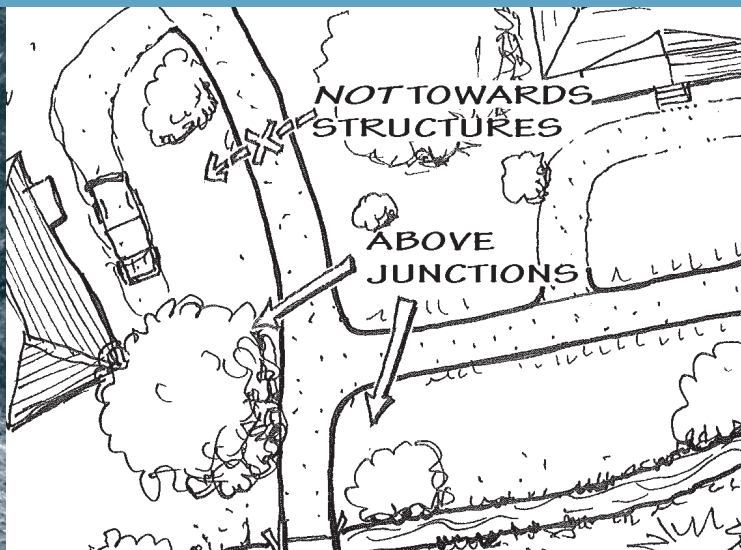
central coast

PRIVATE ROAD MAINTENANCE GUIDE



RESOURCE

CONSERVATION DISTRICTS

ACKNOWLEDGEMENTS

This educational Guide was originally created by the County of Santa Cruz Planning Department, Environmental Division, and has since been updated by the Resource Conservation Districts (RCDs) of Santa Cruz County, San Mateo County and Monterey County. Technical assistance for the Guide was provided by the USDA Natural Resources Conservation Service (NRCS) and funding for development and printing of the Guide was made possible through a State Coastal Conservancy grant. The common mission of Conservation Districts is to help people protect, conserve, and restore natural resources through information, education and technical assistance programs. Each district has unique, locally-driven programs for conservation of soil, water, plant, and wildlife resources tailored to the needs of its specific service area.

The primary resources from which this Guide draws information include: *The Santa Cruz County Stream Care Guide* (Santa Cruz County Planning Department), *the Handbook for Forest and Ranch Roads* (Pacific Watershed Associates & Mendocino County RCD), *Forest Road Contracting, Construction, and Maintenance for Small Forest Woodland Owners* (Oregon State University), *Low Volume Roads Engineering Best Management Practices Field Guide* (by US Forest Service in English and Spanish) and multiple documents from the NRCS. Numerous technical experts provided guidance in the document review as well. For more detailed information on road construction, drainage and management, consult the publications above, along with the California Department of Fish and Wildlife's *California Salmonid Stream Habitat Restoration Manual*. Each of these publications is available through the internet. Complete references are provided at the end of this Guide.

Note: Local, County and State regulations in California cover many of the same subjects presented in this Guide. Regulations are subject to periodic modification, as are the best technical methods of road construction, management, and standards for environmental protection. Be sure to follow applicable regulations covering private road maintenance and related activities for your area. You can obtain more information from your local RCD or planning or building departments.

STATEMENT OF PURPOSE

The Central Coast Private Roads Maintenance Guide ("Guide") is designed for California Central Coast residents who work, live or own property in rural areas, and are concerned about road safety, accessibility and maintenance. A well planned, constructed, and maintained road system is essential for community safety and wise resource management. Nearly everything discussed in this Guide is aimed at producing efficient, low-maintenance roads that have minimal impacts on our watersheds.

The Guide is an introduction to basic road drainage and maintenance concepts and practices. As such, it presents recommended practices and guidelines for maintaining mostly unpaved ranch, forest and residential roads that are described in considerably more detail in the more authoritative roads manuals that were used and referenced as sources for this Guide. This document can be used by the average landowner in communicating and planning with neighbors, road contractors and agencies regarding road management. Some landowners may need to consult more technical documents for the detailed guidance needed for actual project implementation. The Guide includes some technical information, but is presented in a manner more accessible to those without technical or engineering training. The concepts presented in this handbook are tools which should serve as one of your many sources of information and guidance. The success you achieve will be reflected not only in the stability of your roads, but also in the quality of the water and the health of the streams and watersheds through which they pass.

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INTRODUCTION

California's Central Coast contains thousands of miles of private roads whose care and upkeep are the sole responsibility of landowners with property along these roads. Road erosion, washouts and costly annual maintenance requirements are a continual problem for many rural residents. Steep slopes, concentrated rainfall and erosive soils contribute to soil instability, erosion and drainage problems on rural roads. Soil erosion and runoff can pollute streams with sediments that damage habitat for fish and other wildlife, impair or destroy roads, and threaten other properties.

Road erosion is a pervasive challenge. Roads by their nature expose bare ground to the forces of rain and runoff in a form that intensifies their erosive power across changes in slope, soil and land use.

Not surprisingly, roads without safeguards to handle those forces are major sources of erosion and sedimentation in hilly and mountainous regions such as the Central Coast. Although erosion is a natural occurrence in most of the local watersheds along California's Central Coast, such human-induced erosion can cause an unhealthy abundance of sediment in streams that degrades habitat for fish, channel stability and water quality. Over the past 50 years, coho salmon and steelhead trout native to our local streams have experienced a significant decline, and are now in danger of extinction. One of the highest priorities for improving their habitat is reducing impacts from rural roads. Furthermore, when too much sediment enters streams, both bank stability and the stream's ability to carry floodwaters are impaired. A well designed and maintained road sheds runoff effectively without excessive sediment. This saves time and worry for those responsible for maintaining the road while providing safe passage and limiting impacts on the environment it occupies.

This Guide describes basic road design principles and provides information that will assist rural landowners in their efforts to:

- Better understand what factors create a need for road maintenance;
- Reduce the frequency and cost of road maintenance and;
- Create low maintenance roads by applying user-friendly road drainage management techniques to existing roads.

After an introduction to the terms and concepts related to erosion and road design **(Chapter 1)**, the heart of this Guide includes an overview of a variety of road drainage management techniques **(Chapter 2)**, erosion control measures to take during construction **(Chapter 3)**, and maintenance of installed practices and existing roads **(Chapter 4)**. Because critical maintenance and restorative needs on many rural roads are shared by multiple landowners, you will also guidance for creating one of two formal structures for coordinating such work: road associations and County Service Areas **(Chapter 5)**. These road maintenance organizations can make the task of road management much easier to plan, implement and fund. The Guide concludes with information about permitting requirements for road work **(Chapter 6)**. A list of resources by county is provided in **Appendix A.**

The techniques described in this Guide are commonly described as Best Management Practices or "BMPs." They constitute those principles and engineering design practices that have been tested and proven to protect water quality as well as the function of the road when properly applied. The use of BMPs often costs less than repeated repair and maintenance of ineffective road drainage systems. Typical BMPs include properly located and sized culverts, energy dissipaters at culvert outfalls, cross-drains such as waterbars and rolling dips, and proper disposal of spoils

from construction and maintenance of road surfaces. The appropriate practices to implement for your specific private road are best identified by consulting with a qualified engineer, geologist or other professional certified in erosion and sediment control with specific experience in local road construction. Such professional guidance is necessary to adequately evaluate problems, consider local conditions and resources, and implement or adapt these practices as appropriate.

CHAPTER 1.
INTRODUCTION TO EROSION AND ROAD DESIGN

Before getting into a discussion of how to keep a road safe and stable, it is important to understand the parts of a road (Figure 1 and 2) and their functions, as well as the nature of soil and water interactions associated with roads. This section will start with a few key definitions before providing descriptions of the processes and significance of rural road erosion.

ROAD ANATOMY TERMS

Aggregate: Mechanically crushed, angular rock used for road surfacing.

Base course: The layer of road surface rock between the subgrade and the surface layer of crushed rock.

Cross slope: The slope of the road measured perpendicular to the direction of travel.

Culvert: A drainpipe that channels water underneath and off a road.

Cut slope/cut bank: The inside road slope cut into the face of the hill slope.

Ditch relief culvert: A drainpipe to carry water from the inboard ditch to a safe outlet.

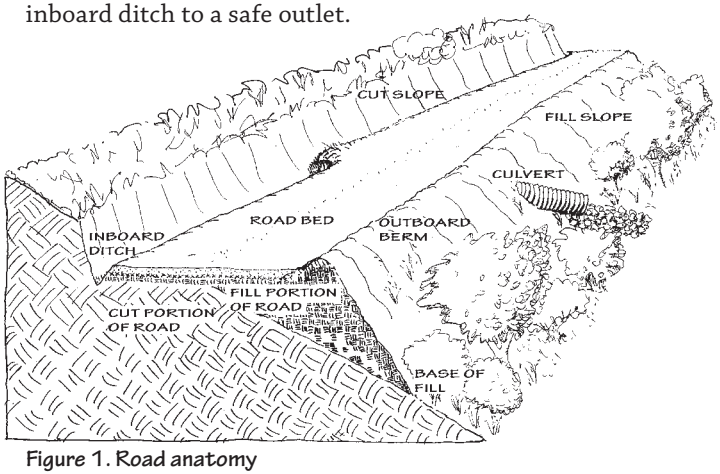


Figure 1. Road anatomy

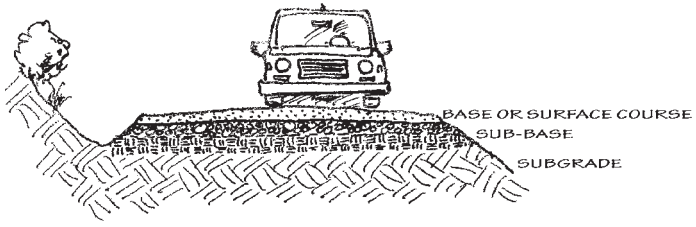


Figure 2. Road layers

Fill: Earthen material used to build a structure above natural ground level.

Fill slope: Area on the downhill side of a roadway that must have excavated material placed on it to build a road section up to grade.

Inboard ditch: A ditch at the base of a cut-slope to carry water from the slope and road surface.

Outboard berm: A small ridge along the outer edge of a road typically placed to keep drainage off the fill slope, but also often inadvertently formed from the spoils of periodic road maintenance grading.

Road alignment: The physical path of a road, typically as defined by a road's longitudinal centerline.

Road grade: The slope of a road surface in the direction of travel, usually expressed in percent of 'rise over run'. For example, a 20% grade equals a change along the road of 20 feet vertical in 100 feet horizontal. See 'slope', below.

Slope: The steepness of the ground expressed most commonly as a percent of 'rise over run', or as a ratio of horizontal to vertical distance (Figure 3). For example, a 2–1 slope means

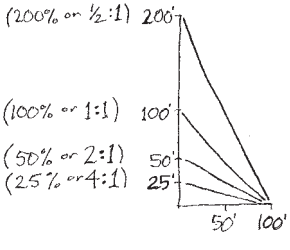


Figure 3. Slope diagram

that for every two feet in the horizontal direction the land surface rises or falls 1 foot in elevation. A 2–1 slope is also said to have a gradient of 50%. A 100% gradient would correspond to a 1–1 slope, and a 25% grade has a 4–1 slope. If you know the degree of the angle, just enter it into your scientific calculator then hit Tangent for the slope and then multiply by 100 for the percent grade. The slope is the tangent of the angle.

Spoils: Excavated soil that can be used and compacted as 'fill' on-site or transported for use or stockpiling elsewhere.

Subgrade: The layer of roadbed on which the base or surface course is placed. On an unsurfaced (dirt) road, the finished subgrade is the traffic-bearing surface.

Surface course: The top layer of a road surface.

SOIL EROSION AND ROADS: WHAT'S THE CONNECTION?

Roads are a major source of erosion on most private, forest and ranch lands.

Paved and unpaved roads, driveways, trails, and footpaths collect and channel surface runoff, resulting in erosion and possible slope instability. Erosion of unpaved roads occurs when soil particles are loosened and carried away by water, wind, traffic, or other transport means. Loosened soil particles can be carried from the roadbed into the road drainage system where they diminish the carrying capacity of roadside ditches, culverts and other drainage structures. This reduced drainage capacity can cause roadway flooding, which subsequently leads to more erosion.

Figure 4. Severe erosion on a poorly constructed insloped road.

The Importance of Managing Road Erosion

Road erosion and washouts are a problem for numerous residents of the Central California coast. Many conditions combine to cause soil instability, erosion and drainage problems which can pollute streams with sediment, damage or destroy roads, and threaten other property.

Poorly placed drains and culverts weaken slopes and create a threat to neighboring properties. Incorrectly designed roads create expensive erosion and maintenance problems that result in sedimentation to waterways and dangerous road conditions. If your road drainage is inadequate or improperly installed, you could be liable for damages. Poor drainage can result in standing water on your road surface resulting in the formation of potholes, thereby increasing repair costs. Proper, timely and selective surface maintenance, including water dispersal, can prevent and

minimize erosion problems and lengthen the life of your road.

Deterioration of a road can be caused by frequent and excessive disturbance of the roadway surface and ditches. Failure to properly slope the road for drainage leads to additional issues causing other roadway problems, which may impair traffic flow and safety.

Physical Factors That Influence Erosion

Some factors that may effect the condition of a road include climate, vegetation, the slope of the land, the types of bedrock and soils through which the road passes, as well as surface and subsurface drainage across the road. The slope of the land is one of the most important elements in determining where and how roads are built. Roads built on steep slopes are more likely to have erosion and stability problems. The stability and viability of a road alignment is controlled by the underlying bedrock and soil material. Bedrock composition and the properties of soils vary dramatically along most road routes. Each soil and bedrock type reacts differently to road construction and road drainage.

Climate

The amount, intensity and frequency of rainfall, and the temperature, all have effects on road erosion. Erosion is normally more severe on bare soils in areas having abundant rainfall than in areas having little rainfall. However, the intensity and frequency of rainfall must be considered when comparing areas of similar precipitation. Both of these rainfall factors influence the amount of runoff that occurs. Runoff occurs when the intensity of rainfall exceeds the infiltration rate and storage capacity of the soil. Frequency of rainfall influences the moisture content of the soil, which in turn has a major influence on the infiltration rate. The higher the moisture content, the lower the infiltration rate, and the greater the potential for runoff.

Vegetation

Vegetation performs a number of important functions: shielding the soil from the impact of raindrops; retarding surface flow of water, thereby permitting greater infiltration; maintaining a pervious soil surface capable of absorbing water; anchoring soil with the addition of root structure; and removing subsurface water between storm events by transpiration. On a graded slope, the condition of the installed vegetation will determine its effectiveness in reducing erosion. A cover of vegetation that is not properly established or maintained will not be fully effective in controlling erosion.

Soil

The types of soil at a site are another major factor affecting soil loss. Soil properties most closely associated with erodibility are texture, structure, and moisture content. Texture refers to the relative distribution of the various sized soil particles. A fine-textured soil having large amounts of clay is least susceptible to erosion from raindrop splash and runoff. Soil structure, on the other hand, refers to the arrangement of soil particles. It influences both the ability of the soil to absorb water and its physical resistance to erosion. Granular structured soils containing large amounts of fine sands and silts with little clay are usually more erodible than soils with a blocky or massive structure. Erodibility is also affected by moisture content because saturated soils are less stable and generate more runoff.

Length and Steepness of Slope

All other factors being equal, long slopes will collect more runoff than short slopes. The more water collected, the greater the concentration of water at the base of the slope and the greater the likelihood of erosion. To minimize this problem, long slopes can be constructed so they function as a series of short slopes by utilizing diversion structures such as benches, terraces, ditches, or dikes. Steepness of slope, surface roughness, vegetative cover and the amount and intensity of rainfall govern the velocity of the runoff flowing down the slope.

Figure 5. This road washout is the result of an undersized and improperly placed culvert.

CHAPTER 2. UNDERSTANDING DRAINAGE

ROAD DRAINAGE

Experienced road engineers like to say that three of the most important aspects of road design are drainage, drainage, and drainage. Adequate road drainage requires careful attention to detail. Those responsible for road design and maintenance should observe the road during rainy periods to see how the water is actually moving, where it is concentrated, what damage it may cause, and what measures are needed to prevent damage and keep drainage systems functioning properly. Standing water in potholes and low spots will weaken the subgrade and accelerate damage. Water concentrated in ruts or kept on the road surface for long distances can accelerate erosion and wash off the surface material. Steep road grades accelerate erosion unless surfaces are armored or water is dispersed or removed frequently.

Runoff water is a powerful agent capable of destroying a road and making it unusable. The ability of water to erode increases exponentially with both volume and slope. If water volume is doubled, the ability of water to erode is increased approximately four times. Likewise, water flowing down a steep slope also increases its ability to erode at an exponential rate. Water flowing at a 10% gradient has four times the erosive ability of water on a 5% gradient.

Accordingly, it is important to design road drainage systems properly. Incorrectly placed cross-drains can weaken already unstable slopes and also create a threat to neighboring properties.

Drainage refers both to subsurface drainage (groundwater flow) and surface drainage (runoff). The key to proper road drainage is to safely divert runoff from the road frequently enough to eliminate or greatly reduce erosion on the road itself or on the slope below.

Subsurface drainage: Water held in the soil is called ground water. If too much water is in the soil (because of seasonal wetness or poor drainage) the weight of vehicles can deform the soil and turn it into mud. On a sloping road, the mud can become a safety hazard, the roadbed may be damaged, and sediment can flow into ditches and nearby streams, causing water quality problems. Some soils are naturally wet and poorly drained, and should be avoided during road building operations. These are often indicated by pools and wet areas on the ground surface, especially during the wet winter months.

Surface drainage: The key to successful surface drainage is to get the water off of the cut slopes, fill slopes and road surface as quickly as possible, before it has the opportunity to concentrate into a large volume of flow. The most important rules for accommodating surface runoff are 1) get water off the road rapidly so it cannot erode or seep into the roadbed, 2) move water off the road often to stop large, flows from developing in long, undrained ditches, and 3) avoid practices that concentrate water flow.

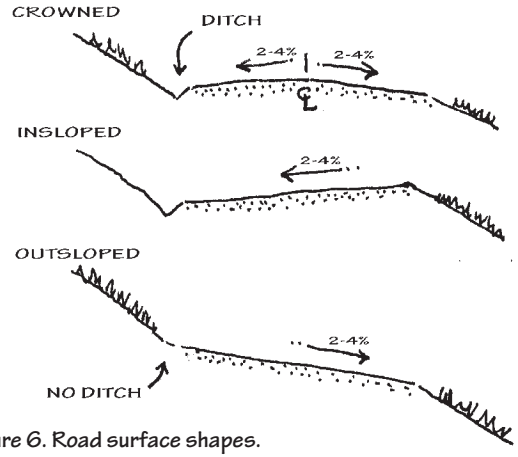


Figure 6. Road surface shapes.

PRACTICES TO AVOID

Long sustained road grades that concentrate flows.

Discharging water onto erosive, unprotected soils.

"Eyeballing" grades in flat terrain*

*Use a clinometer, abney level, or survey equipment to ensure that you have proper slopes or grades.

Road surface drainage is accomplished by insloping, outsloping or crowning (Figure 6) the roadbed. Without adequate cross-slope (3 to 5% is best), the road surface will either pond water, or concentrate runoff down the roadbed and create surface erosion. Roads with springs along the cutbanks are often insloped with an inside ditch. Roads with smaller cutbanks or dry cutslopes may be outsloped for most of their length, and some larger roads are crowned to drain runoff most rapidly from their surfaces.

Drainage practices include controlling surface water and adequately passing water under roads where they intersect with existing drainages. Drainage issues that must be considered include roadway surface drainage, control of water in ditches and at cross drain inlets and outlets, crossings of natural channels and streams, wet area crossings, subsurface drainage, and selection and design of culverts, low water crossings, and bridges.

Outsloped roads best disperse water and limit the necessary road width by reducing the need for an inside ditch, but may require roadway surface and fill slope stabilization. An outsloped road minimizes concentration of water and need for culverts, which means lower installation and maintenance costs. Outsloped roads with slippery road surface materials (such as native soil) often require rock surface stabilization or limited use during rainy periods to assure traffic safety. On road grades over 10 to 12 % and on steep hillslope areas, outsloped roads are difficult to drain and can feel unsafe.

Insloped roads best control the road surface water but concentrate water and thus require a system of ditches, cross-drains, and extra road width for the ditch. Cross-drains, using either rolling dips or culvert pipes, must be spaced frequently enough to remove all the expected road surface water before erosion occurs. The maximum recommended distances should be used for guidance on spacing of cross-drains and ditch relief structures (Table 1). Specific locations should be determined by observing actual water flow patterns, rainfall intensity, road surface erosion characteristics, and available erosion resistant outlet areas.

Culvert cross-drains are used to move ditch water across the road. They are the most common type of road surface drainage, and are most appropriate for high standard roads where a smooth road surface is desired. However, the pipes are expensive, and the relatively small culvert pipes used for cross-drains are susceptible to plugging and require cleaning.

Rolling dip cross-drains (broad-based dips) are designed to pass slow traffic, while also dispersing surface water (Figure 7). Rolling dips usually cost less, require less maintenance, and are less likely to plug and fail than culvert pipes. Rolling dips are ideal on low volume, low to moderate speed roads (10–30 mph).

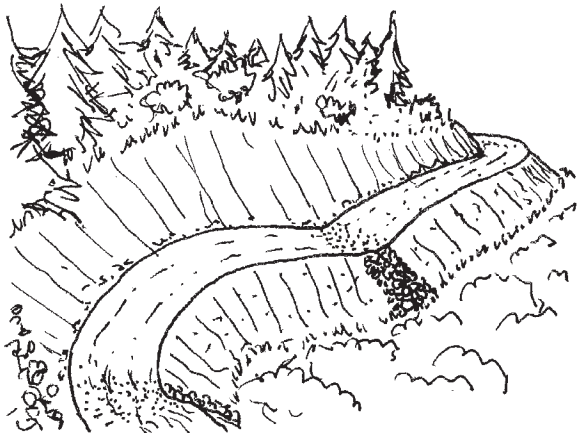


Figure 7. Rolling dip with rock dissipater

Spacing of dips is a function of road grade and soil type, as noted in Table 1.

Other types of roadway surface cross-drain structures occasionally used include open top wood or metal flumes and rubber water deflectors.

Steep road grades are undesirable and problematic, but occasionally necessary. On grades up to 10%, cross-drains with culverts or rolling dips may be used. With grades between 10 and 15%, frequently spaced culvert cross-drains are appropriate, often in conjunction with ditches that have reinforced sides such as rock or concrete lining. On grades over 15%, it is difficult to slow down the water or remove it from the road surface rapidly. On such steep grades, it is best to use frequently spaced cross-drain culverts, with armored ditches. Also, the road surface will need armoring or surfacing with some form of pavement to resist erosion. For seasonal or low use roads, interim drivable waterbars could also be constructed.

Waterbars are used to control drainage on closed or inactive roads, 4-wheel drive roads, skid roads, and skid trails. Waterbars are frequently spaced for maximum erosion control and can be shaped for the passage of high clearance vehicles or to limit traffic.

All of these types of cross-drains are described in more detail in the following pages. With the exception of culverts, all of them are inexpensive to install and can be used to correct existing drainage problems with a minimum of disturbance to the road.

On both outsloped and insloped roads, cross-drains help direct surface runoff to limit its potential to cause erosion, potholes and slippery or muddy road surfaces. On roads which are neither outsloped nor insloped, cross-drains should be used regardless of the grade of the road. When the grade of your insloped road is steeper than 8%, cross-drains should be used.

Installing cross-drains on insloped roads can be challenging since the road surface must be reshaped into a dip or swale around each cross-drain, to ensure the proper gradient for the cross-drain. However, if water drains into a stabilized inside ditch from an insloped road, no reshaping of the roadbed is necessary.

CROSS-DRAINS

Waterbars

A waterbar, also known as a water break, consists of a shallow trench with a parallel berm or ridge on the downslope side and is angled down across the road. They are often installed on infrequently used or closed roads to control surface runoff. Waterbars can be constructed by hand, with a backhoe, or with a blade-equipped tractor. They are usually made of compacted soil, but can also be asphalt or cement for longer life. Waterbars and other cross-drains should be installed at a 30 to 45 degree angle off perpendicular to the road alignment and properly spaced (Table 1 and Figure 8).

Road/Trail Grade %	Low to Non-Erosive Soils*	Erosive Soils**
0–5	75	40
6–10	60	30
11–15	45	20
16–20	35	15
21–30	30	12
30+	15	10

Table 1. Recommended waterbar spacing (meters).
*Coarse rocky, gravelly soils and some clay.
** Fine, friable, silty or fine sandy soils.

Earthen waterbars are best used for low or seasonal access unpaved roads. The optimal size of an earthen waterbar is 12 inches above the road surface and 6 inches below the road surface. If it is smaller, the waterbar may be less effective in diverting water, will require increased maintenance and will probably break down faster. However, for well-traveled roads, smaller waterbars may be necessary (Figure 9). In order to prevent water from bypassing the waterbar, cut the trench 4 to 6 inches into the cutbank.

Figure 8. Proper cross-drain orientation.

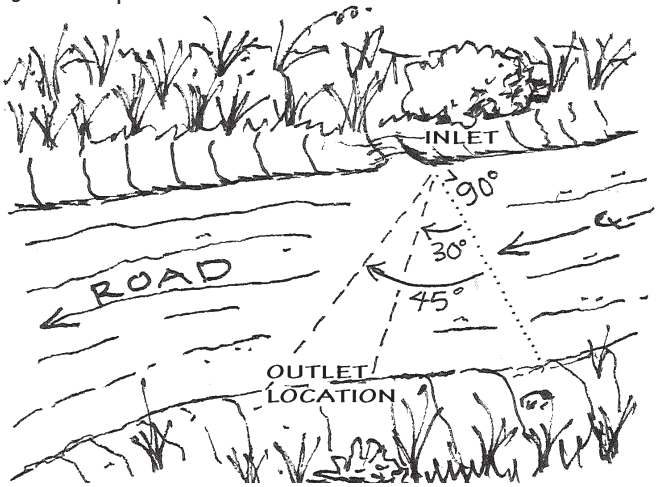
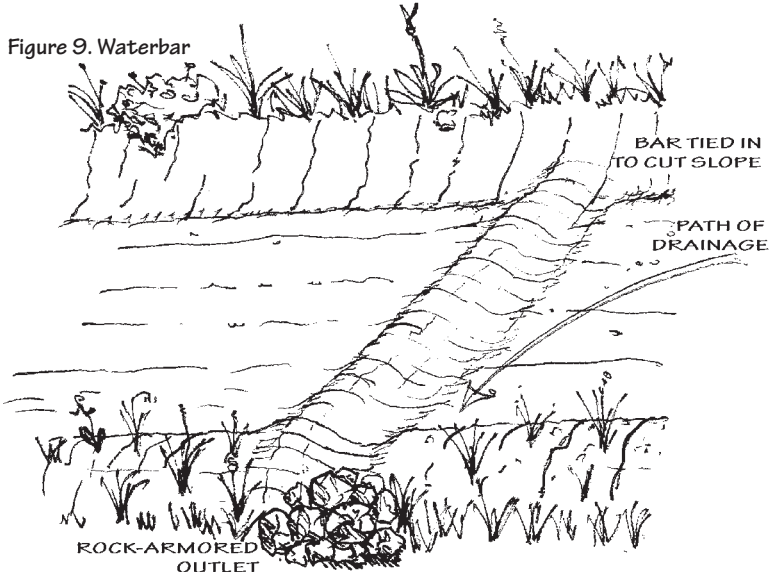


Figure 9. Waterbar



Asphalt or cement waterbars can be smaller in size and thereby provide greater ease of access for vehicles. These more permanent waterbars should not be installed until the road surface is stabilized. Asphalt or cement "drainage bumps" can be as low as 6 inches. They should be anchored into the roadbed at least 6 inches deep, as well as into the cutbank, to prevent water from by-passing this type of cross-drain.

Install energy dissipaters at all waterbar outlets as discussed on page 19.

For driveways or other roads used by passenger cars, a "drainage bump" can be constructed. This is similar to a speed bump except that it should be installed at a 30 to 45 degree angle to the road like a waterbar. A "drainage bump" can be made of soil or asphalt, as shown in Figure 10.

Rubber Waterbars[1] on outsloped roads are a durable, highly effective method of diverting surface runoff from the road. These can be used on road grades over 8%, and should be spaced closely enough that runoff erosion is not an issue

Figure 10. Asphalt waterbar and culvert outlet, both with rock dissipater to reduce erosion.

1 Source; OSU, 2001

(Table 1). Rubber waterbars can be fabricated from a 20-foot length of 4x8 pressure-treated wood and a 1-foot wide piece of 5-ply, 12-inch-wide industrial conveyor belting of matching length. Attach the belting to the narrow face of the board with galvanized lag screws as shown in Figure 11 and place it in an excavated trench that runs 30 to 45 degrees off a line perpendicular to the road alignment. The depth of the trench should be such that three to four inches of the belting protrudes above the finished road surface after backfilling and compacting around it.

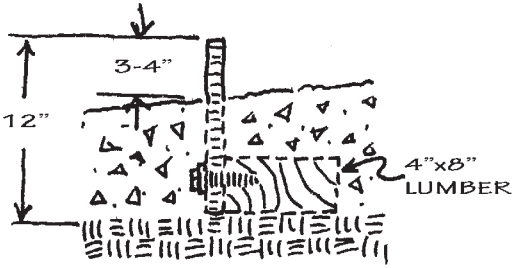


Figure 11. Cross section of a rubber waterbar

Unless the subgrade material is fairly resistant to erosion, such waterbars should not outlet onto fill slopes with a height of more than five feet at the outside of the road shoulder.

Channel Drains

To minimize disturbance to vehicles, a channel drain may be installed. Channel drains can last several years on most low volume roads provided they are adequately installed, maintained, and built of durable materials.

Channel drains (Figure 13) can be constructed of logs or treated lumber. The trough of the drain should be four inches wide and six inches deep to ensure adequate drainage. The slope of the drain should be no less than 4%, or 1/2 an inch per foot of length, to prevent clogging from sediment and debris. As an example, for a 16-foot-long channel drain, the outlet should be eight inches lower than where the drain ties in with the cutbank.

Figure 12. Cross drain set in concrete.

In areas where twig and leaf accumulation is high, channel drains may fill with debris quickly. Under these conditions, it may be better to install a culvert, "drainage bump", or rubber waterbar.

Channel drain spreaders should be spaced about every three to four feet to keep culvert sides from collapsing. Spreaders can be made of wood or metal pipe and should also be placed at both ends of the drain.

As with the waterbar, remember to connect the end of the channel drain into the cutbank by extending the downslope plank four to six inches into the bank.

Channel drains should be placed at a 30 to 45 degree angle off perpendicular to the road alignment.

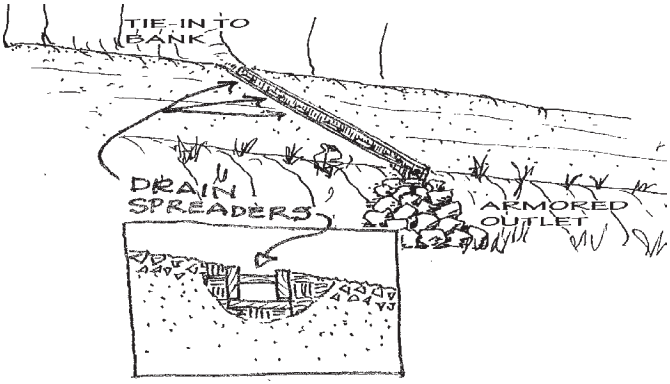


Figure 13. Wood channel drain.

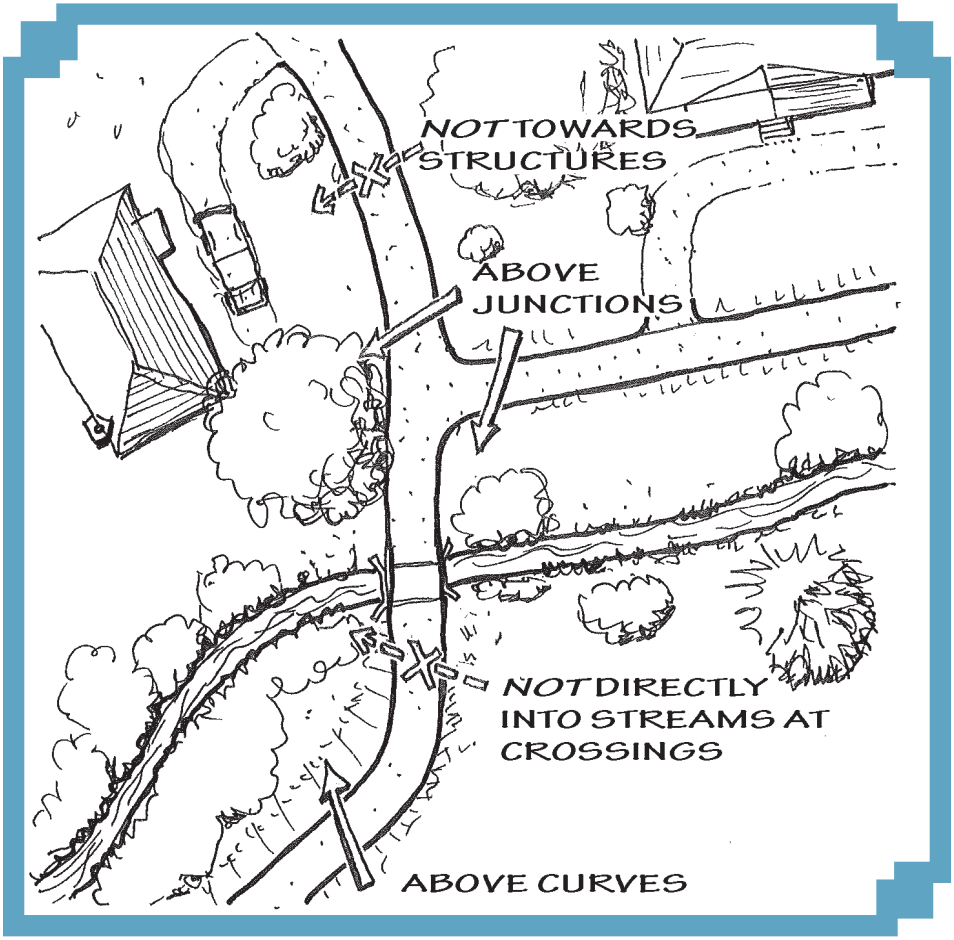


Figure 14. Proper cross-drain locations.

Rolling Dips

A rolling dip is a shallow, rounded dip in the road that reverses grade for a short distance, and directs water off the surface of the road to a controlled or protected outlet. Rolling dips are installed as needed to drain the road surface and prevent erosion. As a road becomes steeper, rolling dips should be made deeper and wider to capture and divert road runoff adequately. Rolling dips are much easier to traverse and require less maintenance than waterbars. Unlike waterbars, they are also substantial enough that they cannot be 'graded out' by routine road-smoothing.

Rolling dips require significant skill to install correctly, so selection of an adequately-experienced road contractor is critical for successful implementation. Install rolling dips rather than culvert cross-drains on low volume, low speed roads with grades less than 12%. Rolling dips should be deep enough to provide adequate drainage, angled 0 to 25 degrees from perpendicular to the road, with a 2-5% outslope, and long enough (50 to 200 feet) to pass vehicles and equipment. All outlets should be armored. In soft soils, the mound and dip should be protected with gravel or rock (Figure 15).

A deep rolling dip or **'critical dip'** can be used as an emergency spillway adjacent to culvert drains and channel crossings. This allows water to move safely across the road and into the intended ditch or channel in case of culvert blockage or failure (See 'Constructing Stream Crossings,' page 29).

Figure 15. Rolling dip technical perspective.

Limitations

- Never outlet rolling dips onto unprotected fill slopes. Install energy dissipaters or oversize drains at outlet ends.
- Use gravel to stabilize the diversion where significant vehicular traffic is anticipated.
- Rolling dips should not be constructed in areas of high-speed vehicle travel.

Construction Guidelines

- Rolling dips should be built at an angle of approximately 0 to 25 degrees to the centerline of the road.
- The axis of the dip should have a minimum outward grade of 2% .
- For rolling dips, the height of the channel bottom to the top of the settled ridge should be 18 inches and the side slopes of the ridge should be 2:1 or flatter where practicable.
- See Table 2 regarding recommended distances between dips.
- Signs alerting motorists to the dip or waterbars should be installed in both directions.
- Entire structures should be excavated and not composed of fill, especially the reverse grade portion of the dip.

Maintenance

- Periodically inspect rolling dips. Inspect after every heavy rainfall for erosion damage.
- Immediately remove sediment from the flow area.
- Check outlet areas and make timely repairs as needed.

Road Grade %	Low to Non-Erosive Soils*	Erosive Soils**
0–3	120	75
4–6	90	50
7–9	75	40
10–12	60	35
12+	50	30

Table 2. Recommended maximum distance between rolling dips or culvert cross-drains (meters).
*Coarse rocky, gravelly soils and some clay.
** Fine, friable, silty or fine sandy soils.

PROPER ROAD CULVERT USE

A ditch relief culvert is used to convey water (often storm water runoff) from one side of the road to the other. Culverts can be made out of corrugated metal pipe, corrugated plastic pipe, rigid plastic pipe, concrete pipe, or other suitable materials.

Design Considerations

Engineering

Culverts for road drainage should be part of an overall road runoff management system that considers type of road surface, road cross-slope, road gradient, roadside ditch design, size of drainage area, and protection of cut/fill slopes. Culverts for stream crossings should be designed by a registered engineer and approved by state and local officials. They should be designed with consideration of stream alignment, anticipated flood flows, stability of the existing channel location, and the need for fish passage. On a stream, this type of installation will require multiple permits, including a Department of Fish and Game Streambed Alteration Agreement and review of the work plan by your county's planning or building inspection department.

Culvert Capacity

The capacity of a road drainage culvert should be designed for at least the peak runoff from a 10-year, 24-hour storm. Stream crossing culverts should have an opening at least equal to the cross-sectional area of the entering stream during flood periods. Factors to consider when determining culvert size include: fish passage; intensity, duration, and frequency of maximum rainfall; area and shape of the watershed drained by the watercourse; vegetative cover; and soil. Engineers have formulas, special tables, and other devices to compute needed sizes.

To reduce clogging in road drainage culverts, the minimum diameter should be 18 inches. For reference, in the high-rainfall Santa Cruz Mountains, an 18-inch culvert will adequately handle runoff from a six-acre drainage area if properly installed and maintained.

Alignment and Elevation

Where streams or natural drainage ways cross the road, culverts should have the same alignment as the drainage channel and should be placed on the normal stream grade. All stream-crossing culverts should be approved beforehand by the California Department of Fish and Game.

Culverts that drain a roadside ditch should be skewed downslope at a 30 to 45 degree angle from a line drawn perpendicular to the direction of travel. Culvert inlets should be slightly higher than the ditch bottom. The culvert grade should be at least one or two percent more than the ditch grade. A slope of at least 5 to 10 % is recommended to prevent clogging.

Location and Spacing

Culverts should be installed at each stream or drainage crossing unless a bridge or ford is used. The location and spacing of culverts that drain roadside ditches is a site-specific determination to be made by an engineer or erosion control specialist. Spacing is based on the amount of runoff, the terrain, the size and erodibility of roadside ditches, and capacity of culverts being used, and the configuration of the road (see Table 2 on previous page for standard recommendations). An overriding rule is that culverts should not be placed in locations where they will cause flooding or erosion damage to downhill property owners.

Installation

A culvert should be seated on two to four inches of compacted clean fill bedding in a trench that is twice the diameter of the pipe. It should be surrounded with compacted or clean fill to a depth of at least one-half the pipe diameter. Fill depth (cover) above the top of the culvert should be at least equal to the thickness of one-half the diameter of the pipe, but never less than one foot (Figure 16). The depth of cover depends on the type of culvert, its size, and the traffic load anticipated. The pipe manufacturer often determines cover requirements. In case of culvert

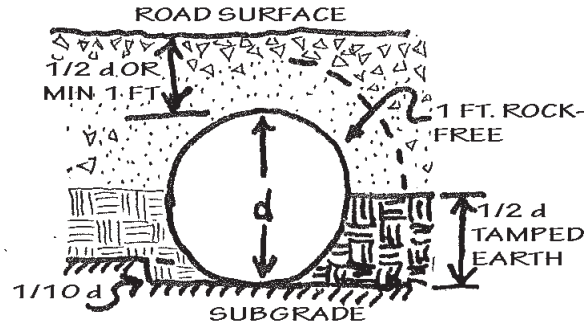


Figure 16. Culvert placement under fill.

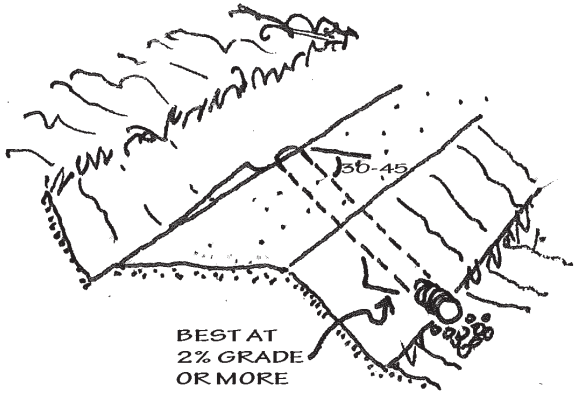


Figure17. Culvert under the road.

clogging or other failure, a "secondary defense" such as a critical dip (see 'rolling dips' earlier, and Figure. 25)should be designed along with installation to handle anticipated flows.

Entrances

If erosion at the culvert entrance is a problem, a watertight headwall must be provided. Concrete, "sakcrete" or pre-fabricated fittings are suitable. Design by a licensed engineer or licensed engineering geologist is helpful. Properly designed headwalls can increase the capacity of existing culverts during periods of heavy flows.

It be necessary to install debris control measures. Sediment boxes (drop inlets) may be used at culvert entrances to catch sediment and prevent erosion. The pipe entrance should be flush with the box wall, and the connection between the two should be watertight. Where sediment storage is desired, the depth of box below the pipe may be increased (Figure 18).

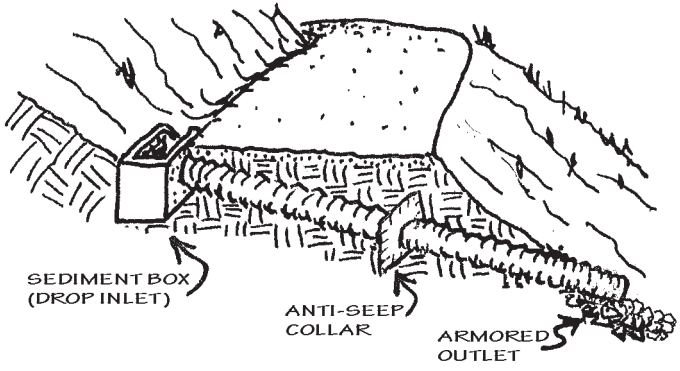


Figure 18. Culvert wtih box inlet under a section of road.

Debris Control

An engineer or erosion control specialist should determine the need for a trash barrier at the entrance of all channel culverts. Trash barriers should be designed to catch only large debris that could plug the culvert. They should be designed so that ponded water behind a blocked debris barrier will still flow into the culvert entrance. An improperly designed debris barrier is worse than none at all. To make a simple and effective trash rack place a T-post in the center of the ditch or channel at a distance two-times the culvert diameter and upstream of the culvert inlet (Figure 19). In general, the best way to prevent clogging is to remove all floatable debris (leaf litter, small sticks and branches) from in or near the channel for a distance of 100 feet upslope on a routine basis.

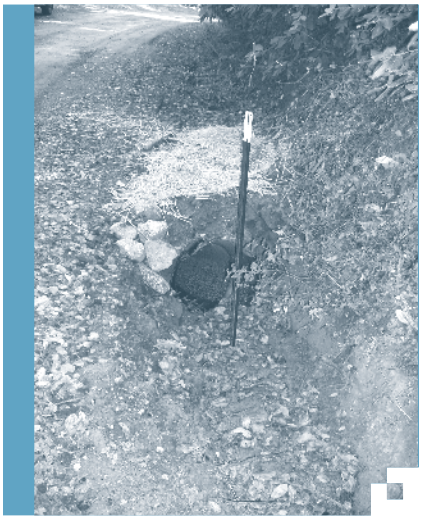


Figure 19. T-post used for a trash rack.

Outlets

Culvert outlets should extend at least two feet beyond the road edge and past the end of the road fill, and should spill onto an apron, stilling basin, rock riprap blanket or other type of energy dissipater that will slow water velocity. On steep slopes, outlets should release water directly onto paved channels, pipe drops, or wood/metal chutes that carry water to the toe of the slope, insofar as possible, and release it onto an energy or velocity dissipater (Figure 20). "T-fittings" are not recommended at pipe ends because of their tendency to clog.

Maintenance

Culverts should be inspected during and after each major storm. Entrances should be inspected for damage or clogging. Outlets and associated structures should be inspected for instability, undermining, gullying, or other erosion. Upstream channels should be cleared of debris.

Considerations for Structural Drainage Control Measures

- » They have a design capacity for a specific storm/runoff event.
- » Constant maintenance is required.
- » They need to be 'designed to fail', requiring a back-up measure to safely convey runoff.
- » They have a limited life expectancy and are subject to damage.
- » If not installed properly or maintained, they can provide a false sense of security.
- » They are expensive.
- » They usually require a specific design by an appropriate professional.
- » Some may require a permit.

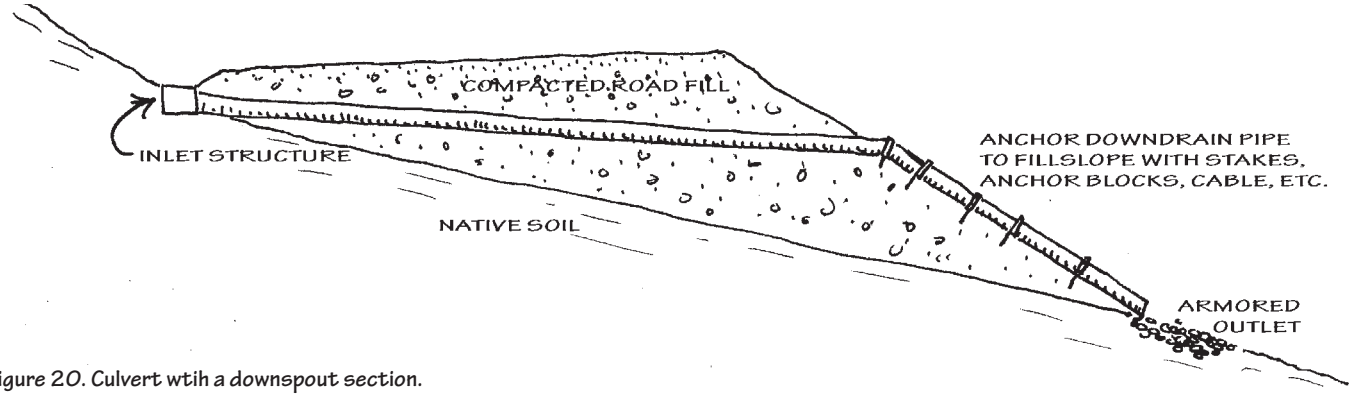


Figure 20. Culvert wtih a downspout section.

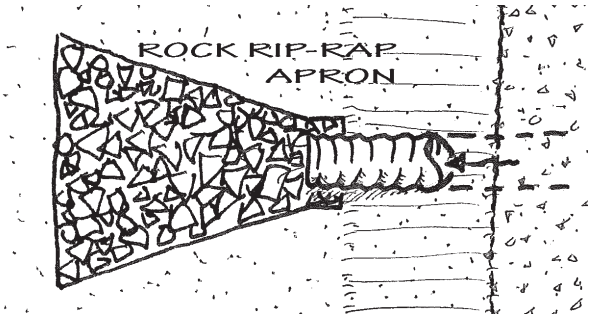


Figure 21a. Plan view of a culvert energy dissipater.

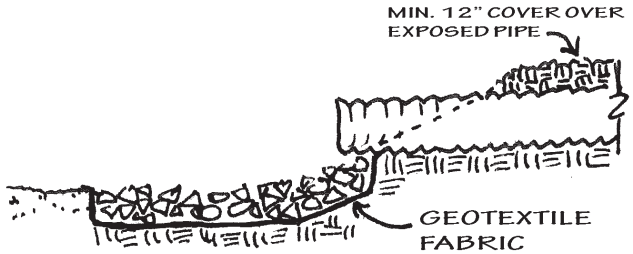


Figure 21b. Section view of a culvert energy dissipater.

Common Mistakes When Using Culverts for Road Drainage

- Not keeping culverts open during a heavy rain (plugging often occurs when culverts are too small to pass normal storm debris).
- Using too few culverts or culverts that are too small to accommodate runoff from a heavy rain.
- Placing culverts too low or on too slight a gradient so that sediment accumulates inside and reduces the water capacity.
- Allowing water from culvert outlets to spill directly onto erodible soil.
- Not compacting the soil around the pipe, thus allowing water to flow through the road fill materials.

INLETS AND OUTLETS OF CROSS-DRAINS AND DITCHES

Water should be controlled, directed, or have energy dissipated at the inlet and outlet of culverts, rolling dips, or other cross-drainage structures. This can ensure that water and debris enter the cross-drain efficiently without plugging, and exit the cross-drain without damaging the structure or causing erosion at the outlet.

Culvert inlet structures (drop inlets) are usually placed in the inside ditch line at the location of a culvert cross-drain. They are commonly constructed of concrete or metal pipe. They are typically used where the ditch is eroding and downcutting, so that the structure controls the ditch elevation. Inlet structures are also useful to change the direction of water flowing in the ditch, particularly on steep grades, and they can help stabilize the cut bank behind the pipe inlet. The outlet of pipes and dips are ideally located in a stable, non-erosive soil area or in a well-vegetated or rocky area.

The accelerated velocity of water leaving a roadway can cause severe erosion or gullying if discharged directly onto erosive soils. The pipe, dip, or drain outlet area can be stabilized, and the energy of the water dissipated, by discharging the water onto graded rock riprap, as seen in Figure 21a and 21b. Rock should be heavy and large enough (six inch minimum diameter) to stay in place. Rock should be carefully laid by hand, forming an evenly lined depression or basin to slow the water down with no spaces left between rocks. If rock is haphazardly piled below the drain outlet, it could cause greater erosion damage or undercutting of the cross-drain. A piece of filter fabric placed between the ground and the rock will increase the stability of an energy dissipater.

When using riprap ensure the riprap consists of a well-graded mixture of rock that is hard, angular, and highly weather-resistant and consult with a licensed professional to determine the appropriate average size of rock needed for a site. This will depend upon variables such as anticipated outlet flows and slope at that location.

Typical rock loads come with a variety of large and small stones graded by a minimum size for a certain percentage (e.g., a 'd50' of 6" means that the diameter of at least 50% of the rock is 6") of the rock. Ensure that you have a sufficient variety of smaller rocks to fill the voids between larger rocks. Larger rocks should predominate, with sufficient smaller sizes to fill the voids between the rocks. Select rock for riprap from rough fieldstone or quarry rock and not river rock, which is smoother and rounder and does not lodge into place as well.

In general, avoid directing concentrated drainage from outlets on to the following areas:

- Fill slopes.
- Landslide deposits, potential slide areas, very steep slopes or otherwise unstable material. Unstable areas can be recognized by tilting trees and by both benches and bowl-shaped depressions on otherwise uniformly sloping hillsides. Natural ponds, seep areas, and hummocky topography can also point to unstable ground.
- Active gullies or eroding areas.
- Septic leach fields.
- Directly into a stream or other water supply.

FILTER STRIPS

In addition to controlling erosion on slopes below the road, it is important to avoid sediment movement into streams from soil erosion upslope. A filter strip is a vegetated area below the road, which can catch sediment before it reaches a stream.

Design a drainage system so that each cross-drain energy dissipater releases onto a filter strip adequately vegetated to trap sediment. If necessary, seed the filter strip area with grass to improve its stability and sediment trapping capability.

CONSTRUCTION BEST MANAGEMENT PRACTICES

The construction phase of a road project is when planning and design decisions are carried out on the ground. To achieve a successful road standard, and to result in minimal impact to the environment, each phase of road construction should be carried out according to the formulated plans. Poor execution of plans, no matter how well designed, can result in a poorly constructed road that causes damage to the watershed and environment.

Every county has specific requirements for construction 'best management practices' for erosion control that must be followed and are typically incorporated as conditions in any grading permit for work such as road construction. The information in this Guide is for general reference to assist users in meeting local erosion control requirements, but it does not supersede them.

Plans and designs may need to be modified during construction as changing conditions are encountered in the field. Minor changes in the proposed work can be accomplished in the field by experienced supervisors and equipment operators. However, only the project engineer should make substantial changes in road alignment or in road and drainage design.

Figure 22. Road grading.

Timing

Roads should be constructed during the time of year when the best results can be achieved with the least damage to the environment. Local grading permits, as required, typically provide specific time 'windows' for different aspects of the work. **Contact your county for specific grading ordinances details and timing.** In general, avoid construction activities during the rainy season, when precipitation can cause washouts, slides and other erosion-related issues.

Clearing and grubbing (cutting and removal of trees and brush from the right-of-way) can be conducted anytime weather permits ground crews to cut the vegetation and equipment to pile or yard it to a storage site.

Have equipment on-hand to remove the material before cutting vegetation.

Yarding (moving and piling cut vegetation) results in soil disturbance and should be limited to reasonably dry soil conditions when rainstorms are unlikely.

Grading (the excavation and creation of the road bench) should be conducted only during spring, summer or early fall conditions due to the large expanses of bare soil created in the process.

Consult an engineer or geologist if you encounter wet soils or springs. This may need to be treated by drying or

de-watering, and an engineer or geologist can recognize soil moisture conditions by using simple field tests.

Conduct stream crossing installation work as quickly as possible during the dry period of summer and early fall, when stream flows are at a minimum (or the channel has dried up) and there will be minimal soil disturbance and risk of sedimentation. The timing is critical to maintaining and protecting water quality and for minimizing impacts on associated amphibians, riparian birds and other animals. Any work along, across or within stream (riparian) areas requires permission from local, state and federal agencies. Timing stipulations, along with other protection measures should be clearly defined in the associated permits.

Clearing and Grubbing

Clearing and grubbing involves the removal and disposal of all unwanted surface and underground material, such as trees, stumps, roots, brush, grass, weeds, downed trees, and other material and debris.

Always mark the road centerline prior to clearing. Flag or stake the upslope and downslope boundaries of the road work area to mark the limits of vegetation removal for work crews and equipment operators who will be performing any clearing. This will help prevent over-clearing. Remember to keep the right-of-way width to a minimum for the planned use of the road.

Keep stumps and other vegetative debris out of the road fill.

Grading and Compaction

The bulk of soil excavation and disturbance occurs during grading. Use slash and organic debris as a rough filter strip by placing it along the base of the side-cast slope. This can help catch and filter soil eroded from the loose slope.

Definitions

Side-casting: excavation material that is pushed from a road cut to a fill area.

Road-benching: a constructed bench is a step or flat area cut into a deep soil or bedrock in order to create a more stable road bed (Mendocino RCD).

Keep **side-casting** and fill material on slopes to a minimum. Over-steepening slope cuts and overloading slopes on the outside of the road are the largest causes of road-related landslides.

Use **road-benching** (Figure 23) techniques on moderate and steep slopes to improve the road's stability. These techniques each utilize construction methods that can lend added stability to the bed and road fill compared to side-casting.

Apply coarse rock surfacing on roads experiencing wet surface conditions. Use one to three inches of clean, graded rock to provide a stable wet-weather surface.

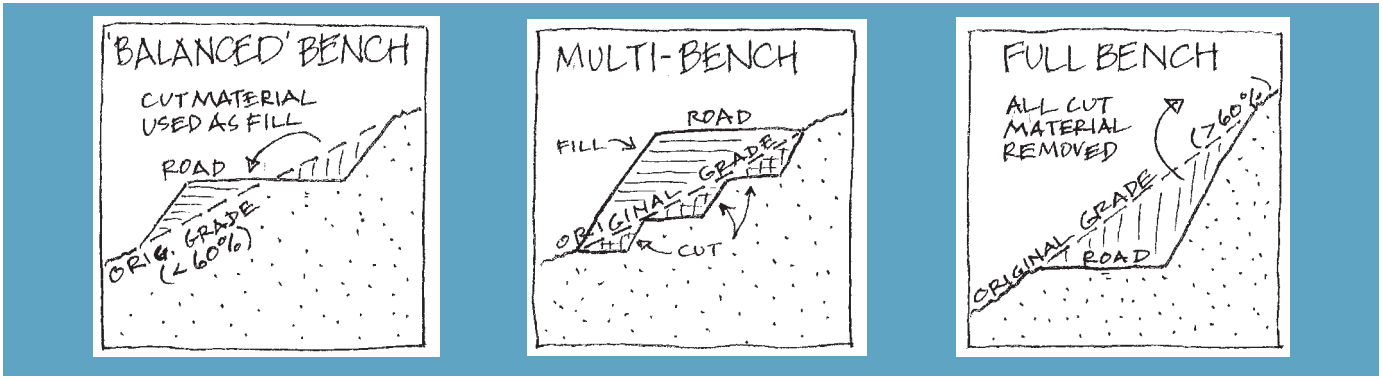


Figure 23. Road benching.

Consult a licensed engineer or engineering geologist when dealing with problems of subsurface drainage. Geo-textiles are commonly used to deal with sub-drainage.

Avoid side-casting (pushing waste soil or debris off downhill side of road) on steep slopes over 60% or in headwater swales, where hill slopes converge into narrow, steep channels. These locations are prime sites for generating debris slides, which can move thousands of feet downslope, scouring steep channels and depositing large amounts of sediment and debris that severely impact fish-bearing streams and domestic water supplies. Identification of debris flow hazard can best be made by a trained geologist or engineering geologist.

Keep total road length to a minimum, especially roads built across steep slopes, to reduce overall risk of slope failure.

Precautions: Using fine textured soils for compaction in overly dry or very wet conditions could be harmful because in these conditions soils often cannot be compacted enough to produce the soil strength needed to support loaded trucks or to remain stable on steep slopes. In efforts to avoid increasing landslide risk, leave the toe of a steep or potentially unstable slope in place; do not cut or remove it. Stay away from altering hillslope drainage by blocking or redirecting surface or subsurface water movement onto fill-slopes or unstable soils. Also avoid disturbing soil near unstable areas and landslides if possible. If road construction must occur on unstable slopes, consult an engineering geologist or geotechnical engineer to develop plans and construction methods for the specific road segment.

General Soil Surface Protection & Vegetation

Keep soil disturbance to an absolute minimum during construction to prevent erosion.

Integrate cuts and fill slopes at stable angles to prevent mass failure. Slopes which develop instability, especially those which threaten to deliver sediment to stream channels, need to be stabilized immediately.

Avoid using silt fence barriers as the only means of erosion control. Silt fences merely temporarily trap the sediment and keep it from moving off the site and into a stream. If installed, it is very important to apply and maintain silt fences correctly for as long as they are left in place.

Do not leave slopes bare after construction operations. Protect these slopes until vegetation can stabilize the surface. Mulching, seeding, planting, compacting, armoring and/or benching prior to the first fall rains can minimize surface erosion on exposed cuts and fills and other cleared ground.

On slopes less than about 50%, vegetate the bare areas as quickly as possible at any visible onset of erosion. Where

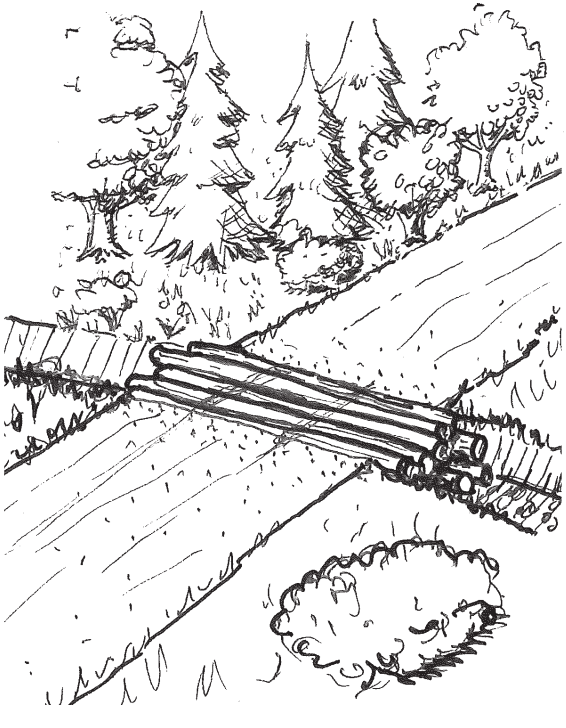


Figure 24. 'Humboldt' log crossings should NOT be used for permanent stream crossings.

needed outside of the immediate road and banks, 'rip' compacted areas of soil to promote revegetation.

Consult a trained a plant ecologist, RCD or the NRCS to see what plants are recommended for revegetation, erosion control and slope protection in your area to avoid inadvertent introduction of noxious, invasive plants.

CONSTRUCTING STREAM CROSSINGS

Any work impacting a stream will require permits, even if the streambank is bare of vegetation. Consult your local RCD for guidance with the various permitting agencies (such as California Department of Fish and Wildlife and your Regional Water Quality Control Board).

Regardless of the construction method chosen, side-casting on stream crossing approaches should be avoided.

Use full bench construction methods (Figure 23) where roads are to cross stream canyons or incised channels with steep side slopes.

Identify potentially unstable soils and slopes near a crossing site before the equipment cuts into the slope, so approaches can be designed to avoid, or drain and stabilize, the unstable area.

Never use 'Humboldt' log crossings (Figure 24) for permanent stream crossings.

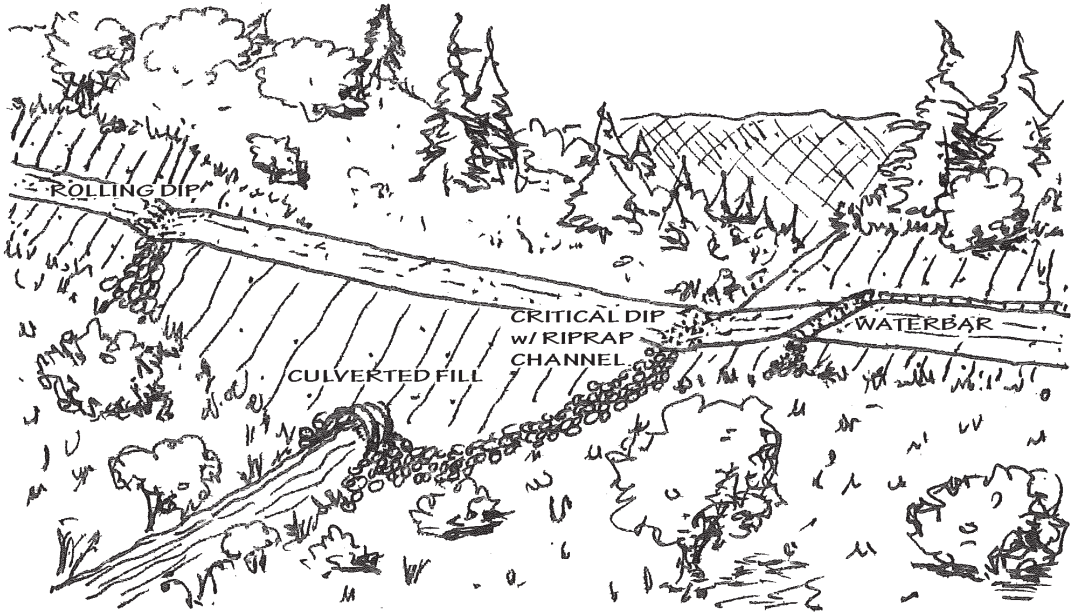


Figure 25. Ideal stream crossing construction.

Incorporate a fail-safe drainage design such as a critical dip (Figure 25) into every stream-crossing fill so that stream flow will not be diverted out of the natural channel and down the road if the culvert plugs with sediment or debris.

Outslope the approaching road or place a rolling dip up the road from the crossing to minimize road runoff directly entering the crossing.

Consult a trained a plant ecologist, RCD or the NRCS to see what plants are best-suited for revegetation, erosion control and slope protection along streams in your area to enhance likelihood of plant establishment and to avoid inadvertent introduction of noxious, invasive plants that might threaten stream habitat quality or long-term channel function.

Bridge Installation

Use bridges for stream crossings in all possible situations. Bridge installation causes less disturbance than a culvert crossing and there is less chance a bridge will fail during floods.

Install a low-impact equipment ford, if needed, to prepare both abutments and approaches for placement of the bridge. A prior consultation with the California Department of Fish and Wildlife is recommended.

Remember that each bridge abutment should be leveled and secured far enough into the bank so that slumping or bank failure will not occur.

Make sure the grade of the bridge is the same as the grade of the approaching road.

Keep all construction activities and equipment out of the stream bed. A crane, excavator, or an excavator and winch-tractor can be used to move a portable bridge into place, with one piece of equipment on each side.

Culvert Installation

During road building, the installation of culverts at stream crossings has the greatest potential of all activities to cause immediate sediment pollution. Permits from local, state and federal agencies with specific conditions may be

Figure 26. Failing culverts were a safety hazard and the crossing flooded during large storm events. The rusted culverts were impeding fish passage.

Figure 27. Replaced with a bridge, residents can now safely access their homes year round and fish can access more spawning ground.

required for general culvert installation. See Chapter 6 and Appendix A for information on local ordinances and permits.

Place stream-crossing culverts at the base of the fill, and at the grade and orientation of the original stream bed (Figure 29).

Although large rocks should be placed at the culvert outfall, avoid leaving large rocks and woody debris in the path of the culvert. Both the culvert foundation and the trench walls must be free of logs, stumps, limbs or rocks that could damage the pipe, or subsequently cause seepage of flow around the outside of the culvert.

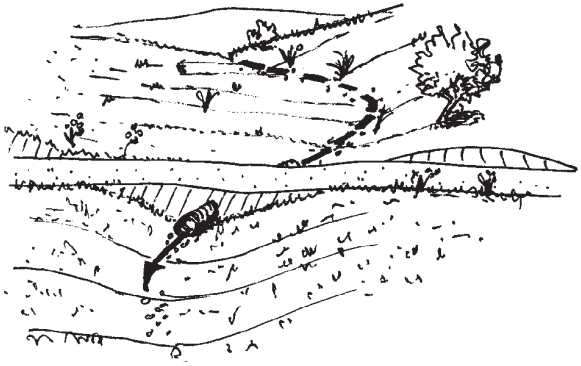


Figure 29. Culvert aligned with channel

Figure 28. The culvert installation included proper angle placement and was back filled and compacted to design specifications.

CHAPTER 4.
ROAD MAINTENANCE

Figure 30. Completing a road walk on an annual basis to evaluate your road condition is a key component of planning and mainteance.

Regular road maintenance usually pays for itself by reducing your long-term costs and liabilities. This section describes some general guidelines on road inspection and assessment, as well as a list of maintenance strategies that will help reduce maintenance costs. Many problems can be dealt with by regularly inspecting before, during, and after storm events. Thorough inspection before storm events is much less expensive than the repair work needed after a minor drainage problem has been neglected and allowed to worsen throughout the winter. For example, clearing debris from a culvert inlet might prevent a stream crossing or road from washing out and necessitating costly road

reconstruction. Additionally, sediment lost due to a road or stream crossing failure can seldom be reclaimed and is usually destined to impact the watershed.

Learning to read the lay of the land and understanding the surrounding landscape, not just the road and immediate area around the road, will go a long way in helping you identify areas of concern before damage occurs to your roads and property. This means working with your neighbors—road issues often extend beyond property lines.

To be effective, a maintenance program must consist of two steps: **Monitor** the road regularly and **maintain** it when necessary.

MONITORING

Walk the road and inspect cross-drainage frequently, especially during wet weather. A simple way to measure the effectiveness of a drainage system is to take the 3-D test below.

1. Is the **distance** between cross-drains short enough to stop water from concentrating on the road?
2. As the water is discharged, is its energy **dissipated** onto a non-erodable material, such as properly sized rock?
3. Does the system actually intercept road runoff and **discharge** it from the road?

PLANNING AND MAINTENANCE

Inspections and Planning Considerations When Maintaining Roads

1. Identify and evaluate existing problems and prioritize them (look beyond the road).
2. Inventory road drainage and erosion control measures.
3. Consider environmental impacts from roads (Chapter 1).
4. Develop a road maintenance strategy.
5. Identify parties that may need to be notified or involved.
6. Monitor road drainage and erosion control facilities.
7. "Plan to fail"—consider secondary defenses.

Road and drainage structures along all roads should be inspected annually, at a minimum prior to the beginning of the rainy season. Inspections should encompass culvert inlets and outlets, ditch relief culverts, and road surface drainage such as waterbars, outsloping, and ditches.

In addition to annual maintenance, pre-winter road and drainage structure inspection crews are needed to inspect and perform emergency maintenance during and following large winter storms. Shovel work at a culvert that is beginning to plug can save the expenditure of thousands of dollars to rebuild an entire stream crossing after it has washed out.

Some drainage structures are more prone to problems than others. For example, culverts on streams with heavy sediment loads or floating woody material may be more likely to plug. Landowners or land managers typically already know which culverts on their roads have had the most problems, and which are most likely to plug during a winter storm.

This background information can be used to develop a rating system and inspection plan for drainage structures in a watershed. Culverts can be coded by signs along the road. The signs would note: 1) where the culvert is located—road name and milepost; 2) the diameter of the culvert; and 3) a number or color coding (red, yellow, green, etc.) that signifies how likely the culvert is to plug, and, therefore, its relative need for inspection during winter storms.

Key Routine Road Maintenance Items:

- Grading and shaping the roadway surface to maintain a distinct insloped, outsloped, or crown shape to move water rapidly off the road surface.
- Compacting the graded roadway surface to keep a hard driving surface and prevent the loss of fines.
- Replacing surfacing material when needed.
- Removing ruts through rolling dips and waterbars, or reshaping them to function properly.
- Keeping inside road ditches clear of debris and

reshaping them when necessary to have adequate flow capacity to drain effectively into cross-drains and not overflow onto the road. Do not grade ditches that do not need it!

» Keeping culverts and waterbar trenches clear of sediment and debris. Make sure inlets and outlets are clear so water can flow freely.

» Protecting any bare or disturbed areas with erosion control grass or other plants.

» Removing debris from the entrances of culverts to prevent plugging and overtopping.

» Checking for damage and signs of piping or scour.

» Ensuring that drain outlets are open and clear of debris and vegetation that could block them in a storm.

» Repairing or replacing rock armor, concrete, or vegetation used for slope protection, scour protection, or energy dissipation, especially after big rains.

» Trimming roadside vegetation (brushing) adequately, but not excessively, for sight distance and traffic safety.

» Replacing missing or damaged road information, safety, and regulatory signs.

MAINTAINING PRIVATE ROADS: PROBLEMS, CAUSES, CURES

One, all or a combination of the CAUSES and INDICATORS, as shown in the following table, could result in the ROAD PROBLEMS shown in the table. If you notice what looks like the onset of a road problem, you can contact your local RCD/NRCS office or a local Certified Professional in Erosion and Sediment Control. For contact information refer Appendix A.

Figure 31. A measuring wheel is an easy to use tool for measuring road length.

PROBLEMS	INDICATORS & CAUSES	TREATMENT OPTIONS
Roadcut Bank Failure (e.g. the road cutbank is slumping)	Indicators 1. Dead, dying, diseased or undermined trees 2. Unstable slope/seepage Causes 1. Slope disturbance 2. Vegetation removal/absence of vegetation 3. Over-steepened cut bank 4. Uncontrolled surface runoff 5. Erodible soil/soil composition	1. Remove or prune hazardous trees 2. Re-slope bank and revegetate 3. Control surface runoff with diversion above cut slope 4. Clean and maintain road ditch 5. Outslope road to eliminate inside ditch 6. Install retaining wall In General: • Minimize disturbance • Maintain appropriate vegetative cover
Road Washout	Causes 1. Accumulation of sediment or debris in cross-drain 2. Undersized or damaged culverts 3. Improper design, placement and construction of road drainage facilities 4. Lack of energy dissipaters at culvert outlets 5. Concentrated runoff on unprotected roadfill 6. Lack of overflow device, 'secondary defense,' such as a spillway 7. No surface drainage provisions 8. Increased runoff and erosion in the area 9. Adjacent streambank erosion 10. Landslide	1. Improve all road drainage control measures 2. Install secondary defense such as a spillway or "critical dip"that can safely carry flow across and off the road if necessary 3. Retain unstable slopes with structures and vegetation 4. Monitor culvert inlets during peak storm events
Roadfill Slope Failure	Indicators 1. Tension cracks on the road 2. Steep unstable slope Causes 1. Uncompacted fill 2. Vegetation removal or lack of establishment 3. Concentrated runoff over fill 4. Road culvert outlets on bare soil or unstable slope 5. Outside berm/curb on an outsloped road 6. Lack of necessary retaining structures 7. Erodible soil	1. Excavate and re-compact weakened fill slope 2. Install energy dissipaters at culvert outlets; extend culverts beyond fill soil 3. Install slope/soil-retaining devices if deemed necessary 4. Inslope unpaved roads to redirect surface runoff away from sensitive fill slopes In General: • Prevent concentration of surface runoff to maintain "sheet" flow • Plant and maintain appropriate vegetative cover • Minimize fill areas

PROBLEMS	INDICATORS & CAUSES	TREATMENT OPTIONS
Other Slope Failures (e.g. mud-slide or landslide, slumps, block glides, debris flows, etc.)	Indicators 1. Difference in type or maturity of vegetation 2. Cracks perpendicular to the slope 3. Evidence of prior slope failure such as: • A bulge at the base or 'toe' of the slope • Flat spots or "benches" on slopes that appear out of character for the slope • Uneven or lumpy terrain • Spoon-shaped hollows in slopes created by the movement of failed material 4. Problems with structures such as jammed doors or windows, cracks in walls, breakage of underground pipes, or tilted utility poles or trees Causes 1. Disturbance or absence of deep-rooted vegetation 2. Unstable soil, deposit, or bedrock material 3. Oversteepened cutbank 4. Unretained cutbank on unstable slope, increased load 5. Slope undercut by stream or roadside ditch 6. Springs or seeps in hillside above or below road 7. Uncontrolled surface drainage on unstable slope, causing saturated soil 8. An intense storm event 9. Earthquake	1. Work with neighbors to control all sources of surface and subsurface drainage on slopes: • Remove excess water from the slope • Prevent the ponding of water in slide areas 2. Construct restraining structures such as retaining walls (with the aid of a geologist or geotechnical expert) 3. Revegetate all disturbed soil with appropriate plant materials after geologist-recommended work is completed 4. Maintain toe of slide whenever possible—The slide debris at the toe acts as a temporary footing for the slope. Removing slide debris may cause additional sliding In General: • Avoid development on unstable or failed slopes
Roadbed Erosion (e.g. rills or gullies running down roadbed)	Causes 1. Berm/curb channeling water down road 2. Inadequate road drainage facilities 3. Poor construction or grading 4. Poor application of surfacing materials 5. Lack of maintenance and/or heavy use of road • Heavy vehicle traffic creates ruts in road that channel runoff	1. Install appropriate road drainage facilities to redirect water to a safer location 2. Install cross-drain devices for drainage 3. Regrade road, outsloping road if site allows 4. Resurface road 5. Reconstruct or relocate all or part of the road 6. Monitor and maintain road conditions throughout the winter 7. Limit heavy vehicle traffic on low-strength roadbeds 8. Perform regular maintenance

PROBLEMS	INDICATORS & CAUSES	TREATMENT OPTIONS
Road Damage From Streambank Erosion	Causes 1. Weak material underlying the roadbed 2. Road too close to the stream 3. Road in flood plain or constructed in historic drainage course 4. Increased runoff in watershed 5. Road runoff onto unprotected streambanks 6. Poor placement and installation of road culverts	1. Remove or prune hazardous trees 2. Re-slope bank and revegetate 3. Control surface runoff with diversion above cut slope 4. Clean and maintain road ditch 5. Outslope road to eliminate inside ditch 6. Install retaining wall In General: • Minimize disturbance • Maintain appropriate vegetative cover
Road Ditch Erosion on In-sloped Roads (e.g. roadside ditch is being downcut)	Causes 1. Steep road ditch grade 2. Undersized or improperly constructed ditch 3. Ditch filled with debris, rock, or choked with vegetation - limits capacity 4. Erodible material (rock, soil, or deposits) 5. Inadequate drainage control/ lack of cross-drains	1. Install more frequent cross-drains 2. Keep ditch free of loose debris 3. Harden ditches with materials such as concrete and grouted rock on steep grades, and loose, angular rock on gentle grades. Avoid obstructing flow with loose materials. 4. Control excessive surface runoff 5. Perform regular maintenance 6. Consider outsloping unpaved roads, eliminating need for an inside road ditch
Water Ponding on Road Surface & Saturated Roadbed	Causes 1. Wet, unstable soils 2. Spring in roadbed 3. Improper surfacing, grading, or design 4. Road drainage facilities undersized or lacking 5. Lack of drainage maintenance resulting in plugged culverts and clogged ditches 6. Broken water or drain pipelines buried under roadbed	1. Install subsurface drain with permeable membrane below road surface on unpaved roads and cover with drain rock (consult a professional for advice and installation assistance) 2. Regrade unpaved road to improve surface drainage; outslope if site allows 3. Perform regular maintenance and remove debris from culverts and roadside ditches 4. Install, renovate or enlarge cross drains
Roadside Erosion to Surrounding Lands (e.g. erosion caused by road runoff)	Causes 1. Lack of road erosion drainage control measures 2. Bare, disturbed, and/or infertile soil 3. Uncontrolled surface drainage causing rills or gullies 4. Sparse vegetative cover 5. Unprotected or undersized drainage outlets	1. Hydroseed and mulch 2. Plant with native groundcovers 3. Maintain existing and newly planted vegetation 4. Install or improve and maintain surface drainage control measures 5. Compact loose and disturbed soil before revegetating 6. Seed and mulch bare soils

SURFACING YOUR ROAD

Permanent roads which will be used for winter and wet weather hauling or heavy traffic need to be surfaced with rock or pavement to serve as "all weather roads" to improve traffic movement and reduce erosion. Serious damage to road surfaces usually begins with the build up of thick (one to four inch) accumulations of dry dust during the summer or excess water and mud during the winter. Standing water is a sign of poor road drainage. Cracks indicate that road strength is deteriorating.

While surfacing protects the roadbed from erosion, it also creates a more impervious surface that increases runoff, so the road's drainage structures and outlets may need to be enhanced or strengthened to accommodate and dissipate the energy of the increased and potentially intensified flow of runoff.

For an "all weather road", how the construction is done is as important as the design. The following are the basic steps in construction. (**Note**: Construction and grading situations are site specific. Slope, soils, drainage, proximity to streams, vegetation, travel needs and emergency access needs for fire suppression all need to be considered.)

Surfacing: Getting the Work Done

- Choose your contractor carefully. Talk to other road associations or individuals who have had work done. Choose a bonded, licensed contractor with the appropriate licensing.
- "Class A" is a General Engineering Contractor. This person is licensed to design structures such as roads, sewer systems, retaining walls, and some buildings.
- "Class C-12" is an Earth Work and Paving Contractor, licensed to do excavating, grading and paving.
- Considering the liabilities and potential for problems, it may be wise to contact the State Contractor's Licensing Board in Sacramento at **(800) 321-2752.** Stay in touch with your contractor each day of construction. Make frequent site visits if possible. If this is new construction or an extensive repair, consider consulting with a state licensed civil engineer, geotechnical or soils engineer, or a licensed Certified Professional in Erosion and Sediment Control (CPESC).

Grading and Compaction

Grading specifications can be found in your county's Grading Ordinance. You are not expected to know these details, but your contractor is. This is one reason why it is important to choose a knowledgeable and experienced contractor. Fill material (used to build the road) must be compacted to 90% of maximum density. This is done with drum rollers or other heavy equipment.

Have your county's Soil Survey information for the site (available from the NRCS at www.ca.nrcs.usda.gov) close at hand. You may find areas of clay along your road, and as it is graded, these areas may become exposed. Because of the ability of certain clays to swell with water, rock surfacing becomes very important. The contractor may tell you that drain rock needs to be placed over the clay areas. Drain rock is washed of most or all fine sediment material and is the best drain material available. It may cost as much as two

times the amount of the Class II aggregate rock, but will save you in maintenance and repair in the future.

Base Rock and Foundation Work

After the road bed is graded and compacted, the base rock is laid down and compacted. The amount used will depend on the soil type and conditions. A general rule of thumb suggests a minimum of five inches for compacted roads. Class II and Class IV types of base rock - or aggregate base - are generally used for small, private roads. Class II compacts quite well due to the smaller size of the particles. It is used by government agencies for this reason. Class IV is used on less traveled roads. It may cost much less than Class II, but is poorer in quality.

A large roller will compact the base rock, while a water truck sprays the base rock. The moisture lubricates the rock, allowing it to slide into place, like puzzle pieces, for better compaction.

Surfacing Materials

Base and Seal Coat

After the base rock is compacted, a primer of penetrating oil (such as SC 70) is applied. Then, a layer of more tacky, sticky oil (RS1 or RS2) is sprayed to retard water infiltration.

Base and Oil Screen ("Oil and Chips" or "Chip Seal')

After the base rock is compacted, a primer of penetrating oil is applied, and finely-graded granite rock "chips" are rolled into the seal-coat oil. The rock chips (or "screenings") average 1/4 to 3/8-inch in "size." This surfacing can last two to six years and may then need recovering.

Double Seal Coat (Double Oil and Screen)

Similar to Base and Oil Screen, a Double Seal Coat adds another layer of finely-graded rock - smaller than those in the first - with a second application of the tackier R81 or RS2 oils. The smaller rocks are wedged in between the larger first layer of granite, forming a harder surface.

WARNING: Decomposed granite should never be used instead of crushed granite. This may mean that your association or contractor may have to go outside the local area for crushed rock. This will increase the transport cost, but remember to consider future repair and maintenance costs when considering using lesser quality materials to save a few dollars.

Base and Hot Mix (also known as asphalt concrete, paving, blacktop, or plant mix)

To create this surface, specific proportions of liquid asphalt and aggregate are heated, and the mix is then spread and compacted on top of a layer of base rock. Base and hot mix may be recommended on slopes steeper than 15%. A primer coat may be applied before the hot mix layer for a more lasting job. This surfacing may cost twice as much as the basic base and seal coat, but can last many times longer.

Concrete

Concrete wears very well, and it can be "scarred" for traction on steep slopes. However, concrete is not as flexible as the other surfacing materials, which makes it susceptible to cracking. Concrete is also generally more expensive than asphalt. The appropriate thickness of a concrete road surface is dependent upon the soil and anticipated loads the road will bear, and may require a layer of sand underneath where soils include clays that expand with moisture.

SLOPE PROTECTION

Vegetation

Apply seed and mulch on bare soil, unprotected slopes, unpaved roads, cutbanks, and other disturbed soil areas.

In some instances, vegetation may need to be used in conjunction with structural practices to prevent erosion caused by the concentration of storm water runoff.

Soil Preparation

Loosen the top few inches of compacted soil prior to seeding. Passing over the soil with a ring-shank roller prepares an excellent seed bed. The finished seedbed should be fairly firm, but loose enough so roots can penetrate. Take care not to loosen too deeply and risk undoing critical compaction work needed for road and bank stability.

If you choose to fertilize, broadcast just prior to seeding to help achieve rapid growth before heavy winter rains start. Fertilizer is especially crucial on sandy, shallow, or infertile soils. Apply fertilizer, such as Ammonium Phosphate with Sulfur (16-20-0) at a rate of five to ten pounds per 1,000 square feet or 200 to 400 pounds per acre, before mulching, either before or during seeding operations. On steep slopes, splitting fertilizer into two or three applications during the growing season will reduce the loss of fertilizer due to storm runoff.

Note: Do not use fertilizer on slopes draining directly to streams to avoid risk of polluting the stream with nutrient-rich runoff. Also, it is best not to broadcast fertilizer if you are seeding native plants, as the fertilizer more often benefits faster-growing weedy species over the expensive natives. Many natives are more competitive in poor quality soils.

Seeding

Lightly bury seed about one inch deep. If relying on winter precipitation, the best seeding time is between mid-September and mid-October. If irrigation is possible, plant earlier so there is some erosion protection before the first storm. Seeding should be done after drainage and erosion control structures/measures are in place so that seed is not disturbed. After mid-October, germination may be reduced and plant growth may be slowed due to cold weather.

Mulch

Immediately after seed and fertilizer are in place, protect the planting and help retain soil moisture with mulch. Weed-free barley, wheat or rice straw can be used. Apply a one to two-inch thick layer (approximately one bale per 1,000 square feet or 45 bales per acre). "Punch in" straw to anchor it on steep slopes, using a shovel or other equipment such as a track-roller. Mulch (see below) may be used alone for erosion control without seeding when it is too late in the season for successful establishment of plants.

Seeding Recommendations

Deciding what seed to plant is a difficult task. Successful germination, growth, and longevity will depend on a variety of conditions, including soil type, climate, and competition from current plant populations. Historically, annual grasses have been the preferred choice for erosion control because they grow more rapidly than do most native perennial grasses. Most native perennial grasses establish more slowly and grow less vigorously in the short term, albeit with longer term benefits of being deeper-rooting and providing more permanent cover along with more effective wildlife habitat. Non-native, annual and perennial grasses can outcompete and suppress native grasses and are not recommended for wildland areas or urban built-up areas adjacent to wildland areas (e.g. avoid grasses such as Blando Brome, Annual Ryegrass, Zorro, Annual Fescue). Cereal barley and triticale are preferable as fast-growing, non-reseeding, and hence non-weedy "nurse" plants for more desirable perennials.

Consult your local seed vendor or a Certified Professional in Erosion and Sediment Control for specific seed mixture recommendations for your site. Seed mixtures stand a better chance of surviving pests or diseases that might wipe out a single-species planting. Consider whether you want the grass species to persist. If not, plant a non-reseeding mix of annuals. If you want permanent grass cover, choose a mix that includes a short-lived species with high seedling vigor (rapid germination and erosion control cover) and a long-lived species with low seedling vigor (to provide long-term site stability).

Contact your RCD for information on individual grass species and legumes and a list of nurseries that carry native grass seed and other native plants.

More on Mulch

Spreading straw mulch is a simple yet time consuming practice. A work crew will make spreading straw mulch over large areas a more manageable task. If the area is extremely large or on a steep slope, you may want to consider hiring a hydroseeding contractor. They can spray the area with seed, straw mulch and a tackifier that will hold it in place. Straw mulch can be sprayed without seed for large areas.

Seeded Areas

Remember that mulch is intended to provide temporary protection. Prior to mulching, seed disturbed soil with the appropriate mix of native grasses and forbs for the site.

Apply straw mulch at a rate of roughly one bale (65 lbs) per 500 to 750 ft^2. Cover the area with no more that two to three inches of straw mulch. Too much mulch will inhibit grass seed germination and establishment.

Anchor Straw on Steep Slopes:

- Use a dull shovel to punch the straw in every one to two feet or;
- Use a bulldozer (or other tracked equipment) to track over the area. Be sure to run the equipment up and down the slope to create small notches in the soil with the tracks that are perpendicular to the slope or;
- Quickly herd goats or sheep through the area (trample method).

Around Trees and Shrubs:

- Hoe, pull or apply herbicide to the weeds around the plant. Be careful not to damage the plant's roots, which may be near the soil surface.
- Apply a four to six-inch mulch layer of straw, woodchips, etc. in a four-foot diameter area around each plant.
- Plants will not need to be watered as often as without mulch. Check plants occasionally to see if too much water is being applied.

As a Seeding Method:

- Many native grass seed suppliers also have seed-rich native grass straw available. Seed-rich straw is cut and baled with the mature seeds still intact.
- Using seed-rich native grass straw provides a less expensive alternative to seeding and mulching separately, although the amount of seed applied to the area that comes in contact with the soil will also be less.
- Spread the seed-rich native grass straw in the same manner as described above in "Seeded Areas."

Erosion Control Blankets

Erosion control blankets (ECBs) provide immediate protection from surface erosion for steep slopes (typically greater than 3:1). They also create an ideal environment for seed germination. The main purpose of ECBs is to provide initial erosion protection while vegetation, which will provide permanent protection, becomes established. ECBs are a combination of natural fibers sandwiched between or otherwise attached to a synthetic netting. ECBs come in rolls varying in thickness, durability and life expectancy. ECBs are biodegradable and last from one to five years.

Site Preparation: It is important that the soil surface is graded and smoothed so that the ECBs have complete contact with the soil. Remove all rocks, logs, sticks, and clumps of dirt from the area. Loosen the top two to three inches of soil in preparation for seeding.

Installation: Installing ECBs is fairly straightforward, but this practice will fail if you do not properly key in the top of the erosion control blanket.

- Begin by digging an anchor trench (six inches deep and six inches wide) across the top of the slope, preferably three to four feet back from the edge. Place the spoils on the upslope side of the trench.
- Seed the area from the trench to the bottom of the slope. Try not to walk on the seeded area. If an area is disturbed, smooth the area and re-seed.

» Secure the end of the ECB in the anchor trench using staples or pins at one-foot intervals (Figure 33). Backfill the trench and compact the soil. Seed the trench and fold over and secure the end flap of the roll, again using staples or pins at one-foot intervals.

» Overlap adjacent rolls three inches. Start at one end of the slope and work across. If installing on a stream bank, start at the downstream end of the site.

» Roll the ECBs down the slope. Secure with staples or pins every three feet starting at the top of the slope and working down. Be sure not to stretch the erosion control blanket. Remember you want complete contact with the soil.

» When splicing together rolls mid-slope, slip the end of the new roll under the end of the roll that just ran out. Be sure there is at least one foot of overlap. Staple or pin the overlap area at one-foot staggered intervals.

» Simply cut the ECB at the bottom of the slope using heavy-duty scissors.

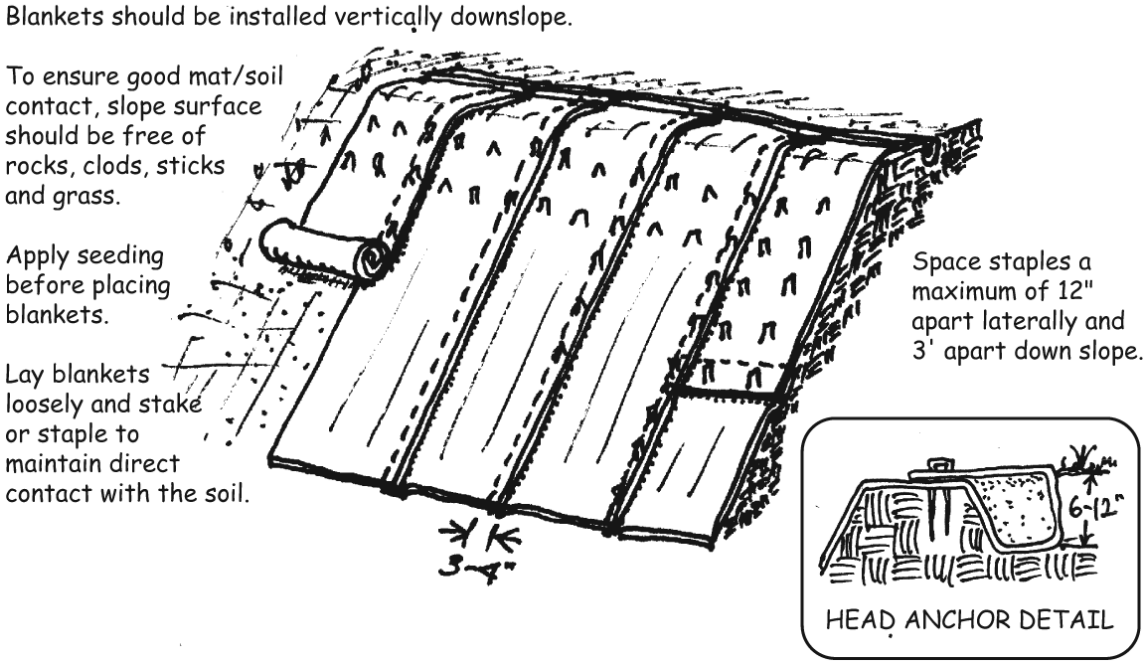


Figure 33. Proper installation of an Erosion Control Blanket.

Plastic Mulch on Slopes and Other Disturbed Areas

Plastic use is site-specific and NOT appropriate for many situations. If not done correctly, plastic can often make a problem worse and/or create new problems.

How to use plastic appropriately

- Consult with an erosion control specialist, geotechnical expert or engineer for a site-specific design and/or planning guidance before installing plastic.
- Use only as a temporary emergency measure.
- Install plastic so that is covers all bare and/or disturbed soil when it is dry or relatively dry.
- If soil is wet or becomes wet, then remove plastic during breaks in the weather.
- Use clear plastic so vegetation and/or root systems are not destroyed.
- Securely fasten plastic to slope. Provide sufficient overlap and a watertight seal.
- Make sure that runoff from plastic is directed to a safe location and does not cause further slope saturation, erosion, or damage to downslope or adjacent properties or road drainage facilities.
- Use appropriate mil (millimeter thickness) of plastic (six mil minimum).
- Replace plastic with a permanent slope protection measure as soon as possible.

Why not to use plastic

- Black, brown, or blue plastic kills vegetation and root systems that are needed to hold soil together.
- Plastic increases runoff and retains moisture in the soil which can lead to slope failure.
- Plastic requires significant maintenance.
- Covering soil with plastic slows the natural restoration process.
- If there are extremely large areas that require covering, it can be very expensive.
- It is only a temporary solution.

CHAPTER 5.
ORGANIZING WORK ON SHARED ROADS

COUNTY SERVICE AREAS AND ROAD ASSOCIATIONS

Property owners sharing road access can organize themselves in multiple ways to handle the costs and responsibilities of managing their roads. Two such organizational tools are County Service Areas (CSAs) and Road Associations. Although no governmental agencies are necessarily involved in the formation and function of a Road Association, a CSA is formed through an appeal to county government to officiate the collection of dues and implementation of road improvement work. Information on how to form a CSA is available through each county's Local Agency Formation Commission. The remainder of this chapter will focus on a process for forming a Road Association.

Road Associations can organize in a variety of ways with varying degrees of formality and function depending entirely upon the group's needs, interest and ability to self-organize. Some associations exist solely on verbal agreements. Others use formal written agreements that are notarized and filed with the County Recorder, making them legally binding on the individuals who have signed them and on future property owners.

WHY FORM AN ASSOCIATION?

Road Associations can do the following:

- Provide a means for an overall road maintenance and improvement plan versus piecemeal efforts by individual property owners. (A safe, attractive, well-maintained road enhances property values).
- Organize property owners sharing road access so that costs can be met together, with each individual assuming his/her fair share of road costs.
- Ensure a well-maintained access for emergency vehicles such as fire trucks or for emergency exits of residents in case of natural disasters.
- Organize individuals sharing road access in order to deal more efficiently with insurance and liability claims.
- Establish a structure for other neighborhood activities such as childcare, residential security, and cooperative gardening.
- Provide a communications network and basic structure for a localized community disaster plan. This can be a major benefit during large storm events and disasters. Members of road associations are already in contact with neighbors through their road system and better prepared for road clearance and rescue procedures.

HOW TO FORM AN ASSOCIATION

Any number of people sharing the use of a road can form a road maintenance association. The larger the percentage of property owners cooperating, the easier it is to finance and organize road maintenance effectively.

Although each road association interviewed in developing this information used a different approach to organize, many agreed on some basic steps to help get things off to a good start and also lay the foundation for smooth operations to follow.

Step 1

Start with a nucleus of interested individuals. The group need not be large. In some cases, it initially consists of only one or two people. This group can then plan a meeting to which others sharing road access will be invited. Residents and owners should be individually invited, as there is often an initial reluctance to get involved. It should be emphasized that this meeting will provide individuals with an opportunity to share ideas and voice concerns before any decisions are reached regarding road association organization. Input from as many property owners as possible is important at this stage.

Step 2

The initial meeting may be a social gathering as well as a business meeting. This gives residents some opportunity to get to know one another and discuss business in a relaxed atmosphere. The group should first consider the pros and cons of forming an association. Sometimes small neighborhoods decide that a road association is unnecessary, that communication and organization already exists and need not be formalized.

If the group does decide to form an association, property owners may want to discuss the following:

Formality of the association—Some groups choose to exist on verbal agreements. Others draw up written agreements, possibly involving legal assistance. Generally, written agreements do work best in the long run.

Assessments—Groups should decide the amount of money to be collected, how and when collection will take place, and how the total maintenance bill will be divided among property owners.

Group resources—There may be lawyers, contractors, and people with other skills useful to the association who can provide expertise and possibly save the group money.

Road construction—Determine whether a contractor will be hired to do all of the construction and maintenance or whether the association will be responsible for various aspect of the work.

Association officers—Elections can be held for road manager (president), secretary, treasurer, and other positions that the association feels are necessary. It is generally wise to choose at least one spokesperson for the group.

NOTE: For this meeting, it is useful to obtain a list of current owners' names, mailing addresses, phone numbers, and email addresses, as well as Assessor's Parcel Numbers, and whether the property is improved or unimproved. A map of the area is extremely helpful in visualizing the locations of the road and the properties involved.

Step 3

Association officers should mail minutes from this meeting to all property owners, including absentee owners (persons owning but not living on site). The date for a follow-up meeting should be decided as well. For mailing purposes, a small collection for stamps, envelopes and paper should have been taken at the initial meeting so that costs are shared by all from the beginning.

Step 4

At follow-up meetings, officers and committees can report back to the group, and agreements can be reviewed and signed.

ASSESSMENTS

How are They Collected?

Because the collection of money seems to be the most common problem faced by associations, the following suggestions are provided to help make the collection process work.

Good Communication

Many associations note that good communication is the chief determining factor in avoiding potential problems. Often, this takes the time and dedication of one or two association members. Many groups feel that smooth operations are directly dependent on good diplomacy as practiced by the Road Manager. His or her ability to work with various personalities, balancing individual needs with efficient road management, is of utmost importance. **People must feel that their personal interests are being considered in order for them to fully support an overall road maintenance effort.**

The Written Agreement

For many associations, communication includes a written agreement. An agreement provides defined rules and group priorities. This also helps members understand that association decisions are of a business rather than personal nature. This agreement might include duties of the Road Manager and other officers, annual meeting date, how assessments are to be collected, check signing and accounting procedures, a provision binding future buyers or heirs to the agreement, etc. The agreement is legally binding only if it includes a legal description of the property involved and is signed, notarized and filed with the County Recorder.

Once the agreement becomes legal, those signing it are subject to all of its provisions. Thus, if provisions for payment are included in the agreement, associations can bring suit against 'holdouts'. Any judgment obtained in court can be recorded against their property as a lien. The lien prevents the owner from selling or borrowing money against his/her property until the lien is satisfied.

Bringing Suit Under Civil Code 845

Road associations sometimes face major difficulties in reaching an agreement on the method which will be used to collect assessments. For example, persons living near the entrance to a road may feel that they should pay a smaller percentage of road maintenance costs than those living a greater distance down the road. Yet, persons with property along these furthest stretches may feel that they already lessen the financial burden of other property owners while causing insignificant additional road wear. A variety of such disagreements may arise and, in some cases, the owners of a road may not be able to reach an agreement. Individuals or an association can file suit in Superior Court under Civil Code 845, which states that all persons with a common right of way must pay an appropriate share of the maintenance of that road. *Thus, even persons who have not signed the associations' agreement may be taken to court under Civil Code 845 to determine their responsibility to bear costs of maintenance.*

To initiate this process, any property owner may file a petition with their county's Superior Court for appointment of an arbitrator. The Law Library of the County Building has formbooks for petition format and style. A judge then assigns an arbitrator to the case. Costs of hiring an arbitrator vary, depending on the arbitrator's fee and the number of sessions necessary to reach a decision. Once a decision is reached, property owners not in agreement may contest the results in court. The court decision is binding to all affected property owners unless appealed.

Who Pays and How Much?

Some associations collect money as needed for routine maintenance and emergencies. Most though, find that a regular annual collection system works best. Road managers and treasurers generally handle the various aspects of billing on terms decided by the group.

Road associations have a variety of options for determining payment amounts. Property owners may do the following:

- Pay a fixed amount per parcel. This is perhaps the simplest method for calculating assessments and collecting them.
- Pay according to total acreage.
- Pay according to front or linear footage along the road.
- Pay according to formulas based on the distance from each parcel to the beginning of the road. Thus, homeowners living furthest down the road may pay a larger percentage of the total maintenance bill.

Note: Provisions are sometimes made for absentee owners and for parcels without improvements so that only a percentage of the assessment figure is paid. Provisions may also be made for individuals to contribute less money in exchange for extra hours spent on road repair work. Many associations, though, cannot afford this exchange due to the ever-existing need for additional dollars.

LIABILITY

Besides the collection of assessments, insurance and liability are of most concern to road organizations. Thus, for persons owning property along private roads, it may be wise to seek legal advice on collective and/or individual liability insurance. Regardless of whether an individual belongs to a road association, if not covered by liability insurance, he or she may be risking exposure to damages from accidents caused by any "dangerous" conditions of that road.

CHAPTER 6. LAWS AFFECTING OR REQUIRING PERMITS FOR ROAD CONSTRUCTION

The following laws and ordinances are important to know for private Road Associations, County Service Areas and any resident who lives on a private road. In maintaining your roads, it is crucial to be aware of endangered or threatened species in the vicinity of your project area. Knowing which laws and ordinances apply to you can save you time and money. RCD and NRCS staff are generally knowledgeable of the permits needed in their counties and can provide guidance for navigating the process efficiently. Some RCDs also have permit coordination programs that greatly reduce the time and expense of permitting for projects that have a natural resource benefit as would a road project reducing erosion into a local stream.

Keep in mind that the following laws and regulations are subject to amendment at any time, so if you have reason to think they may apply to you, check to verify the current status and provisions of the law.

FEDERAL REGULATIONS

Federal Clean Water Act (CWA)

Section 404 of the CWA controls activities affecting the nation's waterways and waterbodies and requires project proponents to consult with the US Army Corps of Engineers for permission to conduct work that might impact 'waters of the state'. Under this law, road improvements along or across a stream or shoreline that would involve placement or migration of 'fill' (rock, soil or plants) into the waterbody would require a permit.

Federal Endangered Species Act (ESA)

The Federal ESA prohibits any person from "taking" endangered or threatened species as identified in a list of at-risk plants and wildlife. The federal law includes harming in its interpretation of "taking" in which harm includes modifying or degrading a species habitat in a way that would significantly impair the area's breeding, feeding, or sheltering capacity and result in injury to the species. The Federal ESA is administered by U.S. Fish and Wildlife Service (USFWS) for terrestrial habitats and inland waters, and by National Marine Fisheries Service (NMFS) for coastal and marine habitats including those of anadromous fish.

Because steelhead trout and Coho salmon are listed as threatened under the Federal ESA, they are now important conservation priorities in the California Central Coast region.

The ESA provides for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend, both through Federal action and by encouraging the establishment of State programs. The California Department of Fish and Game plays a significant role in the protection of listed species. The Department of Fish and Game maintains native fish, wildlife, plant species and natural communities for their intrinsic and ecological value and their benefits to people. This includes habitat protection and maintenance in a sufficient amount and quality to ensure the survival of all species and natural communities.

CALIFORNIA REGULATIONS

California Endangered Species Act (CESA)

Like its federal counterpart, the CESA prohibits any person from "taking" endangered or threatened species identified on the CESA list of at-risk species, and sets forth a policy that state agencies should not approve projects that would result in the destruction or adverse modification of habitat essential to the continued existence of endangered or threatened species.

Streambed Alteration Agreement—Fish and Game Code Section 1601

Under this Code Section, the California Department of Fish and Game regulates activities (grading, filling, and dredging) that occur in state waters (streams, ponds, and lakes). The California Department of Fish and Game reviews construction plans and issues "agreements" signed by the applicant that provide management practices to avoid adverse impacts to state waters and adjacent riparian areas.

Porter-Cologne Water Quality Control Act

The State Water Resources Control Board and Regional Water Quality Control Boards (RWQCB) enforce the Porter-Cologne Act, made law in 1969. Porter-Cologne is California's primary water law, regarding 'waste discharges' (including soil and nutrients) to all surface and ground waters in the state. The provisions of Porter-Cologne meet and exceed the water quality planning requirements of the Federal Clean Water Act. Any project requiring CWA 404 consultation with the Army Corps (above) will require additional '401' certification from the RWQCB regarding water quality compliance.

Coastal Zoning Ordinances

Coastal Development regulations are designed to protect the coastal environment and enable citizens to develop their property within the coastal zone. Since 1981, each county has been responsible for local implementation of the 1976 Coastal Act, established by the State of California, which includes issuing coastal development permits. For further information on getting permits for construction in coastal zones, see the contacts listed for your county in Appendix A.

CALIFORNIA FOREST PRACTICE RULES

The California Department of Forestry and Fire Protection (CAL FIRE) enforces the laws that regulate logging on privately-owned lands in California. Forest Practice Act which was enacted in 1973 to ensure that logging is done in a manner that will preserve and protect our fish, wildlife, forests and streams. Additional rules enacted by the State Board of Forestry and Fire Protection are also enforced to protect these resources.

CAL FIRE ensures that private landowners abide by these laws when harvesting trees. Although there are specific exemptions in some cases, compliance with the Forest Practice Act and Board rules apply to all commercial harvesting operations for landowners of small parcels, to ranchers owning hundreds of acres, and large timber companies with thousands of acres.

The Timber Harvesting Plan (THP) is the environmental review documents submitted by landowners to CAL FIRE outlining what timber he or she wants to harvest, how it will be harvested, and the steps that will be taken to prevent damage to the environment. THPs are prepared by Registered Professional Foresters (RPFs) who are licensed to prepare these comprehensive, detailed plans. THPs can range from about 100 pages to more than 500 pages.

Article 12 of the California Forest Practice Rule Logging titled 'Roads and Landings' provides information on constructing and maintaining forest roads on private lands.

COUNTY ORDINANCES

Grading Ordinances

On the Central Coast, grading permits are typically required for activities such as moving more than 100 cubic yards of earth, creating a cut slope greater than five feet high, and all shoreline protection projects, including seawalls and rip-rap, even if less than 100 cubic yards of material. The ordinances provide that certain activities are exempt from grading permit requirements, such as excavations for basements or routine agricultural work to prepare a field for a crop. For further information on getting a grading permit call the contacts listed for your county in the following section.

Erosion Control Ordinances

Erosion control efforts aim to prevent and minimize erosion and sedimentation along stream banks in riparian corridors, and in upland areas. Excessive sediment in the channel bed impairs water quality, reduces the stream's ability to carry floodwaters, and causes or aggravates bank stability problems. Some of the things you can do to adhere to this ordinance are as follows:

- Maintain runoff rates at or below pre-development levels.
- Keep grading and land clearing to a minimum.
- Revegetate and protect exposed soils by October 15th.
- Avoid erosion-increasing activities in the winter.
- Submit an Erosion Control Plan.

APPENDIX A. RESOURCES

MONTEREY COUNTY

Resource Conservation District of Monterey County
USDA/ Natural Resources Conservation Service—
Salinas Service Center
424 La Guardia Street, Bldg A
Salinas, CA 93905
(831) 424-1036, ext. 3
www.rcdmonterey.org
www.nrcs.usda.gov

County of Monterey Environmental Health
1200 Aguajito Road, #103
Monterey, CA 93940
www.co.monterey.ca.us

County of Monterey Public Works
168 West Alisal St, #3
Salinas, CA 93901-2439
(831) 647-7748
www.co.monterey.ca.us/publicworks/

County of Monterey Planning Department
Salinas Permit Center
168 W. Alisal St., 2nd Floor
Salinas, CA 93901
(831) 755-5025
www.co.monterey.ca.us

California Native Plant Society
Monterey Chapter
www.montereybaycnps.org

SAN LUIS OBISPO COUNTY

Coastal San Luis Resource Conservation District
645 Main St., Suite F
Morro Bay, CA
(805)772-4391
www.coastalrcd.org

Upper Salinas-Las Tablas Resource Conservation District
USDA/Natural Resource Conservation Service—
Templeton Service Center
65 S. Main Street, Suite 107
Templeton, CA 93465
805-434-0396 x 5
www.us-ltrcd.org
Permitting and Grading for Ag Roads:
http://us-ltrcd.org/services/alternative-review-program/

San Luis Obispo County Planning & Building
976 Osos Street, Room 200
San Luis Obispo, CA
805-781-5600
Public Counter - 8:30 a.m. to 4:30 p.m.
Permitting and grading ordinance info:
http://www.slocounty.ca.gov/planning.htm

SAN MATEO COUNTY

San Mateo County Resource Conservation District
USDA/Natural Resources Conservation Service
625 Miramontes Street, Suite 103
Half Moon Bay, CA 94109
(650) 712-7765
www.sanmateorcd.org

County of San Mateo Public Works Department
555 County Center, 5th Floor
Redwood City, CA 94063
(650) 363-4100

County of San Mateo Planning Department
455 County Center, 2nd Floor
Redwood City, CA 94063
(650) 363-4161
www.co.sanmateo.ca.us

County of San Mateo Environmental Health
2000 Alameda de las Pulgas, Suite 100
San Mateo, CA 94403
(650) 372-6200
www.co.sanmateo.ca.us

California Native Plant Society
Santa Clara Valley Chapter
(covers Santa Clara and San Mateo Counties)
www.cnps-scv.org

SANTA BARBARA COUNTY

Cachuma Resource Conservation District
920 East Stowell Road
Santa Maria, CA 93454
(805) 455-2820
acoates@rcdsantabarbara.org

Santa Barbara County Building and Safety Office
Main Office
123 East Anapamu St
Santa Barbara, CA 93101-2058
Building & Safety Counter (2nd floor)
(805) 568-3030

North County Office
624 W. Foster Road
Santa Maria, CA 93455-3623
(805) 934-6230
http://www.sbcountyplanning.org/misc/contacts.cfm

Santa Barbara County Public Works Main Office
123 East Anapamu Street
Santa Barbara, CA 93101
(805) 568-3000

North County Office
620 West Foster Road
Santa Maria, CA 93455
(805) 739-8750
www.countyofsb.org/pwd/pwwater.aspx?id=2630

SANTA CRUZ COUNTY

Resource Conservation District of Santa Cruz County
USDA/ Natural Resources Conservation Service
Capitola Partnership Office
820 Bay Ave, Ste. 128
Capitola, CA 95010
RCD: (831) 464-2950
NRCS: 831-475-1967
www.rcdsantacruz.org

County of Santa Cruz Public Works
701 Ocean St, Rm 410
Santa Cruz, CA 95060
(831) 454-2160

Coastal Watershed Council
Photo monitoring and water quality monitoring
P.O. Box 1459
Santa Cruz, CA 95061
(831) 464-9200
www.coastal-watershed.org

STATE AND FEDERAL AGENCIES

California Department of Fish and Wildlife (CDFW)
Central Region
CDFW should be contacted for any work done within a stream/riparian corridor
20 Lower Ragsdale Drive, Suite 100
Monterey, CA 93940
(831) 649-2870
www.dfg.ca.gov

California Department of Fish and Wildlife (CDFW)
Bay Delta Region
CDFW should be contacted for any work done within a stream/riparian corridor
7329 Silverado Trail
Napa, CA 94558
(707) 944-5500
www.dfg.ca.gov/delta

CAL FIRE
www.fire.ca.gov

San Mateo-Santa Cruz Unit
6059 Highway 9
PO Box Drawer F-2
Felton, CA 95018-0316
(831) 335-5355

San Benito-Monterey Unit
2221 Garden Road
Monterey, CA 93940-5385
(831) 333-2600

San Luis Obispo Unit
635 N. Santa Rosa
San Luis Obispo, CA 93405
(805) 543-4244

Regional Water Quality Control Board
Central Coast Region 3
895 Aerovista Place, Suite 101
San Luis Obispo, CA 93401
(805) 549-3147
www.waterboards.ca.gov/centralcoast

Regional Water Quality Control Board
San Francisco Bay Region 2
1515 Clay Street, Suite 1400
Oakland, CA 94612
(510) 622-2300
www.waterboards.ca.gov/sanfranciscobay

National Marine Fisheries Service (NOAA Fisheries)
NOAA Fisheries must be consulted when anadromous steelhead and salmon are potentially affected by an activity.
777 Sonoma Ave.
Santa Rosa, CA 95404
(707) 575-6050
www.nmfs.noaa.gov

U.S. Fish and Wildlife Service (USFWS)
Ventura, CA 93003,
(805) 644-1766
www.fws.gov

U.S. Army Corps of Engineers (ACOE)
The ACOE regulates the discharge of dredged or fill material in most creeks, rivers, and wetlands.
333 Market Street, 8th Floor
San Francisco, CA
(415) 977-8462

CERTIFIED PROFESSIONALS IN EROSION AND SEDIMENT CONTROL (CPESC)

A complete list of Certified Professionals in Erosion and Sediment Control can be viewed at www.cpesc.net. Other qualified, experienced individuals may also prepare erosion control plans as recommended by your county. Check with your individual county for required qualifications.

APPENDIX B. SOURCES

California Department of Fish and Game. *California Salmonid Stream Habitat Restoration Manual*, Chapter 9: Upslope Assessment and Restoration Practices. Available online at www.dfg.ca.gov. April 2001.

California Department of Fish and Game. *Recovery Strategy for California Coho Salmon.* 2004.

County of Santa Cruz Planning Department: Environmental Division. *Maintaining Your Private Road.* September 1982.

Gordon Keller, P.E. (Geotechnical Engineer) and James Sherar, P.E. (Logging Engineer). USDA Forest Service. *Low Volume Roads Engineering Best Management Practices Field Guide.* Available online at: www.zietlow.com/manual. July 2003.

Kramer, Brian W. 2001. *Forest Road Contracting, Construction, and Maintenance for Small Forest Woodland Owners.* Research Contribution 35, Forest Research Laboratory, Oregon State University, Corvallis. Available at http://www.cof.orst.edu/cof/pub/home/

Monterey Bay National Marine Sanctuary. *Agriculture and Rural Lands Action Plan.* 1999.

National Marine Fisheries Service. *Draft Central California Coast Coho Recovery Plan.* 2010.

San Mateo Resource Conservation District. *Common Mistakes with Culverts* (handout).

USDA Natural Resources Conservation Service. *Soil Erosion and Roads* (handout).

USDA Soil Conservation Service (now the Natural Resources Conservation Service) and Central Coast Resource Conservation and Development Program. *Drainage Improvement Guide for Unpaved Roads.* January 1988.

Weaver, William E. and Hagans, Danny K. Pacific Watershed Associates. *Handbook for Forest and Ranch Roads: A Guide for planning, designing, constructing, reconstructing, maintaining and closing wildland roads.* June 1994. Available from Pacific Watershed Associates at (707) 468-9223,

Guenther, Keith. Wildland Solutions. *Effective Maintenance for Ranch, Fire and Utility Access Roads.* 2012.

RESOURCE

CONSERVATION DISTRICTS