

## **Additional Toe and Bank Protection for High Flow Velocities or Confined Areas**

In the uncommon situations where water velocities are especially high, or where a structure is threatened by its proximity to the bank, additional protection or a hybrid approach may be desired. Placement of rock boulders at the toe of the slope, along with placement of riparian branch cuttings such as willows into the spaces between the boulders into the soil or earth-filled mats can accomplish this goal. Another hybrid approach is to use cellular confinement or rock on the lower slope, and the upper slope can be graded back to a less steep slope and revegetated. The rock must be keyed into the streambed to prevent undercutting and failure of the rock slope protection.

In the cases noted above, the use of bank armoring is likely to cause more problems than it will solve, because it will not address the root cause of the problem. Instead, efforts should be made to reduce the water's velocity, or redirect it away from the bank using j-hook weirs or vanes.

### **Use of Grade Control Structures**

While efforts should be made to construct floodplains/flood benches and to consider hybrid alternatives, it is also important to consider whether a project should be addressed using a grade control structure. For example, sometimes bank erosion is a result of channel bed incision, which increases the height of a bank and reduces vertical support. If a channel is highly incised, simply regrading the slope may not be sufficient in the long-term, and the project will need to address grade control in order to stabilize the bank effectively. A variety of structures can be used, such as log or rock weirs, Newberry weirs, and vanes, in order to encourage sediment deposition and stabilization of the bed.

### **Use of Deflectors**

Finally, in some cases it may be most appropriate to use smaller structures designed to redirect high velocity flow away from eroding banks and into the center of the channel. Examples include spurs, kickers, deflectors, vane dikes, etc., and they should be considered as a way to train flows and reduce the amount of engineered bank protection. The photographs below provide some guidance on how and when these devices can be used. Detailed guidance of these methods, however, is beyond the scope of this Design Guide but should be considered by the design professional.

For a rock cross vane structure, boulders are placed in an upside down "V" shaped structure in the stream. This "V" shaped design serves to slow water velocities near the banks and direct the flow toward the center of the stream. The banks then become depositional areas, instead of erosion areas. At the same time, the increased velocities in the center of the channel actually increase the channel's flow and sediment transport capacity, reducing the risk for infrastructure flooding during high flow events. Finally, the rocks in the center serve as a channel grade control. The drop-off just downstream of the rocks creates a deep hole, which slows flows and can provide an excellent fish hold and hide habitat even at very low flows.

The rock J-hook structure is used to protect one side of the river bank by directing flows from that side to the center of the stream. As with the rock cross vane structure, the increased velocities in the center of the channel increase the channel's flow and sediment transport capacity and the deep hole is created for fish habitat.

### ***Additional Toe and Bank Protection for High Flow Velocities or Confined Areas***

In the uncommon situations where water velocities are especially high, or where a structure is threatened by its proximity to the bank, additional protection or a hybrid approach may be desired.

**Photograph 1: Rock Cross Vane Structure:**



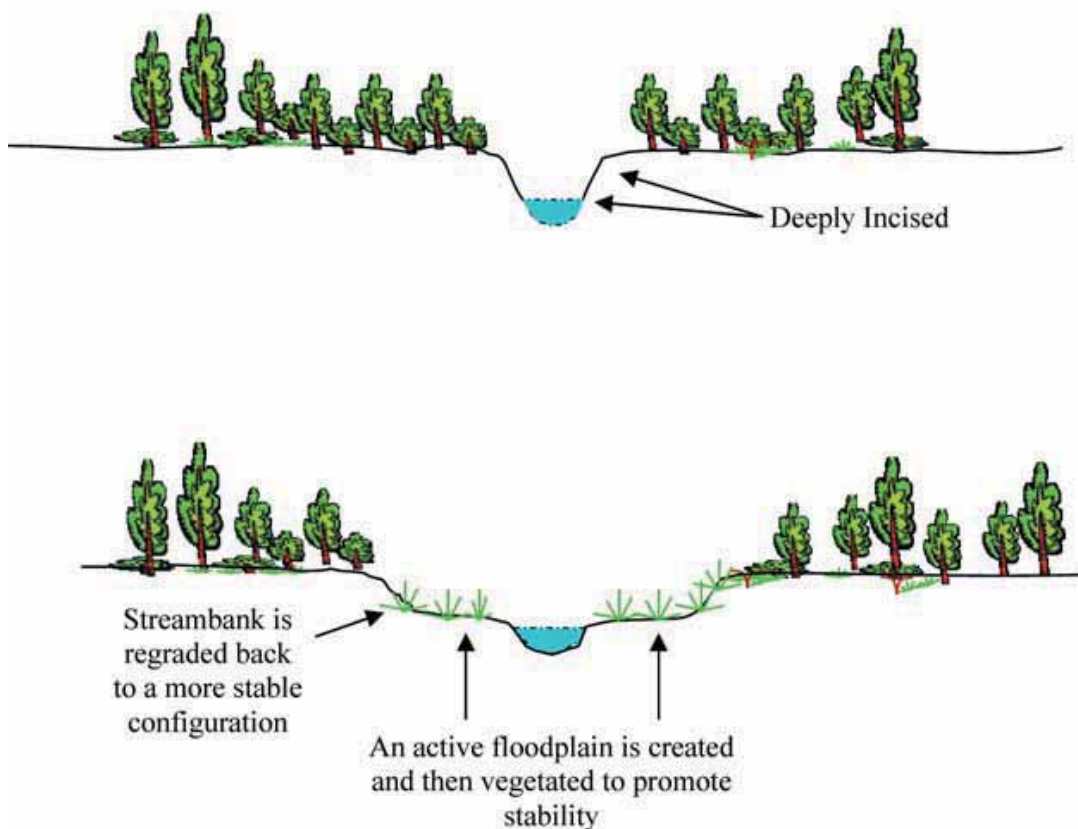
**Photograph 2: Rock J-Hook Structure:**



## **How to Create a Modified Floodplain In Broad Flat Stretches with Sediment Deposition**

In some cases, a stream may have experienced heavy sediment deposition over the years. In contrast to the deeply incised channels, channels with heavy sediment deposition tend to be wide, shallow and rather straight. Although there may have been fish present at one time, the shallow flows make it difficult for them to return. Where there is room, it is important to restore the nature meanders if possible.

Figures 6a and 6b below shows a stream prior to a stream restoration project. As you can see, the channel was wide, shallow and rather straight. The bottom drawing shows that the channel was made narrower and constructed with a proper width/depth ratio at the bankfull level. This helped assure the proper transport of sediment through the area by increasing velocities in the active channel. The active channel was moved away from the right bank and into the center of the channel corridor, creating deep pools for steelhead trout and salmon. Brush rolls were used on the top of the right floodplain to accumulate fine sediment and the right vertical stream bank was sloped back and vegetated.



## **#2: Slope Grading with Vegetation and Floodplain Terraces Space Permitting**

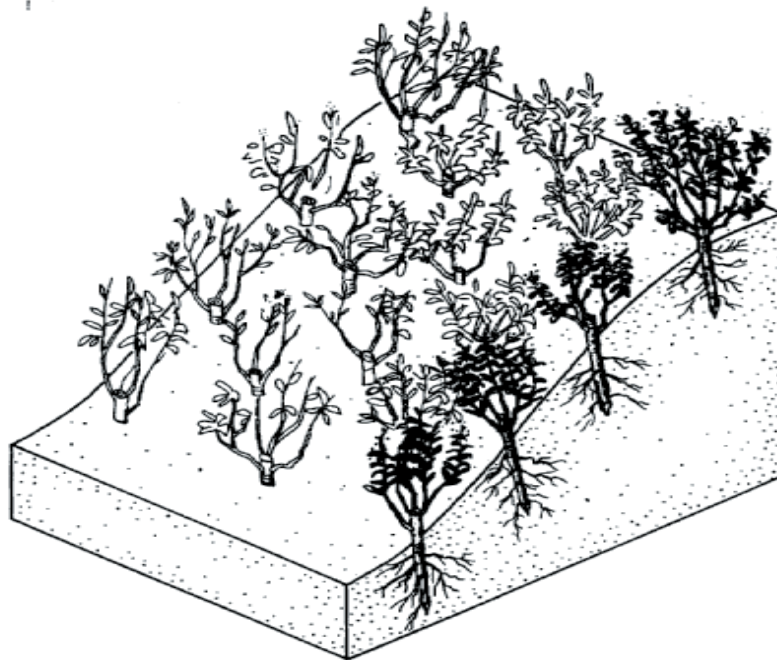
This is perhaps the least engineered, and often most effective, method of long-term bank repair, because it restores the natural contour and vegetative cover of the stream bank. If the bank is undercut or has slumped to a vertical face, consider matching the grade of a nearby stable slope. Usually a 2 horizontal to 1 vertical slope is considered stable for many soil types, and if space allows, a 3

## How to Create a Modified Floodplain In Broad Flat Stretches with Sediment Deposition

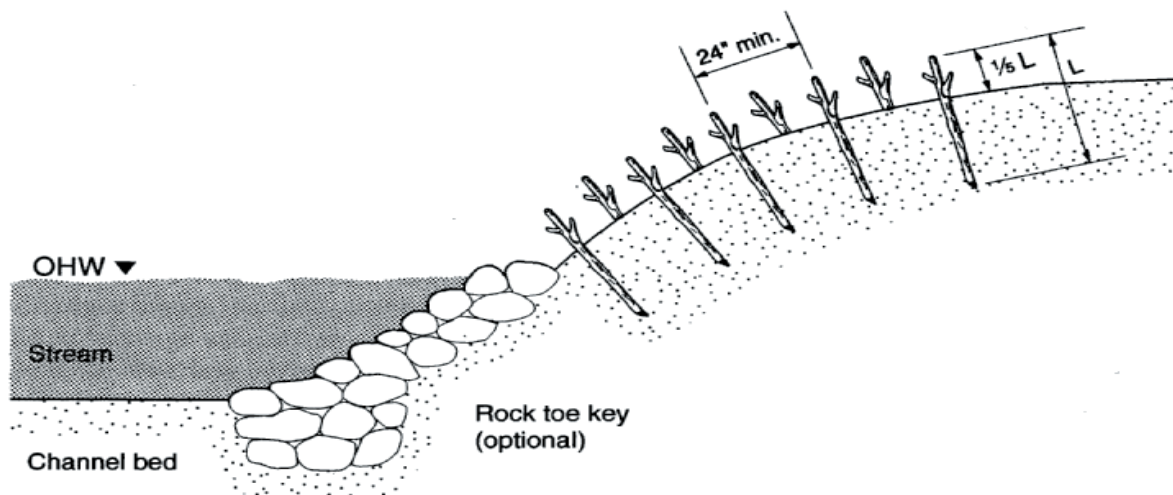
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Figures 6 below shows a stream prior to a stream restoration project. As you can see, the channel was wide, shallow and rather straight. The bottom drawing shows that the channel was made narrower and constructed with a proper width/depth ratio at the bankfull level. This helped assure the proper

### Figure 9a: Slope Grading with Vegetation



### Figure 9b: Cross Section of Slope Grading with Vegetation and Rock Toe Protection



(for definitions and diagrams of bankfull and other terms, see page 5)

### **#3: Erosion Mats**

This method consists of securing geotextile blankets made of biodegradable materials like jute or coconut fiber to channel banks using stakes or staples. Biodegradable fabrics are preferable to plastic because they do not inhibit plant growth, or act like a net if they are dislodged during a storm. The erosion mats provide soft armor protection against erosive forces and are combined with live staking and direct seeding. Abrasive sediment, debris, foot traffic, and sunlight will slowly wear, snag, and tear these fabrics, potentially undermining the structure. That's why erosion mats are intended to be only the foundation of a *vegetated* erosion control system. In other words, the establishment of vegetation is crucial to the long-term success of erosion mats.

#### **Design Considerations:**

- Toe protection may be required where significant toe scour is anticipated.
- The bank must be smooth before installing blankets to ensure adequate contact and prevent subsurface erosion.
- The erosion mats must be installed according to manufacturer's instructions in order to prevent failure.

### **#3a: Erosion Mats with Boulder or Log Toe Protection**

This method consists of grading the lower portion of the eroded slope at a maximum of 1.5:1. The upper portion of the slope is then graded at a minimum slope of 2:1 and smoothed to ensure that the whole erosion mat contacts the soil. Appropriately-sized boulders are placed at the toe of the rebuilt bank up to the bankfull discharge water elevation, or even slightly higher. Voids between the boulders can be planted using live stakes.

#### **Design Considerations:**

- Best for bank slopes of 3:1 or steeper
- Boulders must be keyed in (min. 3 feet) at the toe of the bank.
- Boulder placement must not constrict the channel cross section or reduce the width-to-depth ratio. Otherwise, the repair will likely destabilize the channel.
- The placement of boulders or armoring along the bank may increase turbulence in the area and other areas downstream. This could increase erosion.

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#### **#4: Contour Wattling (Fascines)**

This method consists of tying long bundles of plant cuttings (typically willows or cottonwood) together with twine and anchoring them in shallow trenches, parallel to the stream, with wooden stakes. When the cuttings develop root systems and mature, the plants provide structural soil stability. This technique is generally used to manage surface erosion. It works well in straight stream sections and wherever flow velocity is low.

##### **Design Considerations:**

- The long bundles trap and hold soil on banks by creating small, dam-like structures, effectively segmenting the slope length into a series of shorter slope lengths.
- This method enhances the opportunities for locally native species to colonize and therefore should, where appropriate, be used with other soil bioengineering systems and live plantings.
- Reinforcement at the toe of bank may be a limiting factor.
- Contour wattling does not work well in locations where slopes are undergoing geotechnical failure.

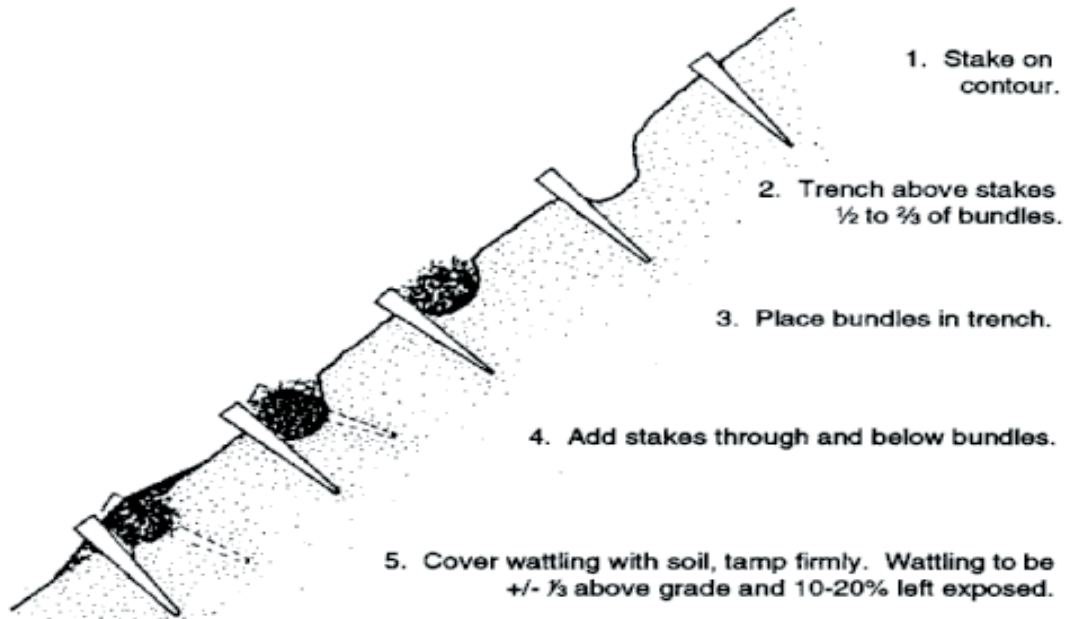
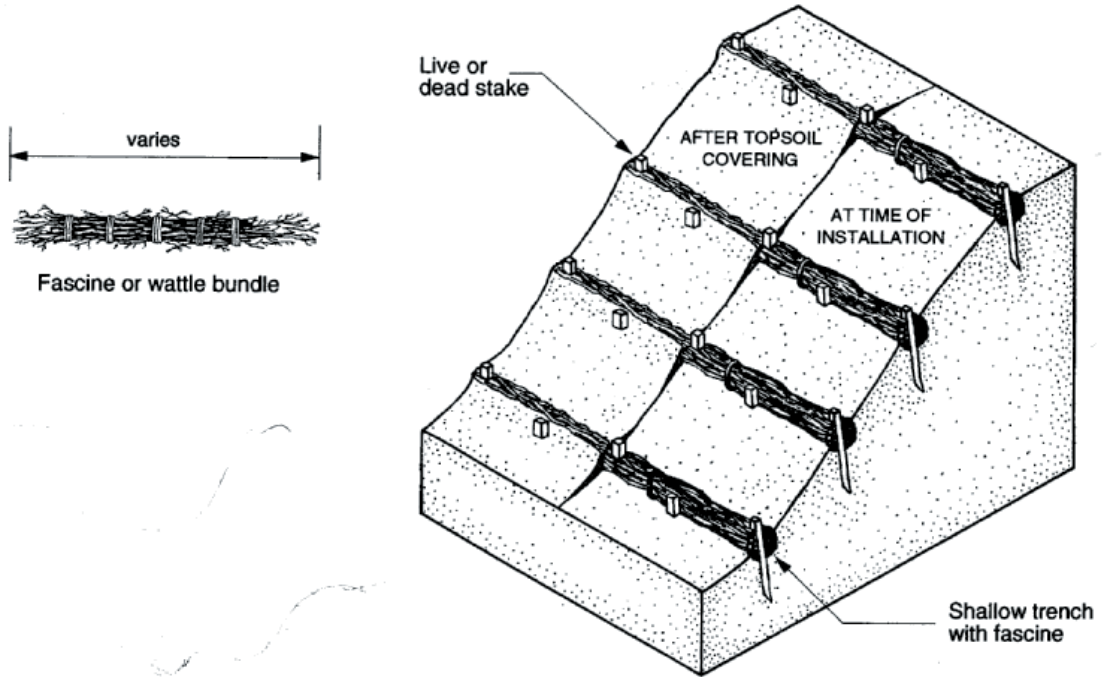
#### **#4a: Contour Wattling with Boulder or Log Toe Protection**

Appropriately-sized boulders are placed at the toe of the rebuilt bank up to the bankfull discharge water elevation or slightly higher. Voids between the boulders can be planted using live stakes.

##### **Design Considerations:**

- Boulder placement must not constrict the channel cross-section or reduce the width-to-depth ratio. Otherwise, the repair will likely destabilize the channel.
- The placement of boulders or armoring along the bank may increase turbulence in the area and other areas downstream, which could increase erosion.

**Figure 10: Contour Wattling**



## #5: Brush Mattress

First, the bank must be prepared. The eroded slope is graded and smoothed to ensure that all willows are in contact with the soil. Then, a deep trench (2 ft. min) is dug at the toe of the bank for the butt ends of the willow branches. Wood, steel, or live willow stakes are partially driven into the soil in rows, on three foot centers, in the area that will be covered by the mattress. After the stakes have been placed, live willow branches are put on the bank with their butt ends in the trench. Straight branches no shorter than four-feet in length and .5 to 1" in diameter are used. If the branches are not long enough to reach the upper end of mattress, several layers may be used; however, it is necessary to "shingle" the layers by lapping each new layer over the one below by at least 18".

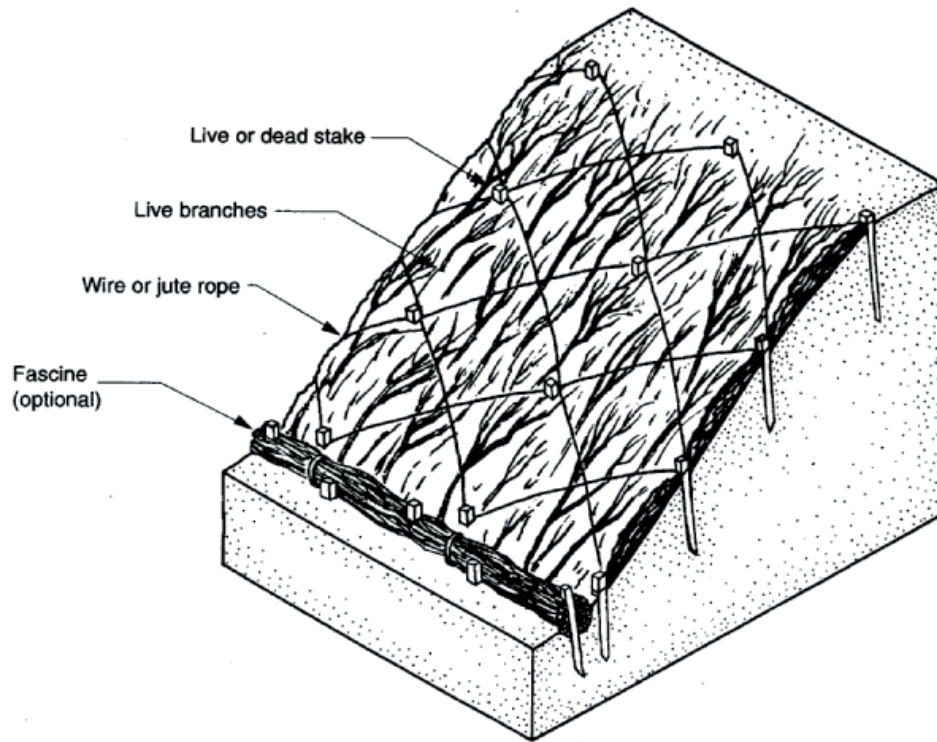
Once the bank is covered by a thick layer of willows, cross branches are placed horizontally over the bottom layer. These branches are placed against the stakes and then tied to the stakes using wire or string. The stakes are then driven into the bank at least two feet deep. After the completion of the mattress, the toe trench is filled with appropriately-sized boulders and rocks to anchor the butt ends of the branches. The brush mattress should be covered with an amount of soil sufficient to ensure a good contact surface between the mattress and the soil, leaving some buds and twigs exposed.

This method forms an immediate protective cover over the stream bank, captures sediment during flood flows, and rapidly restores riparian vegetation and streamside habitat. This measure is not appropriate where toe scour is anticipated, in which case boulders may need to be added at the toe.

### **Design Constraints and Considerations:**

- Branches should be tamped down before tying to create a good contact surface between the soil and the mattress.
- Butt or basal ends of branches must be covered with soil so they can root and to prevent them from drying out.
- Branches should be partially covered with soil.
- **This method should not be used on slopes that are experiencing geotechnical failures or other slope instability.**

**Figure 11: Brush Mattress**



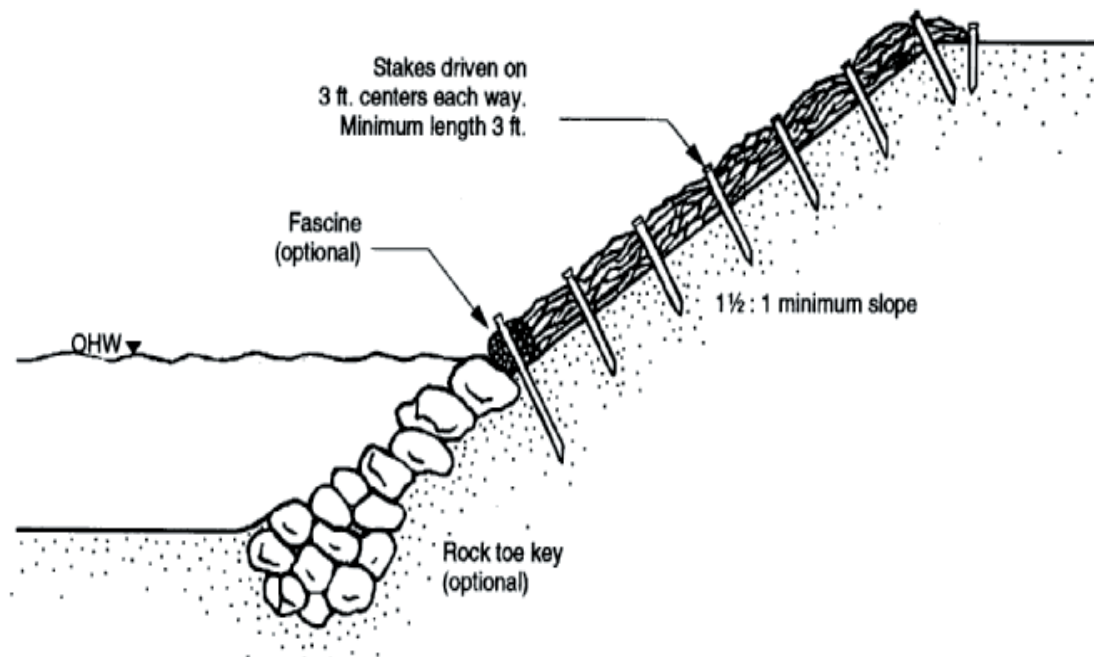
### #5a: Brush Mattress with Boulder or Log Toe Protection

First, the lower portion of the eroded slope is graded at a maximum slope of 1.5:1. Then the upper portion of the slope is graded at a minimum of 2:1 and smoothed to ensure all willows are in contact with soil. Appropriately-sized boulders are placed at the toe of the rebuilt bank, up to the bankfull discharge water elevation or even slightly higher. Live stakes can be placed between the boulders to establish vegetation. This method requires a lot of branches. Therefore, needs to be installed during low flow conditions so that growth can be established. Otherwise, the branches will wash away.

#### Design Criteria:

- Boulders must be keyed in (min. 3 feet) at toe of bank.
- Boulders placement must not constrict the channel cross-section or reduce the width-to-depth ratio. Otherwise, the repair will likely destabilize the channel.
- The placement of boulders or armoring along the bank will increase turbulence in the area and downstream, which could cause increased erosion.

**Figure 12: Brush Mattress with Boulder or Log Toe Protection**



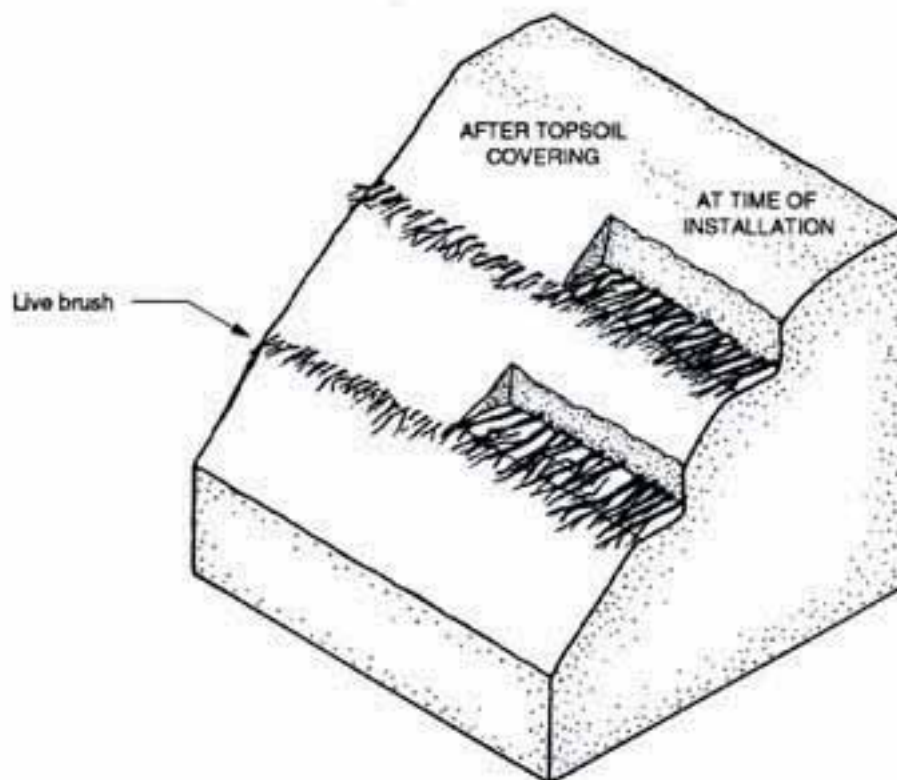
## #6: Brush Layering

In this method, alternating layers of soil and live branches are installed in horizontal rows on the streambank. This method is more substantial than brush mattresses and can be used to repair erosion gullies, scour holes, and other significantly scoured areas. The buried branches take root to reinforce the substrate, while the tips produce vegetative top growth that protects the bank surface. This method can also be used in combination with a rock toe, vegetated geogrid or live cribwall as described later in this section.

### Design Constraints and Considerations:

- Installation is best done during dry periods or low flow conditions since construction requires earthwork.
- A large amount of branches are needed for this method.

**Figure 13 : Brush Layering**



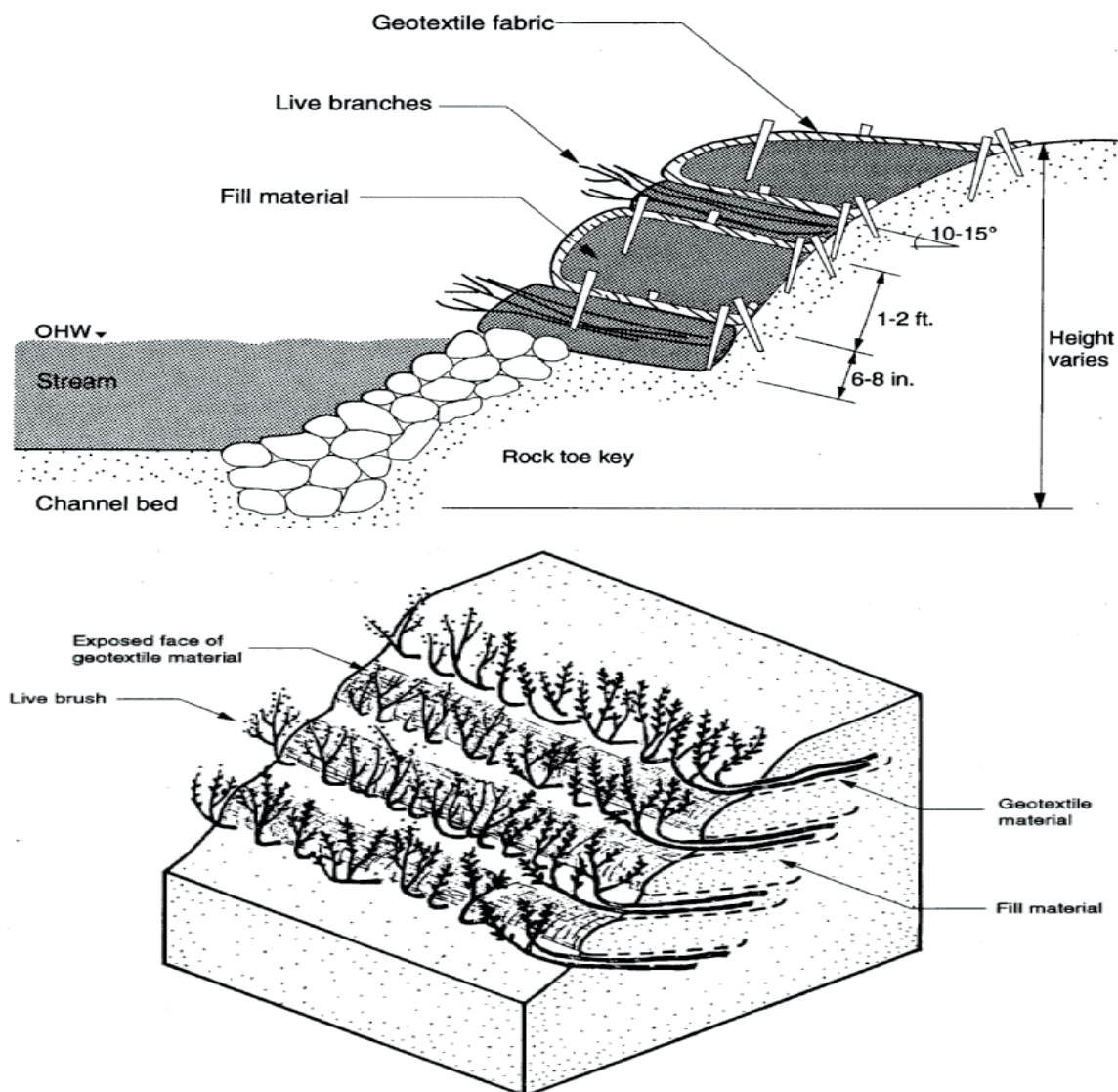
## #7: Vegetated Geogrids or Soil Lifts

This method is similar to brush layering, but adds even more stability by wrapping engineered soil lifts in biodegradable erosion control fabric or geotextiles between layers of live branches. This method is useful where site constraints don't allow the slope to be laid back. Boulder or log toe-protection can also be incorporated into the design where site conditions warrant.

### Design Considerations:

- Boulder placement must not constrict the channel cross-section or reduce the width-to-depth ratio. Otherwise, the repair will likely destabilize the channel.
- Armoring or the placement of boulders along the bank will increase turbulence in the area and other areas downstream, which could increase erosion.

Figure 14: Vegetated Geogrids or Soil Lifts



## **#8: Root Wads and Boulders**

This method consists of using a combination of boulders, logs, and live plant material to armor a stream bank. It enhances fish habitat, and creates a natural-looking bank stabilization structure<sup>1</sup>. Footer logs are set in a toe trench below the thalweg line (the line of maximum depth in a stream), with the channel end pointed downstream and the butt end angled 45 to 60 degrees upstream. A second log (with a root wad) is set on top of the footer log diagonally, forming an "X".

The root wad end is set pointing upstream and the butt end lying downstream 45 to 60 degrees. The apex of the logs are anchored together using boulders, re-bar or cables. Large boulders are placed on top and between the logs at each apex. After all the logs and boulders are set in place, live plant material, such as willows, is placed within the spaces of the structure behind the boulders. Excavated gravel and stream materials can then be placed over the bank end portion of the structure<sup>1</sup>.

This method will tolerate high boundary shear stresses if logs and root wads are well anchored. This method should, where appropriate, be used in conjunction with soil bioengineering or live vegetation plantings in order to stabilize the upper bank and ensure a regenerative source of streambank vegetation. The endurance of the structure depends on the species of logs used; it might need replacement if vegetative colonization does not take place.

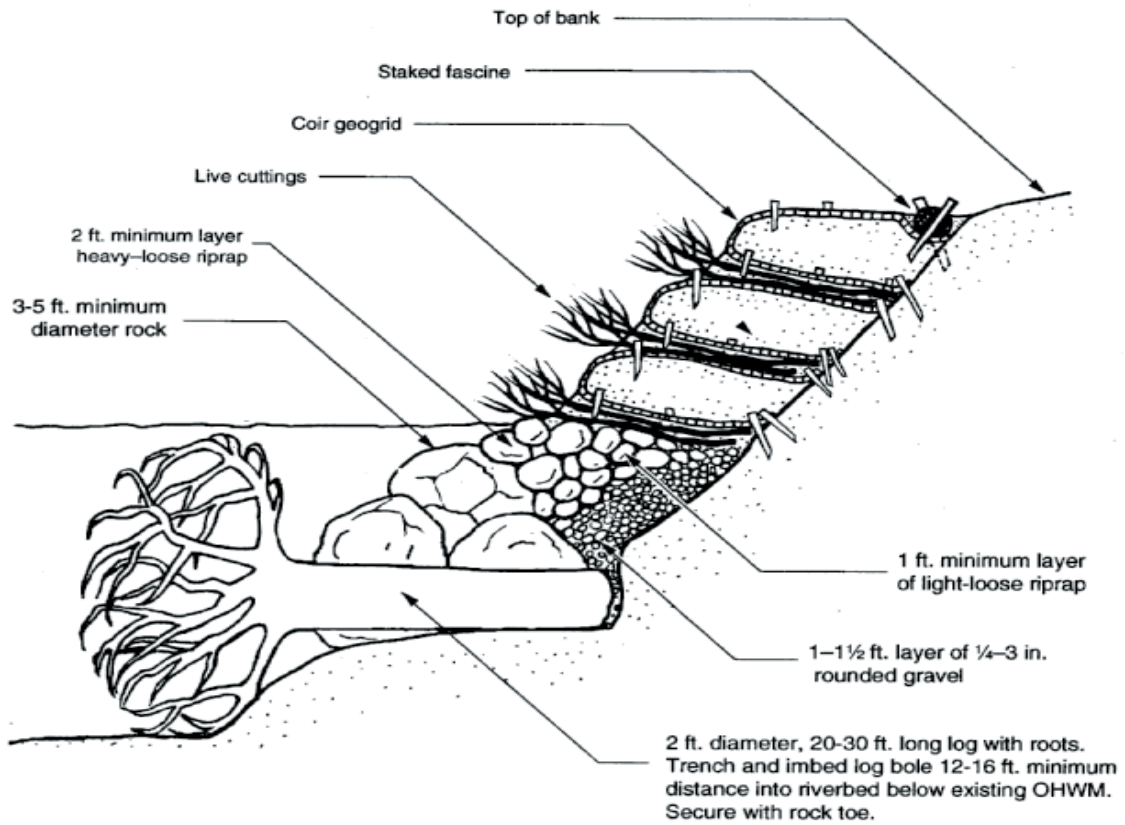
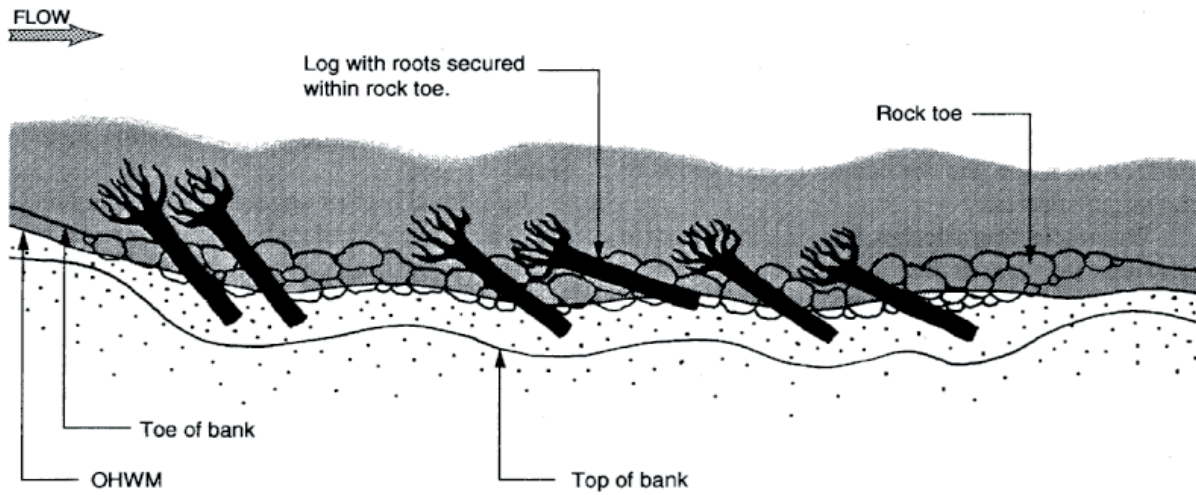
### **Design Considerations:**

- This method may cause channel scour and erosion of downstream and opposite banks if a modified floodplain is not constructed along the opposite bank. It may also cause upstream scour.<sup>2</sup>

<sup>1</sup>Source: California Department of Fish and Game, California Salmonid Stream Habitat Restoration Manual

<sup>2</sup>Source: Natural Resources Conservation Service, Stream Corridor Restoration Principles, Processes and Practices

**Figure 15: Root Wads and Boulders**



## **#9: Boulder/Rock Revetment**

Rock rip-rap is a method for armoring stream banks with boulders that prevent bank erosion. Rock riprap can be used at the toe of the slope in combination with other vegetative methods on the upper portions of the bank. Rock can also be used for drainage outfall structures. Rip-rap footing is laid in a toe trench dug along the base of the bank. The size of the rock is determined according to the expected velocity in the channel, and can vary from 6" to 18" for velocities up to 10 feet per second up to 24" minimum for higher velocities. Large angular boulders are best suited for this purpose because they tend to interlock. The rock's specifications must meet certain standards in order to assure that it is structurally sound.

A gravel blanket that is at least one foot thick should be placed under the rock rip-rap on slopes of 1:1 or greater. This prevents underlying soil from being washed out, which leads to slope slump and failure during periods of high flow. Geotextile fabrics should be avoided, since they prevent the natural establishment of vegetation<sup>1</sup>.

This method should, where appropriate, be used with soil-bioengineering systems, or live vegetation, to stabilize the upper bank and ensure a regenerative source of streambank vegetation. A major benefit of this method is that the components are flexible and their function is not impaired by slight movement from settlement or other adjustments<sup>2</sup>.

### **Design Criteria and Considerations:**

- Rock should be keyed in approximately three feet below the bed elevation.
- Rock can be graded from larger at the toe to smaller at the upper banks.
- This method may cause channel scour and erosion, especially downstream and along opposite banks, if a modified floodplain is not constructed along the opposite bank. It may also cause upstream scour.

### **#9a: Boulder Revetment with Soil and Revegetation**

This method consists of placing soil over the boulders and installing vegetation by staking and/or direct seeding. Biodegradable erosion control mats are placed over the soil to help control erosion until vegetation establishes itself. Special care must be taken while driving live stakes between boulders to avoid damage to the cambium layer of the woody material and to ensure good soil/water/stake contact. Thick rip-rap layers may require special tools for establishing staking pilot holes.<sup>2</sup>

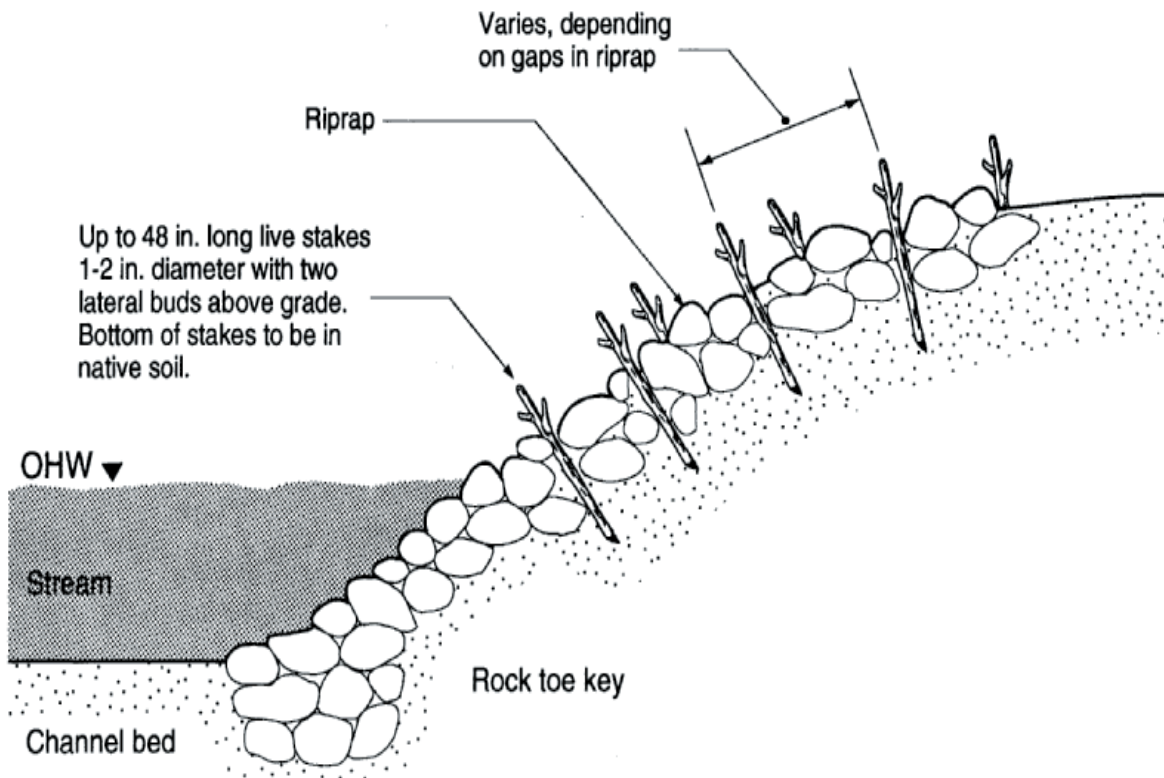
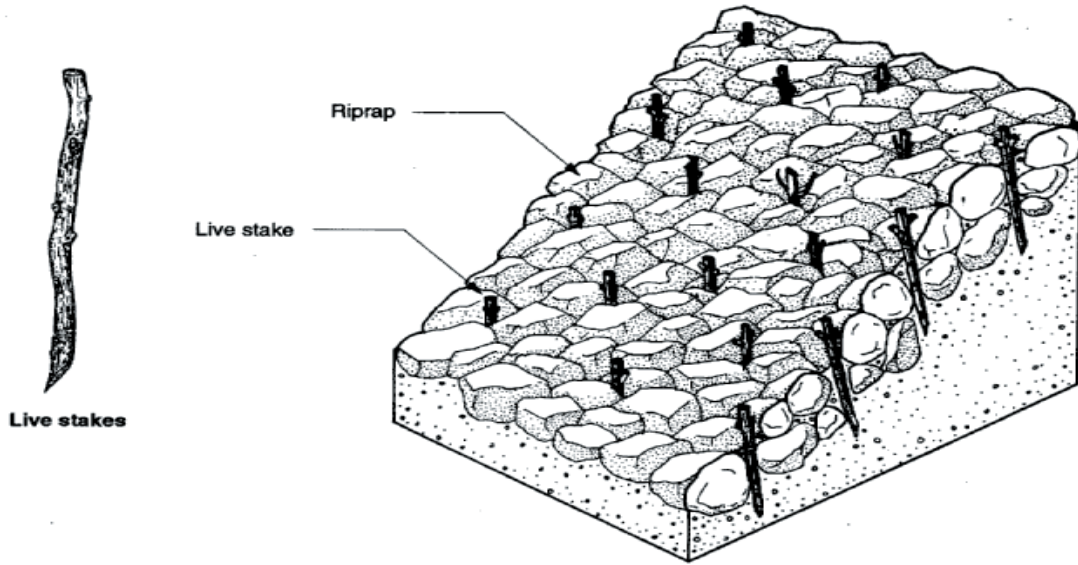
### **Design Considerations:**

- Woody material can be placed using a backhoe with an auger attachment, or by driving a steel bar between boulders, or by placing rock around durable planting tubes.
- This method may cause channel scour and erosion of downstream and opposite banks if a modified floodplain is not constructed along the opposite bank. It may also cause upstream scour.

<sup>1</sup>Source: California Department of Fish and Game, *California Salmonid Stream Habitat Restoration Manual*

<sup>2</sup>Source: Natural Resources Conservation Service, *Stream Corridor Restoration Principles, Processes and Practices*

**Figure 16: Boulder Revetment with Soil and Revegetation**



## **#10: Cellular Confinement System**

Soil cellular confinement system (geocell) is a polyethylene plastic cellular system where structural strength is developed by the composite design of soil, plant roots, and the plastic's cellular configuration. This system is available in eight-inch deep honeycomb mats that can be installed in offset vertical layers to create terraced planting areas. The honeycomb cells are filled with soil, moderately compacted, and planted with woody vegetation and grasses. The structure functions similarly to a crib wall structure. This method can also be used in combination with slope grading and vegetation on the upper slopes.

This method can foster the development of vegetation.

## # 11: Live Log Crib Walls

Live log crib walls are used to reduce sediment input and protect banks in areas where logs are available and boulders are not practical<sup>1</sup>. These temporary structures are designed to rot and degrade after live plant material has established itself. Cribbing provides protection in areas with near-vertical banks where bank sloping options are constrained by adjacent land uses.

In this method, two rows of base logs are placed parallel to the bank, in trenches below stream grade, to minimize undercutting of the structure. Tie-back logs are notched into the base logs and placed at regular intervals (typically 6 to 8 feet) along the base logs. Tie-back logs are attached to the base logs using re-bar pins or cables. There should be at least two tie-back logs connecting each pair of base logs. Once the first row of tie-back logs has been connected, a second set of face logs is placed on top of the tie-backs. This procedure is repeated until the desired level of bank protection is achieved. As each lift is constructed, the face logs and tie-backs are filled with a mix of gravel and cobbles to the top of the face log. It is not necessary to use topsoil in the fill material; but there should be sufficient fine-grain material to insure vegetation growth. Live cuttings are then laid in to form a complete cover layer. These live branches should be long enough to have their butt ends in the soil behind the crib wall. The tips should stick out of the crib wall no more than a quarter of the cutting total length. The branches are then covered with the gravel/cobble mix to the top of the tie-backs, and the next layer is continued.

This method is effective on the outside of bends where high velocities are present, and in situations where a low wall may be required to stabilize the toe and reduce slope steepness<sup>2</sup>. The use of crib walls in a specific location must be considered carefully in the context of the stream's function. If placed incorrectly relative to the active channel, the bends in a meandering stream can induce considerable damage downstream or on the opposite bank. This method does not adjust to toe scour and should be used in combination with soil bioengineering systems and live plantings to stabilize the upper slopes<sup>2</sup>.

### **Design Criteria and Considerations:**

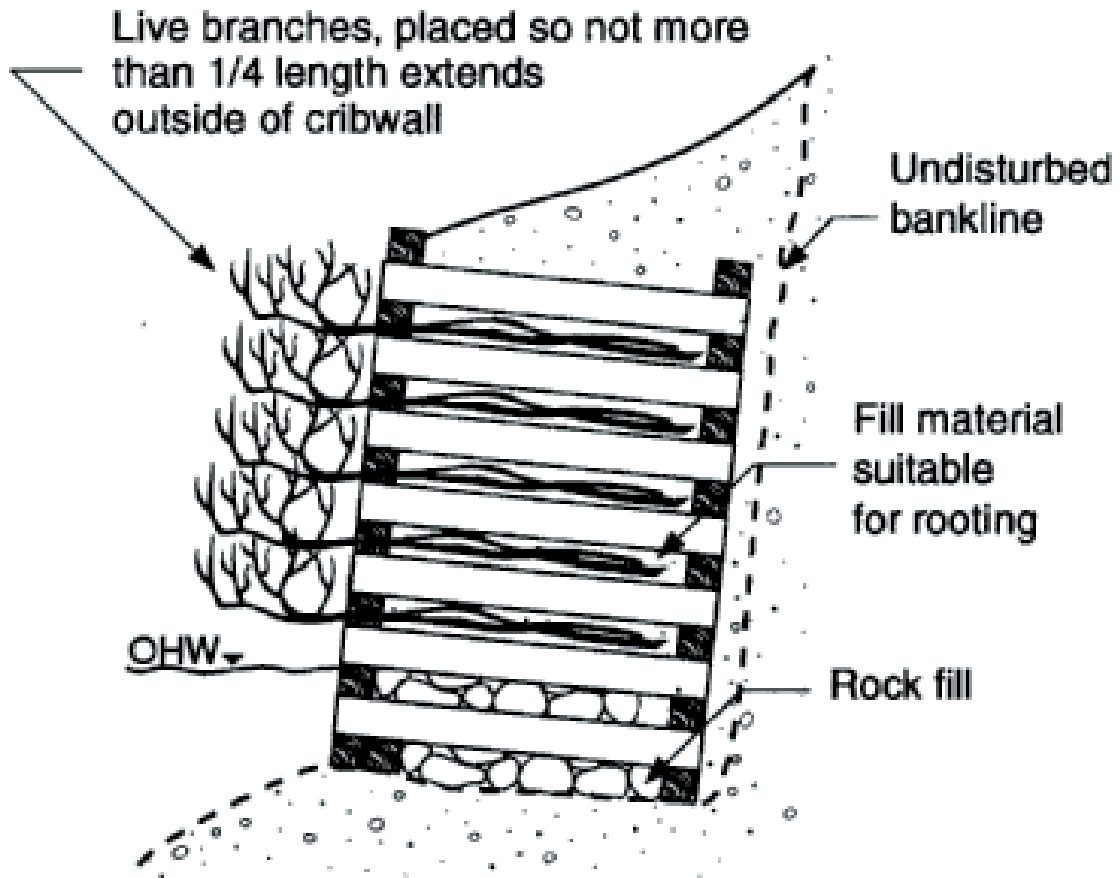
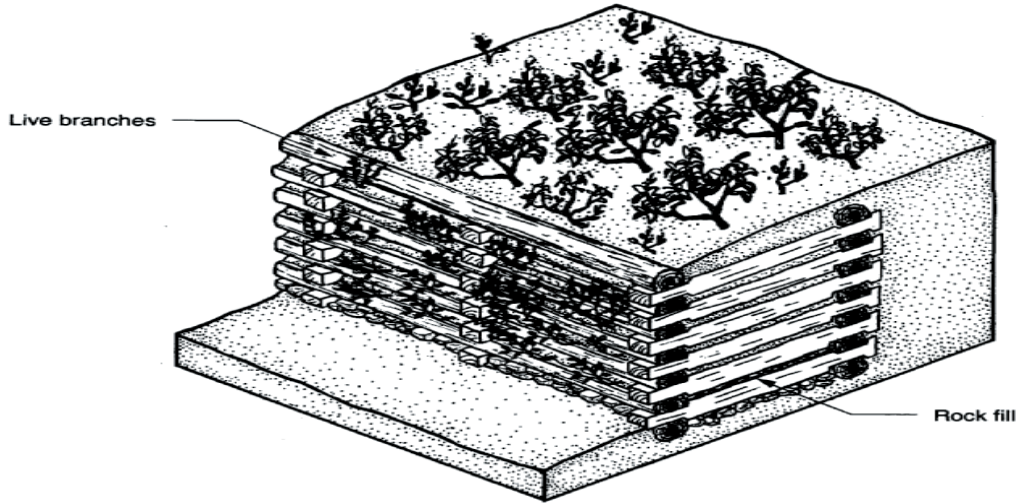
- This method may cause channel scour and erosion of downstream and opposite banks if a modified floodplain is not constructed along the opposite bank. It may also cause upstream scour.
- As the logs rot, the crib wall can be undercut and eventually fail. If the structure fails, hazardous rebar and steel cable can be deposited in the river along with the logs and other debris of the structure.

<sup>1</sup>Source: California Department of Fish and Game, *California Salmonid Stream Habitat Restoration Manual*

<sup>2</sup>Source: Natural Resources Conservation Service, *Stream Corridor Restoration Principles, Processes and Practices*

form mats that can be laid on the channel slope and/or channel bottom.

**Figure 17: Live Log Crib Walls**



**Table 2: Erosion Repair Methods that are NOT Recommended:**

Repair Method	Appropriate Slope	Appropriate Water Velocity	Environ Value	Cost
<b>12 Concrete Crib Walls</b>	Up to 0.25:1	High: up to 15 ft/sec; depending on size of crib wall openings.	Negative	High
<b>13: Articulated Concrete Blocks</b>	Up to 1:1	High: up to 15 ft/sec; for closed cell ACBs, low to medium for open cell ACBs.	Negative	High
<b>14: Gabions</b>	From 0.75:1 up to 3:1	High: up to 15 ft/sec; lower velocity if planted, depending on size and number of planting pockets.	Negative	High
<b>15: Sacked Concrete</b>	Up to 0.5:1	High: up to 15 ft/sec;	Negative	High
<b>16: Guniting Slope Protection</b>	Up to 1:1.	High: up to 15 ft/sec	Negative	Medium

**#12: Concrete Crib Walls**

Concrete crib walls consist of stacked interlocking concrete frames that form a retaining wall. Its structural strength is due in part to the composite design of a concrete frame with compacted backfill. Crib walls are constructed with open face panels that are planted by live staking. This method restricts plant growth to the size of the panel opening. As the crib wall slope is flattened and the lattice becomes more open, the vegetation potential increases, and the allowable velocity decreases because of the exposed soil and vegetation. Concrete crib walls perform similarly to live log crib walls. Because the crib wall is a rigid structure, it is more prone to massive failure in the event of undercutting or settlement.

All crib walls tend to cause channel bed and bank erosion both in the immediate area and other areas downstream, and may also cause erosion upstream. Most crib walls eventually fail because they attempt to resolve a symptom of erosion, not its cause. The use of concrete crib walls is discouraged. This method is mentioned only for reference.

### **# 13: Articulated Concrete Blocks**

Articulated concrete blocks (ACB) consists of concrete interlocking blocks that are cabled together to form mats that can be laid on the channel slope and/or channel bottom.

There are two styles of ACBs: open cell and closed cell. The open cell style allows for vegetation to be recruited into the soil filling each cell. Vegetation growth is restricted by the sizes of the cell openings and by the disconnection caused by the cell walls. In our arid climate, the long-term viability of vegetation within the restricted cell openings is problematic. However, open planting areas can also be constructed into the ACB mats by creating an opening in the mat by removing some of the blocks. The open areas can be revegetated with shrubs and trees. Irrigation is necessary to aid plant establishment.

This method will create channel and bank erosion both down and upstream of protected areas. It is environmentally unfriendly and prone to failure. When it fails, steel cables and stakes hazardously protrude from the mats into the channel. This method is not appropriate for small erosion repair sites, and is discouraged because of the limited potential for biotic resources.

### **#14: Gabions**

This method consists of placing large wire baskets filled with rocks on channel banks, either as mattresses or stacked in layers that resemble steps. Gabions can sometimes naturally revegetate if adequate water and soil are available. Gabions can also be revegetated using planting boxes. (Planting boxes are gabion cells that are left open to bare soil and revegetated with shrubs and trees.) Temporary irrigation may be provided to the planted vegetation in order to aid its establishment. But, wire baskets can deteriorate over time and may be harmful to fish.

Gabions are very hazardous and unfriendly to native fish, especially salmonids, which often try to spawn in gabions below the water line. The basket wire deteriorates quickly, and the fish are injured on the baskets' sharp wire barbs.

Furthermore, the baskets used to line or armor the banks of streams cause bed and bank erosion. They often undercut or fail due to slumping of the soil on which they are constructed. The use of gabions is discouraged and are rarely permitted by the Department of Fish and Game except in extreme situations. The material is included here for information.

### **#15: Sacked Concrete**

Sacked concrete slope protection consists of burlap bags filled with concrete and placed against channel banks. Sacked concrete does not provide any revegetation potential. However, it offers the opportunity to contour walls around existing vegetation such as tree wells.

Sacked concrete should not be used because it causes erosion, degrades water quality, and destroys other beneficial uses. It is included here for reference. There may, however, be extreme circumstances

where site constraints, vertical slopes, and high velocities preclude all other options.

### **#16: Gunite Slope Protection**

Gunite slope protection consists of a pressurized concrete mixture sprayed over an eroded bank. The gunite can be textured, colored, and formed for aesthetics to mimic natural rock. Reinforcing steel may be placed against the bank prior to spraying. This is not an acceptable method of erosion repair, but is included here because it has been successfully used with soil nails to stabilize vertical slopes on upper banks where land use constraints preclude regrading of the slope. Sheet pile retaining walls have been used in a similar manner. Vegetation can be placed on the lower portions of the bank to enhance biotic resources.

Gunite slope protection causes erosion problems, degrades water quality and destroys other beneficial uses. Therefore, the use of gunite slope protection is discouraged and is included here only for reference.

## SECTION 6 - OBTAINING PERMITS FOR STREAM-BANK REPAIR

*(Taken from the Stream-Bank Repair Guidance Manual for the Private Landowner: Guadalupe and Alamos Creeks)*

### **Practical Points to Help You Obtain Permits for Your Project**

As noted earlier, if you are working in or around a creek or stream, you will likely need permits from a local, state, and/or federal agency. Below are some practical points to help you obtain permits for your project as quickly and efficiently as possible. Following this list is a matrix of activities and the agencies, which may require permits for those activities.

- **Learn the rules.** Familiarize yourself with applicable state, local, and federal agency permitting requirements. Determine which agencies may be involved in your project. Take time to study the protocols and regulations of these agencies. Refer to their web sites. Read staff reports, permit conditions, and studies relating to your project or similar projects.
- **Contact the agencies in charge of granting permits for your project.** You may need to obtain different permits for your project from a number of agencies. Contact the agencies that may need to issue a permit for your project to determine who will be involved. Ask about the agency's permitting process, obtain relevant forms, and discuss potential timelines for obtaining your permits. Do not expect to get schedule commitments at this stage, but at least get an idea of the how the process works and a feel for how long it may take.
- **Write a complete project description.** A complete project description is crucial. Include drawings, photographs and other supporting materials to assist the regulatory agencies in understanding what your project entails. Photographs and descriptions enable them to provide guidance and direction before a site visit can be scheduled.
- **Consult early and become familiar with agency staff.** Consultation with permitting and regulatory agencies should begin as early as possible. An in-person meeting is the best way to discuss your project. Try to have plans, maps, photographs of the project location, and other information available at the meeting. You can also request that a staff person meet you at the site.
- **Reduce adverse environmental impacts.** Design your project to eliminate or reduce as many potential health concerns and environmental impacts as possible. Consider environmentally superior alternatives described in the previous section. These methods are also generally easier and much faster to permit. Incorporate the suggestions you receive during early consultation. Employ a qualified design consultant with specialized expertise in stream analysis and design.
- **Pay attention to details.** Follow all the rules and listen to agency staff guidance. Respond promptly to requests for information. Be on time for meetings with representatives of the regulating agencies. Do not cut corners. Get in writing all dates, procedures, fees, etc..
- **Be willing to negotiate.** Recognize that government regulators may have a great deal of authority over your project, but that they are willing to negotiate. You should be, too.
- **When in doubt, ask.** If you are not sure whether your project needs a permit or whether it is regulated at all, ask. Going ahead without following the proper guidelines will ultimately

cost you time, money, and goodwill.

- **Keep good records.** Keep notes of conversations and meetings. Ask for interpretations of rules to be written by the agency representatives. An easy way to do this is to confirm conversations by E-mail. Remember, agency staff time is limited; it is easier for them to review or comment on your understanding than for them to compose the correspondence.

### **Prohibited Activities**

Before you decide to do work near a creek or river, you should consider that it is illegal to place, store, or dispose of materials of any kind on the banks of, or into, a watercourse. Prohibited materials include dirt, soil, and concrete; pool and spa water; paints, solvents, and soaps; yard and animal waste; automobile and machinery fluids; and firewood and building materials. Remember to comply with best management practices that prevent pollution from entering the waterway and damaging the

ecosystem.

## Agencies That May Require Permits

Use this chart to help you determine which agency may be involved in your project. A checked box indicates that an agency may be involved and should be contacted, but does not mean they definitely

	Santa Clara Valley Water District	Your City's Planning or Public Works Dept	NOAA	CalEPA DTSC	SWRCB Water Rights	Regional Water Quality Control Board	California Fish and Game	Army Corps of Engineers	U.S. Fish & Wildlife Service
Involve work on the bank of a river, stream, or lake?	X	X				X	X	X	X
Involve excavation of the bank?	X	X				X	X		
Involve placement of piers?	X		X	X		X	X	X	
stabilization or erosion control?	X	X				X	X	X	X
Require the removal of riparian or other wetland vegetation?	X	X	X			X	X	X	X
Involve planting riparian or wetland vegetation?	X		X			X	X	X	X
Affect native plants, wildlife, or fisheries?	X		X			X	X		X
Result in stormwater discharge into a creek or wetland?	X	X				X	X	X	X
Divert or obstruct the natural flow or change the natural bed or bank of a creek or wetland?	X	X				X	X	X	X
Involve repair, rehabilitation, or replacement of any structure or fill adjacent to a creek or wetland?	X	X				X	X	X	X
Involve placement of bank protection or stabilization structures or materials (e.g., gabions, riprap, concrete slurry/sacks)?	X	X				X	X		X
Involve building any structure adjacent to a creek or wetland?	X	X				X	X	X	X
Involve fish and wildlife enhancement, attraction, or harvesting devices and									

	Santa Clara Valley Water District	Your City's Planning or Public Works Dept	NOAA	CalEPA DTSC	SWRCB Water Rights	Regional Water Quality Control Board	California Fish and Game	Army Corps of Engineers	U.S. Fish & Wildlife Service
Use materials from a streambed (including but not limited to boulders, rocks, gravel, sand, and wood debris)?	X	X		X		X	X	X	X
Require the disposal or deposition of debris, waste, or any material containing crumbled, flaked, or ground pavement with a possibility that such material could pass into a creek or wetland?	X	X		X		X	X	X	X
Involve the removal of any materials from, or add fill to, a creek or wetland?	X	X	X	X		X	X	X	X
Involve grading or fill near a creek or wetland?	X	X	X			X	X		X
Involve a bridge or culvert?	X	X				X	X	X	X
Involve utility pipe lines?	X	X				X		X	
Involve a septic leach field near a creek or wetland?	X	X				X	X		
Require a water well near a creek or wetland?	X	X	X				X		
Involve work within historic or existing coastal wetlands?	X					X	X	X	X
Remove water from a creek for storage or direct use on non-riparian land?	X	X	X		X	X	X	X	X
Require that hazardous materials be generated and/or stored on site?	X	X		X		X			
Take place in, adjacent to, in a building adjacent to or near a river that has been designated as "wild and scenic" under state or federal law?	X					X	X	X	X

	Santa Clara Valley Water District	Your City's Planning or Public Works Dept	NOAA	CalEPA DTSC	SWRCB Water Rights	Regional Water Quality Control Board	California Fish and Game	Army Corps of Engineers	U.S. Fish & Wildlife Service
Require water to be diverted from a river, stream, or lake for the project or activity?	X	X			X	X	X	X	X
Affect water quality by the deposition of silt, an increase in water temperature, a change in the pH level, or in some other way?	X		X			X	X	X	X
Occur in an area where endangered or rare plant species are thought or known to occur?	X	X				X	X		X
Occur in an area where endangered or threatened fish, bird, or animal species are thought or known to occur?	X	X	X			X	X		X

will be involved.

### San Francisco Bay Area Joint Aquatic Resource Permit Application

As discussed earlier, projects in or near creeks and even intermittent streams can be regulated by many agencies, the local city government, local agencies, such as the Santa Clara Valley Water District, state agencies, such as the San Francisco Bay Regional Water Quality Control Board, and California Department of Fish and Game, and federal agencies, such as the Army Corps of Engineers and U.S. Fish and Wildlife Service, to name a few. For projects with an aquatic component, such as work near a creek or stream, a single application called the San Francisco Bay Area Joint Aquatic Resource Permit Application (JARPA) has been designed to replace individual applications for state, regional, and federal agencies. As suggested earlier, consider taking advantage of this consolidated application to streamline the project permit application process.

If a project requires local approval, such as that of the local city government or Santa Clara Valley Water District, be sure to check with these agencies about what to include in the application, since the JARPA document does not consider local agency requirements.

### California Environmental Quality Act

Prior to obtaining permits for a project, a California Environmental Quality Act (CEQA) review will be required if the project is undertaken by a public agency or if a public agency needs to issue a permit for a project. CEQA is found in Section 21000 et seq. of the Government Code, and the CEQA guidelines are found in Section 1500 et seq. of the California Code of Regulations. The Guidelines have the force of law, and lay out the way CEQA is administered.

(See [http://ceres.ca.gov/topic/env\\_law/ceqa/](http://ceres.ca.gov/topic/env_law/ceqa/))

The purpose of the CEQA review is to inform project decision-makers of the issues associated with the project, to identify significant environmental impacts and reduce them, and to disclose to the public the rationale for the decision to approve a project. The agency responsible for the CEQA review is called the lead agency, and it is usually the agency with the most involvement in the project. The local municipality's planning department usually handles the CEQA review, however, CDFG is also a lead agency for purposes of issuing a Streambed Alteration Agreement.

Once the lead agency is identified, all other agencies that require a permit to be issued for the project, whether state or local, become responsible. Responsible and trustee agencies must consider the environmental document prepared by the lead agency and do not, except in rare instances, prepare their own environmental documents.

### **There are four possible scenarios regarding CEQA requirements:**

1. The project is exempt from CEQA. Exemptions are listed in the CEQA Guidelines. Specific rules should be consulted, but essentially, a categorical exemption cannot be used if the project has the potential for an individual or cumulative significant effect on the environment. Documentation of exemptions should be obtained from the lead agency. Unless a public hearing is required by the local agency for the project, a categorical exemption does not require a public hearing. The document is simply filed at the county for a specified period.
2. A **Negative Declaration** is issued by the lead agency for the project.  
A Negative Declaration can be issued if the project will have no significant impact on the environment without the need for mitigation measures to reduce a project impact to a less than significant level. A public hearing to adopt the findings and the Negative Declaration is required.  
**Hint:** If, at any time along the permitting or review process, you find that your proposed project can have a significant impact on the environment, and by redesigning your project, the impact can be eliminated or reduced to insignificant, you will save yourself time and money by redesigning your project.
3. A Mitigated Negative Declaration is issued for the project. This means that there are significant impacts from your project on the environment, but mitigation measures during implementation can be adopted to reduce these impacts to a less than significant level. A mitigation monitoring and reporting plan is required to identify, what, who, when and where for each mitigation measure, thus ensuring that all mitigation measures are implemented. A public hearing is required.
4. An **Environmental Impact Report (EIR)** is required to study the significant impacts of your project on the environment. Various alternatives to your project must be identified and evaluated and the environmentally preferred alternative must be selected unless there are overriding circumstances that make the project desirable, even though there are significant unmitigated impacts. This finding must be made by the approving body of the lead agency, along with the findings and MMRP. Because there are more alternatives to evaluate, there is a slightly longer review period and a requirement to specifically respond to comments. For this reason, an EIR can be the most

time-consuming and complicated scenario.

## **SECTION 7 - REFERENCE MATERIALS**

There is a wide body of literature that provides more detailed information on these bank protection repair techniques. We have identified several of the more comprehensive documents. A more complete list can be found at [http://www.4sos.org/wssupport/ws\\_rest/rest\\_con.asp](http://www.4sos.org/wssupport/ws_rest/rest_con.asp).

**A Citizen's Streambank Restoration Handbook** – This 171 page handbook is a guide to restoring eroding streambanks using vegetation and flexible systems. It, features installation guidelines, sample budgets, case studies and tips on choosing the best restoration solution. \$20 plus \$5 shipping. To order call 800/284-4952 or E-mail [sos@iwla.org](mailto:sos@iwla.org).

**How to Hold Up Banks: Using All the Assets** – An informative, well-illustrated booklet on controlling stream erosion. Produced by the Boquet River Association (BRASS), a small nonprofit group with extensive experience in stream monitoring and restoration, the book helps citizen groups tap community resources and find success with low-cost techniques. Techniques covered include streambank shaping; grass, seedling, and live posts planting; log cribbing and stone riprap installation. To order send \$8 to BRASS, c/o Essex County Government Center, Box 217, Elizabethtown, NY 12932, or call 518/873-3688.

**Stream Corridor Restoration: Principles, Processes, and Practices** – Developed by an interdisciplinary team of stream and watershed management specialists, hydrologists, engineers and other EPA, federal agency, and private group representatives. A printed document is available for \$71, a CD-ROM version sells for \$60. Available through the Center for Watershed Protection. at <http://www.cwp.org>.

**The Practice of Watershed Protection: Techniques for Protecting and Restoring Urban Watersheds** – At \$80, 150 articles are included on all aspects of watershed protection. Drawn from past issues of *Watershed Protection Techniques* as well as a wealth of other Center papers and reports, this 800-page book is organized around the eight tools of watershed protection, and indexed for easy reference. Available through the Center for Watershed Protection. at <http://www.cwp.org>.

**Urban Stream Restoration Practices: An Initial Assessment** – This assesses the performance of 24 urban stream restoration practices from sites around the Mid-Atlantic and Mid-west, and provides recommendations for improving their application in a variety of urban stream environments. It costs \$20. Available through the Center for Watershed Protection. at <http://www.cwp.org>.

**Stream-bank Repair Guidance Manual for the Private Landowner – Guadalupe and Alamitos Creek** – This focuses on erosion repair in mercury-contaminated streams, but it is relevant to a broad range of erosion repair projects. Some of the most relevant information from this document is contained in this Design Guide. This publication can be obtained from the Santa Clara Valley Water District.

**Maintaining Corte Madera Creek: A Citizens' Guide to Creek-Side Property Protection** – Created for the Town of Portola Valley and its residents to help guide bank stabilization and

revegetation efforts along Corte Madera Creek, a tributary to San Francisquito Creek. The report was created to facilitate communications between the Town and private property owners who wish to address erosion and property loss. The document can be found at <http://www.cityofpaloalto.org/public-works/jpa-projects.html>.

**Guidelines for Bank Stabilization Projects: in Riverine Environments of King County**

– Produced by the King County Department of Public Works Surface Water Management Division, Seattle, Washington in 1993. This report is an exceptional manual that clearly and comprehensively describes the planning, design, permitting, and construction aspects of bank erosion repair. From a technical perspective, it is very applicable to California streams. This resource, including some of its illustrations, was used to help prepare this Bank Protection Design Guide.