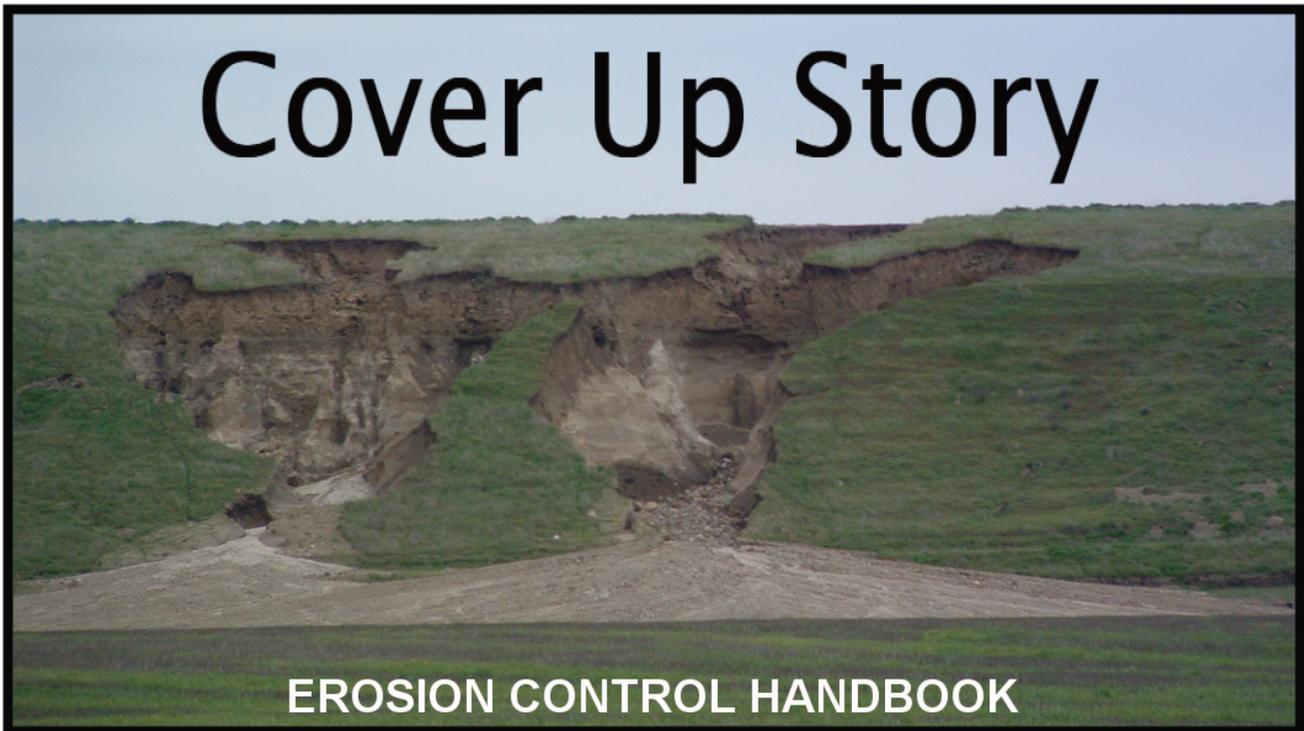


Upper Salinas-Las Tablas Resource Conservation District

and the

**San Luis Obispo County
Planning and Building Department**

Cover Up Story



EROSION CONTROL HANDBOOK

A Practical Guide to Erosion Control and Sediment Reduction

**Third Edition
July 2005**



Acknowledgements

The San Luis Obispo region's first erosion control manual, the 1985 edition of the *Cover Up Story*, was originally prepared by Diana Contasti, Soil Conservationist, USDA Natural Resources Conservation Service (NRCS). The 1994 second edition was prepared by Melissa Cattron with assistance from NRCS staff. The new 2005 updated version is combined with additional erosion control measures and guidelines to create a multi-purpose Erosion Control Handbook for use on the Central Coast.

The document was a collaborative effort that included input from County Planning and Building Department staff, most notably, Elizabeth Szwabowski. The document was prepared by the staff of the Upper Salinas-Las Tablas Resource Conservation District: Donald J. Funk, Art Pearson, Adriana Morales, Mori Seyedan and Marti Johnson. We also thank Margy Lindquist, Tina Vander Hoek, Cheryl Zelus, Ken Oster, Susan Litteral and Karl Striby, NRCS, for their many contributions. In addition, appreciation is extended to Bill Weitkamp of the U.C. Cooperative Extension and Lynn Moody, California Polytechnic State University, for their advice and recommendations.

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→ *Upper Salinas-Las Tablas Resource Conservation District*

→ *Natural Resources Conservation Service*

→ *County of San Luis Obispo Planning and Building Department*

Chapter 1

Introduction

"The nation that destroys its soil, destroys itself." -- *Franklin Delano Roosevelt*

1.1 Erosion is Everybody's Problem

Soil is one of the most critical resources on earth, a basic building block needed to sustain life. Since natural processes produce only one inch of topsoil every 500 years (approximately 0.26 cubic yards per acre per year), it is also a precious and limited resource. Like water, it can be depleted and polluted. Indeed, in San Luis Obispo County, and around the world, soil is slowly being carried into the ocean in the waters of our rivers and streams. This process of disintegration and wearing away is known as erosion.

A certain amount of erosion occurs naturally. Rich valley soils are the result of numerous floods depositing soil eroded from the upper regions of watersheds. Beaches along shorelines are formed from sands carried by streams flowing out to the sea during storm events. Naturally occurring erosion varies from place to place, based upon soil types, the amount of vegetative cover, slope, rainfall and other factors. Within our central coast region, natural erosion probably amounts to less than one ton per acre per year (one cubic yard of soil is roughly equivalent to 1.6 tons). (J. Rodriguez)

Many human activities significantly impact runoff, accelerating erosion to unusually high rates. This extreme erosion causes grave problems such as water pollution, increased flood hazard, loss of fish populations, degradation of habitat, and the general impairment of the stream ecosystem. Eroded material accumulates in our streams where it buries spawning areas, makes water unsuitable for human use, and reduces channel capacity. Unfortunately, eroded material creates problems not only by its presence in streams, but also by its absence from the land. Most of the eroded material is valuable topsoil, full of nutrients necessary for plant growth. Once gone, it will take hundreds of years to replace.

ENVIRONMENTAL COSTS OF EROSION

- Loss of streambank vegetation
- Spawning areas destroyed by sediment deposition
- Deterioration of water quality
- Other loss of habitat

Both urban and agricultural lands within the County of San Luis Obispo are experiencing accelerated soil loss resulting from human impact. The resulting economic and environmental losses are staggering. If the net loss in the County equaled only one cubic yard per acre per year, it would total over 2,000,000 cubic yards per year. The actual losses are probably much higher. At replacement costs of \$20 per cubic yard, the total losses in San Luis Obispo County would exceed \$40,000,000 per year. (GoldmanEEE) The eroded soil poses further economic burdens through the accelerated accrual of sedimentation in other areas.

TYPES OF EROSION

There are several types of erosion. **Water erosion** can be differentiated into splash, sheet, rill, and gully erosion. *Splash erosion* is the dislodgement of soil particles as a result of raindrop impact. *Sheet erosion* is the removal of thin layers of soil over an entire segment of sloping land. It is the least conspicuous and most insidious type of erosion. When runoff water concentrates in streamlets of sufficient volume and velocity to generate cutting power, *rill erosion* results. *Gully erosion* takes place when the concentrated runoff cuts deep incisions (gullies). Usually gullies follow sheet erosion and rill erosion.

Wind can also cause erosion when its sweep is unbroken by topographic features and vegetation is insufficient to cover and anchor the soil. **Wind erosion** is not a significant problem in our county due to the variable topography.

For example, erosion in the Los Osos and Chorro Valleys has filled a significant portion of the Morro Bay Estuary, damaging habitat and necessitating costly clean up and dredging programs. Erosion has also silted Chorro Creek, resulting in the abandonment of older bridges and the construction of a new bridge.

ECONOMIC COSTS OF EROSION

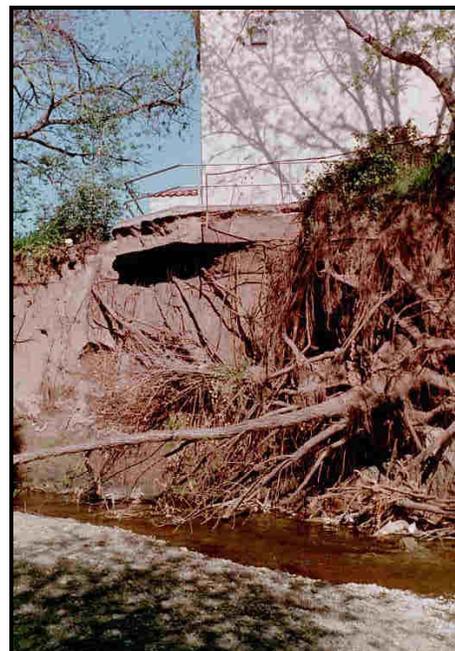
- Removing deposited soil from roads
- Dredging reservoirs, lakes, bays and estuaries
- Undermining of buildings, bridges and roads along creeks
- Replacement of lost soil nutrients
- Loss of top soil (over \$20/cu. yd)

The impacts of erosion are felt both locally and many miles away from the source. Erosion from a construction site in the Upper Salinas River watershed sends sediment over one hundred miles downstream, eventually polluting the Monterey Bay National Marine Sanctuary. As land users, none of our actions are ultimately carried out in isolation. Rather, they widely impact the environment and the communities around us.

There are various government regulations designed to keep our water clean and healthy, but regulations alone can never do the job. It will require your support. When individuals manage their land properly and cooperate with their neighbors to solve erosion and drainage problems, the whole community benefits. According to the eminent conservationist, Aldo Leopold: "We abuse the land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect."

If you are interested in learning more about good land planning to reduce soil loss and sedimentation, there are plenty of resources to help you. This handbook is designed to aid you in planning ahead to prevent or control erosion. In addition, there are many agencies and groups who can provide further education and technical assistance to help you with sound planning. By using the resources provided, along with some common sense, you can develop your land without causing erosion. In doing so, you will protect your land, rivers, and streams, and save yourself money in the long run.

Below, natural vegetation supports a stable creek channel, providing ideal habitat for fish and other animals. To the right, an eroding creek channel bears the impact of vegetation loss and increased urban runoff, undermining the building on the bank.



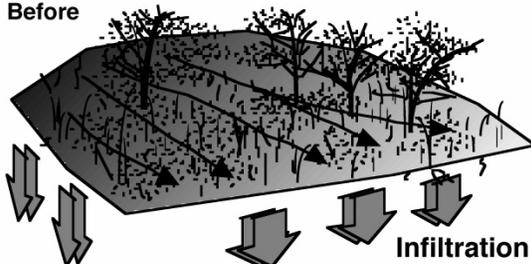
1.2 TYPICAL CAUSES OF EROSION

Any one of the following human activities can cause erosion. If two or more elements are present, erosion will increase significantly.

- Disturbance of existing drainage flow
- Removal of native vegetation
- Construction of impermeable surfaces
- Construction of improperly designed erosion control facilities
- Grading, construction or other disturbance of slopes over 10%
- Disturbance of highly erosive soil
- Off-road use of vehicles
- Roads
- Restrictions of Floodplains

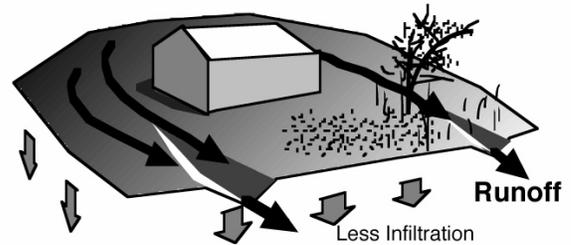
DISTURBING EXISTING DRAINAGE FLOW

Before



- Natural drainage flow
Stabilized over a period of time
- Good soil percolation

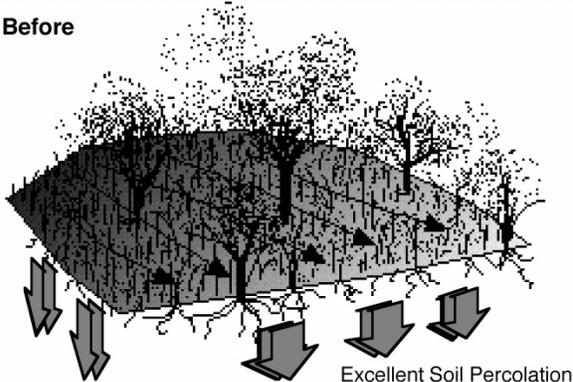
After



- Disturbance of existing drainage flow
- Drainage course altered and flows are concentrated
- Reduced soil percolation

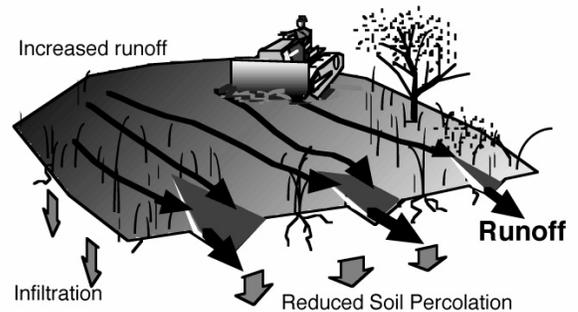
REMOVING EXISTING NATIVE VEGETATION

Before



- Soil protected by native vegetation
- Vegetation roots and coverage promotes infiltration and reduces runoff.

After

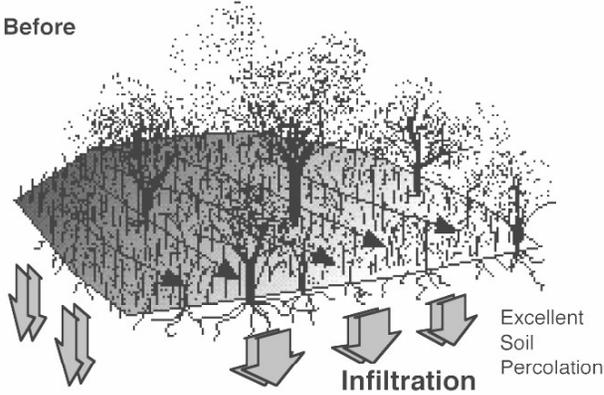


- Removal of vegetation by grading or other means removes protective roots and coverage thus increasing surface flow and greatly reducing soil percolation

ADDITIONAL TYPICAL CAUSES OF EROSION

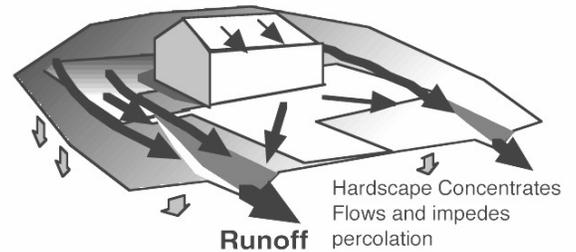
CONSTRUCTION OF IMPERMEABLE SURFACES

Before



- Soil, covered with vegetation buffers against rainfall and reduces surface flow, permitting good soil percolation (infiltration of water into the soil)

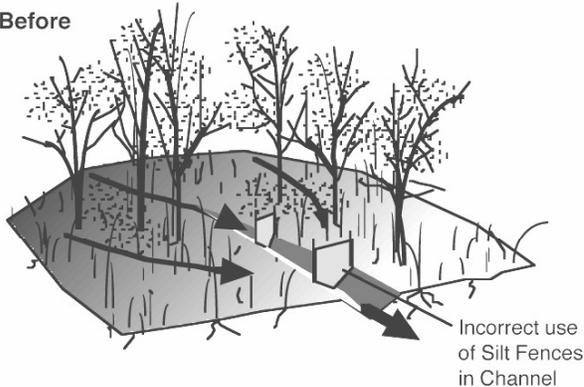
After



- Impermeable surfaces result in increased runoff and increase potential for downstream erosion
- Cumulative impact of increased runoff can be significant

IMPROPER CONSTRUCTION OF EROSION CONTROL STRUCTURES

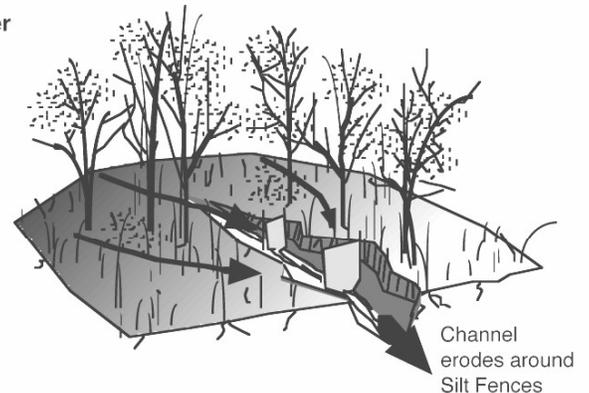
Before



IMPROPER USE OF EROSION CONTROL DEVICES

- Poor use of Silt Fences in small drainage ditch or channel
- Better solution (example only): Use proper matting blankets in combination with planting within ditch or channel

After

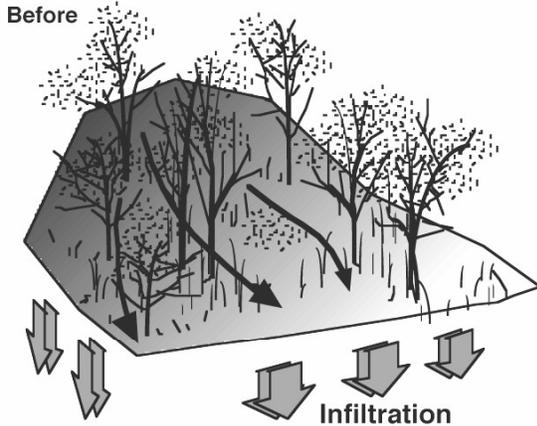


DURING STORM, IMPROPERLY USED SILT FENCES CAN CAUSE EROSION

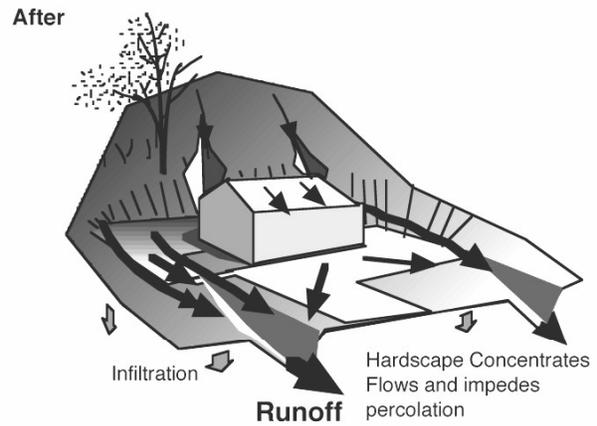
- Silt fences or improperly placed straw bales in channel or drainage ditch will accelerate erosion around and under the silt fence or hay bales
- NEVER use erosion control devices improperly

TYPICAL CAUSES OF EROSION

GRADING OR DISTURBANCE OF SLOPING LAND

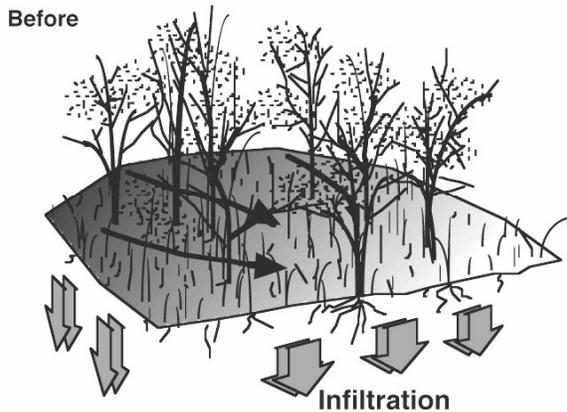


- Unaltered slopes, covered with vegetation remain stable, buffering surface flow, permitting excellent soil percolation

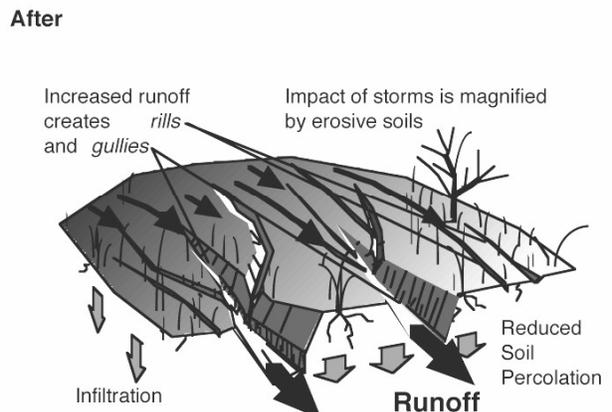


- Construction on slopes can result in accelerated runoff and may increase potential for gullying, slope failure, and downstream erosion

DISTURBANCE OF ERODIBLE SOILS



- Well vegetated erodible soils will remain stable during storms
- The key is the effect of vegetation root and coverage of foliage which protects the ground, significantly reduces surface flow and greatly increases soil percolation

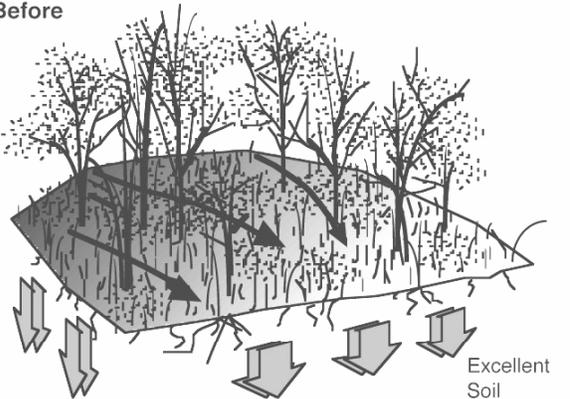


- Ground disturbance or removal of native vegetation accelerates erosion of all soils, but the effect is more dramatic on highly erodible soils.
- Rills are tiny channels only a few inches deep. Gullies are deeper eroded channels.

TYPICAL CAUSES OF EROSION

IMPROPER USE OF OFF-ROAD VEHICLES

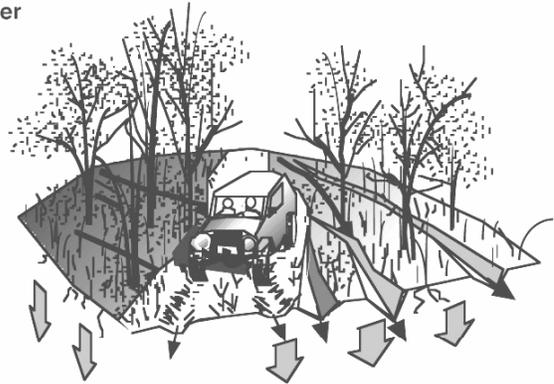
Before



Excellent
Soil
Percolation

- Soil covered with vegetation buffers against rainfall and reduces surface flow.
- This natural state is stable.

After

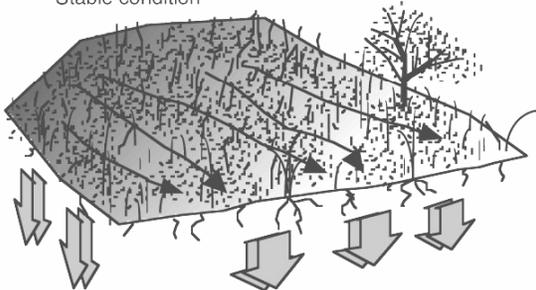


- Unmanaged off-road vehicle use can trample vegetation, compact soil, create ruts and, over time, cause erosion.
- Unauthorized vehicles in stream and river channels add oils and other contaminants.

IMPROPERLY DESIGNED ROADS

Before

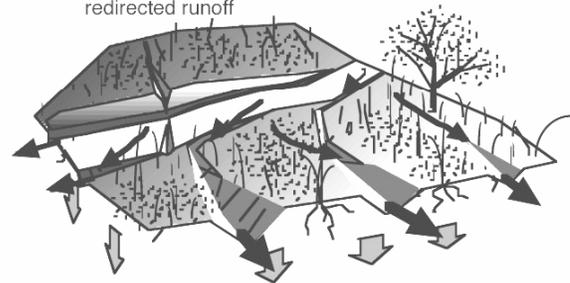
Stable condition



- Before road construction or other development, upland drainage forms sheet flow until it reaches natural channels.
- This condition reduces erosion by spreading out the flows instead of concentrating them.

After

Increased and
redirected runoff

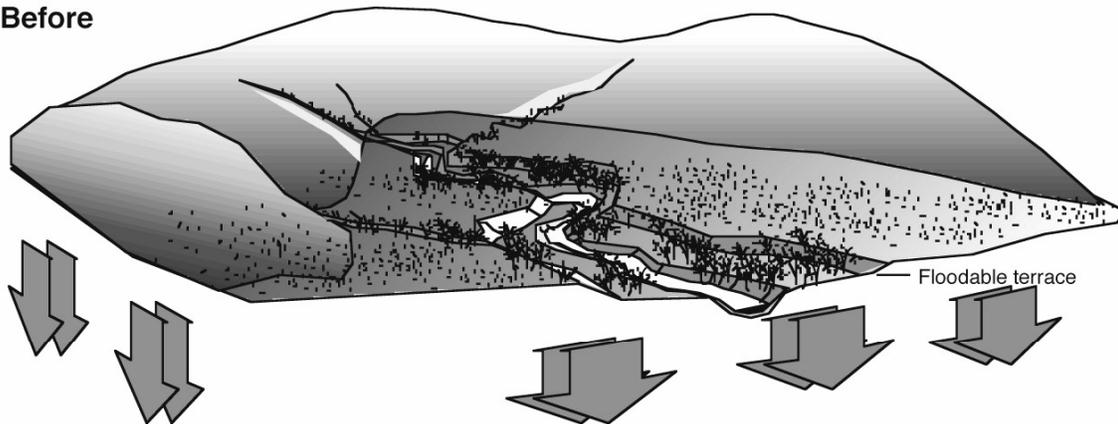


- Improperly designed roads can concentrate drainage
- Natural sheet flow is interrupted and flows are often directed to inadequate drainage ditches. These ditches can quickly erode deeper and wider.
- Soil percolation is reduced.

TYPICAL CAUSES OF EROSION

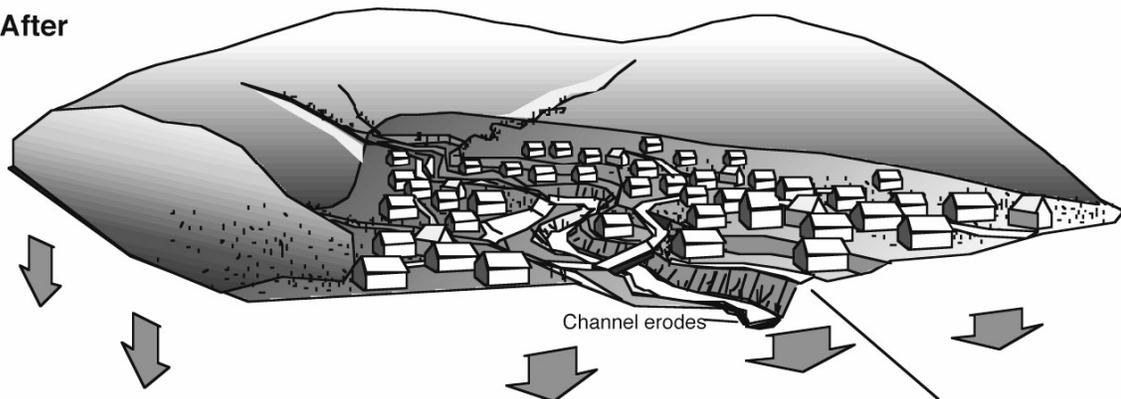
RESTRICTING FLOODPLAINS

Before



- The valley floor is typically comprised of several terraces, the lowest of which will periodically flood. This process replenishes the valley soils and assures a sustainable environment.
- Vegetation protects the channel banks from erosion. Stream water quality is good and a large percentage of rainfall is absorbed by the ground.

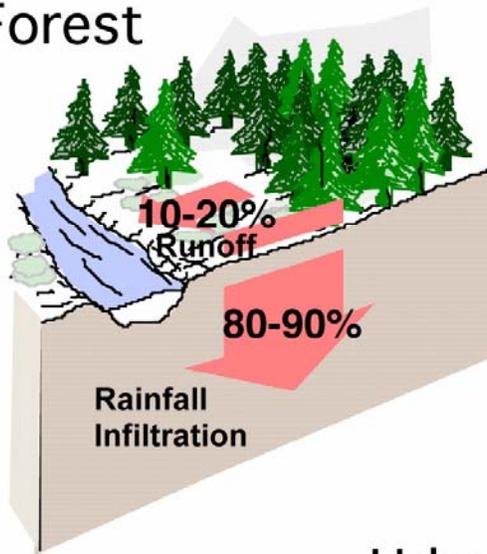
After



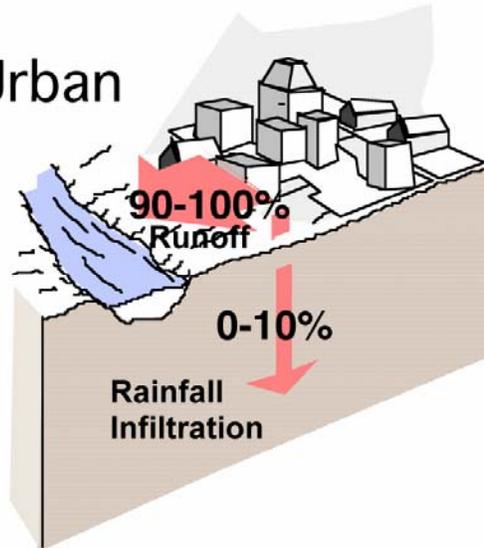
- Buildings, fill, roads and other hardscape prevent soil percolation of rainwater, causing increased runoff and accelerated flood flows. Natural vegetation is removed, further increasing stormwater flows. The result is an increased potential for downstream erosion of banks and channel beds.
- Levee restricts flood flows, concentrating and accelerating the speed of the river currents, causing entrenchment and bank erosion.

1.3 Amount of Rainfall Runoff Related to Land Use and Land Cover

Forest



Urban



1.4 Agencies and Groups Involved in Resource Conservation

Resource Conservation Districts

Local Resource Conservation Districts (RCDs) exist to help get conservation measures on the ground. The RCD program concept is a unique cooperative federal-state-local relationship. The RCD is a legally constituted unit of the State of California organized under provisions of Division 9 of the Public Resource Code. Each district is autonomous and self-governed. The governing body is composed of five to nine directors elected or appointed from within district boundaries. Directors serve without pay for a term of four years.

There are two local RCDs within the County of San Luis Obispo. The Upper Salinas-Las Tablas RCD (US-LT RCD) is located in Templeton. Its jurisdiction covers the north coast and inland areas of San Luis Obispo County and a portion of southeastern Monterey County. The Coastal San Luis RCD (CSL RCD) is located in the City of Morro Bay and covers the coastal area between Morro Bay and the Santa Maria River.

Each RCD was created in the early 1950's to develop and administer a program of soil, water, and related resource conservation. The RCD advises and assists individuals and public agencies in prevention of soil erosion, control of runoff, development and use of water, land use planning, pollution control, conservation of wildlife, and other related natural resources. RCDs are not regulatory agencies.

Landowners contract with the RCD and/or NRCS for grants and assistance for conservation projects on their property. To become a "cooperator" with a district, the landowner or operators make a formal request for assistance from the RCD. Cooperator-agreement forms are available at the district office. In the request, the land user indicates his or her interest in cooperating with the RCD in its program of soil and water conservation. The agreement is non-binding and can be terminated by either party.

Natural Resources Conservation Service (NRCS)

The Natural Resources Conservation Service, an agency of the U.S. Department of Agriculture, furnishes training and conservation technicians to assist the RCD's. NRCS has a local field office in Templeton, staffed by engineers, soils scientists, and conservationists. In addition to providing technical assistance, NRCS also has numerous other resources that they provide to the RCD and the public, including soils mapping and water quality monitoring.

Through a cooperative agreement, NRCS and the RCDs use technical staff to combine the practical experience of land users with a scientific knowledge and skills of professional conservationists and others to develop and carry out locally adapted conservation programs. NRCS does not charge for their services to the RCD and the landowner cooperators.

Central Coast Resource Conservation and Development Council (RC&D)

The Central Coast Resource Conservation and Development Council works together with the RCD and NRCS to provide them with the resources needed to carry out projects useful to landowners. The RC&D also works directly with the community in coordinating funds and resources for private projects.

County of San Luis Obispo Planning and Building Department

The County Planning and Building Department conducts project review, performs environmental determinations, and prepares long and short-range plans for the development of San Luis Obispo County. The Planning and Building Department has sponsored the preparation of the Erosion Control Handbook.

The County has entered into a cooperative agreement with the RCD's to provide erosion control assistance for landowners. As an outgrowth of this service, the Erosion Control Assistance Program (ECAP) and the Alternative Review Program were born. Through ECAP, grading and development projects are reviewed by the RCD and recommendations are given to the County for measures to help reduce possible erosion and impacts on nearby streams, rivers, wetlands, lakes, beaches and coastal waters.

The Alternative Review Program provides agricultural property owners with an option to the regular grading permit process at the County Planning and Building Department. Through this innovative program, the RCD reviews certain grading projects for agricultural uses. (refer to the County Grading Ordinance)

University of California Cooperative Extension

The Cooperative Extension Service is the U.S. Department of Agriculture's primary educational arm. Federal, state and county governments share in financing and conducting Cooperative Extension educational programs to assist the RCD's, farmers, ranchers, and other land users in applying the result of food and agricultural research. Natural resource management is one of the major program areas. Farm advisors are available to provide technical assistance and publications in each county in the central Coast area.

Farm Service Agency (FSA)

Farm Service Agency is an agency of the U.S. Department of Agriculture that administers farm conservation programs including conservation cost-sharing. FSA also administers commodity, environmental protection and emergency programs. Programs may provide for price support payments to farmers, acreage reduction, cropland set-aside, and emergency assistance.

Other Agencies and Groups That Assist Landowners

Army Corps of Engineers
California Department of Forestry
California Department of Fish and Game
California Regional Water Quality Control Board
The Nature Conservancy
The San Luis Obispo Land Conservancy
The Central Coast Vineyard Team

Other Resource Conservation Tools and Groups

Coordinated Resource Management Planning (CRMP)

The solution to natural resources management problems often requires the cooperation of landowners, government agencies, and other interested individuals and groups. CRMP addresses the dilemma of managing area with multiple use ownership, conflicting management objectives and requirements, conflicting land use demands, and off site impacts. CRMP is a tool to keep landowners and agencies working together and in the same direction.

Using the best efforts of private landowners, government agencies, RCDs, and other specialists, CRMP integrates and coordinates resource uses to accomplish specific goals.

Chapter 2

General Erosion Control Guidelines

"So direct is the relationship between soil erosion, the productivity of the land, and the prosperity of the people, that the history of mankind, to a considerable degree at least, may be interpreted in terms of the soil and what has happened to it as the result of human use."

-- Hugh H. Bennett and W.C. Lowdermilk, circa 1930's

2.1 The Importance of Planning

Most erosion originates in adequate planning by land users. In the absence of measures to address these factors, grading practices, building pads, paving, roads, buildings, agriculture, vegetation removal and other construction and development activities can increase sediment yields as much as 40,000 times. Over the course of a year, a ten-acre construction site could generate and send as much as 2,000 tons of sediment downstream, the equivalent of 200 dump truck loads of earth. (Goldman) Since most erosion results from poor land management, forethought and careful planning is a key step in effective erosion control.

An erosion control plan should consider the following:

- soil type
- topography and drainage
- existing vegetation
- characteristics of vegetation to be used
- sensitive resources: creeks, wildlife, culturally significant sites
- type of land use (residential, commercial, industrial, road, farm, ranch, timber harvest, mining, or other use)

A site map is an invaluable tool for general erosion control planning. General topographic maps as well as soils maps and aerial photos for planning are available from the Natural Resources Conservation Service. Urban uses often require site-specific topographic surveys and drainage analysis.

Identify areas of varying soil types in your plan. The NRCS soil surveys indicate soil types and soil descriptions indicating possible limitations for buildings and landscaping.

Take a careful look at the topography. While steep areas may present erosion problems, flat or depressed areas may present drainage problems.

Where feasible, preserve native vegetation. (See "Native and Drought Tolerant Vegetation" in the appendix) Native plants have adapted to the local conditions. Doing this can reduce soil erosion, help beautify an area, save dollars on landscaping costs, provide areas for wildlife, and increase the value of the land.

Other things to consider when planning are discussed in this handbook.

A development plan that includes land conservation measures to protect and maintain your property during and after construction or grading is an essential first step in a successful project. This handbook presents many planning and implementation considerations to help your project be a successful one. If you still have questions, remember that there are many agencies and groups who can provide technical assistance with your projects (see 1.4).



These two gullies were formed by misuse of hay bales. Placed in the path of runoff from an adjacent road, the hay bales interrupted sheet flow, accelerating erosion on either side.



Photo of stream filled with sediment caused by concentrated runoff from poor erosion control practices on roads and slopes.

Poor Planning Can Cause Erosion



Rills Formed by Erosion on Hillside — Caused by Removal of Vegetation



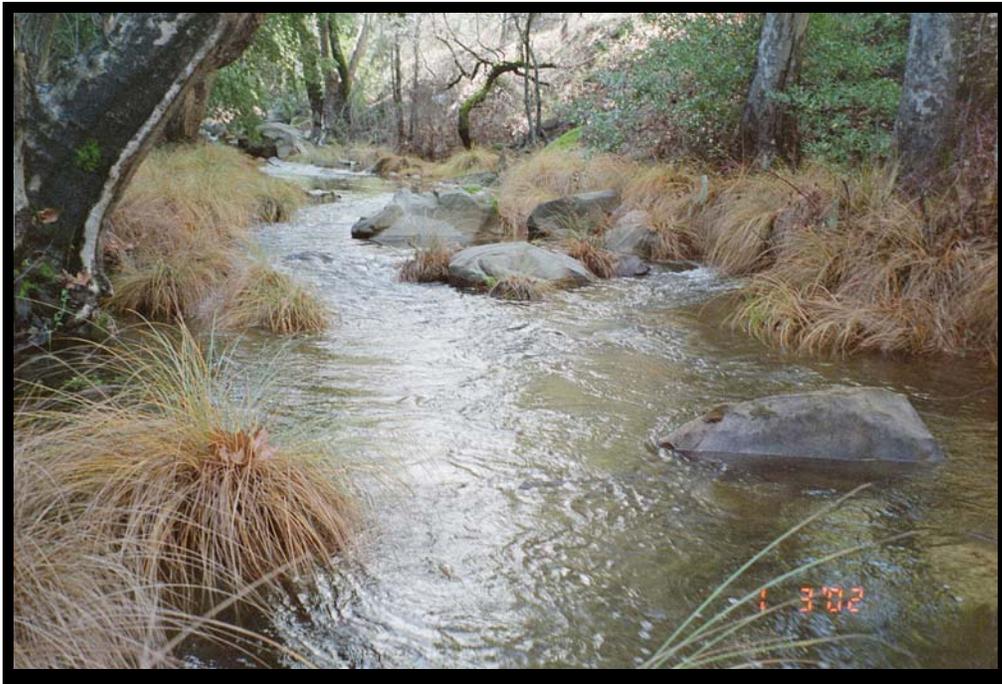
**Example of Improper Use of Hay Bales and Sand Bags in Gully
Hay bales, silt fences, and Sand Bags used in gullies often cause worse erosion.**

US-LT RCD & SLO County Planning & Building

Poor Planning Can Impact Stream



Stream channel erosion caused by excessive urban runoff and the loss of native vegetation. Location: Atascadero Creek



Stable stream channel reduces sediment, improves water quality and provides good habitat. Location: Atascadero Creek

2.2 General Guidelines for Soil Erosion Control

When rain falls on undisturbed land, there are several processes that serve to limit the amount of erosion that occurs. First, natural vegetation breaks the impact of the raindrops falling on the surface and enhances the infiltration of water into the soil surfaces. Next, the root systems hold the soil in place. Then, the undulating terrain disperses the water over a broad area, concentrating flow in swales and river channels. These swales and river channels are typically lined with lush riparian vegetation that further control the amount of erosion.

When human activities modify landscapes, this stabilized drainage flow is interrupted. Protective vegetation is removed and surface flow is redirected and concentrated, greatly accelerating erosion. With proper planning and technique, it is possible to minimize these negative impacts and the resulting pollution of our streams, rivers, lakes and oceans. The following general guidelines establish the basic principles of good erosion control planning.

❖ Retain Natural Vegetation

The most effective way to control soil erosion is to limit the amount of disturbance of the natural landscape. In nature, vegetation helps reduce soil erosion in multiple ways.

- The limbs and leaves protect the soil from the impact of raindrops.
- Plants greatly improve the ability of the ground to absorb water.
- Roots stabilize the ground and protect it from washing away.

Up to 90% of rainfall is absorbed by soil in undisturbed forests and grasslands. Erosion of land covered with natural vegetation is minimal. Remove the natural vegetation and soil absorption is reduced by more than 50%. Put streets, buildings and parking lots on that same land and ground absorption is reduced to 10% or less. When vegetation is removed, not only do we lose soil but we also impact our groundwater basins beneath us and the streams that depend upon year-round spring flow. When more water runs off the land, groundwater recharge, which provides most of the water used in San Luis Obispo County for urban and agricultural uses, is decreased.

⇒ If feasible, natural vegetation should be maintained. However, when it becomes necessary to remove the vegetation, care should be taken to mulch and plant new vegetation to replace the plants that are removed.

❖ **Conduct Grading During the Drier Months and Institute Erosion Control Practices BEFORE the Beginning of the Rainy Season**

In the Central Coast, approximately 90% of rainfall occurs during the period from October through April. When grading occurs during this period or when the ground surface is left bare during these months, erosion accelerates. A substantial portion of the soil erosion in San Luis Obispo County is from construction sites being graded or left bare during heavy rains:

- Grading should not occur between October 15th and April 15th. When unavoidable, grading during the winter months MUST include stringent erosion control measures.

❖ **Use Erosion Control and Sediment Collection Measures**

Erosion control measures for grading and development are typically conducted in two phases. The first phase is performed during grading and construction. These measures are often temporary and will be followed up with permanent erosion control that will be part of the ultimate development. An erosion control plan should be prepared for the design, construction and maintenance of both temporary and permanent erosion control facilities.

- During grading and construction, erosion control measures include:
 - Protect bare ground with the use of:
 - Mulching, planting and properly applied fertilizer, where needed
 - Erosion control blankets and netting
 - Other techniques recommended by the County of San Luis Obispo, Natural Resources Conservation Service or Resource Conservation District
 - In addition, sediment basins, silt fences*, straw and fascine wattles* and other downslope measures should be implemented to catch remaining sediment coming off cleared and graded land. (Sediment catchment should always be accompanied with other erosion control practices.)
 - * Not to be used in gullies and not to be used without mulching and planting of slopes.
- After the construction is complete, examples of permanent erosion control include the following:
 - Mulching, planting and construction of irrigation systems in landscaped areas
 - Properly designed benched graded slopes
 - Detention basins to collect storm runoff
 - Bioretention areas to collect and treat other pollutants other than sediment
 - Vegetated drainage swales
 - Outsloped roads, waterbars, culverts and other roadway drainage improvements

- Other techniques recommended by the County of San Luis Obispo, Natural Resources Conservation Service or Resource Conservation District

❖ **Keep Storm Runoff Velocities Low and Retain Sheet Flow Drainage**

Grading activities interrupt established drainage flow by removing the protective vegetation and redirecting and concentrating surface flow. For instance, when roads are designed insloped (graded to drain the road toward the hill into a drainage ditch along the road), surface flow is concentrated and velocities accelerate, increasing the potential for erosion. When roads are outsloped (graded to drain in the direction of the fall of the hillside), surface flow remains as a shallow sheet of water, reducing the potential for erosion.

- Where possible, keep drainages as a natural sheet surface flow.
- Vegetate all areas of exposed soil.
- Limit the area of paving and building surface.
- Where warranted, use drainage detention basins to slow runoff velocities and allow for percolation of rainwater into the soil.

❖ **Divert All Concentrated Runoff to Stable Outlets and Design Drainageways to Handle Stormwater Flows**

When natural vegetation is removed and the land is modified through grading and the construction of paved surfaces and buildings, much less water is absorbed by the soil. This results in increased surface runoff velocity and quantity. This water reaches channels much sooner than before development occurred. As a result, channel flow velocities are increased. When stormwater from a graded or developed area redirected into a small drainage swale (a low surface depression), often that small swale rapidly becomes an eroded gully. To prevent channel erosion and gully formation, the following principles should be followed:

- At locations of culvert or roadway waterbar outlets, one should install energy dissipating devices such as riprap aprons (see schematic design)
- Culverts should have properly designed inlets and outlets. Construct energy dissipators at all outlets.
- Drainageways should be designed to withstand stormwater peak flows by lining with vegetation and minerals that will stabilize the bed and banks of the drainageway.
- To the extent possible, maintain sheet surface flow.
- Construct drainage detention basins to moderate flow velocities.
- As a temporary measure, line gullies with protective products such as blankets.
- Plant gullies and swales with erosion control vegetation.
- Maintain the vegetation.

❖ **Limit Grading and Fit Development to the Existing Topography**

The less we modify the natural terrain, the less we disturb the processes that control erosion. Expansive terraces that are graded to accommodate buildings, roads and parking areas concentrate large quantities of stormwater runoff, increasing erosion of hillsides, gullies and stream channels. Instead, if development is designed to fit the terrain, erosion will be less.

- Reduce the size of terraces/building pads. Design buildings to fit the natural contours instead of changing the contours to fit the building.
- Locate building pads on the flattest portions of the site.
- Reduce roadway and driveway widths to lessen the amount of grading.
- Design roadways parallel to contours instead of straight up and down the hillside.
- Disturb the smallest area possible.

❖ **Protect Slopes**

While all land is susceptible to erosion, certain land areas are more apt to erode than others. Rain falling on steep slopes runs off much faster than rain that falls on flat land surfaces of less than 10%. The steeper the land, the greater the potential for erosion.

- Intensive development should be located on slopes of less than 10%.
- Slopes between 10 and 30% should have lower intensity development designed to fit the terrain.
- Development should be kept off slopes of over 30%.
- Natural vegetation should be maintained wherever feasible. All exposed slopes shall be stabilized with ground cover or other protection.

❖ **Minimize Creation of Impervious Surfaces**

Impervious surfaces such as paving and buildings reduce the absorption of rainwater into the ground and increase runoff. While natural landscape can absorb up to 90% of rainfall, impervious surfaces prevent any absorption.

- Reduce the area of impervious surfaces to the smallest area possible. Maintain all other areas as planting areas.
- Where feasible, construct parking lots and driveways with ecoblock or similar open grid surface materials. Paving blocks and brick surfaces do not provide for appreciable absorption.
- Install detention basins to collect and slow the runoff from impervious surfaces.

❖ **Inspect and Maintain all Erosion Control Facilities Regularly**

Without regular maintenance, erosion and sediment control facilities will fail. For example, sediment basins and silt fences quickly build up quantities of sediment, reducing their effectiveness and often leading to their failure. Silt fences have very small holes that allow the flow of surface water and collect sediment suspended in that water. These small holes can easily become clogged with soil particles and require constant cleaning. If these holes aren't cleared, the silt fence will cease to pass the surface flow and water will build up behind the fence, causing its failure. This permits sediment-laden water to flow into streams and lakes, causing damage and destroying habitat.

- Ensure that all landscaped areas have plant cover and that surface mulch is maintained.
- Erosion control blankets and other erosion control devices should be repaired immediately upon detection of disrepair.
- After each rainstorm, inspect at locations where sediment has been collected, clean out sediment basins and collection areas at the base of silt fences and straw wattles.
- After each rainstorm, wash off the silt fence surface to clear clogged pores.
- Inspect all control measures during storms to ensure that they are working properly. Culverts should be inspected during storms. All debris should be removed to prevent restricting flows.

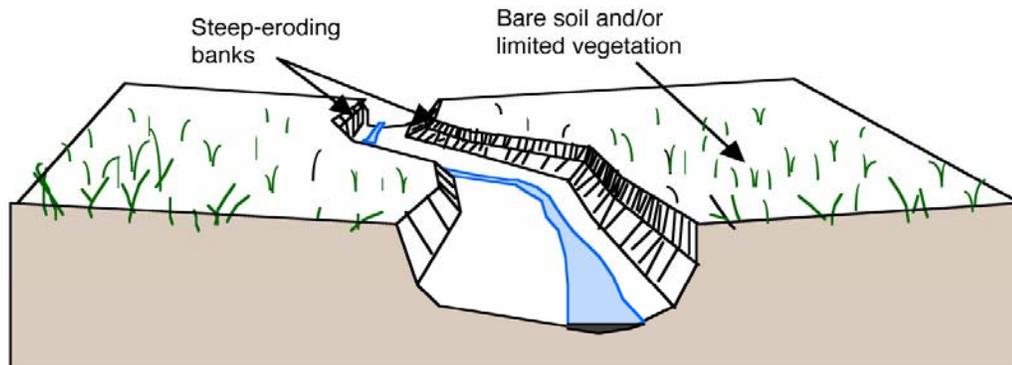
❖ **Train Designers and Contractors on Proper Erosion Control Techniques**

It can be very helpful for the professionals involved in engineering, design, grading, and construction to know the most recent measures that minimize erosion and sedimentation. The Upper Salinas - Las Tablas RCD in conjunction with the San Luis Obispo County provides short courses for the training of professionals and others interested in honing their skills.

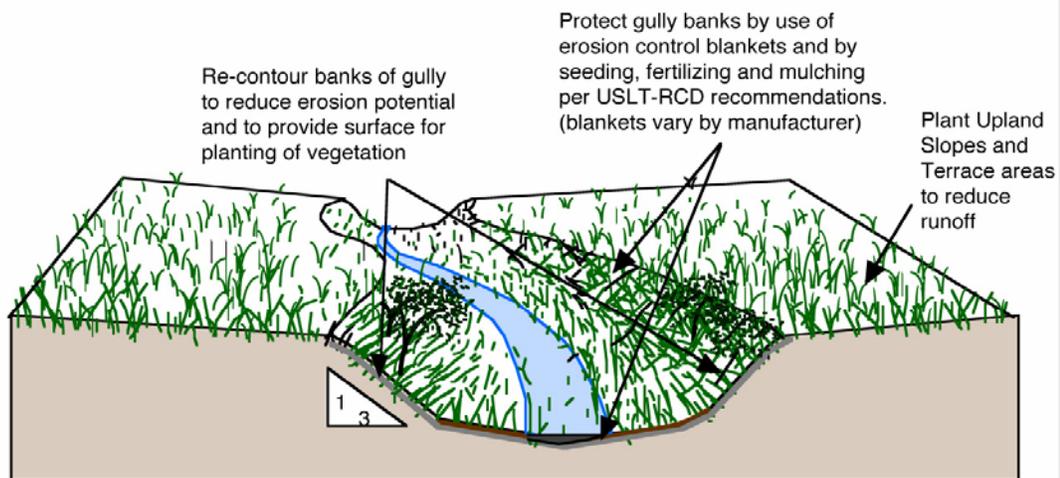
Updated training is an important tool to help individuals:

- Meet the requirements of regulatory agencies such as RWQCB and SLO County.
- Learn new procedures, methodologies and materials available on the market to control erosion in grading and construction sites.
- Discuss and compare procedures and methodologies for erosion control projects.

Example of Gully Stabilization and Restoration



Typical Eroding Gully



**Gully After
Re-contouring/Seeding/Planting
and Channel Blanket**

Note: This diagram applies to ephemeral channels (channels that only flow during rain storms) and does not apply to intermittent or perennial streams. Other measures are necessary in the stabilization of stream channels. The USLT-RCD uses stream channel stabilization measures recommended by State Fish and Game and NRCS.

Upper Salinas-Las Tablas Resource Conservation District &
San Luis Obispo County, Planning & Building Department

10/19/00

Chapter 3
Construction Site and
Short-Term Erosion Control Measures

**"A cloak of loose, soft material, held to the earth's hard surface
by gravity, is all that lies between life and lifelessness"**

--Wallace H. Fuller

3.1 Some Environmental "Do's" on Construction Sites

1. **DO** LEAVE UNDISTURBED AS MUCH OF THE SITE AS POSSIBLE

Grade only those areas of immediate construction. Leave vegetation on the site as long as possible. The more topsoil and vegetation removed from an area, the greater the chance of erosion. Sandy sites should be disturbed the least because of their highly erosive nature.

2. **DO** STOCKPILE TOPSOIL

During grading or excavation, stockpile topsoil for reapplication later. A layer of topsoil about 6" thick is good. Topsoil contains seeds of many native shrubs and grasses that will help provide vegetation growth. In addition, topsoil will enable planted grasses and shrubs to grow rapidly and thus better protect the soil.

3. **DO** APPLY EROSION CONTROL NETTING OR STRAW MULCH ON STEEP SLOPES

On slopes greater than 20%, use erosion control netting or straw mulch to hold the soil and prevent loss of grass seed. Certain highly erodible soils may require the use of erosion control netting on slopes as low as 5%. Consider hydromulching for large steep, compacted areas. All mulches will provide some degree of erosion control, moisture conservation, weed control, and reduction of soil crusting.

4. **DO** PLANT GRASS SEED OR OTHER VEGETATION BEFORE THE FALL RAINS

Plant one of the grass seed mixtures shown in Appendix on all exposed areas and fill slopes for temporary protection. Apply mulch as needed. For long-range protection, plant shrubs and trees.

5. **DO** PRESERVE TREES AND SHRUBS IN STREAMSIDE AREAS

Streamside vegetation can catch and hold sediment before it enters the stream. Roots of plants help hold the soil and reduce bank erosion. Streamside plants also provide food and shelter for wildlife. Preserve streamside vegetation for its value in erosion control and wildlife habitat.

6. **DO** INCORPORATE EXISTING NATIVE VEGETATION INTO THE LANDSCAPING PLAN FOR NEW DEVELOPMENTS

Existing native vegetation requires the least care of any planting materials. Some native plants are drought tolerant and require little water, little or no fertilizer, and can grow on difficult sites. Existing trees can beautify your development while helping to prevent erosion. Consult books such as Native Oaks - Our Valley Heritage, Cooperative Extension publications, or tree experts, to learn how to develop around trees without damaging them.

7. **DO** DIRECT WATER RUNOFF AWAY FROM ERODIBLE AREAS

Direct runoff into detention basins, grassed waterways, well-vegetated areas, storm, drains or other downstream areas not prone to erosion. Pipes, wooden culverts or paved drainage ditches can be used to carry water down steep slopes. On highly erosive soils, rooftop runoff should be run directly to the street or to some form of dry well or French drain. Roads should be outsloped wherever possible in order to evenly distribute drainage over the land.

8. **DO** REDUCE RUNOFF VELOCITY BY USING CHECK DAMS OR ENERGY DISSIPATERS

Energy dissipaters will slow down the movement of water and reduce its capacity to carry soil. Check dams can be used in conjunction with sediment basins or siltation ponds to keep soil on the site and prevent pollution. The California Department of Fish and Game should be consulted before obstructing the natural flow; changing the bed, channel or bank of a stream; or using sandy material from a streambed. Any in-stream requires a permit from the Department of Fish and Game.

9. **DO MAKE SURE CONSTRUCTION PRACTICES CONFORM TO COUNTY AND STATE REGULATIONS**

You may need a County Grading Permit. You should check the San Luis Obispo County Land Use Ordinance, Title 22 for Inland Areas and Title 23 for Coastal Zone Areas for information. You may also be required to get a permit from the California Department of Fish and Game, Regional Water Quality Control Board, U.S. Army Corps of Engineers, Coastal Commission or other governmental agencies, depending on the nature and/or location of your work. In most cases, the permit requirements will be minimal, but be sure to know your obligations under the law before you begin.

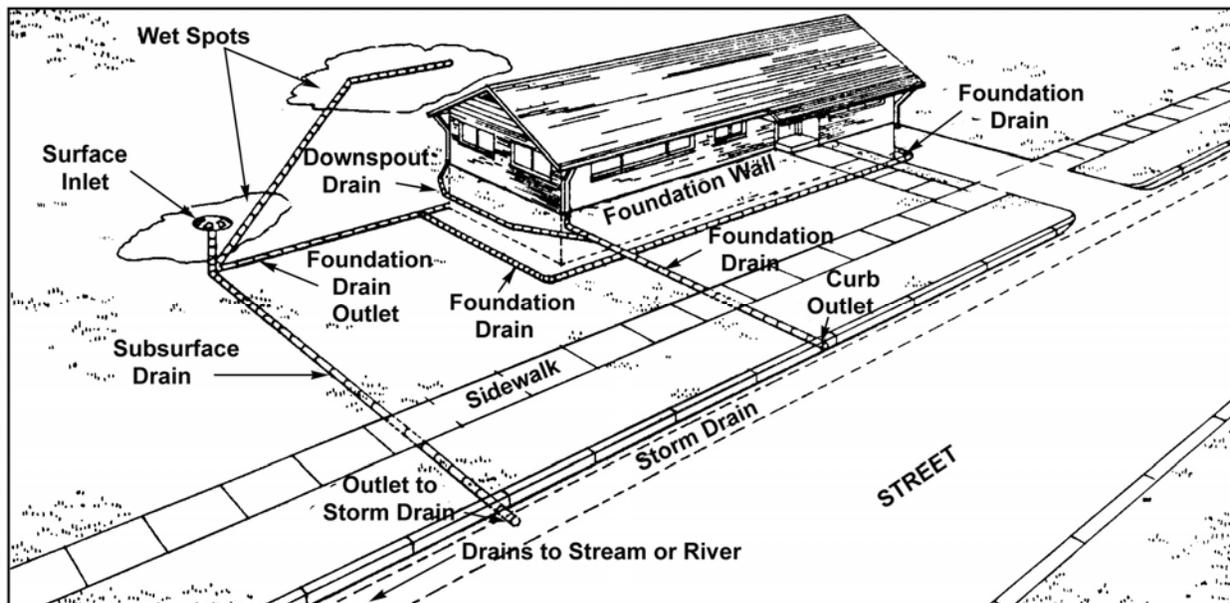
3.2 Ponding, Flooding, and Saturated Soils Around Structures

You may have a drainage problem around your structures if the basement is wet, the yard is flooded periodically, water ponds on your lawn for long periods after a rain, or trees, shrubs, and other plants grow poorly. Wetness, generally, is caused by flooding, ponding of surface water, springs and seeps, seasonal high water table or slow soil permeability.

Ponding of Surface Water

If surface water ponds on your yard or driveway, you can install small diversions or shallow ditches to channel off the water. In developed residential areas, these diversions usually are installed near property lines.

For low flows of surface water, you can install a surface inlet leading to a subsurface drain. The drain outlet can empty into street gutters or storm sewers if permitted by local building codes.



Subsurface drainages around structures can remove excess water.

You should grade your yard so that surface water drains away from the structure. A minimum grade of 1 foot in 100 feet is generally adequate (a slope of approximately $\frac{1}{4}$ "

per foot). When filling in low areas during grading, use the most permeable soil available. Save the topsoil and spread it over the newly filled and graded areas to help establish vegetation.

Installing suitable downspouts to control roof water may be adequate to prevent ponding in low areas of your yard. Downspouts can empty into a subsurface drain or into outlet spreaders installed to discharge water in a thin layer over a grassy area.

Flooding

If your structure is in the flood plain of a nearby stream or creek, it may be flooded if the stream overflows during periods of heavy rainfall. Flooding is a natural occurrence for many areas near streams and rivers. Usually, community-wide measures are needed to insure adequate protection. Flood protection measures include: provisions for blocking openings such as windows and doors, regulating drain outlets, and waterproofing. These measures can be expensive and require careful evaluation to prevent structural damage. Construction within flood plains should be avoided whenever possible. Avoid building on property protected by levies or dikes. If you are starting to build a structure, be sure the site is not highly floodprone, and build the living areas a minimum of 1 foot above any expected flood level. The County can provide you information for floodable areas and give you elevations of possible flooding.

In upland areas, flooding can occur if your structure is built in the path of a natural drainageway or in a pothole or site that is lower than the surrounding area. A drainageway or low area may appear safe in dry seasons but carry runoff water in wet seasons. In housing developments where the landscape has been greatly modified, natural drainage-ways are often blocked or altered. If manmade drainageways or storm sewers are not built to carry the seasonal flow of water, nearby structures may be flooded. Runoff from areas as small as one acre can cause flooding. Measures to remedy this kind of hazard usually require the cooperation of several property owners.

In communities built on old dunes such as parts of Los Osos and Nipomo, there are numerous depressions that have no drainage outlet. These areas are also prone to

periodic flooding. For these floodable areas, it is also recommended that you build living areas a minimum of 1 foot above the highest expected flood level.

Springs and Seeps

On many sites, natural springs and seeps occur because of existing soil, rock and landscape characteristics. Water may flow throughout the year or only seasonally during periods of heavy rainfall.

Water may flow into or around your structure if it is constructed over or near a spring or seep. For protection, it is a good practice to install subsurface drains, at least 4 inches in diameter and surrounded with 6 to 12 inches of gravel, or sand and gravel, along the outside of the foundation wall.

Springs and seeps also affect lawns and on-site septic fields. You can install subsurface drains to collect the groundwater and divert it from such areas. Be sure to check local building codes for approved materials and other drainage regulations.

Subsurface drains are commonly made of clay and concrete tile, perforated plastic, metal, cement, or bituminous (wood fiber) approved materials and other drainage regulation.

Seasonal High Water Table

A water table can be defined as the upper surface of ground water or the level below which the soil is saturated with water. This level may fluctuate by several feet throughout the year depending on soil, landscape, and weather conditions. Where annual rainfall is 20 inches or more, the seasonal high water table is 2 to 5 feet below the ground surface. At times, the seasonal high water table may be only 1 foot below the ground surface.

In some cases, portions of existing communities have been built on top of historic wetland areas. For these areas, constant or periodic subsurface and surface water problems may occur. Such sites should be avoided whenever possible. Solutions are

often very expensive and construction and repair costs for structures may increase significantly.

In selecting a new structuresite, the level of seasonal high water table is a very important consideration. On some sites, the seasonal high water table may be at or near the ground surface for long periods. These areas should be avoided. If the water table is 6 feet deep or more, it may be of little concern, unless septic tanks are in use.

If your structure is already built, you can install drains around the outside wall or under the basement floor. Lowering the water table under the basement floor should be done with the walls.

On lawns, where only a small part is affected by a high water table, a small excavated landscaping feature. Before you build a pond, be sure to check water and local safety regulations that apply to pond construction.

Slow Soil Permeability Problems

If the soil at your site has a dense layer, especially a layer of clay, flow of water through the soil may be restricted and water may pond on your lawn. If the dense layer is near the surface, you can dig a small trench through the layer and fill it with sand, gravel, pinebark, sawdust, or other coarse material it improve permeability in small, low-lying spots.

For larger wet areas, you can install subsurface drains 4 to 6 inches in diameter at a depth of 2 to 5 feet. The drains should be packed with 6 to 12 inches of porous material such as sand or gravel. If available, sand and gravel can be used to backfill the drain trench to within a foot of the ground surface. Topsoil can be used to fill the surface layer.

Even on well-drained soil, heavy foot traffic during wet periods compacts the soil and reduces permeability. Restricting foot traffic in the wet yard helps prevent ponding.

How to Get Help

Local building suppliers, contractors with special training in drainage and erosion control, county and municipal agencies, or RCD's may be able to provide more information about planning and installing drainage measures around your structures.

3.3 Structural Measures and Mechanical Devices for Erosion Control

The following figures illustrate some of the many types of erosion control practices and devices. An explanation of the devices and their usage are given below.

Downdrain

Downdrains are used to convey fast-moving runoff down steep slopes without causing erosion to a safe outlet. A downdrain can be a corrugated pipe, flex pipe, a wooden flume or any kind of lined channel. Downdrains should be designed to at least handle the runoff generated by a ten-year intensity storm. They should be constructed to provide permanent protection.

Velocity or Energy Dissipater

A velocity dissipater is used to slow movement of water, and by doing so, reduce its capacity to carry soil. Velocity dissipaters are commonly used at the end of a downdrain. A velocity dissipater can be anything from a concrete box with a spillway to a pile of concrete rubble and boulders. It should provide permanent protection.

Terraces

Bench terraces constructed across the slope of the land and fitted to the natural terrain are used to break long slopes and slow the flow of runoff. They should be designed to avoid concentrating and directing water onto unprotected surfaces. Small terraces are sometimes used on the face of cut-and-fill slopes to help control runoff and erosion and to allow the establishment of vegetation.

Catchbasin or Siltation Pond

Siltation ponds function to detain runoff and trap sediment before allowing water to pass downstream. Ponds can be excavated or formed by a combination of dam and excavation. In any case, the outlet from the pond should be protected from erosion.

Berm or Waterbar

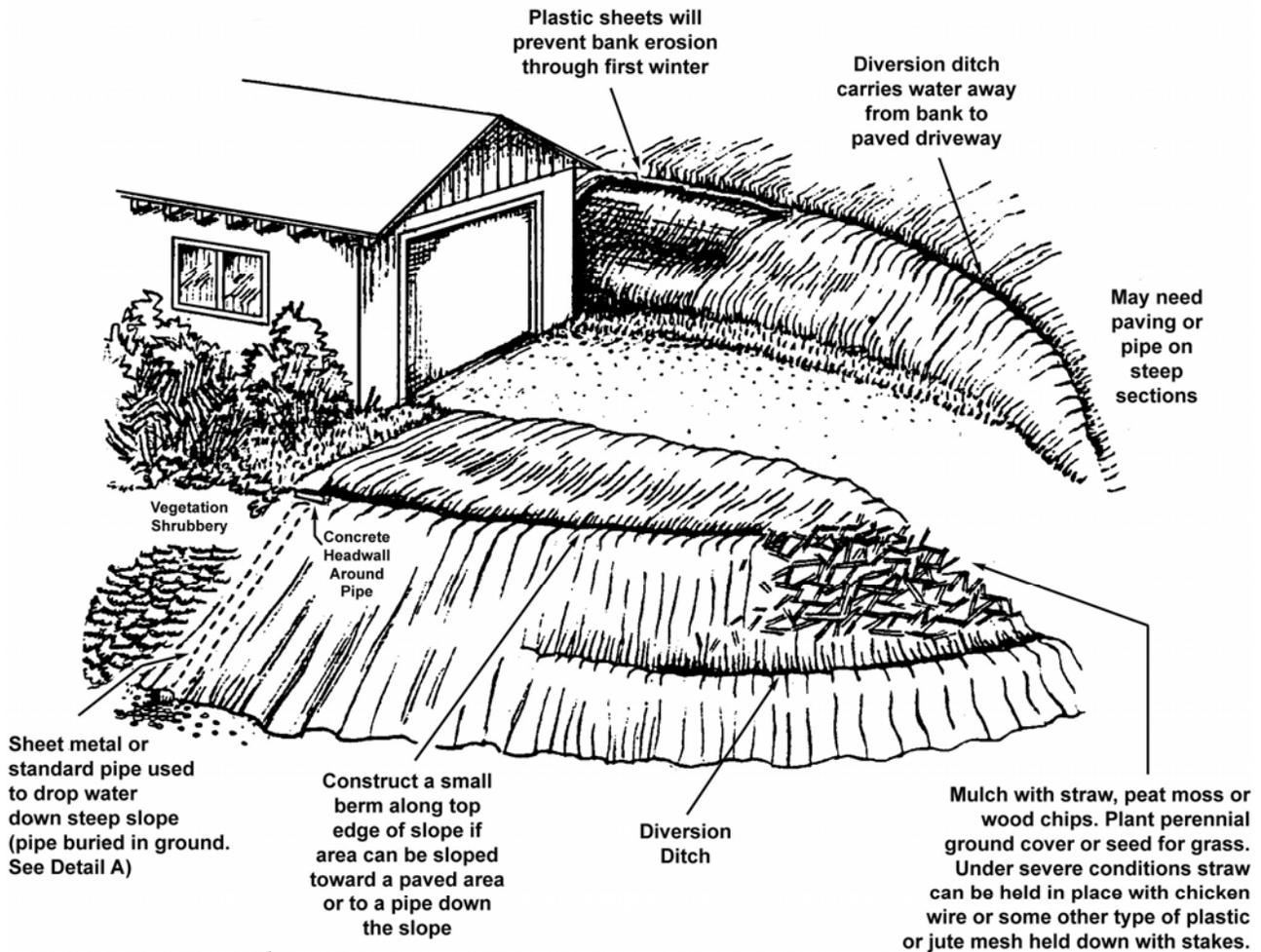
A berm is a compacted earth ridge, which serves to intercept and divert runoff across the slope on slight grades. Berms may be temporary or permanent. They can be constructed across graded rights-of-way in a series and at intervals needed to intercept runoff. Berms need a stable outlet to dispose of water safely. Curbs may be used in place of berms for more permanent protection.

For assistance in selection and design of erosion control structures to meet your problem, consult the Natural Resources Conservation Service.

Roof Runoff and Cisterns

Drainage from roofs and other surfaces can be collected and directed through gutters and pipes to cisterns, tanks or small ponds and reservoirs. This water can be used for irrigation or other purposes if of adequate quality. These storage facilities should be designed properly to ensure that hazards do not exist. Ponds and reservoirs often require engineering design to ensure that failure does not occur.

Hillside Erosion Control Practices and Devices



Detail A

Headwall at upper end of pipe

3.4 Mulching, Erosion Control Blankets, Silt Fences, and Straw Wattles

Mulch and Erosion Control Blankets

Mulch is a protective covering applied to the soil surface. Blanket matting may also be used to protect against erosion, either in combination with mulch, or by itself. If mulch or blankets are applied to the soil surface, they will reduce runoff, prevent compaction, lessen raindrop impact, allow more water infiltration, reduce evaporation, and hold the soil in place. Topsoil protected by mulch or blankets holds more moisture near the surface and promotes better seed germination and seedling growth rates. Mulch and blankets also protect the seed and prevent it from washing away. For emergency soil protection, a good mulch cover or blanket will carry through one normal rainy season even without seeding. Natural mulch from chipping operations is often used on fairly level areas to aid in water infiltration. On steeper slopes a variety of mulches and blankets may be used.

Straw Mulch

One of the most effective and inexpensive methods of applying protective mulch is to spread straw or hay over the seeded and fertilized area, and tacking it into the soil surface. Hay will provide an added source of seed. However, care must be made to assure that unwanted seed (i.e. invasive species) is excluded from the straw source.

Tacking straw into the soil surface is crucial for seeding success, and depending upon the size of the affected area, can be done with a shovel or equipment, such as a crowbar type tractor. Once the straw has been tacked or crimped into the soil surface, the seeding is adequately protected from washing or blowing away.

Hydromulching

Hydromulching and hydroseeding are the application of mulch or seed in a slurry. Mulch, seed, fertilizer, and a binder are often added in this mix, which is sprayed

onto a slope under pressure. This method is often used on roadside banks and other newly constructed areas where it is difficult for equipment to travel.

Hydromulching is not as effective as straw mulch since the smaller pieces can wash away because they are not worked into the soil. Timing of hydromulching is important. This material should be applied September 15 - October 15. If applied earlier, during the summer, breakdown of the material can occur and it loses its soil holding effectiveness even before the winter rains.

Jute Matting or Netting

Jute netting is used to protect straw or wood fiber mulches from wind or water damage. It is used alone or can be applied over the straw or other mulches. This method should provide the best erosion control on a newly seeded site.

However, the cost may be a limiting factor and the netting must be installed properly.

Wood Excelsior Matting

Erosion Control Blanket is a mat of wood excelsior fiber bonded to a paper or plastic reinforcing net. Often used as an alternative to jute netting, it is a little more difficult to install and erosion control is less predictable.

Biodegradable Plastic Woven Matting

Biodegradable plastic woven matting is available for a variety of erosion control uses. Useful on seeded or planted slopes and small drainage channels, it is best suited to sites where soil is moist at time of seeding. A variety of woven plastic mats are available. It does not supply additional moisture holding capacity or organic matter as do other mulches. It does reduce surface impact of raindrops and over-the-slope runoff. Maintenance is more critical with biodegradable plastic

matting than the other mulches listed above and installation would most likely be by professional landscape services.

Straw Matting

Coconut husk fibers coir matting and straw matting are other alternative materials that can be used for erosion control. These materials are often woven with a plastic mesh to hold them together. Similar to jute matting, straw and coir matting can provide good stabilization to the soil allowing plants to get a good foothold.

Maintenance

All erosion control mulches, blankets, and plantings should be monitored throughout the winter rainy season to be sure that they are functioning adequately. Often, one person with a shovel can correct initial runoff problems while they are still small. If left unattended, these small problems could develop into major washouts. Grass and legume stands planted for long-term cover will need periodic maintenance. Maintenance measures will vary from site to site and may include: fertilizing, irrigating, or mowing.

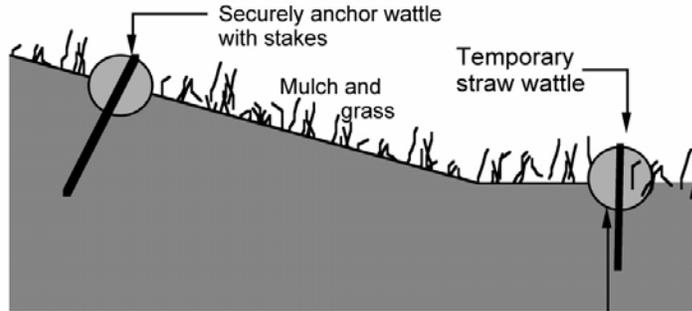
Recommended Straw Wattle Detail

- Maximum of 2 to 1 slope

- **IMPORTANT**

Both straw wattles and silt fences require regular inspections and maintenance. Whenever either becomes clogged with sediment, their effectiveness becomes impaired and they should be replaced immediately.

Note that silt fences and straw wattles should NOT be used without other bank stabilization. Silt fences and straw wattles should NOT be used in swales or gullies.



Both straw wattles and silt fences work by filtering out sediments and temporarily storing sediment from runoff water. Both can easily become clogged and/or otherwise damaged. Both must be replaced and/or repaired whenever this occurs.

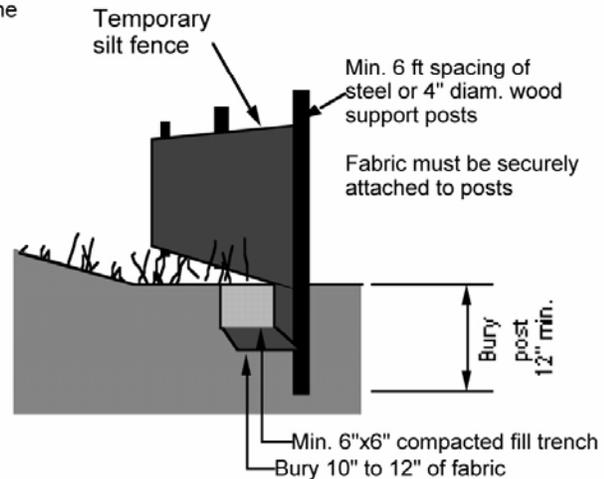
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Partially bury straw wattle

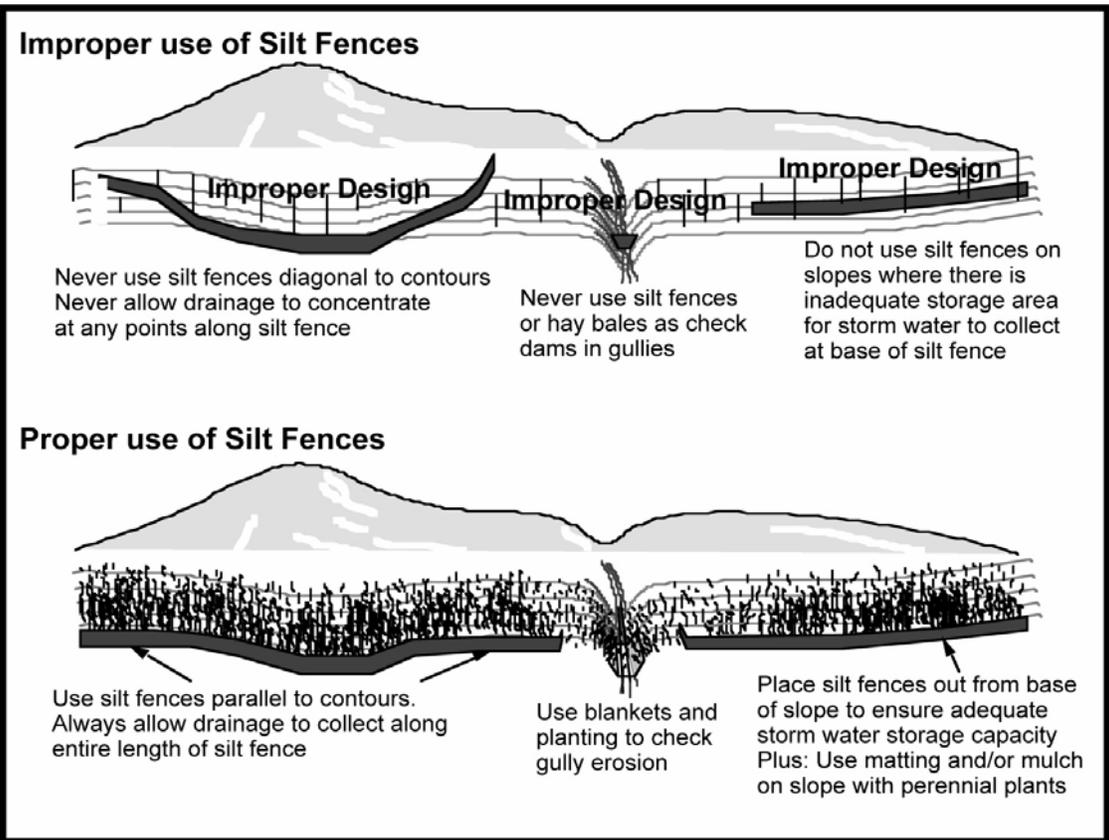
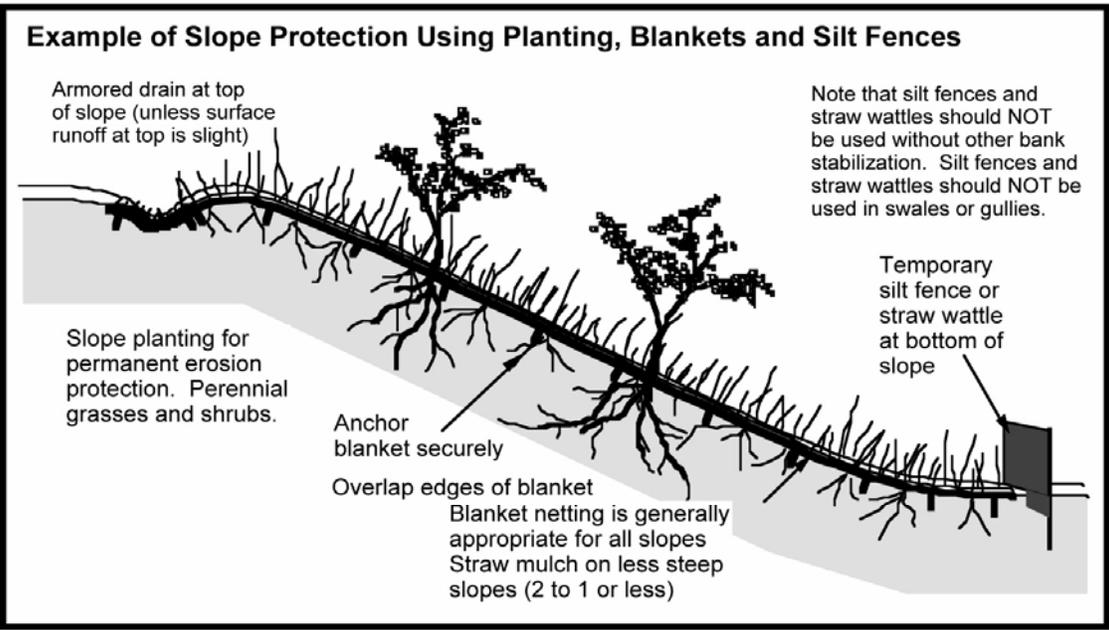
Recommended Silt Fence Detail

- Drainage area for silt fence: 1 acre or less
- Maximum of 2 to 1 slope
- Maximum flow path length of 100 feet above fence
- Select filter fabric on the following basis:
 - 1 If 50% or less of the soil, by weight, is fine particles smaller than the US standard sieve No. 200, the equivalent opening size (EOS) should be equal to the sieve size that 85% of the soil can pass through.
 - 2 For all other soil types, the EOS should be no larger than the openings in the US standard sieve No. 70 (0.21 mm)
 - 3 In no case should an EOS size smaller than standard sieve No. 100 (0.15mm) be chosen (to prevent clogging)

Note that silt fences and straw wattles should NOT be used without other bank stabilization. Silt fences and straw wattles should NOT be used in swales or gullies.



Use this detail unless more stringent criteria are recommended by manufacturer



Improperly Installed Silt Fence



Silt fences should NOT be used in swales or gullies and MUST be keyed into ground

Culverts Partially Clogged with Sediment



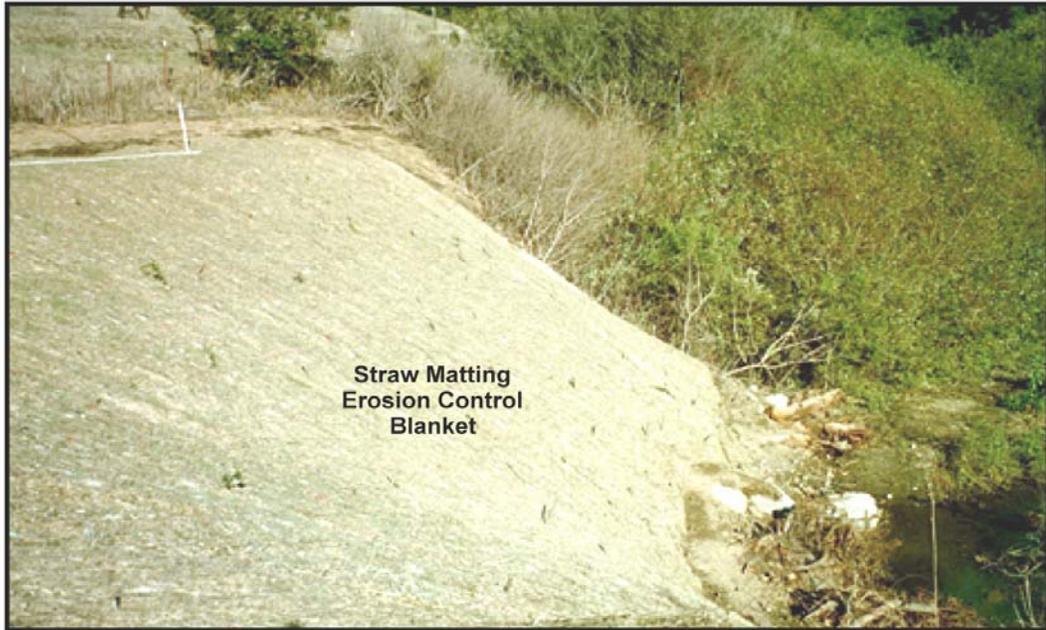
The capacity of the culvert is reduced by sedimentation.

US-LT RCD & SLO County Planning & Building



Failure of Erosion Control Blanket Caused by Excessive Drainage on Slope

Partially Failed Erosion Control Blankets from Excessive Runoff
Runoff should NOT be permitted to concentrate at top of blankets



Straw Matting Erosion Control Blanket

Correctly Installed Straw Matting-Erosion Control Blanket
Blanket secured to bank and water allowed to sheet flow to creek.

US-LT RCD & SLO County Planning & Building

Good Planning Can Significantly Reduce Erosion



Mulch and seed slopes to reduce erosion. Use silt fences to prevent excessive runoff over top of slope. Blankets can be used in place of mulch.



Bench tall slopes to further reduce erosion potential. Collect drainage on each bench and direct to properly designed culverts or lined open drainage swales.



Stake Securing
Straw Wattle

Example of Straw Wattle



Outlet Pipe

Small Detention Basin

Inlet Pipe bigger
than outlet pipe

Example of Temporary Storm Water Drainage Detention Basin

US-LT RCD & SLO County Planning & Building

Chapter 4

Long-Term Erosion Control Measures

"Essentially, all life depends upon the soil....There can be no life without soil and no soil without life; they have evolved together."

--Charles E. Kellogg, 1938

4.1 Using Woody Plants for Long-term Erosion Control

Trees and shrubs play an important role in erosion control and beautification. Being deep rooted and long lived, they can provide long lasting protection with little or no maintenance requirements. Although they will reduce surface erosion and provide partial slope stabilization, they cannot completely prevent slumping of steep slopes that become waterlogged. The role of woody vegetation on landslide susceptible areas is to provide protection of the soil from rainstorm impact, help anchor the soil mantle to the fractured bedrock, and to help maintain proper soil moisture content. These actions benefit slope stability. However, in cases of severe instability of slopes, construction of stabilizing structures may be necessary.

Newly planted trees and shrubs are of little immediate value for erosion control. Newly transplanted or seedling plants will not protect the soil. Their value comes later when they become established on the site and have made considerable growth. Therefore, they cannot be used in place of a grass/legume cover. They do, however, aid in the transition between grass and the return to more stable native vegetation. Trees and shrubs are also quite attractive and provide habitat for many bird and other animal species.

Appendix Table A-2 lists plants that are recommended for erosion control. Site conditions will determine which plants are suitable. However, within the physical constraints, you can choose plantings that suit your own personal tastes and purposes. Environmental factors, such as climate, soil type, amount of soil moisture and wind, and degree of sunlight at a given site must be considered. A good way to judge the physical suitability of a plant to the site is to observe the nearby native vegetation. Select a species from this list that also occurs naturally near the site. Be sure to choose a plant adapted to those conditions.

The three recommended methods of planting trees and shrubs are 1) from container stock (plants in cans), 2) from seed, and 3), from hardwood cuttings and bare root. Establishment by seeding or from cuttings is not suitable for every planting site, but

where conditions are suitable, it is cheaper and requires less maintenance than the use of container stock. However, container stock is readily available at nurseries and is the simplest method. The techniques to use for each of these planting methods are discussed below.

SEEDING WOODY PLANTS

Often it is less expensive to plant seed than container stock. Some native central coast species listed below are excellent candidates for direct seeding. Do not collect seeds on private or public property without permission. Contact a plant nursery or the California Department of Forestry and Fire Protection for the names of seed dealers.

DIRECT SEEDING PROCEDURE

- Dig a hole 4 inches deep. (If gophers are a threat, dig the hole 12-18 inches deep and place a cylinder of ½ inch mesh poultry wire in it, then refill to leave a hole 4 inches in depth.)
- It is recommended that you apply slow release nitrogen fertilizer at 4-inch level (3 teaspoons per hole). If soils in your area are low in sulfur, add 1/4 teaspoon of potassium sulfate.
- Fill hole with soil to the proper planting depth listed in the table below. Tamp firmly to correct level for seed you are planting. Add seeds per table.
- Cover the seeds with pulverized soil. Firm soil by hand or trowel, leaving a depression of the depth specified below.
- Water to settle soil well and to provide ample moisture for seed germination.
- Protect seeds and seedling from birds and rodents by constructing and installing a cage of ½ inch mesh poultry wire 6-15 inches in diameter around the seeded area. Stake the cage down.

Direct Seeding Information for Woody Plants

| Seed Diameter (inches) | Seeds per Hole (number) | Depth of Depression Below Surface (inches) | Depth of Soil Over Seed (inches) | Depth of Depression For Water (inches) |
|------------------------|-------------------------|--|----------------------------------|--|
| < 1/16 | 20 | 1/4 to 3/8 | 1/8 | 1/8 to 1/4 |
| 1/16 to 1/8 | 10 | 3/8 to 1/2 | 1/8 to 1/4 | 1/4 |
| 1/8 to 1/4 | 5 | 1/2 to 3/4 | 1/4 to 3/8 | 1/4 to 3/8 |
| 1/4 to 1/2 | 3 | 7/8 to 1 | 1/2 | 3/8 to 1/2 |
| Acorns | 3 | 2 to 2 ½ | 1 | |

Control weeds until seedlings are big enough to compete. A layer of mulch 2 inches deep and kept 2 inches away from the emerging seedlings on all sides will help. Extend mulch to at least a one-foot radius. Oaks should have a two-foot radius of mulch cover. Be careful not to disturb seedlings when weeding.

Most of these plants will grow without irrigation, but they will get a better start if they are watered their first year.

Trees should be thinned to one per hole by cutting off all but one of the trunks level to the ground. Do not pull out the extras, as this will disturb roots. Wild lilac, flannel bush, and purple sage shrubs will do fine with two plants remaining in each hole.

If planting in an area where irrigation is to be installed or where you will water regularly by hand, fertilize the winter after the first growing season with two times the amount of nitrogen used at planting. Put the nitrogen in two times the amount of nitrogen used at planting. Put the nitrogen in two five-inch holes or spread it in a 4 - 12 inch wide band around the plant. Keep it 4 inches from the plant.

HARDWOOD CUTTINGS

Hardwood cutting are taken from fairly mature wood of various species. Take cuttings during the dormant season (winter) from branches that are one year old and from healthy shrubs and trees in the general area. (Do not take cuttings without permission.) Cut an 18-inch long section of branch (3 foot lengths recommended for willow cuttings). The branch should be at least the thickness of a pencil and have at least 3 leaf buds in the section that you will use to propagate your plants. It is recommended that willow cuttings be approximately 1 inch in diameter.

Cut the bottom diagonally, just below a bud. Cut the top straight across just above a bud. Your cutting should be at least 9 inches long and have at least 3 leaf buds.

Insert the cuttings directly into the soil at the location you have selected for the plant, making sure the slant cut end is placed into the ground and at least two leaf buds are above ground.

Hardwood cuttings may be taken from most ornamental trees and bushes. Willow (*Salix* sp.), cottonwood (*Populus* sp.), quailbush (*Atriplex lentiformis*), and mulefat (*Baccharis viminea*) are excellent candidates for hardwood cuttings. However, use of container stock is generally much easier.

USE OF CONTAINER STOCK

The use of container stock requires the availability of irrigation water. Fall or spring is the preferred time to plant container stock. If planted in the fall, less irrigation will be required. Use plants in flats, one-gallon or five-gallon containers.

Carefully select the planting location. If possible, use sites with wind protection, sufficient sunlight, and with easily worked, well-drained soil. If the soils on the site are compacted, it may be necessary to dig deep and wide, and improve the soil by adding organic matter. If a claypan prevents adequate drainage, either dig a drainage hole thorough the claypan, or use plants adapted to claypan conditions.

There is one disadvantage to the use of container grown plants. Species with large seed, such as Coast Live Oak, will have had their taproot cut in order to tolerate container living. This means that when planted, they will never develop the deep anchoring taproot that one would find in plants established directly from seed.

USE OF TREE AND SHRUB SEED

Spot seeding is the process whereby seed is planted in specially prepared seedbeds or spots. It does not require irrigation water if seeding is done in the fall. Spot seeding is cheaper than container stock, requires less maintenance and assures that species with taproots will develop a normal, deep taproot.

The main difficulty in spot seeding is the fact that, unless you collect the seed yourself, seed can be difficult to obtain. Periods of commercial seed availability vary with the

species, but are often limited to only a few seeds each year following the harvest. The amount of seed available year to year will vary with the size of the harvest. Consequently, planning for spot seeding of woody vegetation should begin several months to a year in advance. Seeding should take place in the fall so as to take full advantage of winter moisture.

USE OF CUTTINGS

Please see "Using Shrubs and Trees to Control Streambank Erosion" in Section 4.2.

4.2 Using Shrubs and Trees to Control Streambank Erosion

In nature, streams are protected from excessive erosion by native riparian vegetation. The loss of riparian vegetation can spell disaster for channel stability. Carefully selected shrubs and trees can be useful in controlling erosion of streambanks. While not a "cure-all" for every bank erosion problem, well-designed plantings are a simple, low-cost and long-term solution in many situations. Plants can also be used in conjunction with other channel stabilizing measures, such as rock weirs, rootwads, and anchored logs.

It should be noted that modifications, including planting and thinning, within a stream channel often require one or more permits. You may need to obtain permits from the California Department of Fish and Game and or the Army Corps and/or the Regional Water Quality Control Board and/or the County of San Luis Obispo. In the Coastal Zone, a coastal permit may be necessary from the County Planning and Building Department. Check with these agencies before attempting any work within any perennial or intermittent stream channel. If coordinated permitting has been adopted for your watershed, you may be able to contact your local RCD office and obtain all of the approvals in one location.

Certain trees and shrubs can easily be established from cuttings for streambank protection in central California. Examples include Willow (*Salix* sp.), cottonwood (*Populus* sp.), California blackberry (*Ribes vitifolius*) California rose (*Rosa californica*), quailbush (*Atriplex lentiformis*) , and mule fat (*Baccharis viminea*). (California blackberry and rose are best established using rooted stock. See Use Of Rooted Stock).

Use of Cuttings

Take cuttings from healthy, low-branching shrubs and trees in the general area. Cut off the unripened new growth at the end of the branch and discard. Then make a cutting at least 3 feet long with an average diameter of approximately 1 inch and not greater than 2 inches at the butt end or less than ½ inch at the tip. Paint the butt (upper) end of the

cutting with water-soluble paint to help it from drying out. Remove any leaves after cutting. Do not allow the cuttings to dry out. Keep moist in a bucket of water. Make a slanted cut at the butt end and a square cut at the tip end. All cuts should be made with sharp tools.

Willows and cottonwood are deciduous; they drop their leaves and become dormant in the winter. For best results, these species must be collected during the winter, placed in cool storage and planted in February or March before the plants break dormancy. (Storage hint: Place cuttings in moist peat moss, sawdust or sand; keep cool and out of the sun.)

Mule fat and quailbush are evergreens and can be collected and planted anytime as long as the soil is moist. However, optimum planting time is late winter to early spring before new growth starts. * Note: Quailbush is a semi-evergreen and will drop leaves in very cold weather. NEVER use non-native invasive plants within a stream channel.

Where To Plant

Cuttings should be planted only in a sunlit location where moisture will be available to the roots year-round. Plant willow and mule fat near the waterline on the streambank but not where they will be under water during growing season. New cuttings can be drowned before establishment. Plant quailbush cottonwood, willow, mule fat, blackberry, and rose in the wick (moist) area on the bank and flood plain

How To Plant

Plant the cuttings in prepared holes made with a probe bar or push them down into the saturated soils with the butt end down. Make sure there is no air around the cutting by running the probe down in the hole. Leave approximately 1 foot (with at least 2 nodes) above ground and a minimum of 2 feet below ground. Plant from 2 to 5 rows alternating the plants, using a 3-foot spacing Better survival will result if the exposed tips are protected with tree grafting sealing compound.

Use Of Rooted Stock

California blackberry and rose can be established by planting rooted stock in the spring utilizing local rooted stocks when available. Transfer rooted stock preferably before leaves break dormancy. Plant in areas that retain soil moisture year-round. In precipitation zones of less than 16 inches, supplemental water may be needed for establishment. Do not plant in areas where rainfall is less than 10 inches.

Select a healthy bush and dig up a clump of vines with well-developed roots. Separate the clump into individual shoots. Dig a hole approximately the depth of the roots on the shoot and a shovel width in diameter. Before planting, add water to the hole and let drain. Place the plant in the hole and fill half way with soil. Tamp soil, add water, and let drain. Fill the hole to the top with soil. Tamp down firmly. Use additional soil to make a watering basin around the plant. Fill basin with water.

Channel Maintenance

Remove sediment bars, snags, stump debris, trees, brush and objectionable vegetation that disturbs the channel flow. Under favorable conditions some vegetation, like willows, grow vigorously, and can invade the stream channel, reduce its capacity, and flooding occurs. To prevent this, prune shrubs and trees that grow in the main stream channel. During major storms, promptly remove accumulated debris to prevent major damages during subsequent storms.

Channel cleaning and maintenance should be done before the rainy season. A permit from the California Department of Fish and Game is required to do any stream clearing or streambank work. Consult your local warden before you do any maintenance work in a stream. Permits may also be required from the County, the Army Corps of Engineers and the Regional Water Quality Control Board. Allow plenty of lead-time in case a permit is needed. If coordinated permitting has been adopted for your watershed, you may be able to contact your local RCD office and obtain all of the approvals in one location.

Things to Consider

- * Select plants to fit your specific soil, climate, and conditions. A good way to judge the physical suitability of a plant to the site is to observe the nearby native vegetation. Select a species that occurs naturally near the site.
- * Planting within channels should be conducted pursuant to a well-designed plan. It is recommended that a professional be contacted to assist you with the design. The RCD is also a good resource for planning assistance with stream channel stabilization.
- * Plantings should be carefully tied into the upstream bank to prevent the stream's cutting from behind.
- * Livestock should be excluded from the planting area. They will browse the tender new buds and set back or kill the young plants. Check with your local NRCS or RCD office regarding short-term and long-term holistic rangeland management techniques.
- * Willow roots are very invasive and should not be planted where they could cause problems, i.e., near septic systems, leach lines, etc.
- * Plant native species. Never plant non-native invasive species in stream channels.
- * Plants that do not take should be replanted.
- * Keep plants in low, "bushy" conditions.
- * High intensity storms can wash out even mature streambank vegetation. Proper installation and maintenance of streambank vegetation is extremely important.

Bank Stabilization and Environmental Enhancement of Channel



The California Conservation Corps, with help from Department of Fish and Game, help build a channel restoration project designed by the Upper Salinas-Las Tablas Resource Conservation District.



Rock veins, logs and rootwads combined with bank riparian planting and erosion control blanket will help to stabilize the stream channel and improve habitat.

US-LT RCD & County Planning and Building

4.3 Native and Drought Tolerant Vegetation

Water conservation is something all of us should keep in mind in planning our landscaping. Water is a limited resource within the central coast. Some of the local aquifers are in an overdraft condition. Several coastal areas are experiencing saltwater intrusion. Streams throughout the region have reduced flows and degraded riparian habitat, due in part to increased water usage. One simple and easy way to conserve water is to utilize native plants. The Appendix lists both native and some non-native plants drought tolerant plants. If you're searching for plants ideally suited to your surroundings, what better choice than plants that have evolved naturally in this area over thousands of years. Although many native plants are drought tolerant, some non-native plants are also drought tolerant. Non-native invasive species should be avoided.

Drought resistant plants have developed certain types of leaves and roots to take advantage of moisture and guard against the loss of moisture. They have extensive root systems in proportion to the size of the plant and often have both surface and deep roots. The leaves are usually small, thick and hard so water loss is reduced. Many leaves of drought tolerant plants also have a waxy surface, which cuts down on a plant's water loss.

Maintenance of a landscape is a concern when selecting plants. Once established, native plants require very little water and care. The best time to plant native or non-native drought tolerant plants from containers is in the spring or fall. If planted in the fall, less irrigation water will be required. To establish natives, they may need to be irrigated if rainfall is low. Often, supplemental watering is necessary for the first several years before the plant is mature enough to survive solely on rainfall. Control of other vegetation within a 2-foot radius of transplants will greatly increase soil moisture availability. Protection against animals such as gophers and rabbits may also be necessary.

The key to saving water for landscaping is good planning. Drought tolerant plants should be grouped together and not mixed in with plants that require frequent watering. Some natives, if given too much water, will develop diseases and root rot. Other

natives, such as river willows, sycamores, sedges, bays, and madrones, while being very beneficial to the environment, are not drought tolerant and require more watering. Such plants are recommended to be planted in close proximity to streams or where irrigation is available. Choosing the proper site and conditions for your natives is essential.

Drought tolerant native plants have other benefits besides water conservation and low maintenance. They also have a high value for wildlife. Most people enjoy seeing birds and other wildlife around their homes. Native plants provide food and cover for animals that might not be attracted to exotic plants. As a result, it is wise to protect your native plants until they become well established.

Some natives can present a fire hazard. If you live in a rural part of the county, maintain a 30 to 60 foot greenbelt around your home. Before planting, check on natives that are less flammable than others. Fire resistant species are listed separately in the Appendix.

Water is a precious resource. By planting drought tolerant vegetation, the landscape around your home will make it through those dry years to come.

4.4 Plant Tolerance Based Upon Soil Groups

Group Descriptions:

1. Plant can tolerate DROUTHINESS AND LOW FERTILITY.
Soils are coarse through gravely medium textures, excessively drained, with less than 5 inches of available water holding capacity in the root zone.
2. Plant can tolerate FINE TEXTURES.
Soils are deep through very deep, moderately fine through fine textured, moderately well-drained, moderately slow through slow permeability.
3. Plant can tolerate VERY SLOWLY PERMEABLE SUBSOILS.
(Claypan) Soils are moderately well-drained, with slow or very slow subsoil permeability.
4. Plant can tolerate WETNESS.
Soils are somewhat poorly through very poorly drained. (Drained soil phases will be placed in appropriate group according to their present drainage status. Slight salinity and/or alkalinity may be present.)
5. Plant can tolerate SALINITY OR ALKALINITY.
Soils are moderately through strongly saline or alkaline, and usually somewhat poorly or poorly drained.
6. Plant can tolerate SHALLOW DEPTH.
Soils are shallow through moderately deep, well-drained, over hardpan, bedrock or other fractured dense material.
7. Plant can tolerate Plant can tolerate LOW pH.
Soils are strongly through extremely acid: pH is less than 5.6.
8. Plant can tolerate TOXIC PROPERTIES OR SERIOUS NUTRIENT IMBALANCE.
Soils are usually moderately through strongly affected by serpentine. Defined locally.
9. Choice of plant DEPENDS UPON ON-SITE INVESTIGATION.
Soils include those in the miscellaneous non-arable category, such as river wash, stony or rocky upland, etc.

4.5 Fire Resistant Landscaping

The rural areas of San Luis Obispo County are wonderful places to live. However the native plant community found in these areas is often flammable during the dry months and subject to frequent fires. There are some landscaping measures that the property owner can take to minimize fire hazard.

First of all, within a distance of at least 100 feet depending on surrounding vegetation around the structure should be maintained in non- or low flammable plants. Desirable characteristics of plants that minimize fire hazard include: low fuel volume, relatively high degree of fire retardance, good root system for erosion control, and acceptable cultural and maintenance requirements.

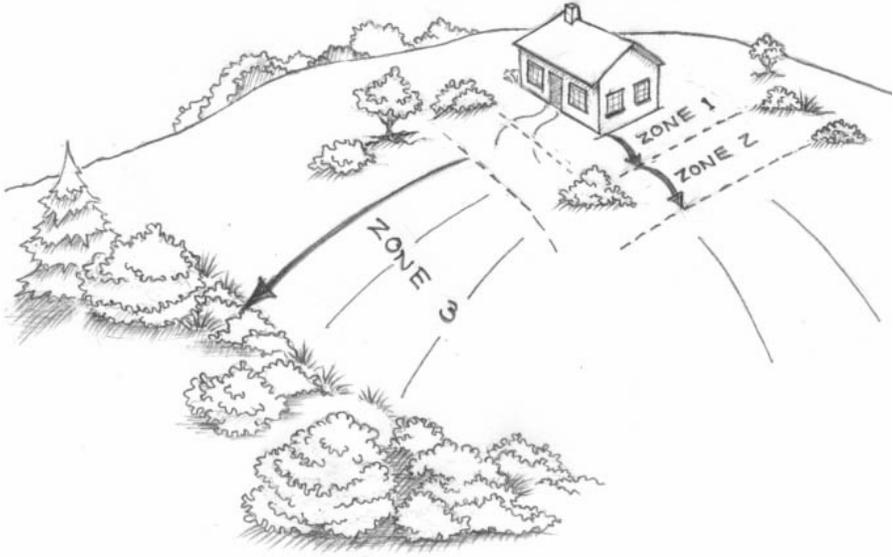
The key to landscaping in fire-prone areas is to selectively replace highly flammable native plants of equal root depth and root strength. Another desirable quality is drought tolerance since many watershed areas are difficult to irrigate and water conservation may be important. You will have to irrigate drought tolerant plantings through the first two or three summers, and occasionally thereafter to maintain fire retardance.

Herbicides and pre-emergent chemicals must be carefully applied according to label instructions. Herbicide overuse can kill landscape plants and sterilize soils thereby leaving the area susceptible to erosion and soil slippage. Inter-planting appropriate shrubs and trees with ground covers will maximize slope stability. These chemicals can also severely impact wildlife and native plants within stream channels and other sensitive areas.

There are other measures that can be taken in the construction and design of your home or business to minimize fire hazards. Contact your local fire department for ideas.

The fire resistant plants listed in the Appendix have a low fuel volume, relatively high moisture content, and many are drought tolerant. They are more resistant to fire than flammable native vegetation. In most cases their fire retardance can be increased by

irrigation, removal of surface litter, weed control and frequent pruning. The plant list in the Appendix is divided by zones around a structure.



4.6 Wetlands Role in Reducing Erosion

Wetlands have value that many landowners overlook when deciding how best to manage their property. During rainstorms, wetlands become shallow ponds, providing a natural method of slowing runoff and reducing soil erosion. They are nature's way of recharging of groundwater aquifers and providing some of the most productive habitat conditions in our region.

Unfortunately, more than half of the wetlands that existed when America was settled have been destroyed. Many of these wetlands would remain today if their value had been known before they were drained.

What are wetlands? They are identified by locating saturated soils and/or vegetation that characteristically grows on damp soils. Wetlands may be wet for portions of each year and dry during others.

Over the years, wetlands were historically drained and planted with crops or converted to urban development. Their conversion diminishes many valuable natural resources. The conversion of wetlands also has contributed to increased soil erosion. In particular, stream channels in our area have begun to erode much more quickly due, in part, to the destruction of wetlands.

Before making changes in wetland and riparian areas, it is crucial that the RCD, NRCS or Cooperative Extension offices be consulted and that you obtain the required permits.

How Wetlands Are Valuable to You

FLOOD CONTROL

Many wetlands store floodwaters and then release them slowly. This reduces the height of downstream floods and lessens the risk of flash floods.

SEDIMENT CONTROL

Wetland vegetation binds the soil and slows the downstream movement of sediment.

POLLUTION CONTROL

Wetlands act as settling ponds, allowing fertilizers, pesticides, and other pollutants to be absorbed and broken down chemically.

WATER SUPPLY

Some wetlands are used as sources of domestic water. Others provide water for irrigation and livestock.

GROUND WATER RECHARGE

Wetlands are important recharge areas for underground fresh water aquifers.

STREAM FLOW

Wetlands also help to maintain spring flows in nearby streams. Water collects in the wetlands, percolates into the soil, and seeps into streams, forming the base flow for many streams.

FISH PRODUCTION

Many of the 4 1/2 million acres of open water in inland wetlands provide an ideal habitat for sport fish.

WILDLIFE PRODUCTION.

Wetlands provide water, food, nesting, and resting areas for a wide array of game and non-game wildlife species, including some federally listed endangered species.

RECREATION.

Wetlands provide areas for recreational activities such as hiking, canoeing, fishing, hunting, photography, and environmental education.

AESTHETICS.

Most wetlands contain a wide variety of plants and animals, providing great beauty and a place for recreational and visual enjoyments.

Offices of the RCD, NRCS, and the Cooperative Extension can help suggest management techniques to assist in wetland development and rehabilitation.

4.7 - Detention and Sediment Basins

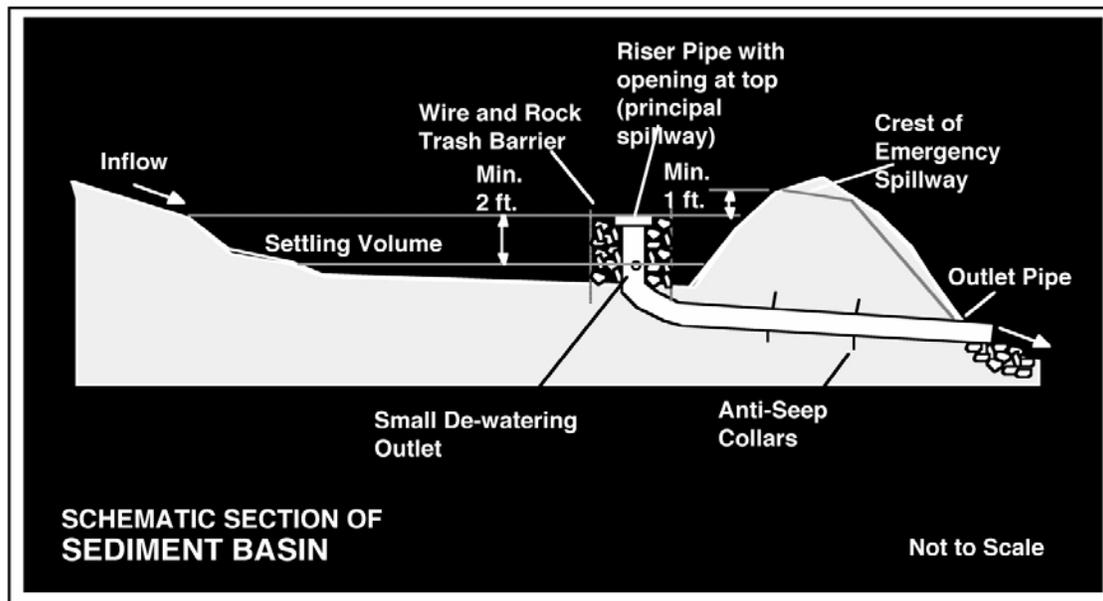
Detention Basins:

A detention basin allows storm water to collect for a period of time and then releases the storm water at a slower rate.

A detention basin simply slows down the flow of storm water. Often, detention basins are used to reduce the potential for downstream channel and gully erosion and flooding.

Much of the accelerated erosion of stream channels in San Luis Obispo County can be attributed to increased runoff from urban areas.

Detention basins are useful in moderating the flow of storm water from construction sites, roads and urban development. The use of detention basins can reduce channel erosion.



Sediment Basins:

A sediment basin is a large detention basin that has the capacity to hold the storm water for sufficient time to allow the suspended sediment (eroded soil) in the water to drop out before the storm water is released down channel.

Water enters the basin at one end, traveling horizontally along the length of the basin. Ideally, sediment in the water drops out as the water ponds in the basin. If the ponding interval is 24 hours or less, its effect on sediment removal will be minimal for any but the largest soil particles.

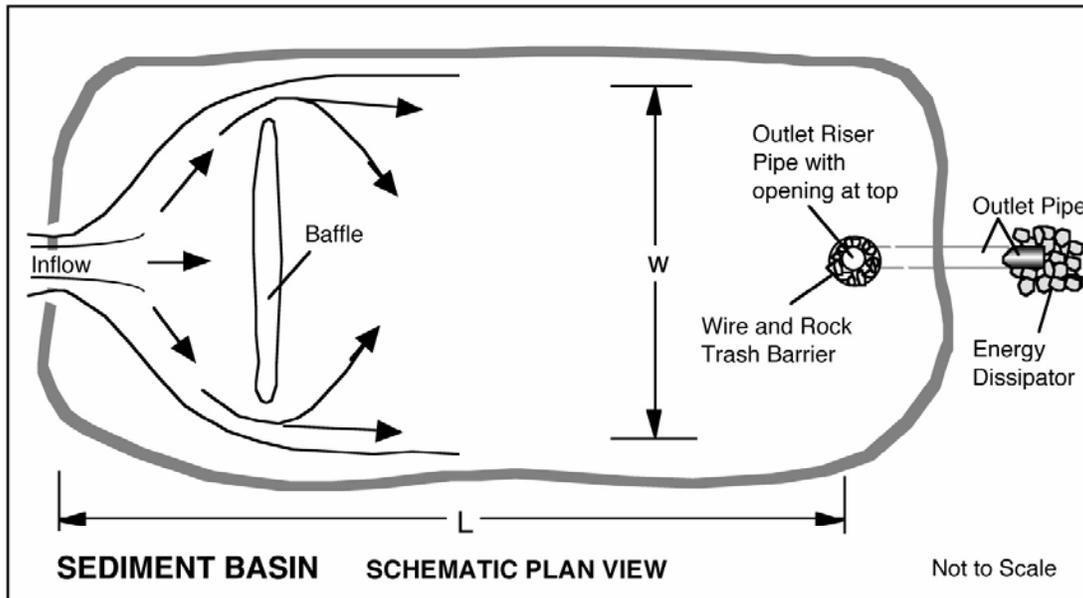
Sediment Basin Basics

Much of the soil in San Luis Obispo County is comprised of fine silt and clay particles. When these small soil particles are eroded from the land and become suspended in storm water, they DO NOT settle out quickly. It requires large basins to capture these soil particles.

IMPORTANT: Sediment basins WILL NOT collect all of the eroded soil. ALL sediment basins should also include upslope erosion control measures.

Unless all of the eroded soil is sand, a sediment basin should be designed to store storm water for a minimum period of **48 to 72** hours or longer. The long storage period is necessary to allow the majority of the sediment to settle out of the storm water.

The effectiveness of the sediment basin is based on the large capacity, length, width, depth and the relatively small size of the outlet pipe.



Design Factors for Sediment Basins

- **Large Size:** A sediment basin must be large enough to ensure that the sediment laden storm water will remain for at least 48 to 72 hours.
- **Prevent Short Circuiting:** Typically, a sediment basin should be longer than it is wide. A width (W) to length (L) ratio of 1 to 8 is recommended. If designed too short, the storm water will travel quickly to the outlet overflow pipe and be carried down channel before the sediment has time to settle out. In addition, baffles can help prevent short circuiting.

4.8 - Removing Other Pollutants with Bioretention Systems

Runoff from urban uses can result in pollution of streams, lakes, wetlands and the ocean. It has been shown that drainage of stormwater runoff through landscape strips can result in the reduction of some of pollutants such as sediment, nitrogen, phosphorus, oil and some trace metals. These landscaped strips are referred to as “bioretention areas.” Bioretention basins should not be confused with detention basins or sediment basins. While bioretention basins may collect small amounts of sediment, **BIORETENTION BASINS ARE NOT SEDIMENT BASINS.**

These landscaped areas are used to treat “first flush” runoff from impervious surfaces such as parking lots, streets and buildings. Nonpoint source pollution is removed through a combination of physical and biological treatment process. These processes occur in the interaction with soil and plants as a part of transpiration, decomposition, evaporation, storage and nutrient uptake. These processes include absorption and filtration of the runoff.

BIORETENTION PRINCIPLES

1 Retain Natural Vegetation

Natural ground cover often serves as an effective filter of pollutants. If feasible, when developing property, leave natural vegetation. In nature, vegetation and its accompanying leaf litter creates a natural filtration system to reduce pollutants. Native plants have adapted to the climatological and soil conditions, requiring little care or maintenance.

Benefits of retaining natural vegetation include:

- the limbs and leaves protect the ground from erosion
- the combination of soil, plants and leaf litter can absorb pollution

2 Create Bioretention Planting Areas

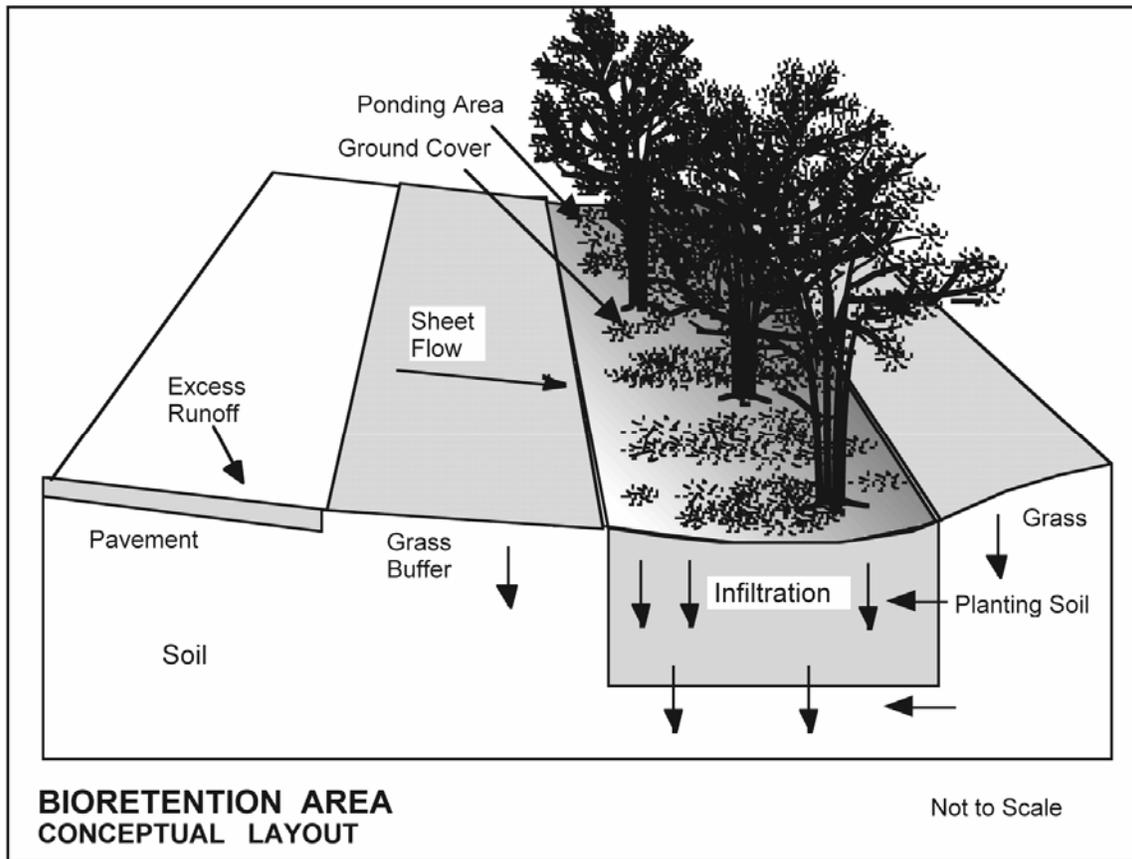
When it is not feasible to retain native vegetation, it is recommended that new developments provide bioretention areas to collect and filter contaminants. A landscaped planter strip is developed near the source of runoff, such as parking lots, driveways, roads and buildings.

Bioretention areas should not be located in major drainage ways. Bioretention areas should be designed as “off-line” treatment system. Heavy runoff may overwhelm the capacity of the bioretention area, thereby defeating its purpose of removing pollutants.

Benefits of constructing bioretention areas include:

- The bioretention area provides infiltration and water storage for uptake of pollutants.

- Bioretention areas also can beautify an urban setting, provide shade, and absorb noise.



3 Components of the Bioretention Area

For purposes of the Erosion Control Handbook, we use the Department of Environmental Resources, Prince George County, Maryland, model for Bioretention Areas. They have established six interrelated components that make up the bioretention area:

The runoff passes through several stages:

a. Grass Buffer Strip

The first stage is a grass buffer strip. The grass buffer strip is developed adjacent to the parking lot, street, driveway or other impermeable surface. The grass buffer reduces the runoff velocity and provides a first filter of suspended runoff particles.

b. Ponding Area

The next stage is the planted ponding area. Once the capacity of the sand bed is reached, runoff is discharged onto the surface of the depressed planted area. This ponding area serves as a small retention basin. The runoff drains through a surface layer of organic mulch and ground cover, and then is stored in the planting soil beneath the mulch.

The root zone of the plants provide another filter of the contaminants, such as nitrogen and phosphorus.

c. Organic Layer or Mulch

The organic layer beneath the plants provides a medium for the biological processes that continue the removal of pollutants. This moist layer protects plant roots and decomposes the organic matter. Microorganisms formed in this process can assist in degrading petroleum compounds. The mulch layer recommended for bioremediation may consist of either aged (by stockpiling a minimum of 6 months) fine shredded hardwood mulch or shredded hardwood chips.

d. Planting Soil

Often, soil contains too much clay or silt to easily absorb the water percolating down from the surface. Clay and silt are made up of very fine particles that pack closely together, leaving little space for water. Sandy soil, on the other hand, has too little organic material to hold the nutrients necessary for good plant growth. Sandy loam, loam or loamy sand are considered the only planting soils that are satisfactory for bioretention basins. These soils have sufficient voids to store stormwater and provide nutrients for the plants. Unless one of three these soils exist at the site, they will have to be imported and placed as shown on the diagram. A mixture of 50% sand, 20% leaf mulch, and 30% top soil is recommended. The maximum allowable clay content is 10%.

e. Plant Material

The purposes of the plants are to protect the ground surface from rain drop impact, to use the nutrients and other pollutants as well as to remove water from evapotranspiration. A mini-forest community structure is replicated. The plants should contain a variety of species similar to that of a forest so that a microclimate is created that is resistant to stresses including heat, winds, disease, and insects.

f. Underdrain

In residential areas, the County of Prince George recommends the use of an underdrain in residential areas to remove excess moisture.

4 Minimum Bioretention Basin Site Guidelines

The following minimum dimensions are recommended for the development of functional bioretention basins:

- a. Minimum Width:** The recommended minimum width is 15 feet. 25 feet is preferable.
- b. Minimum Length:** The minimum recommended length is 40 feet. For basins with width greater than 20 feet, the length should be twice the width.
- c. Maximum Depth of Ponded Area:** The ponded area should have a maximum depth of 6 inches.
- d. Minimum Depth of Planting Soil:** The planting soil should be a minimum depth of 2.5 feet.

Ponding should not exceed four days. If ponding exceeds four days, the choice of plant species will be severely limited and problems with mosquitoes may occur.

5 Coverage Area for Bioretention Systems

The County of Prince George recommends that bioretention systems be limited to drainage areas of .25 to 1.0 acres. The size is limited to the amount of sheet flow runoff from a 10-year storm.

6 Guidelines for the Location of Bioretention Areas

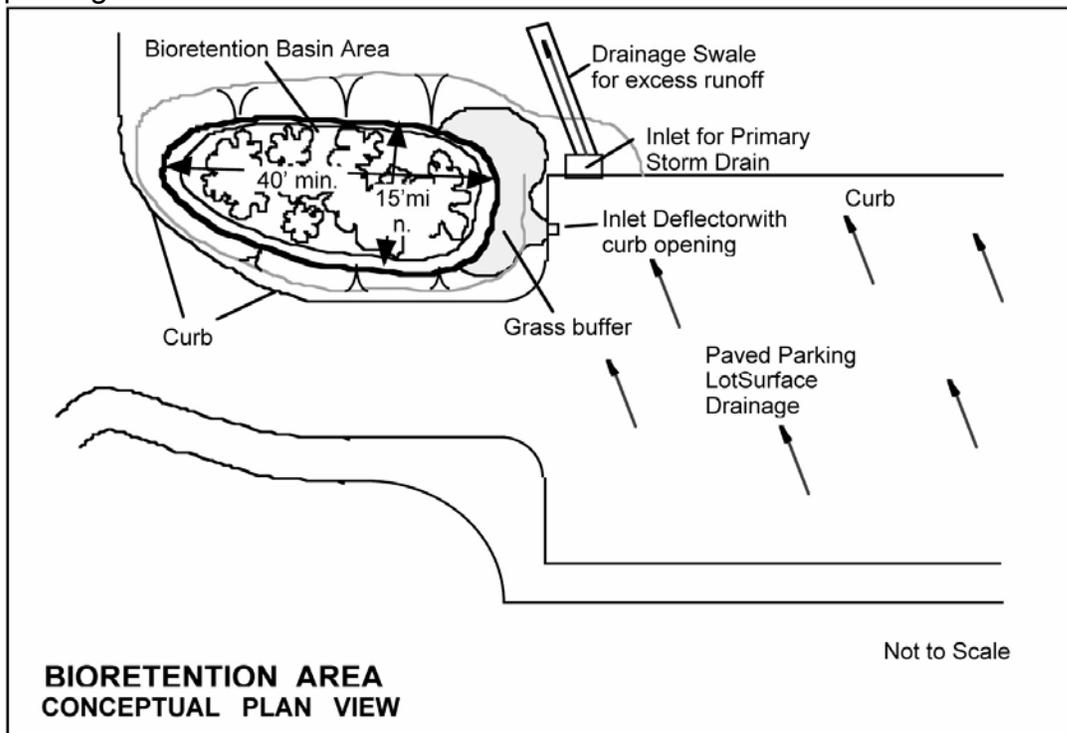
The preferable locations for bioretention areas include:

- ✓ areas upland from inlets or outfalls that receive sheet flow from graded and paved areas
- ✓ areas of a site that will be excavated

Undesirable locations for bioretention areas include:

- areas that have mature trees that would have to be removed to construct the bioretention area
- areas that have a water table within 6 feet of the ground surface
- sites that have a slope of over 20%
- areas in close proximity to unstable soil

The following diagram shows one possible location of a bioretention basin in a parking lot.



Chapter 6

Agricultural Soil Conservation Measures

"...if this is to be a permanent nation we must save this most indispensable of all our God-given assets--the soil, from which comes our food and raiment. If we fail in this, remember that much sooner than we have expected this will be a nation of subsoil farmers."

--H.H. Bennett, 1933

6.1 Cover Crops

Cover crops have been used on California vineyards for over seventy years. Recently, interest in this practice has been increasing as more vineyards and orchards are planted on steep land. In addition to reducing or eliminating erosion, cover crops reduce tillage requirements, and increase water penetration by reducing runoff.

Cover crops keep dust to a minimum and discourage spider mites and other insects associated with dust-laden leaves. Beneficial predatory insects thrive in cover crop habitats, feeding on a variety of harmful insects. Cover crops also reduce the reflection of sunlight and heat characteristics of bare soils, thereby reducing sunburn damage to fruit.

Annual grasses and legumes have been used successfully in this county for establishing vineyard cover. If managed properly, this type of cover will reseed itself indefinitely.

Annual Self-Seeding Cover for Orchards and Vineyards

Establishment

Choose cover crops that correspond to the problems, soil conditions, and the management systems used in the orchards and vineyards.

A brief explanation of plants recommended in this section is provided on page 12. Use a heavier seeding rate for slopes greater than 9%. Rates are provided in the following chart.

| | Slopes less than 9% Lbs/Ac | | Slopes greater than 9% Lbs/Ac | |
|--|-----------------------------------|------------------|-------------------------------------|------------------|
| | <u>Drilled</u> | <u>Broadcast</u> | <u>Drilled</u> | <u>Broadcast</u> |
| | Grass Mix*; 'Zorro' annual fescue | 4 | 6 | 12 |
| Blando brome | 10 | 12 | 10 | 12 |
| Dryland legume mix | 12 | 15 | 15 | 20 |
| Native perennial grass mix such as 2 or 3 of the following varieties: Idaho fescue, California brome, creeping red fescue, California melic, meadow barley, or blue wildrye. | 15 | 20 | 20 | 30 |

* Rose Clover can be added to the above at 2 lbs/acre

The above recommendations are provided by the RCD, NRCS, and UC Cooperative Extension. Contact your farm advisor for legume seeding recommendation. Additional references are also provided at the end of this handbook.

Plant in the fall after harvest. The best time to seed is October 1 through 15.

Management

Cover crops can be left to set seed or mowed with a rotary or flail mower as frequently as necessary. It is recommended that the cover be mowed during the winter months whenever it reaches 8 to 12 inches with the mowing height set at 3 inches to 4 inches.

Self-seeding annuals must not be mowed prior to maturity. This allows the plant to set seed for next year's cover. Dates of maturity will vary from year to year depending on rainfall. Following plant maturity and seed set, the cover can be mowed as close as desirable and left to lay on the surface or turned under with a disk.

Regular vineyard management operations are carried on during the rest of the year. Next year's cover will germinate and grow as the weather cools with fall rains or with the fall irrigation of the vines.

University of California Cooperative Extension studies have shown that tall growing cover crops and freshly disked ground create a cooler condition in vineyards than shredded cover. The use of mowing to control the height of cover along with the sprinklers should minimize frost hazard.

In the spring, we encourage mowing rather than disking or, if unsure, we suggest trying some strips with just a mowing management system.

Maintenance

Be sure to leave permanent vegetation in the drainages. **DO NOT DISK VEGETATION IN DRAINAGES.**

Perennial Grasses as a Cover Crop

Perennial grasses are gaining popularity for use as a cover crop in orchards and vineyards. Native perennials used for this purpose include Dreeping Wildrye, Blue Wildrye, Purple and Nodding Needlegrass, Pine Bluegrass and California melic. (Many non-natives are also available as well). Perennial grasses provide excellent erosion control when established and can be mixed with wildflowers for an attractive cover.

If started from seed, fall is the best time to plant. Availability of supplemental irrigation is advised as these grasses can be harder to establish than annuals, and the seed is often more expensive than for annual grasses. However, the additional cost for seed may be outweighed in the long term by the many advantages of perennial grasses.

Contact the RCD, NRCS, or the Farm Advisor for additional information. Also, refer to the Agricultural Handbook prepared by the Upper Salinas-Las Tablas RCD.

Structural Erosion Control

- * Contour Planting. Vine rows should be planted along the contour of the hillside in areas with less than 15% slope.
- * Terraces. When the hillside slope is greater than 15%, contoured terraces should be installed on a 2% grade, and backsloped into the hill. In order to be effective, the terraces should be implemented when the vineyard is laid out.
- * Diversions. Surface runoff from around the vineyard can cause serious problems if not controlled. A diversion ditch should be established to divert the water safely away from the vineyard.
- * Underground Outlets. Deep gulleying can be caused by excess surface water collecting in natural drainageways. Underground pipes should be laid in these drainageways with strategically placed inlets to collect surface runoff. The water is then drained to a safe outlet.
- * Proper Road Construction. Severe erosion occurs where surface runoff concentrates due to access roads into the vineyard. Recommendations for erosion control are the following: proper grading, culverts, water bars, ditches, and surfacing.
- * Lined Gullies and Waterways. New gullies need immediate attention before they deepen. Grass may be one way to protect against further erosion within a gully. Often, upland measures can reduce the storm water runoff and limit the formation and enlargement of gullies. Protective blankets can be installed and anchored firmly to provide temporary protection of the soil underneath.
- * Filter Fabric. Check dams in small gullies made of filter fabric can be designed to temporarily reduce runoff. Fabric is usually attached to fence posts to act as a barrier to slow runoff. (Check dams are generally not recommended in stream channels.)
- * Mulch. Loose straw or other mulch may also act as a groundcover on the bare ground and help to retain soil.
- * Rock Piles. Rock piles can be used similarly to straw bales. They are only useful to TEMPORARILY slow runoff from the vineyard.

Contact the RCD, NRCS, or Farm Advisor for additional information at:

Natural Resource Conservation Service
United States Department of Agriculture
and
Upper Salinas-Las Tablas Resource Conservation District
65 Main Street, Suite 108
Templeton, CA 93465
(805) 434-0396
NRCS: ext. 3
US-LT RCD: ext. 4

University of California
Cooperative Extension
2156 Sierra way, Suite C
San Luis Obispo, CA 93401
(805) 781-5940

6.2 Guidelines for Urban or Small Acreage Animal Management

Today, with small acreage suburban subdivisions and ranchettes, many poorly managed paddock-pastures are large contributors of sediment and other pollutants to watercourses and they are environmentally undesirable.

Horses graze plants very close to the ground and tend to weaken or destroy the roots of plants. Overgrazing forces animals to eat undesirable (sometimes poisonous) plants. Many undesirable plants can out-compete and replace desirable plants on overgrazed land. Continuous trampling has an adverse effect on plants and soils. When kept in small paddocks, horses usually destroy all ground cover, leaving the soil ripe for severe erosion. Also, when kept in paddocks or small corrals, the potential for surface water contamination is extremely high.

These problems can be solved or alleviated so that the horses and livestock can have a paddock and their pasture. Toward this end, the following guidelines are recommended.

Recommendations to Keep Pasture-Paddocks Productive, Attractive and Non-Polluting:

1. Provide stable space for each horse.
2. Fence off an area of pasture (preferably the least productive) for a paddock or exercise lot. The lot should be a minimum size of 800 square feet per horse with proper drainage to reduce chances of foot and internal pesticide infection. Slope should not exceed 10 percent.PLS INSERT TXT SANTA CRUZ HORSEKEEPING
3. Apply the principles of grass management to pastures.
 - a) Let the forage get a good start before grazing (6 to 8 inches tall). Do not graze until the soil surface is dry enough to prevent damage by trampling. Compacted soil inhibits water percolation and restricts root penetration.
 - b) Do not use pastures with less than 40% vegetative cover. Leaving 40% cover where annual grasses are prevalent will result in a "patchy" appearance and will insure an adequate seed source for the following year.
 - c) Where perennial grasses are prevalent, the plants should be allowed to mature seed every third year to restore food reserves in the root system.
4. Fencing the pasture into two or more parts to permit rotational use will allow the unused grass pasture(s) to rest and regenerate.

6.3 - Establishing and Managing Irrigated and Dryland Pastures for Horses and Livestock - Seeding Practices

Establishing New Pastures and Restoring Old Pastures

Soil erosion can occur when pastures are overgrazed. Well-conceived pasture establishment practices will vary according to dryland or irrigated conditions. Under either situation, proper seedbed preparation is required. If the pasture is to be irrigated, land grading for irrigation or drainage may be necessary.

Test the soil for pH and nutrients to determine if fertilization is needed to maximize pasture productivity. Fertilization during seedbed preparation will depend on soil needs. Sandy and heavy clay soils will require the addition of soil additives to assure good root growth and healthy plants.

Prior to seeding, till the top few inches of soil. The seedbed should be firm, with enough loose soil to cover the seeds lightly. For irrigated pasture, a pre-planting irrigation may be needed.

General Seeding Recommendations

Pasture plants should be palatable, nutritious, and adapted to local conditions. Species selection will depend on whether the pasture is irrigated or dryland. Annual rainfall, soil texture, permeability, and rooting depth should be considered when selecting the appropriate seed. High quality seed should be purchased to help ensure pasture establishment. Legume seed should be freshly inoculated with the correct nitrogen-fixing bacteria for the legume species. For recommended seeding mixtures, see Appendix.

Time of seeding is critical for successful pasture establishment. Seed should be planted prior to the rainy season and before temperatures become too cold. September 15 to October 15 is generally the best period, but pastures that are going to be irrigated can be planted either in the fall or early spring.

Seed can be planted by a seed drill or by hand broadcasting, taking care not to place seed more than 1/4 inches deep. Follow broadcast seeding with ring rolling to cover and press seed into the ground.

The pasture should be grazed in early spring to reduce competition, then allowed to regrow and produce seed

Weed control is necessary to reduce plant competition for water, nutrients, and sunlight. Weeds can also be harmful to the animal's health. Herbicide weed control may destroy beneficial legumes. Common undesirable plants include yellow star thistle, purple star thistle, groundsel, and fiddleneck.

Seeding Recommendations for Cattle, Sheep, and Horses

These recommendations are for erosion control and grazing on small acreages. For site-specific recommendations, contact the USDA Natural Resources Conservation Service, or your local University of California Cooperative Extension farm advisor.

NRCS Seeding Recommendations:

| <u>Pasture</u> | <u>Plant Species</u> | <u>Seeding Rate (Lbs/Acre-Broadcasted)</u> |
|--------------------------|--|--|
| Irrigated Pasture | Perennial ryegrass (Tetraploid and/or Aridi) | 2 |
| | Fawn tall fescue or orchardgrass (Akaroa) | 8 |
| | Narrowleaf birdsfoot trefoil * (withstands poor drainage) | 2 |
| | Salinas strawberry clover * | 1 |
| | Total | 14 |
| | OR | |
| | Fawn tall fescue (withstands trampling) | 12 |

| | | | |
|------------------------|----------------------|-------|--------------|
| Dryland Pasture | Blando brome | | 4-8 |
| | Rose clover * | | <u>2-4</u> |
| | | Total | 6-12 |
| | OR | | |
| | Blando brome | | 2-3 |
| | annual clover mix ** | | <u>10-12</u> |
| | | Total | 13-14 |

* Legumes should be inoculated with proper inoculants.

** Use locally adapted varieties of legumes (clover, medic, or vetch) as recommended by the farm advisor.

University of California Cooperative Extension Seeding Recommendations:

| <u>Pasture</u> | <u>Plant Species</u> | <u>(Lbs/Acre-Broadcasted)</u> |
|--------------------------|---|-------------------------------|
| Irrigated Pasture | Salina strawberry clover ^ | 4 |
| | Dallisgrass (for hot climates) | 0-4 |
| | Perennial ryegrass (Tetraploid and/or Ariki) and/or festulolium | 4 |
| | Fall tall Fescue or Orchardgrass (Akaroa) | <u>4-6</u> |
| | | Total |

Dryland Pasture (range)

| | | |
|---|-------|--------------|
| Blando brome (annual grass) | | 4-8 |
| Rose Clover ^ | | <u>2-4</u> |
| | Total | 6-12 |
| OR | | |
| Blando brome | | 1-2 |
| annual legume mix <u>1/</u> (such as subterranean clover, annual medics, and rose clover) | | <u>10-12</u> |
| | Total | 11-14 |

- 1/ Use locally adapted varieties of legumes (clover, medic, and /or vetch) as recommended by the local farm advisor or in a fact sheet titled "Planting and Managing Range Legumes and Grasses in SLO County".

Note: Legumes will provide excellent erosion control if properly established and managed, but cannot compete with 16 pounds/acre of Blando brome. All legumes should be inoculated with proper inoculants.

Irrigated Pasture Management

Good pasture management should be targeted to include the following factors:

- a) use of an adequate regrowth period for the grasses and clovers
- b) provision for keeping livestock off the pasture while irrigating or when the pasture is wet
- c) proper pasture use
- d) adequate, timely irrigation
- e) adequate fertilization.

Proper Pasture Use

A system of rotational grazing should be used. Pastures must not be grazed until a minimum of 8 inches of growth is reached and stock removed when no less than 4 inches of stubble remains. These heights of feed will vary depending on the varieties of grasses and clovers you have in your pasture.

Regrowth Period

An adequate regrowth period is needed to maintain and maximize production. For instance, Orchard grass, Perennial ryegrass, fawn fescue, and ladino clover need approximately 25 days for regrowth.

Keeping Livestock Off During Irrigation

Livestock must be removed from the pasture when it is wet or while irrigating. Livestock can be returned after a minimum of 2 days after the last irrigation.

Moisture and Seedling Establishment

Fall seeding can be established with little or no irrigation provided winter rains come regularly and hot spells are not a problem. It is safest, however, to have the irrigation system ready to go at spring plantings, frequent irrigation are often essential to allow the plants to grow through the critical period from germination until a good root system is established. Irrigating 2 or 3 times a week may be necessary during hot weather in order to keep the seed and root zone moist. To reduce the amount of irrigation and yet not subject the new plants to cold winter weather before they are big enough to take it, the best time to seed is September or October.

Irrigation of Established Pastures

Once the pasture is established, irrigation is vital in keeping it productive. The frequency and duration of irrigation must be based on the amount of moisture in the soil, soil characteristics, and plant requirements for water. A water supply of at least 6 gallons per minute for each acre is necessary for sprinkler irrigation. The seasonal requirement will be 2 1/2 to 4 1/2 acre-feet per acre.

During the summer, application of 3 inches of water every 7 to 14 hours may be necessary. Frequency depends on the climate of the pasture. In the spring, it is important to begin irrigating before the soil has dried out. Both Spring and Fall will most likely be productive seasons for irrigated pastures if enough moisture is available.

An inexpensive soil sampler available in farm catalogs is very useful in finding depth of soil moisture. Clovers can use moisture down to a depth of 2 feet and grasses down to 3 to 4 feet. Since both legumes and grasses are in the pasture, adequate soil moisture should be maintained throughout the entire root zone of all plants. This means irrigating often enough to keep the shallow-rooted clovers growing vigorously and deep enough for the long grass roots.

Fertilization

As with irrigation, amount and frequency of fertilizer application depends upon pasture production and relative abundance of grasses and legumes. Legumes (clovers, trefoils, and alfalfa) supply nitrogen for themselves and associated grasses if phosphorus, sulfur, and the correct nitrogen-fixing bacteria are present. Since grasses cannot provide their own nitrogen, it is best to establish about a 50:50 ratio of grasses and legumes.

In the case of a phosphorus deficiency, 20-40 pounds of P_2O_5 per acre may be needed annually to provide satisfactory growth of legumes and grasses. Sulfur application at about one half the P_2O_5 rate is also recommended, so compare fertilizers for sulfur content.

When it is necessary to add nitrogen to a pasture, adding 150 to 200 pounds of ammonium sulfate or 70 to 90 pounds of urea every month during the growing season will keep grasses well supplied with nitrogen. Such stimulation of grass growth, however, may crowd legumes out of the pasture, especially if grazing pressure is light, soil moisture is low, or phosphorus and sulfur levels aren't maintained.

Dragging and Clipping

Mow or graze after flush of spring growth. If stalks dry during summer, mow and drag with harrow.

Interseeding With Clover to Renovate Pastures

The preferred method of renovating an old pasture is to plow and crop an annual before reseeding. However, pastures with a low population of legumes can sometimes be

improved by drill- or broadcast-seeding Salina strawberry clover among the established grasses. Seeding 2 to 4 pounds of clover with 300 pounds of single super phosphate per acre following a close grazing is recommended. Pastures with many bare spots may only need a broadcast seeding whereas dense pastures should be seeded with a heavy-duty drill when the soil is moist. Grazing to restrict grass competition and frequent irrigation will help the seedlings get started. It takes about one year for the strawberry clover to become well established since it spreads by creeping stems that root at the nodes.

6.4 - Brush Management for Agriculture

Brush management attempts to restore the natural plant community balance and reduce soil erosion. It manipulates the brush through selective treatments to meet specific needs of the land and the livestock producer.

Many non-native brush plants use three to five times more water than native grasses for each pound of leaf growth. Controlling high water-demanding plants and increasing the number of more water-efficient plants will mean more quality forage for livestock. Care must be made to ensure that good vegetative cover will replace the brush being removed. NRCS Field Office Technical Guide practices should be followed in any brush management project.

With brush management, competition for sunlight and nutrients is reduced. Allowing desirable plants access to sunlight and nutrients results in increased forage yield.

As range condition improves from brush management, the healthier and thicker grass cover will slow runoff, allowing more moisture to soak into the soil. Soil erosion by water and wind will be reduced.

Opening dense areas of brush creates a better wildlife habitat- a place for wildlife to find cover, nesting areas, and food. For many livestock producers, improving the habitat helps attract game for hunting, which may contribute to ranch income.

Brush can be controlled by chemical or mechanical methods, fire, and improved grazing management. The method to use depends on economics, soil, the type of brush on the land, the topography, and the type of ranch operation. Most successful efforts involve a combination of brush control methods.

Chemical methods involve applying selective herbicides to the soil or to the plant by airplane or ground equipment. Because many brush species are tolerant to some

herbicides, results will vary. Success depends on applying the right herbicide at the correct rate when weather conditions are favorable.

Mechanical methods of brush control include mowing, grazing, root plowing, chaining, and bulldozing. These methods have proven quite effective on arid and semiarid ranges.

Prescribed burning is used by many livestock producers to control undesirable non-native woody plants. Historically, nature's most effective brush management practice was fire. However, wildfires do not occur as often now. Deciding factors for use of this practice include sufficient fuel for the fire, favorable weather conditions, and safety.

Proper grazing management prevents overgrazing and assures healthy, vigorous forage. In a healthy range ecosystem, brush problems are reduced.

To be effective, the method to use in managing the brush or rangeland must be followed by proper grazing management. Forage yield will improve after the desirable grasses have had a chance to recover and plant succession has begun. On rangeland where brush has been controlled, the pasture should be rested and grazing time limited for the first growing season following treatment. This allows the grasses to become established.

Reseeding of these areas may be necessary where a natural seed source of the desirable forage plants is not available. Grazing management must be a continuous process. Uncontrolled or improper grazing probably caused the brush problem. Treating the problem without addressing the cause is only a short-term solution.

Most range improvement practices take time to show changes. Do not be discouraged if drastic changes are not noticed immediately. With careful planning, and management of the practices, the range will improve.

The California Department of Forestry (CDF) administers the Chaparral Management Program which offers cost-sharing to private landowners for brush management. Persons

who wish to participate in this program must own or have legal control of the land. There are no maximum or minimum acreage restrictions.

Up to 90% of the costs of a project may be eligible for State cost-sharing.

Participants must:

- A. Be willing to enter into a contract with the California Department of Forestry to conduct the operation;
- B. Be able to assume a proportionate share of the cost of site preparation and other operations, and to guarantee payment of such share; and
- C. Have under development or have completed a plan for follow-up management of the land to be treated under this program.

Chapter 5

Road Construction and Maintenance

"I saw all the people hustling early in the morning to go into the factories and the stores and the office buildings, to do their job, to get their check. But ultimately it's not office buildings or jobs that give us our checks. It's the soil. The soil is what gives us the real income that supports us all..."

--Ed Begley, Jr.

5.1 Guidelines for Roads on Hillsides

General Guidelines for Road Construction

Accelerated erosion occurs due to poor road construction on hillsides. Some causes include: removal or reduction of protective cover; the destruction or impairment of natural soil structure and fertility; increased slope gradients created by cut and fill slopes; decreased infiltration rates (sealing) on parts of the roadway; interception of subsurface flow by roadway cut slopes; decreased shear strength, increased shear stress, or both, on cut and fill slopes; concentration of generated and intercepted water; and blockage or alteration of natural drainage ways

The erosional impacts may be reduced by a variety of practices. These practices may be summarized in four basic principles. All four must be considered in order to reduce total impacts because stressing one individual principle usually will not meet the goal of acceptably reduced erosion. The four basic principles are as follows:

1. Minimize the amount of disturbance caused by road construction by controlling the total length of roads, and reducing the area of disturbance along the road.
2. Avoid construction in high erosion hazard areas.
3. Minimize erosion from areas disturbed by road construction by using proper erosion control practices.
4. Minimize the off-site impacts of erosion.

The first basic principle emphasizes erosion prevention. Minimizing road lengths and disturbed areas reduces erosion considerably.

Reductions in the area disturbed by road construction can be made by careful location and design. Use of variable horizontal and vertical alignment to avoid steep slopes, rock outcrops or deep stream crossings can reduce the width of the disturbed area. For a given slope, additional reduction in the disturbed area may be made by minimizing road and ditch width and by steepening cut and fill slopes, if the steeper slopes are stable and do not increase other erosion hazards.

The second principle also emphasizes erosion prevention. It consists of avoiding high erosion hazard areas such as steep slopes, landslides, seeps and clay beds. This principle also uses variable horizontal and vertical alignment as a means of avoidance.

The third principle is to reduce erosion from disturbed areas. The design of successful erosion control practices requires the knowledge of the major type of erosion that is occurring and the control factors. Erosion control practices are of little value if improper road design causes a concentration of water to flow over fill slopes.

The fourth basic principle is to reduce off-site impacts of the erosion that does occur. This amounts to reducing sediment delivery off the site by: a) reducing disturbed areas

near stream channels; b) using obstructions or vegetation to catch and retain sediment before it reaches the drainage system; c) installing sediment traps or debris basins; and d) recognizing that the form and structure of downhill slopes determine the sediment delivery efficiency.

Guidelines

The guidelines are based on the four basic principles. They are for use in the entire road development process, such as developing road location, doing construction, and maintenance. Modifications may be needed to fit unique site conditions in a particular location. Planning is an important factor governing the total area disturbed by road construction. Decisions related to anticipated traffic, safety requirements, erosional design parameters, and road patterns should be made at this point. These influence road width and alignment, which affect the area of disturbance.

Location

With the information developed in planning, the next step is to determine the specific road location. Alternate routes should be carefully reviewed using all available background information and technical expertise.

Some guidelines to help reduce erosion impacts during road location are:

1. Avoid high erosion hazard sites, particularly in areas where mass erosion is a problem.
2. Reduce the area of road disturbance by taking advantage of landforms such as benches, ridges, and flatter slopes.
3. Use short segments of steeper grade roads to avoid problem areas or to take advantage of landform.
4. Avoid locations on long, steep, unstable slopes, especially where bedrock is highly weathered or soils are plastic.
5. Locate roads on well-drained soils and rock formations that dip into slopes.
6. Avoid slide prone areas such as seeps, clay beds, concave slopes, hummocky areas and rock layers that dip parallel to the slope.
7. Avoid undercutting unstable toe slopes when near valley bottoms.
8. Reduce concentrated flow in drainage ditches and on the road surfaces.
9. Select drainage crossings to reduce channel disturbance and cuts and fills.

Design

Design is where measures to control erosion and reduce off-site impacts are incorporated into the plans. Design converts location, field surveys, and other data into

plans. Design criteria must be flexible to allow for modifications to minimize erosion hazards under varying site conditions.

Vegetative and associated practices must be considered during the design process. Maintenance needs must also be considered. If regular maintenance cannot be assured, design changes must be made so that excessive erosion will not occur. Erosion control practices can be included in the design process. For more information, contact your local NRCS or RCD office.

Construction

The best planning and design is useless unless it is incorporated into the completed work. Supervision and inspection of the construction is the most important factor leading to success. You must be prepared to deal with design changes required due to unforeseen site problems.

Factors to be considered during construction are:

1. Keep slope stabilization work as close to actual road construction as possible.
2. Clearing and grubbing are required on fill sites. Overcasting onto vegetation or incorporating vegetation into fill material leads to serious stability and erosion problems due to settling.
3. Adequate compaction of fills is required.
4. Cleared vegetation may be chopped and used for mulching.
5. Culverts should conform to the existing channel or drainage as closely as possible. Compact fill around culverts very carefully and install headwalls or other cutoffs where possible.
6. Disturb stream flows as little as possible. Do not work in streams during high flows. Be sure to consult the Department of Fish and Game, Army Corps, RWQCB and County before making any streambed or channel alterations.

Maintenance

Maintenance is necessary to assure effective erosion control throughout the life of the road. Following construction, weak spots and deficiencies will require modification and repair. Normal use and natural deterioration will also cause repairs to be needed. Continual annual maintenance should reduce the repair size and cost and road erosion.

Recommended maintenance practices are:

1. The owner should keep a maintenance record for each road, as well as actual construction plans.

2. Culverts, drains, and dips should be cleaned regularly, especially before the rainy season.
3. Debris should be removed from stream drainages upstream of culverts for a minimum distance of 100 feet.
4. Ditches should be cleared of sediment and debris. Avoid disturbing stabilized ditch bottoms or undercutting side slopes.
5. Regrade the road surface to retain original surface drainage (in or out slope). Avoid side casting loose material over fill slopes.
6. Patrol roads during larger storms, if possible, to assure that drainage structures are functioning.
7. Where possible, outsloped roads without berms are your best bet. They avoid water concentration, thereby eliminating gullies and the construction of costly culvert pipes. Water sheets off an outsloped road and reduces erosion. Outsloping would not be appropriate on slippery clay soils.

There are some excellent publications available on road design and construction. Come by the Natural Resources Conservation Service and Resource Conservation District Office to review and/or order them.

Grading removes the natural vegetation and changes the direction and distribution of drainage, increasing soil erosion potential by up to 200 times the natural erosion rate. Soil erosion depletes a natural resource, impacts neighbors, destroys habitat and results in the loss of millions of dollars annually.

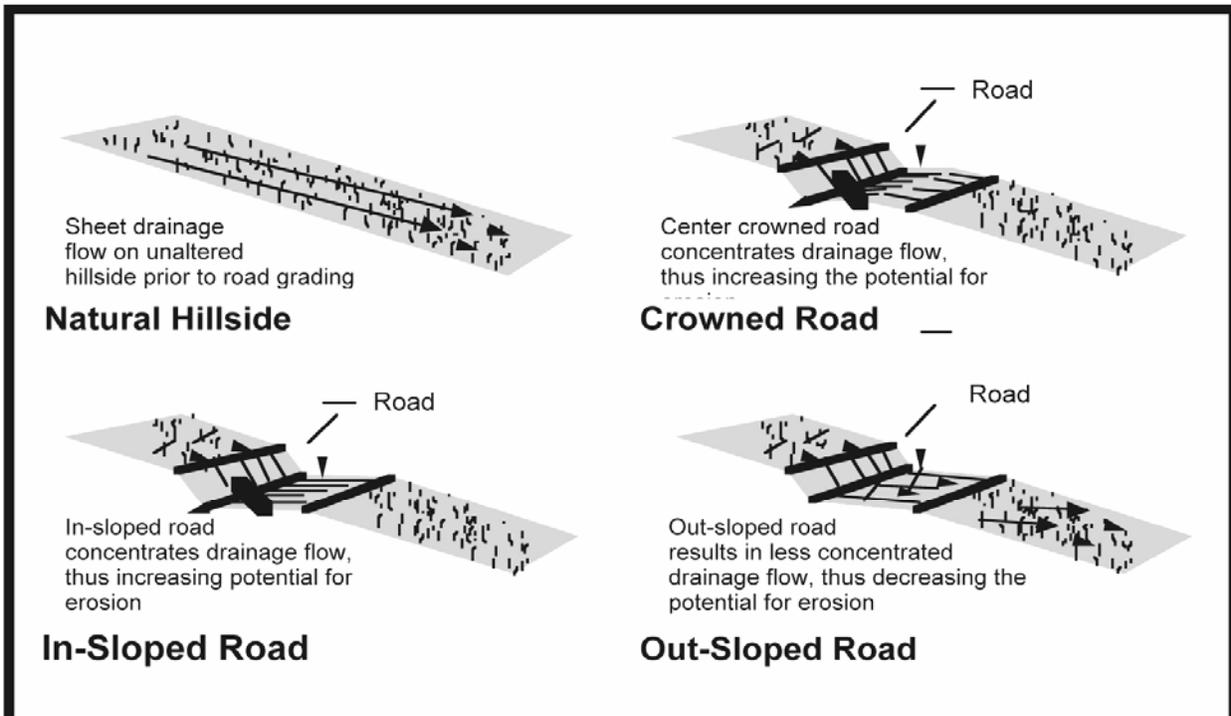


Grading should never occur without adequate measures to reduce the potential for soil erosion.

With good planning and implementation of erosion control measures during and after grading, it is possible to avoid erosion such as shown in these photo examples.

Examples of Erosion Caused by Grading and Road Construction

5.2 In-sloped, Crowned, and Out-Sloped Roads



How Grading Influences Road Surface Drainage:

The manner in which a road is graded has a major influence on drainage and erosion.

- **In-Sloped Roads:** An in-sloped road collects the drainage from the hillside and road surface and conveys the flow in a ditch to one or more collection points. This type of road always increases drainage flow rates and erosion. In-sloped roads should be accompanied with detention basins and/or other devices to moderate flows.
- **Crowned Roads:** The road surface is gently sloped away from the center toward both sides. As with in-sloped roads, drainage is concentrated in a ditch and storm surface drainage is increased.
- **Out-Sloped Roads:** These roads are gently graded in the direction of the hillside. Runoff sheets across the road, resulting in less concentration of flow and usually less erosion than with other types of roads. It is recommended the road surface be of a non-slip type such as decomposed granite, gravel or other similar material.

USLT-RCD & SLO County Planning & Building

5.3 Design Criteria for Culverts, Fords and Waterbars

Channeling Drainage Across Roadways:

When water flows across the roadway, there is almost always a potential for erosion. This can result in road washouts and gully formation. Many tons of sediment can end up in nearby streams, rivers and wetlands.

Rock riprap energy dissipaters, erosion control blankets, mulch and vegetation can guard against excessive erosion. All cut and fill banks should be vegetated with perennial plants.

- **Culverts:** Culverts are usually made of steel, plastic or concrete and can be round, oval or rectangular. They are used to convey small to large drainage channel flows under a road.

There are several common problems that need to be addressed with proper culvert construction:

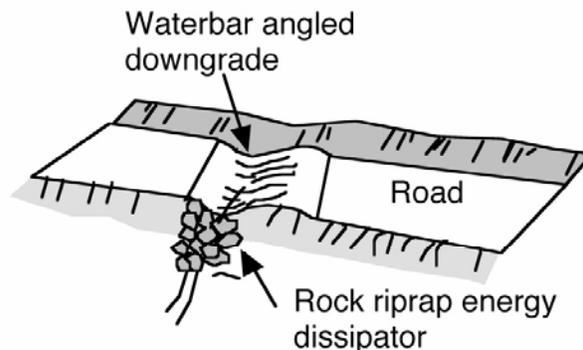
- Culverts need to be sloped adequately to be self cleaning. A general recommendation is a minimum of 6% slope.
- Culverts should be aligned to follow the flow of the natural channel.
- Culverts need to have properly designed inlets and outlets and they should have an energy dissipator at the outlet side to prevent channel scouring.
- Culverts need to be adequately sized to carry more than the expected storm flow. It is recommended that culverts be oversized to accommodate the storm flow in the event that the inlet becomes partially blocked with debris.
- Culverts used in intermittent or perennial streams may require several agency permits.
- Culverts should be engineered and meet NRCS Standards.
- Culverts need to be constantly monitored and maintained. In particular, they should be checked for debris.
- **IMPORTANT:** Work conducted within stream channels, either perennial or intermittent, may require County and Dept. of Fish & Game approval and should be designed to their criteria. They may also require Army Corps and Regional Water Quality Control Board Permits.

- **Fords:** In very small channels and in larger channels where year-round access is not required, fords can provide an alternative to bridging a stream.

- Fords require engineering and should meet NRCS Standards.
- Fords in streams may require several permits.

- **Waterbars:** Waterbars are shallow ditches and low berms constructed diagonally to the roadway. Waterbars can be an effective way to transfer flows across and off of a roadway:

- Use several waterbars if possible to spread the flow over a greater area thus reducing the potential for erosion. As the road steepens, increase the number of water bars.
- Waterbars require frequent maintenance.
- Care should be taken to ensure that waterbars do not excessively concentrate flows on the downslope side of the road.



- **Road Maintenance:** Many winter storm problems can be avoided if roadways and related erosion control facilities are adequately maintained:

- Clean out culverts
- Repair culverts, waterbars and other drainage devices.
- Replant vegetation that died or washed away

Spacing Guide for Waterbars Based on the Road Grade

| <u>Slope of the road</u> | <u>Waterbar spacing</u> |
|--------------------------|-------------------------|
| 5% | 150 feet |
| 10% | 100 feet |
| 15% | 75 feet |
| 25% | 40 feet |
| 30% | 35 feet |

Place waterbars above grade changes. To prevent bank cutting, place waterbars above curves. Waterbars should be constructed above level stretches of the road to prevent water from puddling on the road surface. Do not discharge concentrated flows onto fill slopes. Do not discharge concentrated flows onto fill slopes. Avoid allowing concentrated flow from waterbars onto landslide deposits, potential slide areas, very steep slopes, or otherwise unstable areas.

Unstable material can be recognized by tilting trees or fences, unnatural benches or bowl shaped depressions on otherwise uniformly sloping hillsides. Natural ponds, seeps, and hummocky topography can also point to unstable ground. Do not allow drainage into active gullies or eroding areas. Deep concentrated flow from directly entering a stream.

An energy dissipater is a structure at the outlet of a waterbar that reduces the velocity of water after it leaves the waterbar (see figure on the following page). This is very important for protecting the slope below the road from erosion. An energy dissipater must be a part of all waterbars.

Rock "rip-rap" is usually used for an energy dissipater. 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 with no spaces left between the rocks, in order to slow the water. If rock is haphazardly piled below the drain outlet, it could cause greater erosion damage or undercutting of the waterbar. A piece of filter fabric placed between the ground and the rock will increase the stability of an energy dissipater.

If the rock is not heavy enough, water flow will dislodge it and decrease the effectiveness of the energy dissipater. If necessary, cement grouting, a redwood box, or a section of a large culvert pipe can be used to hold the rock in place.

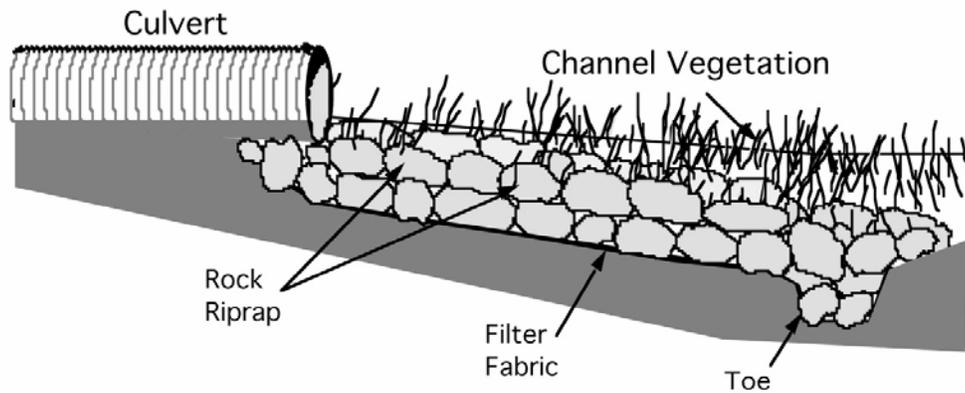
Maintenance of Waterbars:

Regular maintenance is vital for all waterbars. If there is little time for maintenance, more permanent measures such as paving or base rock and installing underground culverts must be considered.

To be effective, the maintenance program must contain two steps: MONITOR the road regularly and MAINTAIN it when necessary.

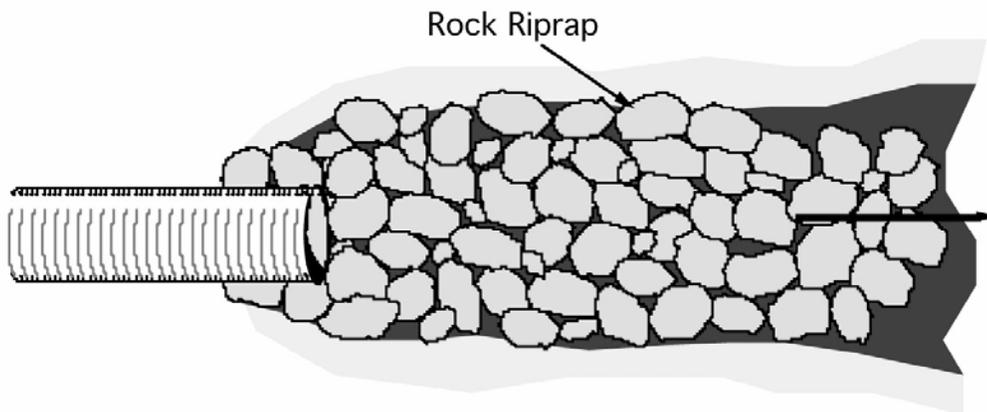
Use of Rock Riprap Energy Dissipator

Culvert Outlet Plan Section Example



Use of Rock Riprap Energy Dissipator

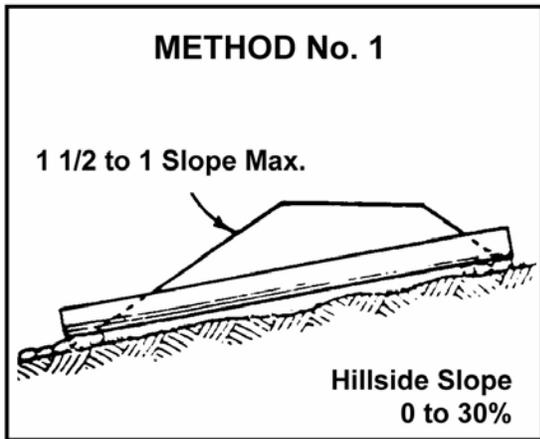
Culvert Outlet Plan View Detail Example



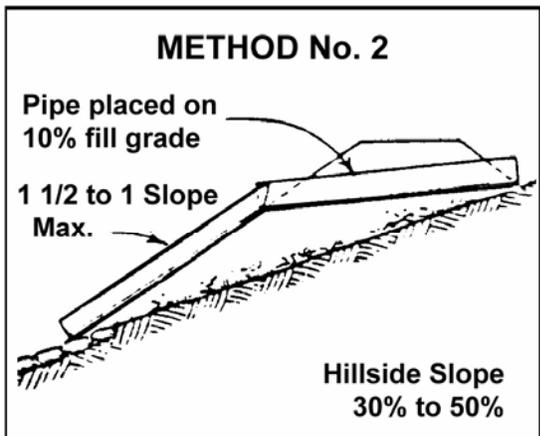
NOTE: Size of rock and outer dimensions of the energy dissipator are dependent upon volume and velocity of flow exiting the culvert. Energy dissipators should be engineered to meet NRCS standards.

Culverts Guidelines

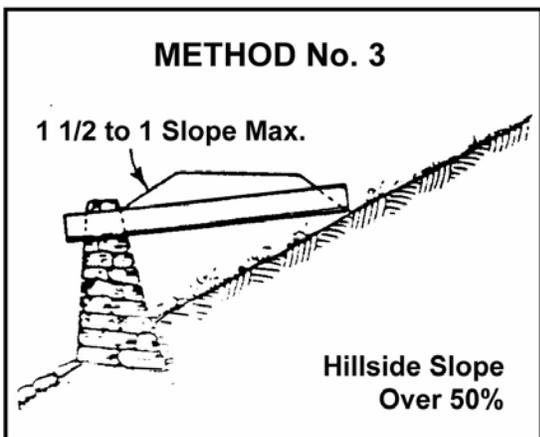
Culvert pipe should be designed by a qualified professional engineer.



Method 1. Where side slopes are from 0 to 30 percent, lay pipe along the natural ground slope in the drainage course. This method could also be used on steeper slopes where a running stream is encountered and sheer installation cost would prohibit the use of either of the two following methods.



Method 2. When side slopes are from 30 to 50 percent, lay the pipe through the fill on a grade of 10 percent and carry the water down the fill slope. This method is helpful where running streams interfere with the installation, or when the pipe can be laid on a skew to carry the water along the natural ground from the lower edge of the pipe to the original drainage channel. The most economical method should be used; in some cases it will be cheaper to protect the lower portions of the fill from wash than to extend the pipe to the toe of the slope.



Method 3. Where side slopes are in excess of 50 percent, either lay pipe through the fill on a 10 percent grade and protect the lower portion of the fill from wash by a hand-placed rock wall, or skew the pipe so the discharge will fall on the natural ground and be carried to the original channel in open ditch.

Culverts Under Fills

In all cases, energy dissipaters should be installed at the outlet end of all culvert pipes.

5.4 Road Maintenance

Unused Roads

Unused roads that are not essential should be taken out of service and treated to reduce erosion. On some sites, unused roads may be regraded to the area's original topography, seeded, fertilized, and mulched to restore vegetative cover. This is the optimum solution. On sites where regrading to the original topography is not feasible, the retired road should be outsloped to reduce water concentration on the roadbed. Steeper roads should also have waterbars constructed at proper intervals, where water can be safely outletted onto hillsides.

Monitoring

Walk the road regularly and inspect the drainage frequently, especially during wet weather. Warning signs from poor drainage control on roads are the following:

- * Puddles and potholes on the road surface.
- * Roadside erosion (on cut and fill banks).
- * Eroding roadside ditches.
- * Gullies and deep wheel ruts in the road.
- * Accumulation of sediment in waterbars and ditches.

Maintenance

The importance of regular maintenance work cannot be over-emphasized. Most maintenance jobs are minor if dealt with immediately. Delaying necessary work can result in washed out roads, gully erosion, and stream pollution. Maintenance activities include:

- * Keep culverts and waterbars clear of sediment and debris. Make sure inlets and outlets are clear so that water can flow freely.
- * Rebuild waterbars whenever traffic wears them down.
- * Keep inside ditches clear of debris and sediment so that they may drain freely and do not overflow onto the road.
- * Make sure that energy dissipaters stay in place.
- * Protect any bare or disturbed areas with an erosion control grass.

Appendices

"If the soil is destroyed, then our liberty of action and choice are gone..."
--*W.C. Lowdermilk, 1953*

Appendix A-1

Seeding Recommendations for Construction Sites and Other Bare Areas

| <u>Seed Mixture Options</u> | <u>Short Term/ Long Term Protection</u> | <u>Pounds per 1000 Square Feet</u> | <u>Pounds Per Acre</u> |
|---|---|--|----------------------------|
| Blando brome (long-term stand) | Long Term | 0.4 | 18 |
| Lana vetch | | 0.3 | 15 |
| Blando brome | | 0.3 | 12 |
| Hykon Rose clover | Long Term | 0.2 | 9 |
| Zorro Annual fescue | | 0.1 | 4 |
| Blando brome | Long Term | 0.3 | 12 |
| Lana vetch | | 0.3 | 15 |
| Briggs barley | Short & Long Term | 2.0 | 90 |
| Blando brome | Short & Long Term | 0.3 | 12 |
| Lana vetch | | 0.3 | 15 |
| Blando brome | Long Term | 0.4 | 18 |
| Briggs barley (short-term stand - 2 years) | | 4.0 | 180 |
| Zorro annual fescue | Long Term | 0.3 | 12 |
| Zorro annual fescue | Long Term | 0.2 | 8 |
| Hykon Rose clover | | 0.2 | 9 |
| Blando brome | | 0.3 | 12 |
| Annual medic mix for soils | 0.4 | 18 | |
| <u>Natives</u> | | | |
| Bromus carinatus | Long Term | 0.5 | 20 |
| Vulpia microstachys | Long Term | 0.3 | 12 |
| Bromus carinatus | Long Term | 0.3 | 12 |
| Vulpia microstachys | Long Term | 0.1 | 4 |

Notes on Recommended Grass and Legume Seeds

Annual Medic (*Medicago species*). Burr Clover and other annual medics are legumes, which are adapted to soils with a neutral or alkaline pH. Some varieties, such as Serena medic, are early-maturing, and therefore very drought tolerant.

Barley (*Hordeum vulgare*) 'common'. A quick spreading annual cereal grass 2 to 3 feet high. Does not reseed itself well. Birds eat the seed. Medium forage value for livestock. 'Briggs' variety is the fastest growing and best overall.

Brome, Blando (*Bromus mollis*). An annual grass 1 to 2 1/2 feet tall with tufted, soft appearance. Rapid growing and reseeds well. Tolerates all well-drained soils. Excellent forage. The best all around annual grass.

Clover, Rose (*Trifolium hirtum*). A freely branching winter growing annual legume, 3 to 24 inches tall. Adapted to well-drained soils. Germinates best in warm weather. Plant before fall rains. Nitrogen-fixing.

Fescue, 'Zorro' Annual (*Vulpia myros L.*). A short, aggressive, early maturing cool-season annual grass with many fibrous roots. Six to twelve inches tall. Matures earlier than most annual grasses and tolerates drought and low fertility soils. Reseeds well.

Vetch, 'Lana' Wollypod (*Vicia dasycarpa*). A semi-prostrate annual legume, to 3 feet tall, with nitrogen-fixing capacity. The fastest growing legume, it competes well with grasses and reseeds itself well. Prefers deep soils, but is widely adaptable. Seed will be eaten by birds if not protected. Difficult to mow.

Appendix A-2

Selecting Plants for Erosion Control

A number of facts have to be considered in order to select the proper plant to prevent or control erosion. Soil conditions, climate and water supply are the essential considerations. Other considerations can be: amount of growing space, other desired uses of the plant, fire hazard, maintenance, growth rate and visual appeal.

Soil conditions can be quite complex and construction operations can significantly change soil properties. Vegetative Soil Groups is a simplified method used by the Soil Conservation Service to aid in plant selection. For site-specific soils information, consult the San Luis Obispo County soil surveys.

Climate is also complex and variable, even within short distances. The Lane Publishing Company has published suitable climate maps for use with their plant selection guides in the "Western Garden Book". The Soil Conservation Service uses Resource Area Maps. A brief description of the two Resource Areas in San Luis Obispo County is given below.

Key to Table

Trees, Shrubs, and Groundcovers for Erosion Control

Primary Uses

E: Erosion Control
G: Gully Control
L: Reduce Landslide Risk
O: Ornamental
S: Screen
St: Streambank Erosion Control
W: Wildlife
Wn: Windbreak

Recommended Form of Planting

Co: Container
Cu: Cuttings
Se: Seed
Se*: Seed must be planted in the fall or else scarified before planting

Resource Area

C: Coastal
I: Inland

Deciduous or Evergreen Plant

D: Deciduous E: Evergreen
N: Native

Explanations:

1. All plants listed are adapted to San Luis Obispo County. This list is not all-inclusive. For additional adaptable species see the Sunset Western Garden Book or your local nurseryman.
2. It is expected that all plants will be watered during the first two years to insure establishment.

3. Where the normal rainfall is inadequate to support growth, a continuing irrigation requirement is shown in "Remarks".
4. Vegetative Soil Groups are defined in chapter 4.4. On-site investigation may be necessary on disturbed soils to determine the vegetative group. Contact your local Resource Conservation District for assistance.

Appendix A-3

Fire Resistant Trees, Shrubs, Groundcover and Vines

Zone 1

Nearest to the structure, 0-15 feet away. Plants recommended for this zone are low growing and have a high moisture content. Some irrigation is recommended during the dry season. Plants should be kept pruned. Excessive amounts of litter are to be avoided. (see example figure in Chapter 4.5, "Fire Resistant Landscaping.")

Trees, Shrubs and Groundcovers:

| | |
|---------------------------------|----------------------------|
| <i>Agapanthus africanus</i> | Lily of the Nile |
| <i>Arbutus unedo</i> | Strawberry tree |
| <i>Armeria alliacea</i> | Sea Pink |
| <i>Armeria maritima</i> | Sea Pink |
| <i>Armeria pseupaemia</i> | Sea Pink |
| <i>Buxus microphylla</i> | Japanese boxwood |
| Citrus varieties | |
| <i>Convolvulus excelsus</i> | Bush Morning Glory |
| <i>Dietes bicolor</i> | |
| <i>Dietes</i> 'Lemon Drop' | Yellow wild iris |
| <i>Dietes vegeta</i> | White fortnight lily |
| <i>Erigeron karvinskianus</i> | Santa Barbara daisy |
| <i>Erigeron</i> 'Moerheimii' | Fleabane |
| <i>Feijoa sellowiana</i> | Pineapple guava |
| <i>Festuca rubra</i> | Red Fescue |
| <i>Gazania</i> 'Mitsuwa Orange' | Orange gazania |
| <i>Gazania</i> 'Mitsuwa Yellow' | Yellow gazania |
| <i>Hemerocallis</i> (assorted) | Day Lilly |
| <i>Japonica</i> var. | Star Jasmine |
| <i>Jasminoides</i> ssp | Star Jasmine |
| <i>Jasminum ligustifolium</i> | Shiny leaf asmine |
| <i>Kniphofia uvaria</i> | Red hot poker |
| <i>Ligustrum texanum</i> | Texas privet |
| Macadamia varieties | |
| <i>Magnolia</i> spp. | Magnolia |
| <i>Metrosideros excelsus</i> | New Zealand Christmas Tree |
| <i>Myoporum laetum</i> | Myoporum |
| <i>Nerine masonorum</i> | Nerine |
| <i>Nerium oleander</i> | Oleander |
| <i>Olea europaea</i> | Olive |
| <i>Persea americana</i> | Avocado |
| <i>Pittosporum</i> spp. | Pittosporum |
| <i>Prunus</i> spp. | Cherry |
| <i>Punica granatum</i> | Pomegranate |
| <i>Pyracantha</i> spp. | Firethorn pyracantha |
| <i>Pyracantha</i> spp. | Santa Cruz pyracantha |
| <i>Quercus</i> spp. | Oak |
| <i>Rhamnus alaternus</i> | Italian buck thorn |
| <i>Schinus molle</i> | California pepper |
| <i>Tecomaria capensis</i> | Cape honeysuckle |
| <i>Trachelospermum</i> | |
| <i>Xylosma congestum</i> | Xylosma |

Zone 2

The "Greenbelt" or buffer zone, from 15-30 feet away from the structure. the plants have a high moisture content, and most are low growing. These plants should be irrigated during the dry season, and kept free of dead branches, stalks, and excessive litter.

| | |
|--|--------------------------------|
| <i>Achillea</i> spp. | Yarrow |
| <i>Aeonium arboreum</i> | Succulent |
| <i>Aeonium undulatum</i> | Saucer plant |
| <i>Agave americana</i> | Agave |
| <i>Agave attenuata</i> 'Nova' | Blue agave |
| <i>Ajuga reptans</i> | Carpet bugle |
| <i>Aloe arborescens</i> | Torch aloe |
| <i>Aloe</i> 'Johnson's Hybrid' | Aloe |
| <i>Aloe nobilis</i> | Aloe |
| <i>Aloe striata</i> | Coral aloe |
| <i>Aloe vera</i> | Medicinal aloe |
| <i>Aloe x spinosissima</i> | Spider aloe |
| <i>Arctotheca calendula</i> | Capeweed |
| <i>Atriplex semibaccata</i> | Australian saltbush |
| <i>Baccharis pilularis</i> var. | Dwarf coyote bush |
| <i>Bulbine caulescens</i> | Bulbine |
| <i>Bulbine</i> 'Hallmark' | Bulbine |
| <i>Carissa grandiflora</i> | Natal plum |
| <i>Cercis occidentalis</i> | Western redbud |
| <i>Cistus salvifolius</i> | Sage / leaved rockrose |
| <i>Coprosma kirkii</i> | Trailing coprosma |
| <i>Cotyledon barbenyii</i> | |
| <i>Cotyledon macrantha</i> | |
| <i>Cotyledon orbiculata</i> | |
| <i>Crassula arborescens</i> | Silver jade plant |
| <i>Crassula argentea</i> | Jade plant |
| <i>Crassula argentea</i> 'Pink Beauty' | 'Pink jade plant |
| <i>Crassula lactea</i> | |
| <i>Crassula multicava</i> | Crassula |
| <i>Duchesnea indica</i> | Mock strawberry |
| <i>Dymondia margaretae</i> | |
| <i>Echevaria</i> var. | Echevaria |
| <i>Eschscholzia californica</i> | California poppy |
| <i>Fragaria chiloensis</i> | Wild strawberry |
| <i>Furcraea iroezlii</i> | |
| <i>Gazania</i> var. | Gazania |
| <i>Hesperaloe parviflora</i> | Red yucca |
| <i>Juniperus conferta</i> | Shore juniper |
| <i>Kalanchoe pumila</i> | Kalanchoe |
| <i>Lampranthus aurantiacus</i> | Bush gold |
| <i>Lotus scoparius</i> | Deerweed |
| <i>Lupinus</i> spp. | Lupine |
| <i>Mimulus puniceus</i> | Monkeyflower |
| <i>Myoporum parvifolium</i> | Myoporum |
| <i>Nerium oleander</i> | |
| 'Mrs. Roeding' | Dwarf pink oleander |
| 'Petite Salmon' | 'Dwarf salmon oleander |
| <i>Osteospermum fruticosum</i> | Trailing African daisy |
| <i>Pelagonium peltatum</i> | Ivy geranium |
| <i>Penstemon</i> spp. & var. | Penstemon |
| <i>Phormium</i> var. | 'Maori Maiden, Queen & Sunset' |
| <i>Phyla nodiflora</i> | Lippia |

| | |
|---|---------------------------------|
| <i>Heuchera maxima</i> | Coral bells or Island alum root |
| <i>Hypericum calycinum</i> | St. Johnswort |
| 'Pacific Coast Hybrids' | <i>Iris</i> |
| <i>Koeleria glauca</i> | California iris |
| <i>Lantana montevidensis</i> | Blue hair grass |
| <i>sellowiana</i> | Lantana |
| <i>Lavandula dentata</i> | French lavender |
| <i>Lavandula stoechas</i> | Spanish lavender |
| <i>Limonium perezii</i> | Statice |
| <i>Linaria maroccana</i> | Toad flax |
| <i>Lotus scoparius</i> | Deerweed |
| <i>Lupinus spp.</i> | Lupine |
| <i>Mimulus longifolius</i> | Red monkeyflower |
| <i>Mimulus puniceus</i> | Mexican evening primrose |
| <i>Oenothera berlandieri</i> | Ivy geranium |
| <i>Pelargonium peltatum</i> | Penstemon |
| <i>Penstemon spp. & var.</i> | Russian sage |
| <i>Perovskia atriplicifolia</i> | Rosemary |
| <i>Rhagodia spinescens</i> | Sage |
| <i>Rosemarinus officinalis</i> 'Prostata' | Sage |
| <i>Salvia</i> 'Allen Chickering' | Sage |
| <i>Salvia aurea</i> | Sage |
| <i>Salvia chamaedyoides</i> | Sage |
| <i>Salvia leucantha</i> | Mexican bush sage |
| <i>Salvia leucophylla</i> | Purple sage |
| <i>Salvia sonomensis</i> | Creeping sage |
| <i>Santolina spp.</i> | Santolina |
| <i>Santolina virens</i> | Green lavender cotton |
| <i>Silene imaritima</i> | Yellow-eyed grass |
| <i>Sisyrinchium californicum</i> | Lamb's ears |
| <i>Stachys byzantina</i> | Wooly blue curls |
| <i>Trichostema lanatum</i> | Yucca |
| <i>Yucca whipplei</i> | Wooly yarrow |
| <i>Zauschneria californica</i> | |

Zone 4

The outermost area, 100 feet or more from the structure. This zone contains native drought tolerant species, which should be thinned to reduce fuel volume. The area should have a light ground cover to prevent erosion.

| | |
|---|----------------------|
| <i>Agave spp.</i> | Agave |
| <i>Alnus rhombifolia</i> | White alder |
| <i>Anaphalis margaritacea</i> | Pearly everlasting |
| <i>Arctostaphylos</i> | Manzanita |
| 'Dr. Hurd' | |
| <i>Arctostaphylos pajaroensis</i> 'Paradise' | Manzanita |
| <i>Arctostaphylos spp.</i> | Manzanita |
| <i>Atriplex lentiformis</i> | Coastal quail bush |
| <i>Ceanothus griseus</i> 'Point Reyes' | Mountain lilac |
| <i>Ceanothus spp.</i> | California lilac |
| <i>Ceanothus horizontalis</i> | Mountain lilac |
| 'Anchor Bay', 'Frosty Blue', 'Joyce Coulter', 'Ray Hartman', 'Snow Flurry', 'Wheeler Canyon', 'Yankee Point', | |
| <i>Cercocarpus betuloides</i> | Mountain mahogany |
| <i>Garrya elliptica</i> 'Evie' | Garrya or silktassel |
| <i>Garrya spp.</i> | Silk tassel |

Heteromeles arbutifolia
Heuchera maxima
Platanus racemosa
Prunus lyonii
Quercus agrifolia
Quercus dumosa
Rhamnus californica
Rhamnus californica 'Eve Case'
Rhamnus crocea
Rhus integrifolia
Rhus laurina
Rhus ovada
Romneya coulteri
Sisyrinchium bellum

Toyon
Coral bells or Island alum root
Western sycamore
Catalina cherry
Coast live oak
Scrub oak
California coffeeberry
Coffee berry
Redberry
Lemonade berry
Laurel Sumac
Sugarbush
Matilija poppy
Blue eyed grass

Non-fire Resistant Plants

The following plants are not resistant to fire and should be removed if growing near a structure.

Adenostoma fasciculatum
Artemisia californica
Eriogonum fasciculatum

Chamise
Coastal sagebrush
California buckwheat

A-4 Plants Resistant to Deer Browsing

Trees and Shrubs:

Calocedrus decurrens

Cedrus doedara

Cistus

Cupressus arizonica

Baccharis pilularis

Juniperus chinensis phitzeriana

Mahonia aquifolium

Mahonia pinnata

Nerium oleander

Pinus attenuata

Pinus muricata

Pinus radiata

Pinus sabiniana

Romneya coulteri

Rosmarinus officinalis

Incense cedar

Deodar cedar

Rockrose

Arizona cypress

Dwarf coyote bush

Pfitzer juniper

Oregon grape

California holly grape

Oleander

Knobcone pine

Bishop pine

Monterey pine

Gray Pine

Matilija poppy

Rosemary

Groundcovers:

Rosmarinus Prostratus

Zauschneria californica

Dwarf Rosemary

California fuschia



Appendix A-5 Cost Comparison of Seeding Methods

| <u>Treatment Labor</u> | <u>Comments</u> | <u>Cost</u> | <u>Landowner</u> |
|--|--|---------------|------------------|
| Seed and fertilizer broadcast and covered with soil (raking or dragging a chain, etc.) No hired labor. | Inexpensive and fast. Most effective on rough seedbeds with minimum slope and erodibility. Does not require special equipment. Offers minimal protection from rain-drop impact and water flowing over the surface. | Lowest | High |
| Broadcast seed and fertilizer with 3000 lbs/acre straw mulch cover punched in with shovel. No hired labor. | Good erosion control protection on small areas and for homeowners. | Low | Highest |
| Hydromulching with 2000lbs/acre wood fiber plus seed and fertilizer. | Produces a true mulch effect with some erosion control protection. | Fairly Low | Minimal |
| Broadcast seed and fertilizer with straw broadcast at 3000 lbs/acre and rolled to incorporate with a straw tamper. | Common on difficult fill slopes in California. Very effective. Cut slopes may be difficult. | Below average | High |
| Broadcast seed, fertilizer, and straw at 3000 lbs/acre tacked with hydromulch. | Very effective. Useful on cut slopes where incorporating straw is difficult. | Below average | Medium |
| 3000 lbs/acre of straw tacked down with plastic biodegradable netting. | Good for difficult areas where straw tacking isn't possible any other way. | Average | High to Minimal |
| Jute netting held in place with wire staples. No landowner labor - all hired. | Adapted to small areas. Generally used to hold soil before groundcover and/or shrubs are established in a landscaping situation. Can be installed in any season; cuts or fills. Difficult to install on rocky soils. | Highest | None |

Appendix A-6 Seed Sources

Feed stores and many farm supply stores are excellent sources of grass or legume seed and also carry hay and straw for mulching purposes. If they do not have the seed in stock, they can usually order it and have it for you in a couple of days. In the San Luis Obispo County area some supply stores are:

San Luis Obispo Farm Supply Co.

1108 Paso Robles St.
Paso Robles
(805) 238-1177 or,
675 Tank Farm Rd.
San Luis Obispo
(805) 543-3751

Double D Feed & Supply

202 Tank Farm Rd.
San Luis Obispo
(805) 543-8410

Western Farm Service

Hwy 46 East
Paso Robles
(805) 238-3825

Karleskin - Crum Inc.

225 Suburban Rd.
San Luis Obispo
(805) 543-3304

If the above local stores do not carry the seed you are looking for, try one of the dealers listed below; they can usually send seed quickly:

ConservaSeed

P.O. Box 1069
Walnut Grove, CA 95690
(916) 776-1200

Stover Seed Co.

P.O. Box 21488
Los Angeles, CA 90021
(213) 626-9668
<http://stoverseed.com/>

S & S Seed

P.O. Box 1275
Carpinteria, CA 93014
(805) 484-0551

Lockhart Seed Co.

P.O. Box 1361
Stockton, CA 95201
Phone: (209) 466-4401

Go Native Nursery

P.O. Box 370103 Montara, CA 94037
(650) 728-2286
<http://gonativenursery.com>
dave@gonativenursery.com

Clyde Robin Seed Co., Inc.

PO Box 2366
Castro Valley, CA 94546
(510) 705-0425

Las Pilitas Nursery

3232 Las Pilitas Rd.
Santa Margarita, CA 93453
(805) 438-5992
<http://www.laspilitas.com>
bawilson@slonet.org

Native Sons Wholesale Nursery

379 W El Campo Road
Arroyo Grande, CA 93420
(805) 481-5996
<http://www.nativeson.com>
native.son@nativeson.com

Hedgerow Farms

21740 County Road 88
Winters, CA 95694
(530) 662-4570

Plant Sources

Trees, Shrubs, and Groundcovers

Orders for native trees and shrubs should be placed well in advance. Such seed and stock, with few exceptions, are only available seasonally. Since the use of fresh seed is usually important, for many species there is only one period of a few months each year when seed is available. All of the introduced and many of the native plants mentioned in this report are available at your local nursery. (see also Appendix A-7) Ask the manager to order it for you or try one of the nurseries listed below*:

Calif. Dept. of Forestry

contact for order form
and plants available-
P.O. Box 151
San Luis Obispo, CA 93406
(805) 543-4244

Las Pilitas Nursery

301 Los Osos Valley Rd.
Los Osos, CA 93402
(805) 528-5300

Moore's Western Nursery

8255 Morro Road
Atascadero, CA 93422
(805) 466-2234

Pacific Home Improvement

9370 El Camino Real
Atascadero, CA 93422
(805) 466-0270

San Simeon Nursery

1690 Villa Creek Rd.
Cayucos, CA 93430
(805) 995-2466

Santa Barbara Botanic Garden

1212 Mission Canyon Road
Santa Barbara, CA 93105
(805) 682-4726

Mostly Native Nursery

27215 Highway 1, P.O. Box 258
Tomales, CA 94971
(707) 878-2009

Wentzel's Gardens Nursery

2500 El Camino Real
Atascadero, CA 93422
(805) 466-3449

Native Sons Nursery

379 W. El Campo Rd.
Arroyo Grande, CA 93420
(805) 481-5996

* These lists of suppliers are not complete and no discrimination is intended by omission. The RCD and County do not endorse any supplier. For a more complete listing of plant and seed sources see the Landscape Restoration Handbook. (CRC Press Inc. 1993).

Appendix A-7 Native Plant Suppliers

| Name | Address | Contact Number | E-mail and Web Site |
|--|--|--|--|
| Bitterroot Restoration, Inc | 11760 Atwood Rd, Suite 5 Auburn, CA 95603 3790 Via De La Valle, Suite 117 Del Mar, CA 92014 | PH: 530-745-9814 FAX: 530-745-9817 PH: 858-481-5865 FAX: 858-481-5870 | laurie@bitterrootrestoration.com dug@bitterrootrstoration.com |
| Cornflower Farms | PO Box 896 Elk Grove, CA 95759 | PH: 916-689-1015 FAX: 916-689-1968 | |
| Creekside Gardens | PO Box 357 Miranda, CA 95553 | PH: 707-943-3246 | creeksideg@aol.com |
| Elkhorn Native Plant Nursery | PO Box 270 Moss Landing, CA 95039 | PH: 831-763-1207 FAX: 831-763-1659 | |
| Freshwater Farms, Inc. | 5851 Myrtle Avenue Eureka, CA 95503-9510 | PH: 707-444-8261 PH: 800-200-8969 FAX: 707-442-2490 | http://www.freshwaterfarms.com/ |
| Go Native Nursery c/o Cypress Flower Farm | 333 Cypress Street Moss Beach, CA 94038 | PH: 650-728-0728 FAX: 650-728-3067 | gonative@coastside.net http://www.gonativenursery.com/ |
| Las Pilitas Nursery | 3232 Las Pilitas Road Santa Margarita, CA 93453 | PH: 805-438-5992 PH: 760-822-1350 | http://www.laspilitas.com/ |
| Native Revival Nursery | 8022 Soquel Drive Aptos, CA 95003-3918 | PH: 831-684-1811 | |
| Native Sons Nursery | 379 W. El Campo Road Arroyo Grande, CA 93420 | PH: 805-481-5996 | http://www.nativeson.com |
| The Native Nursery (Wholesale) | | PH: 831-722-8533 PH: 877-895-2266 | thenativenursery@hotmail.com http://www.thenativenursery.com |
| The Watershed Nursery | 925 Lakeville Hwy #156 Petaluma, CA 94952 | PH: 707-888-3271 | thewatershednursery@earthlink.net http://home.earthlink.net/~thewatershednursery |

Appendix A-8

Wildlife Upland Habitat Management for Quail, Dove, Deer and Turkey

The three essential elements which make up wildlife habitat are food, cover and water.

I. QUAIL

- A. Food - Plant Lana vetch, wheat, safflower, sorghum and milo to supplement the natural food supply.
- B. Escape Cover - Quail need scattered clumps of dense ground cover to escape predators. Hedgerows of rose, berry thickets and quail bushes are examples. Well constructed brush piles make good substitutes but must be renewed every three to five years.
- C. Roosting Cover - Quail roost in trees or tall shrubs and need protection during cold, wet periods of the year. Evergreen trees such as live oak, and Arizona cypress are good examples as are shrubs such as Holly leaf cherry and Toyon.
- D. Water - The California valley quail is reported to range from 1/2 to 1 mile for water while Mountain quail may go 2 miles to water. If a water source is not available, a suitable substitute, such as a guzzler, must be supplied for them.

II. DOVES

- A. Food - Lana vetch, wheat and safflower can be grown for doves to improve their food supply.
- B. Cover - The cover requirement for dove is not too specific. They prefer to nest in trees but will nest in shrubs or on the ground. They prefer to feed in open fields rather than in heavy cover.
- C. Water - Doves require water daily. They drink at the margin of ponds, pools, streams and the like where vegetative cover is not heavy. Ordinarily, they will fly a mile or so to obtain water.

III. DEER

A. Food

- Mature stands of timber, including oaks, shade out most of the understory of shrubs, forbs and grasses that provide deer food and must be opened up by harvesting or selective thinning.
- Mature brush stands provide little deer feed because most growing tips are out of reach of the deer and the canopy shades out forbs and grasses. These brush stands can be opened up to create openings for forbs and grasses and to get new seedlings and sprouts started at ground level for deer to eat.
- In open grassland, hedgerow plantings and tree plantings will provide better food conditions for deer.

B. Cover - Good deer habitat has a diversity of cover types: trees, brush and open grassland.

C. Water - The development of water for deer at 1-mile intervals and at sites with suitable food and cover vegetation will be close to the optimum.

IV. WILD TURKEYS

Things you can do:

- Provide choice turkey foods by planting grasses, grains and legumes in fields adjacent to woodlands.
- Increase food production in woodlands by controlled burning, chemical brush control, thinning trees, and seeding scattered small openings and clearings.
- Save food-producing trees and shrubs from eradication.
- Provide reliable, year-round sources of drinking water.
- Protect turkeys from excessive hunting, nesting disturbances, poultry diseases, and certain kinds of predators, especially free-ranging dogs.

Turkeys are found in extensive woodland areas - usually oak or mixed oak and conifer. Woodland should have an open understory since turkeys do not range well through heavy undergrowth.

Improving Woodlands for Wild Turkeys:

- A. Food: Wild turkeys feed on acorns, nuts seeds, fruits, tubers and greens and on insects (mainly grasshoppers) and other small animals. The food available to wild turkeys can be increased by
- 1) planting grasses, grains and legumes and
 - 2) managing woodland to increase natural foods. The field you plant should be at least 1 acre. If you have deer, the field must be larger (2 to 10 acres) in order to feed them also.

Plants: Clovers - excellent turkey food. Barley, Oats, Ryegrass, and Wheat - suitable winter grazing plants. Fescue and Orchardgrass - perennial winter grasses are fair turkey foods. Though they are less palatable than the annual winter grasses, they make good ground cover and are useful on steeply sloping land or along roadways.

- B. Cover -Controlled burning, brush control, thinning trees, seeding grasses and legumes in openings and leaving food-producing trees and shrubs are ways of providing more food and better feeding conditions.
1. Controlled Burning
No area should be burned more often than once every third year. The best time for burning is December or January, never during the spring nesting season. Controlled burning permits growth of succulent vegetation and better feeding. California Department of Forestry assists landowners with controlled burn and must be contacted in advance.
 2. Brush Control
Mechanical or chemical brush control can be used to remove unwanted brush and trees. With the removal of trees, various grasses and legumes usually volunteer the following spring from seeds lying in the soil. If choice food plants do not appear after the trees have been removed, you can stir the leaf litter with a spring-toothed cultivator or burn it off; then seed whatever species is best adapted to the soils of the area.
 3. Thinning Trees
Selective thinning operations can be planned to create scattered openings in woodlands where choice turkey foods can be seeded.
 4. Seeding Open Areas
Turkey foods can be grown in such places as powerline rights-of-way, field borders, abandoned orchards and fields, along woodland roads and areas that have been bulldozed or burned.

5. Leaving Food Trees and Shrubs

Food producing shrubs and trees should be preserved. Acorns from all the oak species provide excellent turkey food. Blackberry and Buckwheat are excellent food - producing shrubs.

- C. Water - Turkeys drink water daily. Dependable year-round drinking water should be well distributed throughout the turkey range. A nesting hen should have drinking water within 400 feet of her nest.
- D. Control - Turkeys suffer from man's activities, from disease, and from some predators. Illegal extensive hunting, disturbances during nesting season, and free-ranging dogs, livestock and poultry are important factors in preventing turkey increase.

Appendix A-9

Fish Pond Management Can Make a Difference

Fish pond management means developing or improving impounded water to produce fish for domestic use or recreation. Management is needed to improve or maintain fish production and fishery use by making a favorable water habitat and reducing competition from unwanted plants and animals.

Most Central Coast ponds provide warm water habitat (surface water temperatures more than 70 degrees F from May through September each year) suitable for black bass, bluegill, redear sunfish and catfish. Trout are usually not suitable for these ponds except on a put-and take basis during the cooler months of the year.

Newly constructed ponds should not be stocked with fish for one year. It takes this long for plants to grow along the shoreline. These plants provide protection for newly hatched fish. You may stock mosquito fish in your pond if you have a mosquito problem. After the first year bass and redear sunfish or bluegill can be stocked.

What species of fish should you stock in your pond? The largemouth bass thrives in the California warm-water pond environment. It is a very predatory fish, and is at the top of the aquatic food chain. Its presence is necessary to control numbers of other species that may be present such as bluegill or redear sunfish. In newly stocked ponds, bass may spawn during their second year of life. Bluegill have traditionally been stocked with bass. If the pond is properly designed and not too weedy, the bluegill provide excellent angling as well as forage for the bass. The population can withstand heavy fishing pressure. On most ponds, bluegill are underfished. If this is the case with your pond all bluegill caught should be removed from the pond to avoid overcrowding, competition with bass fingerlings and stunting of the fish. Redear sunfish, a close relative of the bluegill, is frequently stocked instead of bluegill in bass ponds. The redear does not spawn as intensively as bluegill and thus does not have the tendency to overpopulate and stunt, even in weedy ponds. Redear grow faster than bluegill, and commonly weigh over one pound. Channel catfish can be added to a bass-bluegill or redear combination, or in ponds by itself. They usually do not reproduce successfully in bass or bluegill ponds, and consequently must be restocked periodically. In catfish-only ponds, they will reproduce successfully if provided with tunnel-like containers in which they can spawn.

Warm water fish ponds need to be stocked only once and are self-sustained there after. After initial stocking, allow the fish to spawn once before commencing to fish. Once a new batch of young fish has been noted, fish the pond heavily. You cannot hurt it. Most ponds are under fished rather than over fished. Harvesting the fish leaves better growing conditions for those remaining. Don't throw back small bluegill. "Thin" them out. The rest will grow larger. Established ponds can be expected to produce a harvestable crop of 100 to 150 pounds of fish per surface acre annually.

A stocking permit is required from the California Department of Fish and Game before an owner may stock a pond.

Central Coast Fish Ponds

Probably the most troublesome management problem of California farm ponds is aquatic vegetation. While sparse to moderate growths of vegetation may be desirable because they may provide habitat for aquatic insects and other pond life, excessive growths are undesirable because:

- 1) they make young fish, particularly bluegill, invulnerable to bass predation, leading to an overpopulation of bluegill;
- 2) they discourage angling and subsequently contribute to overpopulation of bluegill and other forage fish;

- 3) they can cause oxygen depletion when they die and decay;
- 4) they use up nutrients; and
- 5) they decrease the lifespan of the pond by the build-up and accumulation of organic matter (eutrophication).

The best remedy for a weedy pond is renovation involving draining, deepening and steepening the sides. If modifying the pond bottom is not feasible, the pond owner should consider the alternative approaches to weed control-mechanical, fall drawdown, chemical and biological control.

Another aspect of fish pond management is to keep records of the pond harvest. The owner should have people who fish the pond record numbers and sizes of the fish they catch, along with the time spent by each person fishing on each trip. This information can be conveniently recorded on a 3 x 5 card. These data will provide the basis for the owner to evaluate the condition of his pond fish population, as well as a record of the total pond harvest. Records of other pond management activities should also be kept

Sealing Leaking Ponds and Reservoirs

A small pond or reservoir can be a useful addition to your property. A supply of surface water can attract wildlife and decrease the amount of groundwater pumped for irrigation, and provide water for fire protection. After construction many ponds in our area leak. Excessive water loss in ponds is usually due to soils that are too permeable to hold water. That is, the soil by itself does not produce a good enough seal to prevent seepage. Today, there are a variety of methods available to seal a pond, the choice of which depends largely on the proportions of coarse-grained sand and the fine-grained silt and clay in the soil. It is best to get a thorough investigation of the soils in the area before deciding on the best sealing method to use.

For all the different sealing methods, the pond should be prepared by draining and allowed to dry. Any vegetation, stumps, rocks, and debris should be removed; the site should be smoothed and any holes should be filled and compacted.

Sealing by compaction alone is relatively simple and the least expensive method. Its use, however, is limited to sites with enough clay and silt, usually 10 percent or more, to make a good seal. Sites with too little clay can be sealed by a blanket of earth brought in from another area that contains about 20 percent clay. Each layer of soil should be properly compacted and protected from cracking that results from drying.

Bentonite can also be used if there is insufficient clay in the soil. It can be mixed in with the soil and form a layer nearly impervious to water. Bentonite absorbs several times its own weight of water and can swell as much as 8-20 times its original volume. The problem is that it will crack if allowed to dry out, so this method isn't used much if the water level in the pond fluctuates much.

One problem with a fluctuating water level in some areas of the county is the calcium in the water and soil. This causes any clay particles to form an open, porous structure which allows water to pass through. A pond can lose 2 - 3 inches of water per day in this type of condition.

Chemical additives called dispersing agents, made of Sodium compounds, can be used to achieve a seal. This entails draining, mixing and compacting the pond bottom. This is usually good for 3 to 10 years depending on the amount of calcium present.

Physical layers can also be used to seal a pond such as soil cement, concrete, asphalt and pliable membranes (plastic, vinyl or rubber). These methods are expensive but they do work. Physical barriers are subject to puncture by hoofed animals. A 6-inch soil cover should be placed over the membranes to prevent puncture.

After sealing, the points where water flows into the pond should be protected from erosion by rock riprap or other means.

Trees and Shrubs Provide Food and Cover for Wildlife

Almost all plants benefit wildlife in some manner. There are plants listed in Table 3 that are known to contribute substantially to the welfare of wildlife by providing food, cover, or both.

If possible, before setting out young plants, seeds or cuttings, it would be best to observe adult plants growing in natural or uncared-for conditions. By noting where and how they grow best, and by trying to duplicate the same conditions, a higher survival may possibly be obtained. Plants may vary in size and growth pattern if they are started in high fertility soil, have better moisture conditions, and are not crowded by other plants or grasses.

All plants and especially young ones should be considered vulnerable to browsing by animals or girdling by rodents. Be prepared to fence each or all plants when setting them out or at the first sign of damage.

Appendix A-10

Publications Available at University of California Cooperative Extension Offices

| <u>Title</u> | <u>Number</u> |
|--|---------------|
| California Range Brushlands and Browse Plants | 4010 |
| Covercrops for California Agriculture | 21471 |
| Direct Seeding Woody Plants in the Landscape | 2577 |
| A Guide to Shrubs for Coastal California | 2584 |
| Guidelines for Residue Management on Annual Range | 21327 |
| Landscape for Fire Protection | 2401 |
| Living Among the Oaks | No Number |
| Management of Small Pastures | 2906 |
| Monitoring California's Annual Rangeland Vegetation | 21486 |
| Plant Your Own Oak Tree | 21334 |
| Preliminary Guidelines for Managing California's Hardwood Rangelands | 21413 |
| Range-Legume Inoculation and Nitrogen Fixation by Root-Nodule Bacteria | 1842 |
| Seeded Range Plants for California | 21344 |
| Seeding for Erosion Control in Coastal and Central California | 21304 |

Appendix A-11 References

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- Central Coast Resource Conservation and Development Council, Coastal San Luis Resource Conservation District, Land Conservancy of San Luis Obispo County, University of California Cooperative Extension, Upper Salinas-Las Tablas Resource Conservation District and Natural Resources Conservation Service, "The Cover Up Story." 1994
- Council of Bay Area Resource Conservation Districts, in cooperation with the USDA, Soil Conservation Service (NRCS); "Horse Paddocks, Controlling Soil Erosion on Small Pastures."
- Darrach, Alfred G., Saverwein, William J., Hally, Clyde E. "Building Water Pollution Control into Small Private Forest and Ranchland Roads.", September, 1981; U.S. Department of Agriculture, Forest Service, Soil Conservation Service.
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- Marin County Resource Conservation District, "Groundwork, A Handbook for Erosion Control in North Coastal California," 1987
- McCleery, Dick, Area Range Specialist, "Conservation Tips for Ranchettes." Cody Conservation District, Cody, Wyoming Conservation Tips for Ranchettes. USDA - Soil Conservation Service (NRCS).
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- Radtko, Klaus W.H. "A Homeowner's Guide to Fire and Watershed Management At the Chaparral/Urban Interface", 1982. County of Los Angeles, California.
- Riley, Ann L. Restoring Streams in Cities, 1998; Island Press, Washington, D.C.
- Rosgen, David, Applied River Morphology, 1996, Wildland Hydrology, Pagosa Springs, Colorado.

Singer, Steven, "Groundcover...", Santa Cruz County Resource Conservation District, Santa Cruz, California.

Stribling, Lee H., Extension Wildlife Specialist, "Swampbuster" Auburn University, Department of Zoology and Wildlife Science, College of Sciences and Mathematics, AL.

University of California Cooperative Extension, San Luis Obispo County; "Planting and Managing Range Legumes and Grasses in San Luis Obispo County." Bill Weitkamp, 1993.

University of California Dept. of Agronomy and Range Science, Davis. "Annual Medics for Range and Grain Lands." Range Science Report No. 9. Bill Weitkamp and Walt Graves, 1988.

University of California, Cooperative Extension, San Luis Obispo County, "Irrigated Pastures in San Luis Obispo County." Bill Weitkamp, 1993.

USDA - Natural Resources Conservation Service (NRCS); "Ponds - Planning, Design, Construction." 1997

USDA - Soil Conservation Service (NRCS); Tech Note - Range 37

USDA - Soil Conservation Service (NRCS); Tech Note - Range 37

USDA - Soil Conservation Service (NRCS),. "How to Control a Gully" Farmers' Bulletin No. 2171, 1973

USDA - Soil Conservation Service (NRCS),. "Planning a Farmstead Windbreak." 1963

USDA - Soil Conservation Service (NRCS), "Using Shrubs and Trees to Control Streambank Erosion." Paso Robles, CA 1984

USDA - Soil Conservation Service (NRCS), "Drainage Improvement Guide for Unpaved Roads." Santa Cruz County Resource Conservation District. Aptos, CA. 1988

Weitcamp, Bill, "Irrigated Pastures in San Luis Obispo County". Cooperative Extension, San Luis Obispo County

Williamson, J.F., editor, Sunset Western Garden Book, 1979. Lane Publishing Company, Menlo Park, California.

Suggested Plant List for Erosion Control in San Luis Obispo County

| Common Name <i>Scientific Name</i> | Primary Uses | Resource Area | Soil Tolerance | California Native | Height/Spread | E/D | Annual Growth | F |
|--|-----------------|--------------------|-------------------|----------------------|----------------|-----|-------------------|-------------------|
| Trees | | | | | | | | |
| Alder <i>Alnus sp.</i> | E,G,L,St, W | Coastal/ Inland | 1,2,4,5 | Native | 30-60'/10-15' | D | Rapid | C ir |
| Arizona cypress <i>Cupressus arizonica</i> | E,Wn,W,S | Coastal/ Inland | 1,2 | | 20-40'/25-30' | E | Moderate | C ri (|
| Bishop pine <i>Pinus muricata</i> | E,Wn,W | Coastal/ Inland | 1,2,7 | Native | 20-70'/20-35' | E | Rapid | C e |
| Blue oak <i>Quercus douglasii</i> | E,O,W | Coastal/ Inland | 1,2 | Native | to 50'/30-50' | D | Slow | B s S |
| California laurel <i>Umbellularia californica</i> | E,G,L,O,S ,W | Coastal/ Inland | 1,2 | Native | 20-25'/20-25' | E | Moderate | E d S |
| Coast live oak <i>Quercus agrifolia</i> | E,O,S,W | Coastal/ Inland | 1,2 | Native | 20-70'/20-70' | E | Slow | C ti |
| Deodar cedar <i>Cedrus deodara</i> | E,O,W,Wn | Coastal/ Inland | 1,2,3,7 | | 40-80'/20-40' | E | Rapid | C e |
| Fremont cottonwood <i>Populus fremontii</i> | E,G,St,W | Coastal/ Inland | 1,2,4 | Native | 40-60'+/30-50' | D | Rapid | T ir p n |
| Golden rain tree <i>Koelreuteria paniculata</i> | E,O | Coastal/ Inland | 1,2,5 | | 20-35'/10-40' | D | Slow- Moderate | F ir d |
| Incense cedar <i>Calocedrus decurrens</i> | E,S,W,Wn | Coastal/ Inland | 1,2,6,7 | Native | 20-40'15-20' | E | Slow | P ti (|

Suggested Plant List for Erosion Control in San Luis Obispo County

| Common Name <i>Scientific Name</i> | Primary Uses | Resource Area | Soil Tolerance | California Native | Height/Spread | E/D | Annual Growth | F |
|--|-----------------|--------------------|-------------------|----------------------|----------------|-----|------------------|-------------------|
| Trees | | | | | | | | |
| Interior live oak <i>Quercus wislizenii</i> | E,G,O,W | Coastal/ Inland | 1,2 | Native | 20-70'/20-70' | E | Slow | S a (|
| Knobcone pine <i>Pinus attenuata</i> | E,O,S,W | Coastal/ Inland | 1,2 | Native | 20-50'/10-25' | E | Rapid | V e s |
| Maidenhair tree <i>Ginkgo biloba</i> | E,O | Coastal/ Inland | 1 | | 20-30'/10-20' | D | Slow | F tl p (|
| Monterey pine <i>Pinus radiata</i> | E,O,W,Wn | Coastal/ Inland | 1,2,7 | Native | 30-90'/30-50' | E | Rapid | g a |
| Sweet gum <i>Liquidamber styraciflua</i> | E,O,S | Coastal/ Inland | 1,2 | | 60'/20' | D | Moderate | E n (|
| Sycamore <i>Platanus racemosa</i> | E,G,O,St | Coastal/ Inland | 1,2,4 | Native | 50-100'/30-50' | D | Rapid | S d a |
| Valley oak <i>Quercus lobata</i> | E,O,W | Inland | 1,5 | Native | 70'/70' | D | Moderate | L d |
| Willow <i>Salix sp.</i> | E,G,L,St, W | Coastal/ Inland | 4 | Native | 10-40'/10-40' | D | Rapid | S C |

Suggested Plant List for Erosion Control in San Luis Obispo County

| Common Name <i>Scientific Name</i> | Primary Uses | Resource Area | Soil Tolerance | California Native | Height/Spread | E/D | Annual Growth | F |
|--|-----------------|--------------------|-------------------|----------------------|---------------|-----|--------------------|----------------------------|
| Shrubs | | | | | | | | |
| Apache plume <i>Fallugia paradoxa</i> | E | Coastal/ Inland | 1 | Native | 3-8' | E | Moderate | F d |
| Bearberry kinnikinnick <i>Arctostaphylos uva-ursi</i> | E,W | Coastal/ Inland | 1 | Native | 2-6'/to 15' | E | Slow | B |
| Brewer saltbush <i>Atriplex letiformis brewerii</i> | E,G,S,W | Coastal | 1,2,4,5 | Native | 5-7'/6-8' | E | Rapid | F g q s |
| Bush lupine <i>Lupinus sp.</i> | E,O,W | Coastal/ Inland | 1,2,6, | Native | 4-6'/4-6' | D | Slow | A |
| California buckwheat <i>Eriogonum fasciculatum</i> | E,O,W | Coastal/ Inland | 1 | Native | 1-3'/2-4' | E | Moderate | C g o d S |
| California fuschia <i>Epilobium canum</i> | E,O,W | Coastal/ Inland | 1,2 | Native | 1-3'/spread | E | Rapid | A n S |
| California holly grape <i>Mahonia pinnata</i> | E,O,W | Coastal/ Inland | 1,2 | Native | 3-5+'/3-4' | E | Moderate/ Rapid | F h g |
| California-lilac <i>Ceanothus sp.</i> | E,O,W | Coastal/ Inland | 1,2,7 | Native | 2'/8-12' | E | Rapid | S e |
| Catalina perfume <i>Ribes viburnifolium</i> | E,O,W | Coastal | 1,2 | Native | 1-3'/3-12' | E | Moderate | S t r e o u |
| Common snowberry <i>Symphoricarpos albus</i> | E,O,W | Coastal/ Inland | 1,2 | Native | 2-6'/2-4+' | D | Moderate | B r s |

Suggested Plant List for Erosion Control in San Luis Obispo County

| Common Name <i>Scientific Name</i> | Primary Uses | Resource Area | Soil Tolerance | California Native | Height/Spread | E/D | Annual Growth | F |
|--|-----------------|--------------------|-------------------|----------------------|---------------|-----|--------------------|-------------|
| Shrubs | | | | | | | | |
| Coprosma <i>Comprosmia kirkii</i> | E | Coastal/ Inland | 1 | | 2-3' | E | Moderate | F d |
| Coyote bush <i>Baccharis pilularis</i> | E,G,W | Coastal/ Inland | 1,2,3,4,6 | Native | 6-8'/6-8' | E | Rapid | C (|
| Creeping mahonia <i>Mahonia repens</i> | E,W | Coastal/ Inland | 1 | Native | 3' spreads | E | Moderate | S a |
| Dogwood <i>Cornus stolonifera</i> | E,G,O,St, W | Coastal/ Inland | 1 | Native | 6-15'/6-12' | D | Rapid | P s t |
| Elderberry <i>Sambucus mexicana</i> | E,S,St,W | Coastal/ Inland | 1,2 | Native | 8-25'/8-20' | D | Rapid | E g |
| Four-wing saltbush <i>Atriplex canescens</i> | E,G,S,W | Coastal/ Inland | 1,2,4,5 | Native | 3-6'/4-8' | E | Rapid | S g (|
| Hollyleaf cherry <i>Prunus ilicifolia</i> | E,L,O,S,W | Coastal/ Inland | 1,2 | Native | 10-20'/6-10' | E | Moderate | A b e |
| Hollyleaf redberry <i>Rhamnus crocea ilicefolia</i> | E,O,S,W | Coastal/ Inland | 1 | Native | 3-20'/4-10' | E | Moderate | E d S |
| Juniper <i>Juniperus sp.</i> | E,O,S,W | Coastal/ Inland | 1,2,3,7 | Some species | 6"-60' | E | Moderate | F t |
| Lemon bottlebrush <i>Callistemon citrinus</i> | E,O,W,S | Coastal | 1,2,5 | | 10-15'/6' | E | Rapid | C d s |
| Lemonade berry <i>Rhus integrifolia</i> | E,O,W | Coastal | 1,2 | Native | 3-10'/3-10' | E | Moderate/ Rapid | C s |

Suggested Plant List for Erosion Control in San Luis Obispo County

| Common Name <i>Scientific Name</i> | Primary Uses | Resource Area | Soil Tolerance | California Native | Height/Spread | E/D | Annual Growth | F |
|--|-----------------|--------------------|-------------------|----------------------|---------------|-----|--------------------|-------------|
| Matilija poppy <i>Romneya coulteri</i> | E,O,W | Coastal/ Inland | 1,2 | Native | 3-8'/spread | D | Rapid | C a C |
| Shrubs | | | | | | | | |
| Mugwort <i>Artemisia douglasiana</i> | E,O,W | Coastal/ Inland | 1,6 | Native | 2-10'/2-8' | E | Moderate | C s n |
| Mule fat <i>Baccharis salicifolia</i> | E,G,St | Coastal/ Inland | 1,2,4 | Native | 4-6'/3-4' | E | Rapid | E t |
| Oleander <i>Nerium oleander</i> | E,O,S | Coastal/ Inland | 1,2,3,5 | | 15'/15' | E | Moderate | F t r |
| Oregon grape <i>Mahonia aquifolium</i> | E,O,S,W | Coastal/ Inland | 1 | Native | 4-6+'/3-4' | E | Moderate/ Rapid | M e R |
| Pride of Madeira <i>Echium fasteosum</i> | E | Coastal | 1,2 | Native | 3-6'/3-6' | E | Moderate | C b |
| Pyracantha <i>Pyracantha sp.</i> | E,O,S,W | Coastal/ Inland | 1,2,3 | | 8-10'/8'-10' | E | Moderate | F t |
| Quail bush <i>Atriplex lentiformis</i> | E,G,S,W | Inland | 1,2,5 | Native | 8-10'/8-12' | E | Rapid | f c S |
| Rockrose <i>Cistus sp.</i> | E,O,S | Coastal/ Inland | 1,2 | | 1-6'/3-8' | E | Rapid | T a v |
| Rosemary <i>Rosmarinus officinalis</i> | E,O | Coastal/ Inland | 1,6 | | 2-6'/3-8' | E | Moderate | C p |
| Sonoma manzanita <i>Arctostaphylos densiflora</i> | E,O,W | Coastal/ Inland | 1,2,7,8 | Native | 2-6'/4-6' | E | Moderate | a v |
| Sugar bush <i>Rhus ovata</i> | E,O,W | Coastal/ Inland | 1 | Native | 3-10'/3-8' | E | Moderate/ Rapid | F (|

Suggested Plant List for Erosion Control in San Luis Obispo County

| Common Name <i>Scientific Name</i> | Primary Uses | Resource Area | Soil Tolerance | California Native | Height/Spread | E/D | Annual Growth | F |
|--|------------------|--------------------|-------------------|--------------------------------------|---------------|-----|------------------|-----------------------|
| Toyon <i>Heteromeles arbutifolia</i> | E,L,O,S,W ,Wn | Coastal/ Inland | 1,2 | Native | 8-10'/6-8' | E | Moderate | A s s t |
| Vines & Groundcovers | | | | | | | | |
| California blackberry <i>Rubus vitifolius</i> | E,G,O,St, W | Coastal/ Inland | 1,2,3 | Native | 3-6'/spreads | E | Rapid | C s |
| California wild rose <i>Rosa californica</i> | E,O,S,W | Coastal/ Inland | 1,2 | Native | 3-10'/3-5' | E | Moderate | C g a |
| Dwarf coyote bush <i>Baccharis pilularis</i> var. <i>pilularis</i> | E,W | Coastal/ Inland | 1,2,3,5 | Native | 8-24"/6+' | E | Moderate | V n |
| Fescue <i>Festuca</i> sp. | E,St,G | Coastal/ Inland | 1,5 | Native species recommende d | 1.5-30" | E | Rapid | C e c s b |
| Lippia <i>Phyla nodiflora</i> | E,O,W | Coastal/ Inland | 1,2 | | 2"/spreads | E | Rapid | C e b g |