CHAPTER 5:

5 CONSTRUCTION BMPS FOR WORKING IN, OVER OR ADJACENT TO WATERS OF THE U.S.:

5.1 WORKING ON OR OVER WATER; INCLUDING MATERIAL AND EQUIPMENT USE ON WATER:

5.1.1 DESCRIPTION AND PURPOSE

Procedures for the proper use, storage, and disposal of materials and equipment on barges, boats, temporary construction pads, or similar locations that minimize or eliminate the discharge of potential pollutants to a watercourse.

5.1.2 APPROPRIATE APPLICATIONS

Applies where materials and equipment are used on barges, boats, docks, and other platforms over or adjacent to a watercourse including waters of the United States. These procedures should be implemented for construction materials and wastes (solid and liquid), soil or dredging materials, or any other materials that may be detrimental if released.

5.1.3 LIMITATIONS

Dredge and fill activities are regulated by the USACE and DOH-CWB under Section 404/401 of the CWA and Section 10 of RHA. Ensure all appropriate permits are obtained prior to construction activities.

5.1.4 STANDARDS AND SPECIFICATIONS

- Refer to BMPs for Material Delivery and Storage and Spill Prevention and Control.
- Use drip pans and absorbent materials for equipment and vehicles and ensure that an adequate supply of spill clean-up materials is available.
- The exterior of vehicles and equipment that will encroach on a water body within the project should be maintained free of grease, oil, fuel, and residues and may require vegetable based hydraulic oil.
- Drip pans should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle is expected to be idle for more than 1 hour.
- Maintain equipment in accordance with BMPs for Vehicle and Equipment Maintenance. If a leaking line cannot be repaired, remove equipment from over the water
- Provide watertight curbs or toe boards to contain spills and prevent materials, tools, and debris from leaving the barge, platform, dock, etc.
- Secure all material to prevent discharge to receiving waters via wind.

- Identify types of spill control measures to be employed, including the storage of such materials and equipment. Ensure that staff is trained regarding the use of the materials, deployment and access control measures, and reporting measures.
- In case of spills, contact the PE who will contact the USACE and DOH-CWB as soon as possible but within 48 hours.
- Refer to BMPs for Solid Waste Management (non-hazardous) and Hazardous Waste Management. Ensure the timely and proper removal of accumulated wastes.
- Comply with all necessary permits required for construction within or near the watercourse, such as DOH-CWB 401 WQC, USACE 404 permit
- Discharges to waterways should be reported to the USACE and DOH-CWB immediately upon discover. A written discharge notification must follow within 7 days. Follow the spill reporting procedures contained in the SWPPP.

5.1.5 Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.
- Ensure that employees and subcontractors implement the appropriate measures for storage and use of materials and equipment.
- Inspect and maintain all associated BMPs and perimeter controls to ensure continuous protection of the water courses, including waters of the United States.

5.2 Demolition Over or Adjacent to Water

5.2.1 Description and Purpose

Procedures to protect water bodies from debris and wastes associated with structure demolition or removal over or adjacent to watercourses.

5.2.2 Appropriate Applications

Full bridge demolition and removal, partial bridge removal (barrier rail, edge of deck) associated with bridge widening projects, concrete channel removal, or any other structure removal that could potentially affect water quality.

5.2.3 Limitations

Specific permit requirements may be included in the contract documents.

5.2.4 Standards and Specifications

- Refer to Clear Water Diversion and Isolation Techniques, to direct water away from work areas.
- Use attachments on construction equipment such as backhoes to catch debris from small demolition operations.
- Use covers or platforms to collect debris.
- Platforms and covers are to be approved by the PE.
- Stockpile accumulated debris and waste generated during demolition away from watercourses and in accordance with Stockpile Management.
- Ensure safe passage of fish and wildlife.
- Discharges to waterways shall be reported to the DOH-CWB immediately upon discovery. A written discharge notification must follow within 7 days. Follow the spill reporting procedures in the SWPPP.
- For structures containing hazardous materials, i.e., lead paint or asbestos, refer to Hazardous Waste Management procedures. For demolition work involving soil excavation around lead-painted structures, refer to Contaminated Soil Management procedures.

5.2.5 Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.
- Any debris-catching devices shall be emptied regularly. Collected debris shall be removed and stored away from the watercourse and protected from runon and runoff.

5.3 Temporary Stream/River Crossing

5.3.1 Description and Purpose

A temporary stream crossing is a temporary culvert, ford or bridge placed across a waterway to provide access for construction purposes for a period of less than one year. Temporary access crossings are not intended to maintain traffic for the public. The temporary access will eliminate erosion and downstream sedimentation caused by vehicles.

5.3.2 Appropriate Applications

Temporary stream crossings should be installed at all designated crossings of perennial and intermittent streams on the construction site, as well as for dry channels that may be significantly eroded by construction traffic.

Temporary streams crossings are installed at sites:

- Where appropriate permits have been secured for the temporary crossing (404 Permits, and 401 Certifications)
- Where construction equipment or vehicles need to frequently cross a waterway
- When alternate access routes impose significant constraints
- When crossing perennial streams or waterways causes significant erosion
- Where construction activities will not last longer than one year

5.3.3 Limitations

The following limitations may apply:

- Specific permit requirements or mitigation measures such as 401 Water Quality Certification, U.S. Army Corps of Engineers Section 404 or Section 10 permits, U.S. Coast Guard Section 9 or General Bridge Act Permits and approval by USFWS and NMFS supersede the guidance in this BMP. If numerical-based water quality standards are mentioned in any of these and other related permits, testing and sampling may be required.
- Installation and removal will usually disturb the waterway.
- Installation may require dewatering or temporary diversion of the stream. See , Dewatering Operations and Clear Water Diversion BMPs.
- Installation may cause a constriction in the waterway, which can obstruct flood flow and cause flow backups or washouts. If improperly designed, flow backups can increase the pollutant load through washouts and scouring.
- Use of natural or other gravel in the stream for construction of Cellular Confinement System (CCS) ford crossing will be contingent upon approval by fisheries agencies.
- Ford crossings may degrade water quality due to contact with vehicles and equipment.
- May be expensive for a temporary improvement.

- Requires other BMPs to minimize soil disturbance during installation and removal.
- Fords should only be used in dry weather.

5.3.4 Standards and Specifications

5.3.4.1 General

The purpose of this BMP is to provide a safe, erosion-free access across a stream for construction equipment. Minimum standards and specifications for the design, construction, maintenance, and removal of the structure should be established by an engineer registered in California. Temporary stream crossings may be necessary to prevent construction equipment from causing erosion of the stream and tracking sediment and other pollutants into the stream.

Temporary stream crossings are used as access points to construction sites when other detour routes may be too long or burdensome for the construction equipment. Often heavy construction equipment must cross streams or creeks, and detour routes may impose too many constraints such as being too narrow or poor soil strength for the equipment loadings. Additionally, the contractor may find a temporary stream crossing more economical for light– duty vehicles to use for frequent crossings, and may have less environmental impact than construction of a temporary access road.

Location of the temporary stream crossing should address:

- Site selection where erosion potential is low.
- Areas where the side slopes from site runoff will not spill into the side slopes of the crossing.

The following types of temporary stream crossings should be considered:

- **Culverts –** A temporary culvert is effective in controlling erosion but will cause erosion during installation and removal. A temporary culvert can be easily constructed and allows for heavy equipment loads.
- **Fords -** Appropriate during the dry season in arid areas. Used on dry washes and ephemeral streams, and low-flow perennial streams. A temporary ford provides little sediment and erosion control and is ineffective in controlling erosion in the stream channel. A temporary ford is the least expensive stream crossing and allows for maximum load limits. It also offers very low maintenance. Fords are more appropriate for ephemeral drainages in drier areas.
- **Bridges -** Appropriate for streams with high flow velocities, steep gradients and where temporary restrictions in the channel are not allowed.

5.3.4.2 Design

For short duration work in ephemeral drainages, a temporary ford may be sufficient. However, a ford is not appropriate if construction will continue through the rainy season, if summer thunderstorms are likely, or if the stream flows during most of the year. Temporary culverts and bridges should then be considered and, if used, should be sized to pass a design storm (i.e., at least a 2 to 5-year storm). The temporary stream crossing should be protected against erosion, both to prevent excessive sedimentation in the stream and to prevent washout of the crossing.

Design and installation requires knowledge of stream flows and soil strength. Designs should be prepared under direction of, and approved by, a registered civil engineer and for bridges, a registered structural engineer. Both hydraulic and construction loading requirements should be considered with the following:

- Comply with any special requirements for culvert and bridge crossings, particularly if the temporary stream crossing will remain through the rainy season.
- Provide stability in the crossing and adjacent areas to withstand the design flow. The design flow and safety factor should be selected based on careful evaluation of the risks due to over topping, flow backups, or washout.
- Install sediment traps immediately downstream of crossings to capture sediments. See BMP Summary for Sediment Trap.
- Avoid oil or other potentially hazardous materials for surface treatment.
- Culverts are relatively easy to construct and able to support heavy equipment loads.
- Fords are the least expensive of the crossings, with maximum load limits.
- CCS crossing structures consist of clean, washed gravel and CCS blocks. These systems are appropriate for streams that would benefit from an influx of gravel; for example, streams or rivers below reservoirs, and urban, channelized streams. Many urban stream systems are gravel-deprived due to human influences, such as dams, gravel mines, and concrete channels.
- The CCS allows designers to use either angular or naturally occurring rounded gravel, because the cells provide the necessary structure and stability. In fact, natural gravel is optimal for this technique, because of the habitat improvement it will provide after removal of the CCS.
- A gravel depth of 6 to 12 in. for a CCS structure is sufficient to support most construction equipment.
- An advantage of a CCS crossing structure is that relatively little rock or gravel is needed, because the CCS provides the stability.
- Bridges are generally more expensive to design and construct, but provide the least disturbance of the streambed and constriction of the waterway flows.

5.3.4.3 Construction and Use

- Stabilize construction roadways, adjacent work area, and stream bottom against erosion.
- Construct during dry periods to minimize stream disturbance and reduce costs.
- Construct at or near the natural elevation of the streambed to prevent potential flooding upstream of the crossing.

- Install temporary erosion control BMPs in accordance with erosion control BMP fact sheets to minimize erosion of embankment into flow lines.
- Any temporary artificial obstruction placed within flowing water should only be built from material, such as clean gravel or sandbags, that will not introduce sediment or silt into the watercourse.
- Temporary water body crossings and encroachments should be constructed to minimize scour. Cobbles used for temporary water body crossings or encroachments should be clean, rounded river cobble.
- Vehicles and equipment should not be driven, operated, fueled, cleaned, maintained, or stored in the wet or dry portions of a water body where wetland vegetation, riparian vegetation, or aquatic organisms may be destroyed.
- The exterior of vehicles and equipment that will encroach on the water body within the project should be maintained free of grease, oil, fuel, and residues.
- Drip pans should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than one hour.
- Disturbance or removal of vegetation should not exceed the minimum necessary to complete operations. Precautions should be taken to avoid damage to vegetation by people or equipment. Disturbed vegetation should be replaced with the appropriate soil stabilization measures.
- Riparian vegetation, when removed pursuant to the provisions of the work, should be cut off no lower than ground level to promote rapid re-growth. Access roads and work areas built over riparian vegetation should be covered by a sufficient layer of clean river run cobble to prevent damage to the underlying soil and root structure. The cobble must be removed upon completion of project activities.

5.3.5 Inspection and Maintenance

The following limitations may apply:

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two week intervals in the non-rainy season to verify continued BMP implementation.
- Check for blockage in the channel, sediment buildup or trapped debris in culverts, blockage behind fords or under bridges
- Check for erosion of abutments, channel scour, riprap displacement, or piping in the soil
- Check for structural weakening of the temporary crossings, such as cracks, and undermining of foundations and abutments
- Remove sediment that collects behind fords, in culverts, and under bridges periodically

- Replace lost or displaced aggregate from inlets and outlets of culverts and cellular confinement systems
- Remove temporary crossing promptly when it is no longer needed

5.4 Streambank Stabilization

5.4.1 Description and Purpose

Stream channels, stream banks, and associated riparian areas are dynamic and sensitive ecosystems that respond to changes in land use activity. Streambank and channel disturbance resulting from construction activities can increase the stream's sediment load, which can cause channel erosion or sedimentation and have adverse effects on the biotic system. BMPs can reduce the discharge of sediment and other pollutants to minimize the impact of construction activities on watercourses. Proper planning and procedures for work in and around streams and channels can reduce the potential for discharge of sediment and other pollutants and minimize the impacts of construction activities on watercourses and habitat. Streams on the 303(d) list and listed for sediment may require numerous measures to prevent any increases in sediment load to the stream.

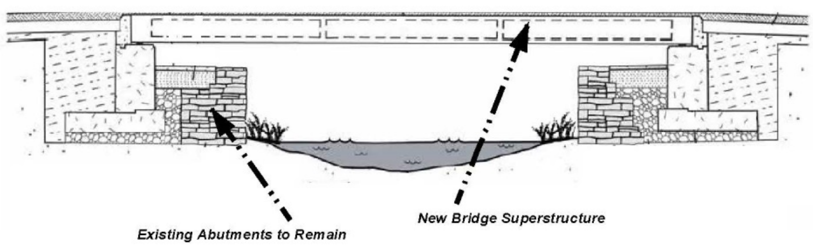
5.4.2 Suitable Applications

These procedures typically apply to all construction projects that disturb or occur within stream channels and their associated riparian areas. The site-specific stream bank practices used will be partially dependent upon the types of soils present, the slope of the bank, gradient of the river, flow, and uses of the watercourse.

5.4.3 Limitations

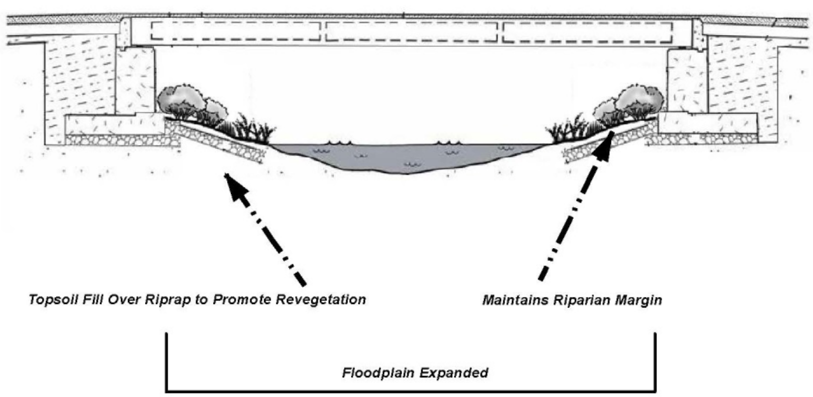
- The appropriate time to apply stream bank erosion controls is dependent upon the method used.
- Specific permit requirements or mitigation measures such as 401 Water Quality Certification, U.S. Army Corps of Engineers Section 404 or Section 10 permits, U.S. Coast Guard Section 9 or General Bridge Act Permits and approval by USFWS and NMFS supersede the guidance in this BMP. If numerical-based water quality standards are mentioned in any of these and other related permits, testing and sampling may be required.

Retain Existing Bridge Abutment Cross-Section:



Notes:
1) Minimizes new disturbance during the short term.
2) Previous active channel and floodplain widths are maintained.
3) Does not support a riparian margin.
4) Does not allow for any bioengineering features to be Integrated into Design

Remove Existing Bridge Abutment with Channel Improvement Cross-Section:



Notes:
1) Supports Riparian Functions
2) Provides Scour Protection Through Buried Riprap
3) Maintains a Riparian Margin Adjacent to Roadway.
4) Allows Bioengineering Features to be Integrated into Design

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Figure 9. Example of streambank stabilization options during bridge replacement.

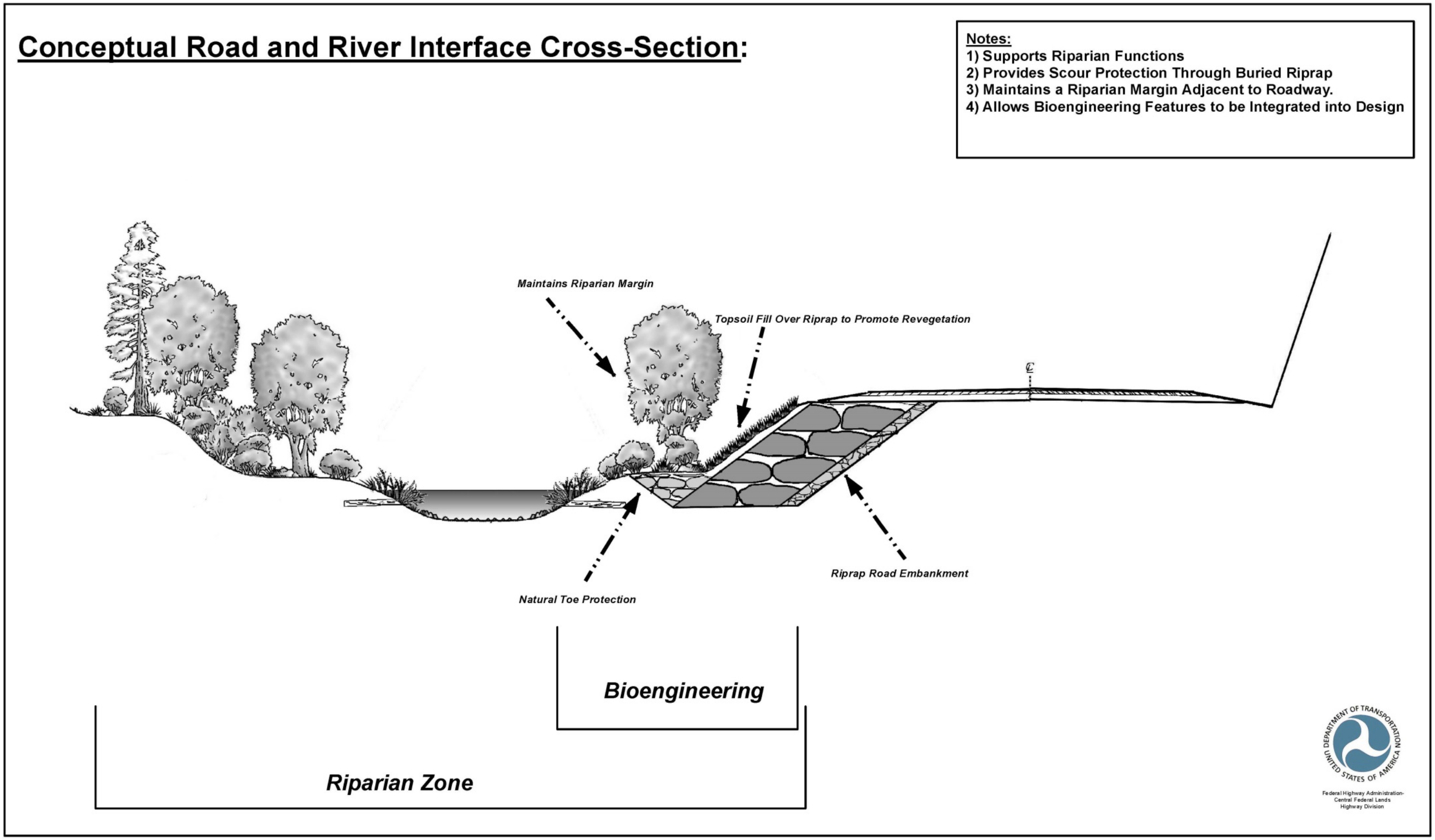

Figure 10. Example of roadway with riprap and bioengineering features.

5.4.4 Implementation

5.4.4.1 Planning

Proper planning, design, and construction techniques can minimize impacts normally associated with streambank construction activities. Poor planning can adversely affect soil, fish, wildlife resources, land uses, or land users. Planning should take into account: scheduling; avoidance/minimization of in-stream construction; minimizing disturbance area and construction time period; using pre-disturbed areas; selecting crossing location; and selecting equipment.

It is important to remember that streams are dynamic. Even without human influence streams may meander, and in the process, cause banks to erode. Therefore, not all eroding banks are “bad” and in need of repair. In fact, the wrong system of BMPs installed in the wrong place may cause more damage downstream (and therefore to the entire stream system) than leaving the stream in its natural state. For example, “hard structures” like large riprap or gabions, placed on one eroding bank, can displace the stream’s energy downstream to a previously stable bank, causing the downstream bank to erode. If this downstream bank is also stabilized with a hard structure, the stream’s energy may be moved further downstream to another previously stable bank, and so on.

So before stabilizing stream banks, consider the cause of the stream bank erosion. If the banks are eroding due to a natural meander, then it may be best to leave the bank alone. If the banks are eroding due to fluctuations in hydrology, the hydrologic fluctuations should be addressed before the banks are stabilized.

Once the cause of erosion is identified and addressed (If possible), determine the goal in stabilizing the stream banks. Some banks are stabilized to protect buildings, land and infrastructure. Others are stabilized to keep soil from entering the stream and to allow recreational or angler access to the stream. The purpose for stabilizing the banks and the users of the stream will help determine the type of structures needed.

Once the above concerns have been addressed, then it is important to work with agencies with expertise in stream bank erosion techniques to address stream bank erosion at the watershed level. Looking at the entire watershed will help prioritize bank stabilization efforts. This is especially important in Hawaii where restoration options must account for Hawaii’s extreme hydrology (steep slopes and intense rainfall regime), extreme channel hydraulics (velocities, shear stress), flood control requirements, and limited space. Design considerations for streambank stabilization techniques should include:

- Channel Grade
- Discharge Frequency
- Discharge Velocities
- Freeboard
- Alignment
- Stream Type and Hydraulic Geometry
- Sediment Load and Bed Material
- Protection Against Failure
- Undermining
- Ends of Revetment
- Debris Removal
- Vegetative Systems

5.4.4.2 Scheduling

Construction activities should be scheduled according to the relative sensitivity of the environmental concerns and in accordance with the Scheduling BMP. Scheduling considerations will be different when working near perennial streams vs. ephemeral streams and are as follows.

When in-stream construction is conducted in a perennial stream, work should optimally be performed during the rainy season. This is because in the summer, any sediment-containing water that is discharged into the watercourse will cause a large change in both water clarity and water chemistry. During the rainy season, there is typically more and faster flowing water in the stream so discharges are diluted faster. However, should in-stream work be scheduled for summer, establishing an isolation area, or diverting the stream, will significantly decrease the amount of sediment stirred up by construction work. Construction work near perennial streams should optimally be performed during the dry season (see below).

When working in or near ephemeral streams, work should be performed during the dry season. By their very nature, ephemeral streams are usually dry in the summer, and therefore, in-stream construction activities will not cause significant water quality problems. However, when tying up the site at the end of the project, wash any fines (see Washing Fines) that accumulated in the channel back into the bed material, to decrease pollution from the first rainstorm of the season.

When working near ephemeral or perennial streams, erosion and sediment controls (see Chapter 4) should be implemented to keep sediment out of stream channel.

5.4.4.3 Minimize Disturbance

Minimize disturbance through: selection of the narrowest crossing location; limiting the number of equipment trips across a stream during construction; and, minimizing the number and size of work areas (equipment staging areas and spoil storage areas). Place non water dependent work areas at least 50 feet (ft) from stream channel to minimize impacts to stream. Field reconnaissance should be conducted during the planning stage to identify work areas.

5.4.4.4 Use of Pre-Disturbed Areas

Locate project sites and work areas in areas disturbed by prior construction or other activity when possible.

5.4.4.5 Selection of Project Site

Select project site that minimizes disturbance to aquatic species or habitat. Try to avoid steep and unstable banks, highly erodible or saturated soils, or highly fractured rock.

5.4.4.6 Equipment Selection

Select equipment that reduces the amount of pressure exerted on the ground surface, and therefore, reduces erosion potential and/ or use overhead or aerial access for transporting equipment across drainage channels. Use equipment that exerts ground pressures of less than 5 or 6 lb/in, where possible. Low ground pressure equipment includes: wide or high flotation tires (34 to 72 in. wide); dual tires; bogie axle systems; tracked machines; lightweight equipment; and, central tire inflation systems.

5.4.5 Streambank Stabilization Methods

Streambanks should be temporarily stabilized using approved soil stabilization and sediment control methods identified in Chapter 4 including but not limited to: preservation of existing vegetation, hydraulic mulch, hydroseeding, soilbinders, strawmulch, geotextiles or mats, silt fence, strawbale barriers, fiber rolls, velocity dissipation devices, slope drains and/or other appropriate erosion and sediment control methods.

There are numerous methods available to permanently stabilize stream banks. Rather than discuss all of them in detail, below is a discussion of the most common practices.

5.4.5.1 Bioengineering

Bioengineering is a method of using vegetation to stabilize a site with or without structural controls. Some refer to bioengineering as softening the traditional rock-the-bank approach because non-invasive vegetation is used to blend the site into its surrounding landscape. Bioengineering techniques may be as simple as installing erosion control blankets, then seeding exposed soil to help prevent soil movement, to full stream restoration plans. Common techniques utilized included:

Table 5: Streambank and Shoreline Stabilization Measures

	Type of Protection and Where Applicable										*Problems Addressed*						
Best Management Practices	Decrease Force	Increase Resistance	Immediate Protection	Protection Below or at Waterline	Streambank	Shoreline	Flat Banks (<2:1)	Steep Banks (>2:1)	Holes, Slumps	Natural Materials Present	Toe Erosioin, Undercutting	Wildlife Habitat	Aquatic Habitat	Water Quality/ Sediment Trap	Saturated Soil	Bare Bank	Overbank Erosion
Bioengineering																	
Fiber Rolls and Fiberschines, Coir Logs		X	X	X	X	X					X	X	X	X			
Brush Mattress		X	X		X	X				X		X		X	X	X	X
Brush Layering or Branch Packing	X	X	X		X	X	X		X	X		X	X	X	X	X	
Brush/Tree Revetment	X	X	X	X	X		X	X									
Brush Trench	X	X	X		X	X	X	X	X	X		X				X	
Stake Plantings		X			X	X	X		X			X		X	X	X	X
Vertical Bundles		X			X	X	X		X			X		X	X	X	X
Live Wattles or Fascines		X			X	X	X		X	X		X		X	X	X	X
Branchpacking	X	X	X		X	X	X		X	X							
Live Cribwall		X	X	X	X	X		X			X	X	X	X	X	X	X
Brushmattress		X	X		X	X				X		X		X	X	X	X
Structural																	
Rock Riffle	X	X	X	X	X		X	X			X		X	X			
Engineered Log Jams and Tree Revetments	X	X	X	X	X					X	X	X	X				

Log, Rootwad, Boulder Revetment	X	X	X	X	X					X		X	X	X			
Post/Pole Planting	X	X	X	X	X					X	X	X			X	X	X
Rock Riprap		X	X	X	X	X	X				X				X	X	X
Rock Gabions			X	X	X	X	X	X			X		X		X	X	
Vanes, Weirs, Barbs	X		X	X	X		X				X		X	X			
Notes: X = BMP may be applicable to activity																	

In a stream bank and shoreline environment, bioengineering and preservation of existing vegetation provides the following benefits:

5.4.5.1.1 *Water Quality Protection:*

Vegetated buffers on slopes trap sediment and promote groundwater recharge. The buffer width needed to maintain water quality ranges from 15 to 100 ft. On gradual slopes, most of the filtering occurs within the first 30ft. Steeper slopes require a greater width of vegetative buffer to provide water quality benefits.

5.4.5.1.2 *Streambank Stabilization*

The root system of riparian vegetation stabilizes stream banks by increasing tensile strength in the soil. The presence of vegetation modifies the moisture condition of slopes (infiltration, evapotranspiration, interception) and increases bank stability.

5.4.5.1.3 *Riparian Habitat*

Buffers of diverse riparian vegetation provide food and shelter for riparian and aquatic organisms. Minimizing impacts to fisheries habitat is a major concern when working near streams and rivers. Riparian vegetation provides shade, shelter, organic matter (leaf detritus and large woody debris), and other nutrients that are necessary for fish and other aquatic organisms. Buffer widths for habitat concerns are typically wider than those recommended for water quality concerns (100 to 1,500 ft).

When working near watercourses, it is important to understand the work site's placement in the watershed. Riparian vegetation in headwater streams has a greater impact on overall water quality than vegetation in downstream reaches. Preserving existing vegetation upstream is necessary to maintain water quality, minimize bank failure, and maximize riparian habitat, downstream of the work site.

5.4.5.1.4 *Installation*

As a general rule, the width of a buffer strip between a road and the stream is recommended to be 50 ft plus four times the percent slope of the land, measured between the road and the top of stream bank.

5.4.5.2 Riprap

Riprap is one of the more commonly used stream bank stabilization techniques. It is a permanent cover of rock used to stabilize stream banks, provide in-stream channel stability, and provide a stabilized outlet below concentrated flows. It is generally used on stream banks at the toe (bottom) of the slope, with other structures placed up-slope to prevent soil movement. It is often a component of many soil bioengineering techniques listed above.

Riprap stabilization designs should include appropriate bank slope and rock size to protect the bank from wave and current action and to prolong the life of the embankment. A final slope ratio of at least 1:2 (vertical to horizontal) is recommended, and a more stable 1:3 slope should be used where possible. However, steeper slopes may be appropriate.

A layer of gravel, small stone, or filter cloth placed under and/or behind the rock helps prevent failure. In many cases, only the toe of the slope may need rock reinforcement; the remainder can be planted with native vegetation.

5.5 Clear Water Diversion and Isolation Techniques

5.5.1 Description and Purpose

Clean water diversions are used to minimize water quality degradation by keeping clean water away from active construction sites. These diversions temporarily intercept and reroute water to 1) isolate surface waters from a construction area that is in or adjacent to water, or 2) divert upslope runoff around an active construction site or one that is newly constructed, unstable, unprotected, or recently seeded, and discharge downstream or down gradient to a protected outlet. They will divert surface waters until the construction is completed, BMPs are installed, and/or slopes are stabilized with vegetation and mulch.

Clear water diversion consists of a system of structures and measures that intercept clear surface water runoff upstream of a project, transport it around the work area, and discharge it downstream with minimal water quality degradation from either the project construction operations or the construction of the diversion. Clear water diversions are used in a waterway to isolate and confine construction area and reduce sediment pollution from construction work occurring in or adjacent to water. Structures commonly used as part of this system include diversion ditches, berms, dikes, slope drains, rock, gravel bags, wood, aqua barriers, cofferdams, filter fabric or turbidity curtains, drainage and interceptor swales, pipes, or flumes. This guidance will summarize these common practices as well as; identify suitable applications, limitations, standards and specifications, and inspection and maintenance of these practices.

5.5.2 Design Considerations

5.5.2.1 Construction Sites:

- Plan in advance for stable discharge of runoff collected in diversions. Discharge points must have outlet protection or energy dissipaters.
- Reduce diversion gradient to reduce water velocity.
- Size clean water diverters adequately for the catchment drainage size.
- Ensure that all diversion pipe connections are completely sealed and conduits are staked securely to the slope. Pipes are preferred to flumes for spill control.
- Ensure that any substance used to assemble or maintain diversion structures (e.g. form oil) or used to minimize seepage beneath these structures (e.g. grout) are non-toxic, non-hazardous, and neutral pH to minimize contamination of clean water.

5.5.2.2 Streams

- Schedule construction for periods of low flows, or when the stream is dry if possible. Consider seasonal releases of water from dams, fish migration and spawning seasons, and water demands due to vegetation irrigation.
- Always allow sufficient flow to pass to maintain aquatic life downstream. Never completely dam stream flow during isolation of a stream reach for construction.
- Never harm or remove riparian vegetation, unless approved by the permitting authority.

- Consider potential impacts to the stream channel or water body before installing diverters. Select less intrusive methods.
- Do not park equipment below the high water mark of a water body, unless approved by the permitting authority.
- Stabilize embankment slopes and diversion ditches with liners such as geotextiles, erosion control blanket systems, rock slope protection, or other slope stabilization materials in areas where erosion is anticipated.
- Avoid disturbing aquatic species during installation, dewatering, maintenance, or removal of clean water diverters. Maintain adequate flow downstream to support aquatic life.

5.5.3 Suitable Applications

A clear water diversion is typically implemented where appropriate permits (Section 10, Section 404, and Section 401 WQC) have been secured and work must be performed in a flowing stream or water body.

- Clear water diversions are appropriate for isolating construction activities occurring within or near a water body such as streambank stabilization, or culvert, bridge, pier or abutment installation. They may also be used in combination with other methods, such as clear water bypasses and/or pumps.
- Temporarily intercept and divert upslope runoff around construction areas and discharge to stable point downslope.
- Suitable for conveying runoff down steep slopes, particularly cut-and-fill slopes.
- Useful for diverting, removing, and treating sediment-laden water encountered during construction.
- Pumped diversions are suitable for intermittent and low flow streams.
- Excavation of a temporary bypass channel, or passing the flow through a heavy pipe (called a "flume") with a trench excavated under it, is appropriate for the diversion of streams less than 20 ft wide, with flow rates less than 100 cubic feet per second (cfs).

5.5.4 Limitations

- Diversion and encroachment activities will usually disturb the waterway during installation and removal of diversion structures.
- Specific permit requirements or mitigation measures such as 401 Water Quality Certification, U.S. Army Corps of Engineers Section 404 or Section 10 permits, U.S. Coast Guard Section 9 or General Bridge Act Permits and approval by USFWS and NMFS supersede the guidance in this BMP. If numerical-based water quality standards are mentioned in any of these and other related permits, testing and sampling may be required.
- Special permits or mitigation measures may be required.
- Diversion and encroachment activities may constrict the waterway, which can obstruct flood flows and cause flooding or washouts. Diversion structures

should not be installed without identifying potential impacts to the stream channel.

- Diversion or isolation activities are not appropriate in channels where there is insufficient stream flow to support aquatic species in the area dewatered as a result of the diversion.
- Diversion or isolation activities are inappropriate in deep water unless designed or reviewed by a hydraulic engineer.
- Diversion or isolation activities should not completely dam stream flow.
- Dewatering and removal may require additional sediment control or water treatment. See SM-17, Dewatering Operations.
- Not appropriate if installation, maintenance, and removal of the structures will disturb sensitive aquatic species of concern.

5.5.5 Standards and Specifications

There are two types of clean water diversions: (1) The diversion method involves intercepting clean runoff water from upslope, diverting it around a construction area, and conveying it by various means to a stable discharge point down slope. (2) The isolation method, on the other hand, uses various techniques to isolate and dewater a construction area that exists in a stream, lake, or other water environment.

5.5.6 General Considerations

- Implement the streambank stabilization guidelines to minimize impacts to streambanks.
- Divert clear water to clear water. This means that a diversion should be of sufficient length to completely bypass the area impacted by construction. If clear water is returned to a waterway too soon, it will exacerbate the sediment control problem rather than mitigating it by increasing the volume of sediment laden water on the job site.
- Where working areas encroach on flowing streams, barriers adequate to prevent the flow of muddy water into streams should be constructed and maintained between working areas and streams. During construction of the barriers, muddying of streams should be held to a minimum.
- Where possible, diversion/encroachment impacts should be avoided or minimized by scheduling construction during periods of low-flow or when the stream is dry (see also the project special provisions for scheduling requirements). Scheduling should also consider seasonal releases of water from dams, fish migration and spawning seasons, and water demands due to crop irrigation.
- Diversion structures must be adequately designed to accommodate fluctuations in water depth or flow volume due to tides, storms, flash floods, etc.
- Heavy equipment driven in wet portions of a water body to accomplish work should be completely clean of petroleum residue, and water levels should be below the fuel tanks, gearboxes, and axles of the equipment unless lubricants

and fuels are sealed such that inundation by water will not result in discharges of fuels, oils, greases, or hydraulic fluids.

- Excavation equipment buckets may reach out into the water for the purpose of removing or placing fill materials. Only the bucket of the crane/ excavator/backhoe may operate in a water body. The main body of the crane/excavator/backhoe should not enter the water body except as necessary to cross the stream to access the work site.
- Stationary equipment such as motors and pumps located within or adjacent to a water body should be positioned over drip pans.
- When any artificial obstruction is being constructed, maintained, or placed in operation, sufficient water should, at all times, be allowed to pass downstream to maintain aquatic life.
- The exterior of vehicles and equipment that will encroach on a water body within the project should be maintained free of grease, oil, fuel, and residues and may require vegetable based hydraulic oil.
- Equipment should not be parked below the high water mark unless allowed by a permit.
- Disturbance or removal of vegetation should not exceed the minimum necessary to complete operations, and as shown on the project plan sheets (i.e. construction limits). Precautions should be taken to avoid damage to vegetation by people or equipment. Disturbed vegetation should be replaced with the appropriate erosion control/soil stabilization measures.
- Riparian vegetation approved for trimming as part of the project should be cut off no lower than ground level to promote rapid re-growth. Access roads and work areas built over riparian vegetation should be covered by a sufficient layer of clean river run cobble to prevent damage to the underlying soil and root structure. The cobble should be removed upon completion of project activities.
- Drip pans should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than 1 hour.
- Where possible, avoid or minimize diversion and encroachment impacts by scheduling construction during periods of low flow or when the stream is dry. Scheduling should also consider seasonal releases of water from dams, fish migration and spawning seasons, and water demands due to crop irrigation.
- Construct diversion structures with materials free of potential pollutants such as soil, silt, sand, clay, grease, oil or other petroleum products.
- • A “Diversion Plan” should be submitted to the Project Engineer for review prior to commencing any clear water diversion activities. This plan should include, at a minimum, the following:
    - Predicted diversion flow rates
    - Pump capacities (if required)

- Material to be used (i.e., piping, plastic sheeting)
- Appropriate permits and approvals (as required)
- Contingency plans
- Additional BMP(s) (as required)
- Removal and restoration plan

5.5.6.1 Stream Isolation Techniques (Temporary Dry Construction Areas)

Isolation techniques are methods that isolate near shore work from a waterbody. Techniques include sheet pile enclosures, water-filled geotextile (Aqua Dam), gravel berm with impermeable membrane, gravel bags, coffer dams, and K-rail.

The selection of which stream diversion or Isolation technique to use will depend upon the type of work involved, physical characteristics of the site, and the volume of water flowing through the project. Costs of clear water diversion vary considerably and can be very high. Manufactured diversion structures should be installed following manufacturer's specifications.

5.5.6.1.1 Filter Fabric

A relatively inexpensive isolation method is filter fabric isolation. This method involves placement of gravel bags or continuous berms to 'key-in' the fabric, and subsequently staking the fabric in place. This method should be used in relatively calm water, and can be used in smaller streams. Note that this is not a dewatering method, but rather a sediment isolation method.

5.5.6.1.2 Turbidity Curtain:

A turbidity curtain is a fabric barrier used to isolate the near shore work area. The barriers are intended to confine the suspended sediment. The curtain is a floating barrier, and thus does not prevent water from entering the isolated area; rather, it prevents suspended sediment from getting out. Turbidity curtains should be used where sediment discharge to a stream is unavoidable.

5.5.6.1.3 K-rail River Isolation:

K-rails are shaped concrete barriers that can be used to isolate an in-stream or near bank construction area or to form a sediment deposition area. The method can be used in streams with higher water velocities than allowable with many other isolation techniques, but it does not allow for full dewatering.

5.5.6.1.4 Sheet Pile Enclosures:

Sheet metal piles are installed in water to provide a waterproof area for full dewatering. This technique is useful in large streams and lakes. This technique is relatively expensive and staging and heavy equipment access areas are necessary.

5.5.6.1.5 Water-Filled Geotextile (Aqua Dam):

This technique allows for partial dewatering of in-stream/lake or near bank construction areas and can be used for small streams to large rivers. An aqua dam consists of a geotextile bag with two separate sections that is placed in water. Each section is then filled with water to reach above the high water level, preventing movement of the bag. Aqua dams are lightweight, easy to transport, reusable, and easy to install.

5.5.6.1.6 Gravel Berm with Impermeable Membrane:

This technique, designed for small streams, allows for partial dewatering of in-stream/lake or near bank construction areas. At the upstream end of the project area, clean washed gravel is placed into the stream to hold in place an impermeable membrane. The area can then be dewatered.

Gravel Bag Berms used in conjunction with an impermeable membrane are cost effective, and can be dewatered relatively easily. If spawning gravel is used, the impermeable membrane can be removed from the stream, and the gravel can be spread out and left as gravel in water habitat if approved in the permit. Only clean, washed gravel should be used for both the gravel bag and gravel berm techniques.

5.5.6.1.7 Gravel Bag:

Overlapping clean and washed gravel filled bags are placed into the water until they reach the height of the high water level. The work area downstream of the gravel bags can then be dewatered. Installation and removal of the gravel bags is labor intensive. Leaks between the gravel bags can also make dewatering an area difficult.

5.5.6.1.8 Coffer dams:

Coffer dams are watertight structures of steel, timber, earth, or other materials built in place to block off the construction area which is normally submerged. These dams are used in a variety of settings, including small to large streams, lakes, and coastal areas. Also, many options are now available and are relatively easy to install.

5.5.6.1.9 Isolation Technique Considerations

- When dewatering behind temporary structures to create a temporary dry construction area, such as cofferdams, pass pumped water through a sediment-settling device, such as a portable tank or settling basin, before returning water to the water body.
- Isolation structures must be in place for life of in-water work. Structures should be installed before work starts and removed after stabilization of in-water work area is complete to avoid impacts to aquatic environment.
- Any substance used to assemble or maintain diversion structures, such as form oil, should be inert, non-toxic and non-hazardous.
- Any material used to minimize seepage underneath diversion structures, such as grout, should be non-toxic, non-hazardous, and as close to a neutral pH as possible.

5.5.6.2 Stream Diversion Techniques

In conjunction with isolating and dewatering the work area in a stream reach, surface water upstream may be diverted around the work area and discharged downstream. There are three types of stream diversions. The stream diversion technique to use depends upon the type of work involved, physical characteristics of the site, and the volume of water flowing through the project. The three stream diversion techniques are:

5.5.6.2.1 Pumped diversions:

Effective for de-watering in relatively flat terrain. Pump capacity must be sufficient for design flow. Pumps require frequent monitoring.

5.5.6.2.2 Pipe/Flume diversions:

Requires moderate slope to generate adequate stream velocity to move water through the pipe/flume to the discharge area.

5.5.6.2.3 Dam-type or excavated diversions:

Water is diverted by temporary dams constructed above and below the work site. Dams must be constructed of erosion resistant materials such as steel plate, sheet pile, washed gravel bags, continuous berms, inflatable water bladders, and similar.

5.5.6.2.4 Diversion Technique Considerations

- When constructing a diversion channel, begin excavation of the channel at the downstream end and work upstream. Once the watercourse to be diverted is reached, and the excavated channel is stable, breach the upstream end, and allow water to flow down the new channel. Once flow has been established in the diversion channel, install the diversion weir in the main channel; this will force all water to be diverted from the main channel.
- All stream diversions will need to have a barrier installed to block the water and force it into the diversion (Refer to Stream Isolation Techniques above). Carefully evaluate site conditions to select type of diversion to use and installation specifications. Size diversions to convey design flood flows. Provide adequate energy dissipation at the outlet to minimize erosion.
- In high flow velocity areas, stabilize slopes of embankments and diversion ditches using an appropriate liner, in accordance with standard specifications for Geotextiles and Mats, or use rock slope protection.
- Where appropriate, use natural streambed materials such as large cobbles and boulders for temporary embankment and slope protection, or other temporary soil stabilization methods.
- Provide for velocity dissipation at transitions in the diversion, such as the point where the stream is diverted to the channel and the point where the diverted stream is returned to its natural channel. See standard specifications for Velocity Dissipation Devices.

5.6 Filter Fabric Isolation Technique

5.6.1 Definition and Purpose

A filter fabric isolation structure is a temporary structure built into a waterway to enclose a construction area and reduce sediment pollution from construction work in or adjacent to water. This structure is composed of filter fabric, gravel bags, and steel t-posts.

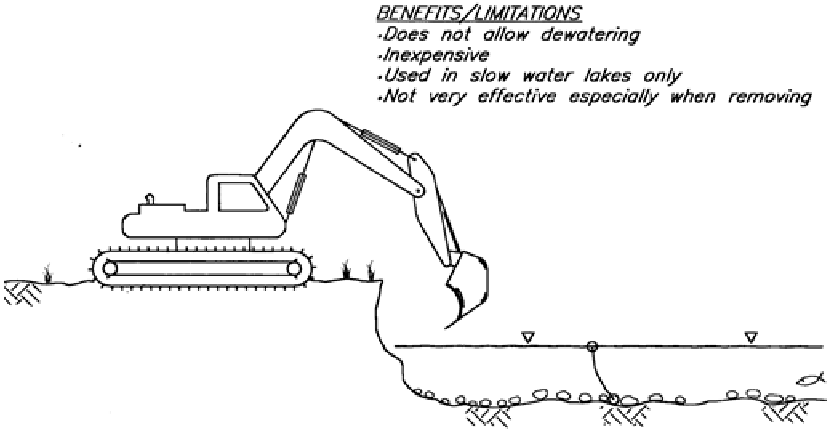

Figure 11: Geotextiles, Silt Barriers, Curtain Enclosure Method.

5.6.2 Appropriate Applications

- Filter fabric may be used for construction activities such as streambank stabilization, or culvert, bridge, pier or abutment installation. It may also be used in combination with other methods, such as clean water bypasses and/or pumps.
- Filter fabric isolation is relatively inexpensive. This method involves placement of gravel bags or continuous berms to 'key-in' the fabric, and subsequently staking the fabric in place.
- If spawning gravel is used, all other components of the isolation can be removed from the stream, and the gravel may be spread out and left as gravel stream habitat if approved in the permit. Whether spawning gravel or other types of gravel are used, only clean washed gravel should be used as infill for the gravel bags or continuous berm.
- This method should be used in relatively calm water, and can be used in smaller streams.
- This is not a dewatering method, but rather a sediment isolation method.
- Water levels inside and outside the fabric curtain must be about the same, as differential heads will cause the curtain to collapse.

5.6.3 Limitations

- Do not use if the installation, maintenance and removal of the structures will disturb sensitive aquatic species of concern.
- Filter fabrics are not appropriate for projects where dewatering is necessary.

- Filter fabrics are not appropriate to completely dam stream flow.

5.6.4 Standards and Specifications

- For the filter fabric isolation method, a non-woven or heavy-duty fabric (refer to Standard Specification FP-14, Section 713) is required over standard silt fence. Using rolled geotextiles allows non-standard widths to be used.
- Anchor filter fabric with gravel bags filled with clean, washed gravel. Do not use sand. If a bag should split open, the gravel can be left in the stream, where it can provide aquatic habitat benefits. If a sandbag splits open in a watercourse, the sand could cause a decrease in water quality, and could bury sensitive aquatic habitat. Exceptions may apply if streambed is composed of sand and similar sand material is used to fill bags.
- Another anchor alternative is a continuous berm, made with the Continuous Berm Machine. This is a gravel-filled bag that can be made in very long segments. The length of the berms is usually limited to 20 ft for ease of handling (otherwise, it gets too heavy to move).

5.6.5 Installation

- Place the fabric on the bottom of the stream, and place either a bag of clean, washed gravel or a continuous berm over the bottom of the silt fence fabric, such that a bag-width of fabric lies on the stream bottom. The bag should be placed on what will be the outside of the isolation area.
- Pull the fabric up, and place a metal t-post immediately behind the fabric, on the inside of the isolation area; attach the silt fence to the post with three diagonal nylon ties.
- Continue placing fabric as described above until the entire work area has been isolated, staking the fabric at least every 6 ft.

5.6.6 Inspection and Maintenance

- Conduct inspections as required by the NPDES, 404 permit, 401 WQC or contract specifications. At a minimum, during construction inspect daily during the workweek.
- Schedule additional inspections during and after storm events.
- Immediately repair any gaps, holes or scour.
- Remove and properly dispose of sediment buildup.
- Remove BMP upon completion of construction activity. Recycle or reuse if applicable.
- Revegetate areas disturbed by BMP removal if needed.

5.7 Turbidity Curtain Isolation Technique

5.7.1 Definition and Purpose

A turbidity curtain is a fabric barrier used to isolate the near shore work area. The barriers are intended to confine the suspended sediment. The curtain is a floating barrier, and thus does not prevent water from entering the isolated area; rather, it prevents suspended sediment from getting out.

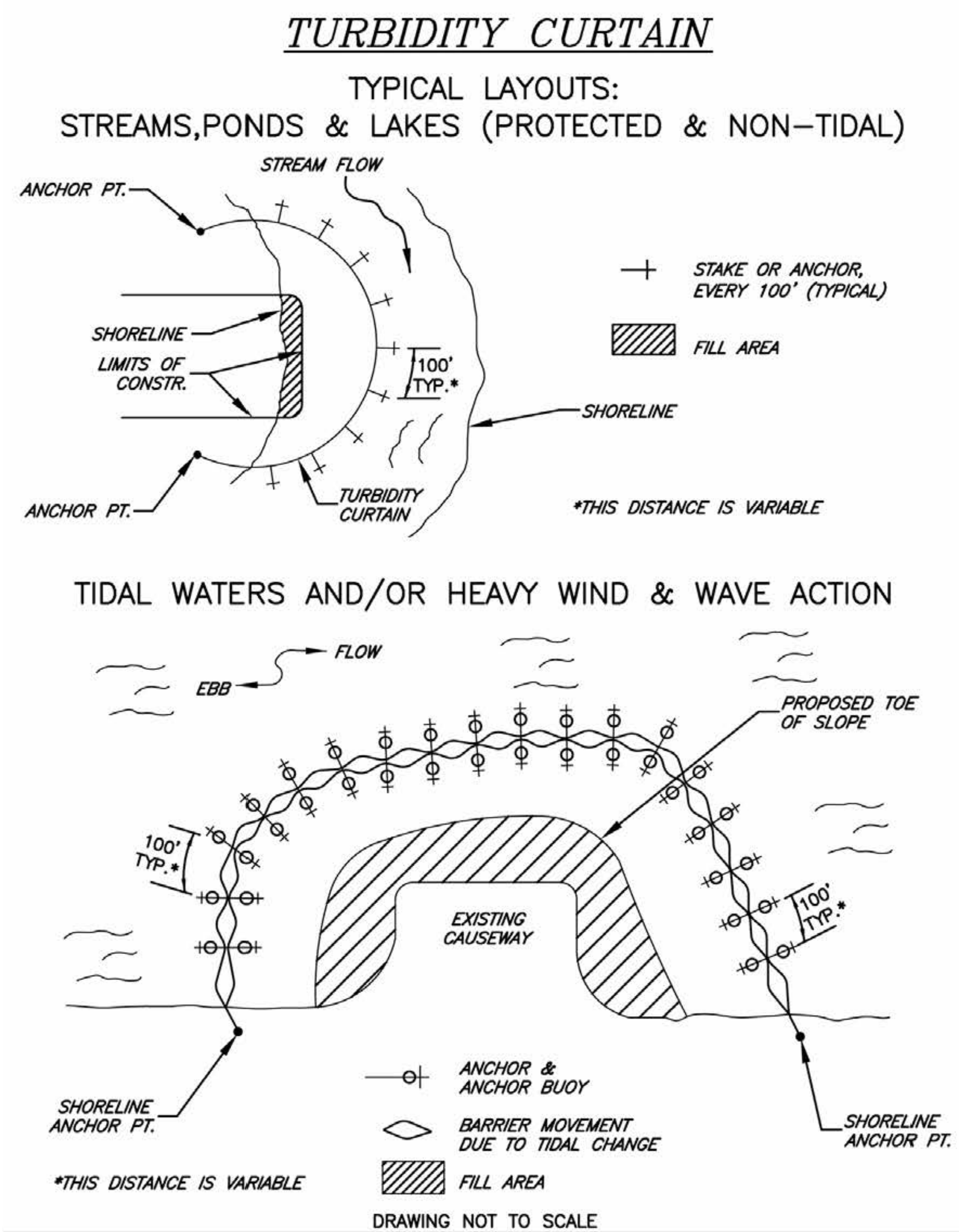

Figure 12: Turbidity Curtain Enclosure Method.

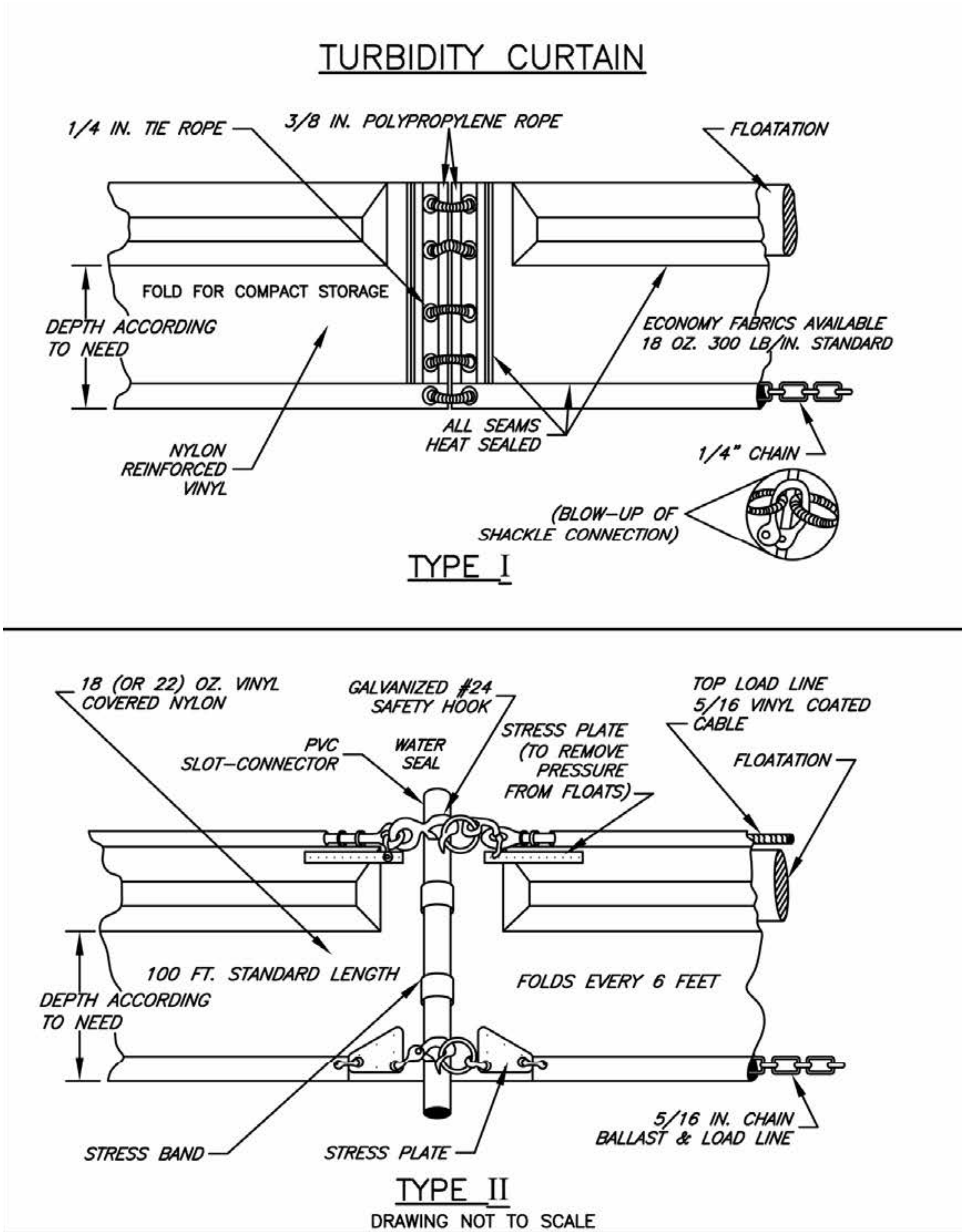

Figure 13: Turbidity Curtain Enclosure Method.

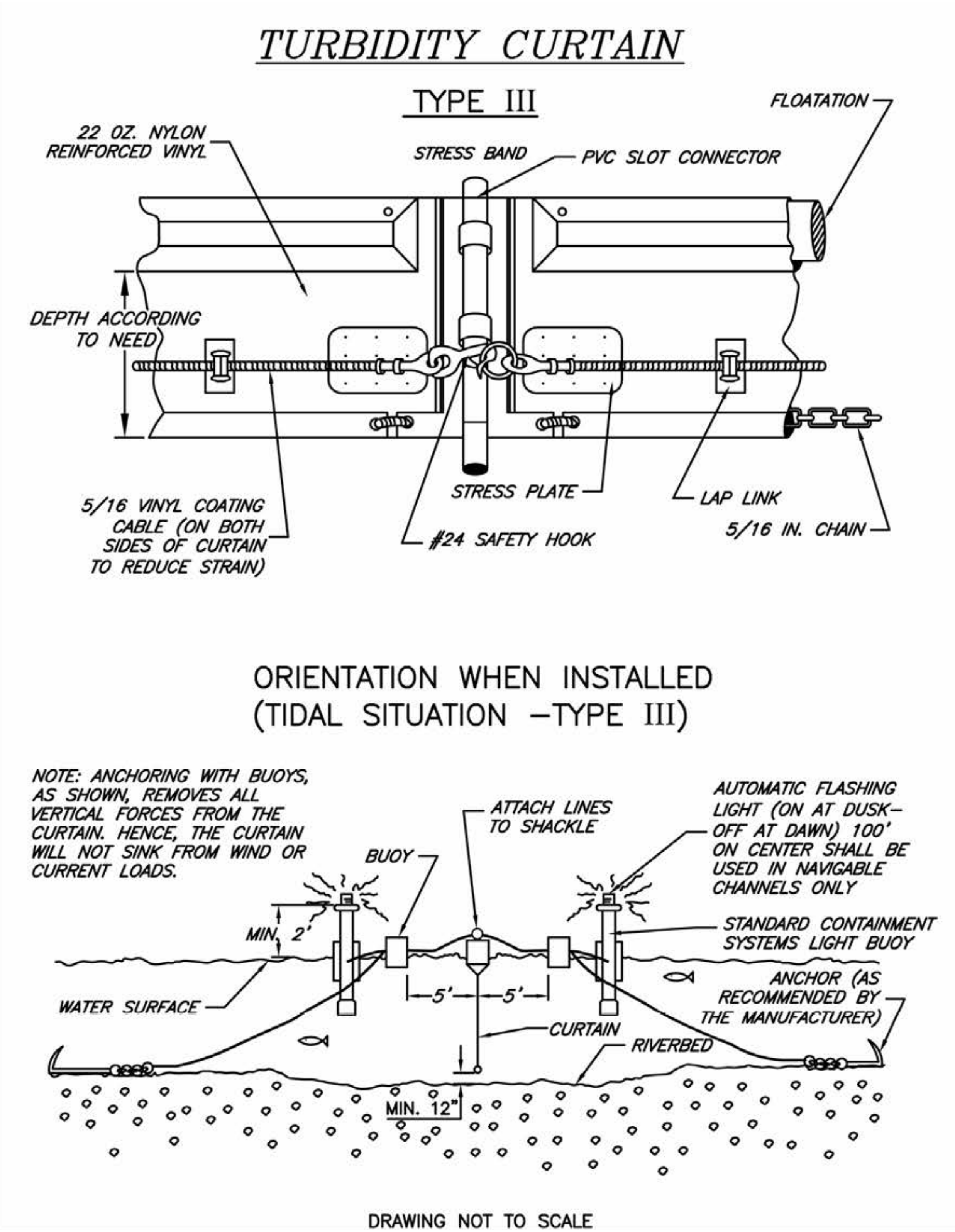

Figure 14: Turbidity Curtain Enclosure Method.

5.7.2 Appropriate Applications

- Turbidity curtains should be used where sediment discharge to a stream is unavoidable. They are used when construction activities adjoin quiescent waters, such as lakes, ponds, and slow flowing rivers. The curtains are designed to deflect and contain sediment within a limited area and provide sufficient retention time so that the sediment particles will fall out of suspension.
- These BMPs are designed and selected for specific flow conditions. For sites with flow velocities or currents greater than 5 feet per second, a qualified engineer and product manufacturer shall approve of the use.

5.7.3 Limitations

- May be insufficient as a primary isolation technique and may be better suited for use in conjunction with other isolation or confinement techniques
- Turbidity curtains should not be used in flowing water; they are best suited for use in ponds, lakes, and very slow-moving rivers.
- Turbidity curtains should not be placed across the width of a channel unless they are specifically engineered to withstand expected flows and approved by project engineer.
- Removing sediment that has been deflected and settled out by the curtain may create a discharge problem through the re-suspension of particles and by accidental dumping by the removal equipment.

5.7.4 Standards and Specifications

- Turbidity curtains shall be installed parallel to the flow of the watercourse, allowing for 10 to 20 percent variance in the straight-line measurements. Allow for at least 50 feet between joints in the curtain and no more than 100 feet between anchor or stake locations.
- The curtain should extend the entire depth of the watercourse in calm-water situations.
- In wave conditions, the curtain should extend to within 1 ft of the bottom of the watercourse, such that the curtain does not stir up sediment by hitting the bottom repeatedly. If it is desirable for the curtain to reach the bottom in an active-water situation, a pervious filter fabric may be used for the bottom 1 ft.
- Multiple concentric curtains, in some cases both top-down and bottom-up, may be necessary to fully contain sediment during in-water work.
- Turbidity monitoring shall be conducted to evaluate curtain effectiveness, and contingency measures shall be implemented immediately if suspended sediment escapes in excess of allowable limits.
- Turbidity curtains shall extend the entire depth of the watercourse. In significant wind, wave, or tidal action areas, a 10- to 12-foot depth is the most practical because of fabric and mooring anchor strain from the heavy water and sediment loads.

- For tidal situations or in areas heavily impacted by wind-generated wave action, turbidity curtains shall have slack to follow the rise and fall of the water level without submerging. Curtains shall also maintain adequate flow-through, usually by using heavier woven fabric for the bottom sections of the curtain.
- Materials shall be of strong, heavyweight materials that have UV inhibitors. The tensile strength shall be sufficient to withstand predicted flows. All material seams and line attachments shall be sewn or vulcanized welded into place. Materials shall be of bright colors, when applicable, to attract attention of boaters or swimmers using areas near the worksite. Flotation devices for turbidity curtains shall be flexible, buoyant units contained in an individual flotation sleeve or collar attached to the curtain. Flotation devices shall be secured to prevent shifting and ensure proper flotation along the entire length of the curtain.
- Turbidity curtains shall be anchored by vinyl-sheathed steel cable at the top, with a breaking strength as per engineer specifications, but 10,000 pounds at the minimum. At the bottom, a load line with chain incorporated into the bottom hem of the curtain shall be used for ballast to hold the curtain vertical.
- Shoreline turbidity curtain anchors and instream sediment mats shall be anchored by chains, 2x4-foot wood, or 1.33 pounds/linear foot metal stakes. Bottom anchors for turbidity curtains shall hold the curtain in position and may be any of the following anchor types: plow, fluke, mushroom, or grappling hook. All instream anchors shall have a floating anchor buoy or other identifying mark.
- Best installation is achieved by setting the upstream anchor points first, then unfurling the fabric, letting the flow carry the fabric downstream or to a vertical position for turbidity curtains.
- The anchors should first be placed, and then the fabric should be towed out in a furled condition and connected to the anchors. The anchors should be connected to the flotation devices, not to the bottom of the curtain. Once in place, the furling lines should be cut, and the bottom of the curtain should be allowed to sink.
- Sediment shall be allowed to settle for a minimum of 6 to 12 hours before BMP removal or cleaning. All cleaning operations shall also use good sediment control practices. However, consideration must be given to the potential for re-suspension of the particles or by accidental dumping of material during removal. It is recommended that the soil particles trapped by the turbidity curtain be removed only if there has been a significant change in the original contours of the affected area in the watercourse.
- Consider sizing materials adequately to allow maintenance to occur only before removal and not throughout the project.

5.7.4.1 Removal Specifications

- Particles should always be allowed to settle for a minimum of 6 to 12 hours prior to their removal or prior to removal of the turbidity curtain.

- All materials shall be removed at low flows and in a way that scoops and traps sediments within the fabric. The removal area shall be clear of any obstructions that could tear the fabric.
- For curtains, consider pulling the bottom line and top lines in together like a parachute to pull soils ashore.
- Spoils shall be reused and controlled for erosion on a nearby bank or upland area needing stabilization.

5.7.5 Inspection and Maintenance

- Inspect turbidity curtains as least daily during in-water work. Immediately repair floats, fabric, or seams to maintain a fully intact barrier. Conduct inspections as required by the NPDES, 404 permit, 401 WQC or contract specifications.
- The curtain should be inspected for holes or other problems, and any repairs needed should be made promptly. Follow the manufacturer's instructions for fabric and material repair.
- Allow sediment to settle for 6 to 12 hours prior to removal of sediment or curtain. This means that after removing sediment, wait an additional 6 to 12 hours before removing the curtain.
- To remove, install furling lines along the curtain, detach from anchors, and tow out of the water.

5.7.5.1 Signs of Failure

Symptoms	Cause	Solution
Turbid water releasing from curtain.	• Bottom anchor is loose or gone. • Joints/overlaps are loose. • Floatation is gone/ diminished. • Curtain material is torn.	• Repair/replace parts as needed. • Reevaluate curtain strength versus strength of water flows.

5.8 K-Rail (Jersey Barrier) River Isolation Technique

5.8.1 Definition and Purpose

This temporary sediment control or stream isolation method uses K-rails to form the sediment deposition area, or to isolate the in-stream or near-bank construction area.

Barriers are placed end-to-end in a pre-designed configuration and gravel-filled bags are used at the toe of the barrier and at their abutting ends to seal and prevent movement of sediment beneath or through the barrier walls.

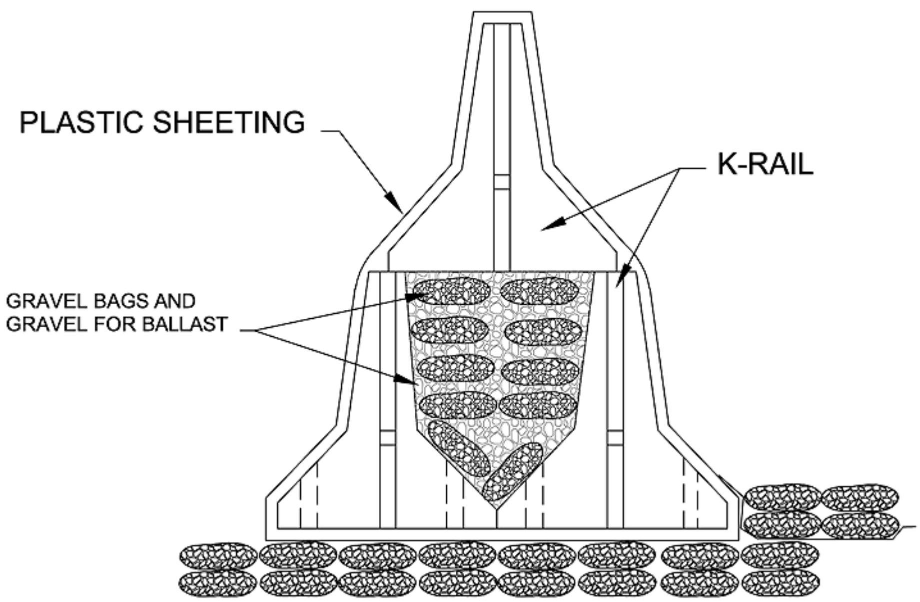

Figure 15: K-Rail Isolation Method.

5.8.2 Appropriate Applications

- The K-rail isolation can be used in streams with higher water velocities than many other isolation techniques.
- This technique is also useful at the toe of embankments, and cut or fill slopes.

5.8.3 Limitations

- The K-rail method should not be used to dewater a project site, as the barrier is not watertight. Refer to standard specifications for construction dewatering techniques.

5.8.4 Standards and Specifications

- To create a floor for the K-rail, move large rocks and obstructions. Place washed gravel and gravel-filled bags to create a level surface for K-rails to sit. Washed gravel should always be used.
- Place the bottom two K-rails adjacent to each other, and parallel to the direction of flow; fill the center portion with gravel bags. Then place the third K-rail on top of the bottom two (See Figure 15). There should be sufficient gravel bags between the bottom K-rails such that the top rail is supported by the gravel. Place plastic sheeting around the K-rails, and secure at the bottom with gravel bags.
- Further support can be added by pinning and cabling the K-rails together. Also, large riprap and boulders can be used to support either side of the K-rail, especially where there is strong current.

5.8.5 Inspection and Maintenance

- Conduct inspections as required by the NPDES, 404 permit, 401 WQC or contract specifications.
- The barrier should be inspected and any leaks, holes, or other problems should be addressed immediately.
- Sediment should be allowed to settle for at least 6 to 12 hours prior to removal of sediment, and for 6 to 12 hours prior to removal of the barrier.

5.9 COFFERDAM AND/OR SHEET PILE ISOLATION TECHNIQUE

5.9.1 DEFINITION AND PURPOSE

Coffer dams and Sheetpile walls are temporary structures built into a waterway to contain or divert movement of water and to provide a reasonably dry construction area. Coffer dams are commonly made of steel sheet pile, rock, gabions, concrete jersey barriers, vinyl tubes filled with water, or wood and may be lined with geotextile, plastic sheeting, or other materials to prevent water from entering the construction area.

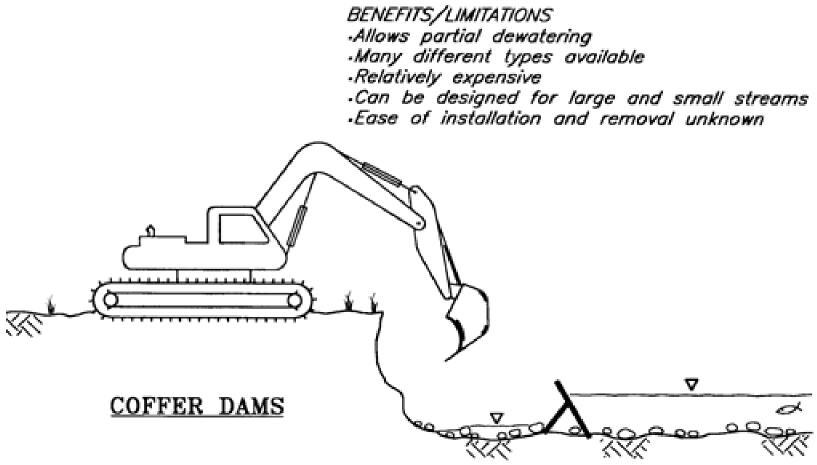

Figure 16: Coffer Dam Isolation Method.

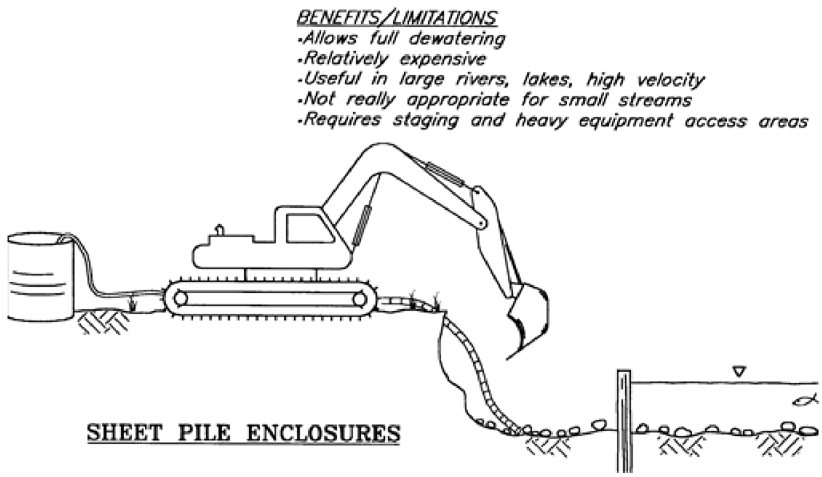

Figure 17: Sheet Pile Isolation Method.

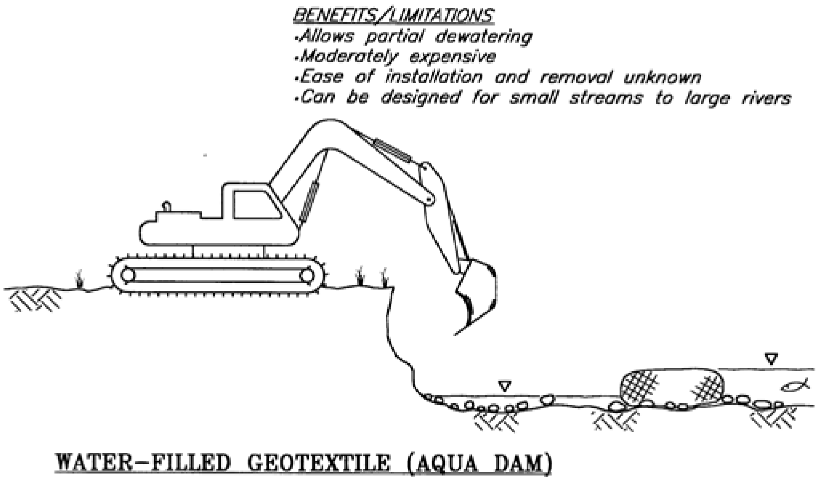

Figure 18: Water-Filled Geotextile (Bladder Dam).

5.9.2 Appropriate Applications

- Where dewatering is necessary.
- Work areas that require isolation from flows.
- Often used in conjunction with stream diversion techniques.

5.9.3 Limitations

- Under some conditions, the design must be developed or approved by a qualified licensed engineer.
- The coffer dam should be sturdy enough to withstand anticipated water pressure, shear stresses and scouring.

5.9.4 Standards and Specifications

- Site specific design is required for a coffer dam.
- Coffer dams should be designed to withstand currents and scour conditions expected under normal stream flow and annual high water. The functional life expectancy is generally 6 months or less.
- Construction materials commonly include steel sheet piles, rock, vinyl tubes, or wood. Piling could consist of standard steel sheet interlocked and driven into the soil or anchored to bedrock. Wooden structures may consist of planks or wood timbers. Concrete jersey barriers may be used, depending on the anticipated water flow, depth and appropriate fit and contact with the stream bed.
- The water side of the coffer dam may be lined with plastic sheeting or some other suitable material that would prevent water passage into the construction area.
- The coffer dam should be built as shown on the plans. Field adjustments should be made as necessary. Water-filled Geotextile (bladder dams) should be installed

following manufacturer's recommendations and guidelines. Rocks or sharp objects should be removed prior to installation.

- If dewatering is required while utilizing a coffer dam, meet dewatering requirements of the NPDES permit and/or 404 permits.

5.9.5 Inspection and Maintenance

- Conduct inspections as required by the NPDES, 404 permit, 401 WQC or contract specifications.
- Remove accumulated sediment and debris regularly and just prior to removing the coffer dam.
- Conduct required dewatering operations such that all permitting requirements are met.
- Upon removal of the coffer dam, stabilize the area and streambed and restore to as near-natural condition as possible. This may require some form of rock riprap and permanent revegetation if the stream bank has been disturbed.

5.10 GRAVEL/ROCK BERM WITH IMPERMEABLE MEMBRANE ISOLATION TECHNIQUE

5.10.1 DEFINITION AND PURPOSE

This temporary sediment control or stream isolation method uses a gravel or rock berm with an impermeable membrane to isolate the in-stream or near-bank construction area.

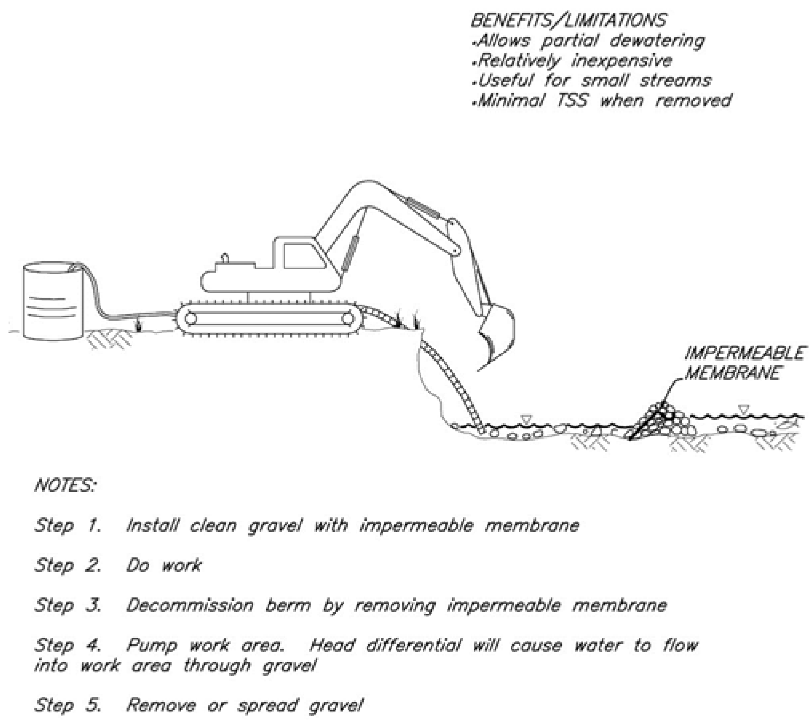

Figure 19: Gravel/Rock Berm with Impermeable Membrane.

5.10.2 APPROPRIATE APPLICATIONS

- Where dewatering is necessary.
- Work areas that require isolation from flows.

5.10.3 LIMITATIONS

- Under some conditions, the design must be developed or approved by a qualified licensed engineer.
- The gravel/rock size should be sturdy enough to withstand anticipated water pressure, shear stresses and scouring.

5.10.4 STANDARDS AND SPECIFICATIONS

- Installation guidelines will vary based on existing site conditions and type of diversion used.

- Gravel berm should be designed to withstand currents and scour conditions expected under normal stream flow and annual high water.
- The impermeable barrier imbedded within the berm should be made of plastic sheeting or some other suitable material that would prevent water passage into the construction area.

5.10.5 INSPECTION AND MAINTENANCE

- Conduct inspections as required by the NPDES, 404 permit, 401 WQC or contract specifications.
- Conduct required dewatering operations such that all permitting requirements are met.
- Check for any erosion and/or undercutting around the inlet and outlet structures, repair as needed.
- Remove accumulated sediment and debris regularly and just prior to removing the coffer dam.
- Upon decommissioning of the gravel/rock berm, stabilize the area and streambed and restore to as near-natural condition as possible. This may require some form of rock riprap and permanent revegetation if the stream bank has been disturbed.
- Inspect berm before and after large storms, and inspect daily during construction. Visually inspect for clogging, damage to linings, accumulation of debris, and adequacy of slope protection. Remove debris and repair linings and slope protection as required. Repair holes, gaps, or scour.
- Upon completion of work, remove the diversion or isolation structure and redirect flow back into the original stream channel.

5.11 Gravel bag or Sandbag Isolation Technique

5.11.1 Definition and Purpose

A sandbag barrier is a temporary linear sediment barrier consisting of stacked gravel bag/sandbags, designed to intercept and slow the flow of sediment-laden sheet flow runoff. Gravel bag / Sandbag barriers allow sediments to settle from runoff before water leaves the construction site. Large gravel bag / sandbag barriers can also be used for in-water work and/or water diversions if site conditions allow.

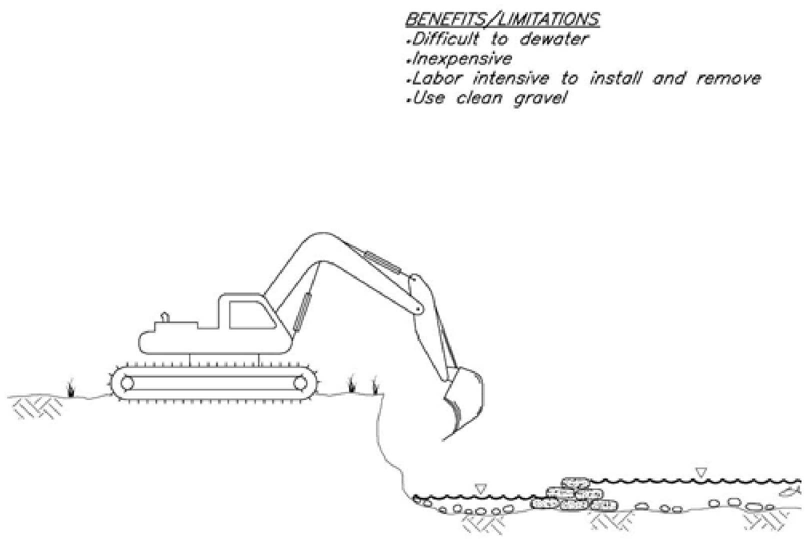

Figure 20: Gravel Bag / Sand Bag Method

5.11.2 Appropriate Applications

- To divert or direct flow or create a temporary sediment/de-silting basin.
- During construction activities in stream beds when the contributing drainage area is typically less than 5 acres.
- To capture and detain non-stormwater flows until proper cleaning operations occur.
- When site conditions or construction sequencing require adjustments or relocation of the barrier to meet changing field conditions and needs during construction.
- To temporarily close or continue broken, damaged, or incomplete curbs.

5.11.3 LIMITATIONS

- The drainage area upstream of the barrier should be limited to 5 acres.
- Degraded sandbags may rupture when removed, spilling sand.
- Installation can be labor-intensive.
- Limited durability of bag material.
- When used to detain concentrated flows, maintenance may increase.

5.11.4 STANDARDS AND SPECIFICATIONS

- Installation guidelines will vary based on existing site conditions and type of diversion used.
- **Bag Material:** Bags should be woven canvas, geotextile, or burlap material that is UV-resistant and impermeable. Minimum unit weight 4 ounces per square yard; Mullen burst strength exceeding 300 psi in conformance with the requirements in ASTM designation D3786; minimum water flow rating of 145 gallons per minute per foot in conformance with the requirements in ASTM D4491; and ultraviolet stability exceeding 70 percent in conformance with the requirements in ASTM designation D4355.
- **Fill Material:** Use clean gravel or sand (if more suitable based on site conditions) to fill bags Fill material should be inert and easily recoverable if spilled (minimum 3" aggregate for gravel). Fill should be inert clean and free from clay balls, organic matter, and other deleterious materials that could leach from the bag. Fill material is subject to approval by the Engineer.
- Place bags in a manner that causes the least amount of disturbance to the stream bed. Applicable in waters with smooth bed surfaces where bag can create seal along bottom.

5.11.5 INSPECTION AND MAINTENANCE

- The barrier should be inspected and any leaks, holes, or other problems should be addressed immediately.
- Conduct inspections as required by any applicable permit or contract specifications.
- Reshape or replace sandbags as needed, or as directed by the Engineer.
- Repair washouts or other damages as needed, or as directed by the Engineer.
- Removed sediment should be incorporated in the project at locations designated by and approved by the Engineer or if deemed contaminated (i.e. hazardous waste) should be disposed of in accordance with federal and state laws.
- Remove sandbags when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilize the area.

5.12 Pipe Piles and Caisson Isolation Technique

5.12.1 Definition and Purpose

Piles and Caissons come in many different forms and are commonly used during construction of transportation structures, including bridges. Driven piles are typically constructed of precast concrete, steel, or timber. Driven sheet piles are also used for shoring and cofferdam construction.

5.12.1.1 Piles

Piled foundations are usually the first alternative considered when it is impractical, uneconomical or unsafe to found conventional structure footings at shallow or intermediate depths below ground. There is a sufficiently wide range of piling systems available from which to select appropriate foundation solutions in most types of ground conditions for road bridges which often require deep founding.

Piles are commonly used to construct bridge or other structural foundations. In this use they are able to transmit the applicable combinations of permanent and transient loads which are applied at the top of the piles, through weak compressible soil or fill materials onto stiff or dense soil strata or rock at lower levels, in such a manner as to prevent excessive settlement, horizontal displacement or rotation of the supported structure.

Driven piles are usually slender, 'column like' structural members (usually acting in groups) which are installed vertically or at a slope in the ground by various techniques, to sufficient depth to achieve the necessary load bearing capacity through frictional resistance along their sides, end bearing resistance at their bases, or combinations of both.

5.12.1.2 Caissons

Caissons provide an alternative means to achieve adequate founding at intermediate to significant depths in both land and water environments. This system has been frequently as a practical means to found major bridges in deep water conditions.

Caissons provide a watertight space for underwater construction. The function of caissons is essentially the same as for piles, they transmit the applicable combination of permanent and transient loads applied at the top of the caisson through weak compressive soil or fill materials onto stiff or dense soil strata or rock at lower levels, in such a manner as to prevent excessive settlement, horizontal displacement or rotation of the supported structure at the caisson cap level.

Caissons for bridge foundations are usually cellular reinforced concrete structures, with circular, rectangular or more streamlined plan cross sections comprising one or more excavation compartments, and which are wholly or partly constructed at higher level and sunk in stages to the desired founding level. Sinking of Caisson usually occurs by internal excavation (bucket or crane excavation) sometimes assisted by the application of weights.

Small diameter concrete shafts comprising single open cells and constructed in the same manner as caissons are usually called cylinders. The distinction between cylinders and caissons is merely one of size. Because of their smaller size (usually up to about 8 foot diameter), cylinders lend themselves readily to precast concrete ring elements in their construction. This form of caisson construction can be very economical down to intermediate depths but are not well suited to sinking through ground containing large boulders or with high water tables. Cylinders constructed with precast concrete rings are usually filled with reinforced concrete.

5.12.2 Appropriate Applications

All construction sites near or adjacent to a watercourse or groundwater where permanent and temporary pile driving (impact and vibratory) takes place.

5.12.3 Limitations

Proper control and use of equipment, materials, and waste products from pile driving operations will reduce or eliminate the discharge of potential pollutants to the storm drain system, watercourses, and waters of the United States.

- Piles and Caissons are required to be founded at sufficient depth to prevent instability due to scour arising from major floods, when located in riverine environments.
- Specific permit requirements or mitigation measures such as 401 Water Quality Certification, U.S. Army Corps of Engineers Section 404 or Section 10 permits, U.S. Coast Guard Section 9 or General Bridge Act Permits and approval by USFWS and NMFS supersede the guidance in this BMP. If numerical-based water quality standards are mentioned in any of these and other related permits, testing and sampling may be required.

5.12.4 Standards and Specifications

- Use drip pans or absorbent pads during vehicle and equipment operation, maintenance, cleaning, fueling, and storage. Refer BMPs for Vehicle and Equipment Cleaning, Vehicle and Equipment Fueling, and Vehicle and Equipment Maintenance.
- Have spill kits and cleanup materials available at all locations of pile driving. Refer to BMP for Spill Prevention and Control.
- Equipment that is stored or in use in streambeds, or on docks, barges, or other structures over water bodies should be kept leak free.
- Park equipment over plastic sheeting or equivalent where possible. Plastic is not a substitute for drip pans or absorbent pads. The storage or use of equipment in streambeds or other bodies of water must comply with all applicable permits.
- Implement other BMPs as applicable, such as Dewatering Operations, Solid Waste Management, Hazardous Waste Management, and Liquid Waste Management.
- When not in use, store pile-driving equipment away from concentrated flows of stormwater, drainage courses, and inlets. Protect hammers and other hydraulic attachments from run-on and runoff by placing them on plywood and covering them with plastic when rain is forecast.
- Use less hazardous products, e.g., vegetable oil, when practicable.

5.12.5 INSPECTION AND MAINTENANCE

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspect equipment every day at startup and repair equipment as needed (i.e., worn or damaged hoses, fittings, and gaskets). Recheck equipment at shift changes or at the end of the day and scheduled repairs as needed.
- Inspect entire pile driving areas and equipment for leaks and spills on a daily basis. Inspect equipment routinely for damage and repair equipment as needed.

5.13 STREAM DIVERSION TECHNIQUES: PUMPED, PIPE/FLUME, AND EXCAVATED

5.13.1 DEFINITION AND PURPOSE

Stream diversions consists of a system of structures and measures that intercept an existing stream upstream of the project, transports it around the work area, and discharges it downstream. The selection of which stream diversion technique to use depends upon the type of work involved, physical characteristics of the site, and the volume of water flowing through the project.

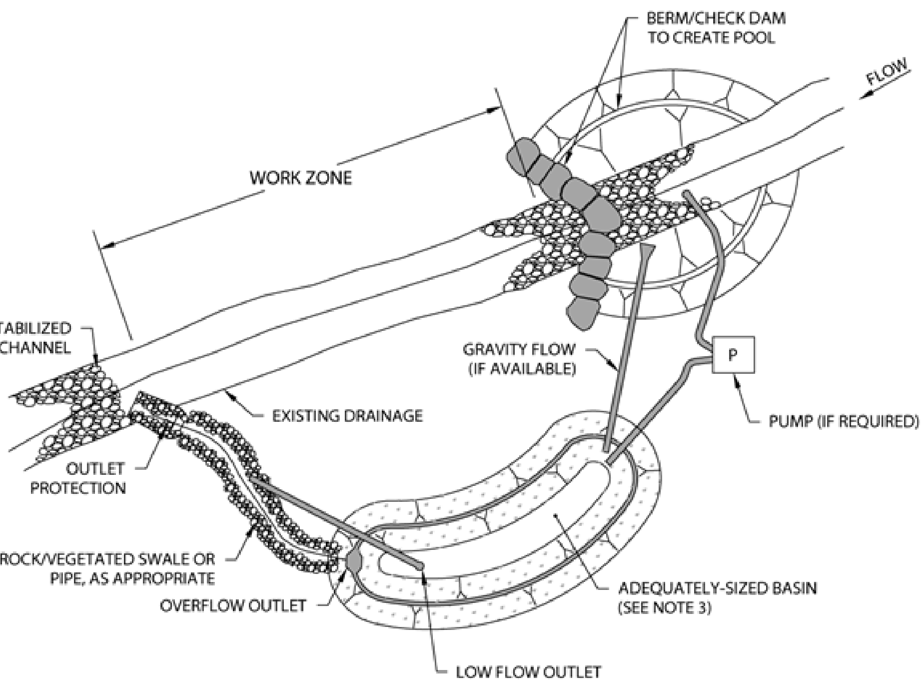

Figure 21: Diversion Method

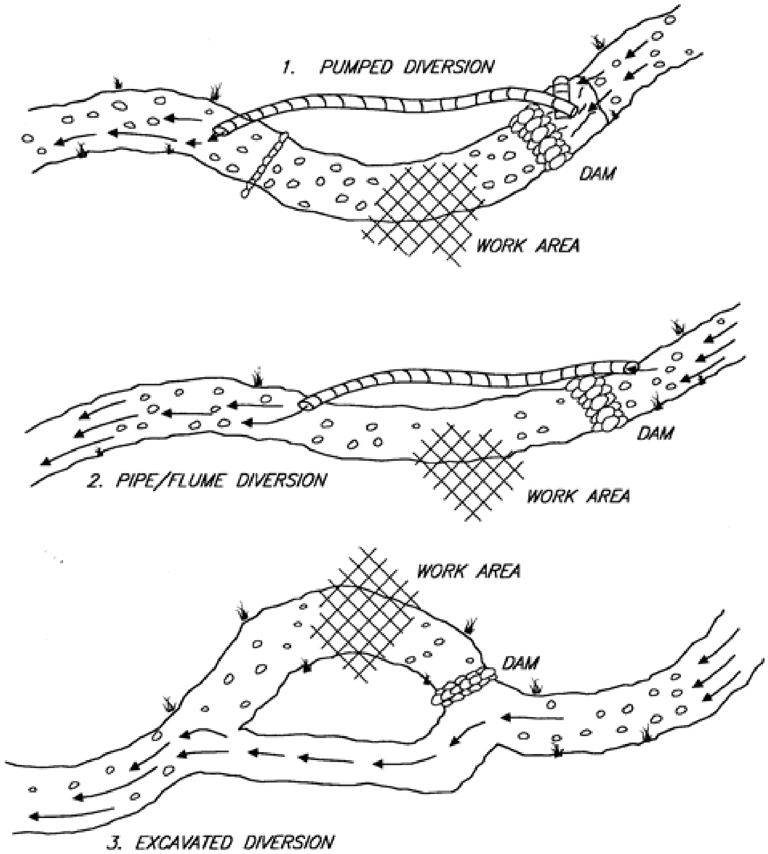

Figure 22: Diversion Methods.

5.13.2 APPROPRIATE APPLICATIONS

- Where Dewatering of the work area is necessary.
- Work areas that require isolation from flows.

5.13.3 ADVANTAGES

- Downstream sediment transport can be nearly eliminated.
- Pipes can be moved around to allow construction operation sequencing.
- The dams can also serve as temporary access to the site.
- Increased flows can be managed by adding more pumping capacity.
- Excavated channels isolate work from water flow and allow dewatering.
- Excavated channels can handle larger flows than pumps.

5.13.4 LIMITATIONS

- Flow volume is limited by pump capacity.
- A pumped diversion requires frequent monitoring of pumps.

- Large flows during storm events can overtop dams.
- Erosion at the outlet can occur.
- Flow diversion and re-direction with small dams involves in-stream disturbance and mobilization of sediment during installation and removal.
- Bypass channel or flume must be sized to handle flows, including possible floods.
- Channels must be protected from erosion.
- Flow diversion and re-direction with small dams involves in-stream disturbance and mobilization of sediment.
- Flow volume is limited by temporary channel/flume capacity.
- Sudden rain could overtop excavated channels/flumes.
- Minor in-stream disturbance is required to install and remove dams to detour water into temporary channels/flumes.

5.13.5 STANDARDS AND SPECIFICATIONS

- Any type of water diversion requires special permitting.
- Water diversions are custom designed for unique site specific conditions. Contact system suppliers or design engineers for assistance.
- Installation guidelines will vary based on existing site conditions and type of diversion used.
- Diversions should be sized to convey design flood flows.
- Pump capacity must be sufficient for design flow; the upper limit is approximately 0.3 m^3/sec (10 cfs) (the capacity of two 200 mm [8 inch] pumps).
- Adequate energy dissipation must be provided at the outlet to minimize erosion.
- Materials used to create dams upstream and downstream of the diversion should be erosion-resistant. Materials such as steel plates, sheet piles, sandbags, continuous berms, inflatable water bladders, etc., would be acceptable.
- Construction of a diversion channel should begin with excavation of the channel at the proposed downstream end, with work proceeding upstream. Once the watercourse to be diverted is reached, and the excavated channel is stable, the upstream end should be breached, and water should be allowed to flow down the new channel. Once flow has been established in the diversion channel, the diversion weir should be installed in the main channel; this will force all water to be diverted from the main channel.
- Installation guidelines will vary based on existing site conditions and type of diversion used.
- Pump capacity must be sufficient for design flow.
- A standby pump is required in case a primary pump fails.

- Dam materials used to create dams upstream and downstream of diversion should be erosion resistant; materials such as steel plate, sheet pile, sandbags, continuous berms, inflatable water bladders, etc., would be acceptable.
- When constructing a diversion channel, begin excavation of the channel at the proposed downstream end, and work upstream. Once the watercourse to be diverted is reached and the excavated channel is stable, breach the upstream end and allow water to flow down the new channel. Once flow has been established in the diversion channel, install the diversion weir in the main channel; this will force all water to be diverted from the main channel.

5.13.6 INSPECTION AND MAINTENANCE

- Conduct inspections as required by the NPDES permit or contract specifications.
- Pumped diversions require frequent monitoring of pumps.
- Monitor pumps, which may be required frequently for pumped diversions.
- Remove debris and repair linings and slope protection as required.
- The barrier should be inspected and any leaks, holes, gaps, scour or other problems should be addressed immediately.
- Upon completion of work, remove the diversion or isolation structure and redirect flow through the new culvert or back into the original stream channel. Recycle or re-use if applicable.
- Re-vegetate areas disturbed by BMP removal, if needed.
- Inspect embankments and diversion channels for damage to the linings, accumulating debris, sediment buildup, and adequacy of the slope protection. Remove debris and repair linings and slope protection as required. Remove holes, gaps, or scour.

5.14 In-stream Construction Sediment Control

5.14.1 Definition and Purpose

Instream sediment control BMPs are designed to provide sediment trapping for projects that must take place within the waterway. Projects that cross or otherwise work within the waterway shall strive to limit the amount of work that occurs within the water flow line. Measures that can reduce the amount of instream work include working from bank areas, diverting the stream around work areas, or scheduling for seasons of no or limited flows.

Instream sediment trapping devices include both floating materials (turbidity curtains described above) anchored to the watercourse bottom, instream sediment collection mats that run along the watercourse bottom and constructed sediment traps within a water coarse. These materials are specifically designed to limit sediment transport impacts within a body of water.

Coarse sediment traps are excavations in the bed or structures across a watercourse designed to limit the downstream movement of sand and gravel from upstream sediment sources. Depending on trap design and stream characteristics, lesser amounts of fine sediments (the fine sand, silts and clays that move in the flow rather than along the bed) can be trapped.

Sediment traps confine sediment deposition to a small reach of channel and reduce excavation costs: Sediment traps are relatively wide, short and deep excavations in the bed. Trapped sediment does not progress downstream where deposition would reduce channel capacity. The trap itself has to be episodically excavated (after major storms) rather than a much greater length of the stream.

5.14.2 Appropriate Applications

These devices provide sedimentation protection for instream, bank, or upslope ground disturbance, dredging, or filling within a waterway. There are three different options currently available for reducing turbidity while working in a stream or river. The stream can be; (1) isolated from the area in which work is occurring by means of a water barrier, (2) the stream can be diverted around the work site through a pipe or temporary channel, or (3) one can employ construction practices that minimize sediment suspension.

5.14.3 Limitations

Instream sediment traps are used in conjunction with other sediment control measures to reduce excessive sediment in watercourses: For upland sediment sources, the most desirable strategy is to implement land management practices that reduce erosion and transport of sediment and associated contaminants. The second strategy is to retain sediments on the land before they get to aquatic resources (e.g. filter strips, sediment retention ponds). For channel sources, streamflow should be retarded to protect the channel (e.g. vegetated banks); eroding banks should be repaired (e.g. contour and vegetate); and livestock that cause erosion should be removed from the channel and banks. If these measures are not undertaken, then continuous in-channel sediment problems will occur. In some cases, an in channel sediment trap can be the first line of defense (e.g. multiple, uncontrollable sediment sources).

5.14.4 Standards and Specifications

The highest hazard for sedimentation from in-stream construction generally occurs when the sediment control structure is being installed and when it is being removed. Generally the best time to install the stream isolation or diversion structure is when the stream is low. Conversely, the optimum time to remove in-stream diversion or isolation structures may be during the rising limb of a storm hydrograph aka the rapid increase in flow resulting from rainfall causing increased surface runoff and stream flow. A probable “worst time” to release high TSS into a stream system with diminishing aquatic habitat might be when the stream is very low; summer low flow, for example. During these times, the flow may be low while the biological activity in the stream is very high. On the other hand, the addition of short-term spike in TSS or sediment during a big storm discharge might have a relatively low impact on the aquatic habitat or turbidity because the stream is already turbid, and the stream energy is capable of transporting both suspended solids, and large quantities of bedload through the system.

- All embankments and structures must be constructed in accordance with accepted engineering practice, and with appropriate materials.
- Determine the design flow for the channel where the sediment trap is to be located and establish the viability of creating a trap (see location).
- Determine the target size of material to be trapped, and the trapping efficiency required. Fine sand (i.e. sediment ≥0.125 mm) and 90% trapping are often used.
- Determine the surface area of the sediment trap.
- Check the depth required to prevent re-suspension of the trapped sediment.
- These BMPs are designed and selected for specific flow conditions. For sites with flow velocities or currents greater than 5 feet per second, a qualified engineer and product manufacturer shall approve of the use.
- Instream sediment mats can be aligned either direction along the watercourse bottom, as long as the upstream mat overlaps the downstream mat (like a drainage ditch erosion control blanket installation). Ensure that the upstream edge is firmly trenched in to prevent flows from going under the mat. Mats shall cross the entire stream and be staked or use stones to keep them in place. Follow the manufacturer’s specifications for the length of mat needed for the site's flow rate.

5.14.4.1 Techniques to minimize Total Suspended Solids

- **Padding -** Padding laid in the stream below the work site may trap some solids that are deposited in the stream during construction. After work is done, the padding is removed from the stream, and placed on the bank to assist in revegetation.
- **Clean, washed gravel -** Using clean, washed gravel as fill decreases solid suspension, as there are fewer small particles deposited in the stream.

- **Excavation using a large bucket -**Each time a bucket of soil is placed in the stream, a portion is suspended. Approximately the same amount is suspended whether a small amount of soil is placed in the stream, or a large amount. Therefore, using a large excavator bucket instead of a small one will reduce the total amount of soil that washes downstream.
- **Use of dozer for backfilling -** Using a dozer for backfilling instead of a backhoe follows the same principles – the fewer times soil is deposited in the stream, the less soil will be suspended.
- **Partial dewatering with a pump -** Partially dewatering a stream with a pump reduces the amount of water, and thus the amount of water that can suspend sediment

5.14.5 INSPECTION AND MAINTENANCE

- The design depth of the sediment trap should be marked in the sediment trap (e.g. a stage gauge board). Once the effective capacity of the sediment trap is reached, the trap effectiveness declines, and the sediment trap should be re-excavated.

5.15 Washing Fines (Streambed Restoration Technique)

5.15.1 Definition and Purpose

Washing fines is an "in-channel" sediment control method, which uses water, either from a water truck or hydrant, to wash any stream fines that were brought to the surface of the channel bed during restoration, back into the interstitial spaces of the gravel and cobbles. This technique is useful in both intermittent or ephemeral stream channels with gravelly to cobbely substrate and may be useful in perennial streams just prior to removing isolation structures.

The purpose of this technique is to reduce or eliminate the discharge of sediment from the channel bottom during the first seasonal flows, or "first flush." Sediment should not be allowed into stream channels; however, occasionally in-channel restoration work will involve moving or otherwise disturbing fines (sand and silt-sized particles) that are already in the stream, usually below bankfull discharge elevation. Subsequent re-watering (resumption of flows) of the channel can result in a plume of turbidity and sedimentation.

This technique washes the fines back into the channel bed. Bedload materials, including gravel cobbles, boulders and those fines, are naturally mobilized during higher storm flows. This technique is intended to delay the discharge until the fines would naturally be mobilized.

5.15.2 Appropriate Applications

- This technique should be used when construction work is required in channels. It is especially useful in intermittent or ephemeral streams in which work is performed "in the dry", and which subsequently become re-watered.

5.15.3 Limitations

- The stream must have sufficient gravel and cobble substrate composition.
- The use of this technique requires consideration of time of year and timing of expected stream flows.
- The optimum time for the use of this technique is in the fall, prior to winter flows.
- Consultation with, and approval from the Department of Fish and Game and the Regional Water Quality Control Board may be required.

5.15.4 Standards and Specifications

- Apply sufficient water to wash fines, but not cause further erosion or runoff.
- Apply water slowly and evenly to prevent runoff and erosion.
- Consult with appropriate Federal and State agencies (i.e. USACE, CWB-DOH, USFWS, NMFS and Department of Land and Natural Resources (DLNR)) for specific water quality requirements of applied water (e.g. chlorine)