NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

CLEARING AND SNAGGING

(feet)
CODE 326

DEFINITION

Removing snags, drifts, or other obstructions from a channel or drainage way.

PURPOSE

Reducing significant human and/or natural environmental risks by improving physical characteristics of a channel to:

- Restore flow capacity;
- Prevent bank erosion by eddies;
- Reduce the formation of bars; and/or
- Minimize blockages by debris and ice.

CONDITIONS WHERE PRACTICE APPLIES

Any channel or urban floodway where the removal of trees, brush, and other obstructions is needed to accomplish one or more of the listed purposes.

CRITERIA

Clearing and snagging measures shall be planned, designed, and constructed to comply with all Federal, State, and local laws and regulations.

Clearing and snagging shall not be completed on any channel where significant channel erosion will occur, major impairment to the landscape resource quality is likely, or significant impairment to habitat for fish and wildlife will occur, unless needed restoration actions are included with the application of this practice.

Capacity. The capacity of the channel, both before and after improvement, shall be determined using Manning's Formula with applicable values of the retardance factor "n" from Supplement B to the National Engineering Handbook, Section 5 – Hydraulics, or similar source. The value of "n" used to determine channel capacity after improvement shall reflect the degree of natural changes and maintenance expected to occur in future years.

Location. The area to be cleared and snagged shall include the perimeter of the channel, the flow area of the urban floodway, or both. Trees on the bank that are leaning over or other objects that may fall into the channel shall also be included. If root balls are still attached to the streambank, cut off the log 6 to 12 inches above the ground and leave the stump and root mass for bank stability.

Stability. Clearing and snagging shall be specified for other areas, including berms, for use as temporary disposal areas or travelways, or for other planned conservation uses where needed to implement this practice.

Clearing and snagging shall not impair channel stability. The criteria for determining channel stability shall comply with Conservation Practice Standard (582), Open Channel. The effect on downstream and upstream reaches due to the removal of obstructions shall be analyzed using appropriate stream and channel geomorphologic procedures.

If clearing and snagging will result in streambank erosion, criteria within Conservation Practice Standard (580), Streambank and Shoreline Protection will be used in conjunction with this standard.

Vegetation. All areas denuded and disturbed during snag removal shall be restored by planting native vegetation where practical. Disturbance of wetlands, riparian areas, and fish and wildlife habitat sites shall be minimized or avoided where possible. Cleared material shall be deposited in approved areas that will not significantly affect the flow capacity of the stream, or otherwise removed from the floodplain.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

CONSIDERATIONS

Water Quantity

1. Removal of deadfalls, stumps, and trees from streambanks and channels may increase discharge, velocity and channel capacity that could reduce flood damage from out of bank flow. Increased discharge could increase the risk of downstream flooding.
2. Improved flow conditions may lower the hydraulic gradient and drain floodplains more quickly. Rapid drawdown may cause sloughing of saturated, unstable streambanks.
3. Decreased groundwater recharge in water-losing streams may result from reduced residence time of water in the channel.

Water Quality

1. During implementation of the practice, there may be increased turbidity due to an increased sediment load. Water quality may be further degraded by chemical substances (i.e. nitrogen or phosphorus) attached to the sediment particles.
2. During construction, a heavy organic load may be produced resulting in a decreased availability of dissolved oxygen. Long-term effects may cause a decrease in yields of sediment and sediment-attached substances.
3. Increased surface water temperatures, at low flow, may occur from removal of shade-producing canopy until regrowth occurs. Accelerated flows may reduce the period of time water is exposed for "sun warming," thus reducing water temperature.
4. In streams carrying dissolved substances, a reduction in ground water recharge may contribute to improved aquifer quality.

Cultural Resources

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Habitat and Landscape Resources

1. Measures and construction methods that enhance fish and wildlife values should be incorporated as needed and practical. Special attention should be given to landscape aesthetics, to protecting and maintaining key shade, food, and den trees, and to stabilization of disturbed areas.
2. The number of pools and riffles forming the channel bottom may be reduced and fish habitat could be adversely affected.
3. Temporary losses of aquatic or wetland habitat may occur with the removal of vegetation.
4. Consider removal methods and the disposal location of cleared material that will not be used for bioengineering (removal from site, placement in or out of the floodplain, not placed in wetland areas, etc.), and implement according to permit conditions.

Endangered Species Considerations

Determine if installation of this practice with any others proposed will have any effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the Fish and Wildlife Service, NOAA Fisheries (formerly the National Marine Fisheries Service) and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species

or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Some species are year-round residents in some streams, such as freshwater shrimp. Other species, such as steelhead and salmon, utilize streams during various seasons. Be aware that critical periods, such as spawning, eggs in gravels, and rearing of young may preclude activities in the stream that may directly affect the stream habitat during those periods. For example there should be no disturbance of stream gravel beds that may have eggs in them. That could include any equipment in the stream or even walking in the stream or work upstream that may result in sediment depositing in the gravel beds. Document any special considerations for endangered species in the Practice Requirements Worksheet.

PLANS AND SPECIFICATIONS

Plans and specifications for clearing and snagging shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose(s).

Construction operations shall be carried out in a manner and sequence so that impacts on the environment will be minimized and held within acceptable limits.

All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used.

OPERATION AND MAINTENANCE

A maintenance program shall be established by the landowner/user to maintain channel capacity and vegetative cover. Items to consider are:

- Where applicable, control grazing in the construction area during vegetative establishment and when soil conditions are wet.
- Fertilize as needed to maintain a vigorous vegetative cover.
- Promptly repair eroded areas.
- Remove major silt and sediment accumulations in the channel cross-section as soon as practical, when the effects are causing significant bank erosion problems.
- Re-establish vegetation cover immediately where scour erosion has removed established seeding.
- Keep inlets to side drainage structures and channels open and armor if necessary.
- Periodically inspect the area for signs of significant streambank undermining or instability.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

326 - CLEARING AND SNAGGING

I. SCOPE

The work shall consist of clearing and disposing of woody growth and/or other obstructions from the designated area as shown on the drawings or as staked in the field.

II. REMOVAL

The limits of the area to be cleared will be marked by means of stakes, flags, tree markings or other suitable methods. Trees to be left standing and uninjured will be designated by special markings placed around the tree. Sediment/gravel bars and other debris accumulations to be left in place shall be identified on the drawings and in the field as practicable.

Site ingress and egress routes shall minimize the removal or destruction of riparian trees and shrubs. When specific routes are identified, avoid traveling over other areas.

When heavy equipment is used, it will be operated in a manner that will minimize disturbance to stream banks and existing vegetation. Other restrictions on the use of heavy equipment, such as permit requirements that limit equipment operation in the channel, will be specified in the accompanying "Practice Requirements Sheet."

All trees, stumps, and brush within the perimeter of the channel and designated for removal shall be cut as close to the ground as the cutting tools permit. In other areas to be cleared, the trees, brush, and other woody vegetation shall be cut within the maximum distance above the ground level specified.

Trees shall be felled in such a manner as to avoid damage to other trees, property, and objects outside the limits of clearing.

If herbicide treatment is planned, the stumps and brush in the specified area shall be treated at the time of clearing according to the recommendations of the manufacturer of the herbicide specified or being used. All herbicide use must be in accordance with applicable laws, rules or ordinances.

Down trees, logs, drifts, boulders, debris, and other obstructions lying wholly or partly in the channel shall be removed as designated in the project plan. Piling, piers, headwalls, and sediment bars that obstruct the free flow of water shall be removed if so designated in the project plan.

The use of explosives in all clearing and snagging operations, when allowed, shall be in strict compliance with applicable state statutes and regulations

III. SNAGGING

Selective snagging, where possible, shall be performed primarily with hand-operated equipment, water based equipment, or small equipment used in a manner that will minimize soil, water, and other resource disturbance.

IV. DISPOSAL

Trees, logs, and all combustible material resulting from the clearing and snagging operations shall be burned, buried, or piled in designated disposal areas as specified for the project. All burning shall be performed outside the channel and shall conform to regulations in effect in the area. In other areas, such as woodland or rangeland, where burning is prohibited, material shall be disposed of in such a manner that it does not float away or reenter the channel. Residue from burning and noncombustible material shall be buried outside the channel or placed in designated disposal areas. All residue material shall have an earth cover of 12 inches or as specified to permit proper land use. Designated disposal areas shall be graded to neat lines, free of mounds and holes, giving a natural appearance that blends into the undisturbed areas.

V. VEGETATIVE COVER

Unless otherwise specified, a protective cover of vegetation shall be established on the disturbed area. The planting of vegetative materials shall conform to the requirements set forth in Specification 342, Critical Area Planting.

VI. SPECIAL MEASURES

Measures and construction methods that enhance fish and wildlife values shall be incorporated as needed and practical. Special attention shall be given to visual resources protecting and maintaining key shade, food, and den trees.

VII. CONSTRUCTION OPERATIONS

Construction operations shall be done in such a manner that erosion and air and water pollution are minimized and held within legal limits. Appropriate measures shall be taken to minimize the chance of any oil or fuel spills from entering the stream. Equipment parking, maintenance, and refueling will be away from the edge of the stream.

Any temporary crossings, bridge supports, cofferdams, silt fences, or other structures specified or needed during construction shall be completely removed from the stream channel at the conclusion of construction.

The owner, operator, Contractor or other persons will conduct all work and operations in accordance with proper safety codes for the type of construction being performed with due regards to the safety of all persons and property.

The completed job shall be workmanlike and present a good appearance.

OPERATION AND MAINTENANCE ITEMS

A properly maintained clearing operation is an asset to your farm for the areas within this project. This was designed and installed to safely convey runoff from the drainage area. The life of this installation can be assured and usually increased by developing and carrying out a good maintenance program.

This practice will require you to perform periodic maintenance and may also require operational items to maintain satisfactory performance. Here are some recommendations to help you develop a good operation and maintenance program:

- Periodically remove material that has redeposited in a previously cleared location, as allowed by and in accordance with pertinent regulations.
- Periodically remove the sediment or soil that is deposited in the channel and restore to the original dimension, as allowed by and in accordance with pertinent regulations.
- Remove all foreign debris that hinders system operation.
- Immediately remove any obstructions or blockage of spillways, trash racks, or pipe inlets.
- All settlement or cracks in the streambank materials should be investigated to determine the cause and repaired as appropriate.
- Eradicate or otherwise remove all rodents or burrowing animals. Immediately repair any damage caused by their activity.
- Immediately repair any vandalism, vehicular, or livestock damage to any earthfills, spillways, outlets or other apparatuses.

Other items specific to your project are listed on the "Practice Requirement" sheet.

U.S DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
CALIFORNIA

PRACTICE REQUIREMENTS
FOR
326 - CLEARING AND SNAGGING

For: Business Name_____

Job Location_____

County_____ RCD_____ Farm/Tract No._____

Referral No._____Prepared By_____ Date_____

IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.

1. Drawings, No._____ _____ _____

2. Practice Specifications_____,_____,_____

3. Special Requirements:_____

_____

_____

_____

_____

_____

_____

_____

4. Special Maintenance Requirements: _____

_____

_____

NRCS, CA
October, 2003

PRACTICE APPROVAL:

Job Classification: (Ref: Section 501 NEM)

Show the limiting elements for this job. This job is classified as, Class _____

Limiting elements:	Units
Bankfull Capacity _____	_____ cfs
_____	_____
_____	_____
_____	_____

Design Approved by: _____ Date: _____

LANDOWNER'S/OPERATOR'S ACKNOWLEDGEMENT:

The landowner/operator acknowledges that:

a. He/she has received a copy of the construction drawings and specification, and that he/she has an understanding of the contents, and the requirements.

b. He/she has obtained all the necessary permits.

c. No changes will be made in the installation of the job without prior concurrence of the NRCS technician.

d. Maintenance of the installed work is necessary for proper performance during the project life.

Accepted by: _____ Date: _____

PRACTICE COMPLETION:

I have made an on site inspection of the site (or I am accepting owner/contractor documentation), and have determined that the job as installed does conform to the drawings and practice specifications.

Completion Certification by:

/s/_____ Date _____

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

DIKE
(feet)
CODE 356

DEFINITION

A barrier constructed of earth or manufactured materials.

PURPOSE

- To protect people and property from floods.
- To control water level in connection with crop production; fish and wildlife management; or wetland maintenance, improvement, restoration, or construction.

CONDITIONS WHERE PRACTICE APPLIES

All sites that are subject to damage by flooding or inundation and where it is desired to reduce the hazard to people and to reduce damage to land and property.

Sites where the control of water level is desired.

The dike standard does not apply to sites where NRCS conservation practice standards Pond (378), Water and Sediment Control Basin (638), Diversion (362), or Terrace (600) are appropriate. Dikes used to reduce flooding are normally constructed adjacent and/or parallel to a stream, river, wetland or water body and are not constructed across the stream, river or water body. Dikes used to control water levels usually have small interior drainage areas in relation to the surface area of the regulated water level.

CRITERIA

Classification - The dike classification is determined by the hazard to life, the design water height, and the value of the protected land, crops, and property. Classification must consider land use changes likely to occur over the life of the dike.

Dikes are classified as Class I when located on sites where failure may cause loss of life or serious damage to homes, primary highways, industrial buildings, commercial buildings, major railroads or important public utilities.

All dikes with a design water height of more than 12 feet above normal ground surface, exclusive of crossings of sloughs, old channels, or low areas shall be classified as Class I.

Dikes are classified as Class II when located on sites where failure may cause damage to isolated homes, secondary highways, minor railroads, relatively important public utilities, high value land, or high value crops.

Dikes are classified as Class III when located on sites where damage likely to occur from failure will be minimal.

Dikes, classified as Class IV-A, are those constructed for wetland and wildlife areas where damage likely to occur from failure will be minimal and frequent overtopping of the dike is expected.

Dikes, classified as Class IV-B, are those constructed for wetland and wildlife areas where damage likely to occur from failure will be minimal and dikes are not expected to overtop.

Constructed Elevation - The constructed elevation of a dike whose purpose is to prevent flooding shall be the sum of the following:

- The water elevation attained by a flood or high tide of the design frequency shown in Table 1 with the critical duration and timing. This is the design high water.

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- The larger of the minimum freeboard in Table 1 or the wave height caused by wind or boat traffic.
- The allowance for settlement.

The constructed elevation of a dike whose purpose is to control water level shall be the sum of the following:

- The water elevation at the highest water level control.
- The rise in water height above the highest water level control caused by a flood of the design frequency shown in Table 1. This is the design high water.
- The larger of the minimum freeboard shown in Table 1 or the wave height caused by wind of the design frequency shown in Table 1.
- The allowance for settlement.

Settlement - Settlement shall be based on an analysis of the fill material, foundation material and condition, and compaction methods.

In lieu of an analysis, the allowance for settlement shall be as follows:

1. For dikes constructed of compacted earth fill material shall be a minimum of 5% of the dike height.
2. For Class II or Class III dikes, constructed of fill material that is hauled from off-site, dumped, and shaped (referred to as "dumped and shaped"), the allowance for settlement shall be a minimum of 15% of the dike height. For fill material that is excavated adjacent to the dike and dropped from the excavator (referred to as "dropped"), the allowance for settlement shall be a minimum of 20% of the dike height. The allowance for settlement of dumped and shaped or dropped organic soil fill material shall be a minimum of 40% of the dike height. Organic soils are permitted only for Class III dikes 6 feet or less in height. Higher dike heights result in excessive settlement and decomposition.

For the purpose of this standard, organic soils are described as follows:

1. Soil layers that are not saturated with water for more than a few days at a time are organic if they have 20 percent or more organic carbon.

   or

2. Layers that are saturated for longer periods, or were saturated before being drained, are organic if:

   (a) They have 12 percent or more of organic carbon and no clay, or

   (b) 18 percent or more organic carbon and 60 percent or more clay, or

   (c) A proportional amount of organic carbon, between 12 and 18 percent, if the clay content is between 0 and 60 percent.

   or

3. All soils described in the local soil survey as an organic soil.

Top Width and Side Slopes - The minimum top widths and side slopes for earth embankments shall be as shown in Table 1.

All dikes must be accessible for maintenance activities. Typically, this may be along the top of the dike or along the berm. Access roads shall provide adequate width for the maintenance equipment and inspection vehicles. The minimum width for vehicular traffic should be 12 feet. Provide wider areas for passing and turning around at regular intervals. Access roads may need to be controlled to prevent vandalism, accidents, and damage.

Berms - The need for a constructed berm on an embankment will be based on the results of an embankment and foundation stability analysis. If a stability analysis is not performed, all earth dikes shall have berms either constructed or occurring naturally on both sides meeting the following criteria:

- Constructed berms shall be at a constant elevation and sloped away from the dike.
- Where dikes cross channels, ditches, borrow areas, streams, sloughs, swales, gullies, etc., they shall have a berm constructed on each side. The top elevation of these berms shall be at least 1 foot above the average ground surface on each side of the channel, ditch, borrow area, stream, slough, swales, gully, etc., and sloped away from the dike.
- The minimum top width of natural or constructed berms shall be as shown in Table 1.

- The minimum side slope ratio of constructed berms shall be 2:1 (Horizontal:Vertical).

Dike Materials - Manufactured materials are erosion resistant materials such as concrete, PVC, steel, or other material that provides the required structural strength and durability for the dike. Dikes constructed of manufactured materials shall have a structural analysis completed for the various loads the dike will be subjected to during its life. These include hydrostatic, ice, uplift, earth, and equipment. The dike shall be analyzed for stability using acceptable safety factors for each loading condition.

Earth dike materials shall be obtained from required excavations and designated borrow areas. The selection, blending, routing, and disposition of materials in the various fills shall be subject to approval by the engineer or designer. Fill materials shall contain no frozen soil, sod, brush, roots, or other perishable materials. Rock particles larger than the maximum size specified for each type of fill shall be removed prior to placement and compaction of the fill. The types of materials used in the various fills shall be as listed and described in the specifications and drawings.

Embankment and Foundation Seepage - Embankment and foundation drainage and seepage control shall be designed on the basis of site investigation, laboratory data, seepage analysis, and stability analysis. The resulting design shall minimize seepage, prevent piping or undermining, and provide a stable embankment and foundation.

An analysis is required on all Class I dikes that have a height of six (6) feet or greater and Class II dikes that have a height of eight (8) feet or greater.

In the absence of more detailed data and analysis, the following criteria for a foundation cutoff apply for Class I dikes less than 6 feet in height, Class II dikes less than 8 feet in height and Class III dikes:

- Minimum of H feet deep for H<3 feet.
- Minimum of 3 feet deep for H≥3 feet.
- Minimum of 4 feet bottom width.
- 1:1 or flatter side slopes.

A stream, channel, ditch, borrow area, slough, swale, gully, etc. shall be far enough away from the dike so that the extension of a line drawn from the design high water elevation on one side of the dike to the dike toe on the opposite side shall not intersect any stream, channel, etc. (See figure 1). This line criterion applies to both sides of the dike. This criterion will minimize the hazard to the dike caused by piping through the foundation.

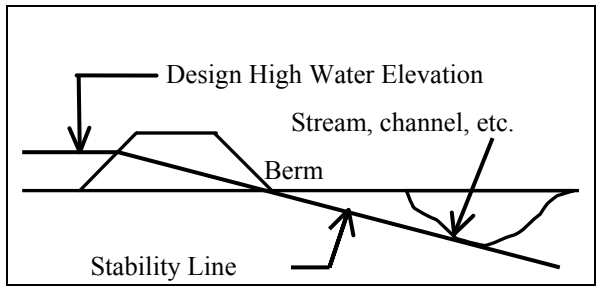

Figure 1

Interior Drainage - Dikes to prevent flooding shall be provided with interior drainage systems for the area being protected. The interior drainage system shall prevent flood damage to the interior area from a flood of the design frequency in Table 1 for both the 1-day and the 10-day storm duration. The interior drainage system may include storage areas, gravity outlets, and pumping plants as needed to provide the required level of flood protection.

Pipes - Pipes installed through a Class I dike below the design high water with a dike height greater than 12 feet shall meet the requirements for PRINCIPAL SPILLWAYS as found in NRCS TECHNICAL RELEASE 60 – Earth Dams and Reservoirs, except for the minimum size requirements.

Pipes through all other dikes shall meet the requirements for a principal spillway in NRCS Conservation Practice Standard, Ponds (378).

Dikes shall be protected from scour at pipe inlet and outlet locations by appropriate measures. A pump discharge pipe through a dike shall be installed above design high water, if feasible. Pump discharge pipes shall be equipped with a flexible connection or similar coupling to prevent vibration of the pumping plant being transmitted to the discharge pipe.

Slope Protection - Slopes of earthen dikes shall be protected from sheet, rill, and gully erosion; erosion from flowing floodwaters; and wave action created by wind and/or boat traffic. Erosion protection measures such as non-woody vegetation, berms, rock riprap, sand-gravel, or soil cement shall be utilized as needed.

Regulatory Requirements - Dikes shall meet the requirements of all federal, state, and local laws or regulations.

CONSIDERATIONS

Berms

Give special consideration to wider berms, additional setbacks, or protecting the berm side slope when adjacent to actively eroding or moving streams to protect the dike for its design life.

Cultural Resources Considerations

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Flood of Record

For Class I dikes, the flood of record should be considered when establishing the top of dike elevation.

Location

When locating the site for the dike, consider the foundation soils, property lines, setbacks from property lines, exposure to open water, distance to streambanks, availability of outlets by gravity or pumping, buried utilities, cultural resources, and natural resources such as wetlands, natural areas, and fish and wildlife habitat.

Fluvial geomorphologic concepts contained in National Engineering Handbook (NEH) Part 653, Stream Corridor Restoration Principles, Processes and Practices should be considered when placing a dike near a stream.

Vegetation

If the dike is vegetated, vegetation should be compatible with the integrity and function of the dike. Refer to Engineering Field Handbook, Part 650, Chapter 13, Wetland Restoration, Enhancement, or Creation, Vegetative design, page 13-45 for 10 critical factors to be considered.

Water Quantity

1. Effects upon components of the water budget, especially on volumes and rates of runoff, infiltration, evaporation and transpiration.

2. Potential for changes in rates of plant growth and transpiration because of changes in the volume of soil water.

3. Effects of changes to upstream or downstream flows on aquifers or other water uses.

4. Effects on the rate or volume of downstream flow to prohibit undesirable environmental, social or economic effects.

Water Quality

1. Effects on erosion and the movement of sediment and soluble and sediment-attached substances carried by runoff.

2. Effects on the movement of dissolved substances to ground water.

3. Short-term, construction and maintenance related effects on the quality of water resources.

4. Potential for earthmoving to uncover or redistribute toxic materials such as saline soils and make them available for undesirable effects on water or vegetation.

5. Effects on wetlands or water-related wildlife habitats.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance plan must be prepared by the Designer for use by the owner or other person responsible for operating this practice. The plan should provide specific instructions for operating and maintaining the system to insure that it functions properly. It should also provide for periodic inspections and prompt repair or replacement of damaged components.

For Class I dikes with a height greater than 12 feet, an emergency action plan meeting the requirements of 500.70 of the National Operation and Maintenance Manual shall be completed prior to construction of the dike. For Class I and Class II dikes, a detailed written Operation and Maintenance Plan in accordance with 500.40 through 500.42 of the National Operation and Maintenance Manual shall be completed and provided to the owner.

All dikes must be maintained to the required shape and height. Maintenance must include periodic removal of woody vegetation that may become established on the embankment.

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Table 1 – Minimum Design Criteria for Dikes

Classification	Material [1/]	Height (H) in Feet [2/]	Minimum Storm Design Frequency in Years-24 hour duration	Minimum Freeboard in Feet	Minimum Top Width in Feet	Minimum Side Slope Ratio [3/] (H:V)	Berm Width in Feet
Class I	Earth	0 to 6	100	H/3	10	2:1	12
		>6 to 12	100	2	10	Note 4/	Note 4/
		>12 to 25	100	3	12	Note 4/	Note 4/
		>25	100	3	14	Note 4/	Note 4/
	Manufactured	0 to 8	100	H/4	N/A	N/A	Note 4/
		>8 to 12	100	2	N/A	N/A	Note 4/
		>12	100	3	N/A	N/A	Note 4/
Class II	Earth	0 to 6	25	H/3	8	2:1	12
		>6 to 12	25	2	8	2:1	15
	Manufactured	0 to 8	25	H/4	N/A	N/A	Note 4/
		>8 to 12	25	2	N/A	N/A	Note 4/
Class III	Mineral Soils	0 to 3	10	H/3	4	2:1	8
		>3 to 6	10	1	6	2:1	8
		>6 to 12	25	2	8	2:1	8
	Organic Soils [5/]	0 to 2	10	H/2	4	2:1	10
		>2 to 4	10	1	6	2:1	10
		>4 to 6	10	2	8	2:1	15

[1/] Earth includes rock. Manufactured materials are erosion resistant materials such as concrete, PVC and steel that provides the structural strength for the dike.

[2/] Height is the difference between normal ground elevation at the dike centerline and the design high water elevation. When determining normal ground elevation, exclude crossings of channels, sloughs, small low areas, small ridges, swales, or gullies.

[3/] Minimum side slope ratios are for compacted earth fill. Dumped earth fill without compaction will be flatter.

[4/] Side slope ratios and berm widths shall be determined by a stability analysis.

[5/] Organic soils are permitted only for Class III dikes 6 feet or less in height. Higher dike heights result in excessive settlement and decomposition. If mineral soil is available, place 6 to 12 inches over the organic soil to reduce oxidation or potential burning of the organic soils.

Table 1 continued

Classification	Material [1/]	Height (H) in Feet [2/]	Minimum Storm Design Frequency in Years-24 hour duration	Minimum Freeboard in Feet	Minimum Top Width in Feet	Minimum Side Slope Ratio [3/] (H:V)	Berm Width in Feet
Class IV-A [7/]	CL, CH, ML, MH [6/]	≤2	10	1	12	6:1	10
Class IV-B	Mineral soils	≤2	10	1	12	4:1 (water side) 2:1 (non-water side)	10

[1/] Earth includes rock. Manufactured materials are erosion resistant materials such as concrete, PVC and steel that provides the structural strength for the dike.

[2/] Height is the difference between normal ground elevation at the dike centerline and the design high water elevation. When determining normal ground elevation, include crossings of channels, sloughs, small low areas, small ridges, swales, or gullies for Class IV-A dikes and exclude crossings of channels, sloughs, small low areas, small ridges, swales, or gullies for Class IV-B dikes.

[3/] Minimum side slope ratios are for compacted earth fill. Dumped earthfill without compaction will be flatter.

[4/] Side slope ratios and berm widths shall be determined by a stability analysis.

[5/] Organic soils are permitted only for Class III dikes 6 feet or less in height. Higher dike heights result in excessive settlement and decomposition.

[6/] The earthfill shall be compacted using one of the methods described in the dike specification, except that Method A shall be used when working with the high ash content of the inter-mountain soils. Compaction testing on the high ash content soils shall be by Method D with the blow content modified to 50 blows per layer.

[7/] Slope protection, for Class IV-A dikes, shall be established as specified by Practice Standard 342, Critical Area Treatment, using a perennial sod forming grass when climatic and soil conditions are suitable. Consider the use of a temporary, biodegradable erosion control product, to provide site protection until the perennial grass has a chance to be established.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

356 - DIKE

I. SCOPE

The work shall consist of excavating and placing earth materials for the construction of dikes to the lines, grades, elevations, and cross-sections as shown on the drawings or as staked in the field.

II. SITE PREPARATION

The foundation area shall be cleared of all trees, stumps, roots, brush, rocks, sod, debris and other objectionable material. All channel banks and sharp breaks shall be sloped to no steeper than 1:1. All topsoil shall be removed. Loose earth shall not be left on the foundation area to a depth in excess of six inches above approved undisturbed foundation material. The surface of the foundation area shall be thoroughly scarified before placement of the embankment material.

The sites of the borrow area shall be stripped to sufficient depth to remove all vegetation, roots, brush, sod and other objectionable material.

Clearing and disposal methods shall be in accordance with applicable state and county laws with due regards to the safety of persons and property.

III. EXCAVATION

Cutoff Trench

The cutoff trench, when specified, shall be excavated to lines and grades as shown on the drawings or as staked in the field. Backfill shall not be placed in the trench until the Engineer has inspected and approved the trench. The trench shall be kept free of standing water during backfill operations.

Conduit

Trench excavation for installation of a conduit, where shown on the drawings, shall be made in original ground. Excavation in compacted fill may be allowed provided the bottom of the trench is at or near undisturbed foundation. The trench shall conform to lines and grades shown in the drawings.

IV. COMPACTED EARTHFILL AND BACK-FILL

Material

All fill material shall be only suitable material obtained from selected areas as shown on the drawings. Fill materials shall contain no sod, brush, roots, or other perishable or unsuitable material. Cobbles and rock fragments over six inches in diameter shall be removed from the material prior to compaction. The suitability of fill material shall be as determined by the Engineer.

Placement

The placing and the spreading of the fill material shall be started at the lowest point of the foundation and the fill shall be brought up approximately horizontal layers, of such thickness that the required compaction can be obtained with the equipment used.

Fill placed around structures will be brought up at approximately uniform height on all sides of the structure.

The distribution and gradation of materials throughout the fill shall have no lenses, pockets, streaks or layers of material differing substantially in texture or gradation from the surrounding material. The surface of the finished dike shall be graded smooth.

Moisture

The moisture content of the fill material shall be adequate to obtain the required degree of compaction with the equipment used.

The proper moisture content will be determined by inspection during the placement operation. The soil should contain sufficient moisture so that the soil will maintain a ball shape when squeezed in the hand. Material that is too wet for proper compaction shall either be removed or allowed to dry prior to compaction. As far as practicable, the material shall be brought to the proper water content in the borrow pit before excavation. Supplemental water, when required, may be applied by sprinkling the materials in

the fill. Uniform distribution of the moisture shall be obtained by discing, blading, or other approved methods prior to compaction.

Compaction

Compaction shall meet the requirements of one of the Method specified on the Practice Requirement sheet and as described below.

Method A. Sheepsfoot roller - The maximum layer thickness shall be eight inches before compaction. The roller shall have staggered, uniformly spaced tamper feet and be equipped with suitable cleaners. The weight of the roller shall not be less than 2,500 pounds per foot of width. The maximum speed of the compaction equipment shall be three miles per hour. The entire surface of each layer placed should receive six passes of this equipment to obtain the necessary compaction. Adjustment in the number of passes may be necessary during construction.

Method B. Pneumatic tired equipment - The maximum layer thickness before compaction shall be six inches. A loaded carryall may be considered a pneumatic roller. The wheels of this equipment must pass over 90 percent of the surface of each lift before a new lift is placed.

Method C. Track laying equipment - (bulldozer) - The maximum layer thickness before compaction shall be four inches. The tracks of the equipment must pass over 90 percent of the surface of each lift before a new lift is placed.

Method D. Compaction shall result in densities equal to or greater than 95 percent of the maximum obtained by laboratory compaction at optimum moisture of like soils in accordance with the procedure given in ASTM D-698, Procedure A.

Heavy compaction equipment shall not be operated within two feet of any structure. Hand directed tampers or compactors shall be used on areas not accessible to heavy compaction equipment, and within two feet of any structure. Fills compacted in this manner shall be placed in layer not greater than four inches in thickness before compaction, and shall meet the same density requirements as adjacent areas.

Compliance with compaction requirements will be determined by the procedure given in ASTM D-1556 or D-2167 for Method D and by observation of performance for Methods A, B, and C. Fill not meeting the specified requirements shall be reworked or removed and replaced with acceptable fill.

V. CONDUITS

All conduits shall be placed on a firm foundation to the lines and grades and in the location(s) shown on the drawings. Selected backfill material shall be placed in layers around the conduit and component parts and each successive layer shall be thoroughly compacted.

VI. ADDITIONAL REQUIREMENTS FOR CLASS III DIKES WITH ORGANIC SOILS

In addition to the requirements stated within this specification, the following specification applies to Class III Dikes with organic soils. Fill material may be organic soils with low coarse fiber content, free of all roots, brush and other objectionable materials, obtained from borrow areas by dredge or dragline. Fill shall be placed so as to permit free drainage. Shaping of the dike shall be such to break up lumps and clods to yield a smooth surface and finish to the lines and grades specified. Compaction shall be by Method C.

VII. VEGETATIVE COVER

Unless otherwise specified, a protective cover of vegetation shall be established on all exposed surfaces of the embankment and borrow areas. Vegetative plantings shall conform with the requirements of Practice Specification 342 - Critical Area Planting. When specified, the embankment shall be fenced where necessary to protect the vegetation.

VIII. SPECIAL MEASURES

Measures and construction methods shall be incorporated as needed and practical that enhance fish and wildlife values. Special attention shall be given to protecting visual resources and maintaining key shade, food and den trees.

IX. CONSTRUCTION OPERATIONS

Construction operations shall be done in such a manner that erosion and air and water pollution are minimized and held within legal limits. The owner, operator, Contractor or other persons will conduct all work and operations in accordance with proper safety codes for the type of construction being performed with due regards to the safety of all persons and property.

The completed job shall be workmanlike and present a good appearance.

OPERATION AND MAINTENANCE

A properly operated and maintained dike is an asset to your farm. This dike was designed and installed to prevent inundation of your farmland from the adjacent watercourse or to regulate water for enhancement of wildlife and wetlands. The estimated life span of this installation is at least 10 years. The life of the structure can be assured and usually increased by developing and carrying out a good operation and maintenance program.

This practice will require you to perform periodic maintenance and may also require operational items to maintain satisfactory performance. Here are some recommendations to help you develop a good operation and maintenance program.

Avoid excessive travel on any portion of the system that will harm or destroy the vegetative cover.

Periodically check the elevation of the earthfills and restore to grade, if necessary.

Maintain vigorous growth of vegetative coverings. This includes reseeding, fertilization and application of herbicides when necessary. Periodic mowing may also be needed to control height.

Remove all foreign debris that hinders system operation.

All settlement or cracks in the soil should be investigated to determine the cause and immediately repaired.

Check all rock riprap sections for accelerated weathering and displacement. Replace to original grades if necessary.

Eradicate or otherwise remove all rodents or burrowing animals and repair any damage caused by their activity.

Immediately repair any vandalism, vehicular, or livestock damage to any earthfills, spillways, outlets or other appurtenances.

ADDITIONAL OPERATIONS AND MAINTENANCE FOR CLASS IV DIKES

Class IV dikes were designed to regulate water for wildlife and wetlands enhancement. These dikes may be overtopped on a frequent basis. Establishment of the vegetation is essential for protection of these levees. Additional maintenance should be expected until the vegetation is established.

Avoid vehicular traffic on the dikes until vegetation is established.

Avoid vehicular travel on the dikes at any time when the dikes are wet to avoid cutting ruts in the dike. Ruts in the dikes will be more prone to erosion with frequent overtopping and should be repaired quickly to prevent further damage.

U.S DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
CALIFORNIA

PRACTICE REQUIREMENTS
FOR
356 – DIKE

For: Business Name_____

Job Location_____

County_____ RCD_____ Farm/Tract No._____

Referral No._____Prepared By_____ Date_____

IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.

1. Drawings, No._____ _____ _____

2. Practice Specifications_____,_____,_____

3. Special Requirements:_____

_____

_____

_____

_____

_____

_____

4. Special Maintenance Requirements:_____

_____

_____

_____

NRCS, CA
October, 2003

PRACTICE APPROVAL:

Job Classification: (Ref: Section 501 NEM)

Show the limiting elements for this job. This job is classified as, Class _____

Limiting elements:	Units
Dike class _____	_____
Depth of water _____	_____ft
_____	_____
_____	_____

Design Approved by:_____ Date:_____

LANDOWNER'S/OPERATOR'S ACKNOWLEDGEMENT:

The landowner/operator acknowledges that:

a. He/she has received a copy of the construction drawings and specification, and that he/she has an understanding of the contents, and the requirements.

b. He/she has obtained all the necessary permits.

c. No changes will be made in the installation of the job without prior concurrence of the NRCS technician.

d. Maintenance of the installed work is necessary for proper performance during the project life.

Accepted by:_____ Date:_____

PRACTICE COMPLETION:

I have made an on site inspection of the site (or I am accepting owner/contractor documentation), and have determined that the job as installed does conform to the drawings and practice specifications.

Completion Certification by:

/s/_____ Date _____

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

POND
(No.)
CODE 378

DEFINITION

A water impoundment made by constructing an embankment or by excavating a pit or dugout.

In this standard, ponds constructed by the first method are referred to as embankment ponds, and those constructed by the second method are referred to as excavated ponds. Ponds constructed by both the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at the auxiliary spillway elevation is 3 feet or more.

PURPOSE

To provide water for livestock, fish and wildlife, recreation, fire control, and other related uses, and to maintain or improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This standard establishes the minimum acceptable quality for the design and construction of low-hazard ponds where:

1. Failure of the dam will not result in loss of life; damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities.
2. The product of the storage times the effective height of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the auxiliary spillway. The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no auxiliary spillway, the top of the dam is the upper limit.
3. The effective height of the dam is 35 feet or less, and the dam is hazard class (a).
4. For class "a" dams with a height-storage product greater than 3,000, and for class "b" and "c" dams, the design criteria shall be the more restrictive of the criteria set forth herein or as outlined in TR-60.
5. Hazard classification shall be documented by the procedures in NEM, Section 520.23(b), CA-Supplement.

GENERAL CRITERIA APPLICABLE TO ALL PONDS

All Federal, State and local requirements shall be addressed in the design.

A protective cover of vegetation shall be established on all exposed areas of embankments, spillways and borrow areas as climatic conditions allow, according to the guidelines in conservation practice standard 342, Critical Area Planting.

Site conditions. Site conditions shall be such that runoff from the design storm can be safely passed through (1) a natural or constructed auxiliary spillway, (2) a combination of a principal spillway and an auxiliary spillway, or (3) a principal spillway.

Drainage area. The drainage area above the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. The drainage area shall be large enough so that surface runoff and groundwater will provide an adequate supply of water for the intended purpose unless an alternate water source exists to serve this purpose. The quality shall be suitable for the water's intended use.

Reservoir area. The topography and geology of the site shall permit storage of water at a depth and volume that will ensure a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. If surface runoff is the primary source of water for a pond, the soils shall be impervious enough to prevent excessive seepage losses or shall be of a type that sealing is practicable.

Water Rights

It is imperative that any owner planning to construct a facility to store runoff water be advised that the state water code requires filing for a water right, regardless of the amount of that storage.

Such a filing is made to the Water Rights Division of the California Water Resources Control Board. The Board may require a conduit or other satisfactory means to enable water to pass through the embankment or other barrier creating the storage. The requirement for a conduit cannot be prejudged. It is determined by the Board based on the circumstances of each individual situation.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

It is the responsibility of the owner to file for the water rights and advise NRCS of the Board's decision on the requirements for a conduit. The owner should also be advised of the possible need for other local, state or federal permits.

DESIGN CRITERIA FOR EMBANKMENT PONDS

Geological Investigations. Pits, trenches, borings, review of existing data or other suitable means of investigation shall be conducted to characterize materials within the embankment foundation, auxiliary spillway and borrow areas. Soil materials shall be classified using the Unified Soil Classification System.

The embankment foundation shall be investigated, thoroughly and to the depth required, to determine the following:

1. Depth to competent impervious layer.
2. Ability of the foundation to withstand load.
3. Seepage potential through the abutments and foundation.

The emergency spillway shall be investigated to determine the following:

1. The suitability of the material as a borrow source.
2. The potential for the spillway to erode.
3. The difficulty of excavation.

The borrow areas shall be defined by at least three pits, trenches, or borings. Quantities of borrow volumes shall be computed based upon the site investigation. The minimum borrow volume, excluding waste, shall exceed the embankment volume by 1.5.

The borrow operation shall not be permitted closer than 50 feet from the upstream toe of the embankment except where the cutoff trench extends into firm impervious material for its entire length.

Since all of California is classified as a high seismic area, appropriate design measures shall be incorporated into the design of each embankment as a defensive measure for earthquakes (NEM 520.24(a)(1). Examples of such design measures that would help the embankment withstand seismic loads include:

1. Constructing the embankment of compacted clayey materials.
2. The addition of a berm (or berms).
3. Increase the embankment top width.
4. Include an embankment drain.

Foundation cutoff. A cutoff of relatively impervious material shall be provided under the dam if necessary to reduce seepage through the foundation. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments as required and be deep enough to extend into a relatively impervious layer or provide for a stable dam when combined with seepage control. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes shall not be steeper than one horizontal to one vertical.

Seepage control. Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage could create swamping downstream, (3) such control is needed to insure a stable embankment, or (4) special problems require drainage for a stable dam. Seepage may be controlled by (1) foundation, abutment, or embankment filters and drains; (2) reservoir blanketing; or (3) a combination of these measures.

Embankment. The minimum top width for a dam is shown in table 1. If the embankment top is to be used as a public road, the minimum width shall be 16 feet for one-way traffic and 26 feet for two-way traffic. Guardrails or other safety measures shall be used where necessary and shall meet the requirements of the responsible road authority. For dams less than 20 feet in height, maintenance considerations or construction equipment limitations may require increased top widths from the minimum shown in Table 1.

Table 1. Minimum top width for dams

Total height of embankment	Top width
feet	*feet*
Less than 10	8
10 – 14.9	10
15 – 19.9	10
20 – 24.9	12
25 – 34.9	14
35 or more	15

Side Slopes. The combined upstream and downstream side slopes of the settled embankments shall not be less than five horizontal to one vertical, and neither slope shall be steeper than two horizontal to one vertical. All slopes must be designed to be stable, even if flatter side slopes are required. Downstream or upstream berms can be used to help achieve stable embankment sections

Slope Protection. If needed to protect the slopes of the dam from erosion, special measures, such as berms, rock riprap, sand-gravel, soil cement, or special vegetation, shall be provided (Technical Releases 56, “A Guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments” and 69, “Riprap for Slope Protection Against Wave Action” contain design guidance).

Freeboard. The minimum elevation of the top of the settled embankment shall be 1 foot above the water surface in the reservoir with the auxiliary spillway flowing at design depth. The minimum difference in elevation between the crest of the auxiliary spillway and the settled top of the dam shall be 2 feet for all dams having more than a 20-acre drainage area or more than 20 feet in effective height.

Settlement. The design height of the dam shall be increased by the amount needed to insure that after settlement the height of the dam equals or exceeds the design height. This increase shall not be less than 5 percent of the height of the dam, except where detailed soil testing and laboratory analyses or experience in the area show that a lesser amount is adequate.

Principal spillway. A pipe conduit, with needed appurtenances, shall be placed under or through the dam, except where rock, concrete, or other types of lined spillways are used, or where the rate and duration of flow can be safely handled by a vegetated or earth spillway.

For dams with a drainage area of 20 acres or less, the principal spillway crest elevation shall not be less than 0.5 feet below the auxiliary spillway crest elevation. For dams with a drainage area over 20 acres, this difference shall not be less than 1.0 feet.

When design discharge of the principal spillway is considered in calculating peak outflow through the auxiliary spillway, the crest elevation of the inlet shall be such that the design discharge will be generated in the conduit before there is discharge through the auxiliary spillway.

Pipe conduits designed for pressure flow must have adequate anti-vortex devices. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the auxiliary spillways. The diameter of the principal spillway pipe shall not be less than 4 inches. Pipe conduits used solely as a supply pipe through the dam for watering troughs and other appurtenances shall not be less than 1-1/4 inches in diameter.

If the pipe conduit diameter is 10 inches or greater, its design discharge may be considered when calculating the peak outflow rate through the auxiliary spillway.

Pipe conduits shall be ductile iron, welded steel, corrugated steel, corrugated aluminum, reinforced concrete (pre-cast or site-cast), or plastic. Pipe conduits through dams of less than 20 feet total height may also be cast iron or unreinforced concrete.

Pipe conduits shall be designed and installed to withstand all external and internal loads without yielding, buckling, or cracking. Rigid pipe shall be designed for a positive projecting condition. Flexible pipe shall be designed for a maximum deflection of 5 percent. The modulus of elasticity for PVC pipe shall be assumed as one-third of the amount designated by the compound cell classification to account for long-term reduction in modulus of elasticity. Different reductions in modulus may be appropriate for other plastic pipe materials.

The minimum thickness of flexible pipe shall be SDR 26, Schedule 40, Class 100, or 16 gage as appropriate for the particular pipe material. Connections of flexible pipe to rigid pipe or other structures shall be designed to accommodate differential movements and stress concentrations.

All pipe conduits shall be designed and installed to be water tight by means of couplings, gaskets, caulking, waterstops, or welding. Joints shall be designed to remain watertight under all internal and external loading including pipe elongation due to foundation settlement.

In lieu of a specific design for strength requirements for the pipe, specifications in Tables 2 and 3 are to be followed for polyvinyl chloride(PVC), steel and aluminum pipe.

Table 2. - Acceptable PVC pipe for use in earth dams[1]

Nominal pipe size *inches*	Schedule for standard dimension ratio (SDR)	Max. depth fill over pipe *feet*
4 or smaller	Schedule 40	15
	Schedule 80	20
	SDR 26	10
6, 8, 10, 12	Schedule 40	10
	Schedule 80	15
	SDR 26	10

[1]Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM-D-1785 or ASTM-D-2241.

Table 3. - Minimum gage for corrugated metal pipe (2-2/3in X 1/2 in corrugations)[1]

Fill height (ft)	Minimum gauge for steel pipe with diameter (in) of 21 and less	24	30	36	42	48	Minimum thickness of aluminum pipe[2] with diameter (in) of 21 and less	24	30	36
1-15	16	16	16	14	12	10	.06	.075	.075	.075
15-20	16	16	16	14	12	10	.06	.075	.075	.105
20-25	16	16	14	12	10	10	.06	.105	.135	[3]

[1]Pipe with 6-,8-, and 10-in diameters has 1-1/2 in x 1/4 in corrugations.
[2]Riveted or helical fabrication.
[3]Not permitted.

Pipe Conduits

Pipe conduits shall be placed through or under embankments where required for safety, for proper operation of the reservoir and spillway, or for water rights requirements.

Where a pipe conduit is to be installed, the following shall apply:

1. No valve shall be installed when the conduit serves the single purpose of carrying flow from a trickle tube riser. For secondary discharge systems, control valves shall be installed on the upstream end unless otherwise approved by the State Conservation Engineer.
2. The conduit shall be placed in a trench excavated in firm foundation or in compacted fill not more than three feet above firm foundation.
3. All pipe conduits through earth embankments shall be concrete bedded or encased in concrete as defined below:

Embankment Minimum Treatment Height:

A. Concrete Pipe with Round Rubber Gasket joints

10 feet or less	2-inch concrete bedding up 1/3 the O.D. on both sides of the pipe centerline.
10 to 25 feet	1/2 O.D. Concrete cradle
25 to 35 feet	1/2 O.D. Concrete cradle

B. Corrugated Metal Pipe and Plastic

25 feet	Complete encasement
25 feet or greater	CMP shall not be used

4. When a pipe conduit is to be encased with concrete, the trench shall be excavated to the neat lines and grades so that the bottom and two sides become suitable forms for the concrete.
5. Anti-seep collars are considered adequate for seepage control along conduits through embankments less than 20 feet in effective height. When used for seepage control they should be installed around the conduit within the normal saturation zone, the upstream two thirds of the conduit length or upstream of a positive embankment drainage system.

   These collars shall extend beyond the pipe or encasement not less than 18 inches in all directions except where a watertight seal can be obtained by tying the collar into firm rock.

   The maximum spacing shall not exceed 15 feet. Corrugated metal collars are not permitted.
6. The installation of trickle tubes are allowed provided the tube is buried in the embankment side slopes at a shallow depth of 1.0 feet to protect the pipe. Usually trickle tubes are installed to convey water to a trough for livestock use.
7. When cathodic protection is needed, the procedures of Design Note 12 shall be used.

Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Other suitable devices such as a Saint Anthony Falls stilling basin or an impact basin may be used to provide a safe outlet.

All steel pipe and couplings shall have protective coatings in areas that have traditionally experienced pipe corrosion, or in embankments with saturated soil resistivity less than 4000 ohms-cm or soil pH less than 5. Protective coatings shall be asphalt, polymer over galvanizing, aluminized coating or coal tar enamel as appropriate for the pipe type. Plastic pipe that will be exposed to direct sunlight shall be ultraviolet-resistant and protected with a coating or shielding, or provisions provided for replacement as necessary

Cathodic Protection. Cathodic protection is to be provided for coated welded steel and galvanized corrugated metal pipe where soil and resistivity studies indicate that the pipe needs a protective coating, and where the need and importance of the structure warrant additional protection and longevity. If cathodic protection is not provided for in the original design and installation, electrical continuity in the form of joint-bridging straps should be considered on pipes that have protective coatings. Cathodic protection should be added later if monitoring indicates the need.

Seepage Control. Seepage control along a pipe conduit spillway shall be provided if any of the following conditions exist:

1. The effective height of dam is greater than 15 feet.
2. The conduit is of smooth pipe larger than 8 inches in diameter.
3. The conduit is of corrugated pipe larger than 12 inches in diameter.

Seepage along pipes extending through the embankment shall be controlled by use of a drainage diaphragm, unless it is determined that anti-seep collars will adequately serve the purpose.

Drainage Diaphragm. The drainage diaphragm, when required, shall function both as a filter for adjacent base soils and a drain for seepage that it intercepts. The drainage diaphragm shall consist of sand meeting the requirements of ASTM C-33, for fine aggregate. If unusual soil conditions

exist such that this material may not meet the required filter or capacity requirements, a special design analysis shall be made.

The drainage diaphragm shall be a minimum of 2 feet thick and extend vertically upward and horizontally at least three times the outside pipe diameter, and vertically downward at least 18 inches beneath the conduit invert. The drainage diaphragm shall be located immediately downstream of the cutoff trench, but downstream of the centerline of the dam if the cutoff is upstream of the centerline.

Water shall be transported safely from the drainage diaphragm, to a point downstream of the dam, in a pipe or series of pipes, called drainage diaphragm discharge pipe(s). A filter and drain system shall be provided around the pipe(s) to prevent movement or piping of drain, filter or embankment material. Protect the outlet for these pipes from surface erosion.

Anti-seep Collars. When anti-seep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe but not more than 25 feet. The minimum spacing shall be 10 feet. Collar material shall be compatible with pipe materials. The anti-seep collar(s) shall increase by at least 15 percent the seepage path along the pipe.

Trash Guard. To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser unless the watershed does not contain trash or debris that could clog the conduit.

Other Outlets. A pipe with a suitable valve shall be provided to drain the pool area if needed for proper pond management or if required by State law. The principal spillway conduit may be used as a pond drain if it is located where it can perform this function.

Auxiliary spillways. Auxiliary spillways convey large flood flows safely past earth embankments and have historically been referred to as “Emergency Spillways”.

An auxiliary spillway must be provided for each dam, unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam. The following are minimum criteria for acceptable use of a closed conduit principal spillway without an auxiliary spillway: a conduit with a cross-sectional area of 3 ft^2 or more, an inlet that will not clog, and an elbow designed to facilitate the passage of trash.

The minimum capacity of a natural or constructed auxiliary spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 4, less any reduction creditable to conduit discharge and detention storage.

The auxiliary spillway shall safely pass the peak flow, or the storm runoff shall be routed through the reservoir. The routing shall start either with the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days’ drawdown, whichever is higher. The 10-day drawdown shall be computed from the crest of the auxiliary spillway or from the elevation that would be attained if the entire design storm were impounded, whichever is lower. Auxiliary spillways shall provide for passing the design flow at a safe velocity to a point downstream where the dam will not be endangered.

Constructed auxiliary spillways are open channels that usually consist of an inlet channel, a control section, and an exit channel. They shall be trapezoidal and shall be located in undisturbed or compacted earth or in-situ rock. The side slopes shall be stable for the material in which the spillway is to be constructed. For dams having an effective height exceeding 20 feet, the auxiliary spillway shall have a bottom width of not less than 10 feet.

Upstream from the control section, the inlet channel shall be level for the distance needed to protect and maintain the crest elevation of the spillway. The inlet channel may be curved to fit existing topography. The grade of the exit channel of a constructed auxiliary spillway shall fall within the range established by discharge requirements and permissible velocities.

Capacity

The minimum capacity of the natural or constructed emergency spillway shall be that required to pass the peak outflow expected from a 50-year 24 hour frequency storm, less any reduction creditable to conduits or detention storage.

The minimum bottom width shall be 5 feet.

The minimum capacity of a closed emergency spillway shall be sufficient to pass the peak flow expected from a 100-year 24-hour frequency storm, less any reduction creditable to principal spillways or detention storage.

Where there are dams in series (NEM, 520.24(a)(1), the design of the downstream structure shall address what will happen should the upstream structure fail. Some precautions that could be considered are:

1. Adding additional freeboard to the embankment.
2. Larger capacity emergency spillway.
3. Address how overtopping will affect the structure being designed.

Freeboard

The minimum difference in elevation between the crest of the earth auxiliary spillway and the settled top of dam shall be either depth of design flow plus 1 foot or 3 feet whichever is greater.

For concrete chute spillways the minimum difference in elevation between the crest of the emergency spillway and the settled top of dam shall be either the depth of flow plus 1.0 feet or 2.0 feet whichever is greater.

Erosion Protection

Earth or vegetated spillways shall be non-erosive for the runoff from a 50 year 24 hour frequency storm. Pipe spillways may be used to carry part or all of this flow where erosion will occur. If some erosion will occur during higher frequency storms, the quantity of sediment and its effect downstream shall be addressed.

Side Slopes

Where spillway levees or training dikes are required to protect the downstream toe of the fill, they shall have side slopes not steeper than 3:1.

The minimum top width for the spillway training dikes or levees shall be 12 feet.

Structural auxiliary spillways. If chutes or drops are used for principal spillways or auxiliary spillways, they shall be designed according to the principles set forth in the Part 650, Engineering Field Handbook and the National Engineering Handbook, Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in table 4, less any reduction creditable to conduit discharge and detention storage.

Table 4. Minimum auxiliary spillway capacity

Drainage area (Ac.)	Effective height of dam[1] (Ft.)	Storage (Ac-Ft)	Minimum design storm[2]	
			Frequency (Years)	Minimum duration (Hours)
20 or less	20 or less	< than 50	10	24
20 or less	> than 20	< than 50	25	24
> than 20	20 or less	< than 50	25	24
All others			50	24

1. As defined under “Conditions where Practice Applies”.
2. Select rain distribution based on climatological region.

State Division of Dam Safety

Drawings and specifications for dams within the jurisdiction of the California Division of Safety of Dams shall also meet the requirements of that organization.

Dams within the State jurisdiction dams are:

1. Dams over 25 feet in height and with storage of 15 acre-feet or more.
2. Dams over 6 feet in height and with storage of 50 acre-feet or more.

In general the design for state-size dams will need to meet the minimum requirements for a "b" hazard structure as outlined in Technical Release 60.

Pipe conduits must be placed through or under all embankments that are of a size to be within the jurisdiction of the California Division of Safety of Dams.

CRITERIA FOR EXCAVATED PONDS

Geological Investigations. Pits, trenches, borings, review of existing data or other suitable means of investigation shall be conducted to characterize materials within the excavation. Soil materials shall be classified using the Unified Soil Classification System.

The area to be excavated for the pond shall be investigated, thoroughly and to the depth of at least 2 feet below the anticipated lowest expected grade, to determine the following:

1. Seepage potential through the pond.
2. The difficulty of excavation.

Clay or plastic pond liners should be used on excavated ponds where seepage losses are considered excessive.

Runoff. Provisions shall be made for a pipe and auxiliary spillway, if needed, that will meet the capacity requirements of Table 4. Runoff flow patterns shall be considered when locating the excavated pond and placing the spoil.

Side slopes. Side slopes of excavated ponds shall be stable and shall not be steeper than one horizontal to one vertical. If livestock will water directly from the pond, a watering ramp of ample width shall be provided. The ramp shall extend to the anticipated low water elevation at a slope no steeper than three horizontal to one vertical.

Inlet protection. If surface water enters the pond in a natural or excavated channel, the side slope of the pond shall be protected against erosion.

Excavated material. The material excavated from the pond shall be placed so that its weight will not endanger the stability of the pond side slopes and it will not be washed back into the pond by rainfall. It shall be disposed of in one of the following ways:

1. Uniformly spread to a height that does not exceed 3 feet, with the top graded to a continuous slope away from the pond.

2. Uniformly placed or shaped reasonably well, with side slopes assuming a natural angle of repose. The excavated material will be placed at a distance equal to the depth of the pond but not less than 12 feet from the edge of the pond.
3. Shaped to a designed form that blends visually with the landscape.
4. Used for low embankment construction and leveling of surrounding landscape.
5. Hauled away.

CONSIDERATIONS

Visual resource design. The visual design of ponds should be carefully considered in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

The embankment may be shaped to blend with the natural topography. The edge of the pond may be shaped so that it is generally curvilinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, islands may be added for visual interest and to attract wildlife.

Cultural Resources. Consider existence of cultural resources in the project area and any project impacts on such resources. Consider conservation and stabilization of archeological, historic, structural, and traditional cultural properties when appropriate.

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Fish and Wildlife. Project location and construction should minimize the impacts to existing fish and wildlife habitat.

When feasible, structure should be retained, such as trees in the upper reaches of the pond and stumps in the pool area. Upper reaches of the pond can be shaped to provide shallow areas and wetland habitat.

If fish are to be stocked, consider criteria and guidance in conservation practice standard 399, Fishpond Management.

Vegetation. Stockpiling topsoil for placement on disturbed areas can facilitate revegetation.

Consider placement and selection of vegetation to improve fish and wildlife habitat and species diversity.

Water Quantity.

Consider effects upon components of the water budget, especially:

1. Effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.
2. Variability of effects caused by seasonal or climatic changes.
3. Effects on downstream flows and impacts to environment such as wetlands, aquifers, and; social and economic impacts to downstream uses or users.
4. Potential for multiple purposes.

Water Quality

1. Consider effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that are carried by runoff.
2. Effects on the visual quality of onsite and downstream water resources.

3. Short-term and construction-related effects of this practice on the quality of downstream water courses.
4. Effects of water level control on the temperatures of downstream water to prevent undesired effects on aquatic and wildlife communities.
5. Effects on wetlands and water-related wildlife habitats.
6. Effects of water levels on soil nutrient processes such as plant nitrogen use or denitrification.
7. Effects of soil water level control on the salinity of soils, soil water, or downstream water.
8. Potential for earth moving to uncover or redistribute toxic materials such as saline soils.

PLANS AND SPECIFICATIONS

Plans and specifications for installing ponds shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed and reviewed with the landowner or individual responsible for operation and maintenance.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

378 - POND

I. SCOPE

The work shall consist of constructing an earthfill embankment and appurtenances to the lines, grades, elevations and dimensions shown on the drawings or as staked in the field for the purpose to construct a pond.

II. FOUNDATION PREPARATION

The foundation area shall be cleared of trees, logs, stumps, roots, brush, boulders, sod, and rubbish, and shall be stripped to sufficient depth to remove all objectionable material. If needed to establish vegetation, the topsoil and sod shall be stockpiled and spread on the completed dam and spillways. Foundation surfaces shall be sloped no steeper than 1:1. The foundation area shall be thoroughly scarified before placement of the fill material. The surface shall have moisture added or it shall be compacted if necessary so that the first layer of fill material can be compacted and bonded to the foundation.

The cutoff trench and any other required excavation shall be excavated to the elevations and cross sections shown on the drawings or as staked in the field. Suitable excavated materials shall be used in the embankment fill. Compacted backfill shall not be placed in the trench until the engineer has inspected and approved the trench.

Existing stream channels in the foundation area shall be sloped no steeper than 1:1 and deepened and widened as necessary to remove all stones, gravel, sand, stumps, roots, and other objectionable material and to accommodate compaction equipment.

III. EARTHFILL PLACEMENT

Material

All fill materials shall be obtained from approved borrow pits and from excavations (if acceptable) required for other parts of the work. Fill materials shall contain no sod, brush, roots, or other perishable or unsuitable material. Cobbles and rock fragments having a maximum dimension of more than six inches shall be removed from the materials prior to compaction, and be disposed of or placed in areas designated by the Engineer.

Placement

Foundation areas shall be kept free of standing water when fill is being placed on them.

The placing and spreading of fill material shall be started at the lowest point of the foundation and the fill brought up in horizontal layers of such thickness that the required compaction can be obtained. The fill shall be constructed in continuous horizontal layers except where openings or sectionalized fills are required. In those cases, the slope of the bonding surfaced between the embankment in place and the embankment to be placed shall not be steeper than 3 horizontal to 1 vertical. The bonding surface shall be treated the same as that specified for the foundation so as to insure a good bond with the new fill.

The distribution and gradation of materials shall be such that there are no lenses, pockets, streaks, or layers of material. If it is necessary to use materials of varying texture and gradation, the more impervious material shall be placed in the center and upstream parts of the fill. If zoned fills of substantially differing materials are specified, the zones shall be placed according to lines and grades shown on the drawings.

Selected backfill material shall be placed around structures, pipe conduits, and anti-seep collars at about the same rate on all sides of prevent damage from unequal loading.

Fill placed around structures will be brought up at approximately uniform height on all sides of the structure.

Moisture content of the fill material shall be adequate for obtaining the required compaction. Material that is too wet shall be dried to meet this requirement, or removed, and material that is too dry shall have water added and mixed until the requirement is met.

The proper moisture content for compaction will be determined by inspection during the placement operation. The material should maintain a ball shape when squeezed in the hand. When specified, the moisture shall be maintained within 2 percentage points of optimum as determined by ASTM D-698.

As far as practicable, the material shall be brought to the proper water content in the borrow pits before

excavation. Supplemental water, when required, may be applied by sprinkling the materials on the fill. Uniform distribution of the moisture shall be obtained by discing, blading or other approved method prior to compaction.

Compaction

Construction equipment shall be operated over each layer of fill to insure that the required compaction is obtained. Special equipment shall be used if needed to obtain the required compaction.

Compaction shall meet the requirements of the method specified on the Practice Requirements sheet and as described below:

A. Sheepsfoot roller - the maximum layer thickness shall be 8 inches before compaction. The roller shall have staggered, uniformly spaced tamping feet and be equipped with suitable cleaners. The weight of the roller shall not be less than 2,500 pounds per foot of width. The maximum speed of the compaction equipment shall be 3 miles per hour. The entire surface of each layer placed should receive 6 passes of this equipment to attain the necessary compaction.

B. Pneumatically tired equipment - The maximum layer thickness before compaction shall be 6 inches. A loaded scraper may be considered a pneumatic roller. The wheels of this equipment must pass over 90 percent of the surface of each lift before a new lift is placed.

C. Track laying equipment (bulldozer) - The maximum layer thickness before compaction shall be 4 inches. The tracks of the equipment must pass over 90 percent of the surface of each lift before a new lift is placed.

D. Compaction shall result in densities equal to or greater than 95 percent of the maximum obtained by laboratory compaction at optimum moisture of like soils in accordance with the procedure given in ASTM D-698, Procedure A.

E. Compaction shall result in densities equal to or greater than 90 percent of the maximum obtained by laboratory compaction at optimum moisture of like soils in accordance with the procedure given in ASTM D-1557, Procedure A.

Heavy compaction equipment shall not be operated within 2 feet of any structure. Hand directed tampers or compactors shall be used on areas not accessible to heavy compaction equipment, and within 2 feet of any structure. Fills compacted in this manner shall be placed in layers not greater than 4 inches in thickness before compaction, and shall meet the same density requirement as for the adjacent area.

Compliance with compaction requirements will be determined by the procedure given in ASTM D-1556 or D-2167 for methods D and E and by observation of performance for methods A, B, and C.

Fill not meeting the specified requirements shall be reworked or removed and replaced with acceptable fill.

Fill adjacent to structures, pipe conduits, and anti-seep collars shall be compacted to a density equivalent to that of the surrounding fill by means of hand tamping or manually directed power tampers or plate vibrators.

The passage of heavy equipment will not be allowed (1) over cast-in-place conduits prior to seven days after placement of the concrete, or (2) over any type of conduit until the compacted backfill has been placed over the top surface of the structure equal to one-half the clear span width of the structure or pipe, or two feet whichever is greater.

Compaction of backfill adjacent to structures shall not be started until after the expiration of the following minimum time interval after placement of the concrete:

Walls and counterforts	10 days
Anti-seep collars, conduits, and cantilever outlet, bents	3 days

IV. PRINCIPAL SPILLWAY (WHEN SPECIFIED)

Corrugated metal pipe shall conform to the requirements of ASTM B-745 or ASTM A-760, as appropriate. Other pipe materials shall conform to specifications suitable for the intended purpose. Anti-seep collars shall be of materials compatible with the pipe and shall be installed so that they are watertight. The pipe shall be installed according to the manufacturer's instructions. The pipe shall be firmly and uniformly bedded throughout its length and shall be installed to the line and grade shown on the drawings.

V. CONCRETE (WHEN SPECIFIED)

Concrete shall conform to the requirement of Construction specification 901 - Concrete.

VI. FOUNDATION AND EMBANKMENT DRAINS (WHEN SPECIFIED)

Foundation and embankment drains shall be placed to the line and grade shown on the drawings. Detailed requirements for drain material and any required pipe shall be shown on the drawings and in the specifications.

Trenches for the filter or filter drains shall be excavated to lines, shapes, and dimensions shown on the drawings. Over excavation disturbing the compacted

foundation will not be permitted, and any disturbed material shall be removed and replaced with compacted earth fill or filter material. The filter material shall be placed and tamped in place to the dimensions shown. When drain pipes are used, they will be installed on line and grade, without displacement due to placement of filter material.

The filter material shall conform to the following gradation unless otherwise specified.

U.S. Standard Sieve Size	Percent Passing
2"	85-90
3/4"	50-90
#16	15-50
Less than #16	0-15

VII. EXCAVATED PONDS

Excavated material may be disposed of away from the job site or placed adjacent to the excavation at locations as shown on the drawings.

Where water storage will occur against fill material, only suitable material excavated from the pond shall be used, and compacted by one of the methods specified above.

The vegetative requirements shall apply to the waste fill area when such fill is within the area of work.

VIII. VEGETATIVE COVER

Unless otherwise specified, a protective cover of vegetative shall be established on the disturbed area. The planting of vegetative materials shall conform to the requirements of Practice Specifications 342, Critical Area Planting.

IX. FENCING (WHEN SPECIFIED)

The embankment, spillway, and other areas shall be fenced as shown on the drawings, and shall be installed in accordance with Practice Specifications 382, Fence.

X. SPECIAL MEASURES

Measures and construction methods shall be incorporated as needed and practical that enhance fish and wildlife values. Special attention shall be given to protecting visual resources and maintaining key shade, food and den trees.

XI. CONSTRUCTION OPERATIONS

Construction operations shall be done in such a manner that erosion and air and water pollution are minimized and held within legal limits. The owner, operator, Contractor or other persons will conduct all work and operations in accordance with proper safety codes for the type of construction being performed with due regards to the safety of all persons and property.

The completed job shall be workmanlike and present a good appearance.

OPERATION AND MAINTENANCE ITEMS

A properly operated and maintained water impoundment structure is an asset to your farm. This structure was designed and installed to entrap and provide storage to runoff water for beneficial use. The estimated life span of this installation is at least 10 years. The life of this installation can be assured and usually increased by developing and carrying out a good operation and maintenance program.

This practice will require you to perform periodic operation to maintain satisfactory performance. Here are some recommendations to help you develop a good operation and maintenance program.

Periodically inspect the spillways and control gates for proper functioning for their ability to maintain the water level to design elevations.

Immediately remove any blockage or obstructions in spillways.

Maintain vigorous growth of vegetative coverings. This includes reseeding, fertilization, and application of herbicides when necessary. Periodic mowing may also be needed to control height.

If fences are installed, they shall be maintained to prevent unauthorized or livestock entry.

Removal of debris that may accumulate at the Pond and immediately upstream or downtream from the pond.

Immediately repair any vandalism, vehicular, or livestock damage to any earthfills, spillways, outlets or other appurtenance.

Make sure all structure drains are functional and soil is not being transported through the drainage system. The screens and/or rodent guards shall also be kept in place.

Eradicate or otherwise remove all rodents or burrowing animals and repair any damage caused by their activity.

Other items specific to your project are listed on the "Practice Requirement" sheet.

U.S DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
CALIFORNIA

PRACTICE REQUIREMENTS
FOR
378 – POND

For: Business Name_____

Job Location_____

County_____ RCD_____ Farm/Tract No._____

Referral No._____Prepared By_____ Date_____

IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.

1. Drawings, No._____ _____ _____

2. Practice Specifications_____,_____,_____

3. Earthfill Compaction by Method:_____

4. Special Requirements: _____

_____

_____

_____

_____

_____

_____

5. Special Maintenance Requirements:_____

_____

_____

NRCS, CA
October, 2003

PRACTICE APPROVAL:

Job Classification: (Ref: Section 501 NEM)

Show the limiting elements for this job. This job is classified as, Class _____

Limiting elements:	Units
Hazard Class _____	_____
Effective height _____	_____ft
Drainage Area _____	_____ac
Storage X Height _____	_____ac-ft^2
Spillway Job Class _____	_____

Design Approved by:_____ Date:_____

LANDOWNER'S/OPERATOR'S ACKNOWLEDGEMENT:

The landowner/operator acknowledges that:

a. He/she has received a copy of the construction drawings and specification, and that he/she has an understanding of the contents, and the requirements.

b. He/she has obtained all the necessary permits.

c. No changes will be made in the installation of the job without prior concurrence of the NRCS technician.

d. Maintenance of the installed work is necessary for proper performance during the project life.

Accepted by:_____ Date:_____

PRACTICE COMPLETION:

I have made an on site inspection of the site (or I am accepting owner/contractor documentation), and have determined that the job as installed does conform to the drawings and practice specifications.

Completion Certification by:

/s/_____ Date _____

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

DAM
(No. and Ac-Ft.)
CODE 402

DEFINITION

An artificial barrier that can impound water for one or more beneficial purposes.

PURPOSE

- Reduce downstream flood damage.
- Provide permanent water storage for one or more beneficial uses such as irrigation or livestock supply, fire control, municipal or industrial uses, or recreational uses.
- Create or improve habitat for fish and wildlife.

CONDITION WHERE PRACTICE APPLIES

This practice applies only to sites meeting all the following criteria:

1. Topographic, geologic, hydrologic and soil conditions at the proposed site are satisfactory for constructing a dam and reservoir.
2. The watershed is protected from erosion to the extent that the sediment yield will not significantly shorten the planned life of the reservoir.
3. Water is available in sufficient quantity and adequate quality to satisfy the intended purposes.

CRITERIA

General Criteria Applicable To All Purposes

All dams designed under this standard shall comply with applicable local, State, and Federal laws, rules and regulations. All required permits must be obtained before construction begins.

A protective cover of vegetation shall be established on all exposed areas of embankments, spillways and borrow areas as climatic conditions allow, according to the guidelines in conservation practice standard 342, Critical Area Planting.

Dams shall be classified as a low, significant or high hazard potential in accordance with NRCS Technical Release 60, Earth Dams and Reservoirs (TR-60), and other references as appropriate for the site-specific conditions.

Design criteria for all dams are contained in TR-60, with the exception that low hazard potential earth dams and appurtenances may be designed to the criteria in Conservation Practice Standard 378, Pond, when:

1. Failure of the dam will not result in loss of life; damage to homes, commercial or industrial buildings, main highways, or railroads; or interruption of the use or service of public utilities.
2. The product of the storage times the effective height of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the auxiliary spillway. The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no auxiliary spillway, the top of the dam is the upper limit; and
3. The effective height of the dam is 35 feet or less.

A principal and auxiliary spillway(s) with needed appurtenances shall be provided, except where the rate and duration of flow can be safely handled by a single spillway for all intended purposes.

The outlet works shall have adequate capacity to release the flow resulting from the combined demands at any time.

Additional outlets may be required to satisfy the supply for downstream water uses such as livestock water, irrigation, or fish and wildlife needs.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

Additional Criteria To Reduce Downstream Flood Damage

Flood control storage may be designed into the permanent storage volume if provisions are made to operate the reservoir for this purpose.

The flood retarding storage capacity requirements shall be sufficient to contain the runoff expected to occur at a frequency consistent with the level of protection to be provided to the downstream benefited area, with proper allowance for discharge through the principal spillway. The flood-retarding storage capacity shall be sufficient to limit the use of the auxiliary spillway to a permissible frequency and duration based upon consideration of the erosion resistance of the spillway material and vegetative protection to be provided.

Additional Criteria For Permanent Water Storage Uses

The reservoir shall include adequate storage volume to meet user demands for all intended purposes of the reservoir. Seasonal variations in demand and the expected losses from seepage and evaporation must be considered to determine the permanent storage volume required for the intended use(s).

The methods, materials, location and capacity of spillways and outlet works shall be selected to safely pass flood discharges and address all functional requirements necessary to facilitate the use of the stored water for the intended purpose(s).

Spillways and other outlet works shall be fenced or otherwise secured to limit human access as necessary to provide for public safety and prevent their use for other than the intended purposes.

If permanent storage is provided for irrigation, the dam and appurtenances shall meet all applicable requirements of NRCS Conservation Practice Standard 436, Irrigation Storage Reservoir.

Site-specific design criteria shall be developed that reflect the functional requirements of the reservoir, dam and appurtenances for the intended recreational benefits.

Additional Criteria For Wildlife Habitat Creation Or Improvement

Site-specific design criteria shall be developed that reflect the functional requirements of the reservoir, dam and appurtenances for the intended wildlife benefits.

When feasible, existing habitat structure or features shall be retained, such as trees in the upper reaches of the reservoir or stumps in the pool area. Upper reaches of the reservoir can be shaped to provide shallow areas, aquatic bed, emergent or scrub-shrub wetland habitat.

If fish are to be stocked, see criteria and guidance in Practice Standard 399, Fishpond Management. Also see Practice Standard 644, Wetland Wildlife Habitat Management for criteria related to wildlife habitat.

CONSIDERATIONS

The plan should consider the potential for changes in the form or function of the watercourse and associated riparian corridor resulting from installation of the dam. Unacceptable negative impacts to natural resources or other uses of the water or areas affected should be mitigated by the design or by imposed operation requirements of the dam.

Visual resource design. The visual design of dams and the reservoir area should be carefully considered in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

The embankment may be shaped to blend with the natural topography. The edge of the reservoir may be shaped so that it is generally curvilinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, both submerged and exposed (above normal water elevation) islands may be added for visual interest and to attract wildlife.

Cultural Resources. Dam installation results in significant ground disturbance. Consider the potential to affect cultural resources in the project area.

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how

the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Water Quantity.

Consider the potential effects on downstream flows and impacts to the environment such as wetlands and aquifers, and also social and economic impacts to downstream uses or users.

Consider the potential for depletion of downstream surface water resources resulting from runoff storage, evaporation from the reservoir surface and seepage from the pool bottom or lake bed.

Consider the potential for increases in surface water volume during normal low flow periods caused by prolonged duration of reservoir releases.

Consider the potential for increase in deep percolation to the ground water resulting from seepage from the reservoir sides and bottom.

Water Quality. Consider the potential for improving downstream surface water quality resulting from trapping of suspended sediments, bedload material, and associated nutrients and pesticides in the pool area.

Consider the potential for increased instability of channel bed and banks. Water discharged from the dam will have reduced sediment content and therefore will have increased sediment transport capacity in the reach downstream from the dam when compared to the pre-dam condition.

Consider the potential for degradation of surface water quality during construction by sediments, fuels, oils, and other chemicals.

Consider the potential influence of the low water outlet elevation on the amount of absorbed nutrients and pesticides in deposited sediments and the potential for their discharge from the reservoir.

Consider the potential for changes in downstream water temperatures and dissolved oxygen content that could result from the design of the outlet structure. Adverse changes should be mitigated if possible in the design of the structure. Where dissolved oxygen may be reduced by outlet placement, plan some means of causing rapid dissolved oxygen recovery.

Consider the potential for increases in soluble nutrients, pesticides, and other contaminants in deep percolating waters caused by seepage through reservoir sides and bottom. Natural or human-induced contaminants may originate from those used in the structure and reservoir area, or may be dissolved in waters from the watershed area.

Consider the potential effects on wetlands and water-related wildlife habitats.

Consider the potential effects of water levels on soil nutrient processes such as plant nitrogen use or denitrification.

Consider the potential effects of soil water level control on the salinity of soils, soil water, or downstream water.

Consider the potential to uncover or redistribute toxic materials such as saline soils at the dam site and borrow areas as a result of earth moving operations.

Fish and Wildlife Habitat. Where fish and wildlife habitat creation or enhancement is not a primary purpose of the structure, the plan should still consider maintaining habitat for fish and wildlife and the potential effects of installing the dam such as:

- Project location and construction should minimize the impacts to existing fish and wildlife habitat.
- When feasible, structure should be retained, such as trees in the upper reaches of the pond, stumps in the pool area. Upper reaches of the pond can be shaped to provide shallow areas and wetland habitat.
- If fish are to be stocked, consider criteria and guidance in Practice Standard 399, Fishpond Management.

Consider the potential for altering fish and wildlife habitat resulting from changes in the quality, quantity, timing, or duration of streamflows after installation of the dam.

Consider the potential for creating a competitive advantage for non-native or undesirable animals or plants resulting from changes in the quality, quantity, timing, or duration of streamflows after installation of the dam.

PLANS AND SPECIFICATIONS

Plans and specifications for installing dams shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

Provisions shall be made as necessary for operation and maintenance requirements and may include a formal plan for larger, more complex dams. The operation and maintenance plan should include an emergency action plan when required by local or state regulations, and for all high hazard class structures.

U.S DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
CALIFORNIA

PRACTICE REQUIREMENTS
FOR
402 – DAM

For: Business Name_____

Job Location_____

County_____ RCD_____ Farm/Tract No._____

Referral No._____Prepared By_____ Date_____

IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.

1. Drawings, No._____ _____ _____

2. Practice Specifications_____,_____,_____

3. Earthfill Compaction by Method:_____

4. Special Requirements: _____

_____

_____

_____

_____

_____

_____

5. Special Maintenance Requirements:_____

_____

_____

NRCS, CA
October, 2003

PRACTICE APPROVAL:

Job Classification: (Ref: Section 501 NEM)

Show the limiting elements for this job. This job is classified as, Class _____

Limiting elements:	Units
Hazard Class _____	_____
Effective height _____	_____ft
Drainage Area _____	_____ac
Storage X Height _____	_____ac-ft^2
Spillway Job Class _____	_____

Design Approved by:_____ Date:_____

LANDOWNER'S/OPERATOR'S ACKNOWLEDGEMENT:

The landowner/operator acknowledges that:

a. He/she has received a copy of the construction drawings and specification, and that he/she has an understanding of the contents, and the requirements.

b. He/she has obtained all the necessary permits.

c. No changes will be made in the installation of the job without prior concurrence of the NRCS technician.

d. Maintenance of the installed work is necessary for proper performance during the project life.

Accepted by:_____ Date:_____

PRACTICE COMPLETION:

I have made an on site inspection of the site (or I am accepting owner/contractor documentation), and have determined that the job as installed does conform to the drawings and practice specifications.

Completion Certification by:

/s/_____ Date _____

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

HILLSIDE DITCH
(feet)
CODE 423

DEFINITION

A channel that has a supporting ridge on the lower side constructed across the slope at defined vertical interval and gradient, with or without a vegetative barrier.

Scope

This standard applies to the planning and design of hillside ditched on steep land.

PURPOSE

To safely control the flow of water by diverting runoff into a protected outlet, thus minimizing erosion and runoff.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to sloping sites where surface flow is damaging sloping upland, and there is sufficient soil depth for constructing a hillside ditch system.

CRITERIA

Location

Hillside ditch systems shall be designed to fit land conditions including soil texture and field slope. They shall drain from the ridge to a stable outlet.

Outlets

Adequate outlets with enough capacity to dispose of discharge water without creating an erosion hazard shall be provided before beginning construction. Such outlets may be a natural or constructed waterway, a stable watercourse, or a stable disposal area, such as well-established pasture. Criteria for a grassed waterway shall be that in Conservation Practice Standard 412 - Grassed Waterway.

Length

Maximum length draining in one direction should be 400 feet. This length may be extended if necessary to reach a stable outlet. In no case shall the maximum length exceed 500 feet.

Grade

The ditch grade may be either constant or variable but must not exceed 3 percent.

Permissible velocities

Velocity in the channel shall be compatible with the soil and shall not exceed the limits in EFH Part 650, Chapter 14, Table 14-3.

Horizontal spacing and cross-section area

The maximum horizontal spacing and minimum cross-sectional area per 100 ft of ditch shall be as specified in Table 1.

Table 1

Average Slope (percent)	Maximum Spacing (feet)	Minimum cross-sectional area per 100-ft length (square feet)
12 or less	40	0.35
12-25	35	.3
25-40	25	.2

Establishment of vegetative barriers will be required in areas where average slopes exceed 25%. Follow guidance of vegetative barrier installation found in Conservation Practice Standard 601 - Vegetative Barrier.

CONSIDERATIONS

When planning this practice, consider the following as applicable:

Cultural Resources Considerations

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Water Quantity

1. Effects upon components of the water budget, especially effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.
2. Effects of snowcatch and melt on water budget components.

Water Quality

1. Filtering effects of vegetation on movement of sediment and dissolved and sediment-attached substances.
2. Short-term and construction-related effects of this practice on the quality of downstream water.
3. Potential for development of saline seeps or other salinity problems resulting from increased infiltration in the presence of restrictive layers.
4. Effects on the visual quality of the water resources.
5. Effects on erosion and movement of sediment, pathogens, and soluble and sediment-attached substances by runoff.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing hillside ditches shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An Operation and Maintenance plan shall be prepared for use by the landowner or operator. The plan shall include provisions to address the following, as a minimum:

Maintaining hillside ditch capacity, ridge height and the outlets.

All vegetative growth and/or debris interfering with the proper functioning of the ditch shall be removed as necessary.

All debris interfering with the outlet operation shall be removed as necessary.

Well-established vegetation shall be maintained in the outlet at all times in order to provide stability.

Sediment accumulated after rainfall period in the ditches shall be removed and disposed of properly, as needed, to maintain the required minimum cross section and grade. Repairs should be made as soon as possible.

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

IRRIGATION STORAGE RESERVOIR
(No. and Ac-Ft)
CODE 436

DEFINITION

An irrigation water storage structure made by constructing a dam, embankment, or pit.

PURPOSE

Conserve water by holding it in storage until it is used to meet crop irrigation requirements.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to irrigation water storage structures that meet all the following criteria:

1. The water supply available to the irrigated area is insufficient to meet conservation irrigation requirements during part or all of the irrigation season.
2. Water is available for storage from surface runoff, streamflow, or a subsurface source.
3. A suitable site is available for the construction of a storage reservoir.

This standard pertains to the planning and functional design of irrigation storage reservoirs. Storage reservoirs shall be planned and located to serve as an integral part of an irrigation system.

This standard does not apply to Irrigation Regulating Reservoirs (552) designed primarily for flow control or to store water for a few hours or days. It does not include detailed design criteria or construction specifications for individual structures or components of the storage facility.

CRITERIA

The installation and operation of an Irrigation Storage Reservoir shall comply with all federal, state and local laws, rules and regulations.

Components addressed in NRCS standards, shall meet design and construction criteria for that particular component. The criteria for the design of components not addressed in NRCS conservation practice standards shall be consistent with sound engineering principles.

Irrigation - The amount of water required to meet variations in water demand within the growing season must be determined to calculate storage requirements. All demand hydrographs shall be computed from the consumptive use-time relationship. Demand hydrographs shall be adjusted to reflect anticipated irrigation efficiency, conveyance losses, and any other consumptive uses, such as leaching or frost control.

Storage - Irrigation storage reservoirs shall be designed to satisfy irrigation requirements in the design area, unless limited by reservoir site characteristics, available watershed yield, or limitations imposed by water rights. Additional capacity shall be provided as needed for sediment storage.

Water releases shall be those increments of the water demand hydrograph that exceed the available direct flows from other sources.

Capacity - Reservoir capacity required to satisfy irrigation demands shall be computed according to the length of the storage period, the anticipated inflow and outflow during this period, and the expected seepage and evaporation losses.

If storage capacity is limited, benefits may be evaluated on the basis of the more frequent availability of water to satisfy irrigation demands for the design area.

Type of structures - The type of dam, embankment, or pit and appurtenant structures shall be based on site-specific hydrologic studies, engineering, geologic investigations, and construction materials.

Foundation, embankment, and spillway - Earthen dams, embankments, pits and appurtenant structures shall be designed to meet the criteria in the NRCS conservation practice standard for Pond, Code 378 or in TR-60, as appropriate.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

Drop spillways, chute spillways, and box spillways shall be designed according to the principles of the Engineering Field Handbook and the National Engineering Handbook, Section 5-Hydraulics; Section 11-Drop Spillways; or Section 14-Chute Spillways, as appropriate.

Overflow protection - Overflow protection shall be provided for enclosed embankments.

Outlet works - Outlet works shall be provided for the controlled withdrawal or release of irrigation water. Outlet works may consist of a direct pumping system, or a gated conduit through or over the dam for gravitational flow to the irrigated area, to a pumping plant or another storage facility.

The capacity of the outlet works shall be sufficient to meet peak period irrigation system demands.

CONSIDERATIONS

When planning this practice the following items should be considered, as applicable:

Cultural Resources Considerations

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of

Water Quantity

1. Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, and deep percolation, and groundwater recharge.

2. Effect on downstream flows or aquifers that would affect other water uses or users.

3. Effects on the volume of downstream flow that could have undesirable environmental, social, or economic effects.

4. Potential use for irrigation water management.

Water Quality

1. Effects on erosion and the movement of sediment and soluble and sediment-attached substances carried by runoff.

2. Effects on the movement of dissolved substance to ground water.

3. Effects on downstream waters that could cause undesirable effects on aquatic and wildlife communities.

4. Short-term and construction-related effects on the quality of downstream water courses.

5. Effects on the temperature of downstream water that could cause undesirable effects on aquatic and wildlife communities.

6. Effects on wetlands or water-related wildlife habitats.

7. Potential for earth -moving to uncover or redistribute toxic materials.

8. Effects on the visual quality of water resources.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing irrigation storage reservoirs shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purposes.

OPERATION AND MAINTENANCE

An Operation and Maintenance plan shall be prepared for use by the landowner or operator. The plan shall provide specific instructions for operating and maintaining facilities to ensure they function properly. The plan shall include the following provisions:

- Periodic cleaning and re-grading of collection facilities to maintain proper flow lines and functionality.
- Periodic checks and removal of debris from trash racks and from inlet and outlet structures to assure proper operation.
- Periodic removal of sediment to maintain design capacity and efficiency.
- Routine maintenance of all mechanical components in accordance with the manufacturer's recommendations.
- Periodic inspection and maintenance of embankments and earth spillways to control erosion and undesirable vegetation.
- Periodic water quality analysis as necessary to evaluate nutrients, pesticides, and pathogens.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

PRECISION LAND FORMING
(acre)
CODE 462

DEFINITION

Reshaping the surface of land to planned grades.

Scope

This standard applies to all precision land-forming operations for drainage and erosion control as well as other purposes such as moisture conservation, leaching, and improving water quality.

PURPOSES

To improve surface drainage, provide land-forming operations for drainage and erosion control as well as other purposes such as moisture conservation, leaching, and improving water quality.

CONDITIONS WHERE PRACTICE APPLIES

On all land that is suitable for the purpose required and where precision land forming is practical. Soils shall be of sufficient depth and of suitable textures so that after precision land forming is completed an adequate root zone remains to permit the planned use of the land and application of proper conservation measure, soil amendments, and fertilizer.

This standard does not apply in areas needing land smoothing (466), or recreation land grading and shaping (566), and irrigation land leveling (464).

CRITERIA

All precision land forming shall be planned as an integral part of an overall system to facilitate the conservation use of soil and water resources.

Design and installation shall be based on adequate engineering surveys and investigation. If the land is to be formed for more than one purpose, it must be formed to meet the requirements of the most restrictive purpose and crop.

All forming work must be designed within the slope limits required for the proposed use and provide for the removal of excess surface water. If other conservation practices such as grassed waterways, drainage field ditches, and filter strips are needed to accomplish the stated purpose, they shall be included in the plans for improvement.

Slope requirements

Slope may be uniform in the direction of flow or may increase or decrease.

Reverse grades in the direction of planned water flow shall not be permitted. Short level sections are permissible to meet field conditions. Cross slopes must be designed so that "breakthroughs" from rainfall runoff are held to a minimum.

Slope to control erosion caused by runoff from rainfall

Design field grades shall be such that erosion caused by runoff from rainfall can be controlled within the limits permissible for conservation farming. When benching between land-formed plots exceeds 1 foot, a permanent grassed area or border ridge must be left between the plots to reduce the possibility of gully erosion.

Surface drainage

All precision land-forming systems shall include plans for removing or otherwise providing for control of excess water.

Designs must provide field elevation and field grades that will permit proper functioning of the planned drainage facilities.

Borrow computations

Excavation and fill material required for or obtained from such structures as benches, ditch pads, and roadways shall be considered part of the precision land-forming design, and the appropriate yardage shall be included when balancing cuts and fills and determining borrow requirements.

CONSIDERATIONS

Cultural Resources Considerations

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice with any others proposed will have any effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Water Quantity

1. Effects on the water budget, especially on volumes and rate of runoff, infiltration, deep percolation and evaporation.
2. Potential for changes in plant growth and transpiration resulting from the changes in the volume of soil water.

Water Quality

1. Effects on erosion and the movement of sediment and soluble and sediment-attached substances carried on by runoff.
2. Effects from the use and management of nutrients and pesticides on surface and ground water quality.
3. Short-term and construction effects of installation on downstream water resources.
4. Potential for earth moving to uncover or redistribute toxic materials, such as saline soils, and make them available to water or plants.
5. Downstream temperature changes.
6. Effects on the visual quality of downstream water resources.

PLANS AND SPECIFICATIONS

Plans and specifications for precision land forming shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance plan must be prepared by the Designer for use by the owner or other responsible for operating this practice. The plan should provide specific instructions for operating and maintaining the system to insure that it functions properly. Such instructions should include periodic checks of drainage structures (field ditches, grassed waterways, etc.) to insure that siltation is not occurring and performing minor maintenance to maintain required field slopes. It should also provide for periodic inspections and prompt repair or replacement of damage components.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

LAND SMOOTHING
(acre)
CODE 466

DEFINITION

Removing irregularities on the land surface.

Scope

This practice applies to operations as rough grading. It does not apply to the "floating" done as a regular maintenance practice on irrigated land or the "planing" done as the final step in precision land forming (462) or in irrigation land leveling (464).

PURPOSE

To improve surface drainage, provide for more effective use of precipitation, obtain more uniform planting depths, provide for more uniform cultivation, improve terrace alignment, facilitate contour cultivation, and improve equipment operation and efficiency.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies on areas where depressions, mounds, old terraces, turn-rows, and other surface irregularities interfere with the application of needed soil and water conservation and management practices.

It is limited to areas having adequate soil depth or where topsoil can be salvaged and replaced.

CRITERIA

The extent of rough grading required and tolerances of the finished smoothing job shall be in keeping with the requirements of the planned cropping system.

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

Irregularities shall be smoothed to the degree required for the planned use.

CONSIDERATIONS

Where possible, the ground surface should be plowed or disked prior to smoothing.

Effects on soil loss due to increased wind erosion potential and subsequent deposition.

Cultural Resources Considerations

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice with any others proposed will have any effect on any federal or state listed Rare, Threatened or Endangered species of their habitat. NRCS's objective is to benefit these species and others of concern or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates the action may adversely affect a listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the Fish and Wildlife Service, National Marine Fisheries Service and/or California

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of the standard, contact the Natural Resources Conservation Service.

Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Water Quantity

1. Effects on the water budget, especially on volumes and rates of runoff, infiltration, and evaporation.
2. Potential for changes in plant growth and transpiration because of changes in the soil water.

Water Quality

1. Effect on erosion and the movement of sediment and soluble substances attached to sediment carried by runoff.
2. Potential for earth moving to uncover or redistribute toxic materials, such as saline soils.

PLANS AND SPECIFICATIONS

Plans and specifications for land smoothing shall be in keeping with this standard and shall describe the requirement for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

Actions shall be carried out to insure that this practice functions as intended. Such actions shall include performing maintenance when needed to insure that surface irregularities are maintained at the degree of smoothness required.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

LINED WATERWAY OR OUTLET
(feet)
CODE 468

DEFINITION

A waterway or outlet having an erosion-resistant lining of concrete, stone, synthetic turf reinforcement fabrics, or other permanent material. The earth above the permanent lining may be vegetated or otherwise protected.

Scope

This standard applies to waterways or outlets having linings of non-reinforced, cast-in-place concrete; flagstone mortared in place; rock riprap; or similar permanent linings. It does not apply to irrigation water conveyance, grassed waterways with stone centers or small lined sections to carry prolonged flows.

PURPOSE

This practice may be applied as part of a resource management system to support one or more of the following purposes:

- Provide for safe conveyance of runoff from conservation structures or other water concentrations without causing erosion or flooding
- Stabilize existing and prevent future gully erosion
- Protect and improve water quality

Properly designed linings may also control seepage, piping, and sloughing or slides.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies if the following or similar conditions exist:

1. Concentrated runoff, steep grades, wetness, prolonged base flow, seepage, or piping is such that a lining is needed to control erosion.
2. Use by people or animals precludes use of vegetation waterways or outlets.
3. Limited space is available for design width, which requires higher velocities and lining.
4. Soils are highly erosive or other soil or climatic conditions preclude using vegetation only.
5. Steep grades, wetness, prolonged base flow, seepage, or piping would cause erosion.
6. Installation of non-reinforced concrete or mortared flagstone linings, shall be made only on low shrink-swell soils that are well-drained or where subgrade facilities are installed.

CRITERIA

General Criteria Applicable To All Purposes

Capacity. The maximum capacity of the waterway flowing at designed depth shall not exceed 200 ft^3/s. The minimum capacity shall be adequate to carry the peak rate of runoff from a 10-year, 24-hour frequency storm. Velocity shall be computed by using Manning's Formula with a coefficient of roughness "n" as follows:

Lining	"n" Value
Concrete	
Trowel finish.....	0.012 – 0.014
Float finish.....	0.013 – 0.017
Shotcrete.....	0.016 – 0.022
Flagstone.....	0.020 – 0.025
1/ Riprap - (Angular Rock)	$n = 0.047(D_{50}\,S)^{0.147}$
Synthetic Turf Reinforcement Fabrics and Grid Pavers	Manufacturer's recommendations

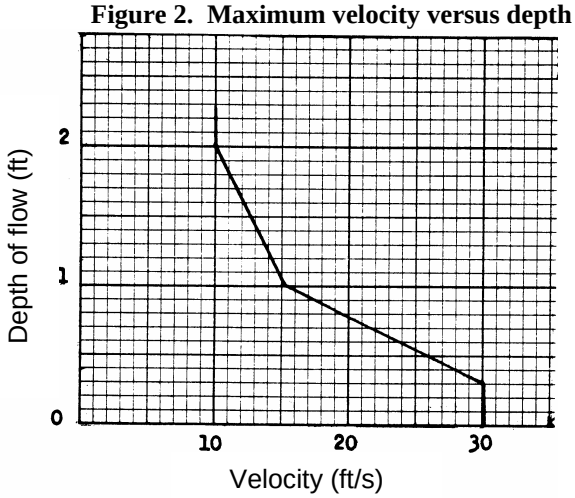
1/ Applies on slopes between 2 and 40% with a rock mantle thickness of 2 x D_{50} where:
D_{50} = median rock diameter (in.),
S = lined section slope (ft./ft.) ($.02 \leq S \leq .4$)

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

Velocity. Maximum design velocity and rock gradation limits for rock riprap-lined channel sections shall be determined using Appendix 16A, Engineering Field Handbook unless a detailed design analysis appropriate to the specific slope, flow depth and hydraulic conditions indicate that a higher velocity is acceptable.

Maximum design velocity for concrete-lined sections should not exceed those using Figure 2.

Figure 2. Maximum velocity versus depth of flow for concrete-lined channels



Maximum design velocity for synthetic turf reinforcement fabrics and grid pavers shall not exceed manufacturer's recommendations.

Stable rock sizes and flow depths for rock-lined channels having gradients between 2 percent and 40 percent may be determined using the following detailed design process. This design process is from **Design of Rock Chutes** by Robinson, Rice, and Kadavy.

For channel slopes between 2% and 10%:

$$D_{50} = [q\,(S)^{1.5}/4.75(10)^{-3}]^{1/1.89}$$

For channel slopes between 10% and 40%:

$$D_{50} = [q\,(S)^{0.58}/3.93(10)^{-2}]^{1/1.89}$$

$$z = [n(q\,)/1.486(S)^{0.50}]^{3/5}$$

D_{50} = Particle size for which 50% of the sample is finer, in.

S = Bed slope, ft./ft.

z = Flow depth, ft.

q = Unit discharge, $ft^3/s/ft$

(Total discharge÷Bottom width)

Except for short transition sections, flow in the range of 0.7 to 1.3 of the critical slope must be avoided unless the channel is straight. Velocities exceeding critical velocity shall be restricted to straight reaches.

Waterways or outlets with velocities exceeding critical velocity shall discharge into an energy dissipator to reduce discharge velocity to less than critical.

Side slope. The steepest permissible side slopes, horizontal to vertical, shall be:

Nonreinforced concrete:
Hand-placed, formed concrete
Height of lining, 1.5 ft or less .....Vertical
Hand-placed screeded concrete or mortared in place flagstone
Height of lining, less that 2 ft .....1 to 1
Height of lining, more than 2 ft .....2 to 1
Slip form concrete:
Height of lining, less than 3 ft .....1 to 1
Rock riprap .....2 to 1
Synthetic Turf Reinforcement Fabrics ..2 to 1
Grid Pavers……1 to 1

Cross section. The cross section shall be triangular, parabolic, or trapezoidal. Cross section made of monolithic concrete may be rectangular.

Freeboard. The minimum freeboard for lined waterways or outlets shall be 0.25 ft above design high water in areas where erosion-resistant vegetation cannot be grown adjacent to the paved or reinforced side slopes. No freeboard is required if vegetation can be grown and maintained.

Lining thickness. Minimum lining thickness shall be:

Concrete.....4 in. (In most problem areas, minimum thickness shall be 5 in. with welded wire fabric reinforcing.)
Rock riprap.....Maximum stone size plus thickness of filter or bedding
Flagstone.....4 in., including mortar bed
Synthetic Turf Reinforcement Fabrics and Grid Pavers……Manufacturer's Recommendations

Lining Durability. Use of non-reinforced concrete or mortared flagstone linings shall be made only on low shrink-swell soils that are well drained or where subgrade drainage facilities are installed.

Related structures. Side inlets, drop structures, and energy dissipaters shall meet the hydraulic and structural requirements for the site.

Outlets. All lined waterways and outlets shall have a stable outlet with adequate capacity to prevent erosion and flooding damages.

Geotextiles. Geotextiles shall be used where appropriate as a separator between rock, flagstone, or concrete linings and soil to prevent migration of soil particles from the subgrade, through the lining material. Geotextiles shall be designed according to AASHTO M288, Section 7.3.

Filters or bedding. Filters or bedding shall be used where appropriate to prevent piping. Drains shall be used to reduce uplift pressure and to collect water, as required. Filters, bedding, and drains shall be designed according to NRCS standards. Weep holes may be used with drains if needed.

Concrete. Concrete used for lining shall be proportioned so that it is plastic enough for thorough consolidation and stiff enough to stay in place on side slopes. A dense durable product shall be required.

Specify a mix that can be certified as suitable to produce a minimum strength of 3,000 pounds per square inch. Cement used shall be Portland cement, Types I, II, or if required, Types IV or V. Aggregate shall have a maximum size of 1-1/2 inch.

Contraction joints. Contraction joints in concrete linings, if required, shall be formed transversely to a depth of about one-third the thickness of the lining at a uniform spacing in the range of 10 to 15 feet. Provide welded wire fabric or other uniform support to the joint to prevent unequal settlement.

Rock riprap of flagstone

Stone used for riprap shall be dense and hard enough to withstand exposure to air, water, freezing, and thawing. Flagstone shall be flat for ease of placement and have the strength to resist exposure and breaking.

Mortar

Mortar used for mortared in-place flagstone shall consist of a workable mix of cement, sand, and water with a water-cement ratio of not more than 6 gallons of water per bag of cement.

CONSIDERATIONS

Cultural resources need to be considered when planning this practice. Where appropriate, local cultural values need to be incorporated into practice design in a technically sound manner.

Consider adding widths of appropriate vegetation to the sides of the waterway for wildlife habitat.

Important wildlife habitat, such as woody cover or wetlands, should be avoided or protected if possible when siting the lined waterway. If trees and shrubs are incorporated, they should be retained or planted in the periphery of the grassed portion of the lined waterways so they do not interfere with hydraulic functions and roots do not damage the lined portion of the waterway. Mid- or tall bunch grasses and perennial forbs may also be planted along waterway margins to improve wildlife habitat. Waterways with these wildlife features are more beneficial when connecting other habitat types; e.g., riparian areas, wooded tracts and wetlands.

Provide livestock and vehicular crossings as necessary to prevent damage to the waterway. Crossing design shall not interfere with design flow capacity.

Establish filter strips on each side of the waterway to improve water quality.

When designing riprap linings and specifying rock gradations, consider that rock delivered to the site is often segregated by size or does not conform exactly to the specified gradation. Adequate safety factor should be incorporated.

Cultural Resources Considerations

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice with any others proposed will have any effect on any federal or state listed Rare, Threatened or Endangered species of their habitat. NRCS's objective is to benefit these species and others of concern or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates the action may adversely affect a listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Water Quantity

1. Effects upon components of the water budget, especially effects on volumes and rates of runoff, infiltration, evaporation transpiration, deep percolation, and ground water recharge.
2. Variability of the practice's effect caused by seasonal and climatic changes.

Water Quality

1. Filtering effects of vegetation on the movement of sediment and dissolved and sediment attached substances will be evaluated.
2. Effects on the visual quality of the water resources.
3. Short-term and construction effects on the quality of water resources.

PLANS AND SPECIFICATIONS

Plans and specifications for lined waterways or outlets shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose(s).

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be provided to and reviewed with the landowner. The plan shall include the following items and others as appropriate.

A maintenance program shall be established to maintain waterway capacity and outlet stability. Lining damaged by machinery or erosion must be repaired promptly.

Inspect lined waterways regularly, especially following heavy rains. Damaged areas shall be repaired immediately. Remove sediment deposits to maintain capacity of lined waterways.

Landowners should be advised to avoid areas where forbs have been established when applying herbicides. Avoid using waterways as turn-rows during tillage and cultivation operations. Prescribed burning and mowing may be appropriate to enhance wildlife values, but must be conducted to avoid peak nesting seasons and reduced winter cover. Control noxious weeds. Do not use as a field road. Avoid crossing with heavy equipment.

REFERENCES

National Engineering Handbook, Part 650, Engineering Field Handbook: Chapter 16, Streambank and Shoreline Protection.

Robinson, K.M., C.E. Rice, and K.C. Kadavy. 1998. Design of Rock Chutes. Transactions of ASAE, Vol. 41(3): 621-626.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

468 - LINED WATERWAY OR OUTLET

I. SCOPE

The work shall consist of grading and shaping a waterway to the lines and grades as shown on the drawings, and includes furnishing and placing a lining of the type and thickness as specified.

II. MATERIALS

Concrete, when specified, will be placed in conformance with the requirements of Construction Specification 901 - Concrete.

Rock riprap, when specified, rock will be placed in conformance with the requirements of Construction Specification 907 - Rock Riprap.

Other materials, when specified other materials will be placed in conformance with the requirements of Special Construction Specifications to be attached to the drawings.

Geotextile fabric, when specified will conform to the required of Construction Specification 905 - Geotextile Fabric.

III. SITE PREPARATION

The foundation area shall be cleared of all trees, stumps, roots, brush, boulders, sod, debris, and other objectionable materials. All topsoil shall be removed and stockpiled until the needed for spreading over areas requiring vegetative cover. Removal operations shall be done in such a manner as to avoid damage to other trees and property.

IV. FOUNDATION

To shape the required cross-section, excavation shall be to the lines and grades as shown on the drawings, or as staked in the field. Subgrade shall be firm and free of water. Any earthfill required to bring subgrade to grade, shall be placed in layers not exceeding 8-inches, and compacted to the same density as the adjacent undisturbed material.

V. PLACEMENT

Placement of the lining materials shall be conformance of the Construction Specification as shown on the Practice Requirement sheet, and as shown on the drawings.

VI. VEGETATIVE COVER

Unless otherwise specified, a protective cover of vegetation shall be established on the disturbed area. The planting of vegetative materials shall conform to the requirements of Practice Specification 342, Critical Area Planting.

VII. SPECIAL MEASURES

Measures and construction methods shall be incorporated as needed and practical that enhance fish and wildlife values. Special attention shall be given to protecting visual resources and maintaining key shade, food and den trees.

VIII. CONSTRUCTION OPERATIONS

Construction operations shall be done in such a manner that erosion and air and water pollution are minimized and held within legal limits. The owner, operator, Contractor or other persons will conduct all work and operations in accordance with proper safety codes for the type of construction being performed with due regards to the safety of all persons and property.

The completed job shall be workmanlike and present a good appearance.

OPERATION AND MAINTENACE ITEMS

A properly operated and maintained lined waterway or an outlet for excess water is an asset to your farm. This lined waterway was designed and installed to safely remove or discharge excess water from your farm. The estimated life span of this installation is at least 10 years. The life of this practice can be assured and usually increased by developing and carrying out a good operation and maintenance program.

This practice will require you to perform periodic maintenance and may also require operational items to maintain satisfactory performance. Here are some recommendations to help you develop a good operation and maintenance program.

Maintain vigorous growth of vegetative coverings. This includes reseeding, fertilization and application of herbicides when necessary. Periodic mowing may also be needed to control height.

Check concrete surfaces for accelerated weathering, spalling, settlement, alignment or cracks. Repair

immediately as they may expose reinforcement and reduce the structure life.

Check metal surface for rust and other damage especially sections in contact with earthfill and with other materials. Repair or replace damaged section and apply paint as protective covering.

Check all rock riprap section for accelerated weathering and displacement, as the rock was placed to prevent structural damage during the design flow. Replace to original grades if necessary.

Remove all foreign debris that hinders system operations.

Limit livestock usage to section that will not be hindered by their activity.

Maintain all fences to prevent livestock and unauthorized entry.

Other items specific to your project are listed on the "Practice Requirement" sheet.

U.S DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
CALIFORNIA

PRACTICE REQUIREMENTS
FOR
468 - LINED WATERWAY OR OUTLET

For: Business Name_____

Job Location_____

County_____ RCD_____ Farm/Tract No._____

Referral No._____Prepared By_____ Date_____

IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.

1. Drawings, No._____ _____ _____

2. Practice Specifications_____,_____,_____

3. Type of Lining_____Thickness_____(inches)(mils)

4. Elevation of turnout in relation to field elevation:_____

5. Special Requirements:_____

_____

_____

_____

_____

_____

6. Special Maintenance Requirements:_____

_____

_____

NRCS, CA
October, 2003

PRACTICE APPROVAL:

Job Classification: (Ref: Section 501 NEM)

Show the limiting elements for this job. This job is classified as, Class _____

Limiting elements:	Units
Drainage area _____	_____ acres
Capacity _____	_____ cfs
_____	_____
_____	_____

Design Approved by:_____ Date:_____

LANDOWNER'S/OPERATOR'S ACKNOWLEDGEMENT:

The landowner/operator acknowledges that:

a. He/she has received a copy of the construction drawings and specification, and that he/she has an understanding of the contents, and the requirements.

b. He/she has obtained all the necessary permits.

c. No changes will be made in the installation of the job without prior concurrence of the NRCS technician.

d. Maintenance of the installed work is necessary for proper performance during the project life.

Accepted by:_____ Date:_____

PRACTICE COMPLETION:

I have made an on site inspection of the site (or I am accepting owner/contractor documentation), and have determined that the job as installed does conform to the drawings and practice specifications.

Completion Certification by:

/s/_____ Date _____

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

POND SEALING OR LINING - FLEXIBLE MEMBRANE

(NO.)
CODE 521A

DEFINITION

A manufactured hydraulic barrier consisting of a functionally continuous sheet of synthetic or partially synthetic, flexible material.

PURPOSE

To control seepage from water and waste impoundments for water conservation and environmental protection.

CONDITION WHERE PRACTICE APPLIES

On ponds and water storage structures that require treatment to control seepage rates within acceptable limits.

On waste storage and waste treatment facilities built in or of excavated earth, and which require treatment to prevent the migration of contaminants from the site.

CRITERIA

Structures to be lined shall have been constructed to meet all applicable NRCS standards. All inlets, outlets, ramps, and other appurtenances may be installed before, during, or after the liner placement, but shall be done in a manner that does not damage or impair the proper operation of the liner.

Design of the flexible membrane shall be in accordance with manufacturer recommendations. All flexible membrane installations shall meet the material and installation requirements of the plans and specifications provided for each installation, and shall be certified by the installer.

Minimum Criteria for Membranes	
Type	**Limiting Parameter**
HDPE	40 mil thickness
LLDPE	40 mil thickness
EPDM	45 mil thickness
PVC	30 mil thickness
PP	
(Reinforced)	36 mil thickness
(Nonreinforced)	40 mil thickness
GCL	0.75 lb./sq ft (bentonite)

HDPE = High Density Polyethylene
LLDPE = Linear Low Density Polyethylene
EPDM = Synthetic Rubber
PVC = Polyvinyl Chloride
PP = Polypropylene
GCL = Geosynthetic Clay Liner

PVC and GCL liners shall be covered with soil a minimum of 12 inches thick.

Select soil materials shall be used as cover for liners where required for the proper performance, protection, and durability of the installation. Cover soils shall not contain sharp, angular stones or any objects that could damage the liner. Maximum allowable particle size of soil cover material shall be 3/8-in (10 mm), unless the liner is cushioned by a needle punched, non-woven geotextile. Cover materials shall be stable under all operational and exposure conditions.

Subgrade preparation shall conform to manufacturer recommendations. Subgrade materials shall not contain sharp, angular stones or any objects that could damage the liner or adversely impact its function.

All banks and fills in the area to be lined must be sloped no steeper than 3:1. Slope the bottom of the pond towards the sides, at 0.005 feet/feet, to allow migration of any gas from beneath the liner.

Liners shall be vented if organic soils are present. Manufacturer recommendations shall be followed regarding vent type.

Vents, when required, shall be spaced at no greater than 50 foot intervals. Install gas vents above the high water line and about 1 foot below the top of bank. The vent must be covered to protect the liner and prevent rainfall from getting below the liner.

Provide a cushion or padding under the liner if the subgrade particles are GM materials greater than $^{3}/_{8}$ inch or GCL materials greater than ½ inch. Vented liners also require padding or a cushion. Padding or cushion can be a heavy non-woven geotextile or properly graded soil on non-vented liners. Padding or cushion can be a heavy non-woven geotextile or sand layer on vented liners.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

All liners shall be anchored to prevent slippage.

All structures shall be fenced to protect the liner from damage and for the safety of humans, livestock, wildlife, and pets. Warning signs shall be provided and posted in a visible location.

Manufacturer recommendations shall be followed with regard to protection from weather and exposure.

CONSIDERATIONS

If high water tables could adversely affect the proper functioning of the facility, interceptor or relief type drainage systems should be considered to control uplift pressures. Consider use of sandbags on exposed liners to provide anchorage against uplift by wind.

Cultural Resources Considerations

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared for specific field sites in accordance with this standard and shall describe the requirements for applying the practice to achieve its intended uses.

OPERATION AND MAINTENANCE

A plan for operation and maintenance of the liner shall be prepared. The plan should include specific instructions for operating and maintaining the system to ensure that it functions properly. It should also provide for periodic inspections and prompt repair or replacement of damaged components.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

521A - POND SEALING OR LINING FLEXIBLE MEMBRANE

I. SCOPE

The work shall consist of furnishing and installing a Flexible Membrane Liner, the necessary mechanical attachments, cover soil, and concrete pads as shown in the drawings or as specified herein.

II. SHIPPING AND STORAGE

The liner shall be shipped to the job site in a manner not to damage the rolls or panels. The liner shall be stored and protected from puncture, dirt, grease, excessive heat, or other damage. Rolls shall be stored on a prepared smooth surface (not wooden pallets) and shall be stacked no more than three rolls high. Palleted panels shall not be stacked on top of one another.

Damaged material shall be repaired or replaced at the contractor's expense. Damaged material that cannot be satisfactorily repaired to comply with the requirements of Material Specification 594 shall not be used and shall be removed from the job site.

III. SUBGRADE PREPARATION

The area to be lined shall be drained and allowed to dry until the surface is firm and can support the equipment that must travel over it during installation of the lining.

All banks and fills in the area to be lined must be sloped no steeper than 3:1.

The foundation area for flexible membrane linings shall be smooth and free of projections that can damage the lining. Subgrade preparation shall include removal of large and sharp objects such as rocks, hard clods, stumps and roots. Remove soft materials and backfill with appropriate subgrade material to provide a uniformly compacted base may be required. Smooth the surface by rolling with a rubber-tired or steel wheel roller or cover with a cushion of fine soil.

When specified, an effective sterilant shall be applied to the subgrade at the rate recommended by the manufacturer.

An anchor trench shall be excavated completely around the area to be lined at the planned elevation of the top of the lining. The trench shall be a minimum of 18 inches deep and 18 inches wide. Location of the anchor trench shall be no closer than 3 feet from the crest of the berm. Material from the trench shall be stored to use as backfill of the trench. The corners of the trench shall be slightly rounded to avoid sharp bends in the liner.

Backfill soil shall be compacted by rolling with rubber-tired equipment or a manually directed power tamper to provide a stable anchor trench for the liner.

The Engineer will inspect and approve the subgrade prior to placement of any liner material.

IV. PLACEMENT

Placement of the geotextile or soil padding and drains, if required, shall be completed prior to placement of the liner.

The liner shall not be placed during fog, precipitation, or in the presence of excessive winds. HDPE and LLDPE liners shall not be placed in temperatures less than 50 degrees Fahrenheit. PVC liners shall not be placed in temperatures less than 40 degrees Fahrenheit or greater than 105 degrees Fahrenheit. EPDM liners shall not be placed in temperatures less than 0 degrees Fahrenheit or greater than 120 degrees Fahreheit.

The liner shall be deployed with a minimum of handling. Liner rolls shall be deployed using a spreader bar assembly attached to a front-end loader, track-hoe bucket, or by other method approved by the liner manufacturer. The liner shall be positioned with the seams up and down the slope. Position the liner to minimize folds with enough overlap to ensure proper seaming. Place sandbags to protect the liner from wind uplift forces. The liner shall be placed on a daily basis and seamed and secured by the end of the workday. No construction equipment shall be allowed directly on the liner except for light ATV's, with ground pressure not exceeding 5 pounds per square inch, and generators to power the seaming equipment.

The liner shall be loosely laid over the foundation with sufficient slack (about 2 percent) to accommodate thermal expansion and contraction encountered during

construction. Each panel shall be laid out and positioned to minimize the number and length of the liner field joints and to be consistent with accepted installation practice. The methods used to place panels shall minimize wrinkles especially along field seams. Wrinkles shall not exceed 6-inches in height or "fold over" during soil cover placement or other load application.

Approximately 36 inches of the top of the lining shall be placed in the anchor trench. The trench shall be backfilled and compacted to the density of the adjacent soil.

For covered liners, the material to be used as a protective cover shall be free of large clods, sharp rocks, sticks, and other objects that can puncture the lining. The cover shall be placed to the specified depth without damage to the membrane.

V. MATERIALS

The liner, welding rod, vent covers, pipe boots, metal battens, bolts, embed channel, and sealant shall conform to the requirements of Material Specification 521A, the Practice Requirements Sheet, and those shown on the drawings.

All lining materials shall be free of damage or defect. Each package delivered to the job site shall bear the name of the material, the manufacturer's name or symbol, the quantity therein, and the thickness or weight of the material.

VI. SEAMING METHODS

HDPE, LLDPE, PP - The primary method of seaming shall be hot wedge fusion welding. Fillet extrusion welding shall be used for repairs, T-seams, and detail work. Hot Air Fusion or Chemical Fusion welding may be used for PP. Seaming shall not be attempted when the ambient sheet temperature is below 45 degrees Fahrenheit or above 90 degrees Fahrenheit.

PVC - Seams shall be joined using hot wedge fusion welding, hot air fusion welding, chemical fusion welding, or an adhesive. Special precautions, as recommended by the manufacturer, shall be taken for seam joining if the ambient sheet temperature is above 105 degrees Fahrenheit. Seam joining shall not be attempted when the ambient sheet temperature is below 40 degrees Fahrenheit or above 140 degrees Fahrenheit.

EPDM - Seams shall be joined using double-faced inseam tape or a cover strip recommended by the manufacturer. Seaming shall not be performed when the ambient sheet temperature is below 0 degrees Fahrenheit or above 120 degrees Fahrenheit.

GCL - Seams shall be formed by overlapping the panels a minimum of 9 inches. A granular bead of clay similar to the material used in the clay liner shall be poured continuously along the seam at a minimum rate of 1/4 pound per linear foot of seam.

VII. SEAMING PROCEDURES

Seaming shall extend to the outside edge of the liner to be placed in the anchor trenches. Seaming shall not be conducted in the presence of moisture, dust, dirt, standing water, or soft subgrade. Seaming procedures shall be in accordance with the liner manufacturer specifications.

Hot wedge welding - Hot wedge welding shall be accomplished by a double-wedge fusion welder that produces a double track weld. Welding equipment and accessories shall be approved by the liner manufacturer. To produce acceptable seams for the site-specific condition, the welder shall be calibrated at the beginning of each seaming period.

Fillet extrusion welding - Extrusion welding equipment and accessories shall be approved by the liner manufacturer. To produce acceptable seams for the site-specific condition, the extrusion welder shall be calibrated once per day at the beginning of each seaming period. To ensure proper bonding of the extrusion weld, edges of the patch material and the adjacent liner shall be properly abraded by a light grinding. This operation shall be done no more than 15 minutes before the welding operation. The abrasion shall remove no more than 10 percent of the material thickness.

Hot Air welding - Hot air welding shall be accomplished by a single or double tracked fusion welder. Welding equipment and accessories shall be approved by the liner manufacturer. To produce acceptable seams for the site-specific condition, the welder shall be calibrated at the beginning of each seaming period.

Chemical Fusion welding - The chemical fusion agent shall be applied to both panels by a squeeze bottle or paint brush. The width of application shall be a minimum of 2 inches. Light pressure shall be applied by an acceptable roller to force intimate contact

between the panels. Excess agent extruded from the seam shall be removed immediately.

Adhesive - The adhesive shall be applied to both panels by a paint brush or other approved method. The adhesive shall cover the entire seam overlap. Light pressure shall be applied by an acceptable roller to force intimate contact between the panels. Excess adhesive from the seam shall be removed immediately. Adhesive shall be approved by the manufacturer and consist of material with a life expectancy similar to the liner material.

Inseam Tape - A primer shall be applied to both panels by a scrub pad or other approved method. The primer shall cover the entire seam overlap. Once the primer has flashed, install the tape on the bottom sheet, remove tape backing, place overlap, and roll it with light pressure to force intimate contact between the panels.

Cover Strip - A primer shall be applied to both panels by a scrub pad or other approved method. Close and roll the seam. Apply additional primer to cover the entire seam overlap. Once the primer has flashed, install the cover strip and roll it with light to force intimate contact between the cover strip and the panels.

Seam overlap - Liner panels shall have a minimum overlap of 4 inches for hot wedge welding, hot air welding, chemical fusion welding, adhesive seams, inseam tape, and cover strip seams. A minimum overlap of 3 inches shall be used for extrusion welded seams. Upslope panels shall overlap downslope panels to provide a shingle effect for drainage.

GCL seam overlap - Native soil and debris should be removed from the contacting GCL surfaces to ensure seam integrity. The GCL panels should be adjusted to smooth out any wrinkles or creases between adjacent panels.

VIII. SEAM TESTING

Seams shall be tested under field conditions at the beginning of each seaming period. Three specimens shall be tested by a tensiometer in shear and peel modes. Test seams shall meet the requirements of Material Specification 521A.

Field seams shall be non-destructively tested over their entire length to ensure seam continuity. Seam testing shall be performed as the seaming work progresses, not at the completion of field seaming.

Nondestructive seam testing - Air pressure tests shall be performed in accordance with ASTM D 5820 on all double-track fusion seams. The air pressure test equipment and procedures shall conform to this specification and the liner manufacturer's specifications. Seal both ends of the seam to be tested. Insert the pressure needle into the seam's air channel. Pressurize the air channel through the needle to 25 to 30 pounds per square inch for HDPE, LLDPE, and PP liners, 15 to 25 pounds per square inch for 30 mil PVC liners, and 20 to 30 pounds per square inch for 40 mil PVC liners.

Monitor any pressure drops for 5 minutes. A loss of pressure in excess of 4 pounds per square inch for HDPE, LLDPE, and PP liners, 5 pounds per square inch for 30 mil PVC liners, 4 pounds per square inch for 40 mil PVC liners, or a continuous loss of pressure is an indication of a leak. Terminate the test by relieving the pressure from the opposing end of the seam. The pressure shall immediately drop to zero upon opening the opposing end of the seam. If this does not occur, the seam channel shall be checked for obstructions and retested. All defects shall be marked for repair.

Vacuum box tests shall be performed in accordance with ASTM D 5641 on all extrusion welds and may be used on PP Chemical fusion welds. Vacuum box tests will not be allowed on PVC liner seams. The vacuum box equipment and test procedure shall conform to this specification and the liner manufacturer's specifications. Apply soapy water solution to the seam area to be tested. The vacuum box, equipped with a transparent viewing window, shall be centered over the seam area and a vacuum of 4 to 8 pounds per square inch shall be drawn. The seam area shall be visually monitored for any soap bubbles for 10 seconds. Seam testing shall continue by overlapping a minimum of 3 inches between each test interval. All defects shall be marked for repair.

Air lance tests shall be performed in accordance with ASTM D 4437 on single-track fusion welds, chemical fusion welds, and adhesive PVC seams, EDPM seams, and may be used on PP chemical fusion seams. The air lance test shall apply a pressure of 50 pounds per square inch through a 3/16-inch nozzle held within 2 inches of the seam. A seam that flaps or produces a whistling sound is an indication of a leak.

Destructive seam testing - If required, seam samples shall be cut at no more than one sample per 500 feet of weld for destructive seam testing. All destructive seam samples shall be tested by a tensiometer in shear and peel modes to verify seams meet the requirements of Material Specification 521A.

IX. REPAIRS

All defective liner areas and bad seams shall be repaired and tested before the installation is completed.

Tears, punctures, material defects - All tears, punctures, and material defects in liner shall be repaired by installing a patch over the defective area. Surfaces of the liner to be patched shall be cleaned before the repair. All patches shall be of the same liner material and extend a minimum of 6 inches beyond the edges of the defect area. All patches shall have rounded corners and shall be seamed to the liner. Alternatively, a bead of extrudant shall be placed over all holes that are less than 0.25 inch in diameter on HDPE, LLDPE, and PP liners.

Seam repair - All failed seams shall be repaired by installing a cap strip over the entire length of failed seam. The cap strip shall be of the same liner material and shall extend beyond the failed seam a minimum of 6 inches in all directions. Alternatively, the seam along the upper flap can be extrusion welded to the liner along the entire length of the failed seam.

X. MECHANICAL ATTACHMENTS

The liner shall be mechanically attached to pipe, concrete, or steel structure as shown in the drawings and according to the liner manufacturer's specification.

Pipe boots - Factory fabricated pipe boots shall be used wherever possible. Pipe boots fabricated in the field shall be from the same material as the liner. The boots shall be welded and clamped to pipes of the same material as the liner. They shall be clamped to other types of pipe as shown in the drawings, or as recommended by the manufacturer, to provide a leak-free attachment.

Metal battens - Metal battens shall meet the requirements of Material Specification 521A and shall be installed according to the drawings and the liner manufacturer's specifications. The battens shall be bolted to structure concrete by bolts on 6-inch intervals to create a leak-free connection under submerged conditions. Bolt spacing shall be increased to 12 inches for connections above the fluid level.

Embed channel - Embed channel shall meet Material Specification 521A and be installed according to drawings and the liner manufacturer's specification. The embed channel shall be prefabricated to the dimensions as shown in the drawings. All sections of the channel shall be welded to the next section continuously to prevent gaps between sections or pieces of the embed channel before their installation in the concrete forms. All corners shall be miter cut and welded all around.

Gas vents and drainage - Gas vent flaps or vent pipes shall be installed in accordance with the drawings to provide adequate venting for the liner system. Drainage systems will be installed as specified and as shown on the drawings.

GCL penetration and structure sealing - Granular clay of a material similar to the material in the GCL shall be packed around the pipe or structure and on the adjacent area so that it is encased in a pure clay seal. The GCL panel should be placed over the penetration and slit into a "pie" configuration where the pipe is to protrude. More granular clay is to be spread around the cut edges and over adjacent areas.

Covering the liner - Cover geomembranes as soon as possible after the liner installation. Cover GCL liners on the same day as installation to prevent hydration of the clay layer. Cover soil on liners, other than GCL, shall be placed during the coolest part of the day.

Work material, from the bottom of the slope to the top, onto the liner maintaining at least 12 inches of soil under the wheels or tracks of light equipment.

Cover soils shall meet the same requirements, as specified for subgrade soils in Section III of this specification. Cover soil placement shall be performed by a loader or bulldozer with ground pressure of less than 8 pounds per square inch. Cover soil shall not be dropped onto the liner from a height greater than 3 feet.

Following construction of an access ramp, the soil shall be placed from the bottom of the slope upward.

Construction equipment or machinery shall not operate directly on the liner.

XI. VEGETATIVE COVER

Unless otherwise specified, a protective cover of vegetation shall be established on the disturbed area outside of the treated area. The planting of vegetative

materials shall conform to the requirements of Practice Specification 342, Critical Area Planting.

XII. SPECIAL MEASURES

Measures and construction methods shall be incorporated as needed and practical that enhances fish and wildlife values. Special attention shall be given to protecting visual resources and maintaining key shade, food and den trees.

XIII. CONSTRUCTION OPERATIONS

Construction operations shall be done in such a manner that erosion and air and water pollution are minimized and held within legal limits. The owner, operator, Contractor or other persons will conduct all work and operations in accordance with proper safety codes for the type of construction being performed with due regards to the safety of all persons and property.

The completed job shall be workmanlike and present a good appearance.

XIV OPERATION AND MAINTENANCE ITEMS

A properly operated and maintained pond is an asset to your farm. This pond sealing was designed and installed to limit the seepage loss from the pond. The estimated life span of this system is at least 20 years. The life of this system can be assured and usually increased by developing and carrying out a good operation and maintenance program.

This practice will require you to perform periodic operation and maintenance to maintain satisfactory performance. Here are some recommendations to help you develop a good operation and maintenance program.

Maintain the soil covering on liners at the construction depth.

Equipment is permitted only on liners with a minimum soil cover of 12 inches. If equipment is allowed on a liner covered with a minimum 12 inches of soil, avoid excessive speeds and sharp turns.

Prevent all livestock from using any area of the pond which was sealed by artificial liners.

Fences shall be maintained to provide warning and/or prevent unauthorized human or livestock entry.

Settlement or cracks in the soil weaken earthen sections and may accelerate the development of flow paths that may result in structure failure. This should be investigated to determine the cause and immediately repaired.

Eradicate or otherwise remove all rodents or burrowing animals. Immediately repair any damage caused by their activity.

Immediately remove any debris that may harm or reduce the effectiveness of sealants.

Immediately repair any vandalism, vehicular, or livestock damage to any earthfills, spillways, or outlets or other apparatuses.

Other items specific to your project are listed on the "Practice Requirement" sheet.

U.S DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
CALIFORNIA

PRACTICE REQUIREMENTS
FOR
521A - POND SEALING OR LINING
FLEXIBLE MEMBRANE

For: Business Name_____

Job Location_____

County_____ RCD_____ Farm/Tract No._____

Referral No._____Prepared By_____ Date_____

IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.

1. Drawings, No._____ _____ _____

2. Practice Specifications_____,_____,_____

3. Type of lining:_____Thickness_____mills

4. Soil cover_____

5. Soil sterilant_____rate of application_____lbs/yd^2

6. Special Requirements:_____

_____

_____

_____

7. Special Maintenance Requirements:_____

_____

_____

NRCS, CA
October, 2003

PRACTICE APPROVAL:

Job Classification: (Ref: Section 501 NEM)

Show the limiting elements for this job. This job is classified as, Class _____

Limiting elements:	Units
Area treated _____	_____acres
Head on lining _____	_____ft
_____	_____
_____	_____

Design Approved by:_____ Date:_____

LANDOWNER'S/OPERATOR'S ACKNOWLEDGEMENT:

The landowner/operator acknowledges that:

a. He/she has received a copy of the construction drawings and specification, and that he/she has an understanding of the contents, and the requirements.

b. He/she has obtained all the necessary permits.

c. No changes will be made in the installation of the job without prior concurrence of the NRCS technician.

d. Maintenance of the installed work is necessary for proper performance during the project life.

Accepted by:_____ Date:_____

PRACTICE COMPLETION:

I have made an on site inspection of the site (or I am accepting owner/contractor documentation), and have determined that the job as installed does conform to the drawings and practice specifications.

Completion Certification by:

/s/_____ Date _____

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

POND SEALING OR LINING - FLEXIBLE MEMBRANE

MATERIAL SPECIFICATION

1. Scope

This specification covers the quality of High Density Polyethylene (HDPE), Linear Low Density Polyethylene (LLDPE), Ethylene Propylene Diene Terpolymer (EPDM), Poly Vinyl Chloride (PVC, and Polypropylene (PP) flexible liner, seams, gaskets, metal battens, bolts, embed channels, clamps, and sealant, as referred to by Conservation Practice Standard and Specifications, 521A Pond Sealing or Lining - Flexible Membrane.

2. Material

***Liner*—**The liner shall have a nominal thickness as specified. The liner shall be manufactured to be suitable for use in the specified exposed or buried conditions. It shall conform to the requirements of this specification, Construction Specification 97 and the requirements shown on the drawings.

***Gaskets, metal battens, clamps, bolts, embed channels, and sealant*—**Gasket material shall be neoprene, closed cell medium, 0.25 inch thick, with adhesive on one side, or other gasket material as approved by the liner manufacturer. Metal battens shall be 0.25 inch thick by 2 inches wide stainless steel. Clamps shall be 0.5-inch-wide stainless steel. Bolts shall be stainless steel. Embed channel shall have the same properties as the liner. Sealant shall be as recommended by the manufacturer. Silicone sealant shall not be used with PVC liner materials.

***Vents and Pipe Boots*—** Vents and pipe boots shall be made of the same material as the liner.

3. Liner properties

The liner shall be uniform in color, thickness, and

surface texture. The liner shall be resistant to fungal or bacterial attack and free of cuts, abrasions, holes, blisters, contaminants, and other imperfections.

***HDPE and LLDPE* —**The HDPE or LLDPE liner shall be manufactured from virgin polymer material and shall meet the property values specified under tables 521A–1 through 521A–4 as applicable.

***EPDM* —**The EPDM liner shall be formulated from virgin compounding materials and shall meet the property values specified under tables 521A–5 through 521A–6 as applicable. Regrind, reworked, or trim materials shall be from the same manufacturer and the same formulation as the liner. Recycled materials shall not be allowed.

***PVC* —** The PVC liner shall be manufactured from virgin polymers and other compounding materials and shall meet the property values specified under table 521A–7 as applicable. Regrind, reworked, or trim materials shall be from the same manufacturer and the same formulation as the liner. No more than 10 percent regrind, reworked, or trim materials shall be used to manufacture the liner. Recycled materials shall not be allowed.

The PVC compound shall consist of 50 to 70 percent PVC resin, by weight. Liquid plasticizers shall be mixed until completely absorbed by the resin powder. Other additives shall be thoroughly mixed into the resin.

***PP* —**The PP liner shall be manufactured from virgin polymer material and shall meet the property values specified under tables 521A–8 and 521A–9 as applicable.

A reinforced PP liner shall consist of one ply of reinforcing polyester (scrim) between two sheets of PP. The polyester scrim shall be of an open weave that permits strike-through of the PP.

Table 521A–1 Requirements for smooth HPDE liner

Property	Test methods	Requirements* - - - - - - - - - - - - - nominal thickness - - - - - - - - - - - - -		
		30 mil	40 mil	60 mil
Density, g/cc	ASTM D 1505	0.940	0.940	0.940
Tensile properties	ASTM D 638 (type IV at 2 in/min)			
yield stress, lb/in		63	84	126
break stress, lb/in		114	152	228
yield elongation, %		12	12	12
break elongation, %		700	700	700
Tear resistance, lb	ASTM D 1004	21	28	42
Puncture resistance, lb	ASTM D 4833	54	72	108
Carbon black content, %	ASTM D 1603	2-3	2-3	2–3
Carbon black dispersion	ASTM D 5596	Cat 1–2	Cat 1–2	Cat 1–2
Seam properties	ASTM D 6392			
shear strength, lb/in		60	80	120
peel strength, lb/in**		39/FTB	52/FTB	78/FTB

* All values, unless specified otherwise, are minimum average roll values as reported for the test method.
** Film tear bond: A failure of one of the bonded sheets by tearing prior to complete separation in the bonded area.

Table 521A–2 Requirements for textured HDPE liner

Property	Test methods	Requirements* - - - - - - - - - - - - - nominal thickness - - - - - - - - - - - - -		
		30 mil	40 mil	60 mil
Density, g/cc	ASTM D 1505	0.940	0.940	0.940
Tensile Properties	ASTM D 638 (type IV at 2 in/min)			
yield stress, lb/in		63	84	126
break stress, lb/in		45	60	90
yield elongation, %		12	12	12
break elongation, %		100	100	100
Tear resistance, lb	ASTM D 1004	21	28	42
Puncture resistance, lb	ASTM D 4833	45	60	90
Carbon black content, %	ASTM D 1603	2 - 3	2 - 3	2 – 3
Carbon black dispersion	ASTM D 5596	Cat 1–2	Cat 1–2	Cat 1–2
Seam properties	ASTM D 6392			
shear strength, lb/in		60	80	120
peel strength, lb/in**		39/FTB	52/FTB	78/FTB

* All values, unless specified otherwise, are minimum average roll values as reported by the specified test methods.
** Film tear bond: A failure of one of the bonded sheets by tearing prior to complete separation in the bonded area.

Table 521A–3 Requirements for smooth LLDPE liner

Property	Test methods	Requirements* nominal thickness		
		30 mil	40 mil	60 mil
Density, g/cc	ASTM D 1505	0.915	0.915	0.915
Tensile properties	ASTM D 638 (type IV at 2 in/min)			
break stress, lb/in		114	150	228
break elongation, %		800	800	800
Tear resistance, lb	ASTM D 1004	16	22	33
Puncture resistance, lb	ASTM D 4833	42	56	84
Carbon black content, %	ASTM D 1603	2–3	2–3	2–3
Carbon black dispersion, %	ASTM D 5596	Cat 1–2	Cat 1–2	Cat 1–2
Seam properties	ASTM D 6392			
shear strength, lb/in		44	58	90
peel strength, lb/in**		37/FTB	50/FTB	75/FTB

* All values, unless otherwise specified, are minimum average roll values as reported for each test method

** Film tear bond: A failure of one of the bonded sheets by tearing prior to complete separation in the bonded area.

Table 521A–4 Requirements for textured LLDPE liner

Property	Test methods	Requirements* nominal thickness		
		30 mil	40 mil	60 mil
Density, g/cc	ASTM D 1505	0.915	0.915	0.915
Tensile properties	ASTM D 638 (type IV at 2 in/min)			
break stress, lb/in		60	80	120
break elongation, %		350	350	350
Tear resistance, lb	ASTM D 1004	17	22	33
Puncture resistance, lb	ASTM D 4833	33	44	66
Carbon black content, %	ASTM D 1603	2–3	2–3	2–3
Carbon black dispersion, %	ASTM D 5596	Cat 1–2	Cat 1–2	Cat 1–2
Seam properties	ASTM D 4437 (1 in wide at 2 in/min)			
shear strength, lb/in		40	53	79
peel strength, lb/in**		33/FTB	44/FTB	66/FTB

* All values, unless otherwise specified, are minimum average roll values as reported for each test method

** Film tear bond: A failure of one of the bonded sheets by tearing prior to complete separation in the bonded area.

Table 521A–5 Requirements for Non-Reinforced EPDM Liner

Property	Test methods	Requirements* - - - - - - - - - - - - - nominal thickness - - - - - - - - - - - - -	
		45 mil	60 mil
Specific Gravity	ASTM D 792	1.1	1.1
Tensile Properties	ASTM D 882 (Type IV at 20 in/min)		
break stress, lb/inch		50	50
break elongation, %		400	400
Tear Resistance, lb	ASTM D 1004	9	11
Puncture Resistance, lb	ASTM D 4833	35	60
Low Temperature Brittleness, ^{o}F	ASTM D 1790	<-45	<-45
Seam Properties	ASTM D413/D4437 NSF modified 20 in./min strain rate		
shear strength, lb/inch**		35	35
peel strength, lb/inch)***		14	14

*All values, unless specified otherwise, are minimum average roll values as reported for the test method.

** At 200% strain

***Cohesive Bond Mode

Table 521A–6 Requirements for Reinforced EPDM Liner

Property	Test methods --Nominal Thickness---	Requirements* 45 mil
Specific Gravity	ASTM D 792	1.1
Tensile Properties	ASTM D 751 Method A	125
Tear Resistance, lb	ASTM D 5884 Method B	130
Puncture Resistance, lb	FTMS 101C Method 2031	45
Ply Adhesion, lbs/in	ASTM D 413 Machine Method	7
Low Temperature Brittleness, ^{o}F	ASTM D 1790	<-45
Seam Properties		
shear strength, lb/inch**	ASTM D 751	35
peel strength, lb/inch)***	ASTM D 413	14

*All values, unless specified otherwise, are minimum average roll values as reported for the test method.

** At 200% strain

***Cohesive Bond Mode

Table 521A–7 Requirements for PVC liner

Property	Test methods	Requirements* - - - - - - - - - - - - - nominal thickness - - - - - - - - - - - - - - - - - - 30 mil	40 mil
Specific Gravity	ASTM D 792	1.2	1.2
Tensile Properties	ASTM D 882		
break strength, lb/inch (MD and XD)		73	97
elongation at break, %		350	400
Tear Resistance, lb	ASTM D 1004	8.5	10.5
Low Temperature Brittleness, ^{o}C	ASTM D 1790	<-29	<-29
Dimensional Stability, % (maximum)	ASTM D 1204	3	3
Hydrostatic Resistance Lbs./in^2	ASTM D 751 Method A	100	120
Seam Properties	ASTM D 6392/D 6214/D 4437 **		
shear strength, lb/inch		58	77
peel strength, lb/inch		15	15

*All values, unless specified otherwise, are minimum average roll values as reported for the test method.

MD = Machine Direction

XD = Cross-Machine Direction

**ASTM D 6392 shall be used for thermally welded seams, D 6214 for chemically welded seams, and D 4437 for all other types.

Table 521A–8 Requirements for Unreinforced PP liner

Property	Test methods	Requirements* - - - - - - - - - - - - nominal thickness - - - - - - - - - - - - - - -		
		30 mil	40 mil	60 mil
Specific Gravity	ASTM D 792	0.90	0.90	0.90
Tensile Properties	ASTM D 638 (Type IV at 20 in/min)			
break stress, lb/inch		60	72	130
break elongation, %		600	600	600
Tear Resistance, lb	ASTM D 1004	9	11	16
Puncture Resistance, lb	ASTM D 4833	28	35	65
Carbon Black Content, %	ASTM D 1603	2-4	2-4	2-4
Carbon Black Dispersion	ASTM D 5596	Cat 1-2	Cat 1-2	Cat 1-2
Low Temperature Brittleness, ^{o}C	ASTM D 1790	<-40	<-40	<-40
Seam Properties	ASTM D 6392/D6214/D 4437 ***			
shear strength, lb/inch		35	45	55
peel strength, lb/inch)***		20/FTB	30/FTB	40/FTB

*All values, unless specified otherwise, are minimum average roll values as reported for the test method.

**ASTM D 6392 shall be used for thermally welded seams, D 6214 for chemically welded seams, and D 4437 for all other types.

***Film Tear Bond: A failure of one of the bonded sheets by tearing prior to complete separation in the bonded area.

Table 521A–9 Requirements for Reinforced PP Liner

Property	Test methods	Requirements* - - - - - - - - - - - - nominal thickness - - - - - - - - - - - -	
		36 mil	45 mil
Specific Gravity	ASTM D 792	0.90	0.90
Tensile Properties	ASTM D 751 Method A	225	225
Tear Resistance, lb	ASTM D 5884 Method B	55	75
Puncture Resistance, lb	FTMS 101C Method 2031	200	250
Ply Adhesion, lbs/in	ASTM D 413 Machine Method	20	20
Carbon Black Content, %	ASTM D 1603	2-4	2-4
Carbon Black Dispersion	ASTM D 5596	Cat 1-2	Cat 1-2
Low Temperature Brittleness, ^{o}C	ASTM D 2136	<-40	<-40
Seam Properties			
shear strength, lb/inch	ASTM D 751	160	200
peel strength, lb/inch**	ASTM D 413	20/FTB	20/FTB

*All values, unless specified otherwise, are minimum average roll values as reported for the test method.
**Film Tear Bond: A failure of one of the bonded sheets by tearing prior to complete separation in the bonded area.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

PUMPING PLANT
(No.)
CODE 533

DEFINITION

A pumping facility installed to transfer water for a conservation need.

PURPOSE

Provide a dependable water source or disposal facility for water management.

CONDITIONS WHERE PRACTICE APPLIES

Wherever water must be pumped to accomplish a conservation objective, which may include but is not limited to one of the following:

- To provide a water supply for such purposes as irrigation, recreation, livestock, or wildlife.
- To maintain critical water levels in swamps, marshes, open water, or for newly constructed wetlands and ponds.
- To transfer wastewater for utilization as part of a waste management system.
- To provide drainage by the removal of surface runoff water or groundwater.

CRITERIA

Design, installation, and operation of a pumping plant shall comply with all Federal, State, and local laws, rules and regulations.

The efficiency of units, type of power, quality of building, automation features, and other accessories installed shall be in keeping with the economic and environmental value of the system to accomplish the conservation objectives.

Criteria for the design of components not addressed in NRCS practice standards shall be consistent with sound engineering principles.

Pump requirements

Capabilities, range of operating heads, and general class and efficiency of equipment shall be determined by appropriate technical means. Size and number of pumps and their performance shall be determined on the basis of system conservation requirements in order to meet the intended purpose. Total head shall be determined for critical operating conditions, taking into account all hydraulic losses. Automatic controls shall be included as required.

Pumps utilized for the transfer of wastewater or manure shall be sized to transfer material at the required system head and flow rate determined by the waste management plan. The pump type shall be based on the consistency of material being pumped and manufacturer's recommendations.

Power units

Power units shall be selected on the basis of availability of fuel or power costs, operating conditions, conservation needs, and objectives, including the need for automation. The power unit shall be matched to the pump and be capable of operating the pump efficiently and effectively within the range of operating conditions. The horsepower requirements, pump efficiency and total head on the pump shall be computed.

Suction and discharge pipes

The size of suction and discharge pipes shall be based on a hydraulic analysis, operating cost, and compatibility with other system components. The arrangement and length of discharge pipe shall be based on the need for recovery of head through siphoning action, and for delivery of water in keeping with conservation and environmental objectives. Gates, valves, pipe connections, discharge bays, and other protective devices shall be installed, as needed, for satisfactory pumping plant operation.

Federal, State, and local laws and regulations concerning back flow prevention shall be followed when pumping from wells or when chernigating.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

NRCS, CA
October, 2003

Building and accessories

The design of the pumping plant and associated housing, if required, shall consider accessibility for equipment maintenance and repairs, and the need for protecting equipment from the elements, vandalism, and fire. The appearance of the plant shall be compatible with the surrounding environment, as applicable.

Foundations shall be designed to safely support the loads imposed. Sheet piling or other measures shall be used, as required, to prevent piping beneath the foundation.

Pumps may be mounted in the open, on piling or concrete foundations, in a well or pit, or by other appropriate means.

Suction bays (or sumps) shall be designed to conform to the hydraulic characteristics established by the pump manufacturer.

The discharge bay or connection with the distribution system shall meet hydraulic and structural requirements. Provisions for repair or removal of pumps and engines shall be provided. Trash racks shall be provided, as needed, to exclude debris and trash from the pump.

All structural features and equipment shall provide adequate safety features to protect workers and the public from injury.

CONSIDERATIONS

When planning this practice the following items should be considered, as applicable:

- Effects on downstream flows or aquifer recharge volumes.
- Effects on existing wetland hydrology.
- Effects on surface and ground water by leaked or spilled fuels and lubricants.
- Secondary containment of spilled fuel for water quality as may be required by federal and state laws or regulations.
- Protection of system components from “natural" events such as floods.
- Sediment production caused by erosion during construction.

Endangered Species Considerations

Determine if installation of this practice with any others proposed will have any effect on any federal or state listed Rare, Threatened, or Endangered species or their habitat. NRCS’s objective is to benefit these species and others of concern or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing pumping plants shall be in compliance with this standard and describe the requirements for properly installing the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An Operation and Maintenance plan specific to the facilities installed shall be prepared for use by the landowner or responsible operator. The plan shall provide specific instructions for operating and maintaining facilities to ensure the pumping plant functions properly. The plan shall include provisions to address the following, as a minimum:

- Inspection or testing of all pumping plant components and appurtenances, as applicable.
- Proper start-up procedures for the operation of the pumping plant.
- Routine maintenance of all mechanical components (power unit, pump, drive train, etc.) in accordance with the manufacturer's recommendations.
- When applicable, the power unit, fuel storage facilities and fuel lines should be frequently checked for fuel or lubricant leaks and repaired as needed.
- Periodic checks and removal of debris as necessary from trash racks and structures to assure adequate capacity reaches the pumping plant.

- Periodic removal of sediment in suction bays to maintain design capacity and efficiency.
- Inspect and maintain anti-siphon devices, if applicable.
- Routinely test and inspect all automation components of the pumping plant to assure they are functioning as designed.
- Inspect and maintain secondary containment facilities, if applicable.
- Periodic inspection of all safety features to ensure they are in place and functional.
- Prior to retrofitting any electrically powered equipment, electrical service must be disconnected and the absence of stray electrical current verified.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION REGULATING RESERVOIR
(No.)
CODE 552

DEFINITION

A small storage reservoir constructed to regulate an irrigation water supply.

PURPOSE

Collect and store water for a relatively short period of time to:

- Improve irrigation water management by regulating fluctuating flows in streams, canals, or from pumping plants.
- Provide storage for tailwater recovery and reuse.
- Improve offsite water quality.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to reservoirs created by impoundment structures and excavated pits for short-term storage of diverted surface water, water from pumped or flowing wells, or water from an irrigation delivery system. This standard applies to structures designed primarily for flow control or those designed to store water for only a few hours or a few days.

This standard applies to sites meeting the following applicable conditions:

1. The existing available irrigation stream is of such size that regulation is necessary to accomplish the intended purposes. For example, low yield irrigation wells where collection facilities are needed for efficient irrigation application.
2. Water must be stored to be used between times of rotation delivery.
3. An adequate and dependable volume of good quality water is or can be made available by storage.
4. Topographic, geologic and soil conditions are suitable for practical construction of a regulating reservoir having adequate storage capacity, and any pervious soils in the reservoir area can be sealed to insure seepage losses are not excessive.
5. If surface runoff enters the reservoir, the contributing drainage area is or can be protected against erosion so that normal sedimentation does not materially shorten planned reservoir life.

This standard pertains to the planning and functional design of irrigation regulating reservoirs. It does not include detailed design criteria or construction specifications for individual regulating reservoirs or components of the regulating facility

This standard also applies to regulating reservoirs constructed of concrete, steel, and other suitable materials used to collect water from two or more irrigation wells for use in irrigation systems.

CRITERIA

General Criteria Applicable To All Purposes

Components addressed in NRCS standards, shall meet design and construction criteria for that particular component. Criteria for design of components not addressed in NRCS practice standards shall be consistent with sound engineering practices.

Installation and operation of irrigation regulating reservoirs shall comply with all federal, state and local laws, rules and regulations.

Irrigation regulating reservoirs created by earthen pits or embankments shall be designed and constructed according to NRCS Conservation Practice Standard and Specification for Pond (378).

Regulating reservoirs constructed of materials other than earth shall be designed according to sound engineering principles for the material being used.

Pumping plants installed to serve irrigation regulating reservoirs shall be designed and

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

constructed according to NRCS Conservation Practice Standard for Pumping Plant (533).

Where additional storage is required to provide for sediment deposition, storage facilities shall be sized accordingly. Allowable retention times shall be site specific to the particular soil type(s).

Additional Criteria Applicable To Regulating Fluctuating Flows In Streams, Canals, Or From Pumping Plants

Capacity - Irrigation regulating reservoirs shall have a usable capacity sufficient to permit the existing irrigation stream to be regulated so that irrigation water can be applied with a reasonably high efficiency. In computing capacity requirements consideration shall be given to diverted inflow, surface runoff, precipitation, evaporation, and seepage, as applicable. Excessive seepage losses shall be prevented by the use of an adapted method of sealing or lining. Additional capacity shall be provided, as necessary, for sediment storage.

Capacity requirements for regulating reservoirs used as part of a system for collecting water from two or more wells shall be based on the discharge capacities of the contributing wells and on the operation frequency of the irrigation system.

Inlet protection - Reservoir embankment or excavated side slopes at inlets shall be protected from erosion by use of pipe inlets or other suitable structures. Inlet structure capacity shall be adequate to accommodate the design inflow rate.

Overflow protection. An overflow protection structure having a capacity equal to or greater than the inlet stream shall be provided for an enclosed embankment. This structure may be designed and installed in combination with the outlet works.

Outlet works - Outlet works shall be provided for the controlled release of irrigation water. The outlet works may consist of a gated conduit through or over the embankment for gravity flow to the irrigated area or to a pumping plant. They may also consist of a pumping plant designed to lift water directly from the reservoir basin.

The capacity of the outlet works shall be adequate to provide the outflow rate needed to meet peak period irrigation system demands.

Additional Criteria Applicable To Storage For Tailwater Recovery And Reuse

Irrigation regulating reservoirs used in irrigation tailwater recovery and reuse systems are often referred to as tailwater pits or sumps.

Capacity - Capacity requirements for irrigation regulating reservoirs for tailwater recovery shall be based on irrigation system runoff volume and rate, as well as, required level of water control at the point tailwater is returned to the irrigation system. Excessive seepage losses shall be prevented by the use of an adapted method of sealing or lining.

For systems where tailwater is discharged into an irrigation pit or regulating reservoir or into a pipeline having facilities for regulating fluctuating flows (e.g. a float valve), small pits or sumps with frequently cycling pumping plants may be used. For systems unable to regulate flows, tailwater sumps or pits shall be made large enough to provide the regulation needed to permit efficient use of the water.

When energy sources for tailwater pump back systems are subject to interruption, safe emergency bypass areas cannot be provided, or tailwater discharges violate local or state regulations, tailwater storage requirements shall, as a minimum, include a volume adequate to store the complete runoff from a single irrigation set.

Inlet protection - Sumps and pits shall be equipped with inlets designed to protect side slopes and collection facilities from erosion. A dike, ditch, or water control structure shall be provided, if required by state law, to limit the entrance of rainfall runoff into the designed inlet. Sediment traps shall be installed as needed.

Additional Criteria Applicable To Improving Water Quality

Capacity - Where additional storage and/or flow regulation is required to provide adequate retention time for breakdown of chemicals in runoff waters, storage facilities shall be sized accordingly. Allowable retention times shall be site specific to the particular chemical of concern.

Seepage from irrigation regulating reservoirs shall be controlled to the extent practical when the facility is expected to receive chemical-laden waters. Control may be in the form of natural soil liners, soil additives, commercial liners, or other approved methods.

Inlet protection - Reservoir embankment or excavated side slopes at inlets shall be protected from erosion by use of pipe inlets or other suitable structures. Inlet structure capacity shall be adequate to accommodate the design inflow rate.

CONSIDERATIONS

When planning this practice the following items should be considered, as applicable:

Cultural Resources Considerations

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Water Quantity

1. Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.

2. Effects on downstream flows or aquifers that would affect other water uses or users.

3. Potential use for irrigation water management.

Water Quality

1. Effects of erosion and the movement of sediment, pathogens, and the soluble and sediment-attached substances carried by runoff.

2. Effects on the movement of dissolved substances to ground water.

3. Short-term and construction-related effects on the quality of downstream water courses.

4. Potential of uncovering or redistributing toxic material.

5. Effects on wetlands or water-related wildlife habitats.

6. Effects on the visual quality of water resources.

PLANS AND SPECIFICATIONS

Plans and specifications for irrigation regulating reservoirs shall be in keeping with this standard and shall describe the requirements for properly installing the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An Operation and Maintenance plan specific to facilities installed shall be prepared for use by the landowner or operator. The plan should provide

specific instructions for operating and maintaining facilities to ensure they function properly. The plan shall include provisions to address the following, as a minimum:

- Periodic cleaning and re-grading of collection facilities to maintain proper flow lines and functionality.
- Periodic checks and removal of debris as necessary from inlet and outlet structures to assure proper operation.
- Periodic removal of sediment from traps and/or storage facilities to maintain design capacity and efficiency.
- Inspection or testing of all pipelines and pumping plant components and appurtenances, as applicable.
- Routine maintenance of all mechanical components in accordance with manufacturer recommendations.
- Periodic inspection and maintenance of embankments including control of erosion and undesirable vegetation.
- Periodic water quality analysis as necessary to evaluate nutrients, pesticides and pathogens.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

ROCK BARRIER
(feet)
CODE 555

DEFINITION

A rock retaining wall constructed across the slope to form and support a bench terrace that will control the flow of water and check erosion on sloping land.

PURPOSE

Stabilize steeply sloping land so that it can be farmed with a minimum of soil loss.

CONDITIONS WHERE PRACTICE APPLIES

Rock barriers are applicable to land suitable for cultivation where soil depth is adequate for benching and where the effectiveness of less intensive measures for soil and water conservation would be questionable. This standard applies to all rock barriers 6 feet or less in height on land slopes as much as 70 percent. Suitable natural outlets or satisfactory sites for constructing outlets must be available.

CRITERIA

Grade -The top of the rock barrier may be level or have a grade toward the outlet. Maximum grade shall be 0.5 percent.

Cross slope - The bench between barriers shall have a negative slope from the top of one barrier to the toe of the upslope barrier. Cross slopes shall have a grade of 1.0 to 3.0 percent.

Surface drain - Surface drainage shall be provided by a longitudinal ditch with a cross-sectional area not less than 0.5 square feet along the toe of the upslope barrier.

Height - The height of the rock barrier shall not exceed 6 feet.

Base width - The minimum base width shall be 18 inches, plus 1.5 inch for each 0.5 feet of height in excess of 2.5 feet. The exposed face of the barrier shall have a batter of 3 inches/foot of height.

Vertical interval - Vertical interval between adjacent benches shall not exceed 5 feet.

Horizontal interval - The minimum horizontal distance between barriers shall be 5 feet.

CONSIDERATIONS

Consider the depth of cut or excavation levels, and the resulting available plant rooting depths.

Consider other measures needed for adequate management of storm runoff.

Consider the excavation and fill material necessary for balancing cuts and fills.

Cultural Resources Considerations

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Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Water Quantity

1. Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.

2. Potential for change in plant growth and transpiration because of changes in the volume of soil water.

3. Effects on downstream flows or aquifers that would affect other water users.

4. Effects on the volume of downstream flow to prohibit undesirable environmental, social or economic effects.

5. The effect on the water table of the field to ensure that it will provide a suitable rooting depth for anticipated land uses.

Water Quality

1. Effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances carried by runoff.

2. Effects of the use and management of nutrients and pesticides on surface and ground water quality.

3. Effects on the visual quality of downstream water resources.

4. Short-term and construction-related effects on this practice on the quality of downstream water.

5. Potential for development of saline seeps or other salinity problems resulting from increased infiltration near restrictive soil layers.

6. Potential for earth moving equipment to uncover or redistribute toxic materials, or low productive soils.

7. Effects on the movement of dissolved substances

PLANS AND SPECIFICATIONS

Plans and specifications for constructing rock barriers shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be prepared for the operator.

Items to be addressed in the operation and maintenance plan are:

1. Provide periodic inspections, especially immediately following runoff events.

2. Promptly repair or replace damaged components as necessary.

3. Remove sediment that has accumulated in surface drain and outlet to maintain designed capacity.

4. Vegetation in the outlet, damaged by livestock, machinery, or erosion must be repaired promptly.

5. Vegetation, where specified, shall be maintained. Trees, brush, and undesirable vegetation shall be controlled by chemical or mechanical means following federal, state, and local regulations.

6. Keep machinery away from steep slope rock barriers. Keep equipment operators informed of all potential hazards.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

ROW ARRANGEMENT
(Acre)
CODE 557

DEFINITION

A system of crop rows on planned grades and lengths.

PURPOSE

Establish crop rows in direction, grade and length to:

- Provide adequate drainage
- Provide erosion control
- Permit optimum use of rainfall and irrigation water.

CONDITIONS WHERE PRACTICE APPLIES

Proper row arrangement is applicable:

1. As part of a surface drainage system for a field where the rows are planned to carry runoff to main or lateral drains.
2. To facilitate optimum use of water in graded furrow irrigation systems.
3. In dryland areas where it is necessary to control the grade of rows to more fully utilize available rainfall.
4. On sloping land where control of the length, grade and direction of the rows can help reduce soil erosion, as a stand-alone practice or in conjunction with other conservation practices.

CRITERIA

General Criteria Applicable to All Purposes

Row arrangement shall accommodate the type and size of farm equipment to be used in the field.

Additional Criteria for Surface Drainage

As part of a surface drainage system, row arrangement shall:

1. Conform to the NEH, Part 650, Engineering Field Handbook, Chapter 14, Water Management (Drainage) for the area regarding grade, depth, and permissible velocities.
2. Facilitate flow of excess water from the field into surface ditches or other appropriate measures.

Additional Criteria for Furrow Irrigation

As part of a furrow irrigation system, row arrangement shall:

1. Conform to the irrigation guide for the area regarding grade and length.
2. Facilitate irrigation water management in the field.

Additional Criteria for Erosion Control and Water Conservation

As part of an erosion control and/or water conservation system for a field, row arrangement shall:

1. Conform to the particular Conservation Practice Standard for the area (such as 449, Irrigation Water Management) for which row arrangement is a facilitating measure.
2. Conform to the grade and length requirements for Conservation Practice Standard 600, Terrace if the arrangement is used without another engineering practice.

CONSIDERATIONS

Cultural Resources Considerations

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Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

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Water Quantity

1. Effects upon components of the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation and ground water recharge.
2. Effects of snow catch and snowmelt on water budget components.
3. The potential for a change in plant growth and transpiration due to changes in the volume of soil water.
4. Effects on downstream flows and aquifers that would affect other water uses and users.
5. Effects on the volume of downstream flow to prohibit undesirable environmental, social or economic effects, such as, effects on wetlands or water-related wildlife habitats.
6. The effects on the water table of the field and/or soil moisture to ensure that it will provide a suitable rooting depth for the anticipated land uses.
7. Potential use for water management to conserve water.

Water Quality

1. Effects of nutrients, sediments and pesticides on surface and ground water quality.
2. Effects on the visual quality of downstream water resources.
3. Effects of water levels on solid nutrient processes such as plant nutrient use.
4. Effects of soil and water level control on the salinity of soils, soil water or downstream water.

PLANS AND SPECIFICATIONS

Plans and specifications for row arrangement shall be in keeping with this standard and shall describe the requirements for properly applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) plan specific to the intended purpose of the row arrangement system shall be provided to the landowner.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

HEAVY USE AREA PROTECTION

(Acre)

CODE 561

DEFINITION

The stabilization of areas frequently and intensively used by people, animals or vehicles by establishing vegetative cover, by surfacing with suitable materials, and/or by installing needed structures.

PURPOSES

This practice may be used as a part of a conservation management system to support one or more of the following purposes.

- Reduce soil erosion
- Improve water quantity and quality
- Improve air quality
- Improve aesthetics
- Improve livestock health

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to urban, agricultural, recreational, or other frequently and intensively used areas requiring treatment to address one or more resource concerns.

CRITERIA

General Criteria Applicable to All Purposes

All planned work shall comply with federal, state, and local laws and regulations.

Safety of the users shall be incorporated into the design of the heavy use area protection.

Design Load - The design load will be based on the type of traffic, (vehicular, animal, or human) anticipated on the heavy use area.

The minimum design load for areas that support vehicular traffic will be a wheel load of 4000 lbs.

Foundation - All site foundations shall be evaluated for soil moisture, permeability, texture and bearing strength in combination with the design load and anticipated frequency of use.

A base course of gravel, crushed stone, other suitable material and/or geotextile shall be provided on all sites with a need for increased load bearing strength, drainage, separation of material and soil reinforcement. Natural Resources Conservation Service (NRCS), National Engineering Handbook (NEH), Parts 642 and 643 (formerly, NEH, Section 20) and AASHTO M-288 (latest edition) provide guidance in quality specification and geotextile selection.

An impervious barrier shall be provided on sites with a porous foundation (high permeability rate), where there is a need to protect ground water from contamination.

Foundation preparation shall consist of removal and disposal of soil and other material that are not adequate to support the design loads.

Surface treatment - The surface treatment shall meet the following criteria:

Bituminous Pavement - The thickness of the pavement course, the kind and size of aggregate, the type of proportioning of bituminous materials, and the mixing and placing of these materials shall be in accordance with Department of Transportation criteria for the expected loading.

Concrete - The quality and thickness of concrete and the spacing and size of reinforcing steel shall be appropriate for the expected loading.

Other Cementitious Materials - Soil cement, roller compacted concrete, and coal combustion by-products (flue gas desulfurization sludge and fly ash) may be used as surface material if designed and installed to withstand the anticipated loads and surface abrasion.

Aggregate - A fine or coarse aggregate surface shall be a minimum 2-inches thick.

Other - Surfacing materials, such as cinders, bark mulch, brick chips, shredded rubber and/or sawdust, shall have a minimum layer thickness of 2 inches.

Structures - All structures shall be designed according to appropriate NRCS standards and specifications or Engineering Handbook recommendations.

Roof Rainfall Diversion Structures - Roof rainfall diversion structures shall be designed, by a registered Civil Engineer, licensed to practice in California, to meet all state, county and local building codes. The engineer shall also provide construction plans, specifications and Operation and Maintenance guidance for the roof rainfall diversion structure.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

The design shall consider all anticipated loads, including live loads, dead loads, wind, snow, ice and seismic loads, that will influence the performance of the structure, material properties and construction quality. Design assumptions and construction requirements shall be indicated on standard plan.

Fabricated structures shall be designed according to the criteria in the following references as appropriate:

- Steel: "Manual of steel construction", American Institute of Steel Construction.
- Timber: "National Design Specifications for Wood Construction", American Forest and Paper Association.
- Concrete: "Building Code Requirements for Reinforced Concrete, ACI 318", American Concrete Institute.
- Masonry: "Building Code Requirements for Masonry Structures, ACI 530", American Concrete Institute
- ASAE EP288.5, Agricultural Building Snow and Wind Loads
- ASAE EP 378.3, Floor and Suspended Loads on Agricultural Structures Due to Use

The plans, including the foundation work, shall be signed and sealed by a registered Civil Engineer.

Sprays, artificial mulches and mulches - Sprays of asphalt, oil, plastic, manufactured mulches, and similar materials shall be installed according to the manufacturer's recommendations. Application of other mulches will follow Mulching – Standard 484.

Drainage and erosion control - Provision shall be made for surface and subsurface drainage, as needed, and for disposal of runoff without causing erosion or water quality impairment. Provision shall be made to exclude unpolluted run-on water from the treatment area. All treatment areas shall be shaped to prevent ponding of water.

Vegetative Measures

Plant Species: Preference should be given to native plants in most settings. However, in heavily used areas or where special characteristics are desirable non-native plants may better adapt to local situations. Plant hardiness and soil suitability are plant selection factors. Species recommendations for local use are contained in the Vegetative Guide of the Field Office Technical Guide.

Plant Spacing: Plants shall be spaced according to the planting plan or specifications. Spacing is determined by many factors including plant height, spread, habit, effect desired, etc.

Planting Methods, Time of Planting, etc., will follow Standard and Specification for Tree/Shrub Establishment – Standard 612 or Critical Area Treatment – Standard 342.

If vegetation is not appropriate, other measures shall be used to accomplish the intended purpose.

Additional Criteria for Areas Utilized by Livestock

The treated area shall extend an appropriate distance from facilities such as portable hay rings, water troughs, feeding troughs, mineral boxes and other facilities where livestock concentrations cause resource concerns.

NRCS conservation practice standards Critical Area Planting, Code 342; Fencing, Code 382; Prescribed Grazing, Code 528A; Filter Strip, Code 393; Roof Runoff Structure, Code 558 or Use Exclusion, Code 472 shall be used as companion practices, when needed, to meet the intended purpose of the heavy use area protection.

Provisions shall be made to collect, store, utilize and/or treat manure accumulations and contaminated runoff in accordance with NRCS's National Engineering Handbook (NEH) Part 651, Agricultural Waste Management Field Handbook.

Additional Criteria for Areas Utilized for Recreation

The treated area shall be conducive to the overall recreation area and aesthetically blend with the general landscape and surroundings.

Plants, landscaping timbers, traffic control measures, wooden walkways, etc. shall be evaluated for effectiveness, aesthetics and accessibility as covered by the Americans with Disabilities Act.

CONSIDERATIONS

When stabilizing heavily used areas consider adjoining land uses and the proximity to residences, utilities, cultural resource areas, wetlands or other environmentally sensitive areas, and areas of special scenic value.

For areas with aggregate surfaces that will be frequently scraped, consideration should be given to the use of concrete or cementitious materials to lessen the recurring cost of aggregate replacement.

The size of heavy use areas utilized by livestock is dependent on the landowner's operation including type and number of animal, confinement periods, and/or the intended use. The size of treatment areas can range

from 30 square feet per animal in partial-confinement to 400 square feet per animal in total confinement to 4000 or more square feet for animal exercise areas. Heavy use protection areas should be kept as small as practicable.

For heavy use areas conducive to protection by vegetation, consideration must be given to the effect(s) of treading and/or miring. The vegetative species selected should tolerate and persist under heavy use conditions. If practicable, consider increasing the size of the area and/or establishing a rest/non-use period to allow plant recovery and increase vigor.

When surface treatments such as bark mulch, wood-fiber or other non-durable materials are used for short-term livestock containment areas, consideration should be given to vegetation of the affected area with a cover crop.

If the purpose of the heavy use area protection is improvement of water quality, the heavy use area should be (re) located as far away from the water body or watercourse as possible. Any work in and/or discharges near streams, wetlands or water bodies may require a permit from the US Army Corps of Engineers, state water quality (permitting) authority, or local authority.

The transport of sediments, nutrients, bacteria, organic matter from animal manures, oils and chemicals associated with vehicular traffic, and soluble and sediment-attached substances carried by runoff should be considered in selection of companion conservation practices. Consider practices to collect and store rainfall away from manured areas.

Cultural Resources Considerations

Determine if installation of this practice with any others proposed will have any effect on any cultural resources. NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. GM 420, Part 401, the California Environmental Handbook and the training for the

California Environmental Assessment Worksheet specify how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information, about cultural resources. The Environmental Handbook is online at www.ca.nrcs.usda.gov/rts/rts.html.

Endangered Species Considerations

Determine if installation of this practice with any others proposed will have any effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Water Quantity

Paved areas installed for livestock use will increase organic, bacteria, and nutrient loading to surface waters. Changes in ground water quality will be minor. Nitrate nitrogen applied as fertilizer in excess of vegetation needs may move with infiltrating waters. The extent of the problem, if any, may depend on the actual amount of water percolating below the root zone.

More impervious protection may decrease or eliminate infiltration; the use of vegetation may increase infiltration. Where vegetation is used, transpiration may increase. Reduced infiltration may decrease potential for deep percolation and ground water recharge.

Heavy use area protection effects on the water budget, especially on volumes and rates of runoff, infiltration, and transpiration due to the installation of less pervious surfaces should be considered in the selection of surfacing materials.

Water Quality

Protection with materials such as asphalt and concrete may decrease the opportunity for infiltration and may result in increased runoff of essentially all of the precipitation. Protection by use of porous paving or cellular blocks will reduce these detrimental effects. Protection with vegetation may reduce runoff by increasing the opportunity time for infiltration.

Protection may result in a general improvement of surface water quality through the reduction of erosion and the resulting sedimentation. Some increase in

erosion may occur during and immediately after construction until the disturbed areas are fully stabilized.

Some increase in chemicals in surface water may occur due to the introduction of fertilizers for vegetated areas and oils and chemicals associated with paved areas. Fertilizers and pesticides used during operation and maintenance may be a source of water pollution.

PLANS AND SPECIFICATIONS

Plans and specifications for heavy use area protection shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. Plans and specifications shall include construction plans, drawings, job sheets or other similar documents. These documents shall specify the requirements for installing the practice, including the kind, amount and quality of materials to be used.

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) plan shall be prepared for and reviewed with the landowner or others responsible for operating this practice.

The plan shall provide specific instructions for operating and maintaining the system to insure that it functions properly. It should also provide for periodic inspections and prompt repair or replacement of damage components.

The plan shall specify that the treated areas and associated practices are inspected annually and after significant storm events to identify repair and maintenance needs.

The O&M plan shall detail the level of repairs needed to maintain the effectiveness and useful life of the practice.

For livestock operations, the O&M plan for heavy use areas may be included as a part of the overall waste management plan. Periodic removal and management of manure accumulations will be addressed in the O&M plan.

O&M guidance for roof runoff diversion structures will be provided by the engineer who designs this aspect of the project.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

SOIL SALINITY MANAGEMENT – NONIRRIGATED

(Acre)
Code 571

DEFINITION

Management of land, water and plants to control subsurface soil water movement and to minimize accumulations of salts on the soil surface and in the root zone of nonirrigated saline seep areas.

PURPOSE

To promote desired plant growth in nonirrigated saline seep areas.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to nonirrigated land where a combination of factors such as topography, soils, geology, precipitation, vegetation, land use and cultural/structural practices can increase the extent and soluble salt concentrations of saline seep areas.

CRITERIA

Use of fertilizers, pesticides and/or other chemicals and soil amendments shall not compromise the intended purpose.

A Nonirrigated Soil Salinity Management Plan will be developed to document the extent and planned management of recharge and saline seep areas. Required Plan components are listed in the Plans and Specifications section of this Standard.

Components addressed in NRCS standards, shall meet design and construction criteria for that particular component. Criteria for design of engineering components not addressed in NRCS practice standards shall be consistent with sound engineering practices.

Additional Criteria Specific To Recharge Area Management

Recharge areas will be delineated in the Management Plan.

Plant and/or maintain adapted high water use vegetation in recharge areas to utilize soil water, minimize infiltration and decrease subsurface soil water movement to saline seep areas.

Where practicable, divert run-on and/or install surface and/or subsurface drainage to minimize infiltration and decrease soil water in recharge areas.

Additional Criteria Specific To Saline Seep Management

Saline seep areas will be delineated in the Management Plan.

Establish adapted vegetation in reclaimed saline seep areas after water tables have been lowered sufficiently to prevent capillary movement of water and salts into the root zone and to the soil surface.

CONSIDERATIONS

Eliminate fallow periods in recharge areas to increase utilization of soil water and to decrease infiltration.

Locate snow fences, windbreaks, vegetative filter strips and other structures that may accumulate rain and snow away from recharge areas.

Seal the bottoms of constructed ponds or dugouts to minimize subsurface soil water movement to saline seep areas.

Install underground outlets or surface waterways to drain storage terraces and minimize infiltration.

Plug leaky artesian wells if they contribute to subsurface water flows.

Roadways that cross natural drainageways can impede surface water flows and increase infiltration. Install or improve culverts to minimize blockage of surface water flows.

Plant cover or green manure crops in recharge areas to utilize excess soil water if the planned crop fails due to conditions such as poor stand establishment, hailstorms, winterkill, disease or insect damage.

Plant deep-rooted trees or shrubs in the recharge area to utilize excess soil water.

Apply practices in the reclaimed saline seep area that will help increase infiltration and leaching.

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Cultural Resources Considerations

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Endangered Species Considerations

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PLANS AND SPECIFICATIONS

Plans and specifications for the implementation and operation of this practice shall be prepared for each field or treatment unit according to the Criteria, and Operation and Maintenance sections included in this Standard.

Plans and Specifications shall be recorded using approved specification sheets, job sheets, narrative statements in the conservation plan and/or other acceptable forms of documentation.

Nonirrigated Soil Salinity Management Plan

Plans for Nonirrigated Soil Salinity Management shall include the following components:

1. An Onsite Investigation Report;
2. Conservation practices and specifications to be implemented in recharge areas to increase soil water utilization and decrease subsurface soil water movement to the saline seep areas;
3. Conservation practices and specifications to be implemented to reclaim saline seep areas after water table elevations have been lowered sufficiently to prevent capillary movement of water and salts into the root zone and to the soil surface; and,
4. Monitoring activities that may be needed to evaluate practice implementation and effectiveness.

Onsite Investigation Report – An onsite investigation will be conducted to identify existing field conditions, delineate recharge and saline seep areas, and to gather supporting data for development of the Nonirrigated Soil Salinity Management Plan.

The Onsite Investigation Report will include the following information for recharge and saline seep areas: location maps, including field numbers and measured acres; groundwater elevations; soil tests to evaluate fertility, pH, electrical conductivity (EC), free lime (calcium carbonate), and sodium adsorption ratio (SAR); topographic, soils and geologic maps; and historic photographs and/or cropping and yield histories that document saline seep development and extent.

Reclamation of saline seep areas with SAR values of 13 and greater (saline/sodic soils) may require amendment applications, as determined by soil testing, to replace adsorbed sodium with soluble calcium.

Water Quantity

1. Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and groundwater recharge.

Water Quality

1. Potential for transfer of salinity conditions to another location where surface or subsurface drains are used.
2. Effects of erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances, including salts which could be carried by runoff.

OPERATION AND MAINTENANCE

The following actions shall be identified in the plan and carried out to ensure that this practice functions as intended throughout its expected life.

Identify any required items needed to assist in stand establishment such as mowing, flash grazing and/or herbicides to control weeds. Address insect and disease control needs where they are likely to create establishment problems.

Any necessary replanting due to drought, insects or other uncontrollable events that prevented adequate stand establishment should be addressed as soon as possible. Replanting activities may vary from complete re-establishment to overseeding or spot replanting.

REFERENCES

Halvorson, Ardell D. 1990. Management of dryland saline seeps. p. 372-392. *In* Kenneth K Tanji (ed.) Agricultural salinity assessment and management. ASCE, New York, N.Y.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

ANIMAL TRAILS AND WALKWAYS
(Ft.)
CODE 575

DEFINITION

Established lanes or travel ways that facilitate animal movement.

PURPOSES

- Provide or improve access to forage, water, working/handling facilities, and/or shelter,
- Improve grazing efficiency and distribution, and/or
- Protect ecologically sensitive, erosive and/or potentially erosive sites.

CONDITIONS WHERE THIS PRACTICE APPLIES

On lands where control of animal movement is needed to facilitate access, improve grazing, prevent erosion, and/or protect ecologically sensitive areas.

CRITERIA

General Criteria Applicable to All Purposes

All planned work shall comply with all federal, state, and local laws and permit conditions and requirements. The landowner shall obtain all necessary permits prior to construction or any land clearing activities.

Location. Animal trails or walkways shall be located to make the best use of topographic features. Trails shall generally follow natural contours to the extent practical and minimize disturbance of drainage patterns.

Drainage and Erosion Control. Provisions shall be made for surface and subsurface drainage, as needed, and for disposal of runoff water without causing excessive erosion.

Culverts, bridges, fords, or rolling dips shall be provided at all natural drainageways as appropriate. The capacity and design shall be consistent with sound engineering principles and shall be adequate for the intended use. When a culvert or bridge is installed in a drainageway, its minimum capacity shall convey the 10-year 24-hour design storm runoff without causing erosion or overtopping.

Trails shall be constructed in such a manner that accelerated erosion of the trail surface will not occur:

- Avoid excessively steep pitches and geologically unstable or otherwise highly erodible terrain.
- Outslope construction along hillsides shall be used whenever possible. Additional drainage measures such as water bars, rolling dips or subdrainage shall be used as needed.
- When inslope or crowned construction is required, inboard ditches with sufficient capacity and erosion protection shall be constructed. Additional measures shall be installed as needed to convey ditch flows across the road without excessive erosion.

Dimensions and Surface Materials. Animal trails or walkways shall be constructed wide enough to accommodate movement of animals and access by operator for management and maintenance.

Sensitivity of the animal's feet, with respect to the intended purpose of the trail or walkway, will be included as a design parameter in selecting the surface material for trails or walkways.

Trails or walkways seeded or planted to vegetative cover will be protected from grazing until the vegetation is fully established and capable of withstanding grazing and/or trampling. Vegetative cover shall be established in accordance with Conservation Practice Standard 342, Critical Area Planting. Where maintaining vegetative cover is necessary but not possible, Conservation Practice Standard 561, Heavy Use Area Protection, will be used to provide adequate surface protection.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

Additional Criteria Applicable to Providing or Improving Access to Forage, Water, Working/Handling Facilities and/or Shelter

Trails and walkways will be designed and constructed of sufficient size to accommodate the expected frequency of use and animal type(s) planned for the operation.

Conservation practice standard 382, Fence, will be used when needed to keep animals confined to the trail or walkway until the desired destination is reached.

When needed to facilitate movement of animals through a series of paddocks or pastures, gate openings and lane layouts shall allow for efficient flow of animals with the least amount of stress.

Additional Criteria Applicable to Improving Grazing Efficiency and Distribution

Fenced or unfenced animal trails or walkways will be used to distribute grazing to overcome terrain features causing uneven grazing distribution and pressure.

Additional Criteria Applicable to Protection of Ecologically Sensitive Areas.

Cultural resources, threatened and endangered species, wetlands, streambanks, floodways or other ecologically sensitive areas, and areas of special scenic value will be protected through the proper design of trail(s) or walkway(s).

CONSIDERATIONS

Other practices that facilitate grazing distribution and proper intensity and reduce potential erosion should be implemented along with this practice as appropriate:

- Conservation Practice Standard 528A, Prescribed Grazing, can be used to further improve grazing distribution and pressure.
- Conservation Practice Standard 472, Use Exclusion, and other conservation practices can be used in conjunction with trails or walkways to minimize the impact on sensitive areas.
- For areas of high livestock concentration, such as around ponds, tanks, troughs, or other feeding areas, use Conservation Practice Standard 561, Heavy Use Area Protection.
- For travelways used by vehicles or equipment for purposes other than management and maintenance of animal trails or walkways, use Conservation Practice Standard 560, Access Road.
- Consider salting, water development, or other methods to facilitate proper grazing distribution.

Water Quantity

1. Avoid locations and layouts that would result in diversion of surface runoff and other hydrologic modifications that could alter flow paths, modify channel hydrology, and/or trigger concentrated flow erosion or mass wasting.
2. Where applicable, consider the effects of snowcatch and melt on the water budget.

Water Quality

1. Improving grazing distribution using this practice in combination with others should improve water quality, although increased bedding on the walkways will increase manure concentrations locally.
2. If this practice is used to gain livestock access to previously inaccessible water sources, the water quality of those sources may be degraded by increased livestock use. Prescribed Grazing, Fencing or other livestock management measures may be needed to prevent excessive degradation.

Endangered Species Considerations

Determine if installation of this practice with any others proposed will have any effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the Fish and Wildlife Service, NOAA Fisheries

(formerly the National Marine Fisheries Service) and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Some species are year-round residents in some streams, such as freshwater shrimp. Other species, such as steelhead and salmon, utilize streams during various seasons. Be aware that critical periods, such as spawning, eggs in gravels, and rearing of young may preclude activities in the stream that may directly affect the stream habitat during those periods. For example there should be no disturbance of stream gravel beds that may have eggs in them. That could include any equipment in the stream or even walking in the stream or work upstream that may result in sediment depositing in the gravel beds. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Cultural Resources

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

PLANS AND SPECIFICATIONS

Plans and specifications for installing animal trails and walkways shall be in keeping with this standard. A site-specific design and construction plan is required to describe the requirements for applying this practice to achieve its intended purpose.

Plans and specifications shall include construction plans, drawings, job sheets, or other similar documents. These documents shall specify the requirements for installing the practice, including the location and the kind, amount, and quality of materials to be used.

OPERATION AND MAINTENANCE

The operation and maintenance (O&M) plan shall specify that the trails or walkways and associated practices be inspected annually and after significant storm events to identify repair and maintenance needs.

The O&M plan shall detail the level of repairs needed to maintain the effectiveness and useful life of the practice. These repairs should include, but are not limited to, the following:

- Periodic grading or re-shaping trails or walkways to maintain the designed grade and dimensions;
- Periodic addition of surfacing materials where used;
- Re-seeding of areas in which the vegetation has been damaged or destroyed;
- Mending of fences and replacement of gates; and/or

Periodic removal and management of manure accumulations will be addressed in the O&M plan.

For multiple adjacent vegetated walkways, the O&M plan should provide guidance as to the rotation of walkways to allow for recovery of vegetation and for improvement of traffic -supporting conditions.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

575 - ANIMAL TRAILS AND WALKWAYS

I. SCOPE

The work shall consist of constructing animal trails and/or walkways to meet the practice purpose at the location(s). Construction shall follow the lines and grades as shown on the drawings (plans) and/or as staked in the field.

II. TRAILS AND WALKWAYS

The following items shall govern the construction of the trails and walkways:

- Minimum width:
    1. Open grass, grass-oak: two (2) feet for livestock and foot trails
    2. Six (6) feet for small vehicles
    3. Dense tree thickets or brush: nine (9) feet
- Maximum allowable grade: 20 percent, except for short distances where necessary to bypass dangerous areas or barriers.
- Angle of switchback turns in the trail should not exceed 135 degrees.
- Avoid trails in canyon bottoms, washes or draws, and across historic and recent landslide areas.
- Construct cross ditches or dips, as needed, to turn water off the trail to prevent erosion.
- Stream crossings should be located where stream reaches have a stable bottom and where flows are low and shallow. Crossing sites that have stable, gently sloping banks are most desirable.
- Culverts, fords, or bridges shall be installed across intermittent or perennial drainageways.
- Minimum width of bridge when needed: six (6) feet, excluding side rails. If the bridge is to be utilized by vehicles, consult with a qualified professional engineer.

III. Additional Requirements

- All work shall be done in accordance with proper safety codes for the type of construction being performed, with due regards to the safety of all persons and property.
- Construction operations shall be done in such a manner that erosion and air and water pollution are minimized and held to within legal limits.

IV. BASIS FOR ACCEPTANCE

After the trail or walkway has been completed, an on-site inspection will be conducted to determine if the practice has been applied to conform to the specifications.

V. OPERATION AND MAINTENANCE

The landowner should provide the necessary maintenance to assure the trails and walkways are functional:

- Maintain the trail in good condition, which includes periodic grading and repair of the surface;
- Remove debris to prevent blockages of stream crossings, culverts, or bridges;
- Remove stones, stumps, fallen trees, earth slides, and other obstructions that interfere with livestock use.
- Immediately repair any damage from vandalism, vehicles, livestock, or burrowing animals.

U.S DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
CALIFORNIA

PRACTICE REQUIREMENTS
FOR
575 - ANIMAL TRAILS AND WALKWAYS

For: Business Name_____

Job Location_____

County_____ RCD_____ Farm/Tract No._____

Referral No._____Prepared By_____ Date_____

IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.

1. Drawings, No._____ _____ _____

2. Practice Specifications 575_____,_____,_____

3. Earthfill Compaction by Method:_____

4. Special Requirements:_____

_____

_____

_____

_____

_____

_____

5. Special Maintenance Requirements:_____

_____

_____

PRACTICE APPROVAL:

Job Classification: (Ref: Section 501 NEM)

Show the limiting elements for this job. This job is classified as, Class _____

Limiting elements:	Units
Length of trail_____	_____ft
_____	_____
_____	_____
_____	_____

Design Approved by:_____ Date:_____

LANDOWNER'S/OPERATOR'S ACKNOWLEDGEMENT:

The landowner/operator acknowledges that:

a. He/she has received a copy of the construction drawings and specification, and that he/she has an understanding of the contents, and the requirements.

b. He/she has obtained all the necessary permits.

c. No changes will be made in the installation of the job without prior concurrence of the NRCS technician.

d. Maintenance of the installed work is necessary for proper performance during the project life.

Accepted by:_____ Date:_____

PRACTICE COMPLETION:

I have made an on site inspection of the site (or I am accepting owner/contractor documentation), and have determined that the job as installed does conform to the drawings and practice specifications.

Completion Certification by:

/s/_____ Date _____

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

STREAMBANK AND SHORELINE PROTECTION

(Ft)
CODE 580

DEFINITION

Treatment(s) used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, reservoirs, or estuaries.

SCOPE

This standard applies to measures used to stabilize and protect the banks of streams, lakes, estuaries, and excavated channels. It does not apply to erosion problems on main ocean fronts and similar areas of complexity not normally within the scope of NRCS authority or expertise. All revetments, bulk-heads, or groins are to be no higher than 3 ft. above mean high tide or, or in nontidal areas, no higher than 3 ft. above mean high water.

PURPOSE

- To prevent the loss of land or damage to land uses, or other facilities adjacent to the banks, including the protection of known historical, archeological, and traditional cultural properties.
- To maintain the flow or storage capacity of the water body or to reduce the offsite or downstream effects of sediment resulting from bank erosion.
- To improve or enhance the stream corridor for fish and wildlife habitat, aesthetics, recreation.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to streambanks of natural or constructed channels and shorelines of lakes, reservoirs, or estuaries where they are susceptible to erosion. It applies to controlling erosion where the problem can be solved with relatively simple structural measures, vegetation, or upland erosion control practices. It does not apply to erosion problems on main ocean fronts and similar areas of complexity not normally within the scope of NRCS authority or expertise.

CRITERIA

General Criteria Applicable to All Purposes

Measures must be installed according to a site-specific plan and in accordance with all applicable local, state, and federal laws and regulations.

Protective measures to be applied shall be compatible with improvements planned or being carried out by others.

Protective measures shall be compatible with the bank or shoreline materials, water chemistry, channel or lake hydraulics, and slope characteristics both above and below the water line.

End sections shall be adequately bonded to existing measures, terminate in stable areas, or be otherwise stabilized.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resource Conservation Service.

Protective measures shall be installed on stable slopes. Bank or shoreline materials and type of measure installed shall determine maximum slopes.

Designs will provide for protection from upslope runoff.

Internal drainage for bank seepage shall be provided when needed. Geotextiles or properly designed filter bedding shall be used on structural measures where there is the potential for migration of material from behind the measure.

Measures applied shall not adversely affect threatened and endangered species nor species of special concern as defined by the appropriate state and federal agencies.

Measures shall be designed for anticipated ice action and fluctuating water levels.

All disturbed areas around protective measures shall be protected from erosion. Disturbed areas that are not to be cultivated shall be protected as soon as practical after construction. Vegetation shall be selected that is best suited for the soil/moisture regime.

Additional Criteria for Streambanks

The channel grade shall be stable based on a field assessment before any permanent type of bank protection can be considered feasible, unless the protection can be constructed to a depth below the anticipated lowest depth of streambed scour.

Streambank protection shall be started at a stabilized or controlled point and ended at a stabilized or controlled point on the stream.

A protective toe shall be provided based on an evaluation of stream bed and bank stability.

Channel clearing to remove stumps, fallen trees, debris, and bars shall only be done when they are causing or could cause detrimental bank erosion or structural failure. Habitat forming elements that provide cover, food, and pools, and water turbulence shall be retained or replaced to the extent possible.

Changes in channel alignment shall not be made unless the changes are based on an evaluation that includes an assessment of both upstream and downstream fluvial geomorphology. The current and future discharge-sediment regime shall be based on an assessment of the watershed above the proposed channel alignment.

Measures shall be functional for the design flow and sustainable for higher flow conditions based on acceptable risk.

Measures shall be designed to avoid an increase in natural erosion downstream.

Measures planned shall not limit stream flow access to the floodplain.

Stream segments to be protected shall be classified according to a system deemed appropriate by the state. Segments that are incised or contain the 5-year return period (20 percent probability) or greater flows shall be evaluated for further degradation or aggradation.

When water surface elevations are a concern, the effects of protective measures shall not increase flow levels above those that existed prior to installation.

Side Slopes:

Minimum side slopes for various types of streambank protection are as follows:

Rock riprap	2:1
Rock and wire mattress	2:1
Sacked concrete	1:1

Footings:

Bank protection measures shall extend below the channel bottom, on the same slope as the bank, a minimum vertical distance of three feet except where bottom materials are non-erosive or stable.

Drainage:

Weep holes shall be provided at 10 foot intervals for impervious linings and should be backed by no less than one cubic foot of permeable drainage material.

Additional Criteria for Shorelines

All revetments, bulkheads, or groins are to be no higher than 3 feet (1 meter) above mean high tide, or mean high water in non-tidal areas

Structural shoreline protective measures shall be keyed to a depth to prevent scour during low water.

For the design of structural measures, the site characteristics below the waterline shall be evaluated for a minimum of 50 ft (15 meters) horizontal distance from the shoreline measured at the design water surface.

The height of the protection shall be based on the design water surface plus the computed wave height and freeboard. The design water surface in tidal areas shall be mean high tide.

When vegetation is selected as the protective treatment, a temporary breakwater shall be used during establishment when wave run up would damage the vegetation.

Additional Criteria for Stream Corridor Improvement

Stream corridor vegetative components shall be established as necessary for ecosystem functioning and stability. The appropriate composition of vegetative components is a key element in preventing excess long-term channel migration in re-established stream corridors.

Measures shall be designed to achieve any habitat and population objectives for fish and wildlife species or communities of concern as determined by a site-specific assessment or management plan. Objectives are based on the survival and reproductive needs of populations and communities, which include habitat diversity, habitat linkages, daily and seasonal habitat ranges, limiting factors and native plant communities. The type, amount, and distribution of vegetation shall be based on the requirements of the fish and wildlife species or communities of concern to the extent possible.

Measures shall be designed to meet any aesthetic objectives as determined by a site-specific assessment or management plan. Aesthetic objectives are based on human needs, including visual quality, noise control, and microclimate control.

Construction materials, grading practices, and other site development elements shall be selected and designed to be compatible with adjacent land uses.

Measures shall be designed to achieve any recreation objectives as determined by a site-specific assessment or management plan. Recreation objectives are based on type of human use and safety requirements.

CONSIDERATIONS

An assessment of streambank or shoreline protection needs should be made in sufficient detail to identify the causes contributing to the instability (e.g. watershed alterations resulting in significant modifications of discharge or sediment production). Due to the complexity of such an assessment an interdisciplinary team should be utilized.

When designing protective measures, consider the changes that may occur in the

watershed hydrology and sedimentation over the design life of the measure.

Consider utilizing debris removed from the channel or streambank into the treatment design.

Use construction materials, grading practices, vegetation, and other site development elements that minimize visual impacts and maintain or complement existing landscape uses such as pedestrian paths, climate controls, buffers, etc. Avoid excessive disturbance and compaction of the site during installation.

Utilize vegetative species that are native and/or compatible with local ecosystems. Avoid introduced or exotic species that could become nuisances. Consider species that have multiple values such as those suited for biomass, nuts, fruit, browse, nesting, aesthetics and tolerance to locally used herbicides. Avoid species that may be alternate hosts to disease or undesirable pests. Species diversity should be considered to avoid loss of function due to species-specific pests. Species on noxious plant lists should not be used.

Livestock exclusion should be considered during establishment of vegetative measures and appropriate grazing practices applied after establishment to maintain plant community integrity. Wildlife may also need to be controlled during establishment of vegetative measures. Temporary and local population control methods should be used with caution and within state and local regulations.

Measures that promote beneficial sediment deposition and the filtering of sediment, sediment-attached, and dissolved substances should be considered.

Consider maintaining or improving the habitat value for fish and wildlife, including lowering or moderating water temperature, and improving water quality.

Consideration should be given to protecting side channel inlets and outlets from erosion.

Toe rock should be large enough to provide a stable base and graded to provide aquatic habitat.

Consider maximizing adjacent wetland functions and values with the project design and minimize adverse effects to existing wetland functions and values.

When appropriate, establish a buffer strip and/or diversion at the top of the bank or shoreline protection zone to help maintain and protect installed measures, improve their function, filter out sediments, nutrients, and pollutants from runoff, and provide additional wildlife habitat.

Consider conservation and stabilization of archeological, historic, structural and traditional cultural properties when applicable.

Measures should be designed to minimize safety hazards to boaters, swimmers, or people using the shoreline or streambank. Protective measures should be self-sustaining or require minimum maintenance.

Water Quantity

This practice will have only a minor effect on the quantity of surface and ground water.

1. Effects on the water budget, especially on volumes and rates of runoff, infiltration, deep percolation, and ground water recharge.

2. Effects on downstream flows and aquifers that affect other uses and users.

3. Effects on the water table of adjoining fields.

4. Effects on the interflow discharge into streams.

Water Quality

This practice will decrease the flow and base of the stream on which it is applied to protect the stream banks. When it is installed to protect shorelines, there can be local enhancement of the water quality, but

generally the shoreline is protected and the benefits on water quality are slight.

1. Filtering effects of vegetation on movement of sediment, and sediment-attached and dissolved substances.

2. Effects on erosion and movement of sediment, and soluble and sediment-attached substances carried by runoff and streamflow.

3. Effects on the visual quality of onsite and downstream water resources.

4. Effects of construction and vegetation establishment on quality.

5. Effects of changes in water temperatures.

6. Short-term and long-term effects on wetlands and water-related wildlife habitats.

Endangered Species Considerations

Determine if installation of this practice with any others proposed will have any effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Some species are year-round residents in some streams, such as, freshwater shrimp. Other species, such as steelhead and salmon, utilize streams during various seasons. Be aware that critical periods, such as spawning, eggs in gravels and rearing of young may preclude activities in the stream that may directly affect the stream habitat during those periods. For example, there should be no disturbance of stream gravel beds that may have eggs in them. That could include any equipment in the stream or even walking in the stream or work upstream that may result in sediment depositing in the gravel beds. Document any special considerations for endangered species in the Practice Requirements Worksheet.

PLANS AND SPECIFICATIONS

Plans and specifications for streambank and shoreline protection shall be prepared for specific field sites and based on this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be prepared for use by the owner or others responsible for operating and maintaining the system. The plan shall provide specific instructions for operating and maintaining the system to insure that it functions properly. It shall also provide for periodic inspections and prompt repair or replacement of damaged components or erosion.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

580 - STREAMBANK PROTECTION

I. SCOPE

The work shall consist of furnishing of materials and constructing streambank protection measures to the lines, grades, elevations and dimensions as shown on the drawings or as staked in the field.

II. SITE PREPARATION

Trees and brush on the banks as marked in the field or shown on the drawings shall be removed and disposed of in designated areas. Removal of any trees and brush shall be done in such a manner as to avoid damage to other trees and property. Disposal of trees, brush, and other materials shall be performed to have the least detrimental effect on the environment.

Fallen trees, stumps, debris, minor ledge outcroppings and sand and gravel bars as shown on the drawings shall be removed and disposed of in designated areas.

Clearing and disposal methods shall be in accordance with state and county laws with due regard to the safety of persons and property.

III. BANK PROTECTION MEASURES

The type and extent of bank protection measures shall conform to the structural requirements of the specifications listed on the Practice Requirements sheet.

IV. FENCING

Fencing shall be installed at locations and of the materials shown on the drawings.

V. VEGETATIVE COVER

Unless otherwise specified, a protective cover of vegetation shall be established on the disturbed area. The planting of vegetative materials shall conform to the requirements of Practice Specification 342, Critical Area Planting.

VI. SPECIAL MEASURES

Measures and construction methods shall be incorporated as needed and practical that enhance fish and wildlife values. Special attention shall be given to protecting visual resources and maintaining key shade, food and den trees.

VII. CONSTRUCTION OPERATIONS

Construction operations shall be done in such a manner that erosion and air and water pollution are minimized and held within legal limits. The owner, operator, Contractor or other persons will conduct all work and operations in accordance with proper safety codes for the type of construction being performed with due regards to the safety of all persons and property.

The completed job shall be workmanlike and present a good appearance.

OPERATION AND MAINTENANCE ITEMS

A properly operated and maintained streambank or shoreline protection is an asset to your farm. The streambank or shoreline protection was designed and installed to stabilize an eroding area. The estimated life span of this installation is at least 10 years. The life of this installation can be assured and usually increased by developing and carrying out a good operation and maintenance program.

This practice will require you to perform periodic maintenance and may also require operational items to maintain satisfactory performance. Here are some recommendations to help you develop a good operation and maintenance program.

Check all rock riprap sections for accelerated weathering and displacement. Replace to original grades if necessary.

Maintain vigorous growth of vegetative coverings. This includes reseeding, fertilization and application of herbicides when necessary. Periodic mowing may also be needed to control height.

All settlement or cracks in the soil should be investigated to determine the cause and immediately repaired.

If fences are installed, they shall be maintained to prevent unauthorized or livestock entry.

Removal of debris that may accumulate at this section, and immediately upstream or downstream from this installation.

Control livestock access on unfenced areas.

Eradicate or otherwise remove all rodents or burrowing animals. Immediately repair any damage caused by their activity.

Immediately repair any vandalism, vehicular, or livestock damage.

Other items specific to your project are listed on the "Practice Requirement" sheet.

U.S DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
CALIFORNIA

PRACTICE REQUIREMENTS
FOR
580 - STREAMBANK PROTECTION

For: Business Name_____

Job Location_____

County_____ RCD_____ Farm/Tract No._____

Referral No._____Prepared By_____ Date_____

IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.

1. Drawings, No._____ _____ _____

2. Practice Specifications_____,_____,_____

3. Type of bank protection:_____

4. Special Requirements:_____

_____

_____

_____

_____

_____

_____

5. Special Maintenance Requirements:_____

_____

_____

NRCS, CA
October, 2003

PRACTICE APPROVAL:

Job Classification: (Ref: Section 501 NEM)

Show the limiting elements for this job. This job is classified as, Class _____

Limiting elements:	Units
Design Capacity _____	_____cfs
Drainage Area _____	_____sq mi
Channel Depth _____	_____ft
_____	_____

Design Approved by:_____ Date:_____

LANDOWNER'S/OPERATOR'S ACKNOWLEDGEMENT:

The landowner/operator acknowledges that:

a. He/she has received a copy of the drawings and specification, and that he/she has an understanding of the contents, and the requirements.

b. He/she has obtained all the necessary permits.

c. No changes will be made in the installation of the job without prior concurrence of the NRCS technician.

d. Maintenance of the installed work is necessary for proper performance during the project life.

Accepted by:_____ Date:_____

PRACTICE COMPLETION:

I have made an on site inspection of the site (or I am accepting owner/contractor documentation), and have determined that the job as installed does conform to the drawings and practice specifications.

Completion Certification by:

/s/_____ Date _____

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

CHANNEL STABILIZATION
(Feet)
CODE 584

DEFINITION

Measure(s) used to stabilize the bed or bottom of a channel

PURPOSE

This practice may be applied as part of a conservation management system to support one or more of the following:

- Maintain or alter channel bed elevation or gradient
- Modify sediment transport or deposition
- Manage surface water and ground water levels in floodplains, riparian areas, and wetlands.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to the beds of existing or newly constructed channels, alluvial or non-alluvial, undergoing damaging aggradation or degradation that cannot be feasibly controlled by clearing or snagging, by the establishment of vegetative protection, by the installation of bank protection, or by the installation of upstream water control measures.

CRITERIA

It is recognized that channels may aggrade or degrade during a given storm or over short periods. A channel is considered stable if over long periods the channel bottom remains essentially at the same elevation.

Measures shall be designed and installed according to a site-specific plan.

Measures to be applied shall be compatible with improvements planned or being carried out by others.

Sufficient depth shall be maintained to provide adequate outlets for subsurface drains, tributary streams or ditches, or other channels.

Effect of channel work on existing structures such as culverts, bridges, buried cables, pipelines, and irrigation flumes shall be evaluated to determine impact on their intended functions.

Measures shall be designed for flow duration, depth of inundation, buoyancy, uplift, scour, angle of attack, and stream velocity.

Measures shall be compatible with the bank or shoreline materials, water chemistry, channel hydraulics, and slope characteristics, both above and below the water line.

Measures shall be designed for anticipated ice action, debris impact and fluctuating water levels.

Spoil material from clearing, grubbing, and channel excavation shall be disposed of in a manner that will not interfere with the function of the channel and in accordance with all local, state, and federal laws and regulations.

All disturbed areas around measures shall be protected from erosion. Vegetation shall be selected that is best suited for the anticipated site conditions.

Measures applied shall seek to avoid adverse effects to endangered, threatened, and candidate species and their habitats, whenever possible.

Measures installed to stabilize stream channels shall also be designed and installed to meet NRCS standards for the particular structure and type of construction.

Channel clearing to remove stumps, fallen trees, debris, and bars shall only be done when they are causing or could cause detrimental bank erosion or structural failure. Habitat forming elements that provide cover, food, pools, and water turbulence shall be retained or replaced to the extent possible.

Measures shall be designed to maintain the appropriate sediment transport regime in order to

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

avoid detrimental erosion or sedimentation upstream and downstream.

Measures shall not impair the floodplain function.

Measures shall not result in adverse affects on the function of the stream or the stream corridor.

When water surface elevations are a concern, the effects of protective measures shall not cause detrimental changes in water surface elevations.

The quantity and character of the sediments entering the reach of channel under consideration shall be analyzed on the basis of both present conditions and projected conditions caused by changes in land use or land treatment and upstream improvements or structural measures.

CONSIDERATIONS

Consider area-wide planning for proper design, function and management of protective measures where the design reach involves by multiple stakeholders.

An assessment of channel stabilization needs should be considered in sufficient detail to identify the causes contributing to the instability (e.g. watershed alterations resulting in significant modifications of discharge or sediment production). Due to the complexity of such an assessment, use of an interdisciplinary team should be considered.

When designing protective measures, consider the changes that may occur in the watershed hydrology and sedimentation over the design life of the measure.

Consider utilizing woody debris removed during construction in the overall practice design.

Measures should consider habitat and migration needs of aquatic species.

Consider maintaining or improving the habitat value for fish and wildlife, which includes lowering or moderating water temperature, and improving water quality.

Consider opportunities to improve habitat for threatened, endangered, and other species of concern, where applicable.

Consider maximizing adjacent wetland functions and values with the project design and minimizing adverse effects to existing wetland functions and values.

Consider protecting side channel inlets and outlets from erosion or sedimentation.

Consider the type of human use and the social and safety aspects when designing the protective measures. Use construction materials, grading practices, vegetation, and other site development elements that enhance aesthetics, recreational use, and maintain or complement existing landscape uses such as pedestrian paths, climate controls, and buffers. Avoid excessive disturbance and compaction of the site during installation.

Measures should be designed to minimize safety hazards to boaters, swimmers, or people using the channel.

Cultural Resources Considerations

NRCS’s objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with

the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Water Quantity

1. Stage-discharge and flow velocity relative to the water budget components, geologic materials comprising the stream channel, and objectives of the channel modification.

2. Effects on water tables, soil moisture storage, and rooting depths and transpiration of vegetation.

Water Quality

1. Temporary and long-term effects on erosion and sedimentation.

2. Changes in stream water temperature that may result from the clearing of vegetation or alteration of water sources to the channel.

3. Effects on the visual quality of the water resource.

PLANS AND SPECIFICATIONS

Plans and specifications for this practice shall be prepared for specific channel reaches and field sites and shall describe the requirements for applying the practice to achieve its intended purpose(s).

OPERATION AND MAINTENANCE

The owner or others responsible for operating and maintaining the system shall prepare an operation and maintenance plan. The plan shall provide specific instructions for operating and maintaining the system to insure that it functions properly. It shall also provide for periodic inspections and prompt repair or replacement of damaged components.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

584 - CHANNEL STABILIZATION

I. SCOPE

The work shall consist of furnishing materials and constructing stream stabilization measures to the lines, grades and elevations as shown on the drawings, or as staked in the field.

II. SITE PREPARATION

The area specified shall be cleared of trees, stumps, roots, brush, boulders, and debris. Removal of this material shall be done in such a manner as to avoid damage to other trees and property.

All material removed shall be piled in designated areas, and disposed of in such a manner as to have the least detrimental effect on the environment.

Clearing and disposal methods shall be in accordance with state and county laws with due regard to the safety of persons and property.

III. EXCAVATION

Excavation under this specification shall be limited to minor channel excavation and shaping as shown on the drawings or as staked in the field.

Excavation material shall be disposed of as shown on the drawing or as staked in the field.

All finished surfaces shall be generally smooth and pleasing in appearance.

IV. EARTHFILL PLACEMENT

Material

All fill material shall be obtained from approved borrow pits and from excavations (if suitable) required for other parts of the work. Fill materials shall contain no sod, brush, roots, or other perishable or unsuitable materials. Cobbles and rock fragment having maximum dimension of more than six inches shall be removed from the materials prior to compaction, and be disposed of or placed in areas designated by the Engineer.

Placement

The placing and spreading of fill material shall be started at the lowest point of the foundation and the fill brought up in horizontal layers of such thickness that the required compaction can be obtained. The fill shall be constructed in continuous horizontal layers except where openings or sectionalized fills are required. In those cases, the slope of the bonding surfaced between the embankment in place and the embankment to be placed shall not be steeper than 3 horizontal to 1 vertical. The bonding surface shall be treated the same as that specified for the foundation so as to insure a good bond with the new fill.

The distribution and gradation of materials shall be such that there are no lenses, pockets, streaks, or layers of material. If it is necessary to use materials of varying texture and gradation, the more impervious material shall be placed in the center and outer parts of the fill. If zoned fills of substantially differing materials are specified, the zones shall be placed according to lines and grades shown on the drawings.

Selected backfill material shall be placed around structures, pipe conduits, and anti-seep collars at about the same rate on all sides to prevent damage from unequal loading.

Fill placed around structures will be brought up at approximately uniform height on all sides of the structure.

Moisture content of the fill material shall be adequate for obtaining the required compaction. Material that is too wet shall be dried to meet this requirement, or removed, and material that is too dry shall have water added and mixed until the requirement is met.

The proper moisture content for compaction will be determined by inspection during the placement operation. The material should maintain a ball shape when squeezed in the hand. When specified, the moisture shall be maintained within 2 percentage points of optimum as determined by ASTM D-698.

As far as practicable, the material shall be brought to the proper water content in the borrow pits before excavation. Supplemental water, when required, may be applied by sprinkling the materials on the fill. Uniform distribution of the moisture shall be obtaining by discing, blading or other approved method prior to compaction.

Compaction

Construction equipment shall be operated over each layer of fill to insure that the required compaction is obtained. Special equipment shall be used if needed to obtain the required compaction.

Compaction shall meet the requirements of the method specified in the Practice Requirements and as described below:

A. Sheepsfoot roller - the maximum layer thickness shall be 8 inches before compaction. The roller shall have staggered, uniformly spaced tamping feet and be equipped with suitable cleaners. The weight of the roller shall not be less than 2,500 pounds per foot of width. The maximum speed of the compaction equipment shall be 3 miles per hour. The entire surface of each layer placed should receive 6 passes of this equipment to attain the necessary compaction.

B. Pneumatically tired equipment - The maximum layer thickness before compaction shall be 6 inches. A loaded scraper may be considered a pneumatic roller. The wheels of this equipment must pass over 90 percent of the surface of each lift before a new lift is placed.

C. Track laying equipment (bulldozer) - The maximum layer thickness before compaction shall be 4 inches. The tracks of the equipment must pass over 90 percent of the surface of each lift before a new lift is placed.

D. Compaction shall result in densities equal to or greater than 95 percent of the maximum obtained by laboratory compaction at optimum moisture of like soils in accordance with the procedure given to ASTM D-698, Procedure A.

E. Compaction shall result in densities equal to or greater than 90 percent of the maximum obtained by laboratory compaction at optimum moisture of like soils in accordance with the procedure given in ASTM D-1557, Procedure A.

Heavy compaction equipment shall not be operated within 2 feet of any structure. Hand directed tampers or compactors shall be used on areas not accessible to heavy compaction equipment, and within 2 feet of any structure. Fills compacted in this manner shall be placed in layers not greater than 4 inches in thickness before compaction, and shall meet the same density requirement as for the adjacent area.

Compliance with compaction requirements will be determined by the procedure given in ASTM D-1556 or D-2167 for methods D and E and by observation of performance for methods A, B, and C.

Fill not meeting the specified requirements shall be reworked or removed and replaced with acceptable fill.

Fill adjacent to structures, pipe conduits, and anti-seep collars shall be compacted to a density equivalent to that of the surrounding fill by means of hand tamping or manually directed power tampers or plate vibrators.

The passage of heavy equipment will not be allowed (1) over cast-in-place conduits prior to seven days after placement of the concrete, or (2) over any type of conduit until the compacted backfill has been placed over the top surface of the structure equal to one-half the clear span width of the structure of pipe, or two feet whichever is greater.

Compaction of backfill adjacent to structures shall not be started until after the expiration of the following minimum time interval after placement of the concrete:

Walls and counterforts	10 days
Anti-seep collars, conduits and cantilever outlet bents	3 days

V. STRUCTURES

All structures within the reach being stabilized, shall be constructed to conform with the reference specifications listed on the Practice Requirements sheet and the drawings.

VI. VEGETATIVE REQUIREMENTS

Unless otherwise specified, a protective cover of vegetation shall be established on all exposed surfaces on the channel banks as indicated on the drawings and shall conform to the requirements of Practice Specification 342, Critical Area Planting. Planted areas shall be fenced where necessary to protect the vegetation until it is established.

VII. SPECIAL MEASURES

Measures and construction methods shall be incorporated as needed and practical that enhance fish and wildlife values. Special attention shall be given to protecting visual resources and maintaining key shade, food and den trees.

VIII. CONSTRUCTION OPERATIONS

Construction operations shall be done in such a manner that erosion and air and water pollution are minimized and held within legal limits. The owner, operator, Contractor or other persons will conduct all work and operations in accordance with proper safety codes for the type of construction being performed with due regards to the safety of all persons and property.

The completed job shall be workmanlike and present a good appearance.

OPERATION AND MAINTENANCE ITEMS

A properly operated and maintained stable stream channel is an asset to your farm. This stable stream channel was designed and installed to stabilize an eroding channel. The estimated life span of this system is at least 10 years. The life of this system can be assured and usually increased by developing and carrying out a good operation and maintenance program.

Maintain vigorous growth of vegetative coverings. This includes reseeding, fertilization and application of herbicides when necessary. periodic mowing may also be needed to control height.

If fences are installed, they shall be maintained to provide warning and/or prevent unauthorized human or livestock entry.

Control livestock access and use of unfenced areas.

Remove all foreign debris as quickly as possible.

Periodic removal of all silt, sand, or gravel deposits.

Repair and revegetate all eroded channel sections.

Eradicate or otherwise remove all rodents or burrowing animals as their burrows may weaken earthen sections and develop flow paths for water and accelerate soil erosion or failure. Immediately repair any damage caused by their activity.

Immediately repair any vandalism, vehicular, or livestock damage.

Other items specific to you project are listed on the "Practice Requirement" sheet.

U.S DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
CALIFORNIA

PRACTICE REQUIREMENTS
FOR

584 - STREAM CHANNEL STABILIZATION

For: Business Name_____

Job Location_____

County_____ RCD_____ Farm/Tract No._____

Referral No._____Prepared By_____ Date_____

IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.

1. Drawings, No._____ _____ _____

2. Practice Specifications_____,_____,_____

3. Earthfill Compaction by Method:_____

4. Special Requirements:_____

_____

_____

_____

_____

_____

_____

5. Special Maintenance Requirements:_____

_____

_____

NRCS, CA
October, 2003

PRACTICE APPROVAL:

Job Classification: (Ref: Section 501 NEM)

Show the limiting elements for this job. This job is classified as, Class _____

Limiting elements:	Units
Design flow _____	_____cfs
Velocity _____	_____fps
_____	_____
_____	_____

Design Approved by:_____ Date:_____

LANDOWNER'S/OPERATOR'S ACKNOWLEDGEMENT:

The landowner/operator acknowledges that:

a. He/she has received a copy of the drawings and specification, and that he/she has an understanding of the contents, and the requirements.

b. He/she has obtained all the necessary permits.

c. No changes will be made in the installation of the job without prior concurrence of the NRCS technician.

d. Maintenance of the installed work is necessary for proper performance during the project life.

Accepted by:_____ Date:_____

PRACTICE COMPLETION:

I have made an on site inspection of the site (or I am accepting owner/contractor documentation), and have determined that the job as installed does conform to the drawings and practice specifications.

Completion Certification by:

/s/_____ Date: _____

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

TERRACE
(feet, meter)
CODE 600

DEFINITION

An earth embankment or a combination ridge and channel, constructed across the field slope.

PURPOSE

This practice may be applied as part of a resource management system to support one or both of the following:

- Reduce soil erosion
- Retain runoff for moisture conservation

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Soil erosion by water is a problem
- There is a need to conserve water
- The soils and topography are such that terraces can be constructed and farmed with reasonable effort
- A suitable outlet can be provided
- Excess runoff is a problem

CRITERIA

General Criteria Applicable To All Purposes

Terraces shall be planned, designed, and constructed to comply with all federal, state, and local laws and regulations.

Spacing - The maximum spacing for terraces for erosion control shall be determined by use of one of the following methods:

1. **V.I. = xs + y or H.I. = (xs + y) (100/s)**

   Where:

   V.I. = vertical interval in feet (m)

   H.I. = horizontal interval in feet (m)

   (See figure 2 and 3)

   x = a variable with values from 0.4 to 0.8 (0.12 to 0.24)

   s = land slope in percent

   y = a variable with values from 1.0 to 4.0 (0.3 to 1.2)

Values of x for different geographical zones are shown in Figure 1. Values of y are influenced by soil erodibility, cropping system and crop management practices. A value of 1.0 (0.3) shall be selected for erodible soils with tillage systems that provide little or no cover during periods of intense rainfall. A value of 4.0 (1.2) shall be used for erosion- resistant soils with tillage systems that leave a large amount of cover (1.5 tons of straw equivalent per acre or 3.4 metric tons per hectare) on the surface. A value of 2.5 (0.75) shall be used if one of the factors indicated is favorable and the other unfavorable. Other values between 1.0 (0.3) and 4.0 (1.2) may be used according to the estimated quality of the factors. The horizontal spacing does not have to be less than 90 feet.

2. Revised Universal Soil Loss Equation (RUSLE). The spacing shall not exceed the critical slope length as determined using RUSLE. When tables are used to calculate critical slope, refer to Table 1 of this standard for terrace P factor. Soil loss in the inter-terrace interval must be less than or equal to the allowable soil loss.

In no case shall the maximum horizontal spacing exceed that shown in Table 2 for the condition shown. The maximum limits may not be exceeded when making adjustments indicated below.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

Spacing may be increased as much as 10 percent to provide better location or alignment, to adjust for farm machinery, or to reach a satisfactory outlet.

The likelihood of benching of steep slopes by tillage, land forming, and erosion shall be considered when determining the terrace interval. For example, use the proposed as-built slope and length in RUSLE calculations.

For level terraces used for erosion control and water conservation, the spacing shall be determined as previously described, but in no case shall the maximum horizontal spacing exceed 600 ft (180 m). An x value of 0.8 (0.24) may be used for all level terraces used primarily to impound water. When using the V.I. or H.I. spacing method, Figures 2 and 3 show the horizontal interval or erosion length to be used in calculating terrace spacing (Figure 4).

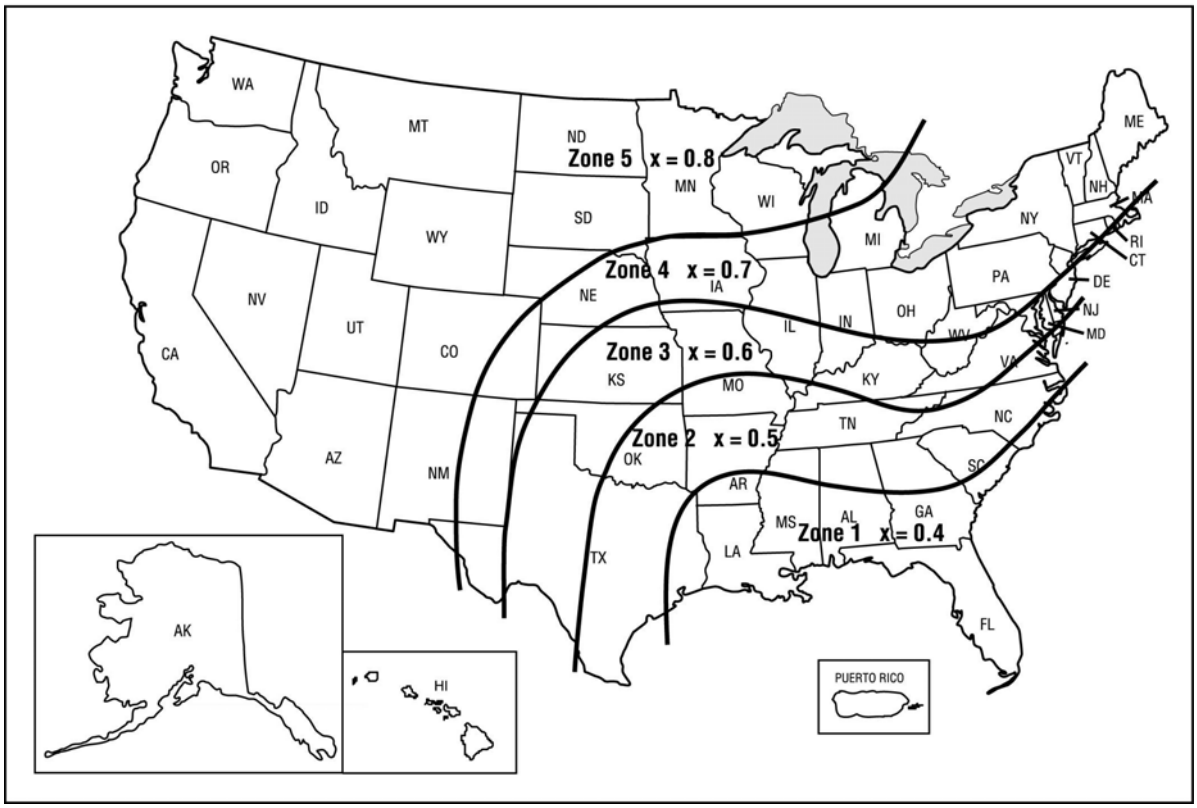

Figure 1. Values of x in equation V.I. = xs + y or H.I. = (xs + y) (100/s)

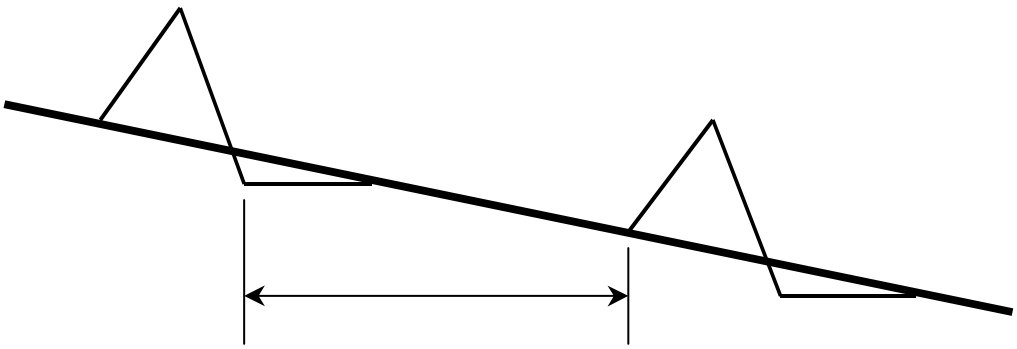

Figure 2. Horizontal Interval for Steep Back-slope Terraces

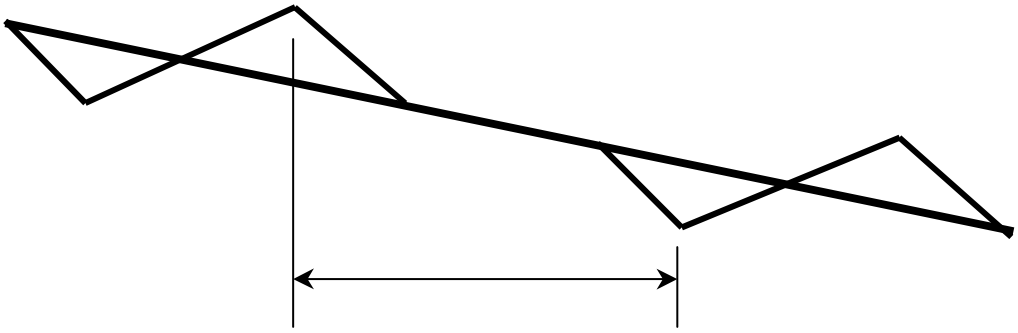

Figure 3. Horizontal Interval for Broad-Based Terraces

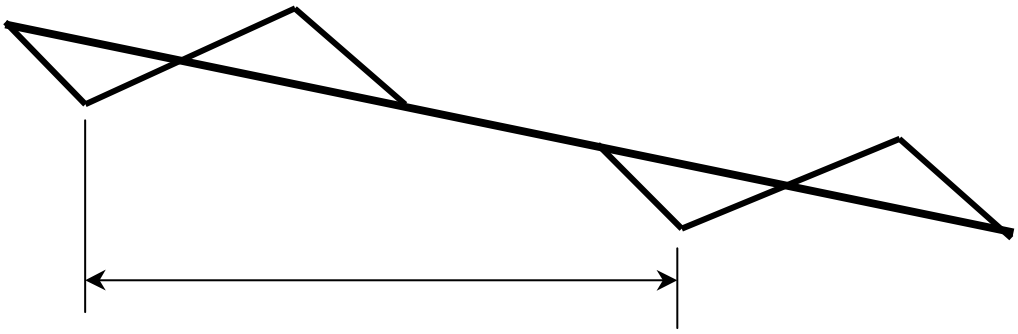

Figure 4. Terrace Spacing

Table 1. Terrace P factors [1]

Horizontal Interval		Closed Outlets [2]	Open outlets with percent grade of: [3]		
(ft)	(m)		0.1 - 0.3	0.4 - 0.7	0.8
Less than 110	Less than 33	0.5	0.6	0.7	1.0
110-140	33-42	0.6	0.7	0.8	1.0
140-180	43-54	0.7	0.8	0.9	1.0
180-225	55-68	0.8	0.8	0.9	1.0
225-300	68-90	0.9	0.9	1.0	1.0
More than 300	More than 90	1.0	1.0	1.0	1.0

NOTE: If contouring or stripcropping P factors are appropriate, they can be multiplied by the terrace P factor for the composite P factor.

1 These figures are not appropriate for sediment yield estimates.

2 "P" factors for closed outlet terraces also apply to terraces with underground outlets and to level terraces with open outlets.

3 The channel grade is measured on the 300 ft. of terrace or the one-third of total terrace length closest to the outlet, whichever distance is less

Table 2. Maximum horizontal spacing for terraces

	RUSLE R Factor of						With Contour Stripcropping		For Concentrated Flow Control	
	0 - 35		35 - 175		> 175					
Percent Slope	Ft	M	Ft	M	Ft	M	Ft	M	Ft	M
0-2	700	210	500	150	450	130	600	180	700	210
2-4	700	210	400	120	300	90	600	180	700	210
4-6	600	180	400	120	200	60	600	180	600	180
6-9	400	120	300	90	150	45	400	120	500	150
9-12	400	120	250	75	150	45	250	75	500	150
12-18	250	75	200	60	150	45	150	45	400	120
> 18	250	75	200	60	150	45	150	45	300	90
Minimum spacing required, all slopes	200	60	150	45	90	27	90	27	200	60

Alignment - Cropland terraces shall be parallel if feasible and as parallel as practicable. Curves shall be long and gentle to accommodate farm machinery.

Capacity - The terrace shall have enough capacity to control the runoff from a 10-year frequency, 24-hour storm without overtopping. For terraces with underground outlets, the capacity shall be increased by the estimated 10-year sediment accumulation, unless sediment is removed through maintenance. Terrace systems designed to provide flood protection or to function with other structures shall have the appropriate design capacity. When the capacity is determined by the formula Q = AV and the V is calculated using Manning's formula, a minimum n value of 0.035 shall be used for bare channels. Agricultural Handbook Number 667, Stability Design of Grass-lined Open Channels, or equivalent shall be used for vegetated channels.

Cross section - The terrace cross section shall be proportioned to fit the land slope, the crops grown, and the farm machinery used. Additional height shall be added if necessary to provide for settlement, channel sediment deposits, ridge erosion, the effect of normal tillage operations, and safety. The ridge shall have a minimum width of 3

ft. (1 m) at the design elevation. The steepest slope of a vegetated front or back ridge slope is 2 horizontal: 1 vertical. Terrace ridges, especially those with steep back slopes, can be very hazardous. All cropped terrace slopes that are to be farmed shall be no steeper than those on which farm equipment can operated safely. Potential hazards must be brought to the attention of the responsible person. The opening at the outlet end of gradient and open-end level terraces shall have a cross section equal to that specified for the terrace channel.

End closures -Level terraces may have open ends, partial end closures, or complete end closures. Partial and complete end closures shall be used only on soils and slopes where the stored water will be absorbed by the soil without appreciable crop damage or where underground outlets are provided.

If terraces with closed or partly closed ends are specified, the end closures must be installed before the terraces are completed. The end closures shall be designed so that the water flows over the end closure before overtopping the terrace ridge.

Partial end closures shall not be more than half the effective height of the terrace ridge. Complete end closures are more than half the height of the ridge. The cross section of the closures may be less than the terrace cross section.

Channel grade - Channel grade shall be determined by one of the following methods:

1. Maximum channel velocities for permanently vegetated channels shall not exceed those used for grassed waterways.

2. Maximum channel velocity for cultivated channels shall be non-erosive for the soil and planned treatment. Maximum velocity for erosion-resistant soils is 2.5 ft/s (0.75 m/s); for average soils, 2.0 ft/s (0.6 m/s); and for easily erodible soils, 1.5 ft/s (0.45 m/s). Velocity shall be computed by Manning's formula, using a maximum n value of 0.035.

For short distances and in upper reaches, channel grades or velocities may be increased to improve alignment. If terraces have an underground outlet, water and sediment will pond in the lower reaches of the channel, thus reducing the velocity in those reaches and allowing steeper channel grades within the impoundment area. Minimum grades shall be such that ponding in the channel caused by minor irregularities will not cause serious damage to crops or delay field operations.

Terrace length - The volume of water stored in level terraces is proportional to the length. Therefore, it is necessary that the length be held within reason so that damage in case of a break is minimized. Level terrace length shall not exceed 3,500 ft. (1,000 m) unless the channel is blocked at intervals not exceeding 3,500 ft. (1,000 m). Normally, the capacity and the non-erosive velocity requirements will control the gradient terrace length.

Outlets - All terraces must have adequate outlets.

Vegetated outlets may be used for gradient or open-end level terraces. Such an outlet may be a grassed waterway or other vegetated area. The outlet must convey runoff water to a point where the outflow will not cause damage. Outlets shall be installed and vegetation established before the terrace is constructed to provide a stable outlet. The water surface in the terrace shall not be lower than the water surface in the outlet at their junction when both are operating at design flow.

Underground outlets may be used on gradient or level terraces. The outlet consists of an intake and an underground conduit. An orifice plate, increase in conduit size, or other features shall be installed as needed to control the release rate and prevent excessive pressure in the conduit. Terraces shall be designed to control a 10-year frequency, 24- hour storm without overtopping. The release time shall not exceed the inundation tolerance of the planned crops. If sediment retention is desired, adjust release rate according to particle size.

The underground conduit shall meet the requirements specified for Underground Outlets (620) or Subsurface Drains (606). Conduits must be installed deep enough to prevent damage from tillage equipment. The inlet shall consist of a vertical perforated pipe or other structure suitable for the intended purpose. The inlet shall be located uphill of the front slope of the terrace ridge, if farmed, to permit passage of farm machinery and, if necessary, provide for the anticipated accumulation of sediment. The outlet of the conduit shall have adequate capacity for the design flow without causing erosion. Blind inlets may be used where they are effective.

Soil infiltration may be used as the outlet for level terraces. Soil infiltration must permit drainage of the design storm from the terrace channel within a

reasonable period so standing water does not significantly damage crops.

Combinations of different types of outlets may be used on the same system to maximize water conservation, to affect water quality, and to provide for economical installation of a more farmable system.

Vegetation - All areas to be vegetated shall be established as soon as practicable after construction.

Drainage -Install subsurface drainage to stabilize terrace where needed. It shall be designed taking into consideration the effect of snowcatch and melt on water budget components.

Additional Criteria Applicable To Retaining Runoff For Moisture Control

Terrace capacity shall be designed in accordance with a water budget analysis.

CONSIDERATIONS

Consider adjusting the spacing to allow an even number of trips with the equipment.

Consider aligning terraces and/or installing subsurface drainage to correct seepage problems.

Cultural Resources Considerations

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Water Quantity

1. Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation and ground water recharge.

2. .Variability effects caused by seasonal or climatic changes.

3. The type of outlet, time of water detention, topography, and geology of the site.

4. Effects of snow catch and melt on water budget components.

5. Potential for a change in plant growth and transpiration because of changes in the volume of soil water.

6. Effects on the downstream or aquifers that could affect other water uses and users.

7. The effect on the water table suitable rooting depth for anticipated land uses.

8. Potential for water management to supply alternate uses.

Water Quality

1. Effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that would be carried by runoff.

2. Effects of nutrients and pesticides on surface and ground water quality.

3. Effects on the visual quality of onsite and downstream water.

4. Short-term and construction-related effects on the quality of onsite and downstream water.

5. Potential for development of saline seeps or other salinity problems resulting from increased infiltration in soils that have restrictive layers.

6. Potential for uncovering or redistributing toxic materials such as saline soils.

7. Effects on the movement dissolved substances below the root and to the ground water.

8. Effects on wetlands and water related wildlife habitats.

PLANS AND SPECIFICATIONS

Plans and specifications for installing terraces shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be prepared for the operator.

The minimum requirements to be addressed in the operation and maintenance plan are:

1. Provide periodic inspections, especially immediately following runoff events.

2. Promptly repair or replace damaged components as necessary.

3. Maintain terrace ridge height and outlet elevations.

4. Remove sediment that has accumulated in the terrace to maintain capacity, a positive channel grade, and to maintain capacity where soil infiltration serves as the outlet.

5. Each inlet for underground outlets must be kept clean and sediment buildup redistributed so that the inlet is in the lowest place. Inlets damaged or cut off by farm machinery must be replaced or repaired immediately.

6. Vegetation, where specified, shall be maintained and trees and brush controlled by chemical or mechanical means.

7. Vegetated outlets should be established before construction when feasible.

8. Keep machinery away from steep back sloped terraces. Keep equipment operators informed of all potential hazards.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

SURFACE DRAINAGE, MAIN OR LATERAL
(Feet)
CODE 608

DEFINITION

An open drainage ditch constructed to a designed size and grade.

PURPOSE

This practice may be applied as part of a water management system to collect and convey excess surface or subsurface water.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to ditches for conveyance of surface and subsurface drainage water primarily collected by drainage field ditches and subsurface drains.

It provides minimum drainage requirements for multiple-purpose channels that provide drainage outlets for agricultural lands. Mains or laterals having a drainage area of more than 1 square mile must meet the stability requirements of Technical Release 25, Design of Open Channels (TR-25). This standard does not apply to collection of water with a drainage field ditch. Standard for Surface Drainage - Field Ditch (607) should be used for that situation.

All lands to be drained shall be suitable for agriculture after installation of required drainage and other conservation practices.

Whether the outlet is by gravity flow or by pumping, the outlet shall be sufficient for the quantity and quality of water conveyed.

CRITERIA

The design and installation shall be based on adequate surveys and investigations. Compliance with all applicable federal, state and local regulations and ordinances is required. The landowner(s) shall be responsible for obtaining and complying with all applicable permits.

Drainage requirements - Mains and laterals shall be located and designed to serve as integral parts of a surface or subsurface drainage system that meets the conservation and land use needs. The degree of drainage required by the crops shall be determined and expressed in terms of drainage coefficients or depth and spacing of drains.

Capacity - The ditch capacity shall be adequate to provide for the removal of excess water, based on climatic and soil conditions and the needs of crops. The required capacity shall be obtained by determining the watershed area; the required topographic, soil, and land use information; and use of the appropriate drainage coefficients.

The required capacity of open ditches for subsurface drainage in irrigated areas shall be determined by evaluating site conditions, including irrigation water deliveries, irrigation canal or ditch losses, soil stratification and permeability, deep percolation losses, field irrigation losses, subsurface drain discharge, and quantity of surface water to be carried by the drainage ditch.

Hydraulic gradeline - The hydraulic gradeline for drainage ditch design shall be determined from control points, including elevations of significant low areas served by the ditch and hydraulic gradelines of any tributary ditches and the outlet. If control point elevations are estimated rather than computed from survey data, the hydraulic gradeline shall be no less than:

1. 1 ft. below fields that will receive normal drainage from ditches draining more than 1 mi^2.
2. 0.5 ft. for ditches draining 40 to 640 acres.
3. 0.3 ft. for ditches draining less than 40 acres.

For lands to be used only for water-tolerant crops, such as certain trees and grasses, these requirements may be modified and the hydraulic gradeline set at ground level. These provisions do not apply to channels where dikes contain flow.

The effects of hydraulic losses caused by culverts, bridges, or other obstructions in the channel section shall be considered.

Depth - Drainage ditches shall be designed deep enough to allow for normal siltation. Ditches that serve as outlets for subsurface drains shall be

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

designed for a normal water surface at or below the invert of the outlet end of the drain. The normal water surface is the elevation of the usual low flow during the growing season. Where site conditions allow, the clearance between a subsurface drain invert or a field ditch invert shall be at least 1 ft. to account for sediment accumulation in the main or lateral.

Cross section - The design ditch cross section shall be set below the design hydraulic gradeline and shall meet the combined requirements of capacity, limiting velocity, depth, side slopes, bottom width, and, if needed, allowances for initial sedimentation. Side slopes shall be stable, shall meet maintenance requirements, and shall be designed on the basis of on-site conditions.

The drainage guide or other local information shall be used to determine side slope limits for specific soils and/or geologic materials. If such information is not available, the design side slopes in the main or lateral shall not be steeper than those shown in Engineering Field Handbook (EFH) Part 650, Chapter 14, Section 650.1412 (d). Stability during rapid drawdown conditions must be considered.

Velocity - The maximum permissible design velocity shall be based on site conditions and shall insure stability of the ditch bottom and side slopes. Design velocities shall not be less than 1.4 ft/s to avoid excessive sedimentation.

The velocity for newly constructed channels with drainage areas in excess of 1 square mile shall meet the stability requirements specified of TR-25.

Capacity design - Manning's equation shall be used in determining the design velocity, and the value of *n* shall be based on alignment, probable vegetative growth expected with normal maintenance, other roughness factors, and the hydraulic radius. Unless special site studies are available to justify other values, the values of *n* in the EFH Part 650, Chapter 14, Section 650.1412 (d) or the local drainage guide, based on the hydraulic radius of the channel and assuming an aged channel with good maintenance and good alignment, shall be used in solving Manning's equation for mains and laterals when determining the design for required capacity.

Berms and spoil banks - Adequate berms at a safe distance from the drain shall be provided and shaped, as required, to provide access for maintenance equipment, to eliminate the need for moving spoil banks in future operations, to provide for work areas and facilitate spoil bank spreading, to prevent excavated material from washing or rolling back into ditches, and to lessen sloughing of ditch banks caused by heavy loads too near the edge of the ditch banks. The spoil shall be spread as soon as practical. Minimum berm widths shall be those recommended in EFH Part 650, Chapter 14, Section 650.1412 (d) or the local drainage guide, except where the spoil is spread according to the standard for Spoil Spreading (572).

Where spoil material is to be placed in banks along the ditch rather than spread over adjacent fields, the spoil banks shall have stable side slopes. Provision must be made to channel water through the spoil bank and into the ditch without causing serious erosion.

Related structures and ditch protection - Mains and laterals shall be protected against erosion where surface water or shallow ditches enter deeper ditches. This may be achieved through the use of chutes, drop structures, pipe drops, other suitable structures or grassed waterway, critical area seeding, filter strips, or specially graded channel entrances.

Grade control structures, bank protection, or other suitable measures shall be used if necessary to reduce velocities and control erosion.

Culverts and bridges shall have sufficient hydraulic capacity and depth to satisfy drainage needs and to minimize obstruction to flow.

Capacities of pipe or drop structures shall be determined by use of the applicable drainage coefficients. Protect the structure from washout by flows exceeding design capacity.

Each structure for an open ditch system shall be designed according to NRCS standards for the kind of structure and type of construction used.

Channel vegetation - Vegetation shall be established according to the standard for Channel Bank Vegetation (322).

CONSIDERATIONS

Cultural Resources Considerations

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Water Quantity

1. Effects on the water budget components, especially with regard to effect on runoff, soil water, and water tables.

2. Potential changes in soil moisture that will affect the growth of desirable vegetation.

3. Effect on ground water recharge.

Water Quality

1. Effects on the detachment and transport of sediment and chemicals and dissolved and sediment-attached substances into water courses.

2. Effects on the salinity of drained soils and downstream watercourses.

3. Effects on wetlands.

4. Use of riparian buffers, filter strips and fencing.

- Possible damages above or below the point of discharge that might involve legal actions or other offsite impacts.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing mains or laterals shall be in keeping with this standard and shall describe the requirements for constructing the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

A site-specific operation and maintenance plan shall be provided to and reviewed with the landowner(s) before the practice is installed. The plan shall adequately guide the landowner(s) in the routine maintenance and operational needs of the surface main or lateral. The plan shall also include guidance on periodic inspections and post-storm inspections to detect and minimize damage to the drain.

Minimum requirements to be addressed in the Operation and Maintenance plan are:

1. Maintain cross-section and gradient by controlling channel erosion and bank sloughing.

2. Remove all foreign debris and trash that hinders system operation.
3. Install and maintain fences to prevent livestock access when adjacent fields are used for pasture.
4. Check all drop pipe inlets, structures and rock riprap sections for accelerated weathering and displacement. Replace to original grades as necessary.
5. Eradicate or otherwise remove all rodents and/or burrowing animals that have or can potentially damage any part of the system. Immediately repair any damage caused by their activity.
6. Immediately repair any vandalism, vehicular or livestock damage.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

608 - SURFACE DRAINAGE MAIN OR LATERAL

I. SCOPE

The work shall consist of constructing a drainage main or lateral to the lines, grades, elevations and cross sections as shown on the drawings or as staked in the field.

II. CLEARING

The surface area of the ditch shall be cleared of all trees, brush, weeds, sod, loose rocks and other undesirable materials.

Clearing and disposal methods shall be in accordance with applicable state and county laws with due regard to the safety of persons and property.

III. EXCAVATION

Unless otherwise noted, the excavation shall begin at the outlet and progress upstream. The excavated surface shall be graded and smooth. Construction activities shall be carried on in a manner that will not restrict flow from upstream channel. Care must be taken to reduce and prevent sediment pollution of water.

There shall be no reversal in slope that will create ponding.

IV. SPOIL

Berms shall be of the width and shape as shown on the drawings.

Excavated material may be deposited along one or both sides of the ditch or spread on adjoining fields as directed by the landowner or his representative. Spoil banks used as levees shall be constructed as shown on the drawings.

V. STRUCTURES

General

Structures are to be located and constructed of the materials specified and to the dimensions shown on the drawings, and as specified in the specification as listed on the "Practice Requirement" sheet.

All structures and other related devices shall be installed as the work progresses.

Backfill

Backfill adjacent to structures shall be placed in a manner that will prevent damage to the structure and will allow the structure to assume the loads from the fill gradually and uniformly. The height of the fill adjacent to a structure shall be increased at approximately the same rate on all sides of the structure.

During placement and compaction of fill, the moisture content of the materials being placed shall be maintained within limits to form and hold the shape of a ball when squeezed in the hand.

Compaction shall result in densities equal to or greater than the adjacent material.

VI. VEGETATIVE COVER

Unless otherwise specified, a protective cover of vegetation shall be established on the disturbed area. The planting of vegetative materials shall conform to the requirements of Practice Specification 322, Channel Bank Vegetation.

VII. SPECIAL MEASURES

Measures and construction methods shall be incorporated as needed and practical that enhance fish and wildlife values. Special attention shall be given to protecting visual resources and maintaining key shade, food and den trees.

VIII. CONSTRUCTION OPERATIONS

Construction operations shall be done in such a manner that erosion and air and water pollution are minimized and held within legal limits. The owner, operator, Contractor or other persons will conduct all work and operations in accordance with proper safety codes for the type of construction being performed with due regards to the safety of all persons and property.

The completed job shall be workmanlike and present a good appearance.

U.S DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
CALIFORNIA

PRACTICE REQUIREMENTS
FOR
608 - SURFACE DRAINAGE
MAIN OR LATERAL

For: Business Name_____

Job Location_____

County_____ RCD_____ Farm/Tract No._____

Referral No._____Prepared By_____ Date_____

IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.

1. Drawings, No._____ _____ _____

2. Practice Specifications_____,_____,_____

3. Method of Debris Disposal:_____

4. Special Requirements:_____

_____

_____

_____

_____

_____

5. Special Maintenance Requirements:_____

_____

_____

NRCS, CA
October, 2003

PRACTICE APPROVAL:

Job Classification: (Ref: Section 501 NEM)

Show the limiting elements for this job. This job is classified as, Class _____

Limiting elements:	Units
Design Capacity _____	_____cfs
Velocity _____	_____fps
_____	_____
_____	_____

Design Approved by:_____ Date:_____

LANDOWNER'S/OPERATOR'S ACKNOWLEDGEMENT:

The landowner/operator acknowledges that:

a. He/she has received a copy of the drawings and specification, and that he/she has an understanding of the contents, and the requirements.

b. He/she has obtained all the necessary permits.

c. No changes will be made in the installation of the job without prior concurrence of the NRCS technician.

d. Maintenance of the installed work is necessary for proper performance during the project life.

Accepted by:_____ Date:_____

PRACTICE COMPLETION:

I have made an on site inspection of the site (or I am accepting owner/contractor documentation), and have determined that the job as installed does conform to the drawings and practice specifications.

Completion Certification by:

/s/_____ Date _____

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

WATERSPREADING
(Acre)
CODE 640

DEFINITION

A system of dams, dikes, ditches, or other means of diverting or collecting runoff from natural channels, gullies, or streams and spreading it over relatively flat areas.

PURPOSE

Supplement natural precipitation in areas where plants can effectively use additional moisture.

CONDITIONS WHERE PRACTICE APPLIES

Waterspreading differs from irrigation in that applications are timed by the availability of natural runoff flow rather than scheduled to meet plant needs. This standard does not apply to Conservation Practice Standard 443 – Irrigation System, Surface and Subsurface.

Although applicable to any climatic condition, areas with an average annual precipitation of 8 to 25 inches show the greatest benefit from waterspreading.

Waterspreading systems apply to areas where:

- Local, state, and federal laws and regulations will permit development;
- Soils have suitable intake rates and adequate water-holding capacities for the type of system and crops to be grown;
- Topography is suitable for the diversion or collection and the benefited area allows uniform spreading of water to achieve the desired result;
- A system can be installed that allows for the economical production of feed, forage, or grain crops;
- Climatic conditions are such that the additional moisture can be expected to improve plant growth;
- Runoff and streamflow are available at the time of year, of suitable quality, and in a volume sufficient to increase plant growth;
- Flows can be collected or diverted and spread and excess water returned without causing excessive erosion;
- Fish, wildlife, and cultural resources will not be adversely affected;
- Grazing of the spreading area can be controlled.

CRITERIA

General Criteria Applicable To All Waterspreading Systems

Laws and Regulations - This practice must conform to all federal, state, and local laws and regulations. Laws and regulations of particular concern include those involving water rights, land use, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.

Drainage area - The contributing area, or ratio of watershed area to benefited area for a “dependable” water supply, must be such that the volume of divertable flow needed for the design water application can be expected on an average of 8 years in 10.

Systems with less than “dependable” water supply are classified “questionable”. To be economical, these systems must typically be less expensive to construct and must furnish at least the application volume that can be expected 1 year out of 2.

Diversion works - The diversion works should be automatic, requiring no manual control to divert the stream into the conveyance system or onto the spreading areas, except on watercourses with expected flow durations of more than 24 hours.

The waterspreading system must be capable of safely conveying the design peak flows through the system or bypassing them at the diversion. Suitable diversion controls should normally be provided so that only the desired rate of flow enters the conveyance system.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

Where significant sediment is present in flood flows, in amounts that will either reduce the life of the system or damage soil characteristics, a low-flow bypass must be installed to exclude bedload from the system.

Inlet control(s) must be adjustable to exclude flow from the spreading areas at undesirable times, such as when crops are to be harvested mechanically. The diverted flow must not cause undue maintenance problems in the diversion works, conveyance system or the spreading area.

Conveyance system - The conveyance system shall have the capacity to safely convey the design flow from the diversion works to the spreading area.

Spreading area - Ditches, dikes, diversions, conduits, and similar structures will be arranged and located to spread diffused flow over the land surface or to pond water over the land, depending on the type of system selected. All slopes will be stable and graded to the slope necessary for management and harvesting operations. Land leveling, land forming, land smoothing, obstruction removal, and similar practices may be performed for more uniform distribution of water and increased operation efficiency. Every component practice, installed as part of the overall system, will comply with the NRCS standard for that practice.

If the water is to be spread over the area as diffused flow, the depth of application should be the approximate depth of water that the soil will absorb in the period equal to the estimated flow duration. For soils that have rapid or very rapid permeability, this depth may be more than is needed to fill that root zone.

If the water is to be impounded on the spreading area, the depth of application should approximate the available moisture holding capacity of the soil profile for the effective root zone of the plants to be grown. Rapidly permeable soils are generally unsatisfactory for impoundment systems. The system should be designed and managed to minimize deep percolation.

Outlet works - A provision must be made for returning excess water from the system to the stream channel or other parts of the system without causing excessive erosion and in time to prevent crop damage by ponded water. The flow line of the structure used for this purpose should be below ground level to improve flow characteristics.

Additional Criteria Applicable To Detention-Type Waterspreading Systems

Topography - Detention type systems are ideally suited to uniform, gently sloping land. Care must be taken to provide drainage for each basin by grading a channel along the uphill side of each dike toward each drain.

Water impounding dike - The maximum depth of water impounded against dikes will be 3 feet except across channels, sloughs, swales, or gullies less than 40 feet wide, where up to 5 feet of depth will be allowed. Water depth greater than this requires embankment design according to Conservation Practice Standard (378) Pond.

Minimum top width of dikes at design top elevation will be 3 feet. Freeboard from design water surface to dike top shall be 1.0 foot or the wave height from wind and fetch length calculations, whichever is greater (see Outlet works section for added criteria).

Side slopes of dikes will not be steeper than two horizontal to one vertical (2:1). They should be flatter as needed for stability and 4:1 or flatter for safe mowing or other operations of farm equipment.

Outlet works - Dikes with a total water storage capacity less than the 10-year, 24-hour runoff volume from the contributing area must have at least one outlet or overflow section that is at least 1.0 ft below the design top elevation. This may be a vegetated spillway, stable rock, weir overflow structure, pipe outlet, or some combination of these.

The minimum design inflow rate is (1) the maximum diverted rate of flow or (2) the 10-year 24-hour peak flow from the contributing area, whichever is less. Total capacity of the outlet must exceed the routed design inflow to the impoundment.

Vegetative Cover - All areas where vegetation has been disturbed during construction should be seeded following completion of construction. Seedbed preparation, seeding, sodding, fertilizing, and/or mulching shall comply with applicable NRCS technical standards.

CONSIDERATIONS

When planning this practice, consider the following, as applicable:

- Other practices needed such as brush removal, fencing, and seeding, when planning a waterspreading system.
- Crops to be grown. Potential benefits are highest with forage, hay or seed crops having maximum effective rooting depth.
- Effect on soils. Do not install a waterspreading system on soils where the hazard of erosion is high. Include erosion control at the diversion works, within the spreading area, and at the outlet facilities as an integral part of the waterspreading system.
- Effects of livestock use of the spreading areas. Manage livestock to prevent compaction when soils are wet and to prevent range degradation by overuse.
- Climate. Northern and mountainous regions receive a large percentage of annual runoff from snowmelt. Volumes, quality, and conditions during snowmelt become important to system design. Typically, a detention type system should be used if snowmelt runoff is diverted, to prevent erosion and promote infiltration.
- Detention area slopes. Slopes greater than 2 percent should generally be avoided. Cost escalates rapidly as slope increases. Effective basin slope may be flattened by taking borrow along top of each basin (immediately below next dike above).

Cultural Resources Considerations

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Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Water Quantity

1. The reduction of downstream surface water quantity, and effects on potential users. Evaluate both the volume of water diverted and volume of return flows.
2. Effects of increased soil moisture and ground water quantity on the waterspreading areas.

Water Quality

1. Sediment, pathogens, adsorbed and dissolved nutrients and pesticides, and soluble chemicals infiltrating in the waterspreading areas.
2. Potential chemical degradation of return flows leaving the waterspreading areas. Consider rate and volume of return flows, chemicals used, time of chemical application in comparison to predictable storm events, and the nature of sediments transported.

3. Potential ground water degradation from applied chemicals caused by increased infiltration. Important factors include available soil moisture storage, evapotranspiration, type and amounts of chemicals used and saline geology.

PLANS AND SPECIFICATIONS

Plans and specifications for waterspreading shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) plan shall be developed for use by the landowner or operator. The plan should be consistent with the purposes of the practice, intended life, and the criteria for its design.

Minimum operation requirements to be addressed in the O&M plan are:

1. Specific instructions and operational requirements to safely divert the desired volume of water into the system, store as applicable, and release return flows.
2. Average water yields by event, times to fill and empty the system, and any other hydrologic and hydraulic information needed to operate the system as designed.
3. Soil infiltration and water-holding capacities, anticipated crops to be grown, effects of inundation, and any other information that will assist the operator in making sound economic and environmental decisions.

Minimum maintenance requirements to be addressed in the O&M plan are:

1. Prompt service, repair, or replacement of components as necessary to maintain their full function.
2. Removal of debris and foreign material from structures, ditches, and other components that might hinder operation.
3. Maintenance of good vegetative cover on all slopes and watercourses.