

**Table 3-2. Overview of Riverbank Stabilization Techniques**

Technique	Technique Description	Application
<b>Vegetative Plantings</b>	<p>Planting of native herbaceous plant material on riverbanks may include the following measures:</p> <ul style="list-style-type: none"> <li>• <b>Plugs</b> - Individual rooted stems of grasses, sedges, or rushes, often planted along the toe of slope below the ordinary high water line.</li> <li>• <b>Live stakes</b> - Live, rootable cuttings of woody material ~2-3 feet in length inserted into bank slope at or below the bankfull elevation. Typical species include silky dogwood and willows.</li> <li>• <b>Live fascines</b> - Cylindrical bundles of live, rootable, woody material ~8-10 feet in length placed in shallow contour trenches in riverbank, typically at or near the toe of the slope.</li> <li>• <b>Brush mattress</b> – Live branch cuttings, often combined with live stakes and live fascines, installed with netting or wire mesh perpendicular to the flow of the river on the stream bank.</li> </ul>	<p><b>Plugs</b> and <b>live stakes</b> are often used on gentle to moderate slopes with coir or other erosion control matting.</p> <p><b>Live stakes</b> are used to promote mechanical strength of sloped banks and small, uncomplicated bank slips and slumps.</p> <p><b>Brush mattresses</b> are often used on the outside of meander bends to help stabilize slopes with high near-bank shear stress.</p>
<b>Coir Fabric</b>	<p><b>Coir fabric</b> or <b>coir matting</b> is an erosion control matting constructed of coconut fibers. The matting biodegrades in about 5 years or so, but provides protection of the banks while vegetation becomes established. Coir fabric is also used as part of a number of other bioengineering systems:</p> <ul style="list-style-type: none"> <li>• <b>Pre-vegetated mats</b> - Coir mats that are pre-planted with sprigs or seeds and grown in a nursery to establish vegetation in the matting prior to use.</li> <li>• <b>Pre-planted coir pillow</b> - Approximately 4"x3'x8' coir fiber planting bed, pre-planted with <i>Juncus</i> or other native plantings.</li> <li>• <b>Vegetated geogrid</b> - Wall composed of 1-foot lifts of compacted soil wrapped with coir or geotextile fabric with a layer of live, rootable, wood material (such as <b>plugs</b> or <b>live stakes</b>) added to each lift.</li> </ul>	<p>Used alone on banks with low to moderate slope and low shear stress, often on inside of meander bends or on long straight reaches; may be used above ordinary high water in higher shear stress conditions, in conjunction with other treatments, such as riprap, that protect the toe of the slope.</p> <p>As above</p> <p>As above</p> <p>Moderately steep slopes above and below ordinary high water, including the outside of bends.</p>

Technique	Technique Description	Application
<b>Constructed Bankfull Bench</b>	Construction or excavation of a flat area 4 feet wide or greater along a bank at the channel-forming (bankfull) elevation.	Used to stabilize channel geometry in incised stream conditions (where river downcuts into channel bottom); increases overall sediment transport capacity of channel while decreasing shear stress on bank
<b>Rootwad Revetments</b>	Installation on the bank of a system of downed trees with root mass exposed, in such a manner that the tree trunk is buried in the bank.	Typically placed along outer bends, sometimes in combination with other techniques such as vanes, to provide protection against sheer stress on bank.
<b>Compartmentalized Placed Fill</b>	Placement of filled bags or tubes of organic material and stone on the riverbank, in various ways, to armor fill slopes, with native vegetation planted between layers or lifts of bags; brand names include Envirolok™ bags.	Moderately steep slopes or areas of moderate to high shear stress.
<b>Log or Rock Vane</b>	<p>Placement of a log with rootwad or row of boulder-size rocks anchored into the bank, angled upstream, and angled down from bankfull height at the bank to the channel bed elevation at the end of the log or rock series.</p> <p>A variation is a <b>bank spur</b>, which is a similar, but smaller and lower, structure designed to work at lower shear stress conditions.</p>	Outer meander bends with moderate shear stress, to deflect flow and reduce steam velocities adjacent to banks.
<b>Articulated Concrete</b>	Individual structures of pre-cast concrete placed in groups along toe of slope to dissipate energy of water against bank; most common are <b>A-jacks</b> .	May be used as an alternate to riprap, for areas of high velocity and/or steep slopes, particularly to stabilize the toe of the bank where stabilization work would be performed while water is flowing in the channel.
<b>Riprap</b>	Placement of a blanket of large, angular rocks. <b>Riprap</b> is often combined with <b>joint planting</b> , which is the insertion of live, rootable cuttings of woody material ( <b>plugs</b> or <b>live stakes</b> ) into bank slope in spaces between the rocks.	From below streambed up to a maximum of bankfull elevation on steep bank slopes in high velocity reaches.
<b>Concrete Block Revetment</b>	Placement of blanket revetment of prefabricated concrete cellular blocks that can be backfilled with soil and planted with grasses.	On steep bank slopes in areas of very high velocity and shear stress.

**Table 3-3. Application of Bank Stabilization Techniques to Bank Conditions**

<b>Stabilization Technique</b>	<b>Geomorphic Position of Bank</b>	<b>Meander Bend Radius</b>	<b>Bank Height</b>	<b>Shear Stress Condition</b>
Concrete Block Revetment	Outside meanders	< 200 ft	> 4 ft	Very High
Riprap with Joint Planting	Outside meanders	< 200 ft	> 4 ft	High
Root Wads	Outside meanders	< 200 ft	> 4 ft	High
Log or Rock Vane	Outside meanders	NA	> 4 ft	High
Bankfull Bench	Straight reaches	NA	> 4 ft	Moderate
Compartmentalized Placed Fill	Outside meanders and straight reaches	> 200 ft	> 4 ft	Moderate
	Outside meanders	< 200 ft	< 4 ft	Moderate
Vegetated Geogrid with Riprap	Outside meanders	< 200 ft	< 4 ft	Moderate
Bank Spurs	Straight reaches	NA	> 4 ft	Moderate
Brush Mattress	Outside meanders	NA	> 4 ft	Moderate
Coir Matting with Riprap	Straight reaches	NA	< 4 ft	Moderate to Low
Grade Bank/Coir Matting	Inside broad meanders and straight reaches	> 200 ft	All heights	Low
Reshape Point Bars	Inside meanders	Low	< 4 ft	Low
Live Stakes	Used in conjunction with other techniques under varying bank conditions			

Note: Articulated concrete may be used as an alternate to riprap, in conjunction with certain techniques, to stabilize the toe of the bank under alternatives in which the stabilization work would be performed while water is flowing in the channel.

**Table 3-6 - Summary of Assumed Reach-/Alternative-Specific Production Rates**

Revised CMS Report, Housatonic River - Rest of River  
 General Electric Company - Pittsfield, MA

Alt.	Reach 5A	Reach 5B	Reach 5C	Reach 5	Reach 6	Reach 7	Reach 7	Reach 8	Reaches
				Backwaters	(Woods Pond)	Impoundments	Channel	(Rising Pond)	9-17
SED 1	NA	NA	NA	NA	NA	NA	NA	NA	NA
SED 2	NA	NA	NA	NA	NA	NA	NA	NA	NA
SED 3	1 crew removal: 110 cy/d eng. cap: 220 cy/d	NA	1.5 crews no removal TLC: 165 cy/d	NA	2 crews no removal TLC: 220 cy/d	NA	NA	NA	NA
SED 4	1 crew removal: 110 cy/d eng. cap: 220 cy/d	1 crew removal: 110 cy/d eng. cap: 220 cy/d TLC: 110 cy/d	1.5 crews no removal eng. cap: 330 cy/d TLC: 165 cy/d	1.5 crews no removal TLC: 165 cy/d	2 crews removal: 550 cy/d eng. cap: 440 cy/d TLC: 220 cy/d	NA	NA	NA	NA
SED 5	1 crew removal: 110 cy/d eng. cap: 220 cy/d	1 crew removal: 110 cy/d eng. cap: 220 cy/d	1.5 crews removal: 412.5 cy/d eng. cap: 330 cy/d	1.5 crews no removal TLC: 165 cy/d	2 crews removal: 550 cy/d eng. cap: 440 cy/d	NA	NA	2 crews no removal TLC: 220 cy/d	NA
SED 6	1 crew removal: 110 cy/d eng. cap: 220 cy/d	1 crew removal: 110 cy/d eng. cap: 220 cy/d	1.5 crews removal: 412.5 cy/d eng. cap: 330 cy/d	1.5 crews removal: 412.5 cy/d eng. cap: 330 cy/d TLC: 165 cy/d	2 crews removal: 550 cy/d eng. cap: 440 cy/d	1 crew no removal TLC: 110 cy/d	NA	2 crews no removal eng. cap: 440 cy/d TLC: 220 cy/d	NA
SED 7	1 crew removal: 140 cy/d eng. cap: 275 cy/d	1 crew removal: 110 cy/d eng. cap: 220 cy/d	1.5 crews removal: 412.5 cy/d eng. cap: 330 cy/d	1.5 crews removal: 412.5 cy/d eng. cap: 330 cy/d TLC: 165 cy/d	2 crews removal: 700 cy/d eng. cap: 440 cy/d	1 crew removal: 275 cy/d eng. cap: 220 cy/d TLC: 110 cy/d	NA	2 crews removal: 550 cy/d eng. cap: 440 cy/d TLC: 220 cy/d	NA
SED 8	1 crew removal: 140 cy/d eng. cap: 275 cy/d	1 crew removal: 140 cy/d eng. cap: 275 cy/d	1.5 crews removal: 525 cy/d eng. cap: 330 cy/d	1.5 crews removal: 525 cy/d eng. cap: 330 cy/d	2 crews removal: 700 cy/d eng. cap: 440 cy/d	1 crew removal: 275 cy/d eng. cap: 220 cy/d	NA	2 crews removal: 700 cy/d eng. cap: 440 cy/d	NA
SED 9	1 crew removal: 250 cy/d eng. cap: 195 cy/d	1 crew removal: 275 cy/d eng. cap: 220 cy/d	1.5 crews removal: 412.5 cy/d eng. cap: 330 cy/d	1.5 crews removal: 412.5 cy/d eng. cap: 330 cy/d	2 crews removal: 550 cy/d eng. cap: 440 cy/d	1 crew removal: 275 cy/d eng. cap: 220 cy/d	NA	2 crews removal: 550 cy/d eng. cap: 440 cy/d	NA
SED 10	1 crew removal: 110 cy/d eng. cap: 220 cy/d	NA	NA	NA	2 crews removal: 550 cy/d	NA	NA	NA	NA

**Notes:**

1. Average removal and eng. cap rates may increase in certain reaches for SED 7 and SED 8 to account for the somewhat faster production anticipated for increased removal volumes from within the same removal area. This results in higher removal rates in the following: Reach 5A and 6 in SED 7; Reach 5A, 5B, 5C, 5 Backwaters, 6, and 8 in SED 8.
2. cy/d = cubic yards per day
3. removal = rate of removal for mechanical excavation/hydraulic dredging
4. eng. cap = rate of placement of engineered cap
5. TLC = rate of placement of thin layer cap

**Table 3-8 – Construction Schedule Summary**

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REACH	SEDIMENT REMEDIAL ALTERNATIVE												
	SED 1	SED 2	SED 3	SED 4	SED 5	SED 6	SED 7	SED 8	SED 9	SED 10			
5A	No Action Alternative	Monitored Natural Recovery (MNR)	7.5	7.5	7.5	7.5	9.5	11.5	3.7	3.4			
5B			0.4	2.8	4.8	4.8	5.8	6.5	2.7	0.1			
5C (Upper Section)			MNR	0.5	1.3	1.3	1.3	1.3	1.9 1.9	3.2	MNR		
5C (Lower Section)			0.5	1.4	1.4	2.4	2.4	2.4	3.4 3.4		0.0	MNR	
5 Backwaters (Small)			MNR	0.2 0.2	0.0	0.2 0.2	0.0	0.4 0.4	0.0	0.4 0.4	1.4	3.1 3.1	MNR
5 Backwaters (Large)			MNR	1.3 1.3	0.0	1.3 1.3	0.0	1.6 1.6	0.0	2.0 2.0	8.2	0.0	MNR
6 Woods Pond (Shallow)			0.7	1.8	1.8	1.8	1.8	2.8	6.6	3.4	1.1	1.6	
6 Woods Pond (Deep)			0.4	0.4	0.6	0.6	0.6	0.6	4.2				
7 (Channel)			MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	
7 (Impoundments)			MNR	MNR	MNR	1.4	2.5	5.0	3.5	1.9	MNR		
8 Rising Pond (Shallow)			MNR	MNR	0.4	0.4	0.5	4.1	1.5	0.8	MNR		
8 Rising Pond (Deep)			MNR	MNR	0.4	0.4	0.4	4.7					
9 to 17			MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	
<b>Total</b>			<b>0</b>	<b>0</b>	<b>10</b>	<b>15</b>	<b>18</b>	<b>21</b>	<b>26</b>	<b>52</b>	<b>14</b>	<b>5</b>	

**Notes:**

- Construction durations are shown in Years.
- The durations of time shown represent the total time that construction activities would be ongoing in each reach, except as noted in Note 3.
- Partially shaded cells indicate those reaches where all or a portion of the construction activities would be performed concurrently with activities in other reaches and thus do not contribute to the overall duration of the alternative. In these cells, the shaded number represents the total length of time of work in that reach, and the unshaded number represents the portion of that time (if any) that contributes to the overall duration of the alternative. This occurs in the following situations: (a) Under SED 4 through SED 9, activities in Reach 5C and the Reach 5 backwaters would be performed concurrently, and only the longer activity would contribute to the overall project duration; and (b) under SED 9, excavation activities in Reach 6, Reach 7 (impoundments), and Reach 8 would be performed concurrently with remediation in Reach 5 (see Figure 3-2g) and only the remaining activities (capping) would contribute to the overall duration of SED 9.

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**Table 3-9 – Age Classes in FCM Corresponding to 120 mm Length, by Species**  
**Used for Comparison of Model Results to IMPGs for Threatened and Endangered Species**

Species	Minimum Age Class	Maximum Age Class
Brown bullhead (bottom feeder)	2	6
Cyprinids (forage fish)	5	6
Largemouth bass (predatory)	2	10
Sunfish (forage fish)	3	6
White sucker (bottom feeder)	2	6

**Table 3-10 — FCM Species Weighting Factors in Each Subreach Used to Compute Average Concentrations for Evaluation of Threatened and Endangered Species IMPGs**

Species	Subreach													
	5A	5B	5C	5D	WP	7A	7B	7C	7D	7E	7F	7G	7H	RP
<b>BB</b>	0	0.322	0.322	0.322	0.644	0.322	0.322	0.322	0.322	0.322	0.322	0.322	0.322	0.322
<b>WS</b>	0.644	0.322	0.322	0.322	0	0.322	0.322	0.322	0.322	0.322	0.322	0.322	0.322	0.322
<b>LMB</b>	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.206
<b>SF</b>	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
<b>CP</b>	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075

Notes:

- BB = Brown Bullhead (bottom feeder)
- WS = White Sucker (bottom feeder)
- LMB = Largemouth Bass (predatory)
- SF = Sunfish (forage fish)
- CP = Cyprinids (forage fish)

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**Table 3-11 – Age Classes in FCM Corresponding to 130 to 400 mm Length, by Species**  
**Used for Comparison of Model Results to IMPGs for Piscivorous Birds**

Species	Minimum Age Class	Maximum Age Class
Brown bullhead (bottom feeder)	2	6
Cyprinids (forage fish)	6	6
Largemouth bass (predatory)	2	10
Sunfish (forage fish)	3	6
White sucker (bottom feeder)	2	6

**Table 3-12 – FCM Species Weighting Factors in Each Subreach Used to Compute Average**  
**Concentrations for Evaluation of Piscivorous Bird IMPGs**

Species	Subreach													
	5A	5B	5C	5D	WP	7A	7B	7C	7D	7E	7F	7G	7H	RP
BB	0	0.2	0.2	0.2	0.25	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
WS	0.25	0.2	0.2	0.2	0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
LMB	0.25	0.2	0.2	0.2	0.25	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
SF	0.25	0.2	0.2	0.2	0.25	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
CP	0.25	0.2	0.2	0.2	0.25	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Notes:

- BB = Brown Bullhead (bottom feeder)
- WS = White Sucker (bottom feeder)
- LMB = Largemouth Bass (predatory)
- SF = Sunfish (forage fish)
- CP = Cyprinids (forage fish)

**Table 3-14 - Sediment Alternatives OMM Program Components**

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Monitoring Programs/Components	Sediment Alternatives									
	SED 1	SED 2	SED 3	SED 4	SED 5	SED 6	SED 7	SED 8	SED 9	SED 10
100-year OMM										
Visual Inspection of Caps/Thin-Layer Caps	NA	NA	Once in each of the following years in affected areas: Yrs 1, 2, 3, 4, 5, 10, 15, 25, 50, 75, 100							
Water Column	NA	Quarterly sampling at 12 locations along the Housatonic River in MA and CT (Yr 1, 2, 3, 4, 5, 10, 15, 25, 50, 75, 100)								
Fish	NA	Adult sampling at 8 locations (4 locations each in MA and CT) (Yr 1, 2, 3, 4, 5, 10, 15, 25, 50, 75, 100)								
Sediment	Sampling as specified below (Yr 5, 10, 15, 25, 50, 75, 100)									
MNR and Removal/Backfill Areas	NA	100 surface sediment samples	75 surface sediment samples	50 surface sediment samples	50 surface sediment samples	50 surface sediment samples	50 surface sediment samples	100 surface sediment samples	50 surface sediment samples	50 surface sediment samples
Removal/Cap Areas	NA	NA	1 core/4-5 acres 3 samples/core	1 core/4-5 acres 3 samples/core	1 core/4-5 acres 3 samples/core	1 core/4-5 acres 3 samples/core	1 core/4-5 acres 3 samples/core	NA	1 core/4-5 acres 3 samples/core	1 core/4-5 acres 3
Cap Areas	NA	NA	NA	1 core/4-5 acres 3 samples/core	1 core/4-5 acres 3 samples/core	1 core/4-5 acres 3 samples/core	1 core/4-5 acres 3 samples/core	NA	1 core/4-5 acres 3 samples/core	NA
Thin-Layer Cap Areas	NA	NA	1 core/4-5 acres 1 sample/core	1 core/4-5 acres 1 sample/core	1 core/4-5 acres 1 sample/core	1 core/4-5 acres 1 sample/core	1 core/4-5 acres 1 sample/core	NA	NA	NA
Total Cores (Per Year Sampled) <sup>1</sup>	0	100	110	110	120	130	130	100	130	55
Total Samples (Per Year Sampled)	0	100	130	180	210	240	260	100	300	65
Biota Consumption Advisories	NA	Maintain signs and conduct other outreach efforts in MA and CT every other year for up to 100 years as necessary								

**Notes:**

1. Total number of sediment cores and samples estimated based on 4 cores/acre, with numbers rounded to the nearest ten.

NA = not applicable