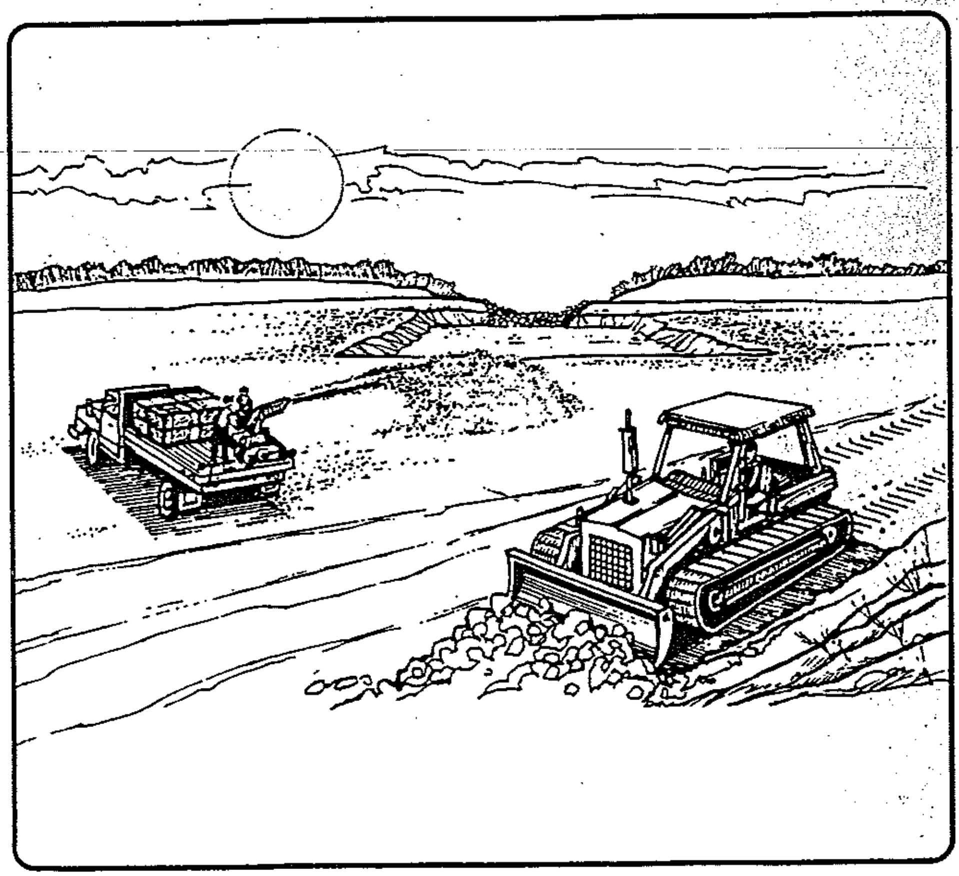
COUNTY OF SHASTA

EROSION AND SEDIMENT CONTROL STANDARDS

DESIGN MANUAL



Prepared by
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Western Shasta Resource Conservation District
County of Shasta Dept of Public Works

Section D (Cont.)

- schedule construction operations in order to minimize soil exposure during the rainy season;
- minimize disturbance and soil exposure by retaining natural vegetation adopting phased construction techniques, and using temporary cover;
- vegetate and mulch all denuded areas to protect the soil from winter rains. The primary effort for controlling sediment pollution from construction sites should be minimizing raindrop impact on bare soil;
- utilize proper grading, barriers, or ditches to minimize concentrated flows and divert runoff away from denuded slopes or other critical areas;
- minimize the steepness of slopes and control the length of slopes by utilizing benches, terraces, contour furrows, or diversion ditches;
- utilize riprap, channel linings, or temporary structures in the channel to slow runoff velocities and allow the drainageways to handle the increased runoff from disturbed areas;
- keep the sediment on-site by utilizing sediment basins, traps, or sediment barriers;
- monitor and inspect sites frequently to assure the measures are functioning properly and correct problems promptly.

Vegetation as a Solution

Dense, healthy vegetation and the associated leaf litter protects the soil from raindrop impact. Raindrop impact is a major force in dislodging soil particles which then allows them to move downslope or form a crust on the soil surface. When a crust forms on the soil surface the rainfall infiltration rate decreases and runoff increases.

Vegetation also protects the soil from sheet and rill erosion. It shields the soil surface from the transport of soil particles and scour from overland flow (sheet flow) and it decreases the erosive energy of the flowing water by reducing velocity.

The shielding effect of the plant canopy and leaves is augmented by roots and rhyzomes that hold the soil in place, improve the soils physical condition, and increase the rate of infiltration, further decreasing runoff. Plants also remove water from the soil through transpiration, thus increasing its capacity to absorb water.

Suitable vegetative cover provides excellent erosion protection, and reduces the need for high cost, low efficiency, high maintenance sediment control measures. Vegetative cover is relatively inexpensive to achieve and tends to be self-healing; it is often the only practical, long-term solution of stabilization and erosion control on most disturbed sites.

Initial investigation of site characteristics and planning for vegetation stabilization reduces its cost, minimizes maintenance and repair, and makes other erosion and sediment control measures more effective and less costly to maintain. Permanent erosion control (post-construction landscaping) is also less costly where soils have not been eroded.

Exposed subsoils are generally, difficult to amend, are infertile, and require more irrigation. Natural, undisturbed areas can provide low-maintenance landscaping, shade, and privacy. Large trees increase property values when they are properly protected during construction.

Besides preventing erosion, healthy vegetative cover provides a stable land surface, reduces heat reflectance and dust, restricts weed growth, and complements architecture. The result is a pleasant environment for employees, tenants and customers, and an attractive site for homes.

Property values can be increased dramatically by small investments in erosion control. Even the final landscaping represents a small fraction of total construction costs, but can contribute greatly to an increased market value of the development. Healthy vegetation and planned development will reduce concentrated flows and peak discharge, thus reducing channel erosion and flooding. Good, healthy vegetative cover greatly reduces the environmental impacts that poor water quality and habitat reduction is having on rivers and streams.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA

EROSION AND SEDIMENT CONTROL PLANS

The erosion control plan shall be submitted with the grading plan as per stipulations in the grading permit. The permit requires the applicant to provide a **permanent** erosion plan, which shall be approved prior to the commencement of any work, and shall be implemented upon completion of the project.

If work will not be completed by October 15, and the permit does not allow work to continue during the wet weather season (Oct 15 through April 15), then a **closure** or **interim** erosion plan shall be required as a condition of the permit.

If the permit allows work to be done during the wet weather season, the permit shall require a **wet weather** operating and erosion control plan. This plan must be approved prior to the commencement of any work and include all necessary temporary and permanent erosion control measures, including those to be followed should the work stop at any time during the wet weather season.

If the site or portion of the site is planned to be idle for more than 45 days, then vegetative stabilization must be accomplished within seven days. The wet weather plan shall include a plan for the immediate (within 24 hours of the first forecast of a storm front) installation of emergency erosion control measures.

GUIDELINES FOR EROSION CONTROL PLANS

PLAN PREPARER

For any project which disturbs more than 5 acres or where the community development director determines that the project may adversely impact a watercourse, the plan shall be prepared by:

- a Registered Civil Engineer experienced in erosion control ;
- a Certified Professional Soil Erosion and Sediment Control specialist (CPESC) ;
- or a Soil Scientist certified by the American Registry of Certified Professionals in Agronomy, Crops, and Soils.

CONTENT

The plan shall consist of three parts:

a. A **narrative**, containing:

- a brief description of the proposed land-disturbing activities, existing site conditions, and adjacent areas (such as creeks and buildings) that might be affected by the proposed clearing and grading;

- a description of critical areas on the site-areas that have a potential for serious erosion problems;
- the date grading will begin and the expected date of stabilization;
- a brief description of the measures that will be used to control erosion and sedimentation on the site and when these measures will be implemented;
- a description of an inspection and maintenance program, with provisions for frequency of inspection, reseeding, repair and reconstruction of damaged structures, cleanout and disposal of trapped sediment, duration of maintenance program, and final disposition of the measures when site work is complete.

b. A **map** showing:

- existing site contours at an interval and scale sufficient for distinguishing runoff patterns before and after disturbance;
- final contours;
- a legend, if necessary;
- limits of clearing and grading;
- existing vegetation, such as grassy areas or vegetative buffers, that may reduce erosion or off-site sedimentation;
- critical areas within or near the project site, such as streams, lakes, wetlands, or the aerial extent of erodible soils;
- the location and types of erosion and sediment control measures, including the aerial extent of vegetative treatments.

c. **Plan details**, including:

- detailed drawing of erosion and sediment control structures and measures, showing dimensions, materials, and other important details;
- design criteria and calculations such as design particle size for sediment basins and peak discharge for channel design and outlets;
- seeding or vegetative specifications;
- inspection and maintenance notes.

Narrative and details shall be placed on Erosion Control Plan map if possible.

PLAN CHECK

General Approach

Responsibility: It is not the responsibility of the plan reviewer to see that the plan is the best possible one. The reviewer can only ensure that the plan meets the minimum standards set by the reviewing agency and its authorizing ordinance. Do not set standards not supported by and ordinance.

Communications: Encourage informal communications between the plan reviewer and the plan preparer. This will enable the reviewer to make informal suggestions that may save the developer money and the preparer time, and it may result in a better, more effective plan. It will also enable the preparer to explain and justify the plan.

Incomplete Plans: Do not review seriously incomplete plans. Send them back with a request for the missing information.

Required Information: Make sure all the required information has been submitted. A checklist can be used by both plan reviewers and plan preparers, however, checklists can encourage laziness. Having everything checked off does not necessarily mean that everything is in order. (see pp. 9, 10)

Plan Concept: The concept should be examined first, starting with the general and moving to the specific. Does the plan make sense?

Schedule: Examine the construction schedule. Will grading be completed before the rainy season or before the summer thunderstorm months? When will storm drainage facilities, paving, and utilities be installed in reference to the rainy season? If grading will take place during months when there is a high probability of heavy rains, what extra precautions will be taken to protect against erosion, sedimentation, and changing drainage patterns (Is a Wet Weather Plan necessary)?

Minimize Disturbance: Does the plan show areas that are <u>not</u> to be disturbed? If possible, native vegetation to be retained and stream buffer areas should be designated on the plan and flagged in the field. A well-conceived erosion control plan will minimize erosion by attempting to minimize disturbance and retain natural vegetation. A phased approach to development can assure that the extent and timing of grading does not exceed the contractors ability to perform erosion and sediment control.

Site Drainage: Make sure you understand where all drainage comes from on and above the site, where it goes, and how it traverses the site. For large sites, require or prepare a drainage area map. If drainage patterns are unclear, ask for clarification.

Sediment Basins and Traps: Locate all sediment basins and traps and define their tributary areas. Erosion control within areas that drain to sediment barriers need not be as intensive as within areas not so protected.

Erosion Control: Check the method used to prevent erosion. Hydraulic seeding and mulching may adequately stabilize some areas, but other areas, because of their proximity to sensitive features such as watercourses, or their steepness and erosive soil, may need far more intensive revegetation efforts. On critical slopes, a reliable backup system for hydraulic seeding, such as punched straw, is strongly recommended.

Channels and Outlets: Examine all drainageways where concentrated flows will occur. Be sure adequate erosion protection is provided both along channels and at channel and pipe outlets. Check the sources of runoff to be sure that all the runoff comes from undisturbed or stabilized areas or has been desilted by sediment basins or other sediment retention devices.

Miscellaneous: Look for haul roads, stockpile areas, and borrow areas. They are often overlooked and can have a substantial effect on drainage patterns. Have construction or access roads been surfaced with rock, as a minimum treatment, before the rainy season? Look at all points of vehicle access to the site and be sure mud and dirt will not be tracked onto paved streets and that sediment-laden runoff will not escape from the site at these points. Pay particular attention to watercourses and their protection.

Plan Details: Once the plan concept has been shown to be sound, check the details to be sure the concept is adequately executed in the plans.

Structural Details: Be sure that sufficiently detailed drawings of each structure (sediment basin, dike, ditch, silt fence, etc.) are included so there is no doubt about location, dimensions, or method of construction.

Calculations: See if calculations have been submitted to support the capacity and structural integrity of all structures. Were the calculations made correctly? Non-engineered structures, such as straw bale barriers, do not generally need hydrologic calculations, however, supporting information such as drainage area and peak flow should be available if requested.

Vegetation: Look at seed, fertilizer, and mulch specifications. Check quantities and methods of application to be sure they are appropriate and consistent with local guidelines. Are there stipulations that ineffective revegetation and/or damage is remedied immediately?

Maintenance: Be sure that general maintenance requirements and, where necessary, specific maintenance criteria, such as the frequency of sediment basin cleaning, are included. Are there stockpiles of spare materials (filter fabric, straw bales, stakes, gravel, etc.) to repair damaged control measures? Routine maintenance inspections should be part of the plans.

Contingencies: The plan must provide for unforseen field conditions, scheduling delays, and other situations that may affect the assumed conditions.

Technical Review: The erosion and sediment control plan should be reviewed by the soils or geotechnical consultant for the project, if there is one.

Signature: The erosion and sediment control plan should be signed by a qualified individual. The local Grading Ordinance stipulates who is qualified to prepare and sign the erosion and sediment control plan–an engineer with experience in erosion control, a CPESC, or a soil scientist certified by ARCPACS.

Source: Manual of Standards for Erosion and Sediment Control Measures—Association of Bay Area Governments (ABAG)

CHECKLIST FOR EROSION CONTROL PLANS

Narrative

- ☐ **Project description** A brief description of the nature and purpose of the land-disturbing activity and the amount of grading involved.
- ☐ **Existing site conditions** A description of the existing topography, vegetation, and drainage.
- ☐ **Adjacent areas** A description of neighboring areas, such as streams, lakes, residential areas, and roads that might be affected by the land disturbance.
- ☐ **Soils** A brief description of the soils on the site including erodibility and particle size distribution (texture).
- ☐ **Critical areas** A description of areas within the developed site that have potential for serious erosion or sediment problems.
- ☐ **Erosion and sediment control measures** A description of the methods that will be used to control erosion and sediment on the site. Temporary erosion control, and temporary sediment control measures.
- ☐ **Permanent stabilization** A brief description of how the site will be stabilized after construction is completed. Permanent erosion control.
- ☐ **Maintenance** A schedule of regular inspections and repairs of erosion and sediment control structures.

Map

The following information should appear on one or more maps:

- ☐ **Existing contours** Existing elevation contours of the site at an interval sufficient to determine drainage patterns.
- ☐ **Preliminary and final contours** Proposed changes in the existing elevation contours for each stage of grading.
- ☐ **Existing vegetation** Locations of trees, shrubs, grass, and unique vegetation.
- ☐ **Soils** Boundaries of the different soil types within the proposed development.
- ☐ **North arrow**
- ☐ **Vacinity Map**
- ☐ **Critical areas** Areas within or near the proposed development with potential for serious erosion or sediment problems.
- ☐ **Existing and final drainage patterns** A map showing the dividing lines and the direction of flow for the different drainage areas

before and after development, and how well off-site water passes through the site without contamination.

- [ ] **Limits of clearing and grading** A line showing the areas to be disturbed, and buffer strips.
- [ ] **Erosion and sediment control measures** Locations, names, and dimensions of the proposed temporary and permanent erosion and sediment control measures.
- [ ] **Storm drainage system** Location of permanent storm drain inlets, pipes, outlets, and other permanent drainage facilities (swales, waterways, etc.), and sizes of pipes and channels.

Details

- [ ] **Detailed drawings** Enlarged, dimensioned drawings of such key features as sediment basin risers, energy dissipators, waterway cross sections, and sediment barriers.
- [ ] **Seeding and mulching specifications** Seeding dates, seeding, fertilizing, and mulching rates in pounds per acre, and application procedures.
- [ ] **Maintenance program** Inspection schedule, spare materials needed, stockpile locations, and instructions for sediment removal and disposal and for repair of damaged structures.

Calculations

- [ ] **Calculations and assumptions** Data for design storm used to size pipes and channels and sediment basins and traps [e.g., 10-year, 6-hour storm = 3.1 in.; i peak = 2.6 in./hr.], design particle size for sediment trap efficiencies, basin discharge rates, size and strength characteristics for filter fabric, wire mesh, fence posts, etc., and other calculations necessary to support drainage, erosion, and sediment control systems.

Source: Manual of Standards for Erosion and Sediment Control Measures—Association of Bay Area Governments (ABAG)

STANDARDS and SPECIFICATIONS for EROSION and SEDIMENT CONTROL MEASURES

SECTION A: SITE PREPARATION STANDARDS

Site preparation standards are probably the most effective erosion control practices. These are the planning standards. By planning for erosion control we can often avoid costly measures and mitigations. Construction activities scheduled between April 15 and Oct 15 require no erosion control practices other than stating on the plan what the proposed schedule is and what will be done if the construction schedule is extended into the winter months. If areas of a construction site are not disturbed and designated as such on the plan, then those areas need not be treated with erosion control. If construction is phased so that sensitive areas are not to be disturbed during the winter, then those areas need not be treated. Reducing the disturbed area can mean the difference between having to construct and maintain a large sediment basin or install a series of sediment barriers. Maintaining vegetation on the site will reduce erosion and may reduce future vegetative and landscape costs.

The other practices in this section, such as Surface Roughening and Topsoiling, are planned construction activities that will ensure the temporary and permanent vegetation will have a better chance of success and be easier to install.

STANDARD

CONSTRUCTION SCHEDULES AND SEQUENCING

Definition: Construction schedules and sequencing is a planning tool that coordinates the timing and phases of land-disturbing activities with expected weather patterns and appropriate erosion and sediment control measures.

Purpose: A construction schedule shows a conscious effort to phase construction in order to reduce on-site erosion and off-site sedimentation by assuring that land-disturbance activities and erosion and sediment control measures are completed in accordance with a planned schedule. A **construction schedule** is required on all erosion and sediment control plans in order to determine the extent of erosion control planning that is necessary. **Construction sequencing** is necessary to assure that erosion and sediment control practices are effectively coordinated with land disturbance and wet weather. **A very effective erosion control measure is to not schedule construction or land disturbance from October 15 to April 15.**

Planning Considerations:

- Designate areas of no disturbance. The removal of existing vegetation and ground cover leaves the site vulnerable to erosion by winter storms and mid-summer thunderstorms.
- Construction access should not damage valuable trees or disturb designated buffer zones. (see Minimize Disturbance and Buffer Strips)
- Install principal sediment control measures before major site grading takes place.
- Locate key runoff-control measures in conjunction with sediment traps to divert water from undisturbed areas out of the traps and sediment-laden water into the traps. Install diversions above areas to be disturbed prior to grading. Place necessary perimeter dikes with stable outlets before opening major areas for development. Install additional needed runoff-control measures as grading takes place.
- Install the main runoff conveyance system with inlet and outlet protection devices early, and use it to convey storm runoff through the development site without creating gullies and washes. Install inlet protection for storm drains as soon as the drain is functional to trap sediment on-site in shallow pools and to allow flood flows to

safely enter the storm drainage system. (see Drop and Curb Inlet Sediment Barriers) Install outlet protection at the same time as the conveyance system to prevent damage to the receiving stream. (see Energy Dissipators)

Normally, install stream stabilization, including necessary stream crossings, independently and ahead of other construction activities. (Any stream disturbance requires a 1603 permit from California Department of Fish and Game.) It is usually best to schedule this work as soon as weather conditions permit. Site clearing and project construction increases storm runoff, often making streambank stabilization work more difficult and costly.

- Begin land clearing and grading as soon as key erosion and sediment control measures are in place. Once a scheduled development area is cleared, grading should follow immediately so that protective ground cover can be reestablished quickly. Do not leave any area bare and exposed for extended periods. Leave adjoining areas planned for development, or to be used for borrow and disposal, undisturbed as long as possible to serve as natural buffer zones.

- Runoff control is essential during the grading operation. Temporary diversions, slope drains, and inlet and outlet protection installed in a timely manner can be very effective in controlling erosion during this critical period of development.

- Immediately after land clearing and grading, apply surface stabilization on graded areas, channels, dikes and other disturbed areas. Apply vegetative stabilization (i.e. mulch and/or temporary seeding) within seven days to any portion of the sitethat is planned to be idle for more than 45 days. Install permanent stabilization measures immediately after final grading, in accordance with the vegetative plan. Temporary seeding and/or mulching may be necessary during extreme weather conditions and permanent measures may be delayed for a more suitable time.

- Coordinate building construction with other development activities so that all work can take place in an orderly manner and on schedule. Experience shows that careful project scheduling improves efficiency, reduces cost, and lowers the potential for erosion and sedimentation problems.

- Permanent erosion control and landscaping are the last major construction phases, but the topsoil stockpiling, tree preservation, undisturbed buffer area, and well-planned road locations established earlier in the project may determine the ease or difficulty of this activity. All disturbed areas should have permanent stabilization practices applied. Unstable sediment should be removed from sediment basins and traps. All temporary structures should be removed after the area above has been properly stabilized. Borrow and disposal areas should be permanently vegetated or otherwise stabilized.

In planning construction work, it may be helpful to outline all land-disturbing activities necessary to complete the proposed project. Then list all practices needed to control erosion and sedimentation on the site. These two lists can then be combined in logical order to provide a practical and effective construction sequence schedule.

Design Criteria: The construction sequence schedule should show the following:

- principal development activities,
- The date of initial land disturbance and the duration of the project.
- If a wet weather plan is required, the date at which the site will be stabilized (winterized) with temporary erosion control.
- Timely construction techniques that can reduce the erosion potential of the site. When areas will be exposed and when they will be protected with temporary cover.
- the erosion and sedimentation control practices to be installed,
- compatibility with the general construction schedule of the contract.
- When and where erosion materials will be stockpiled on-site and when they will be deployed.
- Stages of grading so that only small areas are exposed at any one time; only the areas that are actively being developed should be exposed. As soon as grading is complete in one area, seed and/or mulch or otherwise protect the exposed soils.
- The date when permanent erosion control will be in place.
- The inspection and maintenance periods for the project.

There are many timely construction techniques that can reduce the erosion potential of a site, such as: (1) shaping earthen fills daily to prevent overflows and (2) constructing temporary diversions ahead of anticipated storms. These types of activities cannot be put on the construction sequence schedule but should be used whenever possible.

Using planned construction sequence scheduling to control erosion will help keep field personnel aware of the possibilities of erosion prevention through construction management.

Maintenance: Follow the construction sequence throughout project development. When changes in construction activities are needed, amend the sequence schedule in advance to maintain management control.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA

STANDARD

WET WEATHER PLAN

Definition: A wet weather plan is a detailed erosion and sediment control plan and construction sequence schedule that clearly shows how construction will progress aftr October 15, delineating each phase of construction.

Purpose: To assure that construction activities during the rainy season does not produce accelerated erosion on and sedimentation from the construction site.

Construction Schedule: Construction procedures that limit land clearing, provide the timely installation of erosion and sediment controls, and quickly restore protective covers can significantly reduce the erosion potential of a site.

Design Considerations:

- proximity of the site to streams, waterways, storm sewers or other sediment delivery systems.
- erosive nature of the soils.
- extent and nature of ground disturbance.
- how the site will be stabilized at the end of each day and/or before an ensuing storm.
- ability of construction personnel to effectively implement erosion practices.
- the time of land disturbance and the duration of that disturbance.
- how temporary erosion measures can be cost-effectively (blended into) the overall project.

Specifications: The plans shall clearly show:

- labeling as a Wet Weather Plan-a temporary erosion control plan for winter operations.
- a narrative how erosion will be minimized, how sediment will be kept on-site, and how the site will be protected if and when a storm approches.
- what is the anticipated construction schedule and what is the sequencing and schedule for erosion and sediment control installations.
- the frequency of inspections and when the necessary repairs and maintenance of the erosion and sediment control practices will be conducted.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA

STANDARD

MINIMIZE DISTURBANCE AND BUFFER STRIPS

Definition: Minimizing disturbance and maintaining buffer strips is a planning process which retains natural vegetative cover and also maintains streamside vegetative buffer strips as required by California Department of Fish and Game.

Purpose: Erosion can be reduced 98% by protecting the soil from raindrop impact. Existing native vegetation usually provides the best soil protection. One of the most effective erosion control measures is to only disturb areas immediately needed for construction.

Water quality and wildlife habitat degradation can be greatly reduced by maintaining streamside buffer strips and riparian corridors. The small drainages and intermittent streams are the sediment delivery systems to the rivers and lakes. If sediment can be kept out of the delivery systems, by maintaining buffer strips, then the sediment will not impact the fisheries.

Planning Considerations:

- Existing native vegetation may be incorporated into the final landscape plan. It is adapted to the site, drought tolerant, and will provide shade and erosion protection. Shrubs or trees can be thinned and pruned for beauty and fire hazard reduction.
- Existing trees may be protected as per tree preservation ordinances.
- If the area is not disturbed then it does not require erosion control and concentrated flows down slope will be greatly reduced.
- California Department of Fish and Game requires buffer strips for stream protection.
- Buffer strips around the perimeter of a site can reduce or eliminate off-site sedimentation.

Design Criteria:

- Designate areas of no disturbance. Clearly show on the plans, and flag in the field areas of no disturbance and construction vehicle exclusion.
- Designate trees and shrubs that are to be preserved.

- Designate streamside buffer strips. The following criteria is a guide only for the width of buffer strips.

<u>For slopes up to 15% and adjacent to</u>:

Sacramento River—150 feet from the top of bank or
75 feet from the edge of riparian vegetation,
whichever is greater

Main stems (Churn Creek, Middle Creek, Cow Creek, etc.)
100 feet minimum
50 feet from edge of riparian vegetation

Side tributaries
50 feet minimum
25 feet from the edge of riparian vegetation

Intermittent streams
25 foot buffer from the edge of the channel

The Guide to Small Roads, USDA-SCS, also provides information for sizing buffer strips. The width of a buffer strip between a road and the stream is recommended to be 50 feet plus four times the slope of the land.

Buffer width in feet = 50 + 4(%s).

Contact California fish and Game for specific recommendations and 1603 permits if required.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA;
California Department of Fish &Game, Redding CA and the Guide to Small Roads;USDA, Soil Conservation Service

LAND GRADING FOR MINIMIZING EROSION

Definition: Land grading for minimizing erosion is grading that is intended to minimize the impacts of surface erosion and runoff.

Purpose: Where land grading is necessary for road or building construction, these land grading practices minimize the erosion potential and facilitate plant establishment.

Design Considerations: Design considerations should include the following:

- existing contours;
- land use;
- vegetation;
- soil;
- drainage;
- slope stability;
- slope length;
- slope angle;
- space limitations;
- erosion potential of land disturbance;
- erosion and sediment control measures implementability.

Development should fit existing topography as much as possible so that land disturbance is minimized.

Slope steepness and slope lengths should be kept to a minimum. Benches, steps, or contour furrows can be installed on long slopes to break up the slope length. A bench should be graded back towards the slope and drain with a gentle gradient to a stable outlet.

Drainage from upland areas should be diverted away from exposed slopes.

The surfaces of cut and fill slopes should be left rough or should be serrated so that they hold seeds well and allow for good plant establishment.

Construction Specifications:

1. All graded or disturbed areas including slopes shall be protected during clearing and construction in accordance with the approved erosion and sediment control plan until they are permanently stabilized.

2. All sediment control measures shall be constructed and maintained in accordance with the approved erosion and sediment control plan and the standards and specifications for the appropriate erosion control practices.

3. If topsoil is required for the establishment of vegetation, it shall be stockpiled in the amount necessary to complete finished grading of all exposed areas.

4. Areas to be filled shall be cleared, grubbed to remove trees, vegetation, roots and other objectionable material, and stripped of topsoil.

5. Areas to be topsoiled shall be scarified to a minimum depth of 3 inches prior to placement of topsoil.

6. All fills shall be compacted as required to reduce erosion, slippage, settlement, subsidence and other related problems. Fill intended to support buildings, structures, conduits, etc., shall be compacted in accordance with local requirements or codes.

   The outer face of the fill slope shall be allowed to stay loose. A bulldozer may run up and down the fill slope so the dozer treads (cleat tracks) create grooves perpendicular to the slope. (see Surface Roughening)

7. All fill shall be placed and compacted in layers not to exceed 8 inches per lift.

8. Except for approved landfills, fill material shall be free of brush, rubbish, rocks, logs, stumps, building debris and other objectionable materials that would interfere with or prevent construction of satisfactory fills.

9. Use slope breaks, such as diversions, benches, or contour furrows as appropriate, to reduce the length of cut-and-fill slope to limit sheet and rill erosion and prevent gullying. All benches shall be kept free of sediment during all phases of development.

10. Slopes to be maintained by tractor or other equipment should not be steeper than 3:1. Slopes in excess of 2:1 may require hydroseeding, hydromulching, tackifying, and/or "punch-in" straw, special vegetation, or retaining walls. Roughen the surface of all slopes during the construction operation to retain water, increase infiltration, and facilitate vegetation.

11. Seeps or springs encountered during construction shall be handled in accordance with approved methods.

12. Stabilize all graded areas with vegetation, crushed stone, riprap, or other ground cover as soon as grading is completed or if work is interrupted for 30 working days or more. Use mulch to stabilize areas temporarily where final grading must be delayed. The finished cut-and-fill slopes, which are to be vegetated with grass and legumes, should not be steeper than 2:1.

13. Stockpiles, borrow areas and spoil areas shall be shown on the plans and shall be subject to the provisions of this standard and sample specifications. (see Topsoiling)

Source: John McCullah, C.P.E.S.C, #311, Redding, CA; Manual of Standards for Erosion and Sediment Control Measures—Association of Bay Area Governments (ABAG)

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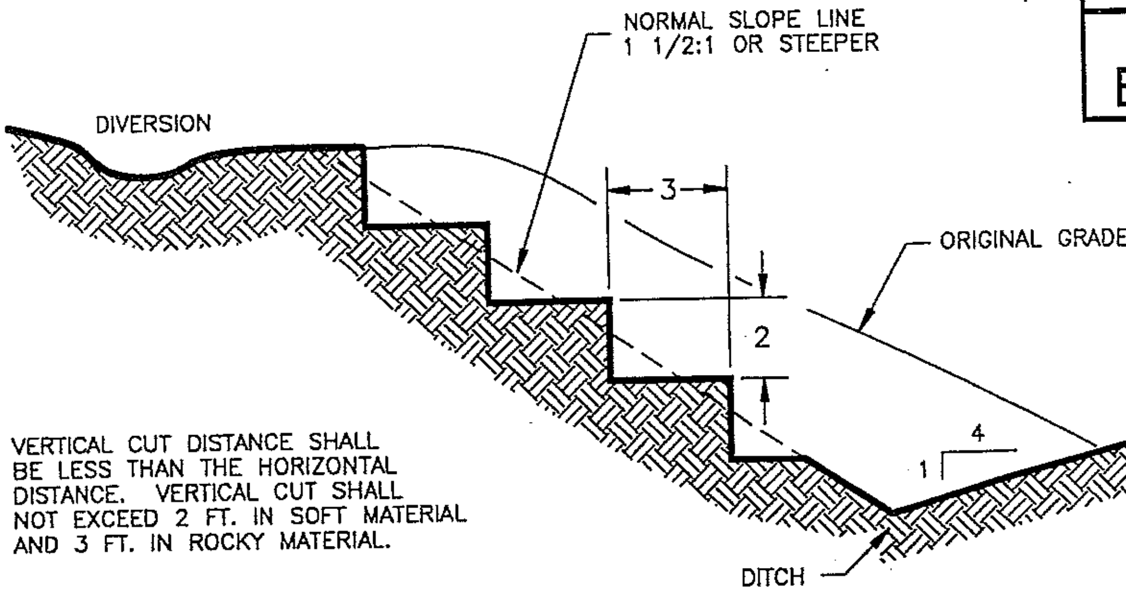
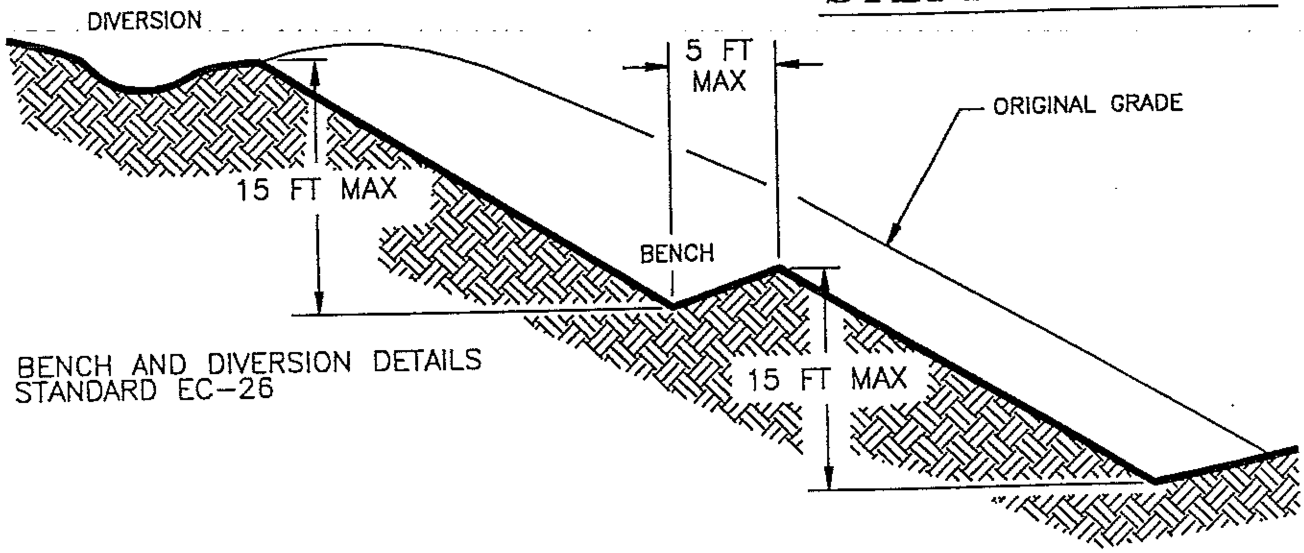
STD. NO. EC-25

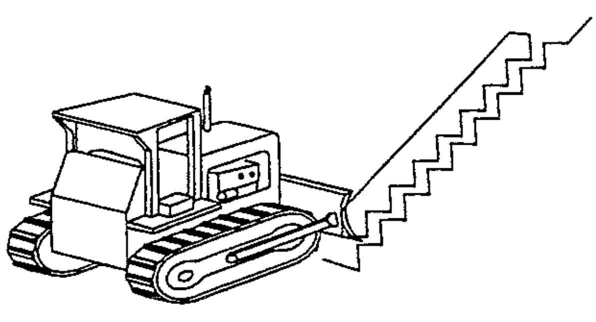


VERTICAL CUT DISTANCE SHALL BE LESS THAN THE HORIZONTAL DISTANCE. VERTICAL CUT SHALL NOT EXCEED 2 FT. IN SOFT MATERIAL AND 3 FT. IN ROCKY MATERIAL.

STEPPED SLOPE

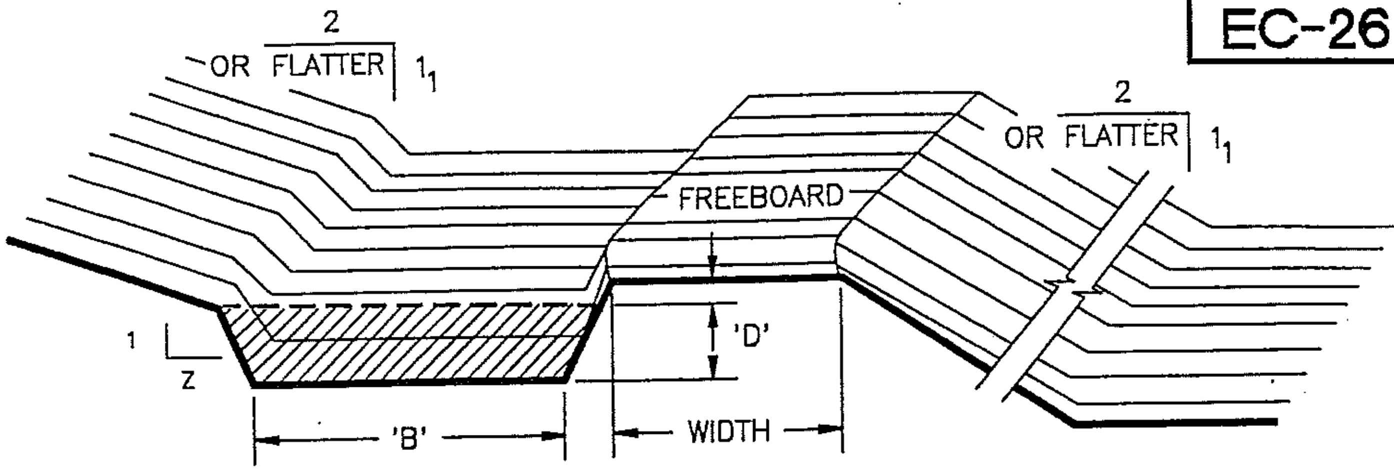


FOR BENCH AND DIVERSION DETAILS SEE STANDARD EC-26



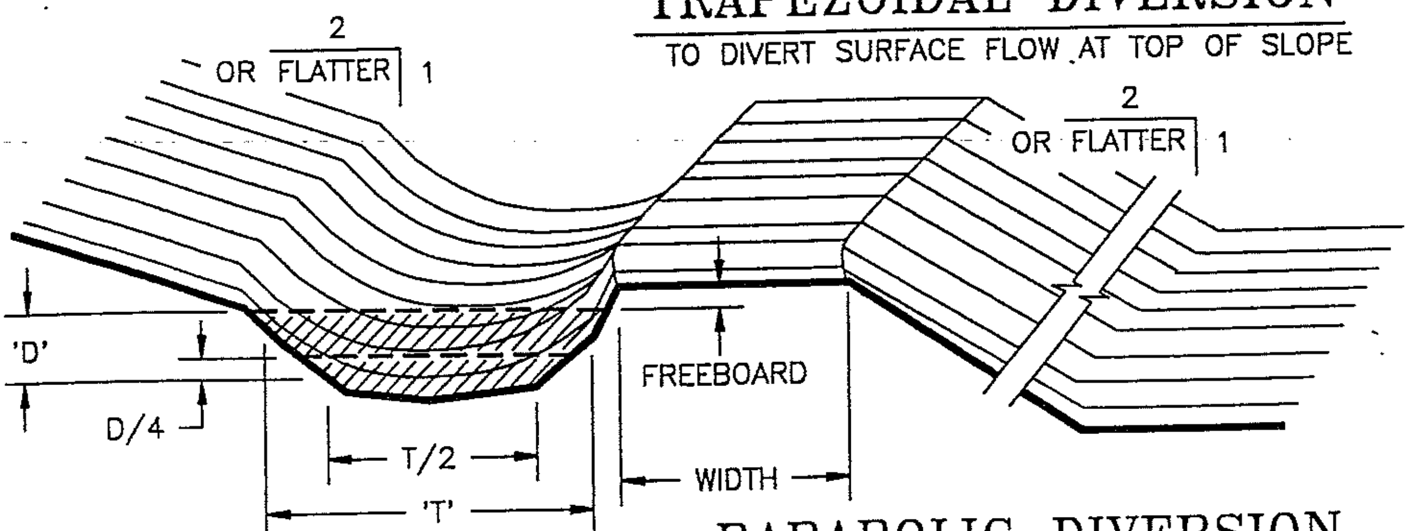
BENCHED SLOPE

DWG DATE 7-89		SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
			APPROVED BY DIRECTOR OF PUBLIC WORKS	STEPPED OR BENCHED SLOPE
MARK	DATE	REVISION		



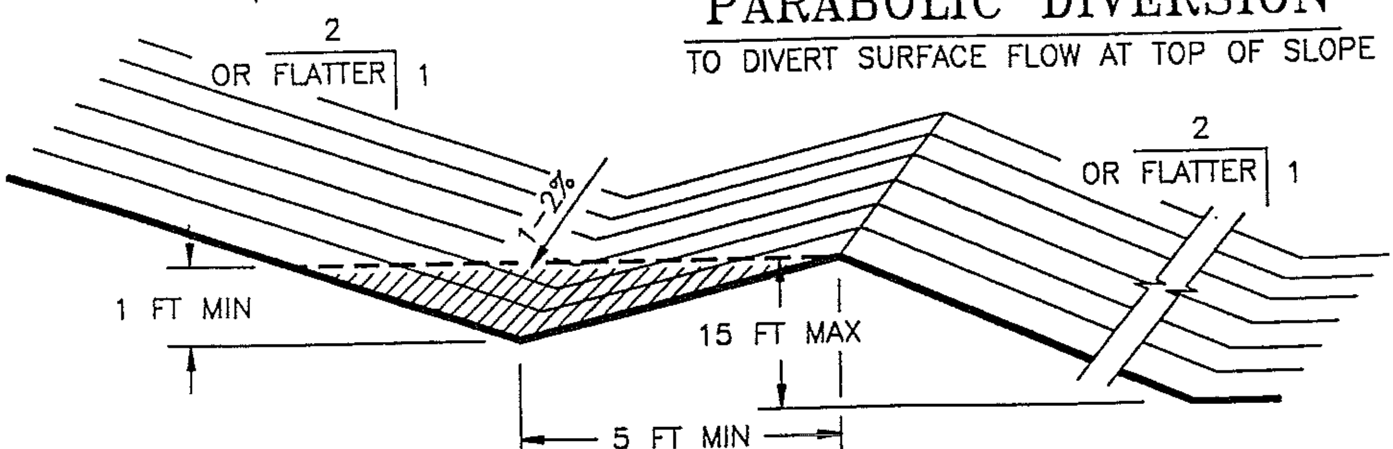
TRAPEZOIDAL DIVERSION

TO DIVERT SURFACE FLOW AT TOP OF SLOPE



PARABOLIC DIVERSION

TO DIVERT SURFACE FLOW AT TOP OF SLOPE



LOCATION OF BENCHES NOT TO EXCEED 15 FT APART (VERTICALLY)

BENCH

DWG DATE		SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
			APPROVED BY DIRECTOR OF PUBLIC WORKS	DIVERSION AND BENCH SECTIONS
MARK	DATE	REVISION		

STANDARD

SURFACE ROUGHENING

Definition: Roughening a bare soil surface with furrows running across the slope, stair stepping, or tracking with construction equipment.

Purpose: To aid the establishment of vegetative cover from seed, to reduce runoff velocity and increase infiltration, and to reduce erosion and provide for sediment trapping.

Conditions Where Practice Applies: All construction slopes require surface roughening to facilitate stabilization with vegetation, particularly slopes steeper than 3:1.

Planning Considerations: Rough slope surfaces are preferred because they aid the establishment of vegetation, improve water infiltration, and decrease runoff velocity. Graded areas with smooth, hard surfaces may be initially attractive, but such surfaces increase the potential for erosion. A rough, loose soil surface gives a mulching effect that provides more favorable moisture conditions than hard, smooth surfaces; this aids seed germination.

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, furrowing, and tracking. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

Construction Standards:

Cut slope roughening for areas not to be mowed: Stair-step grade or groove cut slopes with a gradient steeper than 3:1.

Use stair-step grading on any erodible material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with some subsoil are particularly suited to stair-step grading.

Make the vertical cut distance less than the horizontal distance, and slightly slope the horizontal position of the "step" in toward the vertical wall.

Do not make individual vertical cuts more than 2 feet high in soft materials or more than 3 feet high in rocky materials.

Grooving uses machinery to create a series of ridges and and depressions that run across the slope (on the contour).

Fill slope roughening for areas not to be mowed: Place fill slopes with a gradient steeper than 3:1 in lifts not to exceed 9 inches, and make sure each lift is properly compacted. Ensure that the face of the slope consists of loose, uncompacted fill 4 to 6 inches deep. Use grooving or tracking to roughen the face of the slopes, if necessary. Apply seed, fertilizer and straw mulch then track or punch in the mulch with the bulldozer. (see Mulching)

Do not blade or scrape the final slope face.

Cuts, fills, and graded areas that will be mowed: Make mowed slopes no steeper than 3:1.

Roughen these areas to shallow grooves by normal tilling, disking, harrowing, or use of cultipacker-seeder. Make the final pass of any such tillage implement on the contour.

Make grooves formed by such implements close together (less than 10 inches) and not less than 1 inch deep.

Excessive roughness is undesirable where mowing is planned.

Roughening with tracked machinery: Limit roughening with tracked machinery to sandy soils to avoid undue compaction of the soil surface. Tracking is very effective to "punch-in" straw mulch into soild with a sand component.

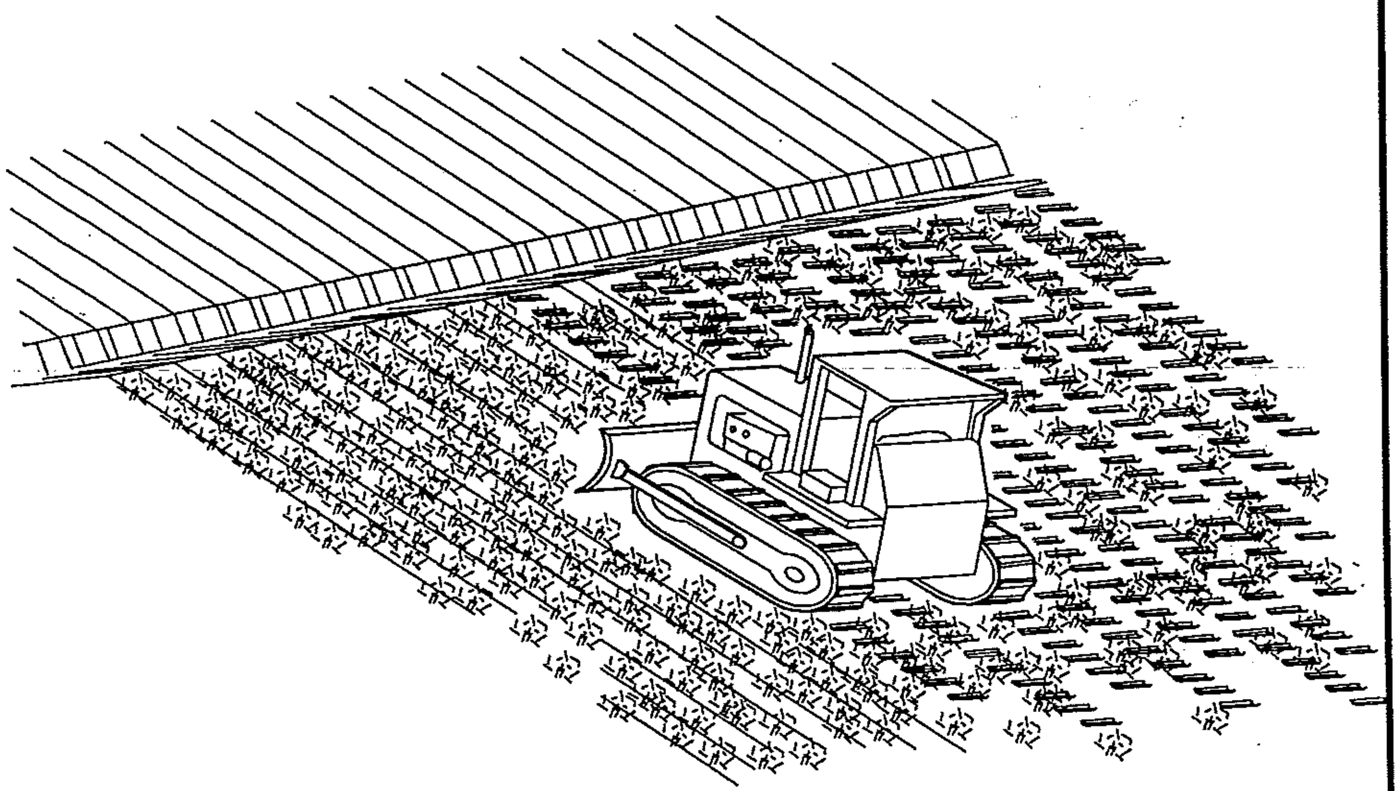
Operate tracked machinery up and down the slope to leave horizontal depressions in the soil. Do not back-blade during the final grading operation.

Seeding: Immediately seed and mulch roughened areas to obtain optimum seed germination and growth.

Maintenance: Periodically check the seeded slopes for rills and washes. Fill these areas slightly above the original grade, then reseed and mulch as soon as possible.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA, adapted from North Carolina Erosion and Sediment Control Planning and Design Manual.and Manual of Standards for Erosion and Sediment Control Measures—Association of Bay Area Governments (ABAG)

'TRACKING' WITH MACHINERY ON SANDY SOIL PROVIDES ROUGHENING WITHOUT UNDUE COMPACTION.



NOTES:

1. ROUGHEN SLOPE WITH BULLDOZER
2. BRODCAST SEED AND FERTILIZER.
3. SPREAD STRAW MULCH 3" THICK. (2 1/2 TONS PER ACRE)
4. TRACK STRAW MULCH INTO SLOPE BY RUNNING BULLDOZER UP AND AND DOWN SLOPE.

DWG DATE 6-92	SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
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STANDARD

TOPSOILING

Definition: Topsoiling is the preservation and use of topsoil to enhance final site stabilization with vegetation.

Purpose: To provide a suitable growth medium for vegetation.

Conditions Where Practice Applies: Where a sufficient supply of quality topsoil is available.

- Where the subsoil or areas of existing surface soil present the following problems,

  The structure, pH, or nutrient balance of the available soil cannot be amended by reasonable means to provide an adequate growth medium for the desired vegetation;

- The soil is too shallow to provide adequate rooting depth or will not supply necessary moisture and nutrients for growth of desired vegetation;

- The soil contains substances toxic to the desired vegetation.

- Where high-quality turf or ornamental plants are desired.

- Where it may be desirable to try to establish native, indigenous grasses, and shrubs from the seeds "banked" in the topsoil.

- Where slopes are 2:1 or flatter.

Planning Considerations: Topsoil is the surface layer of the soil profile, generally characterized as darker than the subsoil due to enrichment with organic matter. It is the major zone of root development and biological activity. Microorganisms that enhance plant growth thrive in this layer. Topsoil can usually be differentiated from subsoil by texture as well as color. Clay content usually increases in the subsoil. The depth of topsoil may be quite variable. On severely eroded sites it may be gone entirely.

Advantages of topsoil include its high organic-matter content and friable consistence (soil-aggregates can be crushed with only moderate pressure), and its available water-holding capacity and nutrient content. Most often it is superior to subsoil in these characteristics. The texture and friability of topsoil are usually much more conducive to seedling emergence and root growth.

In addition to being a better growth medium, topsoil is often less erodible than subsoils, and the coarser texture of topsoil increases infiltration capacity and reduces runoff.

Although topsoil may provide an improved growth medium, there may be disadvantages, too. Stripping, stockpiling, hauling, and spreading topsoil, or importing topsoil, may not be cost-effective. Handling may be difficult if large amounts of branches or rocks are present, or if the terrain is too rough. Most topsoil contains weed seeds, which can compete with desirable species. However, these seeds may be advantageous because they are indigenous and may provide long term, native vegetative cover.

In site planning, compare the options of topsoiling with preparing a seedbed in the available subsoil. The clay content of many subsoils retains moisture. When properly amended, mulched, and fertilized, subsoils may provide a satisfactory growth medium, which is generally free of weed seeds.

Topsoiling is normally recommended where ornamental plants or high-maintenance turf will be grown. It may also be required to establish vegetation on shallow soils, soils containing potentially toxic materials, stony soils, and soils of critically low pH (high acidity).

If topsoiling is to be used, consider the following:

- quality and amount of topsoil,
- location for a stabilized stockpile that will not erode, block drainage, or interfere with work on the site.

Bonding—Scarify subsoil to a minimum depth of 3 inches before placing topsoil. If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly, and it will be difficult to establish vegetation.

Do not apply topsoil to slopes steeper than 2:1 to avoid slippage, nor to a subsoil of highly contrasting texture. Sandy topsoil over clay subsoil is a particularly poor combination, especially on steep slopes. Water may creep along the junction between the soil layers and cause the topsoil to slough.

Construction Specifications:

Topsoil: Determine whether the quality and quantity of available topsoil justifies selective handling.

Texture—loam, sandy loam, and silt loam are best; sandy clay loam, silty clay loam, clay loam, and loamy sand are fair. Do not use heavy clay and organic soils such as peat or muck as topsoil.

Stripping: Strip topsoil only from those areas that will be disturbed by excavation, filling, roadbuilding, or compaction by equipment. A 4 to 6-inch stripping depth is common, but depth varies depending on the site. Determine depth of stripping by taking soil cores at several locations within each area to be stripped. Topsoil depth generally varies along a gradient from hilltop to toe of the slope. Put sediment basins, diversions, and other controls into place before stripping.

Stockpiling: Select stockpile location to avoid slopes, natural drainageways, and traffic routes. On large sites, respreading is easier and more economical when topsoil is stockpiled in small piles located near areas where they will be used.

Sediment barriers—Use sediment fences or other barriers where necessary to retain sediment.

Temporary seeding—Protect topsoil stockpiles by temporarily seeding and/or mulching as soon as possible to assure the stored material is not exposed and allowed to erode. (see Temporary Seeding and Mulching)

Permanent vegetation—If stockpiles will not be used within 12 months they must be stabilized with permanent vegetation to control erosion and weed growth. (see Permanent Seeding)

Site Preparation: Before spreading topsoil, establish erosion and sedimentation control practices such as diversions, berms, dikes, waterways, and sediment basins.

Grading—Maintain grades on the areas to be topsoiled according to the approved plan and do not alter them by adding topsoil.

Liming of subsoil—Where the pH of the existing subsoil is 6.0 or less, or the soil is composed of heavy clays, incorporate agricultural limestone in amounts recommended by soil tests or specified for the seeding mixture to be used. Incorporate lime to a depth of at least 2 inches by disking.

Roughening—Immediately prior to spreading the topsoil, loosen the subgrade by disking or scarifying to a depth of at least 4 inches, to ensure bonding of the topsoil and subsoil. If no amendments have been incorporated, loosen the soil to a depth of at least 6 inches before spreading topsoil.

Spreading topsoil: Uniformly distribute topsoil to a minimum compacted depth of 2 inches on 3:1 slopes and 4 inches on flatter slopes. Do not spread topsoil while it is frozen or muddy or when the subgrade is wet or frozen. Correct any irregularities in the surface that result from topsoiling or other operations to prevent the formation of depressions or water pockets.

Compact the topsoil enough to ensure good contact with the underlying soil, but avoid excessive compaction, as it increases runoff and inhibits seed germination. Light packing with a roller is recommended where high-maintenance turf is to be established.

On slopes and areas that will not be mowed, the surface may be left rough after spreading topsoil. A disk may be used to promote bonding at the interface between the topsoil and subsoil.

After topsoil application, follow procedures for seedbed preparation, taking care to avoid excessive mixing of topsoil into the subsoil.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA adapted from the North Carolina Erosion and Sediment Control Planning and Design Manual.

SECTION B: VEGETATIVE STABILIZATION STANDARDS

CRITICAL AREA TREATMENT METHODS

Ideally, treatment of disturbed sites should consider investigation of site characteristics prior to any disturbance. This allows planning which can determine the future success of the critical area treatment. If the site has a very shallow soil, then the top soil should be stored and redistributed over the disturbed site after completion of the project.

Also, consideration can be given to the potential success of the treatment after disturbance. In some cases, treatment with vegetation has high risk and predisturbance planning could reduce the disturbed area or develop treatment alternatives other than vegetation. The site needs soils investigation prior to disturbance. These actions prevent excessive sediment from being generated after disturbance has occurred and in future years. Also, this allows alternatives to be considered which could prove to be more economically feasible.

Along with plant species, there are specific conditions that must be considered before a treatment plan can be developed. There are factors that can affect the success of the treatment. These factors deal with the plant environment which impacts plant survival and performance. These factors are described below:

- Soil and Aspect where the seeding is to be done. A good guide is the SCS Vegetative Soil Group rating guide. The rating guide describes site conditions and limitations. In the Mediterranean climate aspect, soil characteristics and available water holding capacity becomes very important factors.

  With perennial seedlings, whenever the water holding capacity of a site is less than 5 inches, the risk of failure is high. These sites normally will do better with annual plants or perennials if they are used with supplemental irrigation, especially during the establishment phase.

- Care should be exercised to create a favorable seedbed. A poor seedbed does not allow good seed-to-soil contact, nor is there a favorable environment for root development and growth.

- Attention should be given to the seeding methods and mulching of the treated site. It is important for proper seed placement and to protect the soil surface from erosion, crusting, and creating a favorable microclimate for the seedling emergence and growth. Ideally, a drill should be used to place the seed at correct depth and having the soil firm around the seed. If the seed is broadcast on the surface, care should be exercised for uniform coverage. Harrowing or raking the surface covers the seed.

  The surface should be mulched with straw or other suitable material so approximately 80 percent of the surface is covered. Care needs to be exercised in selecting the mulch so it is weed free and does not contain allelopathic substances that can leach and interfere with seedling germination and growth.

- The quality and quantity of the seed affect the effectiveness of the stand characteristic and protection it provides. Seed should be selected that has a high pure live seed rating (PLS) and seeding rates adjusted for the required seeding rate. Depending upon the site characteristics, seedbed condition, and time of seeding, rates should be adjusted to accommodate existing site conditions.

- The seeding time should be scheduled near the favorable period of germination and growth. Seeding should not be done when there is a long lead time before environmental conditions are favorable for germination and plant growth. Seed can be lost to animals and destroyed by unfavorable weather.

Seeding Recommendations: High potential for wildfires during the drought periods limits the selection of plant materials. Fire hazards are minimized by using plants which do not have large vegetative growth and consequently generate large amounts of fuel. Plant materials recommended in the following paragraphs were selected for their characteristics of large root development with lesser amounts of vegetative growth.

The selection of plant materials or a treatment plan depends upon the type of protection desired and the characteristics of the site being treated. Any number of classification can be developed and used. For the purpose of this report, the following "protection" categories and "site characteristics" were used to assign treatment and seeding recommendations.

Protection Categories:

- Temporary Period Protection: This protection would be for a site where protection would be needed less than a growing year. Uses would be for sites where protection is desired for a short period until further development begins or other site activities are completed.

- Short to Moderate Period of Protection: This protection would be for a site where protection would be required for at least one growing season and not more than 3 to 4 years.

- Long Term, Permanent Protection: This protection would be for a site where protection would be needed for an infinite period of time. Uses would be for sites where development is completed and no further disturbance is anticipated for greater than 3 years.

Site Characteristics:

- Droughty Site: This site would be one with a south or south west aspect and the soil has less than 2 to 3 inches of available water holding capacity.

- Moderate Site: This site would have no aspect limitations with available water holding capacity of greater than 3 inches and less than 5 inches.

- Good Site: This site would have no aspect limitation with available water holding capacity (AWC) greater than 5 inches.

Treatment and Seeding: (Seeding rates are PLS and must be adjusted to the purchased seed rating.)

- Temporary Period Protection, any Site: Use only mulches to protect the surface from rain drop impact, surface sheet and rill erosion, and concentrated flow erosion. (See Mulching)

- Moderate Protection, Droughty, Moderate and Good Sites: Use temporary seeding recommendations for dryland seedings. (Since the protection is for a short period, no perennials are recommended.) Establishment irrigation may be needed in the droughty sites, but not required in the moderate and good sites during a normal rainfall year with plantings in early fall. More vegetative growth can be expected from the good sites with accompanying increased fuel loads especially with Blando Brome and Panoche Red Brome. (See Temporary Seeding)

- Long Term Protection, Droughty and Moderate Sites: For droughty sites only annual plants are recommended because of a minimal risk of failure. (See Temporary Seeding and Mulching)

Moderate sites on northern aspect slopes which are at the high end of the available water holding capacity (near 5 inches of AWC) could be seeded with perennials as recommended in the good site recommendations. These sites would require establishment irrigation and there is risk on long term stand sustainability.

1. Select seeding recommendation from the short term, droughty, moderate protection recommended list. (See Temporary Seeding)

2. If higher risk of failure is acceptable, the moderate sites on northern aspect with AWC approaching 5 inches, perennial seeding recommendations listed in the good sites can be used. Establishment irrigation would be required.

- Long Term Protection, Good Sites: The best protection can be provided by the establishment of perennial plants on good sites. This protection is often achieved by installing a permanent, appropriate landscape. Establishment irrigation is recommended but not required. It reduces establishment failure risks, especially during drought years. Zorro, an annual, is included in all perennial seedings to provide first year initial protection. Perennial plants will not provide acceptable protection in the first 2 to 3 years after establishment. There are some plants listed as recommended that have not been tested and seed may not be readily available. These plants should be used with caution as their performance may vary.

Source: USDA Soil Conservation Service, Redding, CA

STANDARD

TEMPORARY SEEDING AND MULCHING

Definition: Temporary seeding and mulching is an erosion control measure intended to establish a vegetative cover on soils that will be exposed for periods up to 12 months.

Purpose: To temporarily stabilize the soil, reduce damage from sediment and runoff to downstream and off-site areas, and to provide protection to disturbed areas until permanent vegetation or other erosion control measures can be established. Seeding and mulching greatly reduces soil erosion, thus enhancing the effects of and reducing the reliance on sediment control.

Temporary seeding with legumes will increase nutrient cycling within the soil, reducing the need for amendments when permanent landscaping is installed.

Conditions Where Practice Applies: Graded or cleared areas which are exposed and subject to erosion during the wet weather season (October 15 to April 15) or those areas scheduled to remain bare more than 45 days. Some additional considerations are:

- For temporary protection (less than 6 months) of areas that are scheduled for further disturbance, mulches may be used without seed and fertilizer. (See Mulching)
- Cut slopes greater than 1:1 and comprised of more than 60% rock need not be treated.
- On slopes steeper than 2:1 that cannot receive adequate seedbed preparation and mulch is difficult to anchor, the slopes shall be hydroseeded. (See Hydroseeding)

Specifications:

1. Prior to seeding, install necessary erosion and sediment control measures such as diversions, berms, grade stabilization structures, (check dams), dikes, and sediment basins.
2. **Prepare the seedbed**—The seedbed **should** be granular, loose, uniform, 2- to 4-inches deep, and free of large clods,rocks and other objectionable material. Where hydroseeding methods are used, the surface may be left with a more irregular surface of large clods and stones.
3. **Surface roughening**—if the soil surface is loose, additional surface roughening may not be required except to break up large

clods. If rainfall causes the soil surface to become sealed or crusted, loosen it just prior to seeding by discing, harrowing, raking, or other suitable methods. Groove or furrow slopes steeper than 3:1 on contour before seeding. (See Surface Roughening)

4. Construction activities usually expose the infertile subsoil material. Fertilizer is necessary for rapid growth of grasses or legumes.

5. **Mulching**: The use of appropriate mulching is necessary under normal conditions and is essential to seeding success under harsh site conditions. Harsh site conditions include:
   - seeding in the late fall for winter cover,
   - slopes steeper than 3:1,
   - excessively hot or dry weather,
   - adverse soils (shallow, rocky, or high in clay or sand)
   - decomposed granite soils, and
   - areas receiving concentrated flows.

See Mulching Standard for specifications.

6. **Seeding:** Select seed blend from Table S-1.

Table S-1

Blends/Species	Rate	Optimum Seeding Date
Fescue 'Zorro' annual Rose clover (trifolium hirtum)*	5#/ac 7#/ac	Sept 15 - Nov 15
Brome 'Blando' Rose clover*	10#/ac 7#/ac	Sept 15 - Nov 15
Brome' Panoche' Rose clover*	10#/ac 7#/ac	Sept 15 - Nov 15
Fescue 'Zorro' Brome, Panoche red Rose clover*	5#/ac 5#/ac 7#/ac	Sept 15 - Nov 15
Crimson clover* Rose clover* Poppies, California Fescue 'Zorro' annual	25#/ac 45#/ac 3#/ac 5#/ac	Sept 1 - Nov 15 (beautiful flowers in the spring)

* All legume seeds shall be inoculated with the proper fresh, age-dated rhyzobium inoculant prior to broadcasting the seed. Inoculated legume seeds shall be dry applied (not hydroseeded) by hand or with an air operated seed gun.

Seed shall be broadcast evenly over the site, followed by mulching (See Mulching) or site shall be hydroseeded (See Hydroseeding). Pure live seed rates (PLS) less than 80% shall lead to adjustment of pounds/acre to meet the above seeding rates specified.

Late season, emergency erosion control (December-March) can be attempted by using:

Barley	240 #/ac
Fescue 'Zorro' annual	15#/ac

7. **Fertilizer:** Apply ammonium phosphate with sulfur:

16-20-0 + S 500#/acre.

Inspection and Maintenance: Inspect seeding areas six weeks after seasonal rains begin. Check for damage after significant storms (1" in 24 hours). If vegetation has not established or stands are not adequate, fertilize, reseed, and mulch damaged and sparse areas immediately.

Fall plantings can be top dressed with 50#/ac of nitrogen fertilizer in February or March.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA; and USDA Soil Conservation Service, Redding, California.

PERMANENT SEEDING

Definition: Permanent seeding is a measure to establish perennial vegetative cover on disturbed areas.

Purpose: This practice will provide long term, permanent protection for a site where development is complete and no further disturbance is anticipated for 3 or more years. The purpose is to permanently reduce erosion and sediment yield from a disturbed area.

Conditions Where Practice Applies: This practise is for finish-graded areas which permanent, perennial vegetative cover is the most practical or most effective method of stabilizing the soil. Permanent seeding may also be used on rough-graded areas that will not be brought to final grade for a year or more.

Areas to be stabilized with permanent vegetation must be seeded by October 15, or immediately after final grade is reached in the fall or winter, unless temporary stabilization is applied. (See Temporary Seeding and Mulching)

- Cut slopes greater than 2:1 and comprised of more than 60% rock need not be treated.
- On slopes steeper than 2:1 that cannot receive adequate seedbed preparation and mulch is difficult to anchor, the slopes shall be hydroseeded. (See Hydroseeding)
- Irrigation during establishment is recommended but not required.
- 'Zorro' Fescue, an annual, is included in all perennial seedings to provide first year, initial protection.

Specifications:

1. Prior to seeding install necessary erosion and sediment control measures such as diversions, berms, grade stabilization structures, (check dams), dikes, and sediment basins.
2. **Prepare the seedbed**—The seedbed **should** be granular, loose, uniform, 2- to 4-inches deep, and free of large clods,rocks and other objectionable material. Where hydroseeding methods are used, the surface may be left with a more irregular surface of large clods and stones.
3. **Surface roughening**—if the soil surface is loose, additional surface roughening may not be required except to break up large

clods. If rainfall causes the soil surface to become sealed or crusted, loosen it just prior to seeding by discing, harrowing, raking, or other suitable methods. Groove or furrow slopes steeper than 3:1 on contour before seeding. (See Surface Roughening)

4. Construction activities usually expose the infertile subsoil material. Fertilizer is necessary for rapid growth of grasses or legumes.

5. **Mulching**: The use of appropriate mulching is necessary under normal conditions and is essential to seeding success under harsh site conditions. Harsh site conditions include:

- seeding in the late fall for winter cover,
- slopes steeper than 3:1,
- excessively hot or dry weather,
- adverse soils (shallow, rocky, or high in clay or sand)'
- decomposed granite soils, and
- areas receiving concentrated flows.

6. **Seeding**: Select seed blend from Table S-2.

Table S-2

Blends/Species	Rate	Optimum Seeding Date
Fescue 'Zorro' annual Fescue 'Scaldis','Durar' or 'Covar' Delar !Small Burnet' Rose clover (trifolium hirtum)*	5#/ac 8#/ac 2#/ac 7#/ac	Sept 15 - Nov 15
Fescue 'Zorro' annual Fescue 'California' or 'Idaho' Delar "Small Burnet' Rose clover (trifolium hirtum)	5#/ac 8#/ac 2#/ac 7#/ac	Sept 15 - Nov 15

Seed shall be broadcast evenly over the site, followed by mulching. (See Mulching) Pure live seed rates (PLS) less than 80% shall lead to adjustment of pounds/acre to meet the above seeding rates specified.

Late season, emergency erosion control (December-March) can be attempted by using:

Barley	240 #/ac
Fescue 'Zorro' annual	15#/ac

7. **Fertilizer:** Apply ammonium phosphate with sulfur:

16-20-0 + S	500#/acre.

On typical disturbed sites, full establishment requires refertilization in the second growing season.

8. **Irrigation:** Moisture is essential for seed germination and seedling establishment. Supplemental irrigation can be very helpful in assuring adequate stands in the droughty, moderate sites or to speed development of full cover. Irrigation should be used where feasible, however, irrigation is not critical for these blends if planted at the appropriate time of the year and mulched properly.

Inspection and Maintenance: Inspect and maintain until fully established. Permanent vegetation cannot be determined to be fully established until soil cover has been maintained for one full year from the time of planting. Inspect seeded areas for failure and make necessary repairs promptly and do the reseeding within the same season, if possible.

Reseeding: If a stand has inadequate cover, re-evaluate the choice of plant materials, quantities of fertilizer and amendments, and use of irrigation. Re-establish the stand after seedbed preparation or over-seed the existing stand. consider temporary seeding and mulching of the time of year is not appropriate for permanent seeding.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA; USDA , SCS Field Design Manual; and North Carolina Erosion and Sediment Control Planning and Design Manual.

STANDARD

HYDROSEEDING

Definition: Hydroseeding is a method of applying seed to critical sites hydraulically. The seed is usually applied as a slurry that also contains wood fiber (hydromulch), fertilizer, and a dye. The slurry is applied with equipment called a Hydromulcher.

Purpose: The purpose of this seeding method is to uniformly broadcast seed, fertilizer, and fiber mulch. This treatment is specially effective for slope that are steeper than 2:1 and cannot receive adequate seed bed preparation. The dye, usually green, provides a visual indicator to assure uniform coverage.

Conditions Where Practice Applies: Graded or cleared areas which are exposed and subject to erosion during the wet weather season (October 15 to April 15) or those areas scheduled to remain bare more than 45 days. Some additional considerations are:

- On highly erosive soils such as DG, where it may be necessary to apply seed, fertilizer, machine blown straw, and a mulch binder (tackifier) in successive applications.
- On slopes steeper than 2:1 that cannot receive adequate seedbed preparation and mulch would be difficult to anchor.
- Where the slope surface is irregular with large clods, stones, or a high percentage of rock.
- Where hydromulching equipment will have access.
- Where the dye is needed to monitor uniform coverage.

Design Considerations: It is mandatory for successful planting that there is good seed-to-soil contact. It is also recommended that critical erosion sites, such as steep DG cut slopes or where water quality impacts must be addressed, receive the equivalent of 2.5 Ton /acre of mulch, applied in two or three applications. Applying the seed with the mulch in one application would prevent good seed-to-soil contact. It is therefore recommended that the seed, dye, and 1/2 the wood fiber be applied. That first application shall be followed by an application of blown straw, followed by an application of tackifier, fertilizer, and the remainder of the wood fiber.

Construction Specifications

1. Prior to seeding install necessary erosion and sediment control measures such as diversions, berms, grade stabilization structures, (check dams), dikes, and sediment basins.

2. **Prepare the seedbed**—The seedbed **should** be granular, loose, uniform, 2- to 4-inches deep, and free of large clods,rocks and other objectionable material. Where hydroseeding methods are used, the surface may be left with a more irregular surface of large clods and stones.

3. **Surface roughening**—if the soil surface is loose, additional surface roughening may not be required except to break up large clods. If rainfall causes the soil surface to become sealed or crusted, loosen it just prior to seeding by discing, harrowing, raking, or other suitable methods. Groove or furrow slopes steeper than 3:1 on contour before seeding, if possible. (See Surface Roughening)

4. Hydromulching: Use 1500#/acre (minimum) to 3000#/acre wood fiber equivalent (fiber). This can be in the form of newsprint, virgin wood fibers, corrugated (Kraft) paper, or blends of newsprint/corrugated and newsprint/wood fiber. 1/

5. For critical slopes apply: (3 or 4 step application)
   1. Dry apply inoculate legume seed
   2. Fiber @ 500#/acre with grass seed
   3. 1-2 Ton/acre blown straw
   4. Fiber @ 400-500#/acre with tackifier @ 80-120 lbs/acre with recommended fertilizer

6. **Seeding:** Select seed blend from Table S-1 or Table S-2, Temporary Seeding and Mulching or Permanent Seeding.

Inspection and Maintenance: Inspect seeding areas six weeks after seasonal rains begin. Check for damage after significant storms (1" in 24 hours) and make repairs immediately. If stands are not adequate, reseed, fertilize, and mulch damaged or sparse areas.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA.; Vickie Bacon, Caltrans Landscaping Unit, District 2, Redding CA;

1/ U.C. Davis Agronomy Progress Report #98-Hydromulching Fibers-What's New, Burgess L. Kay

MULCHING

Definition: Mulching is the application of a protective layer of straw or other suitable material to the soil surface. Straw mulch is used as a temporary measure to protect bare or disturbed soil areas that have not been seeded. Straw mulch is also used in conjunction with seeding, and hydroseeding of critical areas for the establishment of temporary or permanent vegetation.

Purpose: To temporarily stabilize bare and disturbed soils, to protect the soil surface from raindrop impact, to increase infiltration, to conserve moisture, to prevent soil compaction or crusting, and to decrease runoff. Mulching also fosters growth of vegetation by protecting the seeds from predators, reducing evaporation, and insulating the soil.

Design Considerations: Mulch can be applied to any site where soil has been disturbed and vegetation removed. These practices provide temporary protection until the permanent vegetation can be established. As a temporary practice, mulching is applicable only for relatively short periods of time (6 months) or until the next seeding season has been reached.

Rice straw is a very good mulch. Air Quality Standards for the Sacramento Valley require a reduction in burning of the rice fields. As a consequence, rice straw could become more available for erosion control. Rice straw seems more durable and the bales are almost twice as heavy, therefore it is more cost effective. It does, however, tend to clump and is more difficult to spread uniformly.

Site Preparation: Prior to mulching, install any needed erosion and sediment control practices such as diversions, grade stabilization structures, berms, dikes, grassed waterways and sediment basins.

Design Criteria: Straw is an excellent mulch material. Because of its length and bulk, it is highly effective in reducing the impact of raindrops and in moderating the microclimate of the soil surface. Straw mulch can be applied by hand on small sites and blown on by machine on large sites. Straw blowers have a range of about 50 feet. Some commercial models advertise a range up to 85 feet and a capacity of 15 tons per hour.

Straw mulch should cover the exposed area to a uniform depth. If the mulch is being used without seeding, then the depth can range from 2 to 4 inches. However, the mulch should not be applied more than 2 inches deep on seeded sites, unless it is incorporated into the soil by tracking, discing, or other 'punching in' technique. If the straw is applied at rates higher than 3 tons per acre, the mulch may be too dense for the sunlight and seedlings to penetrate. Approximately one bale of straw covers 1000 square feet adequately. The soil surface should be barely visible through the straw mulch. Straw must be anchored to keep it from blowing away.

Straw mulch is commonly anchored by:

1. Crimping, **tracking**, disking, or punching into the soil;
2. Covering with a netting; or
3. Spraying with a chemical or organic tackifier.

On small sites, where straw has been distributed by hand, it can be anchored by hand punching it into the soil every 1 to 2 feet with a dull, round-nosed shovel. A sharp shovel will merely cut the straw and not anchor it.

Studies have been done comparing the effectiveness of wood fiber and straw mulch on 2:1 and 5:1 slopes of seven soil types. The wood fiber was applied hydraulically at rates of 1500# and 3000#/acre. Straw mucch was applied at 3000#/acre and tackified. Straw mulch provided much greater protection on all soils, but particularly on the uncemented fine sands, the decomposed granites, and the clay loams. (Erosion and Sediment Control Handbook, S. Goldman et al) **The most effective mulching technique for decomposed granite soils is to blow clean, dry straw onto the slope (2 Ton/acre) then hydraulically apply wood fiber (500#/acre) with organic tackifier (80#/acre).**

Mulching Specifications:

Mulch Matting—Erosion control blankets made of excelsior, coconut, or straw must be stapled to the surface especially in waterways and on steep slopes. Follow manufacturer's recommendations.

Straw—Obtain **clean** wheat, barley, oat, or rice straw in order to prevent the spread of noxious weeds. Avoid moldy, compacted straw because it tends to clump and is not distributed evenly.

The straw shall be evenly distributed by hand or machine to the desired depth (2 to 4 inches).
<u>Seeded sites</u>: **1 1/2 -2 ton /acre**, 1-2" deep, covering 80% of the soil surface.
<u>Unseeded sites</u>: **2-3 ton/acre**, 2-4 " deep, covering 90% (min.) of the soil surface.

Wood chips—Apply at the rate of approximately **6 tons per acre** or 275 pounds per 1,000 square feet when available and when feasible. These are particularly well suited for utility and road rights-of-way. If wood chips are used, increase the application rate of nitrogen fertilizer by 20 pounds of N per acre (200 pounds of 10-10-10, or 66 pounds of 30-0-0 per acre.

Wood cellulose fiber—Apply at the rate of 1500-3000 lbs/acre or 35-70 lbs/1,000 square feet by hydroseeding. When hydroseeding highly erosive soils such as **decomposed granite** (DG) use two applications—one application of 500 lbs/acre with seed, followed by the application of wood fiber at 1000 lbs/acre or followed by the application of straw at 1.5 Ton/acre then sprayed with 500 lbs/acre wood fiber and 80 lbs/acre tackifier.

Anchoring Mulch:

Mulch must be anchored immediately to minimize loss by wind or water. This may be done by one of the following methods, (listed by preference) depending upon size of area, erosion hazard, and cost. On sloping land practice No. 1 below should be done on the contour whenever possible, except "tracking" which should be done up and down the slope with cleat marks running across the slope.

1. **Mulch Anchoring Tool and Tracking** (Punching in) —A mulch anchoring tool is a tractor drawn implement designed to punch and anchor mulch into the top two inches of soil. This practice affords maximum erosion control but is limited to flatter slopes where equipment can operate safely. "Tracking" is the process of cutting mulch (usually straw) into the soil using a bulldozer or other equipment that runs on cleated tracks. Tracking is used primarily on slopes 3:1 or steeper,.where the equipment can operate. This is an effective practice for fill slopes.

2. **Mulch Nettings**—Staple lightweight biodegradable paper, plastic or cotton netting over the mulch according to manufacturer's recommendations. Netting is usually available in rolls four feet wide and up to 300 feet long.

3. **Tackifiers**—Organic tackifiers are generally applied at rates of 80-120 lbs/acre, however manufacturers recommendations vary. Applications of liquid mulch binders should be heavier at edges, in valleys, and at crests of banks and other areas where the mulch will be moved by wind or water. All other areas should have a uniform application of the tackifier.

4. **Wood cellulose fiber**—The fiber binder shall be applied at a net dry weight of 750 pounds/acre. The wood cellulose fiber shall

be mixed with water, and the mixture shall contain a maximum of 50 pounds. of wood cellulose fiber per 100 gallons.

5. **Peg and Twine**—Drive 8-to 10-inch wide pegs to within 2 to 3 inches of the soil surface every 4 feet in all directions. Stakes may be driven before or after applying mulch. Secure mulch to soil surface by stretching twine between pegs in a criss-cross within a square pattern. Secure twine around each peg with two or more turns.

Maintenance: If properly applied and anchored, little additional maintenance is required during the first few months. After high winds. mulched areas should be checked for adequate cover and remulched if necessary. Straw mulch can last from 6 months to 3 years. Erosion control blankets are effective for up to three years.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA; adapted from North Carolina Erosion and Sediment Control Planning and Design Manual; "Water Quality Management Plan for the Lake Tahoe Region" Volume II Handbook of BMPs (TRPA); and Delaware Erosion and Sediment Control Handbook

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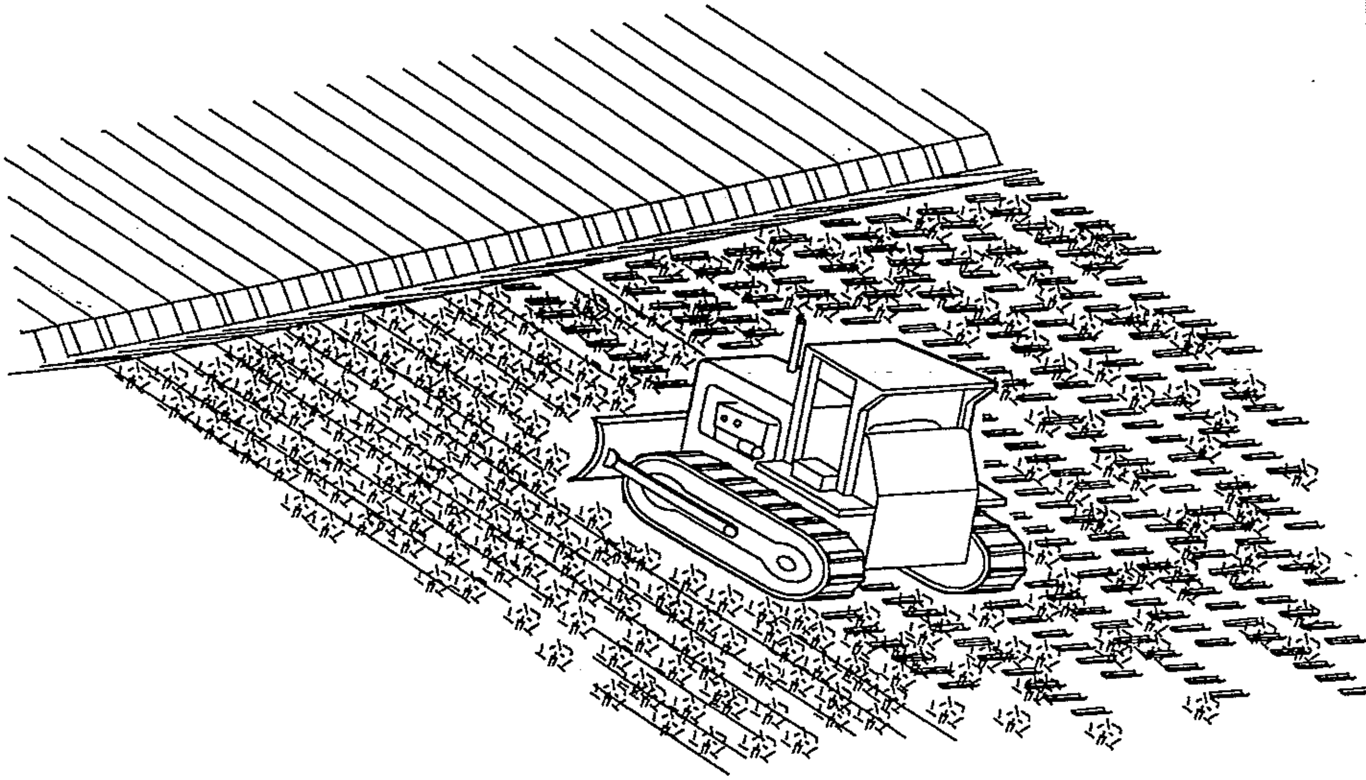
STD. NO. EC-42

'TRACKING' WITH MACHINERY ON SANDY SOIL PROVIDES ROUGHENING WITHOUT UNDUE COMPACTION.



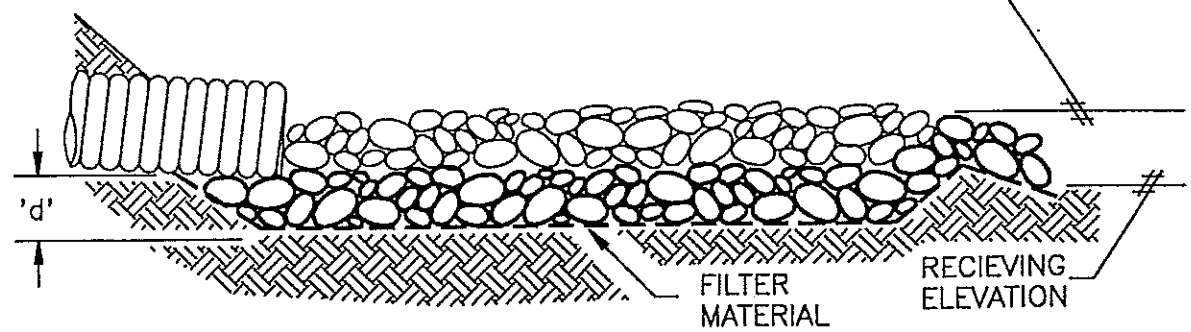
NOTES:

1. ROUGHEN SLOPE WITH BULLDOZER
2. BRODCAST SEED AND FERTILIZER.
3. SPREAD STRAW MULCH 3" THICK. (2 1/2 TONS PER ACRE)
4. TRACK STRAW MULCH INTO SLOPE BY RUNNING BULLDOZER UP AND AND DOWN SLOPE.

DWG DATE 6-92	SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
MARK | DATE	REVISION	APPROVED BY DIRECTOR OF PUBLIC WORKS	STRAW ANCHORING

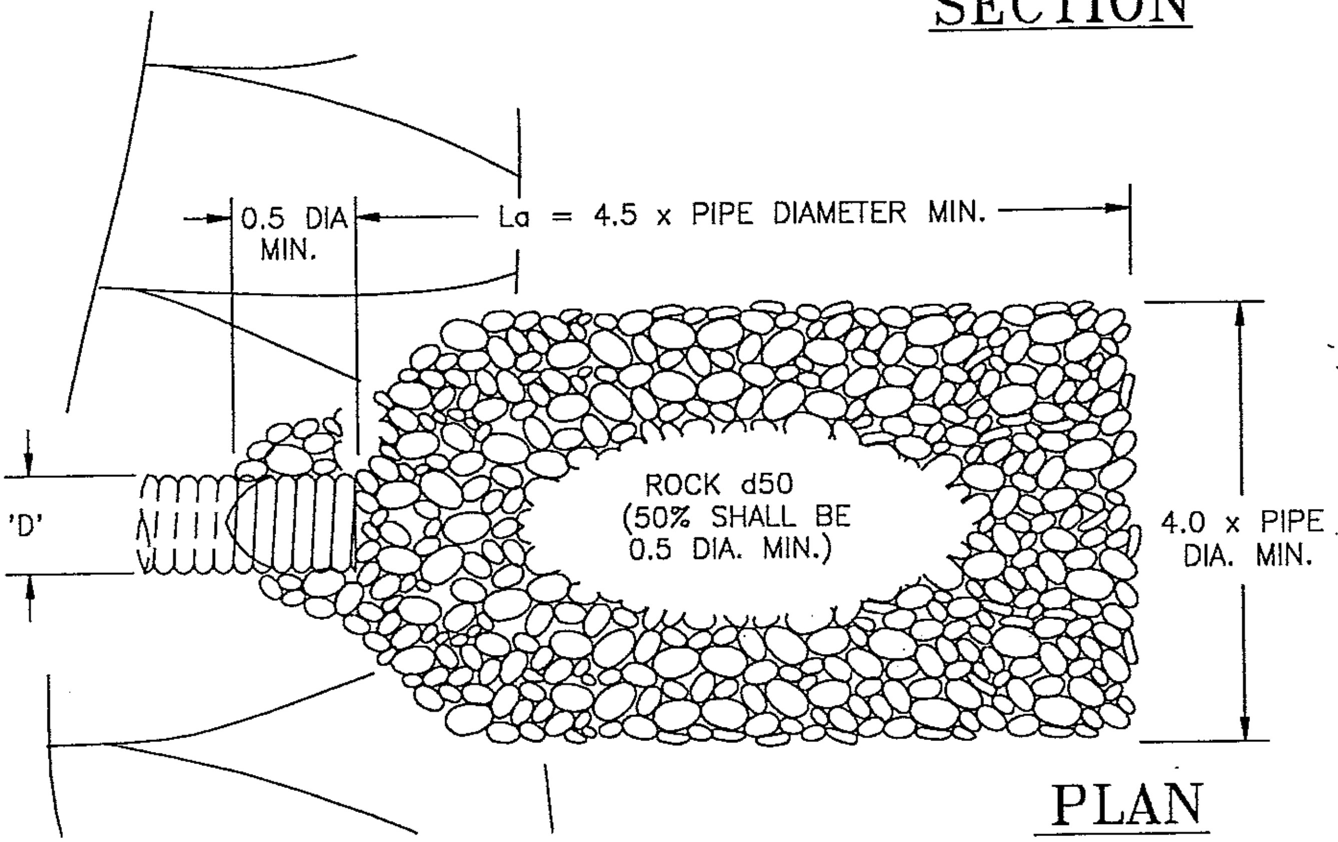
PAGE XXX.XX

STD. NO. EC-30



THICKNESS (d) = 1.5 x MAX ROCK DIAMETER (6" MIN.)

SECTION



PLAN

NOTES:

1. 'La' = LENGTH OF APRON. DISTANCE 'La' SHALL BE OF SUFFICIENT LENGTH TO DISSIPATE ENERGY. APRON SHALL BE SET AT A ZERO GRADE AND ALIGNED STRAIGHT.
2. FILTER MATERIAL SHALL BE FILTER FABRIC OR 6" THICK (MIN.) GRADED GRAVEL LAYER.

DWG DATE 7-89	SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
		APPROVED BY	ENERGY DISSIPATOR
MARK / DATE	REVISION	DIRECTOR OF PUBLIC WORKS	

SECTION C: RUNOFF CONTROL STANDARDS

STANDARD

TEMPORARY DIKE

Definition: A temporary dike is a temporary ridge of compacted soil installed immediately above a new cut or fill slope or around the perimeter of a disturbed area.

Purpose: A dike performs either of two functions. When located above an exposed slope, it intercepts storm runoff from small upland areas and diverts it to an acceptable outlet. When located around the perimeter of a disturbed area, it prevents runoff from entering this area and also prevents sediment-laden runoff from leaving the disturbed area. A dike remains in place until permanent drainage features are installed and/or slopes are stabilized.

This standard applies to all earth-fill structures constructed according to *Earth Dams and Reservoirs* (USDA, Soil Conservation Service, Technical Release No. 60, June 1976).

Design Considerations:

Design considerations should include the following:

- drainage area;
- top width and height;
- side slopes and grade;
- quantity of water diverted;
- velocity of water diverted;
- stabilization against erosion;
- outlet.

SAMPLE SPECIFICATIONS FOR TEMPORARY DIKE

Construction Specifications:

1. The drainage area shall be less than 5 acres (for larger drainage areas see Standard and Sample Specifications for Permanent Waterway).

2. The top width shall be a minimum of 2 feet.

3. The height (compacted fill) shall be a minimum of 18 inches measured from the existing ground at the upslope toe to the top of the dike. The maximum height shall be 30 inches.

4. The side slopes shall be 2:1 or flatter.

5. The grade along the face of the dike (flow area) shall be dependent on topography, but shall be a minimum of 1% (sufficient grade to drain) to an adequate outlet. Drainage must be positive. The "flow area" of the dike is defined as the upslope portion of the dike face and adjacent ground surface over which diverted runoff water flows.

6. The flow area shall be stabilized:

a. where the slope of the flow area exceeds 5%; or

b. where the slope of the flow area is 1% to 5% and the maximum flow velocity from the 10-year frequency storm is exceeded as specified below:

Flow Area Surface	Maximum Velocity (feet per second)
Sand and sandy loam	2.5
Silt loam	3.0
Sandy clay loam	3.5
Clay loam	4.0
Clay, fine gravel and graded loam to gravel	5.0
Graded silt to cobbles	5.5
Shale, hardpan and coarse gravels	6.0

7. Stabilization, when required by No. 6 above, shall be:

a. in accordance with the *Standard and Sample Specification for Grass Protection of Waterways, Swales and Dikes*, when the dike intercepts runoff from a protected or stabilized area (see ABAG Manual); or

b. by lining the flow area with stone that meets MSHA size No. 2 or AASHTO M43 size No. 2 or 24 in a layer at least 3 inches thick and pressed into the soil. The lining shall extend up the upslope side of the dike to a height of at least 8 inches measured vertically from the upslope toe and shall extend upslope from the upslope toe a distance sufficient to include the flow area.

8. Diverted runoff from:

a. a protected or stabilized area shall outlet directly to a grade stabilization structure and/or receiving water channel;

b. a disturbed or exposed upland area shall outlet to a sediment trap or a sediment basin or to an area protected by these practices.

9. All dikes shall be machine-compacted with the tires or tracks going over at least 90% of the surface. There shall be a maximum of 6 inches of lift between each compaction

10. The dike shall be inspected periodically and maintained as required.

Source: Manual of Standards for Erosion and Sediment Control Measures—Association of Bay Area Governments (ABAG)

STANDARD

TEMPORARY SWALE

Definition: A temporary swale is a temporary ditch or drainageway constructed across or around disturbed areas of less than 5 acres, such as building pads or rights-of-way for pipelines and streets.

Purpose: A swale performs either of two functions. When located on a slope bench, it reduces the potential for erosion by intercepting storm runoff and diverting it to a stabilized outlet or sediment-trapping device. When located around the perimeter of a disturbed area, it prevents storm runoff from entering this disturbed area or directs sediment-laden runoff leaving this disturbed area. Runoff carried by a swale should be adequately handled to prevent flooding or erosion damage to adjacent property. A swale remains in place until permanent drainage features are installed and/or slopes are stabilized.

Design Considerations: Design considerations should include the following:

- location;
- drainage area;
- quantity and velocity of water being conveyed;
- bottom width;
- depth;
- side slope;
- grade;
- stabilization;
- outlet;
- traffic crossings;
- spacing between swales.

Construction Specifications:

1. The drainage area shall be less than 5 acres (for larger drainage areas, see *Standard and Sample Specifications for permanent Waterway* (see ABAG Manual).

2. The bottom width shall be a minimum of 7 feet and the bottom shall be level.

3. The depth shall be a minimum of 1 foot.

4. The side slope shall be 2:1 or flatter (flat enough to allow construction traffic to cross if desired).

5. The grade shall be dependent on topography, but shall be a minimum of 1% (sufficient grade to drain) to an adequate outlet. Drainage must be positive.

6. The swale shall be stabilized:

a. where the slope of the swale bottom exceeds 5%; or

b. where the slope of the swale bottom is 1% to 5% and the maximum flow velocity from the 10-year frequency storm is exceeded as specified below:

Flow Area Surface	Maximum Velocity (feet per second)
Sand and sandy loam	2.5
Silt loam	3.0
Sandy clay loam	3.5
Clay loam	4.0
Clay, fine gravel and graded loam to gravel	5.0
Graded silt to cobbles	5.5
Shale, hardpan and coarse gravels	6.0

7. Stabilization, when required by No. 6 above, shall be:

a. in accordance with the *Standard and Sample Specifications or Grass Protection of Waterways, Swales and Dikes* when the swale receives runoff from a stabilized area; or

b. by lining the flow area with stone that meets MSHA No. 2 or AASHTO M43 size No. 2 or 24 in a layer at least 3 inches thick and pressed into the soil. The lining shall extend across the bottom and up both sides of the channel to a height at least 8 inches vertically above the bottom.

8. At all points where the swale will be crossed by vehicles several times a day, the swale shall be stabilized according to 7b above, except that the stone lining shall be at least 6 inches thick for the whole width of the traffic crossing.

9. Diverted runoff from:

a. a protected or stabilized upland area shall outlet directly to a overside drain, temporary slope drain, or other grade stabilization structure and/or a receiving water channel;

b. a disturbed or exposed upland area shall be conveyed to a sediment trap or basin or to an area protected by these practices.

10. The swale shall be located to take advantage of the most suitable outlet The swale shall discharge without causing erosion at its outlet.

11. All trees, brush, stumps, obstructions and other objectionable material shall be removed and disposed of so as not to interfere with the proper functioning of the swale.

12. The swale shall be excavated and/or shaped to line, grade and cross-section as required to meet the criteria specified herein, and be free of bank projections or other irregularities that will impede normal flow.

13. Fills shall be compacted as needed to prevent unequal settlement that would cause damage in the completed swale.

14. All earth removed and not needed in construction shall be spread or disposed of so it will not interfere with the functioning of the swale.

15. The swale shall be inspected periodically and maintained as required.

Source: Manual of Standards for Erosion and Sediment Control Measures—Association of Bay Area Governments (ABAG)

STANDARD

GRASSED WATERWAYS, SWALES AND DIKES

Definition: Vegetation lining a natural or constructed waterway, swale or dike to protect it from erosion.

Purpose: Grass protection of drainageways reduces erosion by lowering water velocity over the soil surface and by binding soil particles with roots. A drainageway, as used in this standard, is any ground surface over which concentrated runoff travels. It is typically a manmade waterway, swale or ditch. It may also be the upslope side of a dike or berm, which intercepts overland flow of water and directs the concentrated flow along the surface of the barrier.

Grassed drainageways or vegetative linings should be used where:

- a vegetative lining can provide sufficient stability for the channel cross section and grade;
- ~~slopes are generally less than 5 %;~~
- space is available for a relatively large cross section.

Design Considerations:

1. The placement of a grassed drainageway must be carefully considered. Its design should be based on a comprehensive evaluation of the surface contours and, for permanent waterways, on estimated peak surface runoff from the design storm. Natural subsurface drainage conditions should be evaluated to determine whether drainage from a grassed drainageway will adversely affect the subsurface drainage system. Where the drainage area exceeds 10 acres, it is recommended that grass-lined channels be designed by an engineer experienced in channel design. Establishment of a dense, resistant vegetation is essential. Construct and vegetate grass-lined channels early in the construction schedule before grading and paving increase the rate of runoff.

2. **Grass-lined channels must not be subject to sedimentation from disturbed areas.** They shall not be placed below high sediment producing areas unless measures (such as sediment basins) are installed to prevent sediment from reaching the channel.

3. Water velocity in grassed drainageways will be slower than in concrete or earth-lined drainageways. Therefore, grassed drainageways may need to be larger. If space does not permit the design of a wide or gently sloping channel, then other linings must be used.

4. An established grass-lined channel resembles natural drainage systems and, therefore, is usually preferred if design velocities are below 5 ft/sec. Velocities up to 6 ft/sec can be safely used under certain conditions. (See references for the design of stable channels.)

5. Outlets should function with a minimum of erosion. (see Riprap and Energy Dissipator)

6. Factors to consider in the selection of plants include:

- plants tolerant of temporary or seasonally high moisture and waterlogged soil conditions;
- plants that establish extensive fibrous roots or rhizomes to bind the soil mass and prevent erosion;
- plants that have low biomass and that do not mat excessively or cause flow to channelize;
- plants that develop and establish rapidly following the normally occurring light, early-season rains;
- plants that reseed and develop well from seed or provide continuous vegetative growth.

7. Seeding rates for plants should be sufficiently high to provide a dense grass stand. The seeds should be uniformly distributed to reduce patchy growth and soil exposure, especially when seeding bunching or non spreading grasses.

8. Seeding, mulching, fertilizing and irrigating considerations are the same as those discussed in Permanent Seeding. However, Hyrdoseeding should be used only if grass is established before the rainy season by irrigating.

9. Stabilization of a grassed drainageway should be accomplished before the first erosive rains of the season. Seeding should be completed by September 15 to maximize the chances of intercepting the light, early-season rains and the chances of grass establishment by October 15. A good indicator of stabilization is the absence of exposed soil in the drainageway.

Germinating rains do not always come before erosive rains. In addition, early season rains are often insufficient to establish adequate grass cover before the period of heavy winter rains . (December to February). Therefore, a contingency plan is advised to ensure either grass establishment or another form of drainageway protection. Temporary irrigation measures can be used to establish grass. Measures such as straw mulching at the time of seeding can provide temporary protection until grass is established.

10. Specialized erosion control liners or erosion control blankets can be installed at the time of seeding Geotextile fabrics, erosion blankets, or special mulch protection such as fiberglass roving or straw and netting provide stability until the vegetation is fully established or as part of a contingency plan to be implemented if grass is not established by October 15. These protective liners must be used whenever design velocities exceed 2 ft/sec for bare soil conditions. It may also be necessary to divert water from the channel until vegetation is established or to line the channel with sod. Sediment traps may be needed at channel inlets and outlets.

11. If the area downstream from the drainageway is a critical area or warrants increased protection, the grass should be established in the drainageway by artificial means before the rainy season begins (before October 15).

Additional Design Criteria:

Capacity—As a minimum, grass-lined channels should carry peak runoff from the 1-year storm without eroding. Where flood hazard exists, increase the capacity according to the potential damage. Channel dimensions may be determined by using design tables with appropriate retardance factors or by Manning's formula using an appropriate "n" value. When retardance factors are used, the capacity is usually based on retardance "C" and stability on retardance "D". (See references for determining peak discharge)

Velocity—The allowable design velocity for grass-lined channels is based on soil conditions, type of vegetation, and method of establishment. (See references for the design of stable channels)

If design velocity of a channel to be vegetated by seeding exceeds 2 ft/sec, a temporary channel liner is required. The design of the liner may be based on peak flow from a 2-year storm. If vegetation is established by sodding, the permissible velocity for established vegetation may be used and no temporary liner is needed. Whether a temporary lining is required or not permanent channel linings must be stable for the 10-year storm.

Cross section—The channel shape may be parabolic, trapezoidal, or V-shaped, depending on need and site conditions.

- **V-shaped grass channels** generally apply where the quantity of water is small, such as in short reaches along roadsides. The V-shaped cross section is least desirable because it is difficult to stabilize the bottom where velocities may be high.

- **Parabolic grass channels** are often used where larger flows are expected and space is available. The shape is pleasing and may best fit site conditions.

- **Trapezoidal grass channels** are used where runoff volumes are large and slope is low so that velocities are non-erosive to vegetated linings.

Side slopes—Grassed channel side slopes generally are constructed 3:1 or flatter to aid in the establishment of vegetation and for maintenance. Side slopes of V-shaped channels are usually constructed 6:1 or flatter along roadways for safety.

Grade—Either a uniform or gradually increasing grade is preferred to avoid sedimentation. Where the grade is excessive, grade stabilization structures may be required or channel linings of riprap or paving should be considered.

Inspection and Maintenance: During the establishment period, check grass-lined channels after every significant rainfall (1" in 24 hours). After grass is established, periodically check the channel for debris, scour, or erosion and immediately make repairs. It is particularly important to check the channel outlet and all road crossings for bank stability and evidence of piping or scour holes. Remove all significant sediment accumulations to maintain the designed carrying capacity. Keep the grass in a healthy, vigorous condition at all times, since it is the primary erosion protection for the channel. (See Permanent Seeding) Permanent grassed waterways should be seasonally maintained by mowing or irrigating, depending on the type of vegetation selected.

Source: Manual of Standards for Erosion and Sediment Control Measures—Association of Bay Area Governments (ABAG) and the North Carolina Erosion and Sediment Control Planning and Design Manual.

STANDARD

ROCK LINED CHANNEL

Definition: Rock-lined channels are channels or roadside ditches lined with rock or riprap.

Purpose: To convey concentrated surface runoff without erosion.

Conditions Where Practice Applies: This practice applies where design flow exceeds 2 ft/sec such that channel lining is required, but conditions are not suitable for vegetative protection. Specific conditions include:

- Decomposed Granite (D.G.) areas. All roadside ditches or drainage channels greater than 2% (max. permissible velocity is 2.5 fps.) located in D.G.soils.

- Design velocity exceeds that allowable for a grass-lined channel

- Channel will continue to down-cut without protection because it is adjusting to increased flow or a new base line (outlet elevation).

Design Criteria:

- Capacity: peak runoff from 10 year storm

- Side slopes: 2:1 or flatter

- Stone size: d= 2" minimum. Use engineering design procedures for sizing riprap for large or critical drainage channels. See reference material for the design of stable channels.

- Riprap thickness: T= 1.5 times the stone diameter or as shown on the plans; 6-inch-thick minimum.

- Foundation: Extra-strength filter fabric or an aggregate filter layer, if required. Use a foundation for D.G. soils.

- Channel cross section: as shown on plans for design high flow.

- Outlet: must be stable.

Construction Specifications:

- Excavate cross section to the grades shown on plans. Overcut for thickness of rock and filter.

- Place filter fabric or gravel filter layer, and rock as soon as the foundation is prepared.
- Place rock so it forms a dense, uniform, well-graded mass with few voids. Hand placement may be necessary to obtain good size distribution.
- No overfall of channel construction should exist. Grass-lined channels with riprap bottoms must have a smooth contact between riprap and vegetation.

Maintenance: Inspect channels at regular intervals and after major storms. Remove debris and make needed repairs where stones have been displaced. Take care not to restrict flow area when stones are replaced.

Give special attention to outlets and points where concentrated flow enters channel. Repair eroded areas promptly.

Check for sediment accumulation, piping, bank instability, and scour holes. repair promptly.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA

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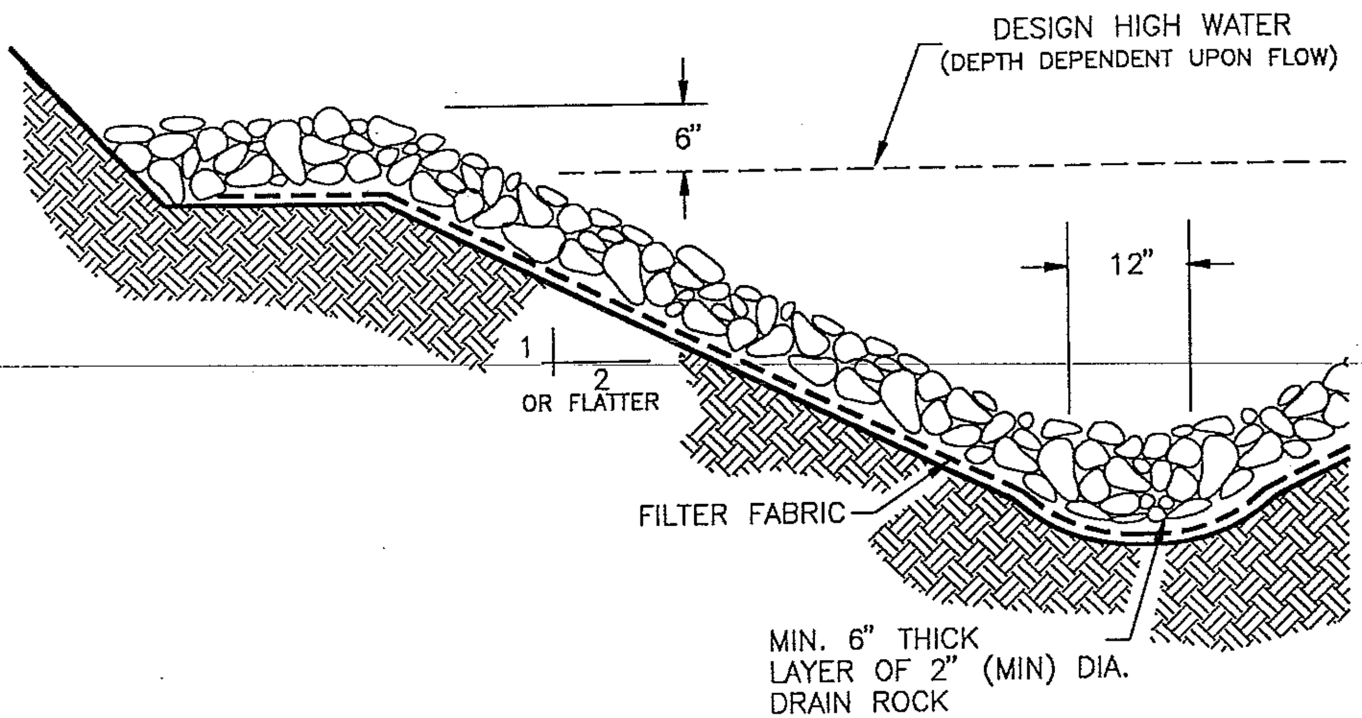
EC-12



TYPICAL HALF SECTION

DWG DATE 7-89	SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
MARK / DATE	REVISION	APPROVED BY DIRECTOR OF PUBLIC WORKS	ROCK LINED CHANNEL

RIPRAP

Definition: Riprap is a layer of stone designed to protect and stabilize areas subject to erosion.

Purpose: To protect the soil surface from erosive forces and/or improve stability of soil slopes that are subject to seepage or have poor soil structure.

Conditions Where Practice Applies: Riprap is used for the following applications:

- cut-and-fill slopes subject to seepage or weathering, particularly where conditions prohibit establishment of vegetation,
- channel side slopes and bottoms,
- inlets and outlets for culverts, bridges, slope drains, grade stabilization structures, and storm drains,
- streambank and stream grades,
- shorelines subject to wave action.

Planning Considerations: Riprap is a versatile, highly erosion-resistant material that can be used effectively in many locations and in a variety of ways to control erosion on construction sites.

Graded Versus Uniform Riprap

Riprap is classed as either graded or uniform. Graded riprap includes a wide mixture of stone sizes. Uniform riprap consists of stones nearly all the same size.

Graded riprap is preferred to uniform riprap in most applications because it forms a dense, flexible cover. Uniform riprap is more open and cannot adjust as effectively to movement of the stones. Graded riprap is also cheaper to install requiring less hand work for installation than uniform riprap, which must be placed in a uniform pattern. Uniform riprap may give a more pleasing appearance.

Riprap sizes are designated by either the mean diameter or the weight of the stones. The diameter specification is often misleading since the stones are usually angular. However, common practice is often misleading since the stones are usually angular. Common practice is to specify stone size by the diameter of an equivalent size of spherical stone. Table—Size of Riprap Stones lists some typical stones by weight, spherical diameter, and the corresponding rectangular dimensions. These stone sizes are based upon an assumed specific weight of 165 lb/ft^3.

A method commonly used for specifying the range of stone sizes in graded riprap is to designate a diameter for which some percentage, by weight, will be smaller. For example "d_{85}" specifies a mixture of stones in which 85% of the stone by weight would be smaller than the diameter specified. Most designs are based on "d_{50}", or median size stones.

Riprap and gravel are often designated by classes. (Table-Riprap Classes).

Table—Size of Riprap Stones

Weight (lb)	Mean Spherical Diameter (ft)	Length (ft)	Rectangular Shape Width/Height (ft)
50	0.8	1.4	0.5
100	1.1	1.8	0.6
150	1.3	2.0	0.7
300	1.6	2.6	0.9
500	1.9	3.0	1.0
1000	2.2	3.7	1.3
1500	2.6	4.7	1.5
2000	2.8	5.4	1.8
4000	3.6	6.0	2.0
6000	4.0	6.9	2.3
8000	4.5	7.6	2.5
20000	6.1	10.0	3.3

When considering riprap for surface stabilization, it is important to anticipate visual impacts, including weed control, hazards from snakes and other animals, danger of slides and hazards to areas below steep riprap slopes, damage and possible slides from children moving stones, and general safety.

Proper slope selection and surface preparation are essential for successful long term functioning of riprap. Adequate compaction of fill areas and proper use of filter blankets are necessary.

Sequence of construction—Schedule disturbance of areas that require riprap protection so the placement of riprap can follow immediately after grading. When riprap is used for outlet protection, place the riprap before or in conjunction with the installation of the structure so that it is in place before the first runoff event.

Design Criteria:

Gradation— Riprap should be a well-graded mixture with 50% by weight larger than the specified design size. The diameter of the largest stone size in such a mixture should be 1.5 times the d_{50} size with smaller sizes grading down to 1 inch.

The designer should determine the riprap size that will be stable for design conditions. Having determined the design stone size, the designer should select the size or sizes that equal or exceed that minimum size based of riprap gradations commercially available in the area.

Thickness—Construction techniques, dimensions of the area to be protected, size and gradation of the riprap, the frequency and duration of flow, difficulty and cost of maintenance, and consequence of failure should be considered when determining the thickness of riprap linings. The minimum thickness should be 1.5 times the maximum stone diameter, but in no case less that 6 inches.

Quality of stone—Stone for riprap may consist of field stone or quarry stone. The stone should be hard, angular, of such quality that it will not break down on exposure to water or weathering, and suitable in all other respects for the purpose intended. The specific gravity of the individual stones should be at least 2.5.

- **Slope Stabilization** —Riprap stone for slope stabilization not subject to flowing water or wave action should be sized for stability for the proposed grade. The gradient of the slope to be stabilized should be less than the natural angle of repose of the stone selected.

  Riprap used for surface stabilization of slopes does not add significant resistance to sliding or slope failure and should not be considered a retaining wall. The inherent stability of the soil must be satisfactory before riprap is used for surface stabilization. Slopes approaching 1.5:1 may require special stability analysis.

- **Outlet protection**—Design criteria for sizing stone and determining the dimensions of riprap pads at channel or conduit outlets are presented in: USDA , SCS Field Design Manual; Manual of Standards for Erosion and Sediment Control Measures—Association of Bay Area Governments (ABAG); and other engineering design manuals.

- **Channel stabilization and streambank protection**—Design criteria for sizing stone for stability of channels are contained in: USDA , SCS Field Design Manual; Manual of Standards for Erosion and Sediment Control Measures—Association of Bay Area Governments (ABAG); and other engineering design manuals.

Filter blanket—A filter blanket is a layer of material placed between the riprap and the underlying soil to prevent soil movement into or through the riprap.

A suitable filter may consist of a well-graded gravel or sand-gravel layer or a synthetic filter fabric manufactured for this express purpose. The design of a gravel filter blanket is based on the ratio of particle size in the overlying filter material to that of the base material in accordance with the criteria below. The designed gravel filter blanket may consist of several layers of increasingly large particles from sand to erosion control stone.

A **gravel filter blanket** should have the following relationship for a stable design:

$$\frac{d_{15} \text{ filter } d_{85}}{\text{base}} \leq 5$$

$$5 \leq \frac{d_{15} \text{ filter } d_{15}}{\text{base}} \leq 40$$

$$\frac{d_{50} \text{ filter } d_{50}}{\text{base}} \leq 40$$

In these relationships, filter refers to the overlying material and base refers to the underlying material. These relationships must hold between the filter material and the base material (soil foundation) and between the riprap and the filter. More than one layer of filter material may be needed. Each layer of filter material should be at least 6 inches thick.

A synthetic filter fabric may be used with or in place of gravel filters. The following particle size relationships should exist:

- Filter fabric covering a base with granular particles containing 50% or less (by weight) of fine particles (less than U.S. Standard Sieve no. 200 (0.074mm):

  a.
  $$\frac{d_{85} \text{ base (mm)}}{\text{EOS* filter fabric (mm)}} > 1$$

  b. total open area of filter should not exceed 36%

- Filter fabric covering other soils:

  a. EOS is no larger than U.S. Standard Sieve no. 70 (0.21mm)

  b. total open area of filter should not exceed 10%.

  * EOS - Equivalent Opening Size compared to a U.S. standard sieve size.

No filter fabric should have less than 4% open area or an EOS less than U.S. Standard Sieve No. 100 (0.15mm). The permeability of the fabric must be greater than that of the soil. The fabric may be made of woven or nonwoven monofilament yarns and should meet the following minimum requirements:

- thickness 20-60 mils,
- grab strength 90-120 lb,
- conform to ASTM D-1682 or ASTM D-177.

Filter blankets should always be provided where seepage is significant or where flow velocity and duration of flow or turbulence may cause the underlying soil particles to move through the riprap.

Construction Specifications:

Subgrade preparation—Prepare the subgrade for riprap and filter to the required lines and grades shown on the plans. Compact any fill required in the subgrade to a density approximating that of the surrounding undisturbed material or overfill depressions with riprap. Remove brush, trees, stumps, and other objectionable material. Cut the subgrade sufficiently deep that the finished grade of the riprap will be at the elevation of the surrounding area. Channels should be excavated sufficiently to allow placement of the riprap in a manner such that the finished inside dimensions and grade of the riprap meet design specifications.

Sand and gravel filter blanket—Place the filter blanket immediately after the ground foundation is prepared. For gravel, spread filter stone in a uniform layer to the specified depth. Where more than one layer of filter material is used, spread the layers with minimal mixing.

Synthetic filter fabric—Place the cloth filter directly on the prepared foundation. Overlap the edges by at least 12 inches, and space anchor pins every 3 feet along the overlap. Bury the upper and lower ends of the cloth a minimum of 12 inches below ground. Take care not to damage the cloth when placing riprap. If damage occurs remove the riprap and repair the sheet by adding another layer of filter material with a minimum overlap of 12 inches around the damaged area. If extensive damage is suspected, remove and replace the entire sheet.

Where large stones are used or machine placement is difficult, a 4-inch layer of fine gravel or sand may be needed to protect the filter cloth.

Stone placement—Placement of riprap should follow immediately after placement of the filter. Place riprap so that it forms a dense, well-graded mass of stone with a minimum of voids. The desired distribution of stones throughout the mass may be obtained by selective loading at the quarry and controlled dumping during final placement. Place riprap to its full thickness in one operation. Do not place riprap by dumping through chutes or other methods that cause segregation of stone sizes. Take care not to dislodge the underlying base or filter when placing the stones.

The toe of the riprap slope should be keyed to a stable foundation at its base as shown in Figure EC-21. The toe should be excavated to t depth about 1.5 times the design thickness of the riprap and should extend horizontally from the slope.

The finished slope should be free of pockets of small stone or clusters of large stones. Hand placing may be necessary to achieve the proper distribution of stone sizes to produce a relatively smooth, uniform surface. The finished grade of riprap should be apparent.

Maintenance: In general, once a riprap installation has been properly designed and installed it requires very little maintenance. Riprap should be inspected periodically for scour or dislodged stones. Control of weed and brush growth may be needed in some locations.

Source: North Carolina Erosion and Sediment Control Planning and Design Manual.

PAGE
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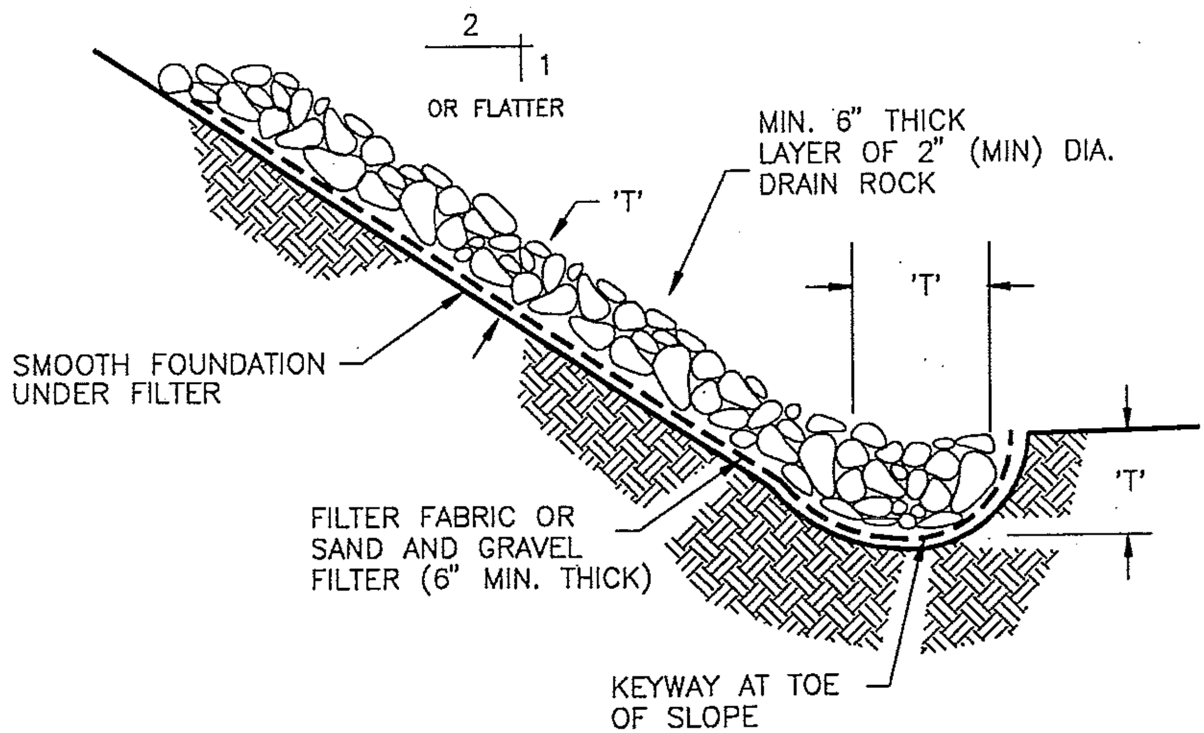
EC-21



TYPICAL SECTION

NOTE:

'T' = THICKNESS : THICKNESS SHALL BE DETERMINED BY THE ENGINEER.

MINIMUM THICKNESS SHALL BE 1.5x THE MAXIMUM STONE DIAMETER, NEVER LESS THAN 6 INCHES.

DWG DATE 6-92		SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
			APPROVED BY	RIPRAP PROTECTION
MARK	DATE	REVISION	DIRECTOR OF PUBLIC WORKS	

TEMPORARY SLOPE DRAIN

Definition: A temporary slope drain is a flexible tubing, pipe, overside drain, or other conduit extending temporarily from the top to the bottom of a cut or fill slope.

Purpose: To convey concentrated runoff down the face of a cut or fill slope without causing erosion.

Conditions Where Practice Applies: This practice applies to construction areas where stormwater runoff above a cut or fill slope will cause erosion if allowed to flow over the slope. Temporary slope drains are generally used in conjunction with diversions to convey runoff down a slope until permanent water disposal measures can be installed.

Planning Considerations: There is often a significant lag between the time a cut or fill slope is graded and the time it is permanently stabilized. During this period, the slope is very vulnerable to erosion, and temporary slope drains together with temporary diversions can provide valuable protection.

It is very important that these temporary structures be sized, installed, and maintained properly, because their failure will usually result in severe erosion of the slope. The entrance section to the drain should be well-entrenched and stable so that surface water can enter freely. The drain should extend downslope beyond the toe of the slope to a stable area or appropriately stabilized outlet.

Other points of concern are failure from overtopping from inadequate pipe inlet capacity and lack of maintenance of diversion channel capacity and ridge height.

Design Criteria:

Capacity—Peak runoff from the 10-year storm. See reference material for determining the peak runoff.

Pipe size—Unless they are individually designed, size drains according to Table below:

Maximum Drainage Area per Pipe (acres)	Pipe Diameter (Inches)
0.50	12
0.75	15
1.00	18
>1.00*	as designed

* Inlet design becomes more complex beyond this size.

Conduit—Construct the slope drain from heavy-duty, flexible materials such as nonperforated, corrugated plastic pipe, open top overside drains with tapered inlets, or CMP. Install reinforced, hold-down grommets or stakes to anchor the conduit at intervals not to exceed 10 feet with the outlet end securely fastened in place. CMP or corrugated plastic pipe must have one (1) anchor assembly for ever 20 feet of slope drain.The conduit must extend beyond the toe of the slope.

Entrance—Construct the entrance to the slope drain of a standard flared-inlet section of pipe with a minimum 6-inch metal toe plate. Make all fittings watertight. A standard T-section fitting may also be used at the inlet. An open top flared inlet for overside drain may also be used.

Temporary diversion—Generally, use an earthen diversion with a dike ridge or berm to direct surface runoff into the temporary slope drain. Make the height of the ridge over the drain conduit a minimum on 1.5 foot and at least 6 inches higher than the adjoining ridge on either side. The lowest point of the diversion ridge should be a minimum of 1 foot above the top of the drain so that design flow can freely enter the pipe.

Outlet protection—Protect the outlet of the slope drain from erosion with an energy dissipator.

Construction Specifications: A common failure of slope drains is caused by water saturating the soil and seeping along the pipe. This creates voids from consolidation and piping and causes washouts. Proper backfilling around and under the pipe "haunches" with stable soil material and hand compacting in 6-inch lifts to achieve firm contact between the pipe and the soil at all points will eliminate this type of failure.

1. Place slope drains on undisturbed soil or well-compacted fill at locations and elevations shown on the plans.

2. Slightly slope the section of pipe under the dike toward its outlet.

3. Hand tamp the soil under and around the entrance section in lifts not to exceed 6 inches.

4. Ensure that fill over the drain at the top of the slope has minimum dimensions of 1.5 foot depth, 4 foot top width, and 3:1 side slopes.

5. Ensure that all slope drain connections are watertight.

6. Ensure that all fill material is well-compacted. Securely fasten the exposed section of the drain with grommets or stakes spaced no more than 10 feet apart.

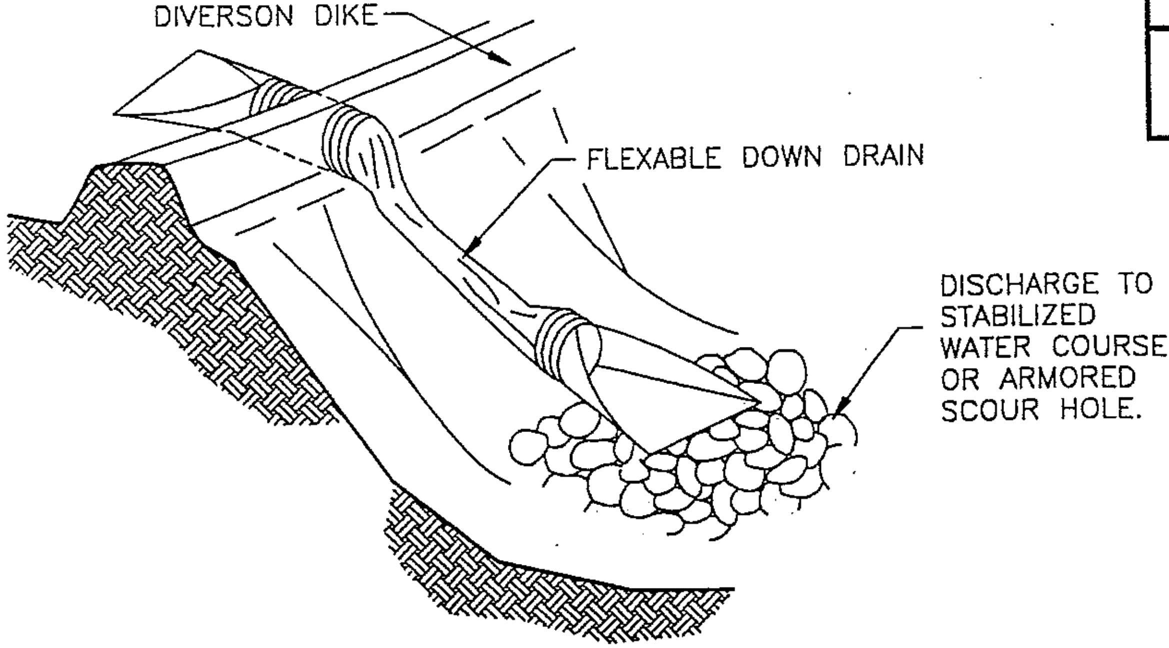
7. Extend the drain beyond the toe of the slope and adequately protect the outlet from erosion.

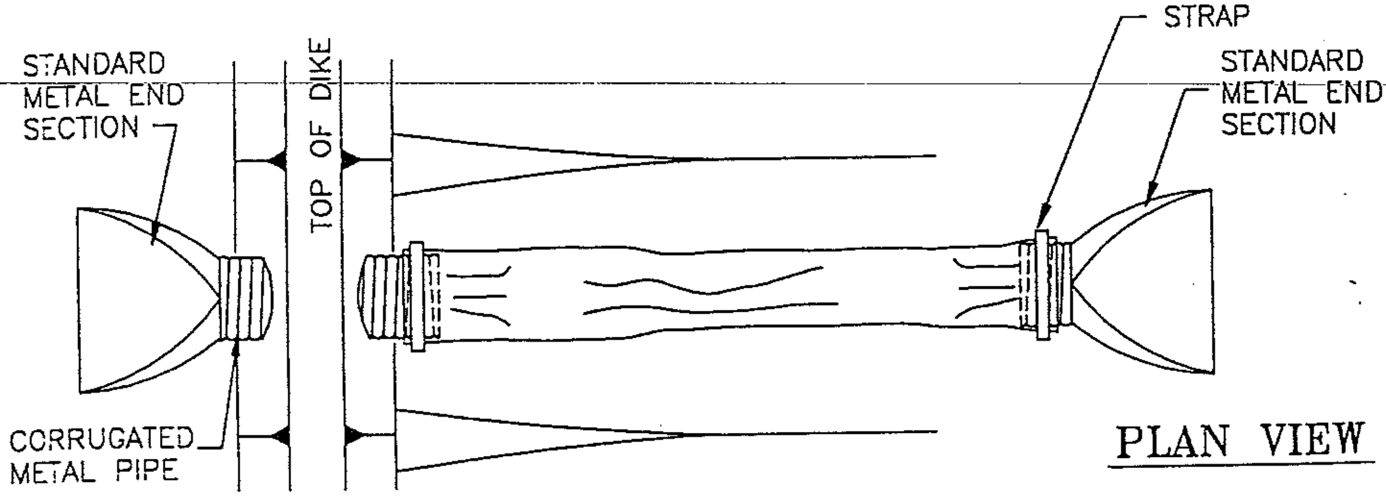
8. Make the settled, compacted dike ridge no less than 1 foot above the top of the pipe at every point.

9. Immediately stabilize all disturbed areas following construction.

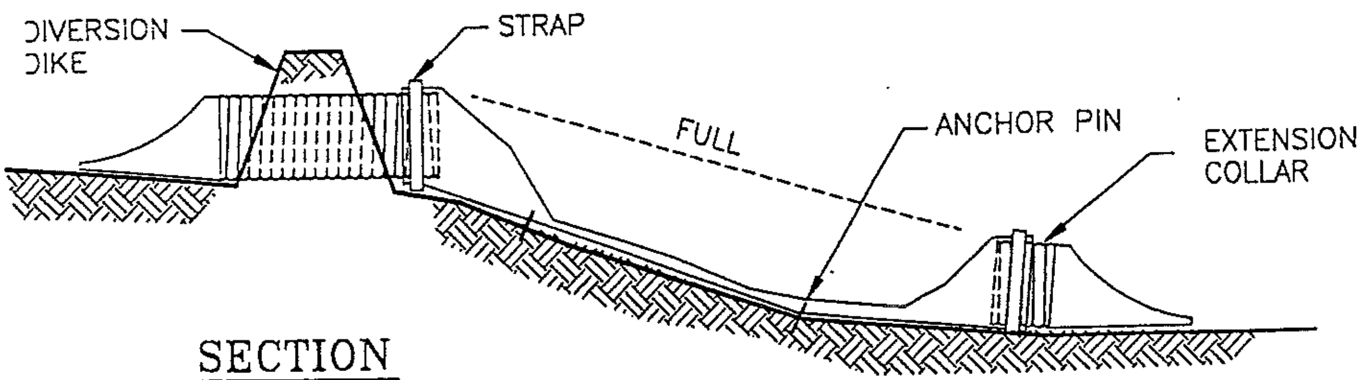
Maintenance: Inspect the slope drain and supporting diversions after every rainfall and promptly make necessary repairs. When the protected area has been permanently stabilized, temporary measures may be removed, materials disposed of properly, and all disturbed areas stabilized appropriately.

Source: John McCullah-CPESC #311, Redding, CA; Adapted from North Carolina Erosion and Sediment Control Planning and Design Manual.





PLAN VIEW



SECTION

DWG DATE 7-89	SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
		APPROVED BY DIRECTOR OF PUBLIC WORKS	TEMPORARY FLEXIBLE DOWNDRAIN
MARK | DATE	REVISION		

EC-8a OSD Drawing

STANDARD

CONSTRUCTION ROAD STABILIZATION

Definition: Construction road stabilization is the stabilization of temporary construction access routes, on-site vehicle routes, emergency fire ingress/egress roads, and parking lots by dispersing runoff and surfacing.

Purpose: To control erosion on temporary construction routes and parking areas. This practice also reduces erosion from driveways, permanent access roads, and emergency fire roads that have been constructed on highly erodible soils such as decomposed granite (DG).

Planning Considerations: Construction road stabilization shall apply to roads on sites requiring a **Wet Weather Plan**, roads and driveways in DG soils, and other unstabilized dirt roads that are generating sediment and/or excessive runoff. Improperly planned and maintained construction roads can become a continual erosion problem. Excess runoff from roads causes erosion on adjacent areas, and an unstabilized road may become a dust problem.

Construction vehicle traffic routes are especially susceptible to erosion because they become compacted and collect and convey runoff water along their surfaces. Rills, gullies, and troublesome muddy areas form unless the road is stabilized. During wet weather, unstabilized dirt roads may become so muddy they are virtually unusable, generating sediment and causing work interruption. Proper grading and stabilization of construction routes often saves money for the contractor by improving the overall efficiency of the construction operation while reducing the erosion problem.

1. Situate construction roads to reduce erosion potential, following the natural contour of the terrain. Avoid steep slopes, wet or rocky areas, and highly erosive soils. If the temporary construction roads are anticipated to be the permanent roads, then there will be no additional cost to temporary rock surfacing, since base will need be applied before final paving.

2. Outsloped and unbermed roads do not concentrate runoff. Outsloped sections of road will disperse the runoff over the entire section of road. A road that is outsloped and bermed will concentrate flows and an overside drain or temporary slope drain will be required to safely drain the road.

3. Insloped roads will require a non-erosive roadside ditch. Steep gradients, concentrated flows and erosive soils may require a stabilized roadside ditch, using riprap, geotextiles and vegetation.

4. Minimize stream crossings and install them properly. Obtain 1603 permits from California Department of Fish and Game for working in or altering a stream channel.

5. When practical, install permanent paved roads and parking areas and use them for construction traffic early during the construction operation to minimize site disruption.

6. Outsloped roads with a berm or diversion dike will require temporary slope drain or other device to protect the fill slopes from concentrated runoff.

Design Criteria:

Fill slope of road embankment—2:1 or flatter for vegetative stabilization.

Ditch capacity—Roadside ditch and temporary slope drains—10 year peak runoff. (See Rock Lined Channels)

Rock surface—Use a 6-inch minimum base rock or other approved rock.

Permanent road standards—See road design standards.

Construction Standards:

1. Ensure that road construction follows the natural contours of the terrain if it is possible. Outslope road if possible.

2. Locate parking areas on naturally flat areas if they are available. Keep grades sufficient for drainage but generally not more than 2 to 3%.

3. Provide surface drainage, and divert excess runoff to stable areas by using waterbars, rolling dips, temporary slope drains or other runoff control measures. (See Waterbars and Rolling Dips; Temporary Slope Drain)

4. Apply a minimum 6 inches of road base, gravel, or other approved rock to the road surface before October 15.

5. Keep cuts and fills at 2:1 or flatter for safety and stability and to facilitate establishment of vegetation and maintenance.

6. Vegetate cuts, fills, and other disturbed areas as soon as grading is complete. Vegetate, rock line or otherwise stabilize roadside ditches if they are actively eroding. (See Rock Lined Channels.)

7. Where seepage areas or seasonally wet areas must be crossed, install subsurface drains or geotextile fabric cloth before placing the crushed stone.

8. Provide appropriate sediment control measures to prevent off-site sedimentation.

Maintenance: Inspect construction roads and parking areas periodically for condition of surface. Topdress with new gravel as needed. Check road ditches and other seeded areas for erosion and sedimentation after runoff-producing rains. Maintain all vegetation in a healthy, vigorous condition. Sediment-producing areas should be treated immediately.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA; Adapted from North Carolina Erosion and Sediment Control Planning and Design Manual.

STANDARD

WATERBARS AND ROLLING DIPS

Definition: Waterbars and rolling dips are ridges or ridge-and-channels constructed diagonally across a sloping road or utility right-of-way that is subject to erosion.

Purpose: To limit the accumulation of erosive volumes of water on roads by diverting surface runoff at predesigned intervals.

Conditions Where Practice Applies: Where runoff protection is needed to prevent erosion on sloping access right-of-ways or other long, narrow sloping areas generally less than 100 feet in width.

Planning Considerations: Construction of access roads, power lines, pipelines, and other similar installations often requires clearing long narrow right-of-ways over sloping terrain. Roads concentrate runoff. Gully formation may be especially severe in tire tracks and ruts. To prevent gullying, runoff can often be diverted across the width of the right-of-way to undisturbed areas by using small waterbars or rolling dips.

A waterbar is a berm and excavation built diagonally across the road. Waterbars generally become less effective if driven over during wet weather, and are difficult to cross with low clearance vehicles. Rolling dips are gently sloping excavations running diagonally across the road surface, and are more appropriate for winter use. Rolling dips are more difficult to construct, but are much easier to traverse.

Special attention should be given to the placement of each individual outlet area and the cumulative effects of each additional diversion. If possible, outlet the diversion onto a stable area such as on a ridge line, onto a stable vegetated (brush) area, or onto a rock dissipator. Never outlet waterbars or rolling dips onto unprotected fill slopes. Use gravel to stabilize the waterbars or rolling dips where significant vehicular traffic is anticipated.

Give special consideration to each individual outlet area, as well as to the cumulative effect of added diversions. Use gravel to stabilize the diversion where significant vehicular traffic is anticipated.

Design Criteria: Height—18 inch minimum measured from the channel bottom to the ridge top.

Side slope—2:1 or flatter; 3:1 or flatter where vehicles cross

Base width of ridge—6 foot minimum

Spacing of waterbars/rolling dips is shown below:

Slope (%)	Spacing (feet)	Spacing (feet) D.G. Soils
<5	125	100
5 to 10	100	75
10 to 20	75	50
20 to 35	50	25
>35	25	25

The distance it takes for the unrocked running surface of a nearby road to develop a 1-inch rill is a rough measure of the appropriate spacing distance.

Grade and angle—Positive grade not to exceed 2%. A crossing angle of approximately 60 degrees is preferred.

Outlet—Diversions should have stable outlets, either natural or constructed. Site spacing may need to be adjusted for field conditions to use the most suitable areas for water disposal—into brush, onto a ridge line, or onto an energy dissipator.

Construction Specifications:

1. Install the diversion as soon as the right-of-way has been cleared and graded.
2. Construct a rolling dip if the road is intended for winter use and normal vehicular use—low clearance.
3. The waterbars and rolling dips should be built at an angle of 45 to 60 degrees from the centerline
4. The diversion should have a positive grade of 2%.

5. The height from channel bottom to the top of the settled ridge shall be 18 inches and the side slopes of the ridge shall be 2:1 or flatter.

Maintenance: Periodically inspect right-of-way diversions for wear and after every heavy rainfall for erosion damage. Immediately remove sediment from the flow area. Check outlet areas and make timely repairs as needed. When permanent road drainage is established and the area above the temporary right-of-way diversions is permanently stabilized, remove the diversion to blend with the natural ground, and appropriately stabilize the disturbed area.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA; North Carolina Erosion and Sediment Control Planning and Design Manual; USDA-Soil Conservation Service: Guide to Building Small Roads

EC-drawing Waterbar and Rolling Dip

STANDARD

ENERGY DISSIPATOR

Definition: An energy dissipator is a structure designed to control erosion at the outlet of a channel or conduit.

Purpose: To prevent erosion at the outlet of a channel or conduit by reducing the velocity of flow and dissipating the energy.

Conditions Where Practice Applies: This practice applies where the discharge velocity of a pipe, box culvert, diversion, open channel, or other water conveyance structure exceeds the permissible velocity of the receiving channel or disposal area.

Planning Considerations: The outlets of channels, conduits, and other structures are points of high erosion potential, because they frequently carry flows at velocities that exceed the allowable limit for the area downstream. To prevent scour and undermining, an outlet stabilization structure is needed to absorb the impact of the flow and reduce the velocity to non-erosive levels.

A riprap-lined apron is the most commonly used practice for this purpose because of its relatively low cost and ease of installation. The riprap apron should be extended downstream until stable conditions are reached, even though this may exceed the length calculated for design velocity control.

Riprap-stilling basins or plunge pools reduce flow velocity rapidly. They should be considered in lieu of aprons where overfalls exit at the ends of pipes or where high flows would require excessive apron length. Consider other energy dissipators such as concrete impact basins or paved outlet structures where site conditions warrant. The City of Redding Construction Standards show permanent type, concrete energy dissipators.

Design Criteria: The criteria for design of riprap outlets are:

Capacity—10-year peak runoff or the design discharge of the water conveyance structure, whichever is greater.

Tailwater depth—Determine the depth of tailwater immediately below the pipe outlet based on the design discharge plus other contributing flows. If the tailwater depth is less than half the diameter of the outlet pipe and the receiving stream is sufficiently wide to accept the divergence of flow, it is classed as a minimum tailwater condition.

If the tailwater depth is greater than half the pipe diameter, it is classed as a maximum tailwater condition. Pipes that outlet onto broad flat areas with no defined channel may be assumed to have a minimum tailwater condition unless site conditions indicate otherwise.

Apron size—The apron length and width can be determined according to the tailwater condition. If the water conveyance structure discharges directly into a well-defined channel, extend the apron across the channel bottom and up the channel banks to an elevation of 0.5 feet above the maximum tailwater depth or to the top of the bank, whichever is less.

Determine the maximum allowable velocity for the receiving stream, and design the riprap apron to reduce flow to this velocity before flow leaves the apron. Calculate the apron length for velocity control or use the length required to meet stable conditions downstream, whichever is greater.

Grade—Ensure that the apron has zero grade. There should be no overfall at the end of the apron; that is, the elevation of the top of the riprap at the downstream end should be the same as the elevation of the bottom of the receiving channel or the adjacent ground if there is no channel.

Alignment—The apron should be straight throughout its entire length, but if a curve is necessary to align the apron with the receiving stream, locate the curve in the upstream section of riprap.

Materials—Ensure that riprap consists of a well-graded mixture of stone. Larger stone should predominate, with sufficient smaller sizes to fill the voids between the stones. The diameter of the largest stone size should be no greater than 1.5 times the d_{50} size.

Thickness—The minimum thickness of riprap shall be 1.5 times the maximum stone diameter.

Stone quality—Select stone for riprap from field stone or quarry stone. The stone should be hard, angular, and highly weather-resistant. The specific gravity of the individual stones should be at least 2.5.

Filter—Install a filter to prevent soil movement through the openings in the riprap. The filter should consist of a graded gravel layer or a synthetic filter cloth. Design filter blankets by the method described in Riprap Standard.

Construction Specifications:

1. Ensure that the subgrade for the filter and riprap follows the required lines and grades shown in the plan. Compact any fill required in the subgrade to the density of the surrounding undisturbed material. Low areas in the subgrade on undisturbed soil may also be filled by increasing the riprap thickness.

2. The riprap and gravel filter must conform to the specified grading limits shown on the plans.

3. Filter cloth, when used, must meet design requirements and be properly protected from punching or tearing during installation. Repair any damage by removing the riprap and placing another piece of filter cloth over the damaged area. All connecting joints should overlap a minimum of 1 foot. If the damage is extensive, replace the entire filter cloth.

4. Riprap may be placed by equipment, but take care to avoid damaging the filter.

5. The minimum thickness of the riprap should be 1.5 times the maximum stone diameter.

6. Riprap may be field stone or rough quarry stone. It should be hard, angular, highly weather-resistant and well graded.

7. Construct the apron on zero grade with no overfall at the end. Make the top of the riprap at the downstream end level with the receiving area or slightly below it.

8. Ensure that the apron is properly aligned with the receiving stream and preferably straight throughout its length. If a curve is needed to fit site conditions, place it in the upper section of the apron.

9. Immediately after construction, stabilize all disturbed areas with vegetation.

Maintenance: Inspect riprap outlet structures after heavy rains to see if any erosion around or below the riprap has taken place or if stones have been dislodged. Immediately make all needed repairs to prevent further damage.

Source: Adapted from North Carolina Erosion and Sediment Control Planning and Design Manual.and Tahoe Regional Planning Agency, Vol II Handbook of BMPs.

PERMANENT STORM DRAIN OUTLET

Definition: De-energizing devices and erosion-resistant channel sections between storm drain outlets and stable downstream channels.

Purpose: These protection measures convert pipe flow to channel flow and reduce water velocity. They are used where storm drain outlets, road culverts, paved channel outlets, etc., discharge into existing streams or drainage systems. The entire length of the channel from the end of the structure to the stream or drainage system is protected by rock-lining, vegetation, concrete paving or other erosion-resistant material.

Design Considerations:

- depth of flow, roughness, gradient, side slopes, bottom width,discharge rate and velocity of each channel reach between the storm drain outlet and the existing publicly-maintained system or natural stream channel. (A channel reach is defined as a length of channel throughout which the hydraulic characteristics do not change);
- maximum allowable water velocity through each channel reach;
- type of storm drain outlet protection (aprons, lined waterways, riprap or grass protection);
- compliance with local and state regulations and requirements;
- maintenance requirements.

Refer to the City of Redding Construction Standards for two types of permanent Energy Dissipators.

For alternative methods of design and more information, consult a qualified engineer.

Source: Manual of Standards for Erosion and Sediment Control Measures—Association of Bay Area Governments (ABAG)

SECTION D: SEDIMENT CONTROL STANDARDS

Some erosion during construction is unavoidable. The purpose of sediment retention structures is to prevent sediment from leaving the site after it has been eroded from its place of origin. Sediment laden runoff should be detained on-site so that the soil particles can settle out before the runoff enters receiving waters.

The most common sediment retention structures are sediment basins, sediment traps, straw bale barriers, straw bale dikes, and silt fences. Sediment basins and traps are placed at low points below disturbed areas. Grading or drainage swales are used to route drainage from the disturbed areas into the basins. Straw bale dikes and silt fences can be placed below small disturbed areas on gentle to moderate slopes. Storm runoff temporarily ponds up behind these barriers, which allows the sediment to settle out. Straw bale barriers can be placed in gentle swales or drainageways to trap sediment and slow runoff velocities, thus reducing erosion.

All sediment retention structures are temporary and require careful installation. Many erosion problems are worsened by the inappropriate use or substandard installation of sediment retention structures. These measures require regular inspection, repair, regular cleanout intervals, and the sediment trapped must be disposed of.

STANDARD

TEMPORARY SEDIMENT BASIN

Definition: A temporary sediment basin is a basin with a watershed of 5 acres or larger constructed to collect and store sediment or debris, with a life span of 3 years or less.

Purpose: Sediment basin collects and holds runoff to allow suspended sediment to settle out. A number of small basins are preferable to one large basin. They are particularly useful below construction operations that expose soil to erosion. Sediment basins remain in place until the disturbed area is permanently stabilized.

This standard establishes the minimum acceptable standards for the design and construction of sediment basins:

The effective height of the basin dam is less than 10 feet. (The effective height is the difference in elevation measured from the emergency spillway crest to the lowest point in the cross-section taken along the centerline of the dam. If there is no emergency spillway, the top of the dam is the upper limit). For basin dams exceeding 10 feet in height, consult a registered civil engineer.

The earth fill structure is constructed according to Earth Dams and Reservoirs (USDA Soil Conservation Service, Technical Release No. 60, June 1976) and all local codes and regulations.

The basin is to be removed within 12 months after the completion of construction on the site.

Plans and specifications should comply with the rules and regulations of the California Division of Dam Safety, the California Department of Fish and Game and other state or local agencies.

Design Considerations: Design considerations should include the following:

- state and local laws, rules and regulations;
- drainage area less than 100 acres;
- design capacity;
- cleanout frequency;
- embankment and/or excavation specifications;
- principal and emergency spillway;
- compatibility with existing topography;
- risk of basin failure;
- soil erodibility, settleability, accumulation rate and particle size;
- controlled access for safety.

It is permissible to have a number of small sediment basins rather than one large basin. Small basins may be easier to locate, cheaper to build and easier to maintain. In addition, property damage risk is generally much lower with small basins. However, no basin should discharge to a lower basin unless the lower basin is designed to handle the runoff from the entire drainage area.

This standard and sample specifications describes a method to size sediment basins according to a surface area criterion. The surface area is determined by the expected flow and the settling velocity of the particle size to be captured.

The basin volume consists of a settling zone and a storage zone. The settling zone should be a minimum of 2 feet deep. The storage volume is estimated using the Universal Soil Loss Equation. Storage requirements will vary considerably depending primarily on local rainfall. Sediment storage volumes in the Bay Area can range from 30 to 120 cubic yards per acre, based on annual cleanout, 10% slopes, no other erosion control practices, and typical rainfall values.

Ideally a basin designed to this specification will attain a maximum practical sediment capture of approximately 60 to 70%. However, the fine particles common in Bay Area soils are very difficult to contain in a settling basin. Thus, sediment basins alone are not sufficient protection against soil loss. Erosion and sediment control plans that include vegetative cover of exposed slopes and nonerosive channeling of runoff greatly reduce the expected sediment yield. With such measures included in the plan, the storage volume of sediment basins can be significantly smaller than the figures quoted above and performance will be maximized.

Due to the nature of soils, it is strongly recommended that sediment basins be supplemented with other erosion control measures.

The Universal Soil Loss Equation can also be used to estimate the effect of vegetation and other erosion control measures on sediment loss. For example, established vegetation reduces soil loss by an approximate factor of 10. If this reduced figure is used to calculate the required storage volume of a basin, an inspection schedule should be implemented to ensure that vegetation does become established. In addition, unexpected high-intensity storms can generate more sediment than predicted. Therefore, sediment basins should be inspected for clean out after every storm, regardless of vegetative cover.

Design Specifications: Plans and specifications shall comply with rules land regulations as set forth by the California Division of Dam Safety, California Department of Fish and Game, and other federal, state or local agencies.

1. For the purpose of these specifications, sediment basins are classified as follows:

Classification of Temporary Sediment Basins:

Size	Max. Drainage area, acres	Max.Height* of dam, ft.	Min. Embank top width	Embank s/s	Seep collar
1	100	10'	10'	2:1 or flatter	Yes
2**	100	15'	10'	2.5:1 or flatter	Yes

* height is measured from the low point of original ground along the centerline of dam to top of the dam.

** for dam heights exceeding 10 feet, a registered civil engineer should be consulted for basin design.

2. The sediment basin shall be located to obtain the maximum storage benefit from the terrain and for ease of cleanout of the trapped sediment. It shall be located to minimize interference with construction activities and construction of utilities.

3. The volume of the sediment basin shall consist of two portions: a sediment storage zone and a settling zone.

4. The sediment storage zone shall consist of sufficient volume to retain sediment expected to be captured by the basin between maintenance cleanouts. For a one-per-year cleaning, storage for an entire season's soil capture shall be provided. This volume is in addition to the settling zone volume of the basin and may be estimated using the Universal Soil Loss Equation for incoming sediment and assuming basin efficiency for retaining sediment.

5. The sediment settling zone shall always be kept free of sediment. Within it, particles of sediment settle to the storage zone. The sediment settling volume shall be based upon a minimum 2-foot depth to the storage zone.

6. The surface area of the sediment basin shall be calculated at the height of the rim of the riser as follows:

$$A = \frac{K \times Q}{Vs}$$

where: **A** is the surface area of the sediment basin, in square feet;

Q is the design overflow rate at the riser or spillway, in cubic feet per second

Vs is the settling velocity of the selected particle size, expressed in feet per second. (All soil particles greater than or equal to the selected particle size are to be retained in the basin.)

K is an adjustment factor for nonideal settling basins, equal to **1.2.**

7. The design overflow rate at the riser, Q, shall be calculated by the TR-55 or Rational Method, or other approved method, and shall be based upon a minimum rainfall intensity of the 10 year frequency, 24 hour duration rainfall total, averaged over 24 hours, for the site in question. The emergency spillway when required shall be designed for the 50 year frequency, 24 hour duration rainfall total, averaged over 24 hours for the site in question. Runoff computation shall be based upon the soil cover conditions expected to prevail in the contributing drainage area during the anticipated effective life of this sediment basin. The sediment basin spillway shall be designed for a minimum storm event of 50 year, 24 hours. The riser can be sized to handle this event or sized to handle the 10 year, 24 hour event in which case an emergency spillway will be required to handle the 50 year, 24 hour event storm.

8. The settling velocity, Vs, which shall be for the 0.02 millimeter particle, is 0.00096 feet per second.

9. The basin configuration shall be such that the length is greater than or equal to the width. Basins constructed with length-to-width ratios ranging from 1:1 to 9:1 shall have a baffle constructed anywhere from near the inlet to the basin to mid-way to the riser. This baffle shall divert the inflow evenly across the width of the basin. The basin dimensions necessary to obtain the required volume and configuration shall be clearly shown on the plans.

10. The combined capacities of the riser or principle spillway and the emergency spillway shall be sufficient to pass the peak rate of runoff from a storm size commensurate with the degree of protection required.

11. Sediment basins shall be cleaned out when the storage volume is full. Unexpected high-intensity storms can generate higher quantities of sediment than predicted by the Universal Soil Loss Equation. Therefore, sediment basins shall be inspected for cleanout after every major storm.

This cleanout shall restore the sediment basin to its original design volume. The elevation corresponding to the maximum allowable sediment level shall be determined, shall be stated in the design data as a distance below the top of riser, and shall be clearly marked on the riser. In no case shall this sediment level be less than 2 feet below the top of the riser. It shall be clearly marked on the plan where the sediment that is removed from the basin will be placed.

12. The principle spillway shall consist of a vertical pipe or box-type riser joined with a watertight connection to a pipe extending through the embankment and outlet beyond the downstream toe of the fill. The principle spillway shall beet the following specifications:

a. The minimum capacity of the principle spillway shall be equal to the peak flow expected from the design storm. For those basins with no emergency spillway, the principle spillway shall have the capacity to handle the peak flow from a rainfall event commensurate with the degree of hazard involved. The minimum diameter of the pipe through the embankment shall be 18 inches. The minimum riser size shall be 1.5 times the diameter of the pipe through the embankment.

b. When used in combination with an emergency spillway, the crest elevation of the riser shall be 1 foot below the elevation of the control section of the emergency spillway.

c. The riser shall be completely watertight, and shall not have any holes, leaks, rips or perforations, except for the inlet opening at the top and a dewatering opening.

d. Means for dewatering the settling zone shall be included in the sediment basin plans submitted for approval, and shall be installed during construction of the basin.

Dewatering shall be done in such a manner as to remove the relatively clean water without removing any of the sediment that has settled out and without removing any appreciable quantities of floating debris.

The sediment itself will have a high water content, to the point of being soupy. Dewatering the sediment is not required but does facilitate cleanout of the basin and provides a public safety factor. The only practical means of dewatering the sediment is by the use of an under drain.

e. A concentric anti-vortex device and trash rack shall be securely installed on top of the riser.

f. A base with sufficient weight to prevent flotation of the riser shall be attached to the riser with a watertight connection. Tow approved bases for risers 10 feet or less in height are:

concrete base 18 inches thick with the riser embedded 6 inches in the base;

1/4 inch minimum thickness steel plate attached to the riser by a continuous weld around the circumference of the riser to form a watertight connection. The plate shall have 2.5 feet of stone, gravel or tamped earth placed on it to prevent flotation.

In either case, each side of the square base shall be twice the riser diameter. For risers higher than 10 feet, computations shall be made to check flotation. The minimum safety factor shall be 1.25 (downward forces=1.25 x upward forces).

g. Anti-seep collars shall be installed around the pipe conduit within the normal saturation zone to increase the seepage length at least 10 percent when any of the following conditions exist:

the settled height of dam exceeds 10 feet;

the embankment material has a low silt-clay content (Unified Soil Classes SM or GM) and the pipe diameter is 18 inches or greater.

The phreatic line may be approximated with a line drawn downward on a 4:1 slope from the intersection of the normal pool (corresponding to the top of the riser and the upstream face of the embankment). The seepage length is the length of the flow path of a particle of water along the conduit from the riser to the point of intersection between the approximate phreatic line and the invert of the pipe conduit. When anti-seep collars are used, the equation for revised seepage length becomes:

$$Ls + 2nV > 1.1Ls \text{ or } n > .05Ls/V$$

where:

Ls is the saturated length of pipe between the riser and the intersection of the phreatic line and the pipe invert, in feet;

n is the number of anti-seep collars;

V is the vertical projection of the collar from the pipe, in feet.

The anti-seep collar and its connection to the pipe shall be watertight. The anti-seep collar(s) shall be located below the phreatic line in the embankment and should be equally spaced. The maximum spacing, in feet, between collars shall be 14 times the minimum projection of the collar measured perpendicular to the pipe. Collars shall not be located closer than 2 feet to a pipe joint. There shall be sufficient distance between collars to allow passage of hauling and compacting equipment.

h. An outlet shall be provided, including a means of conveying the discharge in an erosion-free manner to an existing stable stream. Drainage easements shall be obtained if this discharge crosses the property line before reaching the stream. These easements shall be in writing, shall be referenced on the erosion and sediment control plan, and shall be submitted for review along with the erosion and sediment control plan. Protection against scour at the discharge end of the pipe spillway shall be provided. Measure may include impact basin, riprap, revetment, excavated plunge pools, or other approved methods.

13. Emergency spillways shall not be constructed on fill. The emergency spillway cross-section shall be trapezoidal with a minimum bottom width of 8 feet. Emergency spillways shall meet the following specifications:

a. The minimum capacity of the emergency spillway shall be that required to pass the peak rate of runoff from a 50 year frequency storm, 24 hour event.

b. Erosion protection shall be provided by vegetation or other suitable means such as riprap, asphalt or concrete.

c. The velocity of flow in the exit channel shall not exceed 5 feet per second for vegetated channel. For channel with erosion protection other than vegetation, velocities shall be within the nonerosive range for the type of protection used.

d. The freeboard shall be at least 1 foot. Freeboard is the difference between the design high water elevation in the emergency spillway and the top of the settled embankment. If there is no emergency spillway, it is the difference between the water surface elevation required to pass the design flow through the pipe and the top of settled embankment.

14. Embankment cross sections shall be as follows:

a. Size 1 basins: The minimum top width shall be 10 feet. The side slopes shall not be steeper than 2:1.

b. Size 2 basins: The minimum top width shall be 10 feet. The side slopes shall not be steeper than 2 1/2:1.

15. Points of entrance of surface runoff into excavated sediment basins shall be protected to prevent erosion. dikes, swales, grade stabilization structures or other water control devices shall be installed as necessary to ensure direction of runoff and to protect points of entry into the basin. Points of entry should be located so as to ensure maximum travel distance of entering runoff to point of exit from the basin.

16. The sediment basin plans shall indicate the method(s) of disposing of the sediment removed from the basin. The sediment shall be placed in such a manner that it will not erode from the site. The sediment shall not be deposited downstream from the basin or in or adjacent to a stream or flood plain.

The sediment basin plans shall also show the method of disposing of the sediment basin after the drainage area is stabilized, and shall include the stabilizing of the sediment basin site. Water lying over the trapped sediment shall be removed from the basin by pumping, cutting the top of the riser or other appropriate method prior to removing or breaching the embankment. Sediment shall not be allowed to flush into a stream or drainageway.

17. Sediment basins are attractive to children and can be very dangerous. Therefore, they shall be fenced or otherwise made inaccessible to persons or animals unless this is deemed unnecessary due to the remoteness of the site or other circumstances. In any case, regulations regarding health and safety shall be adhered to.

Construction Specifications:

1. Areas under the embankment and any structural works shall be cleared, grubbed and stripped of any vegetation and rootmat as shown on the erosion and sediment control plan. In order to facilitate cleanout and restoration, the basin area shall be cleared also.

2. A cut-off trench shall be excavated along the centerline of the earth fill embankments. The minimum depth shall be 2 feet. The cut off trench shall extend up both abutments to the riser crest elevation. The bottom width shall be wide enough to permit operation of excavation and compacting equipment and a minimum of 4 feet. The side slopes shall be no steeper than 1:1. Compacting requirements shall be the same as those for the embankment. The trench shall be dewatered during the backfilling compacting operations.

3. Fill material for the embankment shall be taken from approved borrow areas. It shall be clean mineral soil free of roots, woody vegetation, oversized stones, rocks or other objectionable material. Relatively pervious materials such as sand and gravel (Unified Soil Classes GW, GP, SW and SP) shall not be placed in the embankment. Areas on which fill is to be placed shall be scarified prior to placement of fill. The fill material shall contain sufficient moisture so that it can be formed by hand into a ball without crumbling. If water can be squeezed out of the ball, it is too wet for proper compacting.

   Fill material shall be placed in 6-inch lifts, continuous layers over the entire length of the fill. Compacting shall be obtained by routing the hauling equipment over the fill so that the entire surface of each layer of the fill is traversed by at least one wheel or tread track of the equipment, or by the use of a compactor. The embankment shall be constructed to an elevation of 10 percent higher than the design height to allow for settlement if compacting is obtained with hauling equipment. If compactors are used for compacting, the overbuild may be reduced to not less than 5 percent.

4. The principle spillway riser shall be securely attached to the discharge pipe by welding all around and all connections shall be watertight. The pipe and riser shall be placed on a firm, smooth soul foundation. The connection between the riser and the riser base shall be watertight. Pervious materials such as sand, gravel or crushed stone shall not be used as backfill around the pipe or anti-seep collars.

   The fill material around the pipe spillway shall be placed in 4-inch layers and compacted under the shoulders and around the pipe to at least the same density as the adjacent embankment. a minimum of 2 feet of hand compacted backfill shall be placed over the pipe spillway before crossing it with construction equipment. Steel base plates shall have at least 2 1/2 feet of compacted earth, stone or gravel over them to prevent flotation.

5. The emergency spillway shall not be installed in fill. Elevations, design width, and entrance and exit channel slopes are critical to the successful operation of the emergency spillway.

6. Baffles shall be constructed of 4" by 4" posts and 4' by 8' 1/2" exterior plywood. The posts shall be set at least 3 feet into the ground, no further apart than 8 feet center to center, and shall reach a height 6 inches below the riser crest elevation. The plywood shall be securely fastened to the upstream side of the posts.

7. The embankment and emergency spillway shall be stabilized with vegetation immediately following construction (See Standard and Sample Specifications for Planting of Exposed Soils).

8. Construction operations shall be carried out in such a manner that erosion and water pollution will be minimized.

9. State requirements shall be met concerning fencing and signs warning the public of hazards of soft sediment and floodwater.

10. Maintenance and repairs shall be carried out as follows:

   a. All damages caused by soil erosion or construction equipment shall be repaired before the end of each working day.

   b. Sediment shall be removed from the basin when it reaches the specified distance below the top of the riser. This sediment shall be placed in such a manner that it will not erode from the site. The sediment shall not be deposited downstream from the embankment or in or adjacent to a stream or floodplain.

11. When temporary structures have served their intended purpose and the contributing drainage area has been properly stabilized, the embankment and resulting sediment deposit shall be leveled or otherwise disposed of in accordance with the approved erosion and sediment control plan.

INFORMATION TO BE SUBMITTED FOR APPROVAL

Sediment basin designs and construction plans submitted to the reviewing agency shall include the following:

- Specific location of the dam;
- Plan view of dam, storage basin and emergency spillway;
- Cross section of dam, principle spillway and emergency spillway;

- Details of pipe connections, riser to pipe connection, riser base, anti-seep collars, trash rack and anti-vortex device;
- Runoff calculation for 10 year 24 hour storm and 50 year 24 hour storm events;
- Storage calculations including total volume required, total volume available, and level of sediment at which cleanout shall be required (stated as a distance from the riser crest to the sediment surface);
- Calculations showing design of pipe and emergency spillway.

(Note: Runoff, storage and design calculations may be submitted using the design data sheets in the appendix.

TEMPORARY SEDIMENT BASIN DESIGN DATA SHEET

INSTRUCTIONS:

1. Calculate runoff for the average hourly rainfall from the 10 year, 24 hour storm and the 50 year 24 hour storm, by using TR-55 or the Rational Method. Particle size analysis can be performed by the engineering firm providing the geotechnical report. The basin will be designed to capture the 0.02 mm particle.

2. The minimum surface area, to capture particles of selected diameter and larger, is the inverse of the particle settling velocity multiplied by 1.2 and by the average runoff in ft^3/sec. (For 0.02 mm diameter particles the surface area is 1250 square feet per ft^3/sec of runoff).

3. The minimum settling depth is 2 feet.

4. For the required storage depth, estimate the soil loss in cubic yards using USLE, (average dry unit weight of sediment eroded and deposited in reservoirs is approximately 75 lbs/cubic feet and 1 ton/cubic yard; convert to cubic feet; multiply by E from step 1; E approximates the capture efficiency of a properly designed basin, and finally, divide by the surface area to obtain the required depth of storage in feet).

5. The required volume of the basin is the surface area times the sum of the storage and settling depths.

   The volume of a naturally shaped (no excavation in basin) basin may be approximated by the formula V=0.4Ad, where V is in cubic feet; A is the surface area of the basin, in square feet, and d is the maximum depth of the basin, in feet. Volume may be computed from contour information or other suitable methods.

If volume of basin is not adequate, excavate to obtain the required volume.

Unobstructed basin settling depth must be maintained. Therefore cleanout is required when sediment accumulates within 2 feet of the top of the riser.

6. Calculate peak runoff by applying 50% in one hour of the 10 year, 24 hour and 50 year, 24 hour total rainfall to the TR-55 or rational Method.

7. Design the pipe spillway to carry the 10 year, 24 hour storm or both the 10 year, 24 hour storm and the 50 year, 24 hour storm. If the pipe is designed for the 10 year 24 hour storm, only an emergency spillway is required. (see USDA, SCS Field Design Manual, ABAG Manual, or listed design reference material)

8. Determine value "H" from field conditions; "H" is interval between the centerline of the outlet pipe and the emergency spillway, to the design high-water.

9. See Trash Rack and Anti-Vortex Device Design. (see ABAG or listed design reference material)

10. Design the emergency spillway to carry at least the peak runoff from the 50 year, 24 hour storm. A design storm event should be used commensurate with the degree of risk associated with failure of the structure.

11. See Anti-seep Collar Design. (see ABAG or listed design reference material)

12. The emergency spillway crest must be set no closer to riser crest than value of h, which causes pipe spillway to carry the minimum required Q. Therefore, the elevation difference between spillways shall be equal to the value of h, or one foot, whichever is greater. Design high water is the elevation of the emergency spillway crest plus the value of Hp, or if there is no emergency spillway, it is the elevation of the riser crest plus h required to handle the 50 year storm. Minimum top of dam elevation requires 1.0 feet of freeboard above design high water. See detail Typical Sediment Basin)

PROCEDURE FOR DETERMINING OR ALTERING SEDIMENT BASIN SHAPE

As specified in the standard and Specification, the pool area at the elevation of crest of the principle spillway shall have a length to width ration (L:W) of at least 1 to 1. For L:W ranging from 1:1 to 9:1 a baffle must be inserted. For L:W of 10:1 or greater, no baffle is necessary. The purpose of this requirement is to minimize the "short-circuiting" effect of the sediment laden inflow to the riser and thereby allow the effectiveness of the sediment basin to approach ideal performance. The purpose of this procedure is to prescribe the parameters, procedures and methods of determining and modifying the shape of the basin.

The length of the flow path (L) is the distance from the point of inflow to the riser (outflow point). The point of inflow is the point that the stream enters the normal pool (pool level at the riser crest elevation). The pool area (A) is the area of the normal pool. The effective width (W_e) is found by the equation:

$$W = A/L$$

$$\text{and L:W ratio} = L/W_e$$

In the event there is more than one inflow point, any inflow point at L:W less than 10:1 which conveys more than 30 percent of the total peak inflow rate shall be baffled.

The required basin shape may be obtained by proper site selection, by excavation or by constructing a baffle in the basin. The purpose of the baffle is to increase the effective flow length from the inflow point to the riser. Baffles shall be placed from near the inflow to mid-way between the inflow point and the riser. The baffle length shall be as required to effectively distribute inflow across the entire width of the basin. The effective length (le) shall be the shortest distance the water must flow from the the inflow point around the end of the baffle to the outflow point.

Source: USDA , SCS Field Design Manual, Redding, California; Adapted from Manual of Standards for Erosion and Sediment Control Measures—Association of Bay Area Governments (ABAG).

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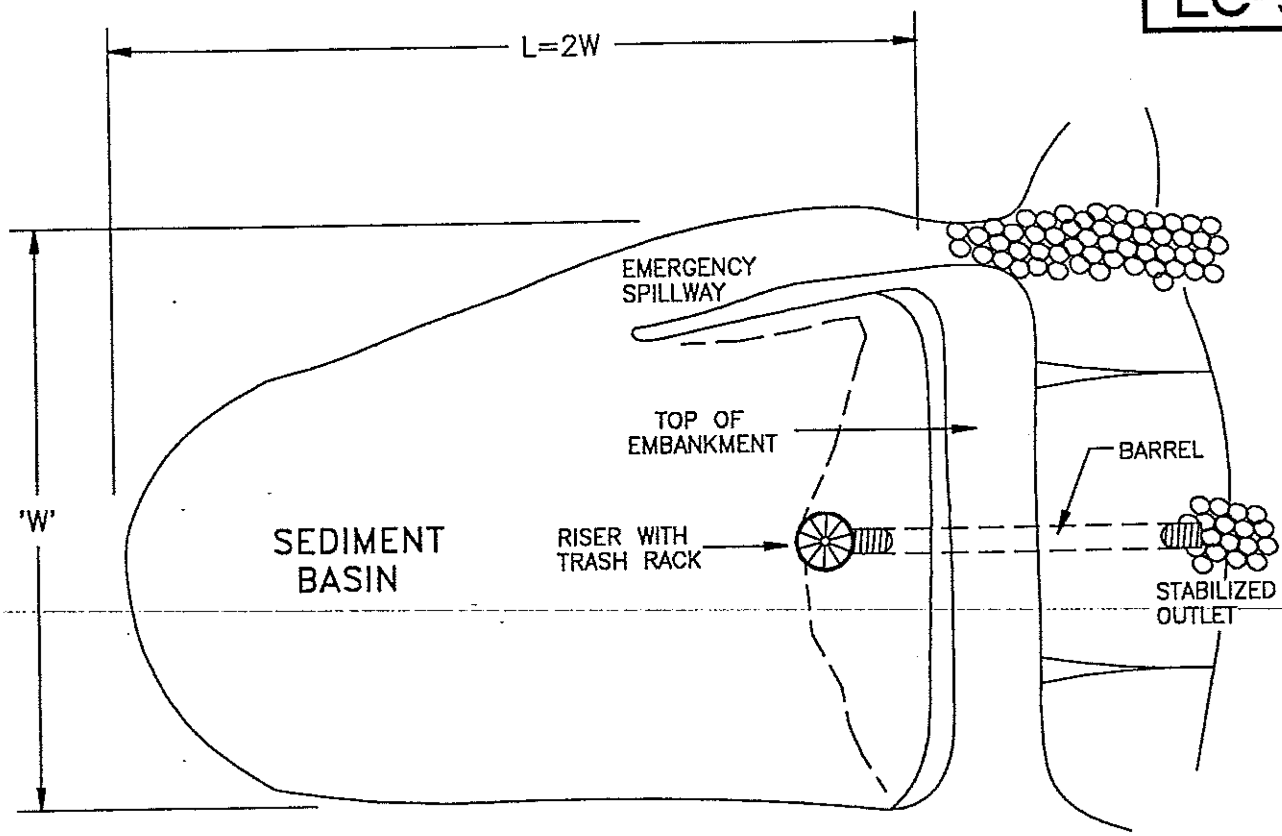
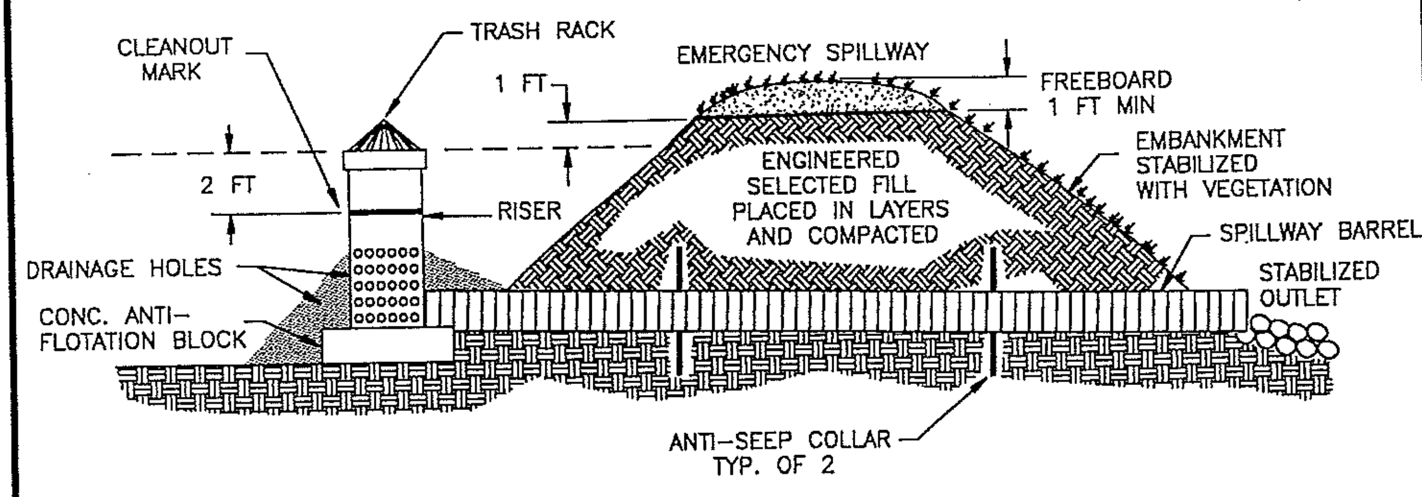




DWG DATE 6-92	SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
		APPROVED BY	SEDIMENT BASIN
MARK / DATE	REVISION	DIRECTOR OF PUBLIC WORKS	

TEMPORARY SEDIMENT TRAPS

Definition: A temporary sediment trap is a small ponding basin formed by an embankment or excavation to capture sediment.

Purpose: To detain sediment-laden runoff and trap the sediment to protect receiving streams, lakes, drainage systems, and protect adjacent property.

Conditions Where Practice Applies: At the outlets of diversions, channels, slope drains, or other runoff conveyances that discharge sediment-laden water.

- Below areas that are 5 acres or less.
- Where access can be maintained for sediment removal and proper disposal.
- In the approach to a storm water inlet located below a disturbed area as part of an inlet protection system.
- Structure life limited to 2 years.

Planning Considerations: Select locations for sediment traps during site evaluation. Note natural drainage divides and select trap sites so that runoff from potential sediment-producing areas can easily be diverted into the traps. Ensure the drainage areas for each trap does not exceed 5 acres.

Make traps readily accessible for periodic sediment removal and other necessary maintenance. Plan locations for sediment disposal as part of trap site selection. Clearly designate all disposal areas on the plans.

In preparing plans for sediment traps, it is important to consider provisions to protect the embankment from failure from storm runoff that exceeds the design capacity. Consider nonerosive emergency spillway and bypass areas, particularly if there could be severe consequences from failure. If a bypass is not possible and failure would have severe consequences, consider alternative sites.

Sediment trapping is achieved primarily by settling within a pool formed by an embankment. The sediment pool may also be formed by excavation, or by a combination of excavation and embankment. Sediment-trapping efficiency is a function of surface area and inflow rate. Therefore, maximize the surface area in the design. Installations that provide pools with large length to width ratios reduce short circuiting and allow more of the pool surface area for settling. This optimizes efficiency.

Because well-planned sediment traps are key measures to preventing off-site sedimentation, they should be installed in the first stages of project development.

Design Criteria: Ensure drainage area for a sedimentation trap does not exceed 5 acres.

Storage capacity— Keep the minimum volume of the sediment trap at 1800 ft^3/acre based on disturbed area draining into the basin. Measure volume below the crest elevation of the outlet. The volume of a natural sediment trap may be satisfactorily approximated by the equation:

$$\text{volume } (ft^3) = 0.4 \times \text{surface area } (ft^2) \times \text{maximum pool depth } (ft)$$

Trap cleanout—Remove sediment from the trap and restore the capacity to original trap dimensions when sediment has accumulated to one-half the design depth.

Embankment—Ensure that embankments for temporary sediment traps do not exceed 5 feet in height measured at the center line from the original ground surface to the top of the embankment. Additional freeboard may be added to the embankment height to allow flow through a designated bypass location. Construct embankments with a minimum top width of 5 feet and side slopes of 2:1 or flatter. Machine compact embankments.

Excavation—Where sediment pools are formed or enlarged by excavation, keep side slopes at 2:1 or flatter for safety.

Outlet section—Construct the sediment trap outlet using a stone section of embankment located at the low point in the basin. The stone section serves two purposes: (1) the top section serves as a nonerosive spillway outlet for flood flows, and (2) the bottom section provides a means of dewatering the basin between runoff events.

Stone size—Construct the outlet using well-graded stones with a d_{50} size of 9 inches (class B erosion control stone is recommended), and a maximum stone size of 14 inches. A 1-foot thick layer of 3/4 - inch aggregate should be placed on the inside face to reduce drainage flow rate.

Side slopes—Keep the side slopes of the spillway section at 2:1 or flatter. To protect the embankment, keep the sides of the spillway at least 21 inches thick.

Depth—Keep the crest of the spillway outlet a minimum of 1.5 feet below the settled top of the embankment.

Protection from piping—Place filter cloth on the foundation below the riprap to prevent piping. An alternative would be to excavate a keyway trench across the riprap foundation and up the sides to the height of the dam.

Weir length and depth—Keep the spillway weir at least 4 feet long and sized to pass the peak discharge of the 10-year storm. A maximum flow depth of 1 foot, a minimum freeboard of 0.5 feet, and maximum side slopes of 2:1 are recommended. Weir length may be approximated from table shown.

Design of Spillways

Drainage Area (acres)	Weir Length* (ft)
1	4.0
2	6.0
3	8.0
4	10.0
5	12.0

* Dimensions shown are minimum

Construction Specifications:

1. Clear, grub, and strip the area under the embankment of all vegetation and root mat. Remove all surface soil containing high amounts of organic matter and stockpile or dispose of it properly. Haul all objectionable material to the designated disposal area.

2. Ensure that fill material for the embankment is free of roots, woody vegetation, organic matter, and other objectionable material. Place the fill in lifts not to exceed 9 inches and machine compact it. Over fill the embankment 6 inches to allow for settlement.

3. Construct the outlet section in the embankment. Protect the connection between the riprap and the soil from piping by using

filter fabric or a keyway cutoff trench between the riprap structure and the soil.

- Place the filter fabric between the riprap and soil. Extend the fabric across the spillway foundation and sides to the top of the dam; or

- Excavate a keyway trench along the centerline of the spillway foundation extending up the sides to the height of the dam. The trench should be at least 2 feet deep and 2 feet wide with 1:1 side slopes.

4. Clear the pond area below the elevation of the crest of the spillway to facilitate sediment cleanout.

5. All cut and fill slopes should be 2:1 or flatter.

6. Ensure that the stone (drainage) section of the embankment has a minimum bottom width of 3 feet and maximum side slopes of 1:1 that extend to the bottom of the spillway section.

7. Construct the minimum finished stone spillway bottom width, as shown on the plans, with 2:1 side slopes extending to the top of the over filled embankment. Keep the thickness of the sides of the spillway outlet structure at a minimum of 21 inches. **The weir must be level and constructed to grade to assure design capacity.**

8. Material used in the stone section should be a well-graded mixture of stone with a d_{50} size of 9 inches (class B erosion control stone is recommended) and a maximum stone size of 14 inches. The stone may be machine placed and the smaller stones worked into the voids of the larger stones. The stone should be hard, angular, and highly weather-resistant.

9. Ensure that the stone spillway outlet section extends down stream past the toe of the embankment until stable conditions are reached and outlet velocity is acceptable for the receiving stream. Keep the edges of the stone outlet section flush with the surrounding ground and shape the center to confine the outflow stream.

10. Direct emergency bypass to natural, stable areas. Locate bypass outlets so that flow will not damage the embankment.

11. Stabilize the embankment and all disturbed areas above the sediment pool and downstream from the trap immediately after construction.

12. Show the distance from the top of the spillway to the sediment cleanout level (one-half the design depth) on the plans and mark it in the field.

Maintenance: Inspect temporary sediment traps after each period of significant rainfall (1" in 24 hours). Remove sediment and restore the trap to its original dimensions when the sediment has accumulated to one-half the design depth of the trap. Place the sediment that is removed in the designated disposal area and replace the contaminated part of the gravel facing.

Check the structure for damage from erosion or piping. Periodically check the depth of the spillway to ensure it is a minimum of 1.5 feet below the low point of the embankment. Immediately fill any settlement of the embankment to slightly above design grade. **Any riprap displaced from the spillway must be replaced immediately.**

After all sediment-producing areas have been permanently stabilized, remove the structure and all unstable sediment. Smooth the area to blend with the adjoining areas and stabilize properly.

Source: North Carolina Erosion and Sediment Control Planning and Design Manual.

STANDARD

TEMPORARY EXCAVATED IMPOUNDMENTS

Definition: A temporary excavation is a small temporary sediment trap formed by excavation and/or construction of an embankment around existing storm drains. Temporary excavations are smaller than sediment basins or sediment traps and are used for drainages less than 2 acres.

Purpose: Temporary excavated impoundments are intended to intercept sediment-laden runoff, pond the water, and allow the sediment to fall out. This standard applies to all temporary sediment traps with a drainage area of less than 2 acres and have:

- been constructed by excavation or building an embankment;
- an existing storm drain inlet that can be utilized as an outlet

Design Considerations: Design considerations should include the following:

- phased construction to utilize storm drainage system;
- drainage area - less than 2 acres;
- design capacity - 312 sq. ft./acre;
- clean-out intervals - frequent;
- embankment and/or excavation specifications;
- outlets and the accumulation of ponded water between storms;
- soil erodibility, settleability, and accumulation rate.

The fundamental difference between sediment traps and sediment basins is the size of the contributing area. Temporary excavated impoundments serve a smaller area, under 2 acres, and can be adequately sized using the same criteria for designing a sediment basin. The example below illustrates how to size a temporary excavated impoundment.The area was calculated by using the following equation:

$$A = \frac{1.2\,(Q)}{Vs}$$ where $Q = C \times i \times A$ $Q = .5(.5''/hr)1ac = .25\ ft^3/sec$

where Vs = settling velocity .02mm particle =.00096 ft/sec

therefore: $A = \frac{1.2(.25\ ft^3/sec)}{.00096\ ft/sec} = 312\ ft^2$ surface area

This was calculated for a 10-year, 6-hour precipitation for an area north of Redding by applying the rational method—the runoff coefficient (C=.5) was chosen to represent a smooth graded area with no vegetation. The calculations indicate that there should be 312 ft^2 of sediment trap surface area (when trap is full of water) for each acre of area draining to the to the trap.

Temporary impoundments can be as simple as excavations around existing drop or curb inlets, constructed before final grade and paving is complete. A series of traps can be efficient in trapping the larger to medium sized particles if constructed in gently sloping areas and deep enough to allow the sediment-laden water to pond before being discharged. Sediment traps and excavations are not generally designed to de-water so considerations must be given to release ponded water yet not release sediment.

On a small construction site, sediment traps and temporary impoundments can capture sediment and prevent much of it from leaving the site. However, if the capture of very fine soil particles is essential and frequent clean-out is not possible, a carefully designed sediment basin must be used so the basin has the proper settling velocity for the design particle size, proper capacity, and de-watering capabilities. See Temporary Sediment Basin

Inspection and Maintenance: Inspect temporary sediment traps after each period of significant rainfall (1" in 24 hours). Remove sediment and restore the trap to its original dimensions when the sediment has accumulated to one-half the design depth of the trap. Place the sediment removed to an area that can be stabilized and not allow transport of the spoils off-site.

After all sediment-producing areas have been permanently stabilized, remove the structure and all unstable sediment. Smooth the area to blend with the adjoining areas and stabilize properly. If sediment traps and excavations have been paved over but there is still a risk of sediment entering the storm drains, then Curb and Drop Inlet Sediment Barriers should be installed.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA adapted from Erosion and Sediment Control Handbook by Goldman, Jackson, and Bursztynsky

STANDARD

STRAW BALE DIKE

Definition: A straw bale dike is a temporary barrier consisting of straw bales installed across a slope, at the toe of a slope, and/or around the perimeter of the construction site.

Purpose: A straw bale dike intercepts and detains small amounts sediment transported by sheet flow type runoff. The dikes detain sediment by ponding water and allowing sediment to settle out. Straw bale dikes also slow runoff velocities, thus reducing sheet and rill erosion. Straw bale dikes are also useful for erosion and sediment control around the perimeter of a construction site. Straw bale dikes may be used where the following conditions apply:

- The area draining to the barrier is 1 acre or less
- The maximum slope gradient behind the barrier is 2:1
- The maximum slope length above the barrier is 100 ft
- Sheet and rill erosion would occur

Design Considerations: A formal design is not required. The bales are to be placed along the slope contour or at the toe of the slope. The principal mode of action is to pond water and allow particles to settle. Straw bale dikes are not designed to withstand high heads of water, therefore they should be located where shallow pools can form and the bales do not always need to be anchored. The straw bales are either wire-bound or nylon string tied. Wire-bound bales may deteriorate rapidly if the wire is placed in contact with the soil. Straw bales have a useful life of less than 6 months, however, the life is extended when used with filter fabric.

Construction Standards:

1. The bales shall be placed on the slope contour or around the perimeter of the construction site. If the dike is constructed at the toe of a slope, place it 5 to 6 ft away from the slope if possible (see detail).

2. Do not construct the dike more than one bale high.

3. Bales shall be placed in a row with the ends tightly abutting.

4. Each bale shall be embedded in the soil a minimum of 4-inches. Use straw, rocks, or filter fabric to fill any gaps between the bales and tamp the backfill material to prevent erosion under or around the bales.

5. If the bales are wire bound, they should be oriented so the bindings are around the sides rather than along the top and bottom. Wire bindings that are placed in contact with the soil soon disintegrate and may allow the bale to fall apart.

6. The bales shall be securely anchored in place by two wooden stakes or rebar driven through the bales. The first stake in each bale shall be driven toward the previously laid bale to force the bales tightly together. Drive the stakes at least 18 inches into the ground.

7. The straw bales do not need to be anchored if the following conditions apply:

   - the slope has a gradient of less than 5%,
   - the slope length is less than 100 feet,
   - the bales are properly embedded, and
   - the straw bale dike is inspected regularly, the trapped sediment is removed when required, and repairs are made promptly.

   or

   - if the bales are to be removed and replaced daily to facilitate construction.

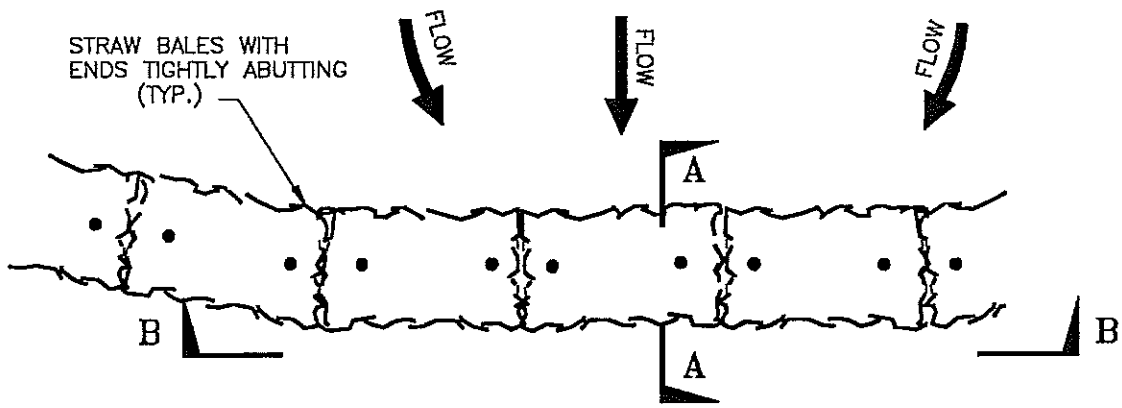
Inspection and Maintenance: The straw bale dikes shall be inspected periodically during the winter and after each significant storm (1" in 24 hr). Repairs and/or replacement shall be made promptly. Remove the straw bales when the upslope areas have been permanently stabilized.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA; Adapted from Erosion and Sediment Control Handbook by Goldman, Jackson, and Bursztynsky

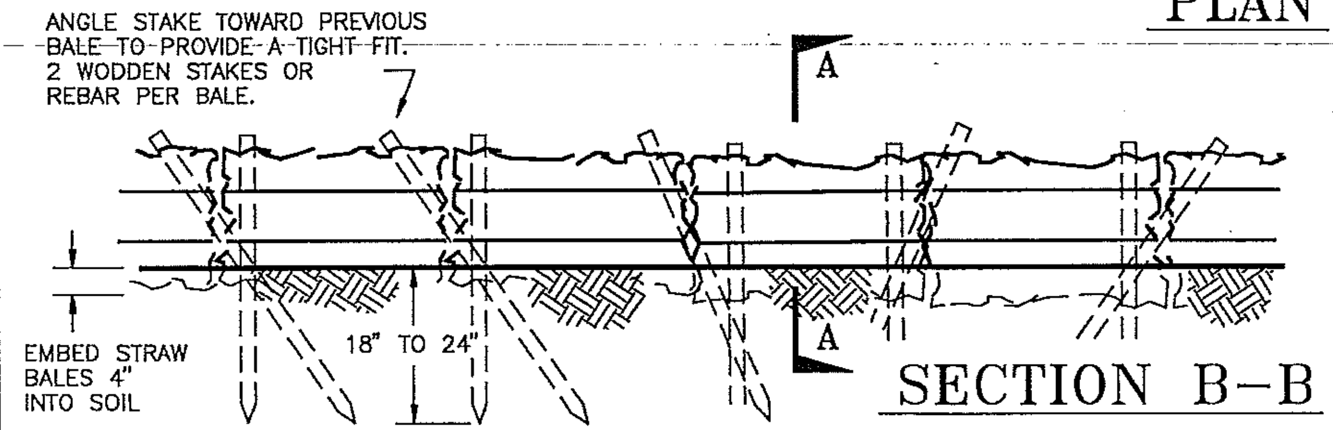
STD. NO.
EC-4

NOTE:

BALES TO BE PLACED IN A ROW WITH THE ENDS TIGHTLY ABUTTING. USE STRAW, ROCKS, OR FILTER FABRIC TO FILL GAPS BETWEEN THE BALES AND TAMP THE BACKFILL MATERIAL TO PREVENT EROSION OR FLOW AROUND BALES.



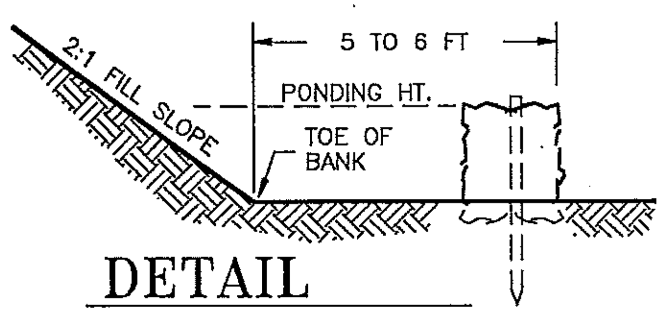
PLAN



SECTION B-B

NOTES:

1. EMBED BALES 4" INTO THE SOIL.
2. THE STRAW BALES SHALL BE PLACED ON SLOPE CONTOURS OR AROUND THE PERIMETER OF THE SITE.
3. IF BALES ARE WIRE BOUND, THEY SHALL SHALL BE ORIENTATED SO THE BINDINGS ARE AROUND THE SIDES RATHER THAN THE TOP AND BOTTOM OF BALE TO PREVENT BINDINGS FROM RUSTING FROM CONTACT WITH THE SOIL.
4. IF DIKE IS CONSTRUCTED AT TOE OF SLOPE, PLACE IT 6 FT. MIN. AWAY FROM THE SLOPE IF POSSIBLE (SEE DETAIL)



DETAIL

WHEN PLACED AT TOE OF SLOPE

DWG DATE 7-89		SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
			APPROVED BY	STRAW BALE DIKE
MARK	DATE	REVISION	DIRECTOR OF PUBLIC WORKS	

STANDARD

STRAW BALE SEDIMENT BARRIERS

Definition: A straw bale sediment barrier is a temporary barrier consisting of straw bales placed across small drainages or gently sloping swales.

Purpose: Straw bale sediment barriers are intended to intercept and detain small amounts of sediment while allowing runoff to flow through or over the barrier. The barriers also slow runoff velocities thus reducing channel erosion downslope. Straw bale sediment barriers may be used where the following conditions apply:

- The drainage area is 1 acre or less
- The maximum slope gradient for the swale above the barrier is 2:1
- The maximum slope length above the barrier is 100 feet
- Less than 1 ft^3/sec flow

Design Considerations: The straw bales are either wire-bound or nylon-string tied. Wire-bound bales may deteriorate rapidly if the wire is placed in contact with the soil. Straw bales have a useful life of less than 6 months, however the life is extended when used with filter fabric. Design considerations should include the following:

- drainage area;
- runoff velocities;
- secure installation;
- compatibility with existing topography;
- spillways or energy dissipators;
- use of extraneous materials such as rocks and/or filter fabric;
- accessibility for maintenance, repairs, and cleaning.

Construction Standards:

1. Place bales in a single row, lengthwise, oriented perpendicular to the flow, and with ends of adjacent bales tightly abutting one another.
2. Each bale shall be embedded in the soil a minimum of 4 inches. Use straw, rocks, or filter fabric to fill any gaps between the bales and tamp the backfill material to prevent erosion under or around the bales.
3. The barriers shall not be constructed more than one bale high (24-inch maximum height).

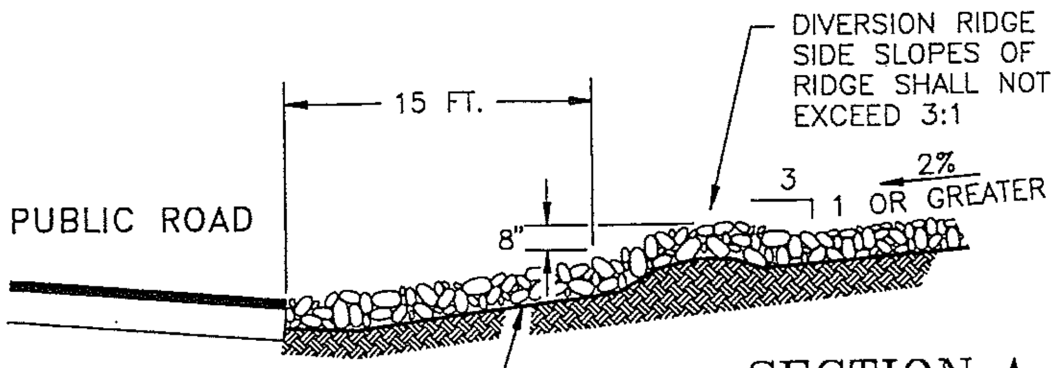
4. If the bales are wire bound, they should be oriented so the bindings are around the sides rather than along the top and bottom. Wire bindings that are placed in contact with the soil soon disintegrate and may allow the bale to fall apart.

5. The bales shall be securely anchored in place by two wooden stakes or rebar driven through the bales. The first stake in each bale shall be driven toward the previously laid bale to force the bales tightly together. Drive the stakes at least 18 inches into the ground. Proper staking is particularly important in channel flow applications.

6. Extend the barrier, across the swale, to such a length that the bottoms of the end bales are at a higher elevation than the top of the lowest middle bale (spillway) to assure that sediment-laden runoff will flow either through or over the barrier but not around it (see detail). Rock and/or filter fabric placed over and immediately downstream of the middle bale will dissipate the energy of the falling water and reduce downstream erosion.

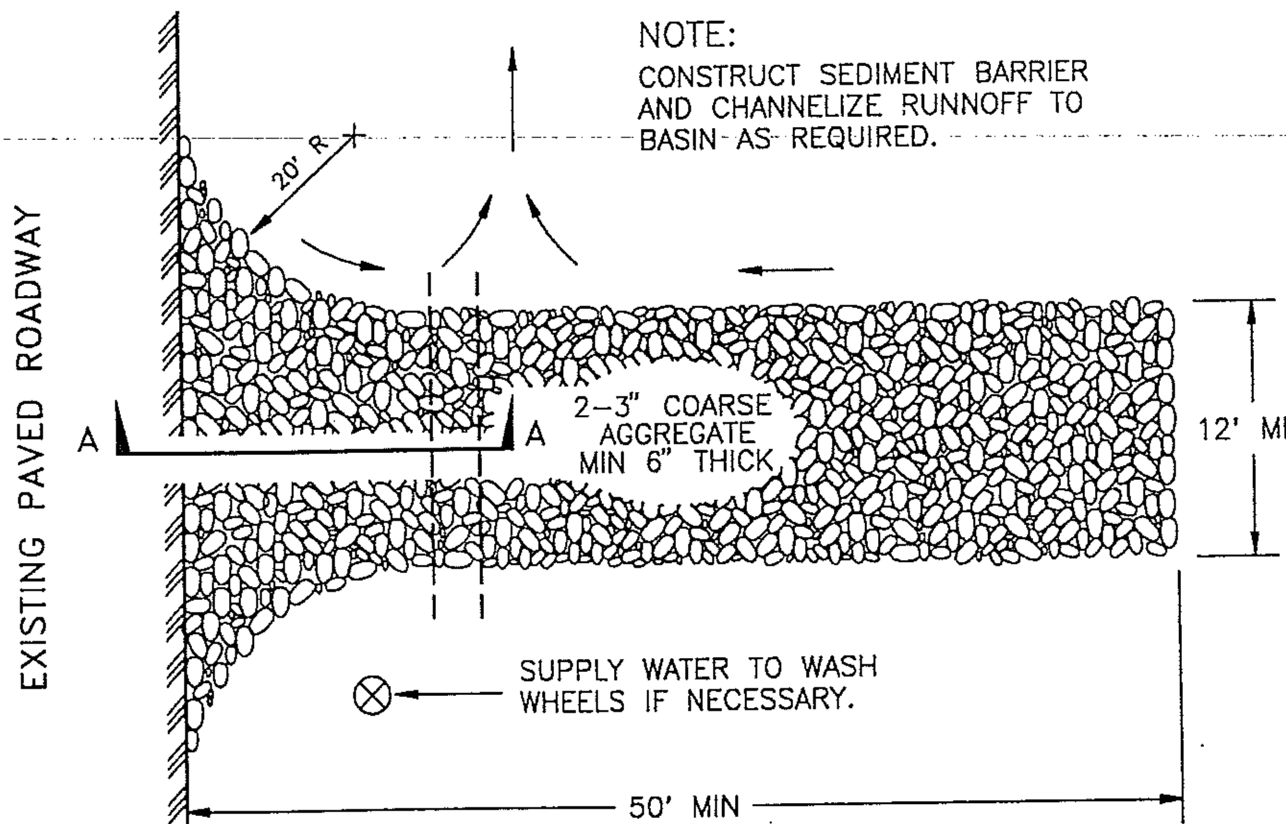
Inspection and Maintenance: The straw bale barriers shall be inspected periodically during the winter and after each significant storm (1" in 24 hr). Repairs and/or replacement shall be made promptly. Sediment shall be removed when the barrier is 60% full. This sediment shall be placed in an area where it will not re-enter the barrier or a waterway, and then be stabilized. Remove the straw bales when the upslope areas have been permanently stabilized.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA; Adapted from Manual of Standards for Erosion and Sediment Control Measures—Association of Bay Area Governments (ABAG); Erosion and Sediment Control Handbook by Goldman, Jackson, and Bursztynsky



SECTION A–A

DIVERSION RIDGE
WHERE GRADE
EXCEEDS 2%



PLAN

DWG DATE 7–89	SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
		APPROVED BY	TEMPORARY GRAVEL CONSTRUCTION ENTRANCE/EXIT
MARK / DATE	REVISION	DIRECTOR OF PUBLIC WORKS	

SEMI-PERVIOUS SEDIMENT BARRIERS

Definition: A semi-pervious sediment barrier is a temporary barrier consisting straw bales and a rock semi-pervious spillway placed across small drainages or gently sloping swales.

Purpose: Semi-pervious straw bale sediment barriers are intended to intercept and detain small amounts of sediment while allowing runoff to flow through or over the barrier. These barriers are suited for small channel flow situations. The semi-pervious sediment barriers can be used in situations having expected flows that are larger than those appropriate for **Straw Bale Barriers**.

The rock size can be enlarged to accommodate the larger flows. Since the rock is more permeable these structures do not restrict flows. The barriers also slow runoff velocities thus reducing channel erosion downslope. Semi-pervious straw bale sediment barriers may be used where the following conditions apply:

- The drainage area is 1 acre or less
- The maximum slope gradient for the swale above the barrier is 2:1
- The maximum slope length above the barrier is 100 ft
- Less than 2 ft^3/sec flow

Design Considerations: The straw bales are either wire-bound or nylon string tied. Wire-bound bales may deteriorate rapidly if the wire is placed in contact with the soil. Straw bales have a useful life of less than 6 months, however the life is extended when used with filter fabric. If used, the filter fabric should cover the bales, be enveloped in the rock at the spillway in order to better filter out fine soil particles, and extend beyond the spillway to act as an energy dissipator. Design considerations should include the following:

- drainage area;
- runoff velocities;
- secure installation;
- compatibility with existing topography;
- spillways or energy dissipators;
- use of extraneous materials such as rocks and/or filter fabric;
- accessibility for maintenance, repairs, and cleaning.

Construction Standards:

1. The rock spillway shall be constructed of graded drain rock,1 1/2" minimum, that is sized according to expected flows. Filter fabric

may be used to cover the bales and be enveloped in the rock spillway. Filter fabric will greatly increase the useful life of the barrier (1 year).

2. The rock spillway shall be constructed to a height of 2/3 that of the straw bales.
   a. The maximum height of the spillway shall be 2 feet.
   b. Place bales in a single row, lengthwise, oriented perpendicular to the flow, and with ends of adjacent bales tightly abutting one another.

2. Each bale shall be embedded in the soil a minimum of 4 inches. Use straw, rocks, or filter fabric to fill any gaps between the bales and tamp the backfill material to prevent erosion under or around the bales.

3. If the bales are wire bound, they should be oriented so the bindings are around the sides rather than along the top and bottom. Wire bindings that are placed in contact with the soil soon disintegrate and may allow the bale to fall apart.

4. The bales shall be securely anchored in place by two wooden stakes or rebar driven through the bales. The first stake in each bale shall be driven toward the previously laid bale to force the bales tightly together. Drive the stakes at least 18 inches into the ground. Proper staking is particularly important in channel flow applications.

5. Extend the barrier, across the swale, to such a length that the bottoms of the end bales are at a higher elevation than the top of the rock spillway to assure that sediment-laden runoff will flow either through or over the barrier but not around it (see detail). Rock and/or filter fabric placed immediately downstream of the rock spillway will dissipate the energy of the falling water and reduce downstream erosion.

Inspection and Maintenance: The semi-pervious straw bale barriers shall be inspected periodically during the winter and after each significant storm (1" in 24 hr). Repairs and/or replacement shall be made promptly. Sediment shall be removed when the barrier is 60% full. The removed sediment shall be deposited in an area that will not contribute sediment off-site and can be permanently stabilized. Remove the straw bales and rock when the upslope areas have been permanently stabilized.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA; Adapted from Manual of Standards for Erosion and Sediment Control Measures—Association of Bay Area Governments (ABAG); Erosion and Sediment Control Handbook by Goldman, Jackson, and Bursztynsky

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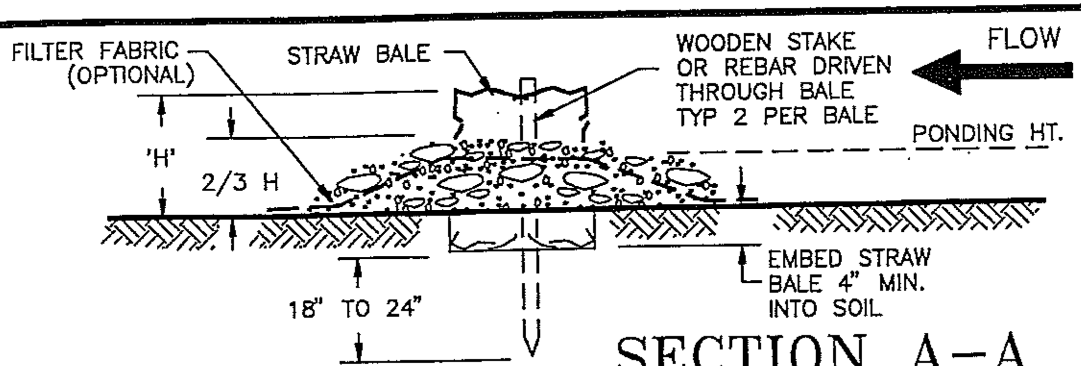
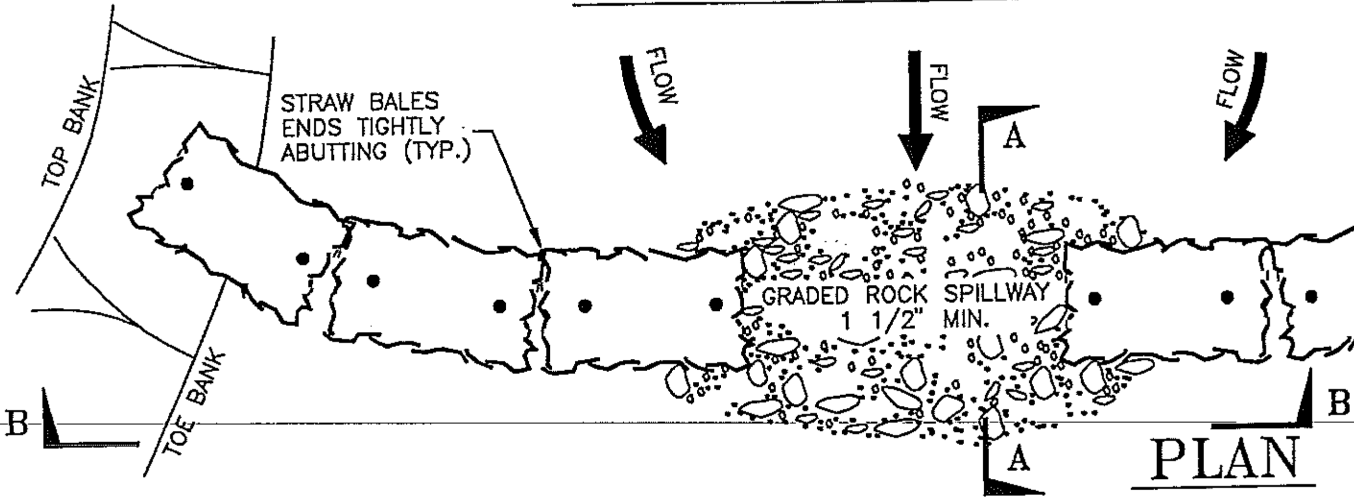
STD. NO.
EC-3

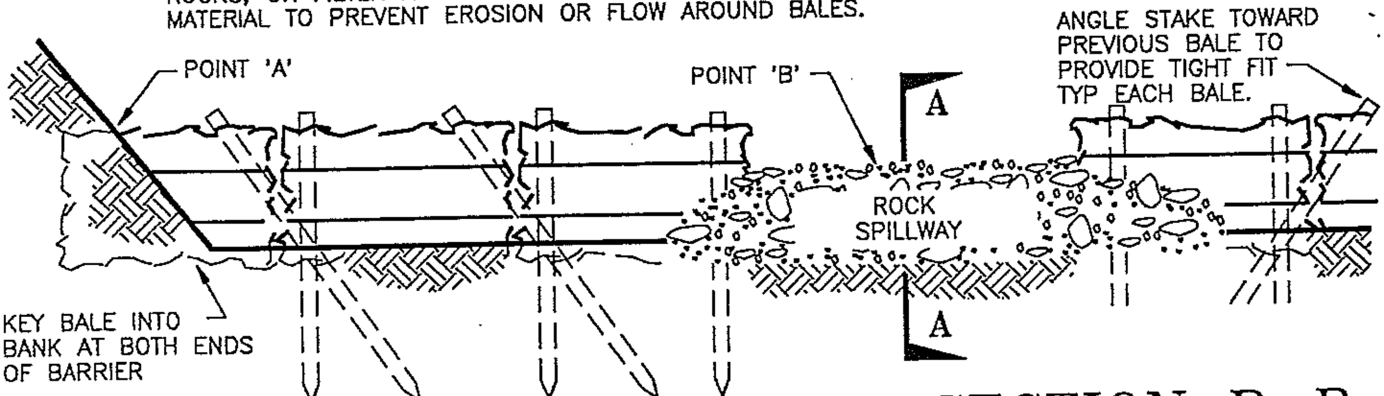


SECTION A-A



PLAN

NOTE:
BALES TO BE PLACED IN A ROW WITH THE ENDS TIGHTLY ABUTTING. USE STRAW, ROCKS, OR FILTER FABRIC TO FILL GAPS BETWEEN THE BALES AND TAMP THE MATERIAL TO PREVENT EROSION OR FLOW AROUND BALES.



SECTION B-B

NOTES:

1. EMBED THE BOTTOM OF THE BALES 4" INTO THE SOIL AND KEY END BALES INTO BANK AT EACH END.
2. THE STRAW BALES SHALL BE PLACED PERPENDICULAR TO FLOW.
3. POINT 'A' SHALL BE HIGHER THAN POINT 'B'.
4. IF BALES ARE WIRE BOUND, THEY SHALL BE ORIENTED SO THE BINDINGS ARE AROUND THE SIDES RATHER THAN ALONG THE TOP AND BOTTOM OF THE BALE TO PREVENT BINDINGS FROM RUSTING FROM CONTACT WITH THE SOIL.
5. SPILLWAY HEIGH SHALL NOT EXCEED 24 INCHES.
6. INSPECT BARRIER AFTER EACH SIGNIFICANT STORM (1" IN 24 HOURS). MAINTAIN AND REPAIR PROMPTLY.
7. REMOVE SEDIMENT WHEN BASIN IS 60% FULL.

DWG DATE 7-89		SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
			APPROVED BY	SEMI-PERVIOUS STRAW BALE SEDIMENT BARRIER
MARK	DATE	REVISION	DIRECTOR OF PUBLIC WORKS	WITH SAND AND GRAVEL SPILLWAY

STANDARD

ROCK, LOG, AND STRAW BALE CHECK DAMS

Definition: A check dam is a small temporary dam constructed across a swale, gully, or drainageway.

Purpose: A check dam is used to protect a drainage channel from erosion by reducing the velocity of flow. A check dam will trap and store larger-sized particles but it is not intended to be a sediment-trapping device. A check dam is a grade stabilization structure that can be used temporarily until the drainageway is permanently stabilized. Check dams should **not** be used in small streams. The following conditions apply:

- the drainage area is less than 2 acres
- the drainageway is not a perennial stream.

Since these structures are located in watercourses, take special precautions to prevent erosion and sedimentation during construction of the structures. Permits may be required from the state Fish and Game.

Design Considerations: An engineered design is not required. Check dams are an expedient way to reduce gullying in the bottom of channels that will be stabilized or filled at a later date. It is usually better to line the channel or divert the flow to stabilize the channel than to install check dams. If these alternatives are not feasible, then check dams are very helpful.

Design Criteria: The following criteria shall be used when designing a check dam:

- Ensure that the drainage area is less than 2 acres
- The maximum height of the check dam center shall be 2 ft.
- The center of the check dam shall be 6 inches lower than the outer edges.
- Stabilize the overflow areas along the channel to resist erosion caused by the check dam by extending rock spillways and/or building more check dams such that the maximum spacing between dams places the toe of the upstream dam dam at the same elevation as the top of the downstream dam (see detail).
- Obtaining appropriate permits and approvals for working in a stream channel, if necessary.

Construction Standards:

1. Obtain appropriate permits or approvals from California Department of Fish and Game.

2. The check dam must be centered in the drainageway so that flows will not go around the ends.

3. The maximum spacing between the dams shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam. (See sample drawing)

4. Rock dams shall be constructed of 2-to 15-inch rock. Keep the center rock section at least 6 inches lower than the outer edges, where the rock dam meets the natural channel edge. Extend the abutments 18" into the channel bank. Hand or mechanical placement will be necessary to achieve complete coverage and insure that the center is lower than the outer edges.

5. Log check dams shall be constructed of 4- to 6-inch logs that are salvaged from the site, if possible. The logs shall be embedded into the soil at least 18 inches. The center must be 6 inches lower than the outer edges. (See sample drawing)

6. Straw bale check dams shall be constructed as follows:

    a. Bales shall be placed in a single row, lengthwise, oriented perpendicular to the flow, with the ends of adjacent bales tightly abutting one another.

    b. The dam shall be extended to such a length that the bottoms of the end bales are higher in elevation than the top of the lowest middle bale spillway to insure that sediment-laden runoff will flow either through or over the barrier, but not around it.

    c. Each bale shall be embedded in the soil a minimum of 4 inches. Use straw, rocks, or filter fabric to fill any gaps between the bales and tamp the backfill material to prevent erosion under or around the bales.

    d. If the bales are wire bound, they should be oriented so the bindings are around the sides rather than along the top and bottom. Wire bindings that are placed in contact with the soil soon disintegrate and may allow the bale to fall apart.

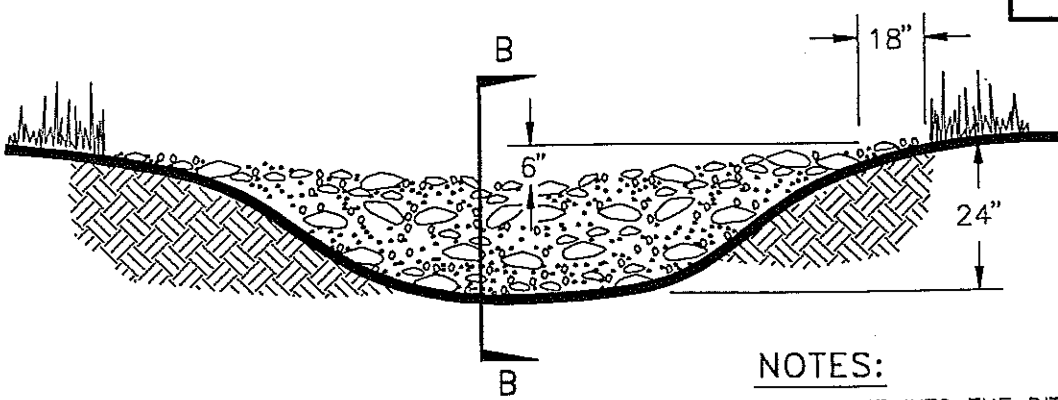
e. The bales shall be securely anchored in place by two wooden stakes or rebar driven through the bales. The first stake in each bale shall be driven toward the previously laid bale to force the bales tightly together. Drive the stakes at least 18 inches into the ground. Proper staking is particularly important in channel flow applications.

f. Rock and/or filter fabric placed immediately downstream of the spillway will dissipate the energy of the falling water and reduce downstream erosion.

Inspection and Maintenance: The check dams shall be inspected for damage periodically during the winter and after each significant storm (1" in 24 hours) Prompt repairs shall shall be made to ensure that center of the dam is lower than the edges and any erosion caused by flows around the edges of the dam shall be corrected immediately.

Remove sediment from behind the dams when they become 60% full, or as needed, to prevent damage to channel vegetation, and to allow the channel to flow through the check dam, and to prevent high flows from carrying sediment over the dam. The removed sediment shall be deposited in an area that will not contribute sediment off-site and can be permanently stabilized.

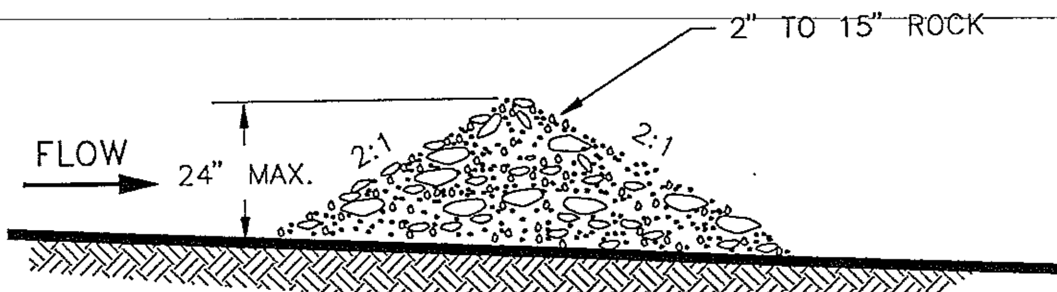
Source: Manual of Standards for Erosion and Sediment Control Measures—Association of Bay Area Governments (ABAG) and John McCullah, C.P.E.S.C, #311, Redding, CA, and Erosion and Sediment Control Handbook by Goldman, Jackson, and Bursztynsky



VIEW LOOKING UPSTREAM

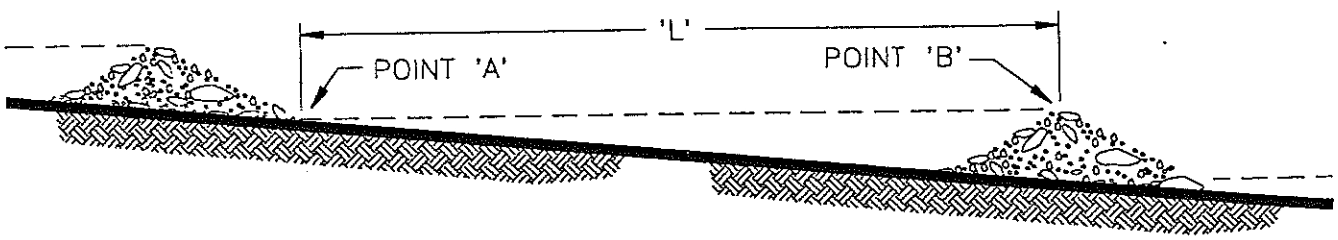
NOTES:

KEY STONE INTO THE DITCH BANKS AND EXTEND IT BEYOND THE ABUTMENTS A MINIMUM OF 18" TO PREVENT OVER FLOW AROUND DAM.



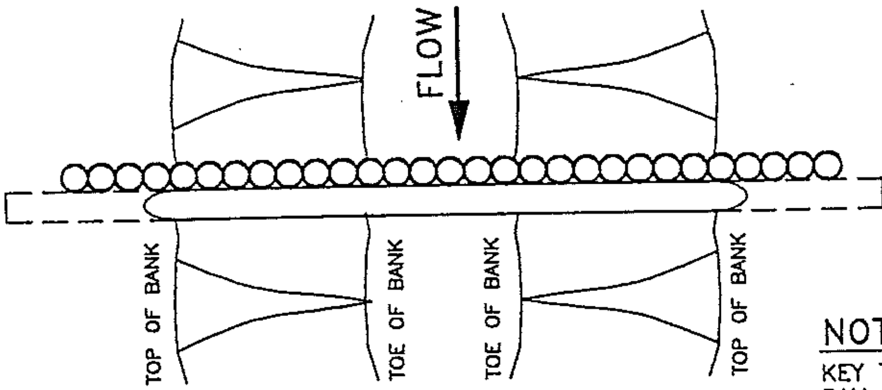
SECTION B-B

'L' = THE DISTANCE SUCH THAT POINTS 'A' AND 'B' ARE OF EQUAL ELEVATION



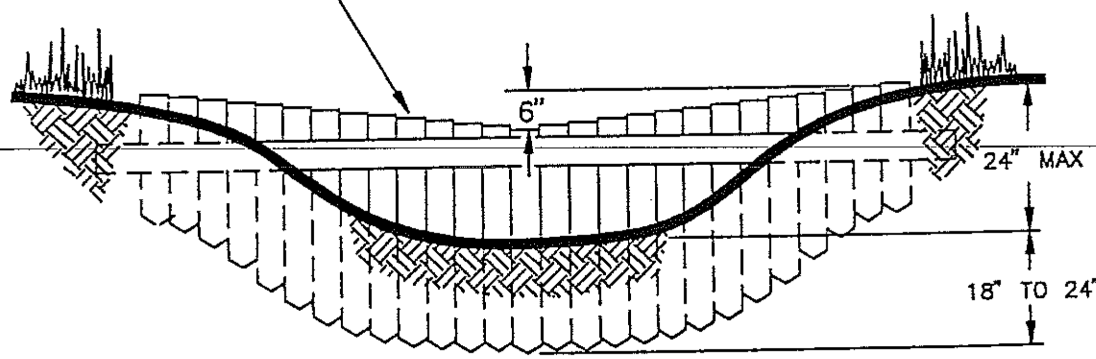
SPACING BETWEEN CHECK DAMS

DWG DATE 7-89	SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
		APPROVED BY	ROCK CHECK DAM
MARK | DATE	REVISION	DIRECTOR OF PUBLIC WORKS	



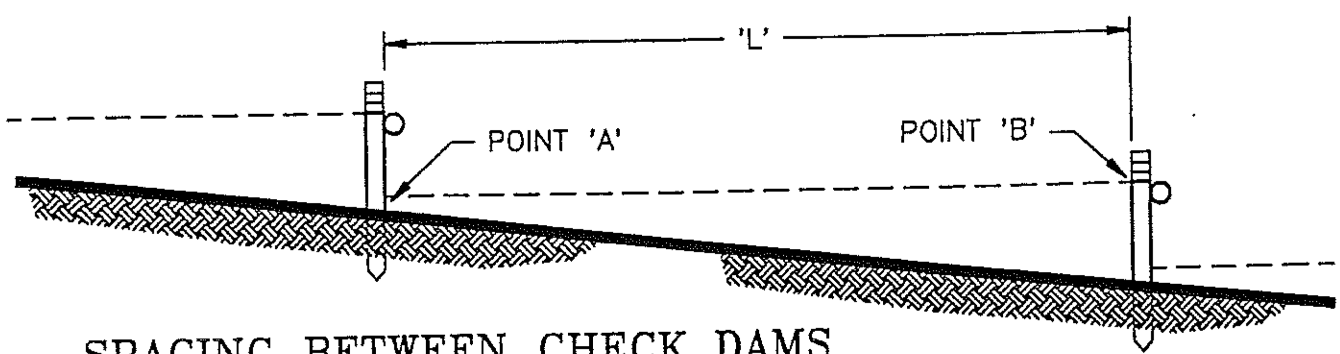
PLAN VIEW

NOTE:
KEY THE ENDS OF THE CHECK DAM INTO THE CHANNEL BANK
LOGS SHALL BE PRESSURE TREATED IF GRADE STABILIZATION STRUCTURE IS INTENDED TO BE PERMANENT.



VIEW LOOKING UPSTREAM

'L' = THE DISTANCE SUCH THAT POINTS 'A' AND 'B' ARE OF EQUAL ELEVATION



SPACING BETWEEN CHECK DAMS

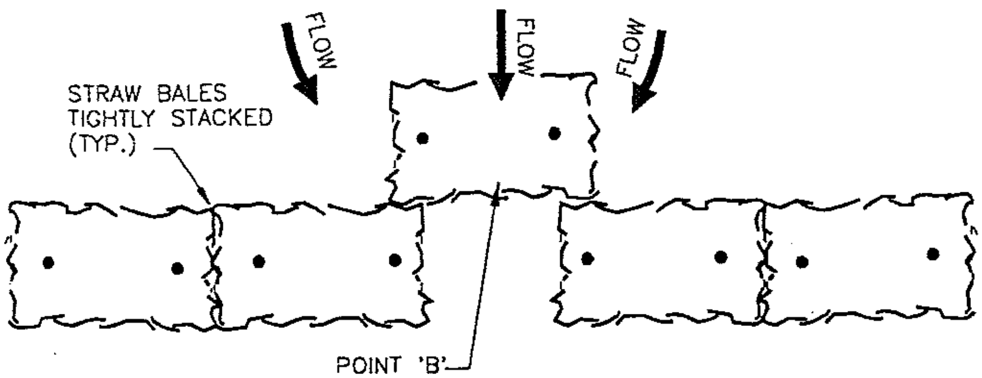
DWG DATE 7-89		SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
			APPROVED BY	LOG CHECK DAM
MARK	DATE	REVISION	DIRECTOR OF PUBLIC WORKS	

PAGE XXX.XX

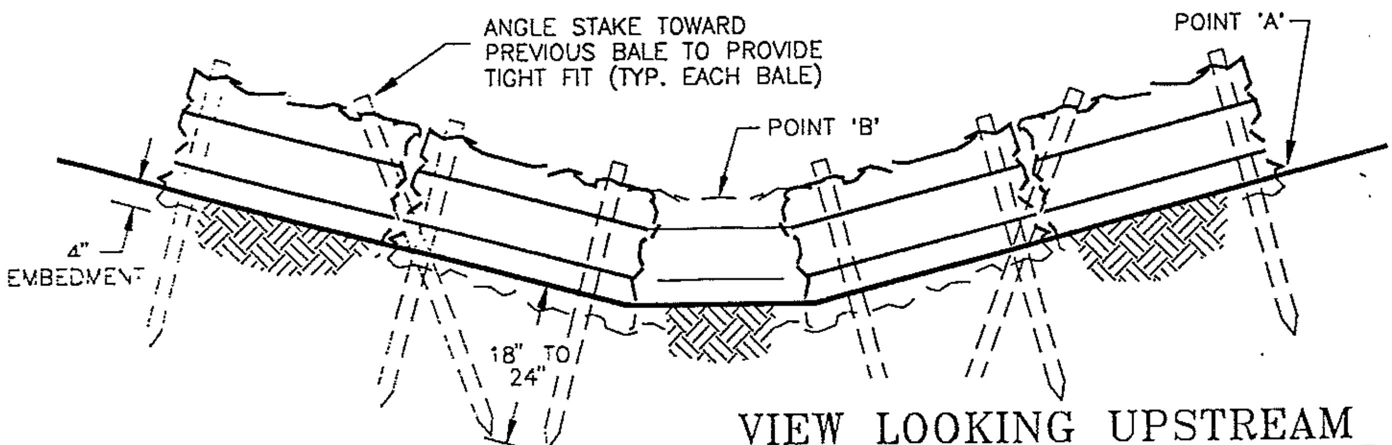
STD. NO. EC-7

NOTE:

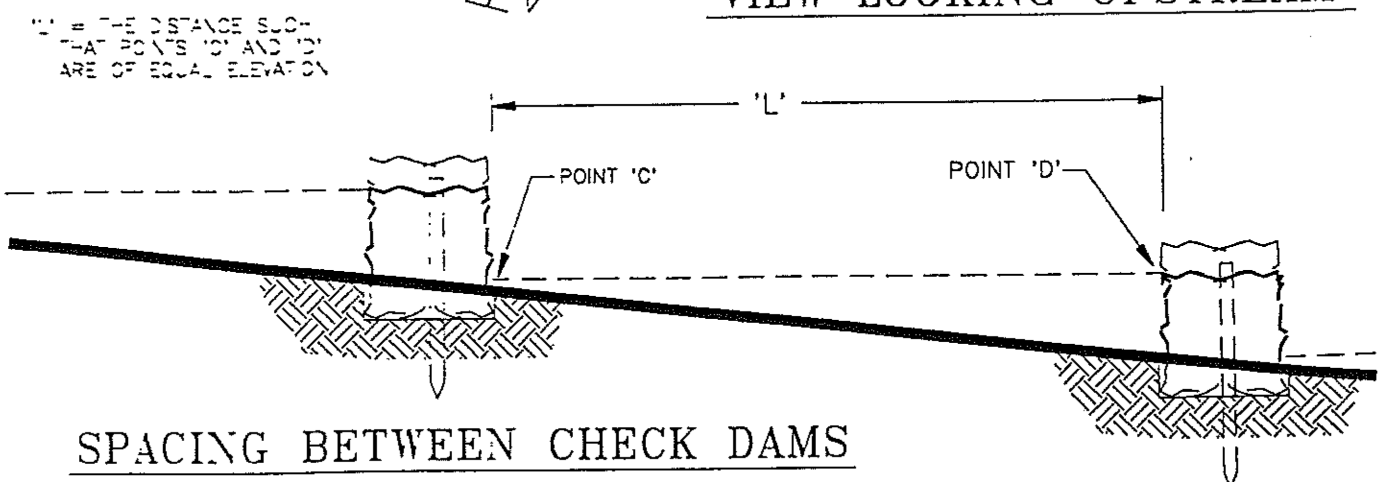
1. EMBED THE BOTTOM OF THE BALES 4" INTO THE SOIL AND KEY BALES INTO BANK AT EACH END.
2. BALES TO BE PLACED IN A ROW WITH THE ENDS TIGHTLY ABUTTING. USE STRAW, ROCKS, OR FILTER MATERIAL TO FILL GAPS BETWEEN BALES AND TAMP THE BACKFILL MATERIAL TO PREVENT EROSION OR FLOW AROUND BALES.
3. IF BALES ARE WIRE BOUND, THEY SHALL BE ORIENTATED SO THAT THE BINDINGS ARE AROUND THE SIDES RATHER THAN THE TOP AND BOTTOM OF THE BALE TO PREVENT BINDINGS FROM RUSTING FROM CONTACT WITH THE SOIL.
4. EMBED BALES 4" INTO SOIL AND KEY BOTH ENDS INTO BANK.
5. SPILLWAY HEIGHT NOT TO EXCEED 24 INCHES.
6. INSPECT AFTER EACH SIGNIFICANT STORM (1" IN 24 HOURS). MAINTAIN AND REPAIR PROMPTLY.
7. REMOVE SEDIMENT WHEN BASIN IS 60% FULL.



PLAN



VIEW LOOKING UPSTREAM



SPACING BETWEEN CHECK DAMS

DWG DATE 7-89	SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
		APPROVED BY	STRAW BALE CHECK DAM
MARK	DATE	REVISION	DIRECTOR OF PUBLIC WORKS

SILT FENCE

Definition: A silt fence is a temporary sediment barrier placed on the slope contours, consisting of filter fabric and wire mesh attached to supporting posts and entrenched. Extra-strength filter fabrics do not require wire mesh but they do require closer spacing of the support posts.

Purpose: A silt fence detains sediment by ponding water behind it and allowing sediment to settle out. They may be used to divert sediment-laden water if placed slightly off the contour. It can be used where:

- sheet and rill erosion would occur;
- protection of adjacent property or areas beyond the limits of grading is needed (perimeter control);
- the size of the drainage area is no more than 1/4 acre per 100 linear feet of silt fence.;
- the maximum flow path length behind the barrier is 100 feet;
- the maximum slope gradient behind the barrier is 2:1;
- small swales are carrying silt, the slope is less than 2%, and the drainage area is less than 2 acres;
- no practice other than a silt fence is feasible.

Design Considerations: No formal design is required. Silt fences have a useful life of one season. Their principal mode of action is to slow and pond the water and allow particles to settle. Silt fences are not designed to withstand high heads of water, therefore they should be located where only shallow pools can form. Their use is limited to situations in which sheet or overland flows are expected.

Silt fences should be placed on contour to be most effective. Site perimeters and property boundaries rarely follow slope contour. If silt fences are placed along property boundaries, water may be diverted to the low point and failure may occur.

Silt fences normally cannot filter the volumes generated by channel flows. When installed across a concentrated flow path, undercutting of the fence often occurs. Silt fences should **not** be designed to impound sediment or water more than 18" high. Sediment shall be cleaned from behind the fence when it reaches 50% of the designed impoundment height (9").Design considerations include:

- type, size and spacing of fence posts;
- type of filter cloth;
- size of woven wire support fence if required;
- method of anchoring filter cloth.

Construction Standards:

1. The height of a silt fence shall not exceed 36 inches. Storage height shall never exceed 18". On slopes, the fence line shall follow the contour as closely as possible.

2. If possible, the filter fabric shall be cut from a continuous roll to avoid the use of joints. When joints are necessary, filter cloth shall be spliced only at a support post, with a minimum 6-inch overlap and both ends securely fastened to the post.

3. Posts shall be spaced a maximum of 10 feet apart and driven securely into the ground (minimum of 12 inches). When extra-strength fabric is used without the wire support fence, post spacing shall not exceed 6 feet.

4. A trench shall be excavated approximately 4 inches wide and 6 inches deep along the line of posts and upslope from the barrier.

5. When standard-strength filter fabric is used, a wire mesh support fence shall be fastened securely to the upslope side of the posts using heavy duty wire staples at least 1 inch long, tie wires or hog rings. The wire shall extend into the trench a minimum of 2 inches and shall not extend more than 36 inches above the original ground surface.

6. The standard-strength filter fabric shall be stapled or wired to the fence, and 6 inches of the fabric shall extend into the trench. The fabric shall not extend more than 36 inches above the original ground surface. Filter fabric shall not be stapled to existing trees.

7. When extra-strength filter fabric and closer post spacing are used, the wire mesh support fence may be eliminated. In such a case, the filter fabric is stapled or wired directly to the posts with all other provisions of No. 6 above applying.

8. The trench shall be backfilled and the soil compacted over the toe of the filter fabric.

9. Silt fences placed at the toe of a slope shall be set at least 6 feet from the toe in order to increase ponding volume.

10. Silt fences shall be removed when they have served their useful purpose, but not before the upslope area has been permanently stabilized.

Inspection and Maintenance:

1. Silt fences and filter barriers shall be inspected immediately after each significant storm (1" in 24 hr.) and at least daily during prolonged rainfall. Any required repairs shall be made immediately.

2. Should the fabric on a silt fence or filter barrier decompose or become ineffective prior to the end of the barrier's expected usable life and the barrier still be necessary, the fabric shall be replaced promptly.

3. Remove sediment deposits as necessary to provide adequate storage volume for the next rain and reduce pressure on the fence. Sediment deposits should be removed when they reach a height of 9 inches. The removed sediment shall be deposited in an area that will not contribute sediment off-site and can be permanently stabilized.

4. Any sediment deposits remaining in place after the silt fence or filter barrier is no longer required shall conform with the existing grade and be vegetated or otherwise stabilized.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA.:adapted from North Carolina Erosion and Sediment Control Planning and Design Manual and Manual of Standards for Erosion and Sediment Control Measures—Association of Bay Area Governments (ABAG)

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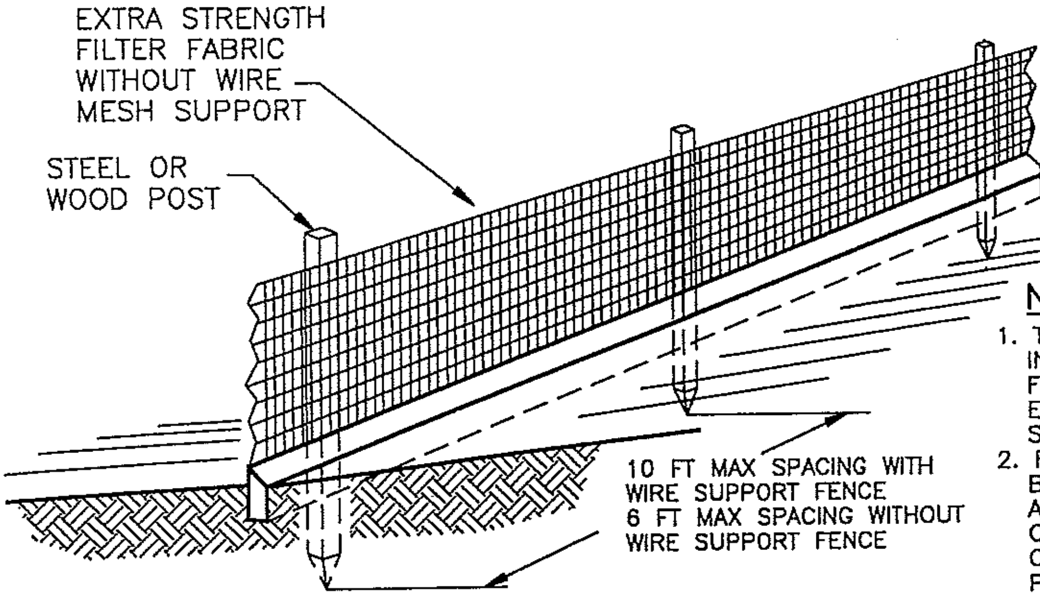
STD. NO.

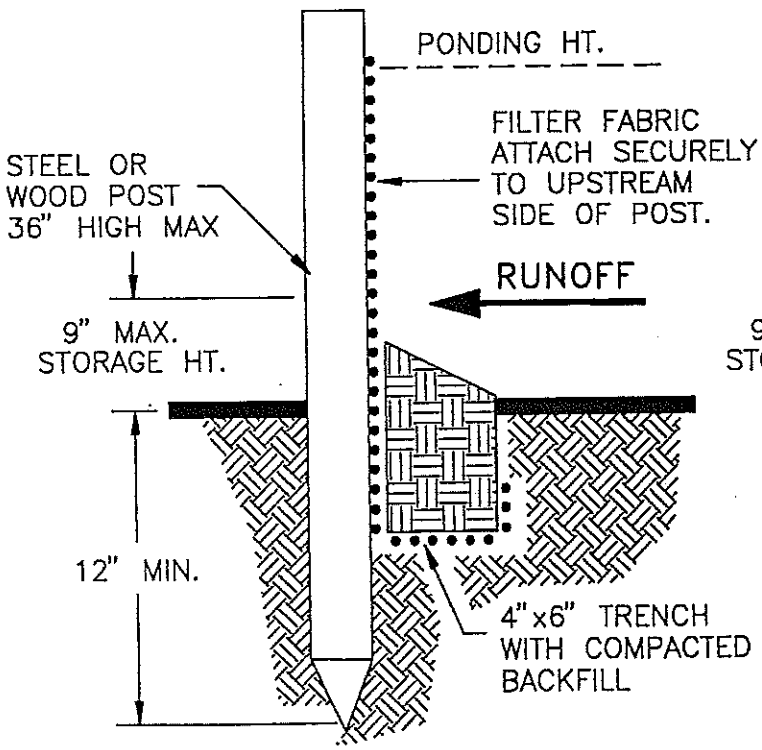
EC-9

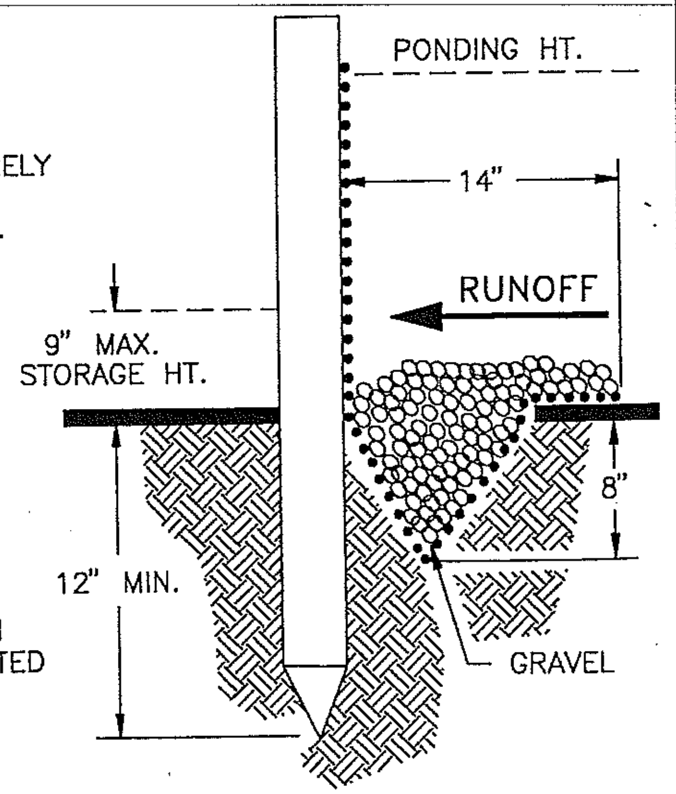


FLOW

NOTE:

1. THE CONTRACTOR SHALL INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY.
2. REMOVED SEDIMENT SHALL BE DEPOSITED TO AN AREA AREA THAT WILL NOT CONTRIBUTE SEDIMENT OFF-SITE AND CAN BE PERMANENTLY STABILIZED.
3. SILT FENCE SHALL BE PLACED ON SLOPE CONTOURS TO MAXIMUM PONDING EFFICIENCY.





STD. DETAIL

TRENCH WITH NATIVE BACKFILL

ALT. DETAIL

TRENCH WITH GRAVEL

DWG DATE 7-89		SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
			APPROVED BY	SILT FENCE
MARK	DATE	REVISION	DIRECTOR OF PUBLIC WORKS	

DROP INLET SEDIMENT BARRIERS

Definition: A drop inlet sediment barrier is a temporary barrier placed around a drop inlet. The sediment barrier may be constructed of straw bales and gravel, gravel and stone, block and gravel, or silt fence material.

Purpose: To prevent sediment from entering the storm drains during construction operations. This practice allows early use of the storm drain system and is applicable for the phased construction schedule of a wet weather plan. Sediment-laden runoff is ponded before entering the storm drain, thus allowing some sediment to fall out of suspension.

Design Considerations: A straw bale drop inlet sediment barrier can be used where the inlet is intended to drain a relatively flat disturbed area (slopes no less than 5 %) in which runoff is low—less than 0.5 ft^3/sec) occurs. Barriers of this type should **not** be placed around inlets receiving concentrated flows such as those along major streets or highways. This practice must not be used near the edge of fill material and must not divert water over cuts or fills.

Drainage area is 1 acre maximum. The ponding area shall be relatively flat (less than 1%) with sediment storage of 35 cubic yard/acre disturbed.

As an optional design, the straw bales may be omitted and the entire structure made of gravel and stone. A structure made entirely of stone is commonly called a "gravel doughnut" The top elevation of the structure must be at least 6 inches lower than the ground elevation downslope from the inlet. It is important that all storm flows pass over the structure and into the storm drain, and not past the structure. Temporary diking below the structure may be necessary to prevent bypass flow. Material may be excavated from inside the sediment pool for this purpose.

Construction Standards:

1. Excavate a 4-inch deep trench around the inlet and make the trench as wide as a straw bale.in order to embed the bales properly. If silt fence is used, embed fabric 12" minimum.

2. Orient straw bales with the bindings around the sides of the bales rather than over and under the bales so the wire does not come in contact with the soil.

3. Place bales lengthwise around the inlet and press the ends of adjacent bales together. The bales may be loosely joined and more gravel utilized if heavier sheet flows are expected.

4. Drive two 2-by 2-inch stakes through each bale to anchor the bale securely in place.

5. Support posts for silt fence must be steel fence posts or 2- by 4-inch wood, length 3' minimum, spacing 3' maximum, with a top frame support recommended. (See detail)

6. Height of the silt fence shall be 1.5' maximum, 1' minimum, measured from the top of the inlet.

7. Backfill the excavated soil and compact it against the bales. Crushed rock (4" minimum) or compacted soil (12' minimum) is required backfill for silt fences.

8. Utilize 3/4" to 2" gravel to fill the void spaces between the bales if necessary to dewater the ponded area more rapidly.

9. **Gravel doughnut**—Keep the stone slope toward the inlet at 3:1 or flatter to help prevent stone from being washed into the drop inlet. A minimum 1-foot wide level area set 4 inches below the drop inlet crest will add further protection against the entrance of material. Stone on the slope toward the inlet should be 3 inches or larger for stability, and 1 inch or smaller on the slope away from the inlet to control flow rate. Wire mesh with 2-inch openings may be placed over the drain grating, but must be inspected frequently to avoid blockage by trash.

Inspection and Maintenance: Inspect the barrier after each rain and promptly make repairs as needed. Sediment shall be removed after each significant storm (1" in 24 hours) to provide adequate storage volume for the next rain. The removed sediment shall be deposited in an area that will not contribute sediment off-site and can be permanently stabilized.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA; adapted from North Carolina Erosion and Sediment Control Planning and Design Manual; and, Erosion and Sediment Control Handbook by Goldman, Jackson, and Bursztynsky.

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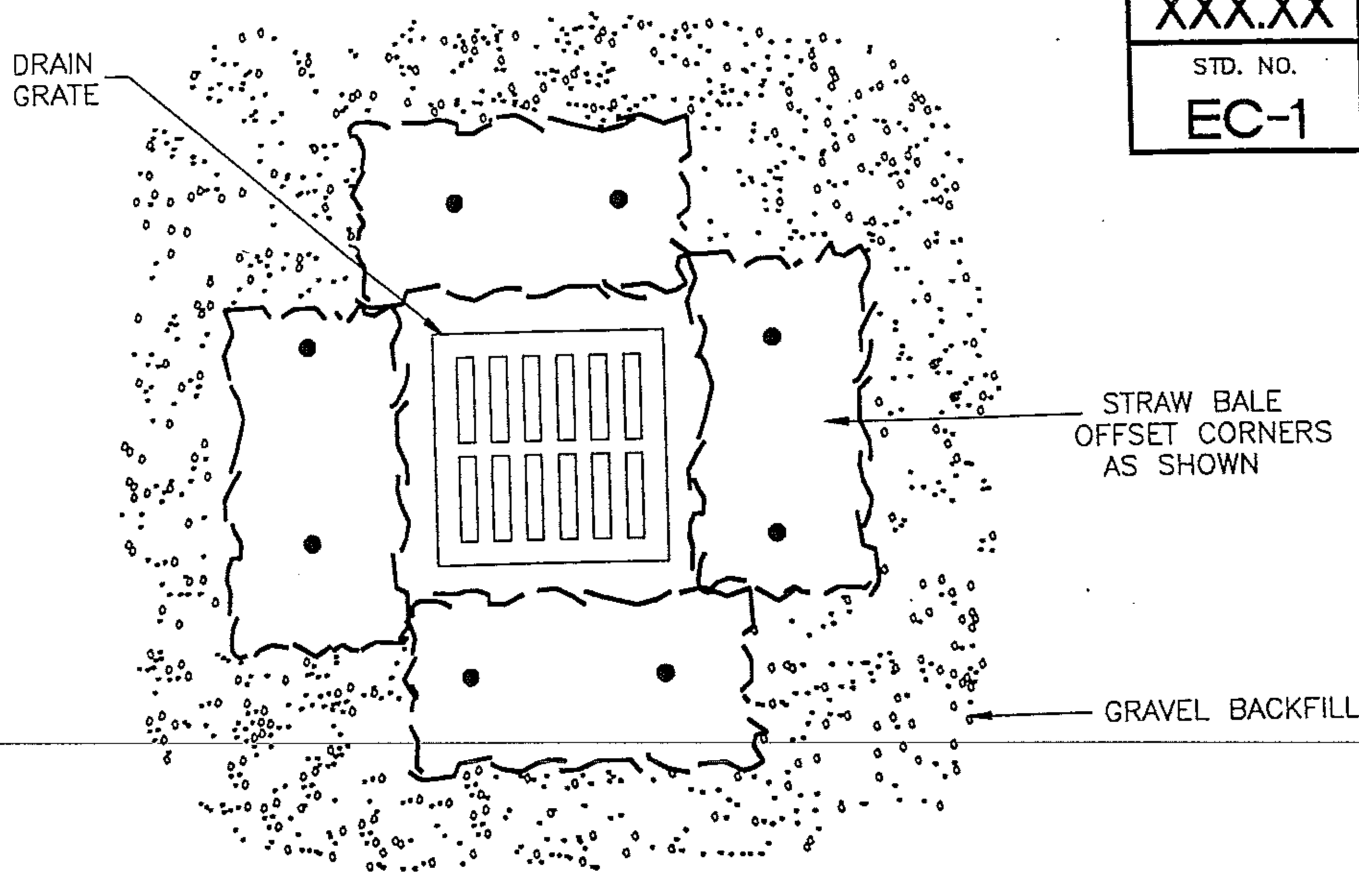
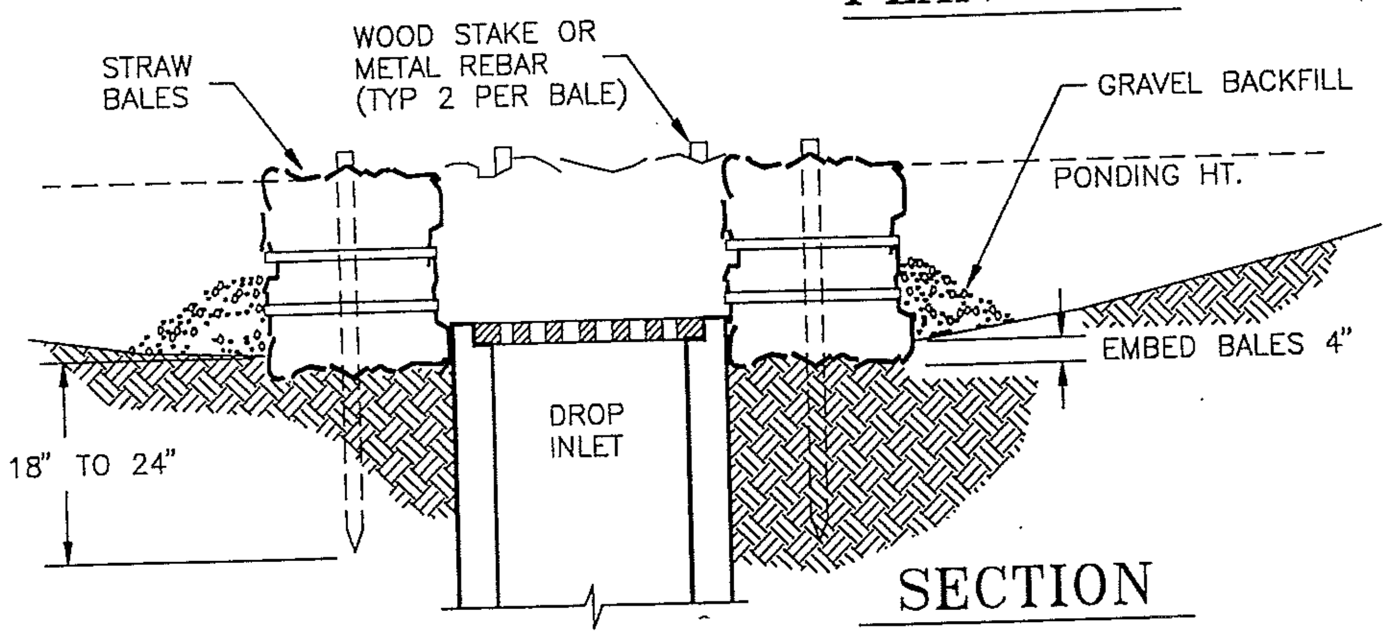


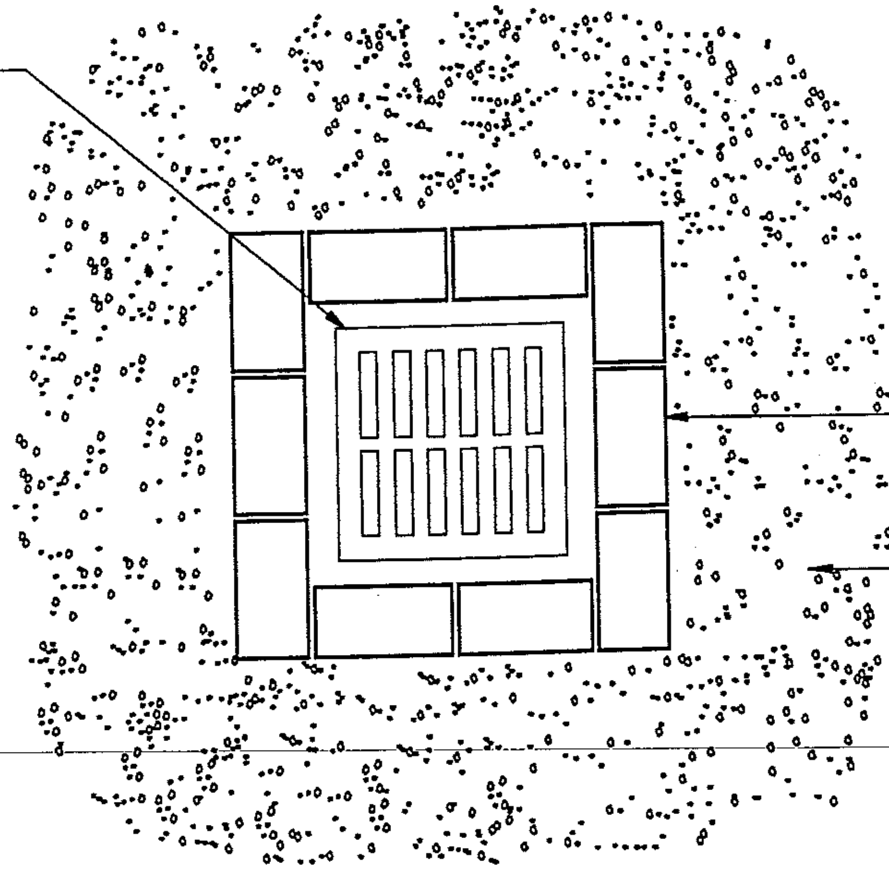
PLAN VIEW



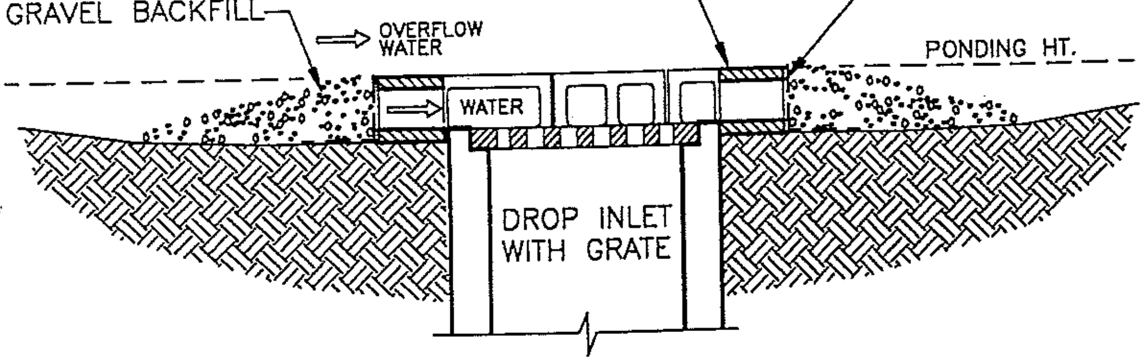
SECTION

NOTE:
TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS (LESS THAN 5%) AND AREA IMMEDIATELY ADJACENT TO INLET SHOULD BE RELATIVELY FLAT (LESS THAN 1%)

DWG DATE 1-92		SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
			APPROVED BY DIRECTOR OF PUBLIC WORKS	TEMPORARY STRAW BALE/GRAVEL DROP INLET SEDIMENT BARRIER
MARK	DATE	REVISION		



PLAN VIEW



SECTION

DWG DATE 1-92		SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
			APPROVED BY DIRECTOR OF PUBLIC WORKS	TEMPORARY BLOCK AND GRAVEL DROP INLET SEDIMENT BARRIER
MARK	DATE	REVISION		

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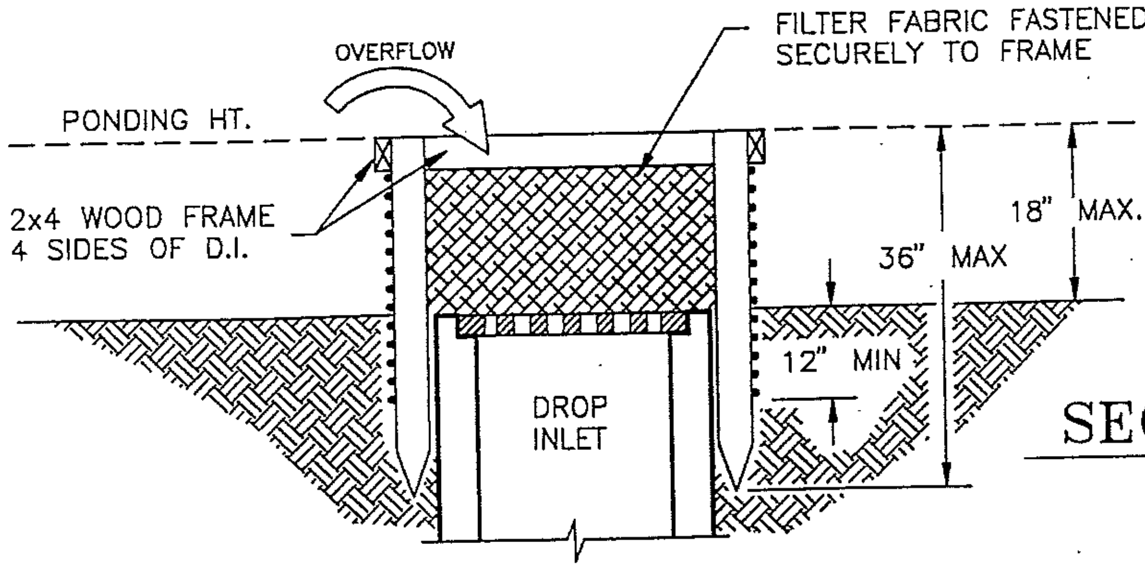
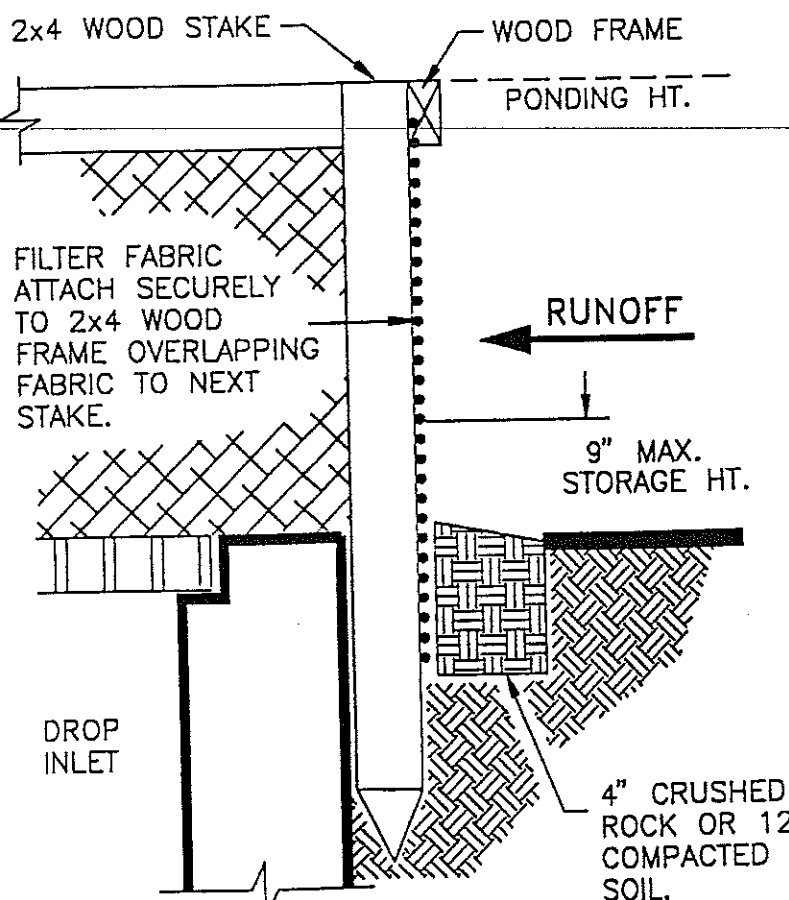


SECTION



BACKFILL DETAIL

TRENCH WITH NATIVE BACKFILL

NOTES:

1. TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS (LESS THAN 5%) AND AREA IMMEDIATELY ADJACENT TO INLET SHOULD BE RELATIVELY FLAT (LESS THAN 1%)
2. FOR STAKES, USE 2x4 INCH WOOD (PREFERED) OR EQUIVALENT METAL WITH MIN. LENGTH OF 3 FT.
3. SPACE STAKES EVENLY AROUND PERIMETER OF INLET A MAXIMUM OF 3 FT APART.
4. FASTEN 2x4 WOOD FRAME AROUND TOP OF STAKES TO INSURE STABILITY.
5. MAXIMUN OVERFLOW HEIGHT 18" ABOVE DROP INLET GRATE.
6. THE TOP OF THE FRAME AND FABRIC MUST BE WELL BELOW THE GROUND ELEVATION DOWNSLOPE FROM THE DROP INLET TO KEEP RUNOFF FROM BY–PASSING THE INLET. IT MAY BE NECESSARY TO BUILD A TEMPORARY DIKE ON THE DOWN SLOPE SIDE OF THE STRUCTURE.

DWG DATE 7–89		SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
			APPROVED BY DIRECTOR OF PUBLIC WORKS	TEMPORARY SILT FENCE DROP INLET PROTECTION
MARK	DATE	REVISION		

STANDARD

CURB INLET SEDIMENT BARRIERS

Definition: Curb inlet sediment barriers are temporary barriers constructed from concrete block and gravel or gravel filled sandbags.

Purpose: Curb inlet sediment barriers are intended to reduce the sediment discharged into storm drains by ponding the runoff and allowing the sediment to settle out. The structures allow for overflow from high runoff events and the gravel allows the ponds to dewater rapidly.

Design Considerations: The sandbag curb inlet and block and gravel sediment barrier can be used at curb inlets on gently sloping, paved streets where:

- water can pond and allow sediment to separate out of suspension
- runoff is relatively low—less than .5 ft^3/sec

Once the small catchment areas behind the sandbags or block and gravel fill with sediment, future sediment-laden runoff will enter the storm drain without being desilted. Therefore, sediment must be removed from these structures during or after each storm. Additional storage can be obtained by constructing a series of sandbag barriers along the gutter so that each barrier traps small amounts of sediment.

Construction Standards:

1. Place on gently sloping streets where water can pond.
2. Barriers shall allow for overflow from a severe storm event. Slope runoff shall be allowed to flow over blocks and gravel and not be bypassed over the curb. A spillway shall be constructed with the sandbag structures to allow overflow.
3. The sandbag should be of woven-type geotextile fabric since burlap bags deteriorate rapidly.
4. Sandbags shall be filled with 3/4" drain rock or 1/4" pea gravel.
5. The sandbag shall be placed in a curved row from the top of curb at least 3 feet into the street. The row should be curved at the ends, pointing uphill.
6. Several layers of bags should be overlapped and packed tightly.

7. Leave a one-sandbag gap in the top row to act as a spillway.

For Block and Gravel type:

1. Place two concrete blocks on their sides perpendicular to the curb at either end of the inlet opening. These will serve as spacer blocks.

2. Place concrete blocks on their sides across the front of the inlet and abutting the spacer blocks. The openings in the blocks should face outward, not upward.

3. Cut a 2- by 4-inch stud the length of the curb inlet plus the width of the two spacer blocks. Place the stud through the outer hole of each spacer block to help keep the front blocks in place.

4. Place wire mesh over the outside vertical face (open ends) of the concrete blocks to prevent stone from being washed through the blocks. Use chicken wire, hardware cloth with 1/2-inch openings, or filter fabric.

5. Pile 1 1/2- to 3-inch gravel against the wire to the top of the barrier.

Inspection and Maintenance: Inspect and clean barrier after each significant storm (1" in 24 hours) and remove sediment from behind sandbag structure after every storm. Sediment and gravel shall be immediately removed from the traveled way of roads. Removed sediment shall be placed where it cannot enter a storm drain, stream, or be transported off site.

Source: John McCullah, C.P.E.S.C, #311, Redding, CA; adapted from Erosion and Sediment Control Handbook by Goldman, Jackson, and Bursztynsky; North Carolina Erosion and Sediment Control Planning and Design Manual; Handbook of Best Management Practices, TRPA; Soil Conservation Service, Redding, California.

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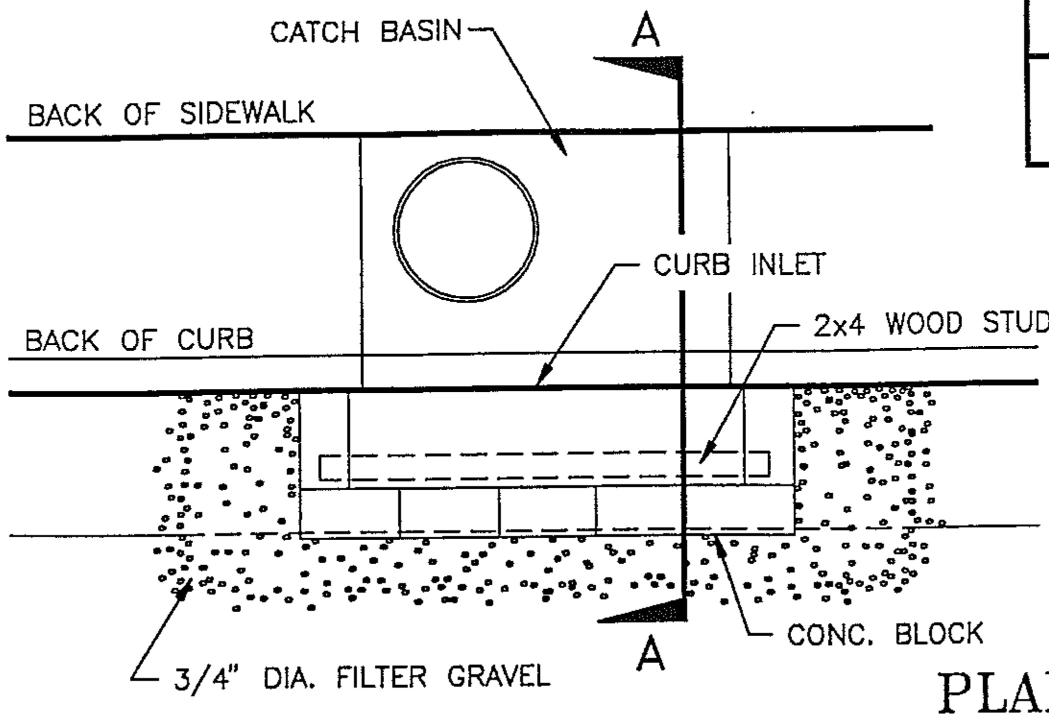
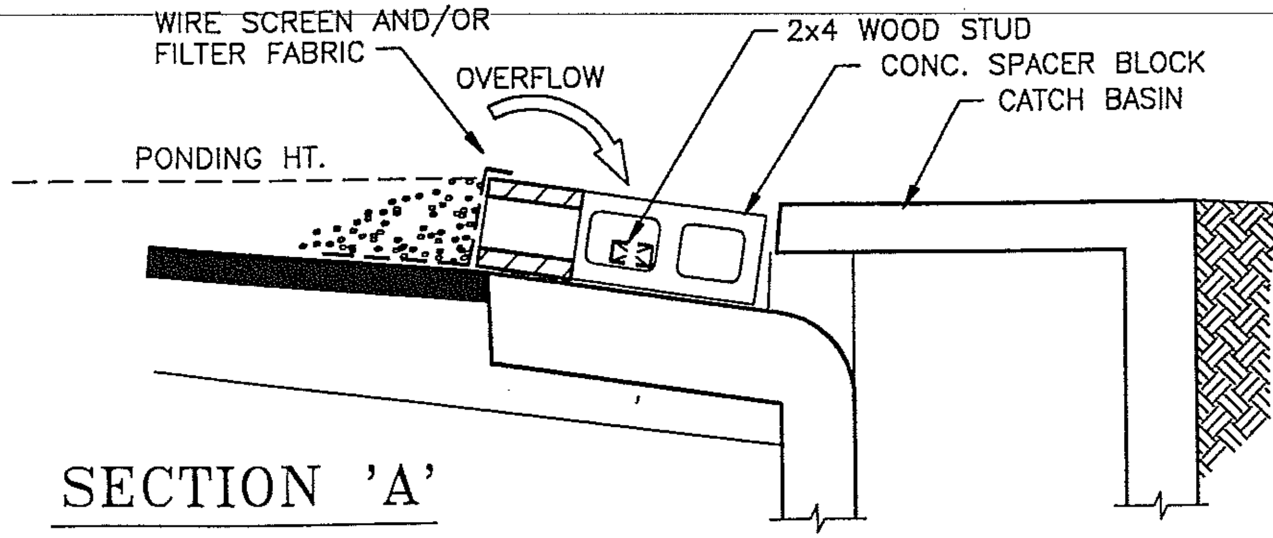


PLAN

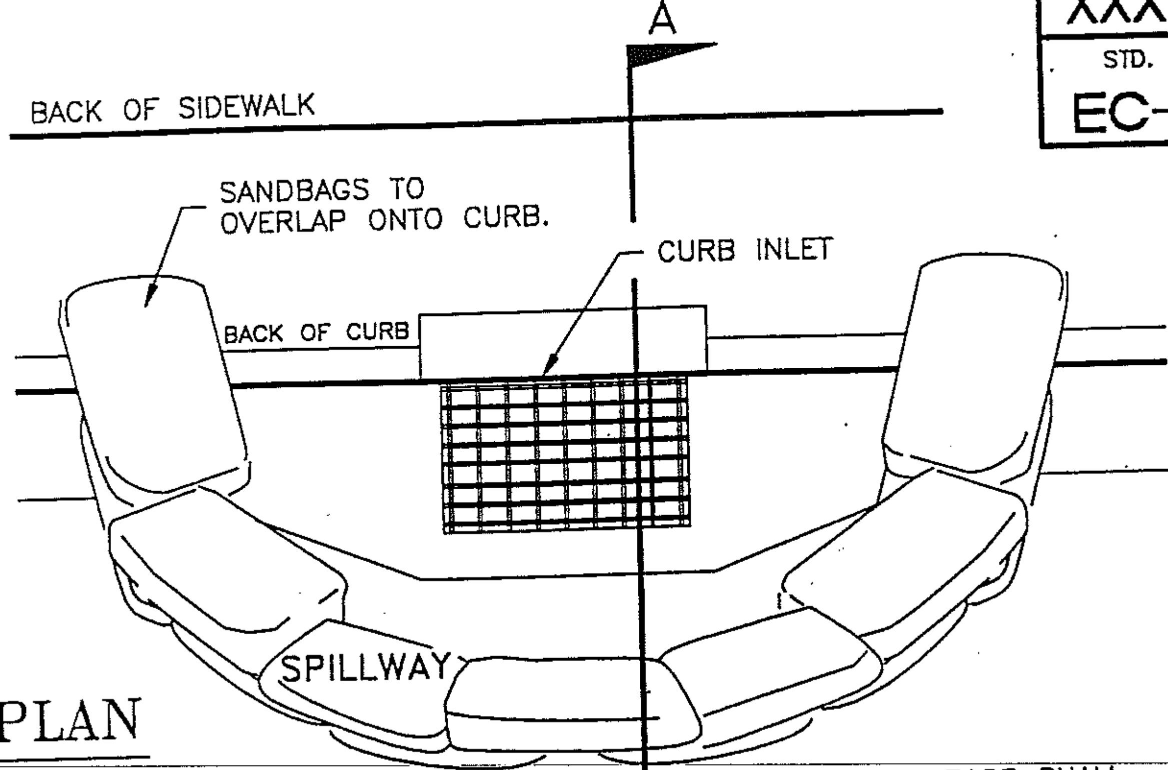


SECTION 'A'

NOTES:

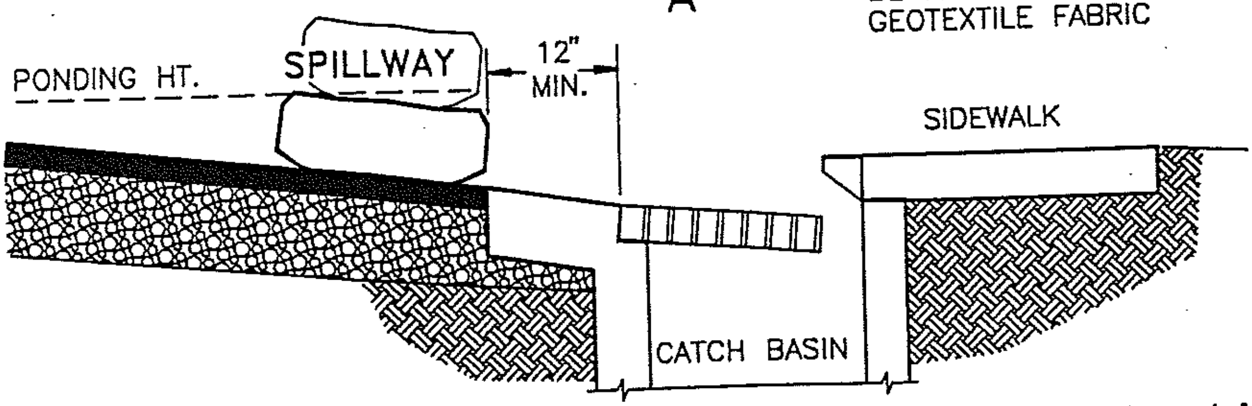
1. PLACE ON GENTLY SLOPING STREETS WHERE WATER CAN POND AND ALLOW THE SEDIMENT TO SEPERATE OUT OF SUSPENSION.
2. BARRIER SHALL ALLOW FOR OVERFLOW FROM A SEVERE STORM EVENT.
3. INSPECT AND REPAIR BARRIERS AFTER EACH STORM EVENT. REMOVE SEDIMENT WHEN PONDING HEIGHT IS EXCEEDED.
4. SEDIMENT AND GRAVEL SHALL BE IMMEDIATELY REMOVED FROM TRAVELED WAY OF ROADS. SEDIMENT SHALL BE DEPOSITED TO AN AREA TRIBUTARY TO A SEDIMENT BASIN OR OTHERWISE PROTECTED.

DWG DATE 7-89		SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
			APPROVED BY	CURB INLET SEDIMENT BARRIER
MARK	DATE	REVISION	DIRECTOR OF PUBLIC WORKS	(BLOCK & GRAVEL TYPE)



PLAN

SANDBAGS SHALL BE MADE OF WOVEN GEOTEXTILE FABRIC



SECTION 'A-A'

NOTES:

1. SANDBAGS SHALL BE WOVEN GEOTEXTILE FABRIC.
2. CONSTRUCT ON GENTLY SLOPING STREETS WHERE WATER CAN POND AND ALLOW SEDIMENT TO SEPERATE OUT OF SUSPENSION.
3. LEAVE A GAP OF ONE BAG IN THE MIDDLE OF THE TOP ROW OF BAGS TO SERVE AS THE SPILLWAY. SPILLWAY HEIGHT SHALL BE LOWER THAN CURB HEIGHT AND SUFFICIENT IN SIZE TO PASS FLOWS FROM SEVERE STORM EVENT.
4. PLACE 2 LAYERS OF SANDBAGS, OVER LAPPING BAGS AND PACK THEM TIGHTLY TOGETHER TO MINIMIZE THE SPACE BETWEEEN BAGS. FILL BAG WITH 3/4" DRAIN ROCK OR 1/4" PEA GRAVEL.
5. INSPECT AND REPAIR FILTERS AFTER EACH STORM EVENT. REMOVE SEDIMENT WHEN ONE HALF OF THE FILTER DEPTH HAS BEEN FILLED. REMOVED SEDIMENT SHALL BE DEPOSITED IN AN AREA TRIBUTARY TO A SEDIMENT BASIN OR OTHER FILTERING MEASURE.
6. SEDIMENT AND GRAVEL SHALL BE IMMEDIATELY REMOVED FROM TRAVELED WAY OF ROAD.

DWG DATE 7-89		SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
			APPROVED BY	CURB INLET SEGIMENT BARRIER (SANDBAG TYPE)
MARK	DATE	REVISION	DIRECTOR OF PUBLIC WORKS	

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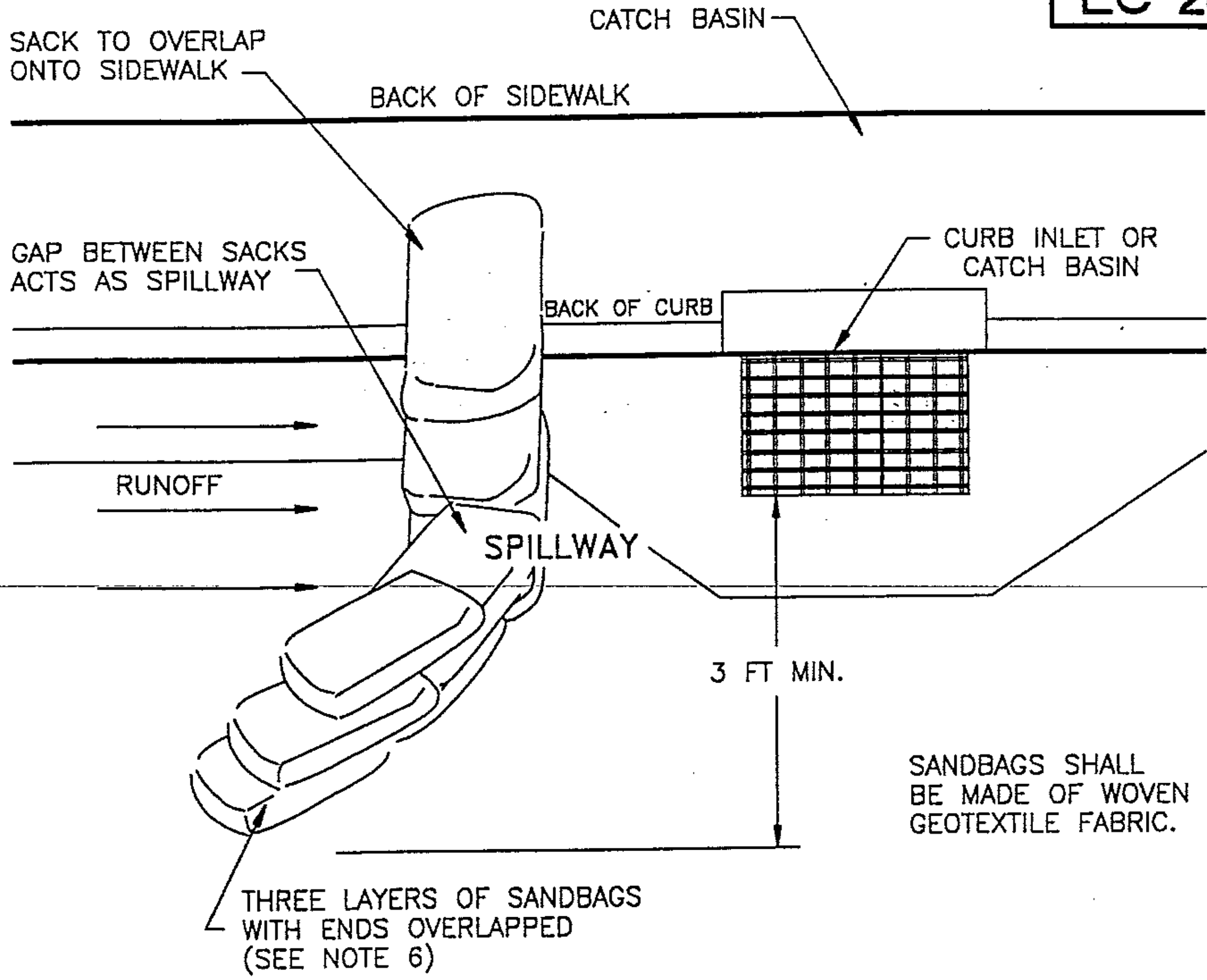


NOTES:

1. CONSTRUCT ON GENTLY SLOPING STREETS WHERE WATER CAN POND AND ALLOW SEDIMENT TO SEPERATE OUT OF SUSPENSION.
2. PLACE SEVERAL LAYERS OF SANDBAGS OVER THE FIRST, OVERLAPPING BAGS AND PACK THEM TIGHTLY TOGETHER TO MINIMIZE THE SPACE BETWEEN BAGS.
3. LEAVE A GAP OF ONE SACK IN THE MIDDLE OF THE TOP ROW OF SACKS TO SERVE AS THE SPILLWAY. SPILLWAY HEIGHT SHALL BE LOWER THAN CURB HEIGHT ANS SUFFICIENT SIZE TO PASS FLOWS FROM SEVERE STORM EVENT.
4. INSPECT AND REPAIR BARRIER AFTER EACH STORM EVENT. REMOVE SEDIMENT WHEN IT REACHES TOP OF SPILLWAY (CURB HEIGHT).
5. SEDIMENT SHALL BE DEPOSITED IN AN AREA TRIBUTARY TO A SEDIMENT BASIN OR OTHER PROTECTIVE MEASURE AND WILL NOT ENTER STORM DRAIN.
6. SEDIMENT AND GRAVEL SHALL BE IMMEDIATELY REMOVED FROM TRAVELED WAY OF ROAD.
6. SANDBAGS SACKS TO BE FILLED WITH 3/4" DRAIN ROCK OR 1/4" PEA GRAVEL.

DWG DATE 7-89		SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
			APPROVED BY	CURB INLET SEDIMENT BARRIER (SANDBAG TYPE)
MARK	DATE	REVISION	DIRECTOR OF PUBLIC WORKS	

STANDARD

TEMPORARY GRAVEL CONSTRUCTION ENTRANCE/EXIT

Definition: A temporary gravel construction entrance/exit is a stabilized pad of crushed stone located at any point where traffic enters or leaves a construction site onto a public right-of-way, street, alley, sidewalk or parking area.

Purpose: A stabilized construction entrance is intended to reduce off-site sedimentation by eliminating the tracking or flowing of sediment onto public rights-of-way.

Design Considerations: Construction plans should limit traffic to properly constructed and stabilized entrances, especially during wet weather operations. Design considerations should include the following:

- locations of entrances and exits;
- proximity to an available water source;
- proximity to streams, storm drains, or other sediment delivery systems
- materials;
- dimensions of the pad;
- maintenance requirements.

Construction Standards:

1. The aggregate size for construction of the pad shall be 2-to 3-inch stone. Place the gravel to the specific grade and dimensions shown on the plans, and smooth it

2. The thickness of the pad shall not be less than 6 inches. Use geotextile fabrics, if necessary, to improve stability of the foundation in locations subject to seepage or high water table.

3. The width of the pad shall not be less than the full width of all points of ingress or egress and not less than 12 feet.

4. The length of the pad shall be as required, but not less than 50 feet.

5. Locate construction entrances and exits to limit sediment from leaving the site and to provide for maximum utility by all construction vehicles. Avoid steep grades and entrances at curves in public roads.

6. The entrance shall be maintained in a condition that will prevent tracking or flowing of sediment onto public rights-of-way. This may require periodic top dressing with additional stone as conditions demand, and repair and/or cleanout of any measures used to trap sediment. All sediment spilled, dropped, washed or tracked onto public rights-of-way shall be removed immediately.

7. Provide drainage to carry water to a sediment trap or other suitable outlet.

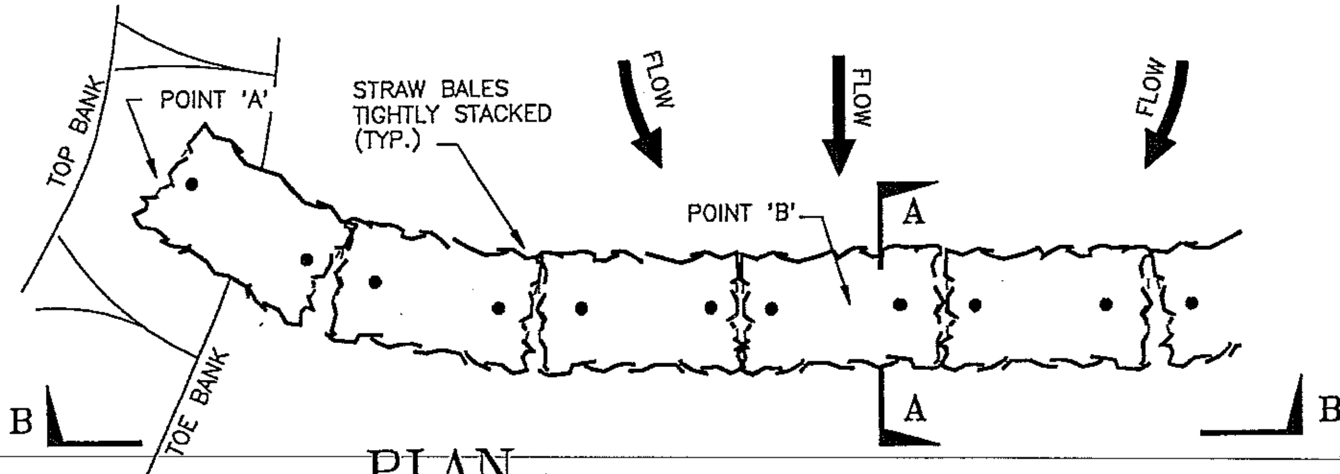
8. When necessary, wheels shall be cleaned to remove sediment prior to entrance onto public rights-of-way. When washing is required, it shall be done on an area stabilized with crushed stone that drains into an approved sediment trap or sediment basin. All sediment shall be prevented from entering any storm drain, ditch or watercourse through use of sand bags, gravel, straw bales, or other approved methods.

Maintenance: Maintain the gravel pad in a condition to prevent mud or sediment from leaving the construction site. This may require periodic topdressing with 2 inch stone. After each rainfall, inspect any structure used to trap sediment and clean it out as necessary. Immediately remove all objectionable materials spilled, washed, or tracked onto public roadways.

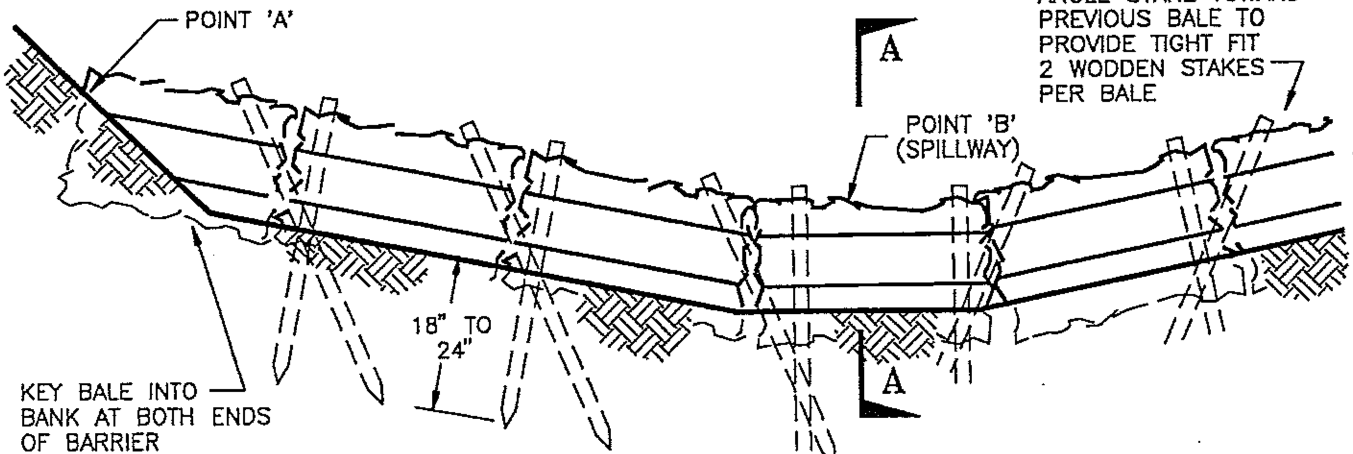
Source: John McCullah, C.P.E.S.C, #311, Redding, CA.;adapted from North Carolina Erosion and Sediment Control Planning and Design Manual.and; Manual of Standards for Erosion and Sediment Control Measures—Association of Bay Area Governments (ABAG)

NOTE:

BALES TO BE PLACED IN A ROW WITH THE ENDS TIGHTLY ABUTTING. USE STRAW ROCKS, OR FILTER FABRIC TO FILL GAPS BETWEEN THE BALES AND TAMP THE THE BACKFILL MATERIAL TO PREVENT EROSION OR FLOW AROUND BALES.



PLAN



SECTION B–B

NOTES:

1. EMBED THE BOTTOM OF THE BALES 4" INTO THE SOIL AND KEY BALES INTO THE BANK AT EACH END.
2. POINT 'A' SHALL BE HIGHER THAN POINT 'B' (SPILLWAY).
3. THE STRAW BALES SHALL BE PLACED ON SLOPE CONTOUR OR PERPENDICULAR TO THE FLOW.
4. IF BALES ARE WIRE BOUND, THEY SHALL BE ORIENTATED SO THE BINDINGS ARE AROUND THE SIDES RATHER THAN THE TOP AND BOTTOM OF BALE TO PREVENT BINDINGS FROM RUSTING FROM CONTACT WITH THE SOIL.
5. SPILLWAY HEIGHT SHALL NOT EXCEED 24 INCHES.
6. INSPECT BARRIERS AFTER EACH SIGNIFICANT STORM (1" IN 24 HRS.). MAINTAIN AND REPAIR PROMPTLY.
7. REMOVE SEDIMENT WHEN BASIN IS 60% FULL.

DWG DATE 7–89		SCALE NTS	CITY OF REDDING • DEPT OF PUBLIC WORKS • ENGINEERING DIVISION	
			APPROVED BY DIRECTOR OF PUBLIC WORKS	STRAW BALE SEDIMENT BARRIER
MARK	DATE	REVISION		