SIMPLE SOLUTIONS FOR YOUR ERODING BACKYARD STREAM

PennState Extension

Is your stream getting deeper or wider? Are you losing some of your land every time it rains? Have you wondered why your streambanks are changing so rapidly and what you can do about that?

The changing landscape of Pennsylvania means more homes, commercial buildings, parking lots, and roads. We also have less forested land. Forests play a huge role in helping to slow down and absorb rainwater once it hits the ground. With fewer forests and more buildings comes more stormwater, the rainwater that isn't absorbed. This increased volume of water rushes at great speeds directly into our streams, carrying pollutants off the land with it and frequently leading to local flooding (Neary et al. 2009).

When one inch of rain falls on a one-acre parking lot, it becomes 27,000 gallons of stormwater flowing into our streams. In Pennsylvania we average 41 inches of rain each year (PA State Climatologist). That adds up to a lot of water! All this extra water contributes to eroding our streambanks. That streambank soil becomes sediment pollution (Taniguchi and Briggs 2015), which is one of Pennsylvania's biggest water quality problems. Sediment contributes to flooding and suffocates stream-bottom-dwelling animals (PA DEP 2012).

This publication is part of the Penn State Extension Backyard Stream Repair Program, which is implemented by the Penn State Extension Water Resources Team. You can find more information at extension.psu.edu/water.

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Contents

An Introduction to the Water's Edge

Riparian buffers, streamside forests, and shoreline gardens all refer to the vegetated area along the water's edge. There are many benefits to you, your downstream neighbors, and the surrounding environment when plants with deep roots grow on the creek bank (Sweeny and Newbold 2014; Bin et al. 2009).

- Improve bank stability and reduce erosion, saving property from washing away.
- Add aesthetic value to property.
- Create a sense of place and reduce noise.
- Cost less to maintain than turf—no need for mowing, watering, and fertilizing.
- Slow surface stormwater flow.
- Intercept pollution (fertilizer, pesticides, heavy metals, etc.).
- Allow sediment to settle out before clouding up a waterway.
- Cool stormwater runoff heated by sunlight on hard surfaces.
- Create shade that moderates water temperatures for aquatic species.
- Provide habitat for many types of wildlife (butterflies, hummingbirds, frogs, dragonflies).

Being around water brings a sense of calm and relaxation. Most people living near water want a clear view, and so they remove all the landscape. Why not? If you live near the water, you want to see it! But what if all your upstream neighbors want that too? Oftentimes we don't realize that by simply removing vegetation or keeping an area only in turf grass next to the creek we actually contribute to erosion, increase the likelihood for flood damage, and decrease the available habitat for wildlife. There is a compromise; utilize the right plant for the right place to create a shoreline garden (Bin et al. 2009; Hu et al. 2019).

Before you consider altering your streambanks, you need a clear image of what a healthy, stable stream looks like. It can be difficult to find healthy streams in urban areas to use as an example. Study the two photos on the right. Which one looks more stable with less erosion? Is there shade on either stream?

Vertical banks more than 1 foot high are unstable.

Credit: Jennifer Fetter, Penn State

Gently sloping banks are stable.

Credit: Matthew Royer, Penn State

The top image has a stream with steep banks that could present a safety issue, especially if you were on a mower! The bottom image shows a stream with a more gentle slope and forest vegetation growing along the stream. It has much easier and safer access.

Streams that rise and fall quickly during and after rainfall events can saturate and loosen the soil (Taniguchi and Briggs 2015). Plant roots hold soil in place, but their effectiveness depends on their root depth (Arnold and Toran 2018). Turfgrass may only have 2-to-6-inch-deep roots (Landschoot 1997). Unanchored soil will continue to wash away until water finds a stable point that is difficult to erode, usually bedrock. It may take only a few storms or decades to see significant impact, but the damage is inevitable. Flooding and water quality degradation are another frequent consequence (Taniguchi and Briggs 2015).

A mix of native trees, shrubs, flowers, ferns, and grasses at varying heights provides a tangled mix of different root structures that help hold soil to the banks. These plants provide all kinds of other benefits to the environment as well (Sweeny and Newbold 2014).

Many herbaceous plants have fibrous root systems and protect banks from surface erosion. Woody species with deeper or wider roots will be better at increasing soil cohesion and reducing mass slope failure. The best approach is a combination of plant types.

Credit: Amanda Grube, Penn State

Backyard Stream Repair

Step 1: Evaluate Your Streambank

Take a stroll along your streambank and observe the current conditions. One way to measure your current stream health is to use Penn State Extension's First Investigation of Stream Health (FISH), which you can find online at https://extension.psu.edu/first-investigation-of-stream-health-fish-protocol.

Questions to ask about your stream:

- Does your stream flow year-round, seasonally, or only during rain events?
- Does the stream rise and fall quickly with rainfall events?
- Does the soil along the bank slide off after rain events?
- How deep and wide is the creek?
- Are there any culverts or drainage pipes flowing into your stream?
- Is the stream straight or does it meander through the landscape?
- Does your shoreline have a variety of plant types?
- Do you know if the plants are native versus invasive?
- What kind of root structure do existing plants have?

An example of a highly erosive, unstable streambank.

© Bill Lord

Step 2: Determine Your Options

There are many different ways to manage streambanks. Choose from one of the following options to stabilize a streambank.

(Appendix B provides additional help.)

Option 1: Do nothing and let it grow wild as much as 15 feet or more from the water's edge. Allow whatever seeds are in the soil, as well as what washes from upstream neighbors, to establish on the streambank.

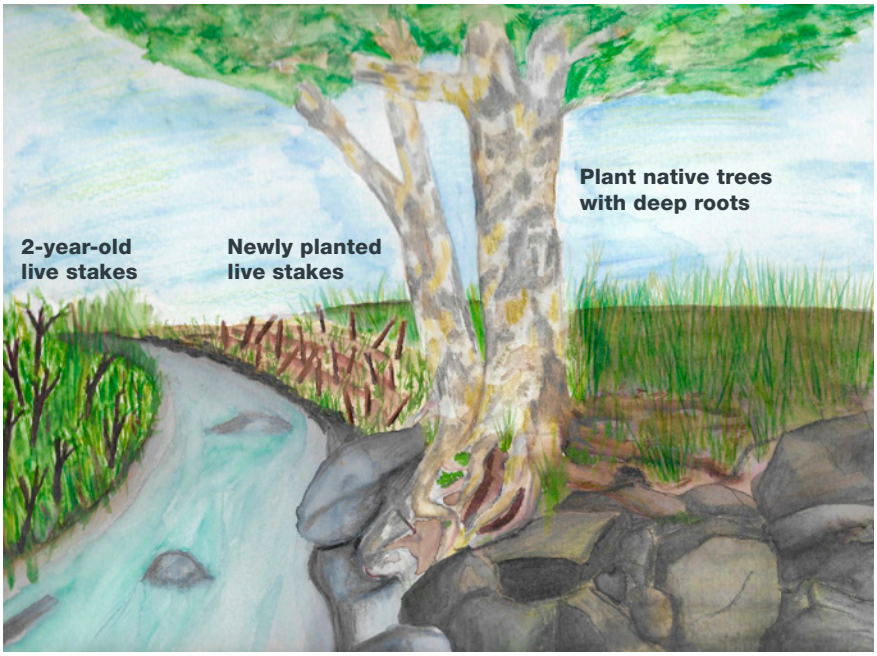
- Optimal time of year: This can be done anytime of year.
- Pros: No work and no costs.
- Cons: Undesirable plants (invasive weeds such as Japanese knotweed) can take over the area. It can look weedy and still erode for several years until plants mature. This might violate noxious weed laws or your municipal weed ordinances.
- Next step: Do nothing; you're done with this guide.

Option 1: This landowner is letting vegetation grow 15 feet from the water's edge without mowing.

© North Carolina Cooperative Extension

Option 2: Plant native vegetation without changing the grade of your streambanks. Start planting native trees 5 feet from the edge of bank, regardless of slope (see illustration on next page). Plant live stakes (cuttings of native trees and shrubs; see pages 8–9) every 3 feet along the eroding streambanks. Soil may still slough off, but as plants grow, the root mass will begin to hold the soil together.

- Optimal time of year: Live stakes are best planted in late winter and early spring (dormant season). Trees and shrubs are best planted in fall and spring.
- Pros: Cost-effective and slows erosion. No permits required to add plants to your stream.
- Cons: May be a temporary fix and land can still be lost. Takes time (years) for results.
- Next step: Skip to plant selection on pages 4–7. Look over maintenance suggestions on page 14.



Option 2: Plant diverse, native flora without changing the grade (above left illustration). Above right photo shows live stakes installed every 1 foot on the existing slope to create a snag and quick root mass.

Credits: Amanda Grube, Penn State (left); Kristen Koch, Penn State (right)

Option 3: Grade banks to a gentle slope and add plants. A 3:1 slope is most ideal for a stable bank. Take time to plan whether you will do the work yourself or hire someone, select type of plants you want (or copy the design on page 12), and determine how you will maintain the appearance you want (tips on page 14).

- Optimal time of year: Dormant season to allow for live staking and additional plantings soon after grading.
- Pros: Safer, stable banks; not losing land; and more attractive.
- Cons: Financial investment and potential soil compaction from heavy equipment. Requires a preapproved permit regardless of project size in Pennsylvania.
- Next steps: Skip to grading section on pages 15–17. Pay special attention to permit requirements.

Option 3: A repaired stream site where the landowner's home is less than 20 feet from the water with 2-to-3-foot vertical banks (above left photo). Above right photo shows the now graded, stabilized, and planted bank.

Pennsylvania Permit Requirements

Small Docks and Boat Launches

Credit: Jennifer Fetter, Penn State

Intakes and Outfalls

Credit: Jennifer Fetter, Penn State

Bank Rehab and Stabilization

Credit: Kristen Koch, Penn State

Construction in Wetlands

Credit: U.S. Fish and Wildlife Service Northeast Region

All of these things and more are regulated by 25 PA Code Chapter 105. A General Permit 3 (GP3) is required for grading work on less than 500 feet of continuous streambanks and/or adding rock or other nonpolluting structures to the streambank or channel.

Step 3: Choosing the Right Plants

Select plants for streambanks based on the needs of the plants as well as your needs and wants as the property owner. Some things to consider include the plant's soil moisture tolerance, sun exposure needs, mature height, and the width or spread. Choose plants that are native to our region for the best results.

TIPS FOR PLANNING A GARDEN AT THE WATER'S EDGE

View

Consider the views you want to maintain and frame a "view corridor" from your home. Utilize vegetation that will vary in height as it matures. You can trim trees and shrubs to see the water, but be sure to use proper pruning practices. The more plants you have growing, the more root mass there will be stabilizing the streambank.

Plant Location

Choose plants according to their moisture tolerance. Plants located at the water's edge (often referred to as the wet zone) will have wet roots 99 percent of the time. Soil saturation could vary greatly over the next 1 to 6 feet from the water's edge. To determine where the soil is saturated and where it is not, dig a 1-foot-deep hole. Try to make a ball with soil at the bottom of the hole. If it crumbles, it's not saturated. In this area (often referred to as the moist or mesic zone), plant roots may only be wet 67 to 99 percent of the time, such as during storm events or seasonal inundation. Depending on your property, you may also be planting in an area where plants will experience drier soil conditions but still must be adapted to seasonal flooding (often referred to as the dry zone).
(See illustration on next page.)

Foliage

Do you want to attract certain birds and butterflies? Do you want seasonal color throughout the year? Adding texture, form, and various growth habits can produce interesting plant patterns. Choosing a variety of deciduous and evergreen plants provides seasonal interest.

Spacing

There are two ways to space plants. You can overplant for quicker root mass to stabilize the soil. You can also space your plants according to their future mature height and spread. If you overplant, it may save you from ongoing property loss, but it will mean an additional cost of plants and a need to thin out your planting someday in the future. If you space them with the future in mind, it can take several years for any noticeable protection of your streambanks. In either case, plant in groupings of species to create a garden or landscaped feel. Research shows that you'll keep it if you love it!

Inventory

You might be able to use plants that you already have on site. Dividing and transplanting can save you a lot of money. Be careful to avoid using existing invasive nonnative plants. In fact, try to eliminate those invasives from your streambanks because they tend to outcompete everything, become a monoculture, and provide little benefit. Watch for plant pests and diseases—you also don't want to transplant those into your new planting area.

STREAM REPAIR PLANT SELECTION POSSIBILITIES

The next few pages provide a sampling of plants that you might choose for your stream repair planting. This list is not all inclusive, but it should help you start thinking about your planting selections.

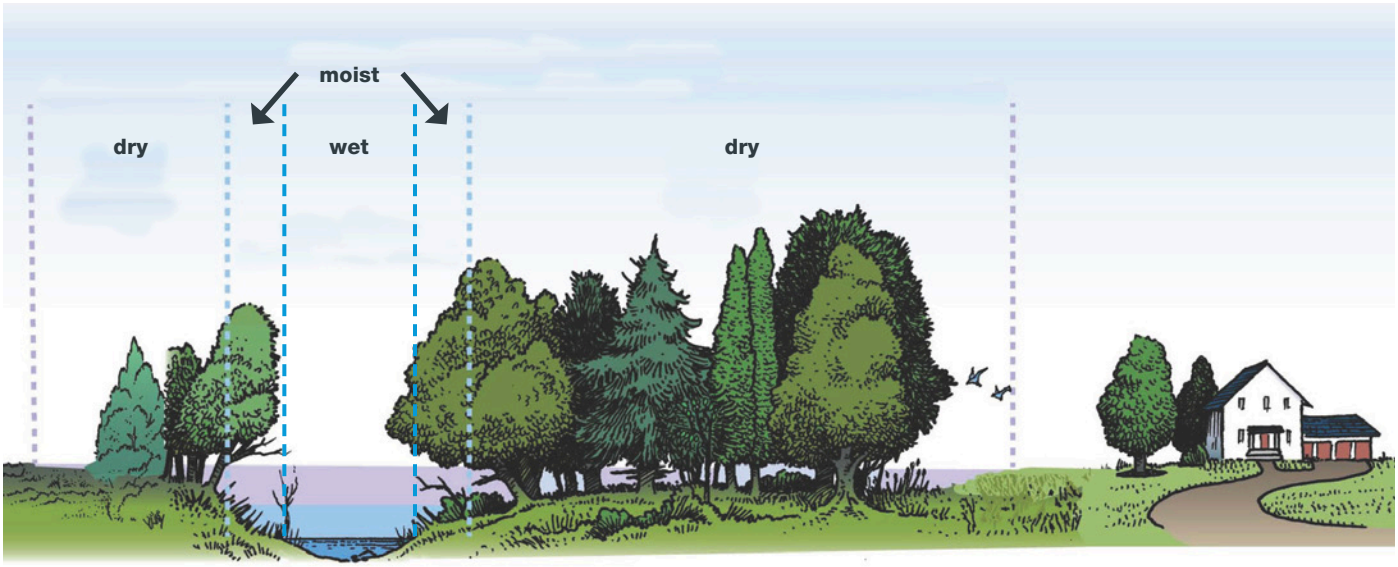
Below is a key to the abbreviations used throughout the list. Refer back here when you need help decoding the information.

Sun Exposure	
F	Full sun (6+ hours)
P	Partial sun (2–6 hours)
S	Shade (<2 hours)

Foliage Type (D/E)	
D	Deciduous
E	Evergreen

Bloom Color	
BLU	Blue
BUR	Burgundy
CRM	Cream
GRN	Green
ORG	Orange
PNK	Pink
PUR	Purple
RED	Red
WHT	White
YEL	Yellow

Wetland Code		
OBL	Wet zone	Obligate Wetland: found in wet zones 99% of time; plant roots tolerate saturation
FACW	Moist zone	Facultative Wetland: usually occurs in wetlands (67–99% of time), but occasionally found in non-wetlands (e.g., fluctuating river levels)
FAC	Moist and dry zones	Facultative: equally likely to occur in wetlands or non-wetlands; estimated probability 34–66%
FACU	Dry zone	Facultative Upland: usually occurs in non-wetlands (67–99% of time), but occasionally found in wetlands (1–33% of time)
UPL	Dry zone	Obligate Upland: occurs almost always in non-wetlands (99% of time)



Credit: Courtesy of the Penn State Extension Master Watershed Steward program

Wet Zone: Herbaceous (Nonwoody) Plants

Below is a sampling of herbaceous plants that can bend with the stream flow at the water's edge.

Type	Common Name	Botanical Name	Sun	Height (feet)	Wetland Code	Bloom Time	Bloom Color	D/E	Features
FERN	Chain fern	*Woodwardia areolata*	P–S	1–2	OBL	N/A	N/A	D	Amphibian shelter
GRASS	Sweet flag	*Acorus calamus*	F–P	2–4	OBL	N/A	N/A	D	Iris-like leaves, waterfowl habitat
GRASS	Fringed sedge	*Carex crinita*	P–S	2–3	OBL	May–June	CRM	E	Drooping seed heads
GRASS	Common spikerush	*Eleocharis palustris*	P	1–3	OBL	July–Sept.	N/A	E	Dark yellow/brown fruits more notable than flowers
GRASS	Soft rush	*Juncus effusus*	All	2–4	OBL	July–Sept.	GRN	E	Clump forming
PERENNIAL	Swamp milkweed	*Asclepias incarnata*	F–P	2–5	OBL	July–Aug.	PNK	D	Pollinator
PERENNIAL	Hardy hibiscus	*Hibiscus moscheutos*	F	3–7	OBL	July–Sept.	RED	D	Showy flowers, attracts butterflies
PERENNIAL	Blue Flag iris	*Iris virginica*	F	2–3	OBL	May–June	BLU, WHT	D	Attracts birds and pollinators
PERENNIAL	Cardinal flower	*Lobelia cardinalis*	F–P	2–5	OBL	July–Sept.	RED	D	Hummingbird, pollinator
PERENNIAL	Pickerelweed	*Pontedieria cordata*	F	3–4	OBL	June–Oct.	BLU, PUR	D	Mat forming, wildlife food, fish habitat, attracts butterflies
PERENNIAL	New York ironweed	*Vernonia noveboracensis*	F–P	3–6	FACW	July–Sept.	PUR	D	Pollinator, tolerates deer

Look for them in plugs or small containers. You may find some available in seed as well. Seeds will need to be held in place with straw mulch and/or fabric to prevent them from washing away. These nonwoody plants may also readily transplant.

Moist Zone: Live Stakes

Live stakes are cuttings from certain native, dormant trees and shrubs. They are inexpensive and hardy. The ones listed below have proved successful in streambanks.

Type	Common Name	Botanical Name	Sun	Height x Width (feet)	Wetland Code	Bloom Time	Bloom Color	D/E	Features
SHRUB	Buttonbush	*Cephalanthus occidentalis*	F–P	12 x 8	OBL	June–Sept.	WHT	D	Showy, fragrant flowers; attracts hummingbirds and butterflies
SHRUB	Silky dogwood	*Cornus amomum*	F–P	12 x 12	FACW	May–June	WHT	D	Attracts birds, tolerates deer
SHRUB	Red osier dogwood	*Cornus sericea*	F–P	9 x 12	FACW	May–June	WHT	D	Showy, red stems; attracts birds and butterflies
SHRUB	Ninebark	*Physocarpus opulifolius*	F–P	10 x 6	FACW	Spring	WHT, PNK	D	Copper-colored fall leaves; papery, peeling bark
SHRUB	Pussy willow	*Salix discolor*	F–P	6–15 × 4–12	FACW	March–April	GRN, YEL	D	Winter interest, tolerates black walnut, used in dried arrangements
SHRUB	Elderberry	*Sambucus canadensis*	F–P	5–12 × 5–12	FACW	June–July	WHT	D	Edible fruit, attracts wildlife
TREE	Black willow	*Salix nigra*	F–P	30–60 × 30–60	OBL	March–April	GRN, YEL	D	Drops and breaks limbs frequently, so should not be used in small residential plantings
TREE	American sycamore	*Platanus occidentalis*	F	75–100 × 75–100	FACW	April	YEL, RED	D	Large shade tree, white mottled bark, creates winter interest

You can purchase live stakes from nurseries or harvest them from healthy trees and shrubs on your property (or a willing friend's property). Instructions for harvesting and planting live stakes can be found on pages 8–9.

Wet Zone: Herbaceous (Nonwoody) Plants

Swamp Milkweed (*Asclepias incarnata*)

Credit: Jodi Sulpizio, Penn State

Common Spikerush (*Eleocharis palustris*)

Credit: Andrey Zharkikh on flickr.com CC BY 2.0

Cardinal Flower (*Lobelia cardinalis*)

Credit: Jodi Sulpizio, Penn State

Moist Zone: Live Stakes

Red Osier Dogwood (*Cornus sericea*)

Credit: Jennifer Fetter, Penn State

Elderberry (*Sambucus canadensis*)

Credit: Connie Schmotzer, Penn State

Buttonbush (*Cephalanthus occidentalis*)

Credit: Tim Abbey, Penn State

Dry Zone: Containerized Plants

While this zone is not necessarily dry all of the time, it's not right in or along the water, so it has the potential to dry out. For the best success, plant this zone with plants grown in pots or containers. You might also use bareroot trees and shrubs to plant this zone, but keep them properly watered as they establish. In addition to the plants listed below, all of the trees and shrubs listed on the previous table as live stakes could also be planted in this zone as container plants.

Type	Common Name	Botanical Name	Sun	Height x Width (feet)	Wetland Code	Bloom Time	Bloom Color	D/E	Features
GROUND COVER	Allegheny spurge	*Pachysandra procumbens*	P–S	6 inches x 2 feet	UPL	March–May	WHT	D	Fragrant
GROUND COVER	Green and gold	*Chrysogonum virginianum*	P–S	1 x 1.5	UPL	May–Oct.	YEL	D	Showy, yellow flowers
PERENNIAL	Black-eyed Susan	*Rudbeckia hirta*	F	2 x 2	FACU	June–Sept.	YEL	D	Daisy-like, attracts butterflies
PERENNIAL	Butterfly weed	*Asclepias tuberosa*	F	2.5 x 1.5	UPL	June–Aug.	ORG	D	Leaves are food for monarch caterpillars
SHRUB	Wild hydrangea, sevenbark	*Hydrangea aborescens*	P	3–6 × 3–5	FACU	June–Sept.	GRN, WHT	D	Showy flowers
SHRUB	Winterberry	*Ilex verticillata*	F–P	12 x 12	FACW	June–July	WHT	D	Birds will eat red berries in winter
SHRUB	Virginia sweetspire	*Itea virginica*	F–P	4 x 6	OBL	May–June	WHT	D	Fall color, fragrant
SHRUB	Spicebush	*Lindera benzoin*	F–P	6–12 × 6–12	FACW	March	GRN	D	Fragrant, deer tolerant, attracts birds and butterflies
TREE	River birch	*Betula nigra*	F–P	40–60 × 40–70	FACW	April–May	GRN	D	Peeling, showy bark; fast grower
TREE	Swamp white oak	*Quercus bicolor*	F	50–60 × 50–60	FACW	April	YEL	D	Acorns provide wildlife food
TREE	Eastern redbud	*Cercis canadensis*	F–P	30 × 35	FACU	April	PNK	D	Showy flowers
TREE	Red maple	*Acer rubrum*	F–P	40–70 × 30–50	FAC	March–April	RED	D	Spring and fall color
TREE	Eastern white pine	*Pinus strobus*	F–P	50–80 × 20–40	FACU	—	—	E	Fast growing, produces cones
TREE	Pawpaw	*Asimina triloba*	F–P	15–30 × 15–30	FAC	April–May	PUR	D	Edible fruits, attracts wildlife

You can purchase containerized and bareroot plants from nurseries or transplant them as seedlings if they are already growing on your property (or a willing friend's property). Some species will not transplant as well as others, but it can certainly save you money if they do.

Dry Zone: Containerized Plants

Eastern Redbud (*Cercis canadensis*)

Credit: Dan Keck on flickr.com Public Domain

Spicebush (*Lindera benzoin*)

Credit: Ruth Benner, Penn State

Eastern White Pine (*Pinus strobus*)

Credit: Dan Keck on flickr.com Public Domain

About Live Stakes

Live stakes are branch cuttings that can be used to help stabilize eroding streambanks. They will eventually grow into new trees or shrubs. Live stakes establish a root network in the streambanks to help prevent further soil loss and can rebuild previously eroded banks.

Credit: Kristen Koch, Penn State

Where to Get Live Stakes

- Purchase them from select nurseries.
- Harvest them directly from your property or a property where you have permission to take cuttings.

Harvesting Live Stakes

Harvest live stakes when source material is dormant, in late winter or early spring, before bud break when new growth starts. This will fall somewhere between late February and mid-April depending on what region of Pennsylvania you live in.

MATERIALS NEEDED:

- Pruners or loppers for cutting branches
- Bucket with a few inches of water

HARVESTING DIRECTIONS:

1. Identify trees or shrubs appropriate for live stakes (see page 6). If not on your own property, make sure you have permission first.
2. Prune off healthy branches that are at least 18 inches long and 0.5 to 1.5 inch in diameter (about the width of your pinky to your thumb). Make your cuts just above a node on the parent plant.
3. Trim off all of the smaller side branches.
4. Cut the branch into pieces that are 18 to 24 inches long. You may get several stakes from one branch. Some side branches are large enough to become stakes too.
5. On each stake, make a flat top cut and an angled bottom cut (forming a point).
6. Place bottom of stakes into your bucket with enough water to cover the bottom cut.

Credits: Jennifer Fetter, Penn State; Kristen Koch, Penn State

Planting Live Stakes

Live stakes should also be planted while the stakes are still dormant; however, you may need to wait until the ground is unfrozen. You can store your live stakes in a cold, dark environment to keep them dormant until you are ready to plant. Don't let them dry out.

MATERIALS NEEDED:

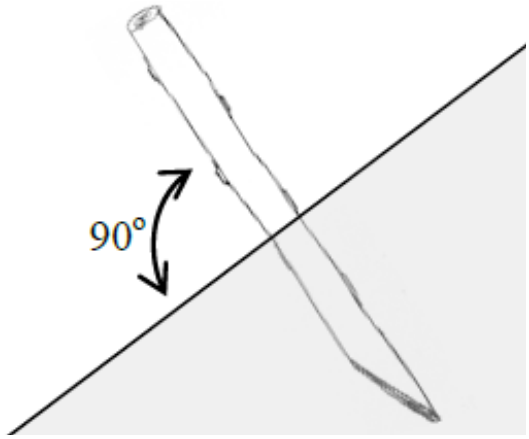
- Live stakes (harvested or purchased)
- Gloves and boots (preferably waterproof)
- Pilot hole drill (rebar section, long drill bits, or even weeding tools can help)

PLANTING DIRECTIONS:

1. Plan to plant a live stake every 2 to 3 feet along your streambank, above the water level. If you have streambanks that are over 2 feet in height, you can plant a second row staggered above your first (still maintaining a 2-to-3-foot spacing), forming a zigzag pattern along the bank.

Credit: Jennifer Fetter, Penn State

2. Live stakes need moisture to grow roots, so don't plant them above where soils tend to stay damp.
3. Drill a pilot hole first. Insert your rebar or other drill tool into the soil at a 90-degree angle to the soil surface.



Credit: Jennifer Fetter, Penn State

4. Remove the drill and replace it with a live stake. If you didn't harvest your live stakes the same day, make a fresh cut on the pointed (bottom) end of each live stake before planting.
5. Insert the live stake, point first, as far as possible. Less than half of the stake (as little as 6 inches) should remain above the ground. You can use a rubber mallet to gently tap the stake into the soil if needed. If you damage the end of the stake, make a fresh cut.
6. Angling your stakes slightly downstream can help reduce the amount of debris they collect and increase their success in growing.

Managing Your Live Stakes for Success

- Check on your live stakes every few weeks and gently pull back weeds around them to make sure they don't get smothered.

Credit: Kristen Koch, Penn State

- After major storm events, check on your stakes and remove any heavily collected debris from around them.

Credit: Kristen Koch, Penn State

- Even if you don't see above ground growth, your stakes may be growing roots. After six months, you can try gently tugging on a few to check them.
- Additional stakes can be added in future years to fill in holes or replace failed stakes.

Safety First

- Don't live stake in hazardous conditions, like after storms when water is high and moving fast.
- Have a plan for safely entering and exiting the stream.
- Have warm, dry clothes nearby just in case.
- Take a buddy or let someone know where you will be and what you will be doing.

Common Nonnative Invasive Plants Along Pennsylvania's Streams

Avoid planting and spreading these harmful plants.

Trees and Shrubs

- Autumn olive (*Elaeagnus umbellate*)
- Burning bush (*Euonymus alata*)
- Common privet (*Ligustrum vulgare*)
- Exotic bush honeysuckle (*Lonicera* sp.)
- Glossy buckthorn (*Rhamnus frangula*)
- Japanese barberry (*Berberis thunbergii*)
- Multiflora rose (*Rosa multiflora*)
- Norway maple (*Acer platanoides*)
- Princess tree (*Paulownia tomentosa*)
- Tree-of-heaven (*Ailanthus altissima*)

Multiflora rose overtaking and smothering an eastern redbud tree planted as part of a stream restoration project.

Credit: Kristen Koch, Penn State

Grasses and Grasslike Plants

- Common reed (*Phragmites australis*)
- Japanese stiltgrass (*Microstegium vimineum*)
- Reed canary grass (*Phalaris arundinacea*)

Nonwoody Flowering Plants

- Bull thistle (*Cirsium vulgare*)
- Canada thistle (*Cirsium arvense*)
- Garlic mustard (*Alliaria petiolata*)
- Giant hogweed (*Heracleum mantegazzianum*)
- Japanese knotweed (*Fallopia japonica*)
- Lesser celandine (*Ranunculus ficaria*)
- Poison hemlock (*Conium maculatum*)
- Purple loosestrife (*Lythrum salicaria*)
- Spotted knapweed (*Centaurea maculosa*)

Japanese knotweed (*Fallopia japonica*), a common problem plant, seen here rapidly growing along a newly restored stream site. It spreads by underground rhizomes, up to 30 feet away from the parent plant, as well as from seed and plant parts that float downstream.

Credit: © North Carolina Cooperative Extension

Vines

- English ivy (*Hedera helix*)
- Japanese honeysuckle (*Lonicera japonica*)
- Japanese hops (*Humulus japonicus*)
- Mile-a-minute (*Polygonum perfoliatum*)
- Oriental bittersweet (*Celastrus orbiculatus*)

Optimal Stream Repair Planting Schedule

LATE WINTER/EARLY SPRING
OR IN SOME CASES LATE AUTUMN

Live stakes: plant while dormant when the soil is not frozen

EARLY TO MID-SPRING

Bareroot tree and shrub seedlings

PLANT AFTER LAST SPRING FROST

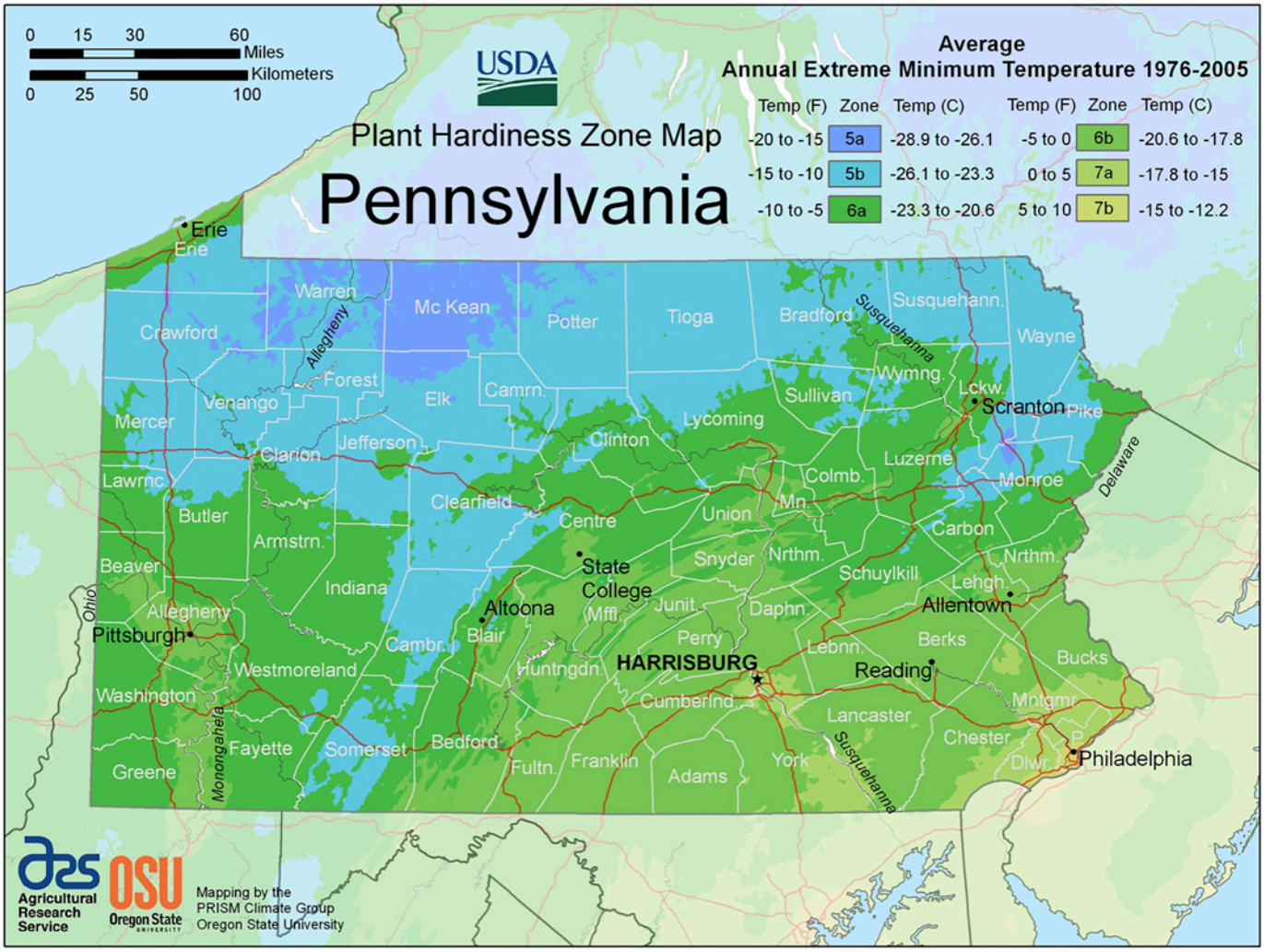
Stream edge herbaceous (nonwoody) transplants or plugs

SPRING AND FALL

Trees and shrubs in containers

SUMMER

Avoid planting—new plantings require 1 inch of water or rainfall per week



Credit: planthardiness.ars.usda.gov

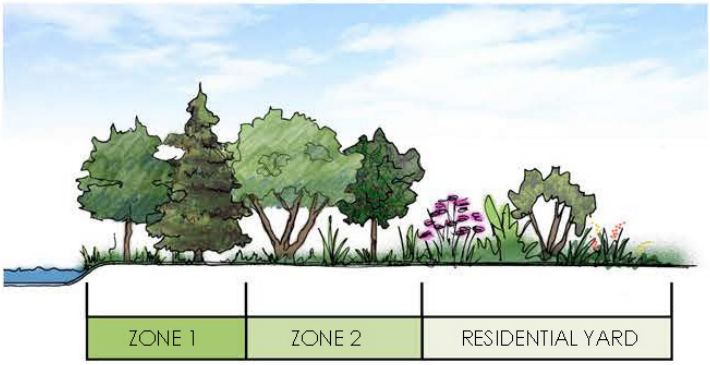
Familiarize yourself with the USDA hardiness zone and the average first and last frost dates in your area. Spring weather comes earlier in the southeastern part of Pennsylvania than it does in northern counties. Therefore, ideal planting dates will also vary.

	Spring Frost Dates			Autumn Frost Dates		
Area	**10% Chance**	**50% Chance**	**90% Chance**	**10% Chance**	**50% Chance**	**90% Chance**
Selinsgrove, PA (Snyder County)	May 14	April 29	April 14	Oct. 1	Oct. 15	Oct. 30
Norristown, PA (Montgomery County)	April 26	April 17	April 7	Oct. 6	Oct. 25	Nov. 13
Slippery Rock, PA (Butler County)	June 9	May 21	May 2	Sept. 14	Sept. 30	Oct. 15
Hawley, PA (Wayne County)	May 24	May 11	April 27	Sept. 20	Oct. 2	Oct. 14

Source: NOAA National Centers for Environmental Information (January 2020).

Example Stream Side Planting Plan

SECTION OF BUFFER ZONES



PLANTING SCHEDULE: ZONE 1				
ID	QTY	SCIENTIFIC NAME	COMMON NAME	SIZE
SHADE TREES				
BN	2	*Betula nigra*	River Birch**	15 gal con.
SMALL TREES/SHRUBS				
AS	10	*Alnus serrulata*	Smooth Alder	5 gal con.
CAC	42	*Clethra alnifolia 'compacta'*	Summersweet	5 gal con.
RV	24	*Rhododendrom vicosum*	Swamp Azalea	5 gal con.
VC	8	*Vaccinium corybosum*	Highbush Blueberry	5 gal con.
PLANTING SCHEDULE: ZONE 2				
ID	QTY	SCIENTIFIC NAME	COMMON NAME	SIZE
SHADE TREES				
CC	1	*Cercis canadensis*	Eastern Redbud	15 gal con.
SMALL TREES/SHRUBS				
AM	19	*Aronia melanocarpa*	Black Chokeberry	5 gal con.
CA	2	*Cornus amomum*	Silky Dogwood	5 gal con.
KL	5	*Kilmia latifolia*	Mountain Laurel	5 gal con.
IV	4	*Ilex verticillatta*	Winterberry Holly	5 gal con.
GRASSES				
AT	26	*Amsonia tabernaemontana*	Common Bluestar	5 gal con.

SAMPLE OF PROPERTY LINING STREAM

PLANTING APPROACH

To help facilitate planting buffers along the stream corridor, a specific approach must be implemented. The edge of the bed will be clustered with flood tolerant shrubs and grasses. The root systems will protect the shore line from erosion. If there is a steep slope down to the water's edge, the slope will be planted from bottom to top with clusters of plants.

Both zones, as well as the residential yard will be augmented with a seed mix to create a more natural riparian habitat. A recommendation for seed mix includes Ernst PA Valley and Ridge Province Riparian Mix (Product #: ERNMIX-233).

Most residential lots that abut streams and water bodies are not alike and, therefore, the buffer areas will vary. There are two zones of plantings that residents can look at when planting a buffer to protect their property from erosion and degradation from streams.

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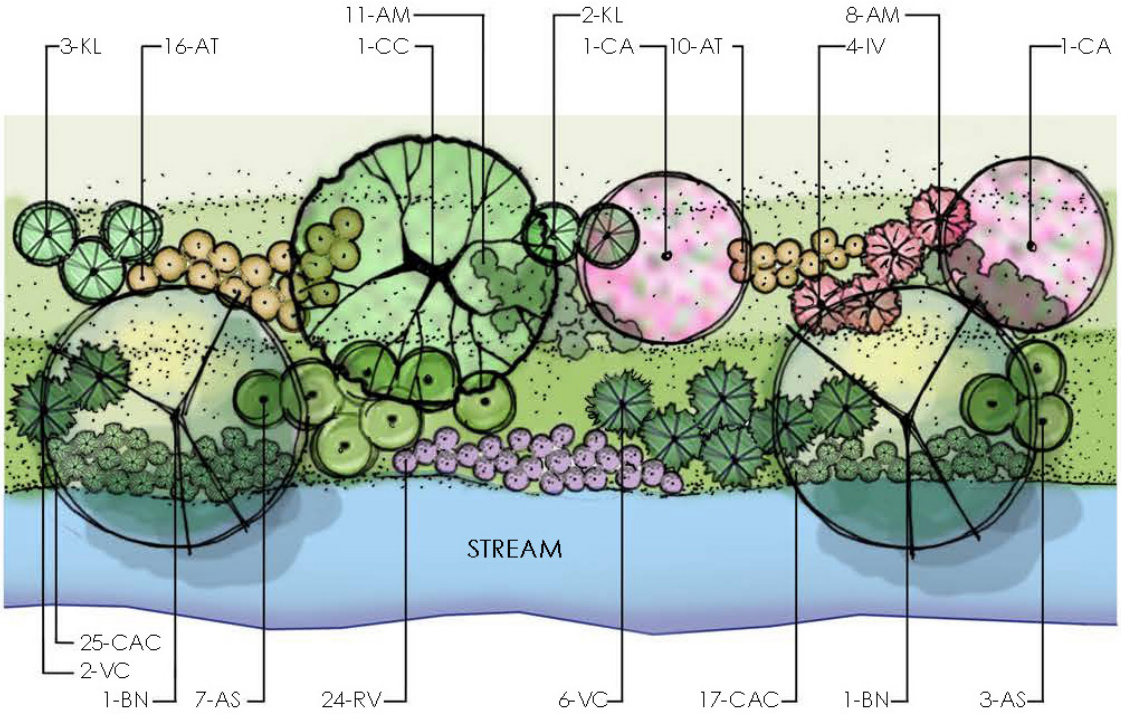
AN EMPLOYEE-OWNED COMPANY

EXAMPLE PLANTING PLAN



ZONE 1

The first 5 to 10 feet adjacent to either side of the stream edge shall be planted with native riparian species. This zone is to be predominantly planted with flood tolerant hardwood species which will provide shade to the stream. Low to medium height shrubs, grasses and small trees shall be planted in clusters along the stream bank so that the root system will protect the bank from erosion.

Planting recommendations for Zone 1 according to moisture content.
TREES:

Silver maple	*Acer saccharinum*
Box Elder	*Acer negundo*
River Birch	*Betula nigra*
Sycamore	*Acer pseudoplatanus*
Cottonwood	*Populus deltoides*
Swamp White Oak	*Quercus bicolor*
Black Willow	*Salix nigra*
Red Maple	*Acer rubrum*
Buttonbush	*Cephalanthus occidentalis*

SMALL TREES / SHRUBS:

Smooth alder	*Alnus serrulata*
Red Chokeberry	*Aronia melanocarpa*
Black Chokeberry	*Aronia melanocarpa*
Silky Dogwood	*Cornus amomum*
Summersweet	*Clethra alnifolia 'compacta'*
Winterberry	*Ilex verticillata*
Swamp Azalea	*Rhododendron viscosum*
Meadowsweet	*Spriea ulmaria*
Highbush Blueberry	*Vaccinium corybosum*

ZONE 2

From the landward edge of Zone 1, Zone 2 will extend out 5 to 15 feet or to where the edge of the flood zone ends. Hardy trees, shrubbery and grasses shall be planted within this zone.

Planting recommendations for Zone 2 according to moisture content.
TREES:

Red maple	*Acer rubrum*
Black Birch	*Betula lenta*
River Birch	*Betula nigra*
Hackberry	*Celtis occidentalis*
American Beech	*Fagus grandifolia*
White Ash	*Fraxinus americana*
Honey Locust	*Gleditsia triacanthos*
Tuliptree	*Iriodendron*
Black Gum	*Nyssa sylvatica*
Pin Oak	*Quercus palustris*

SMALL TREES / SHRUBS:

Redbud	*Cerci canadensis*
Mountain Laurel	*Kilmia latifolia*
American Hornbeam	*Fagus sylvatica*
Shadbush	*Amelanchier*
Flowering Dogwood	*Cornus florida*
American Hazelnut	*Corylus americana*
Common Spicebush	*Lindera benzoin*
Rosebay Rhododendron	*Rhododendron maximum*
Southern Arrowood	*Viburnum dentatum*
Bayberry	*Myrica cerifera*

Step 4: Maintaining Your Streamside Garden

In the first year, expect additional volunteer plants and invasive weeds to grow. Learn to identify and decide whether to pull out or manage these plants. Waiting too long to start weed management can make the job very difficult.

Some plants can die back but may sprout from the base of the plant; give plants a season before giving up and replacing them. It may take more than a year for seed to germinate and begin to grow.

It may take a few seasons to a few years for plants to establish (grow beyond their root ball and not need 1 inch of water per week), depending on the plant.

Throughout the year, sediment and debris may deposit in your planting area. It is okay to leave some deposits in place, but you may need to remove debris that is straining your plants or covering them completely.

Helpful Plant Identification Guides

- Conservation Buffers: Design Guidelines for Buffers, Corridors, and Greenways: https://www.srs.fs.usda.gov/pubs/33522
- Edible and Floral Riparian Plants: https://pecpa.org/wp-content/uploads/DCNR-Riparian-Plants-Book.pdf
- Invasive Plants in Pennsylvania: https://www.dcnr.pa.gov/Conservation/WildPlants/InvasivePlants/Pages/default.aspx
- National Wetland Plant List: http://wetland-plants.usace.army.mil/
- Pennsylvania Native Plant Society: http://www.panativeplantsociety.org/

Soft rush (*Juncus effusus*) and jewelweed (*Impatiens capensis*, pictured above) will often come up along creek banks without planting. These two plants bend with river flows and stabilize the water's edge.

Credit: © North Carolina Cooperative Extension

Unmaintained, this invasive bindweed is overtaking an oak tree planted along a stream.

Credit: Ryan Hill, Penn State

Streamside Maintenance Checklist

The best care is the least care when it comes to a stream buffer. Resist the urge to tidy up. Here are some typical maintenance suggestions.

- ❏ Install tree shelters to protect plants from wildlife browsing for the first couple of years.
- ❏ Initial fertilization/liming: Get a soil test to determine what the soil needs are.
- ❏ Visit streambank at least seasonally.
  ○ Spring ○ Summer ○ Fall ○ Winter
- ❏ Pick up litter and trash, as it will most likely wash down from upstream.
- ❏ Observe plant survival rates to determine what needs to be replanted (remember to be patient). Succession happens, so eventually perennials will thin out due to shade from trees and shrubs. Consider replanting with shade-tolerant species when this happens.
- ❏ Observe and ID invasive plants to determine your eradication management plan. If you keep up with what is supposed to be there, and get rid of what's not on your list, it will make for much easier maintenance in the future.
- ❏ Prune only as needed for future health of the trees. The object is to build a strong belowground root system to protect bank integrity and allow a dense canopy to shade the stream. If a large tree threatens to fall from a steep bank, you can cut the tree 10 feet above the ground surface and leave the root system in place. The "snag" that remains on the streambank will provide a great home for wildlife. In Pennsylvania, you need a permit to remove a tree's root mass from a streambank.
- ❏ Mowing: While not always needed or required, herbaceous plants could occasionally be mowed to 6 inches once plants are established. This should be done in late fall or early spring, but watch for trees and shrubs. Mowing and weeding tools can damage your planted vegetation and open the door to future disease and early plant death. This is a good reason to space your newly planted trees far enough to allow your mower to fit between them.
- ❏ Inspect after large rain events or flooding. Repair small eroded spots before they get worse. If large woody debris is going to dam the creek and cause inundation, remove a 2-foot piece out of the log so water can flow through, but leave the rest for fish habitat. No permit is needed to remove that log portion from the stream.

Helpful tip: Search online for pictures of what was planted by season so you know what you've got and don't accidentally cut down good vegetation!

Appendix A: About Grading Your Stream

Grading your streambanks may be your best or only option. We highly recommend getting professional help with this activity. While the work itself may be simple enough for you to do, Pennsylvania has very specific permitting requirements for any work that involves moving soil in and along a stream.

The following guidance about streambank grading is intended to help you decide if this is the right solution for your backyard stream.

Before You Start Grading!

Contact your local technical resource. You will need a permit before starting this type of work near the stream.

- Army Corps of Engineers (Pre-Construction Notification, Section 404 Permit & Ordinary High Water determination): https://www.saw.usace.army.mil/Missions/Regulatory-Permit-Program/
- Pennsylvania Department of Environmental Protection Regional Office: https://www.dep.pa.gov/About/Pages/Office-Locations.aspx
- County Conservation District: https://pacd.org/?page_id=59
- Local municipal government (to determine if any buffer ordinances apply)

After complying with all local and state requirements . . .

1. **Determine 3:1 slope.** A "three-to-one slope" (33.5 percent or 18 degrees) is considered the ideal, stable slope. When applying for your permit, you should indicate that this is the slope you will be grading to.

   To calculate a 3:1 slope for grading a streambank, measure the change in elevation (from the ordinary high water mark to top of the bank). Multiply that height measurement by 3. Then measure the multiplied distance from the bank into the landscape and mark it.

2. **Acquire stabilization supplies.** Temporary and permanent seeds are needed along with other erosion control materials until vegetation establishes.

   a. Seed mixes: Purchase pounds of seed per acre (lb/A) of streambank disturbance per specifications of seed supplier. Permanent mixes might include but are not limited to deertongue, Virginia wild rye, big bluestem, indiangrass, partridge pea, switchgrass, blue vervain, autumn bentgrass, ox-eye sunflower, little bluestem, boneset, soft rush, New York ironweed, black-eyed Susan, Joe Pye weed, great blue lobelia, and wild bergamot.

   You can search online for suppliers with native perennial mixes for Pennsylvania streambanks. You might search for "riparian" seed mixes for Pennsylvania.

For a bank that is 2 feet high, multiply by 3 (2 feet × 3 feet = 6 feet). Measure 6 feet back into the landscape and flag it. Grade between the landscape flag and the ordinary high water flag (depicted by white circles above).

Credit: Matt Royer, Penn State

   b. Straw: Apply straw over newly seeded area at a rate of 140 pounds per 1,000 square feet. An average small bale of straw is around 30–45 pounds (*DEP Erosion and Sediment Pollution Control Program Manual* 2012).

   c. Coir erosion control matting: Biodegradable matting is sold in rolls and can be found in several natural materials such as coir (coconut fiber), jute, and more. It breaks down naturally over several years as your vegetation takes over stabilization. Avoid materials with any plastic or other nonbiodegradable components. Be sure to get a matting with an openweave netting that allows plants to grow through it. The length and width of your streambank grading project will determine how much matting you need. Check with local suppliers for availability options.

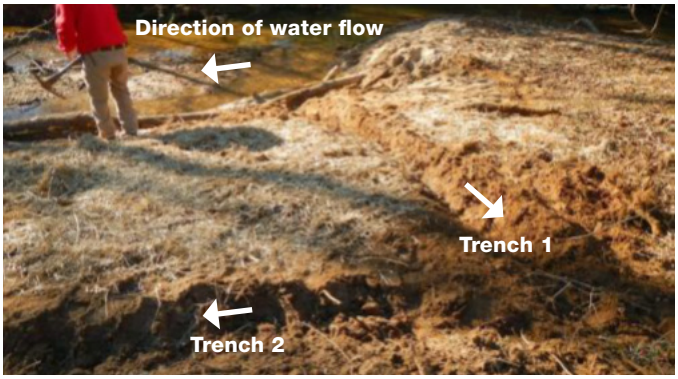
   d. Stakes: You will need 12-inch-long biodegradable eco-stakes (approximately one per 12 square feet of matting) and 2-foot-long oak stakes (approximately one per 16 square feet of matting). These materials can be purchased from erosion control companies and landscape farm supply stores.

   e. Other helpful tools: Mallets, shovels, tampers, rakes, seed spreaders, and volunteer manpower.

Temporary Seed and Specifications

COMMON NAME	SCIENTIFIC NAME	OPTIMAL PLANTING TIME
Spring oats	*Avena fatua*	Spring
Winter rye	*Secale cereale*	Fall
Annual rye	*Lollium multiflorum*	Spring or fall

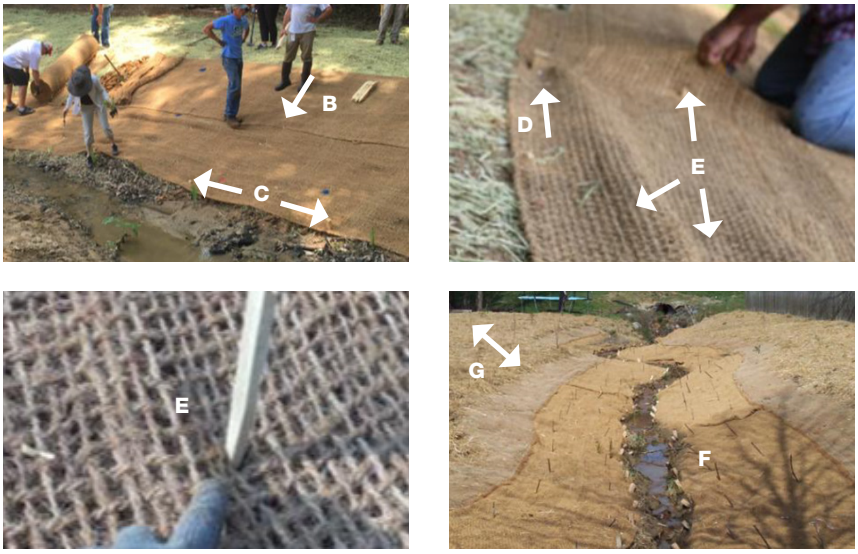
3. **Grade bank(s) to the appropriate slope (3:1 is ideal).** Equipment is helpful, but this can also be done by hand (it will be labor intensive). Avoid dropping sediment into the water. Keep equipment out of the water unless you have an approved permit that allows heavy equipment in the water. Your permit must detail the process you plan to use and your design. Follow your approved permit plans exactly.
4. **Prepare the seedbed.** Lightly rake your newly graded soils within riparian areas to provide maximum soil contact for seed germination and seedling growth. Surface soils should be loose enough for water infiltration and root penetration. Making sure that you get successful plant growth that covers these disturbed soils will be a key part of your permit requirements.
5. **Dig trenches to secure matting.** Matting should be secured to prevent overland flow and high water streamflow from cutting under it.



Credit: © North Carolina Cooperative Extension

- Trench 1: Dig a trench line at the upstream end of your matting. The trench should run perpendicular to the stream from the water's edge to the top of matting (about 6 feet or whatever the width of your matting roll is). If you graded further than 6 feet from the stream you may need to overlap two rolls of matting and the trench will need to be long enough to reach the top of your disturbed soils in the graded area.
- Trench 2: Another trench line should be created along the top edge of where matting will be laid for the entire length of the matting, parallel to the stream.

6. **Spread temporary and permanent seed mix.** Choose temporary seed based on time of year (see the table on page 15) and select permanent seed for longer-term establishment. Many seed suppliers can premix temporary and permanent seed together. Seed suppliers can assist you with a rate per square foot based on the seeds you select. Use a spreader for more uniform planting.
7. **Lightly cover the seed with straw.** Covering the seeds provides moisture for growth and protects them from scavenging birds.
8. **Cover with coir matting.** The following sequence explains how to install matting (see images below and on next page):
   - A: Lay the starting edge of the matting in Trench 1, and tamp in 2-foot oak stakes every 1.5 feet from the top of the trench to the stream edge. (Tip: Drive a nail partway into the side of each of these stakes, near the top, before tamping into matting. This will provide a catch that will hold this edge of the matting on to the stakes during high-water events.)
   - B: If your graded area extends away from the stream farther than the width of one roll of matting, overlap extra matting rolls by at least 1 foot. The bottom mat should be closest to the stream.
   - C: Roll out matting and tamp down oak stakes every 4 feet at water's edge. Follow the contours of streambank with matting constantly touching soil. Do not pull taut.
   - D: Add 2-foot oak stakes every 10 feet to top of matting in Trench 2.
   - E: Hammer in eco-stakes randomly, about 4 to 6 feet apart, throughout the matting, including along the top edge.
   - F: You can also plant live stakes (see pages 8–9) directly through the matting for added security and vegetation.
   - G: Once all the matting is laid out and secured with stakes, cover the trenches with a few inches of soil, tamp it down and lightly cover top edge with straw, extending to the undisturbed landscape above your grading.
9. Return to pages 4–7 to choose appropriate trees and shrubs to complete your streamside planting.

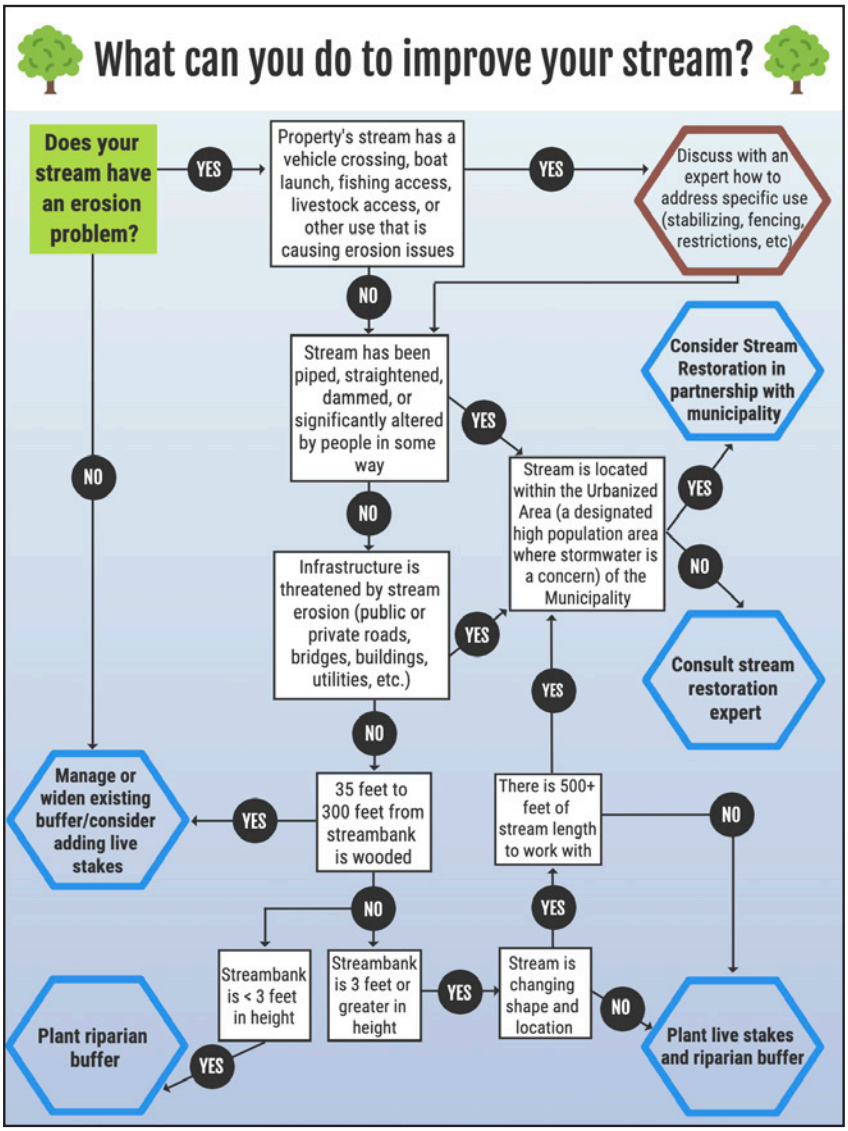


These images provide a demonstration of the matting sequence described on page 16.

Credit: © North Carolina Cooperative Extension

> "When purchasing seed, remember that 'cheap' seed is generally not a bargain. Inexpensive seed usually is below minimum standards in germination or purity, or both. In addition, inexpensive seed often contains excessive amounts of weed seed or seed of other crops."
>
> —Landschoot (1997)

Appendix B: Stream Improvement Decision Tool



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