

A photograph of a dirt road in a wooded area. The road is heavily eroded, with a deep, wide gully on the left side. The soil is exposed and appears loose. The road surface is covered in gravel and dirt. The background shows a dense forest of trees.

Improving and Maintaining Roads to Reduce Impacts on Erosion and Water Quality

Presentation Outline

- Review the common problems associated with rural roads.
- Provide guidance on diagnosing problems in the field.
- Describe treatments, including improvements and road removal.
- Describe procedures for road maintenance.



Common Symptoms of “Bad” Roads

- Excessively steep (>15 percent)
- Erosion or mass movement on cut and fill slopes or on road surface
- Unstable fills close to streams
- Poor drainage (standing water, potholes, rills or gullies on surface, obstructed ditches or culverts)
- Gullies below roads
- Undersized stream crossings
- Inadequately sized or spaced cross drains

Excessive Grade

Roads that are excessively steep usually have other problems as well.

Excessively steep roads are commonly a legacy from previous uses e.g., former skid trails, and were never intended to be permanent roads.



Road Prism Erosion

Road surface rills and sheet erosion, in-board ditch erosion, fill slope erosion at crossings, cut bank sloughing



Unstable Fills

Roads close to streams or intercepting groundwater,
“perched” fills on steep slopes



Poor Drainage

“Through cut” roads, flat roads, inadequate cross drains, sub-surface water



Gullies

Gullies may be created in several ways:

- At the outfall of ditch relief culverts or rolling dips.
- When stream crossings fail and water flows down the road.
- If ditches are not sufficiently relieved and diversions occur.
- When stream flow is concentrated or diverted into inadequately sized channels.

THESE PROBLEMS CANNOT BE SOLVED
BY “FILLING THE HOLE”



Deficient Stream Crossings or Culverts



Culverts may be too small to pass peak flows plus entrained wood and debris. They may be plugged, broken or rusted through. They may be improperly aligned or not have the right slope

Inadequate Cross Drains



Cross drains are culverts or rolling dips that intercept and “relieve” ditch flow. They may be inadequately sized or spaced. As a result, ditches may erode or excessive runoff may be diverted down the road, causing rills and gullies.

What is Diversion Potential?



Evaluating Your Roads



UNIVERSITY OF
CALIFORNIA
Division of Agriculture
and Natural Resources
<http://anrcatalog.ucdavis.edu>

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Rural Roads: A Construction and Maintenance Guide for California Landowners

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Many thousands of miles of privately maintained rural roads extend throughout California, and they are used for resource management as well as residential and recreational access by over 500,000 landowners (fig. 1). The California Department of Forestry and Fire Protection (CAL FIRE) estimates that another 2.7 million acres of forest and rangeland will be developed over the next 40 years, requiring the construction of thousands of miles of new roads (CAL FIRE 2003). Poorly located, designed, or maintained roads are the primary cause of water quality degradation in rural watersheds.

This publication is designed to help rural landowners understand how to improve and maintain existing roads. It also provides guidance on planning new roads. It is written for people who have little to no previous experience in managing a road. If you have recently purchased a rural parcel or have become responsible for road maintenance on an existing parcel—or otherwise feel unprepared for maintaining roads—this publication should help you. It mainly addresses single-lane dirt or rock-surfaced rural roads, also known as “low-volume” roads because they are not expected to carry high traffic levels.

This publication should enable you to

- understand the basic principles of good road design and maintenance
- recognize current and potential road erosion and drainage problems
- consider remedial treatments that may be needed
- develop rough estimates for the costs of road improvements and maintenance
- communicate clearly with contractors who may perform work on your roads



Figure 1. Low-volume road that has been newly gravelled and out-sloped, San Bernardino County. Photo: Richard Harris.



Handbook for Forest, Ranch & Rural ROADS

A Guide For
Planning,
Designing,
Constructing,
Reconstructing,
Upgrading,
Maintaining
And Closing
Wildland Roads

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Road Assessment Checklist

University of California
Cooperative Extension

Assessing the Condition of Your Roads

The purpose of this worksheet is to enable you to evaluate the condition of the roads on your property. Understanding road conditions will help you plan and prioritize actions that will improve your ability to manage your property. The assessment process includes several steps:

- Identifying access routes to your property and your rights and responsibilities concerning them.
- Mapping existing roads on your property.
- Deciding which roads you need for management.
- Deciding if you need new roads.
- Evaluating the condition of your existing roads, including both those you will use and those you won't use.

Note: The worksheet asks for yes-no answers. A don't know answer may imply a need-to-know.

Access to Your Property

If a public road adjoins or abuts your property and you have a legal encroachment permit to use it for access, you are in good shape. However, just because you have a driveway from a public road to your property does not necessarily mean that it is legal. Check your deed or check with the jurisdiction (city, county or state) that has responsibility for the public road. If you have access from a road on land owned by a federal agency such as the Forest Service, check with the agency's local offices.

If you have access to your property through another property or by private road, you need to know if you have legal rights of access. This is usually recorded on your deed as a right-of-way. If you don't have deeded access, then you need to know what rights you have to use the road. You also need to know what responsibilities you have for maintaining the road and what uses are restricted (e.g., hauling logs). In the absence of a legal right to use the road, you are vulnerable to the whims of your neighbor and need to negotiate that right.

1. Does a public road provide access to your property (e.g., county road or state highway)?

☐ Yes ☐ No ☐ Don't Know

2. Does a private (including public agency) road provide access to your property (e.g., subdivision road, road through adjoining private or public lands)?

☐ Yes ☐ No ☐ Don't Know

3. Do you have deeded access to your property?

☐ Yes ☐ No ☐ Don't Know

If you don't have deeded access, by what right can you use the road?

4. If access is by private road, does it receive regularly scheduled maintenance?

☐ Yes ☐ No ☐ Don't Know

5. Are you part of a road maintenance agreement or association?

☐ Yes ☐ No ☐ Don't Know

6. Do you have responsibilities for maintaining roads that provide access to your property?

☐ Yes ☐ No ☐ Don't Know

Access on Your Property

There may be several roads on your property, some of which are a legacy of past uses (e.g., old logging roads). Legacy roads can be a liability if they are causing environmental damage.

Sometimes roads are shown on published topographic maps or other maps of your property.

Sometimes they must be located in the field or with aerial photographs and sketched on a map.

1. To the best of your ability, use a topographic map (quadrangle) to indicate the road system on your property. Identify and number (Road #1, Road #2, etc.) main and secondary roads that are in use as well as any roads that exist but are not used.

2. Does your on-site road system allow you to access all your property?

☐ Yes ☐ No ☐ Don't Know

3. Indicate on a map what parts of your property are not currently accessible by road.

4. Now, you need to walk or drive your roads. For each existing road, provide the following descriptive information (note: for all these tables, use the road numbering system for reference and duplicate tables for as many roads and crossings as necessary):



	Road #1	Road #2	Road #3
Width (running surface in feet)			
Range of grades (from steepest to gentlest slopes, in percent)			
Surfacing (native, rock, paved)			
Drainage (in-sloped with inboard ditch, out-sloped, not evident or don't know)			

5. For each existing road, provide any information on the following problems. If possible, use your map to indicate where the problems are located:

	Road #1	Road #2	Road #3
Cutback sloughing or failure			
Fill slope erosion or failure			
Rutting on the road surface			
Potholes on the road surface			
Wet spots on the road surface			
Gully erosion below the road			
Eroding ditch or plugged cross drains			
Other			

6. Indicate on a map all existing stream crossings on existing roads (note: streams may be ephemeral, intermittent or perennial). Identify each by sequentially numbering in relation to road numbering system (Road #1, Crossing #1, Road #2, Crossing #1, etc.). For each crossing, provide the following descriptive information:

	Road #			
	Crossing #	Crossing #	Crossing #	Crossing#
Crossing type (culvert, ford, bridge)				
Crossing condition (good, fair, poor)				
Fill slope condition (stable, some erosion, major erosion)				

7. For each crossing, provide any information on the following problems:

	Road #			
	Crossing #	Crossing #	Crossing #	Crossing#
Crossing undersized for the size of the stream				
Crossing not aligned with channel				
Crossing is not at the slope of the stream				
Downstream channel or bank erosion				
Upstream channel or bank erosion				
Upstream sediment deposition				
Prone to plugging with debris				
Diversion potential				

This approach is suitable for landowners with minimal technical skills.

The results can be used to plan and prioritize improvements and seek funding from resource agencies.

More sophisticated approaches may be warranted (see next slides)

Summary of Findings

1. Is access to your property adequate?

☐ Yes ☐ No ☐ Don't Know

2. If not, what issues need to be addressed?

- Rights of access:
- Road condition and maintenance:
- Other:

3. Is access within your property adequate?

☐ Yes ☐ No ☐ Don't Know

4. If not, what issues need to be addressed?

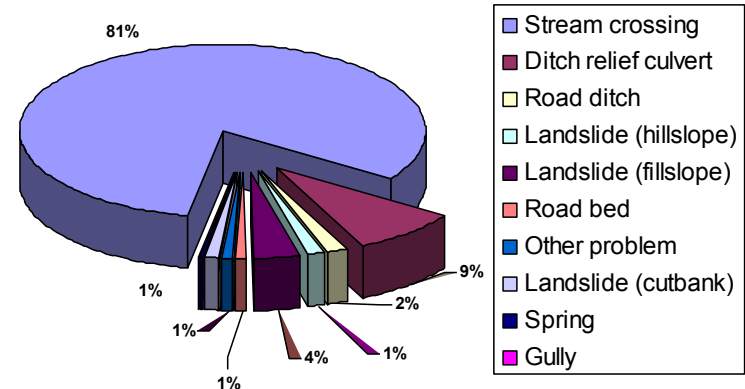
- Need for additional access:
- Condition of roads that are used or will be used:
- Condition of other roads:
- Condition of crossings on used roads:
- Condition of crossings on unused roads:

Five County Program Sediment Source Inventory

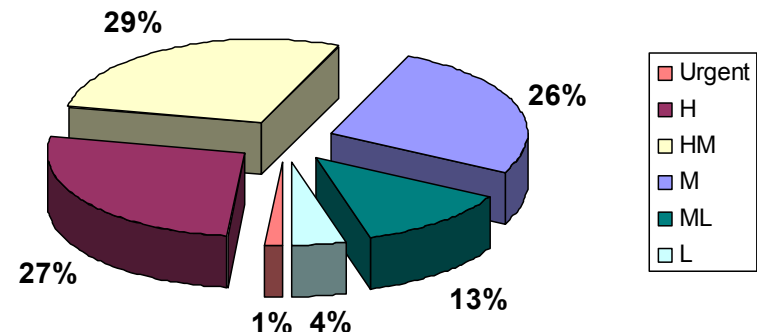
Volume Yd³ Sites

Stream crossing	2,958,981	6299
Ditch relief culvert	315,775	2454
Road ditch	61,378	381
Landslide (hillslope)	44,385	24
Landslide (fillslope)	134,563	76
Road bed	31,593	217
Other problem	33,282	89
Landslide (cutbank)	36,490	32
Spring	7,249	80
Gully	2,511	9
Total	3,626,205	9,661

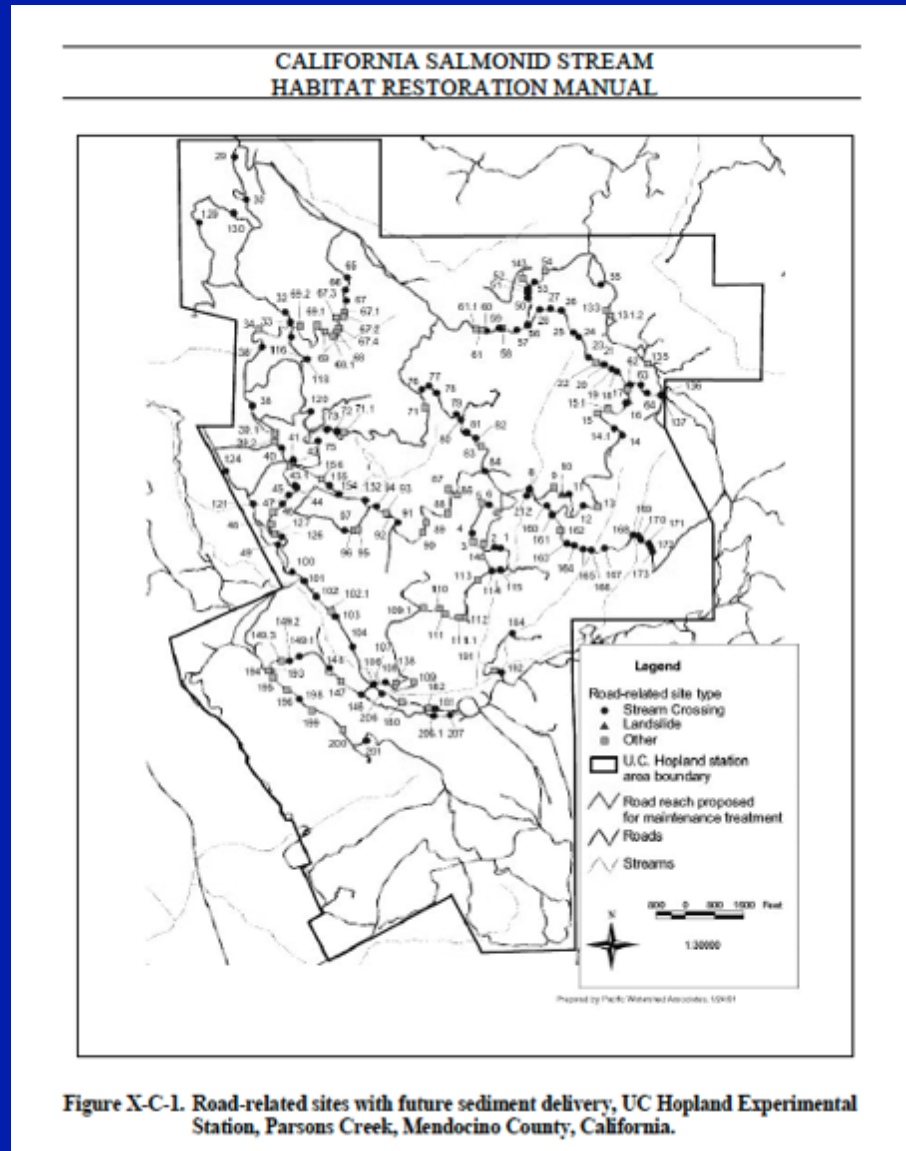
DIRT Sites by Type, Percent of Total Volume



DIRT Sites by Immediacy, Percent of Total Volume



Watershed Scale Assessments



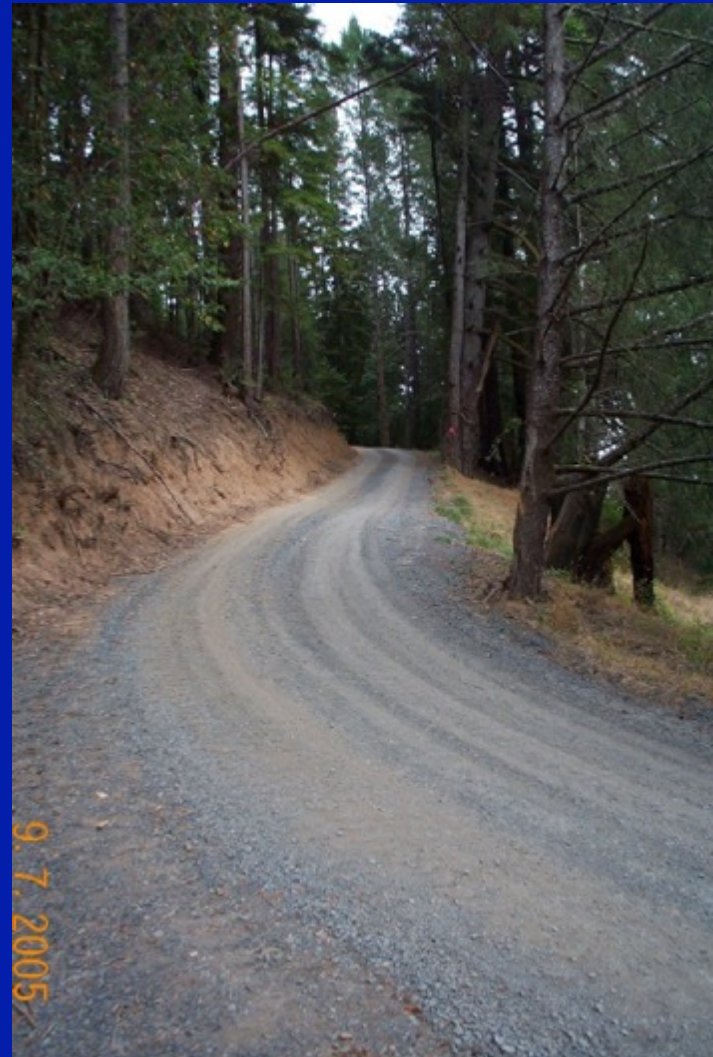
When You Need Help

- Contact local NRCS, watershed groups, Department of Fish and Wildlife, CAL FIRE.
- Contact specialists in road evaluation and upgrading e.g., Pacific Watershed Associates.
- Avoid “convenience” contractors.

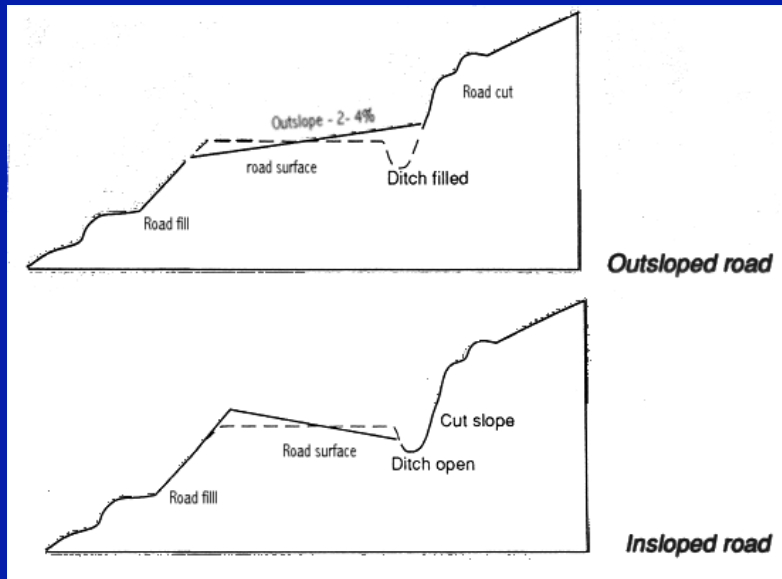
Questions About Diagnosing Problems?

Upgrading Existing Roads

- **Improving drainage**
 - Out-sloping where appropriate
 - Increasing the frequency or size of cross drains
 - Replacing undersized or otherwise deficient stream crossings
 - Eliminating stream diversion potential



Out-sloping

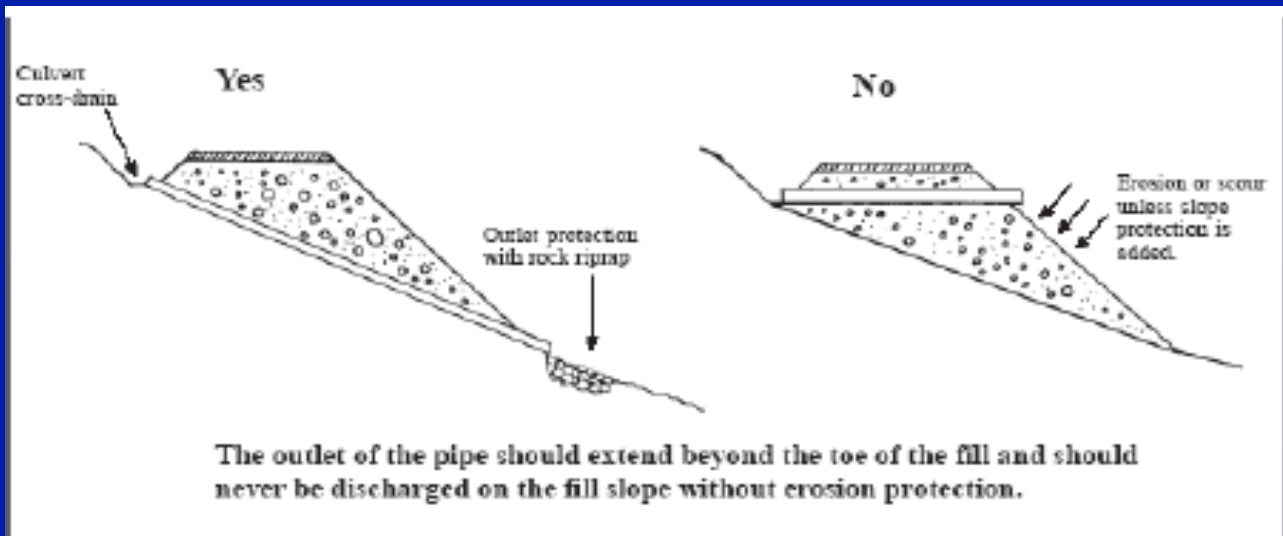


Increasing Frequency or Size of Cross Drains

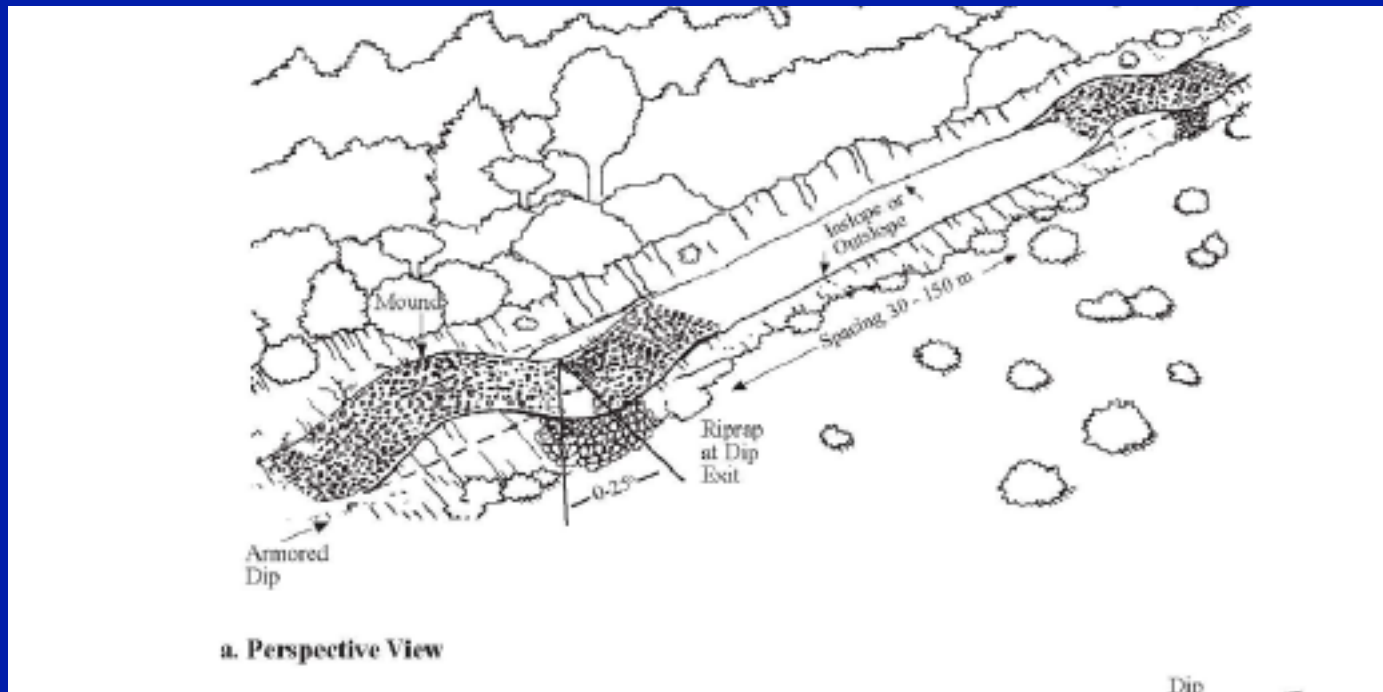
Table 1. Rolling dip and ditch relief culvert recommendations

Road Grade (percent)	Soil Erodibility	
	Low to Non- erosive soils	Erosive soils
0-3%	400'	250'
4-6%	300'	160'
7-9%	250'	130'
10-12%	200'	115'
12+	160'	100'

Adapted from Sherar and Kellar, 2003



Discharge points of ditch relief culverts and rolling dips should be chosen carefully and if necessary, armored to prevent gullying



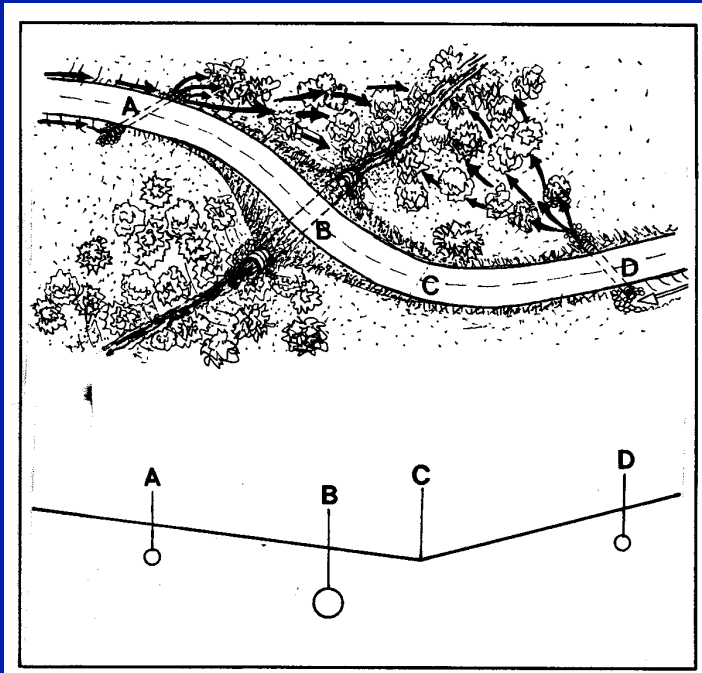
Replacing Undersized or Otherwise Deficient Stream Crossings

Too small, too old, too high in fill, not at slope of channel, wrong orientation



Eliminating Diversion Potential

Ensuring that if a crossing is plugged or overtopped, flow will return to the channel and not go down the road



Sufficiently sized stream crossing is placed at “B”. “C” is critical dip axis. “A” and “D” are cross drains placed to intercept road runoff and disperse it over land instead of into the stream

Upgrading Existing Roads (cont.)

- **Improving stability**
 - Stabilizing failing or vulnerable fill slopes
 - Eliminating causes of gully erosion and protecting drainage outfall sites



Stabilizing Fill Slopes and Stream Banks Adjacent to Roads



Eliminating Causes of Gully Erosion



Eliminating gully erosion involves diverting road runoff before it reaches unprotected slopes and/or protecting outfall sites.

Upgrading Existing Roads (cont.)

- **Reducing fine sediment production and delivery**
 - Surfacing
 - Eliminating connectivity between roads and streams
 - Dust control with palliatives or watering



Surfacing



Surfacing may be done on an entire all-season road or at critical locations such as stream crossings.

Figure 12.1 Commonly used low-volume road surfacing types and structural sections.

a. Native Soil



— Native (In-Place) Soil

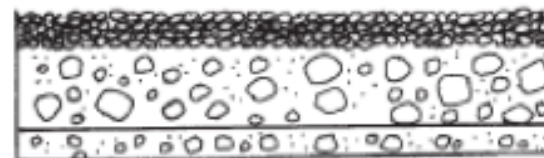
b. Aggregate



— Crushed Surface Aggregate or Gravel

— Native Soil

c. Aggregate and Base



— Crushed Surface Aggregate or Gravel

— Aggregate Base

— Native Soil

d. Cobblestone

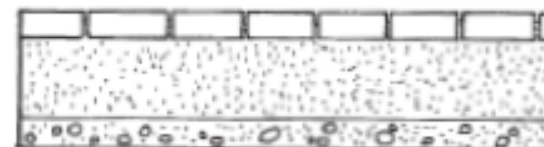


— Cobblestones

— Sand

— Native Soil

e. Concrete Block

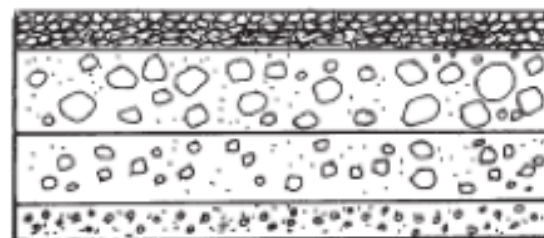


— Concrete Blocks

— Sand

— Native Soil

f. Asphalt Surfacing



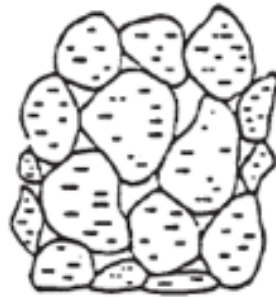
— Asphalt Pavement

— Aggregate Base

— Aggregate Sub-Base (Optional)

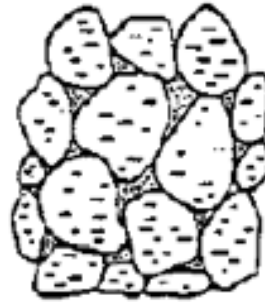
— Native Soil

Figure 12.3 Physical states of soil-aggregate mixtures. (Adapted from Yoder and Witczak, 1975)



**Aggregate with
no Fines**

- Grain-to-grain contact
- Variable density
- High Permeability
- Non-Frost Susceptible
- High stability when confined, low if unconfined
- Not affected by water
- Difficult to compact
- Ravels easily



**Aggregate with
Sufficient Fines for
Maximum Density**

- Grain-to-grain contact with increased resistance against deformation
- Increased to maximum density
- Low permeability
- Frost susceptible
- Relatively high stability in confined or unconfined conditions
- Not greatly affected by adverse water conditions
- Moderately easy to compact
- Good road performance



**Aggregate with High
Amount of Fines
(>30 percent)**

- Grain-to-grain contact destroyed, aggregate is "floating" in soil
- Decreased density
- Low permeability
- Frost susceptible
- Low stability and low strength
- Greatly affected by water
- Easy to compact
- Dusts easily

Compaction

- Almost all treatments require compaction
- Any treatment improves with compaction
- Cheapest treatment to apply
- Compaction = right size roller for the right material and properly used



Eliminating Connectivity

The goal is to intercept and disperse road runoff and sediment before it enters a stream.

Can be accomplished with cross drains or out-sloping that disperses runoff onto vegetated slopes.



Additional Treatments



Trash racks placed
above stream crossings.



Water bars on temporary
or seasonal roads.

Treatment Costs (2012)

Activity	Ideal Equipment	Cost Rate*	Production Rates***	Costs
Out-sloping road and filling ditch	Motor Grader with rippers	\$140/hour	500 feet/ hour for a 20 foot wide road	\$280/ 1,000 feet
Rolling dip	Small Dozer with rippers John Deere 450	\$130/hour	1 hour each (30-40' long on flat roads) 2 hours each (50-100' long on steep roads)	\$130-\$260 each
Remove berm or clean ditch	Motor Grader	\$140/hour	1000' / hour	\$140/ 1000 feet
Rock road (1.5" minus crushed)	Dump truck spread	\$25-\$50/ yd ³ delivered**	4" deep X 20' wide = 250 yds ³ /1000 foot road	\$6,250 - \$12,500 /1000 ft
Install ditch relief culvert (40' of 18" culvert)	Backhoe or Tractor Laborer	\$120/hr or \$95/hr \$55/hr	3 hours each + culvert (\$35/ft + \$25 coupler + \$165 labor)	\$1950 each
Stream crossing installation (36" X 40' culvert with 200 yd ³ fill)	Excavator Small Dozer Water truck Laborer	\$175/hr \$130/hr \$95/hr \$55/hr	\$2,350 culvert (w/coupler) + \$1225 excavator + \$910 dozer + \$190 water truck + \$165 labor + \$125 tamper	\$4,965 each
Culvert downspout installation	Hand labor Equipment (>24" culvert)	\$55/hr \$125/hr	20' X 24": 2 hrs labor 40' X 36": 3 hrs labor	\$110 + materials \$375 + materials
Straw mulch bare soils areas	Labor	\$55/hour \$7.5/straw bale incl. tax/delivery	1 bale/600 ft ² – 700ft ² + spreading @ 4 bales/ hour	\$36-\$40/1000 ft ²
Complete road upgrading	Motor Grader, Skip Loader, Dump truck Water truck Riding Compactor	\$140/hr \$110/hr \$85/hr \$95/hr \$95/hr	Average mid-slope road requiring stream crossing upgrades	\$45,000 to \$77,000 per mile

Questions on Road Upgrading?

When Should a Road be Eliminated?

Roads that are poorly located, chronic sources of sediment, unneeded or likely to fail catastrophically are candidates for elimination



Decommissioning Roads

- Eliminating a road does not mean just closing it
- Road “decommissioning” requires
 - Reducing its potential for failure during stressing weather events
 - Restoring natural drainage by removing crossings and treating the road surface e.g., deep ripping
 - Re-vegetation of road surface and cut and fill slopes

- Total decommissioning of roads and crossings means restoring the natural terrain and streams
 - This can be extremely expensive and disruptive
 - It is not necessary unless there are over-riding objectives e.g., natural area restoration



Maintaining Roads

For roads used by several landowners, agreements are necessary (and desirable)

California Civil Code Section 845 says:

- (a) The owner of any **easement** in the nature of a private right-of-way, or of any land to which any such **easement** is attached, **shall maintain it in repair.**
- (b) If the **easement** is owned by more than one person, or is attached to parcels of land under different ownership, **the cost of maintaining it in repair shall be shared by each owner of the easement** or the owners of the parcels of land, as the case may be, pursuant to the terms of any agreement entered into by the parties for that purpose. If any owner who is a party to the agreement refuses to perform or fails after demand in writing to pay the owner's proportion of the cost, an action for specific performance or contribution may be brought against that owner in a court of competent jurisdiction by the other owners, either jointly or severally.
- (c) **In the absence of an agreement, the cost shall be shared proportionately to the use made of the easement by each owner.** Any owner of the **easement**, or any owner of land to which the **easement** is attached, may apply to any court where the right-of-way is located and that has jurisdiction over the amount in controversy for the appointment of an impartial arbitrator to apportion the cost. The application may be made before, during, or after performance of the maintenance work. If the arbitration award is not accepted by all of the owners, the court may enter a judgment determining the proportionate liability of each owner. The judgment may be enforced as a money judgment by any party against any other party to the action.

Maintaining Roads (cont.)

- A funding mechanism is needed
- Monitoring is necessary
 - A system for “naming” roads and identifying crossings
 - Yearly inspections before the winter hits
 - Tracking “problem” places, especially crossings e.g., flagging or staking road at culverts prone to plugging
 - Monitoring after major storms

Maintaining Roads (cont.)

- Typical **annual** maintenance tasks include
 - Clearing culverts and ditches of debris
 - Checking for signs of instability

What to Look For During a Road Inspection

- *Culverts: Clear debris and sediment from culvert inlets (Figure 16). Straighten bent culvert ends. If erosion has occurred at outlets, install energy dissipaters or armoring.*
- *Bridges: Inspect bridge abutments. Remove logs or branches lodged in the bridge structure.*
- *Water-bars: Confirm that the water-bars are working properly and directing drainage off the side of the road. Inspect the area downslope of the water-bars for evidence of rills or gullies indicating that the slope requires additional protection from concentrated roadside drainage.*
- *Rolling dips: If erosion has occurred at the outside edge of the dip, install energy dissipaters or armoring.*
- *Inside ditches: Use a shovel to clear debris from the ditch. Avoid grading in ditches*
- *Cut and fill slopes: Inspect for rilling, slumping or cracks. Install more drainage structures if problems are found. Remove unstable material with an excavator.*

The single most important thing to do is to keep crossings and culverts clear



- **Periodic** maintenance tasks include
 - Clearing accumulated soil and rock from road surface
 - Grading and re-surfacing (avoiding excessive grading)
 - Replacing or repairing damaged culverts
 - Re-vegetation



Sources of More Information

- Updated Handbook for Forest, Ranch and Rural Roads download at www.pacificwatershed.com
- See stream crossing design handbook at [http://calfire.ca.gov/resource_mgt/downloads/100%20yr%20revised%208-08-17%20\(final-a\).pdf](http://calfire.ca.gov/resource_mgt/downloads/100%20yr%20revised%208-08-17%20(final-a).pdf)
- See DANR publications at <http://anrcatalog.ucdavis.edu>. Search on “road management”

A photograph of a dirt road in a forest. On the left side of the road, there is a large, exposed landslide of soil and rocks. The road itself is covered in loose gravel and dirt. The background shows a dense forest of tall trees.

Thank You!

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Forest Stewardship Helpline

(800) 738-TREE