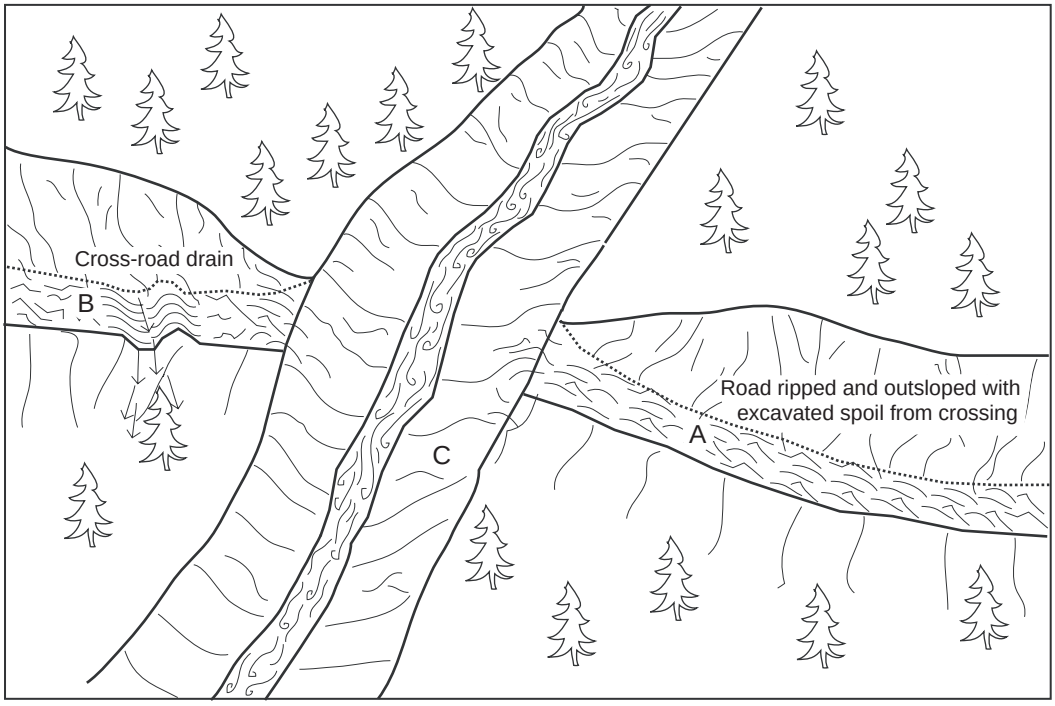


Treatment standards (after)

A - Diversion prevented by road surface ripping and outsloping using excavated spoils

B - Road surface and ditch disconnected from stream by road surface decompaction and cross-road drains

C - Stream crossing fill completely excavated



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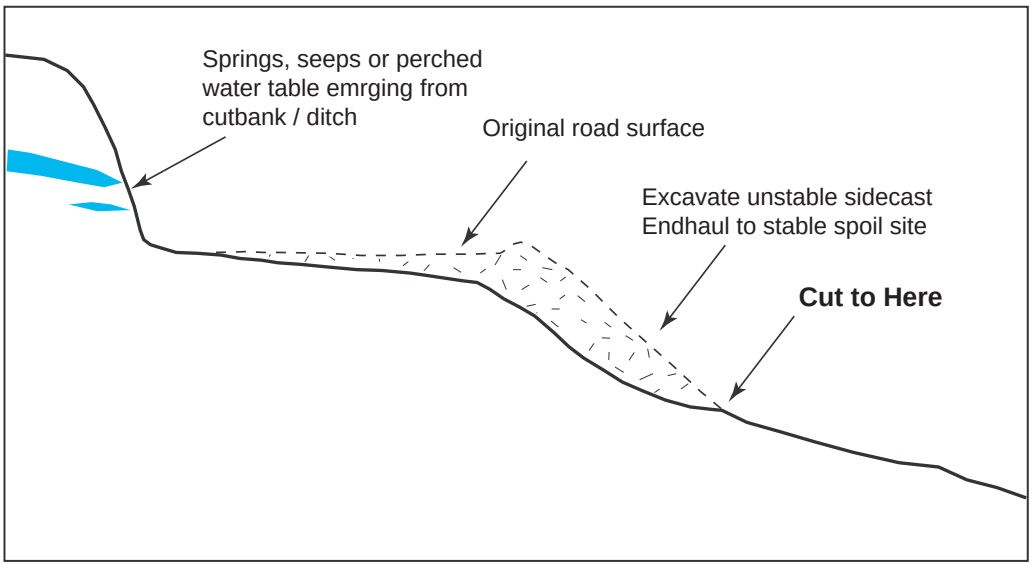
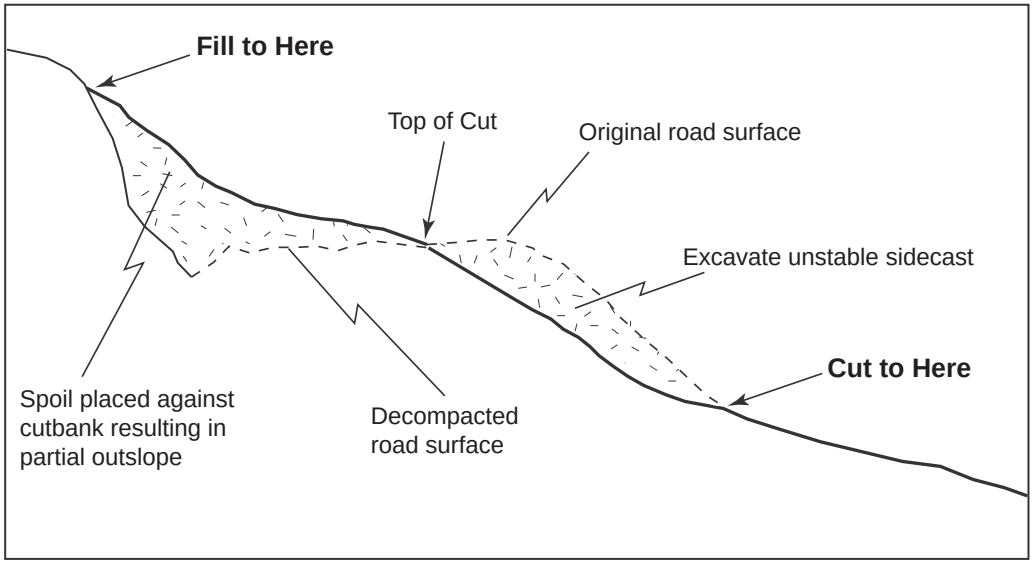
Typical Design for Road Decommisioning Treatments Employing Export and In-Place Outsloping Techniques

Export outslope (EPOS)



In-place outslope (IPOS)



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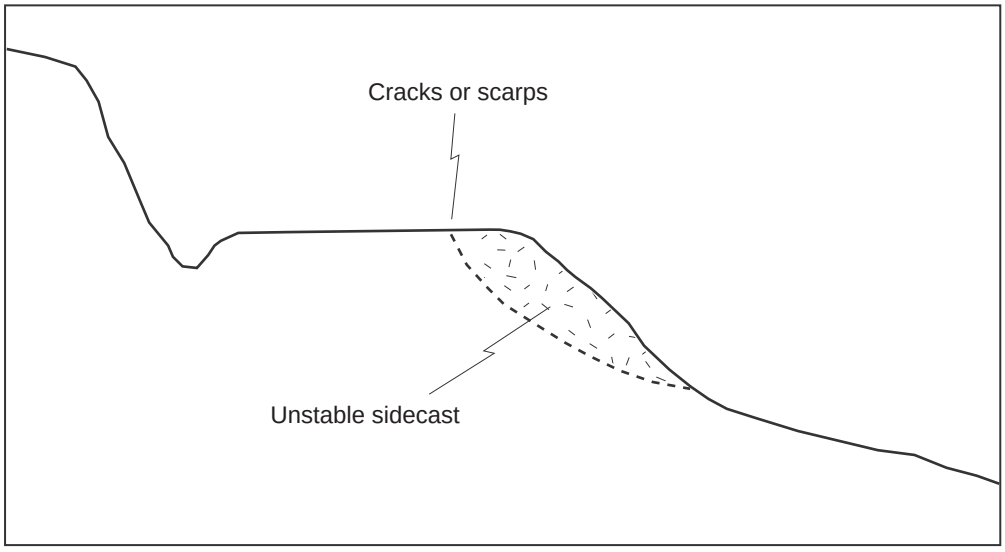
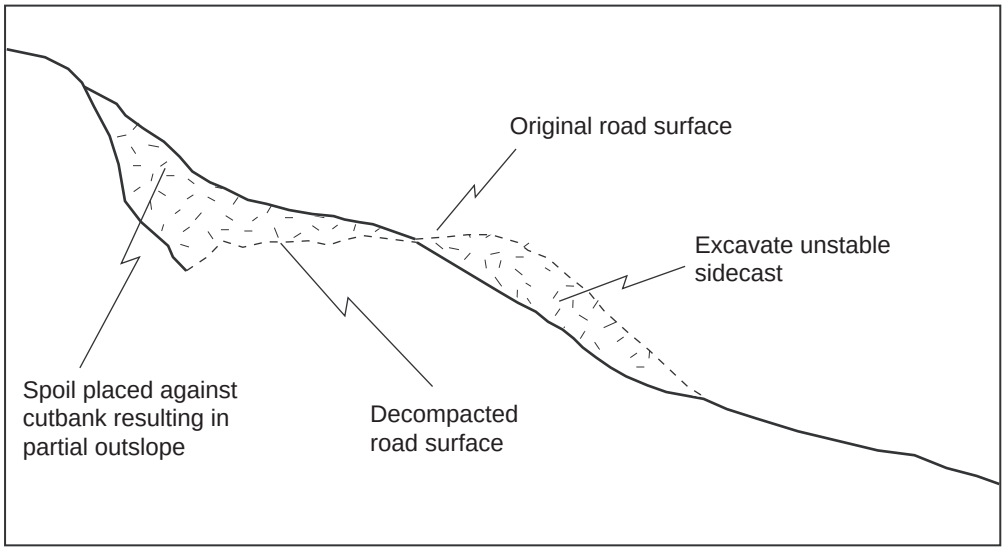
Typical Excavation of Unstable Fillslope on a Decommissioned Road

Before



After



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