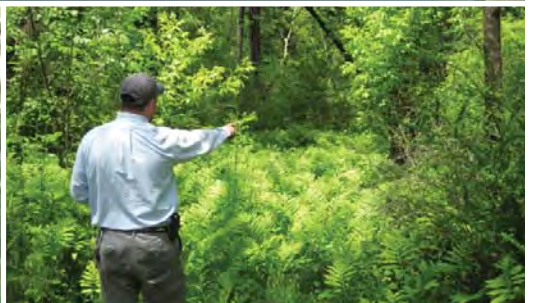




# Shoreline Management Manual

A Homeowners Guide to Shoreline Stabilization and Vegetated Buffer Zones



March 2014

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# INTRODUCTION

If you are a lake resident on Candlewood Lake, Lake Lillinonah, or Lake Zoar, you are living on the shores of a reservoir that is part of a hydroelectric project. These lakes were created with the construction of hydroelectric facilities along the Housatonic River in the earlier part of the twentieth century. Today, together with areas around Bulls Bridge and Falls Village, these hydroelectric facilities and impoundments are owned and operated by FirstLight Hydro Generating Company under a license from the Federal Energy Regulatory Commission (FERC) Project P-2576.



1934 Aerial of Rocky River Impoundment – Candlewood Lake

## Falls Village

The Falls River Station was constructed in 1914 at the Great Falls of the Housatonic River in Falls Village and is the northernmost dam/impoundment. It impounds approximately 150 acres of surface water and has a capacity of 9,300 kilowatts.

## Bulls Bridge

The Bulls Bridge Station was the first of the Housatonic Project's hydroelectric facilities to be constructed in 1904. The reservoir impounds 120 acres of the Housatonic River and has a capacity of 7,100 kilowatts.

## Candlewood Lake

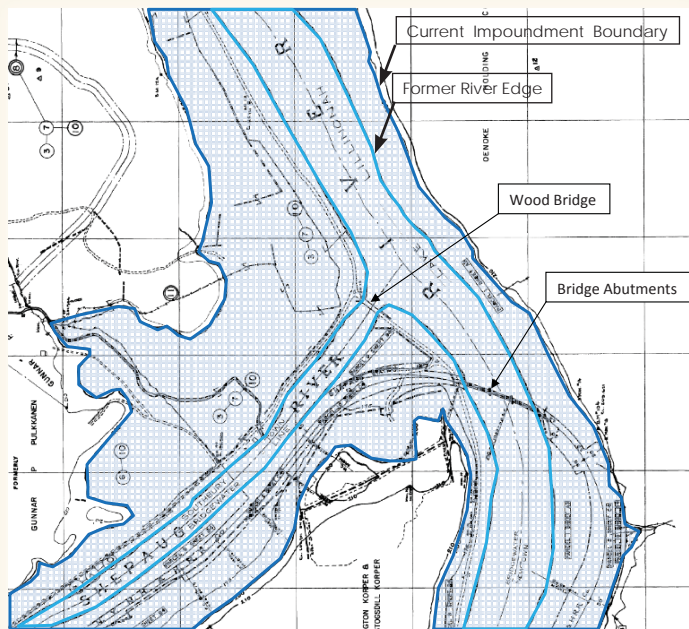
The idea of the construction of the Rocky River Station and the creation of Candlewood Lake to fuel the station was conceived by Connecticut Light & Power in 1926. The first of its kind in the United States, Rocky River is a pumped storage facility. Water is pumped from the Housatonic River up 240 feet through the Rocky River Station in New Milford to Candlewood Lake. When pumping water from the Housatonic River up to the reservoir, the station consumes electricity. The station and penstock, or pipe, can be seen from Route 7 in New Milford. During periods of high electric demand, the reservoir water is released and flows back down to the Rocky River Station to power the turbine and generate electricity. This pumped storage facility allows for the ability to generate power at peak demand. Candlewood Lake would not fill up naturally from its watershed without seasonal pumping to a summer recreational level. Over 6,000 acres of land in five towns needed to be purchased to construct the Rocky River Station and its reservoir of Candlewood Lake. With a lake surface area of 8.5 miles or 5,500 acres and with over 60 miles of shoreline, Candlewood Lake is the largest reservoir in the Housatonic River Project and the largest lake in the State of Connecticut. The lake is almost 11 miles long and is 2 miles wide at the widest point. Rocky River Station has the capacity to generate 29,000 kilowatts of power.



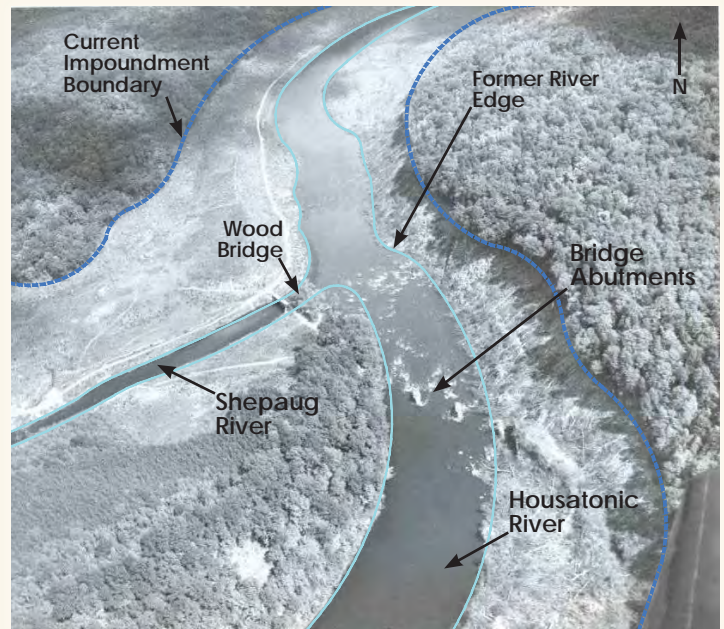
# INTRODUCTION

## Lake Lillinonah

Lake Lillinonah was the last of the reservoirs to be created, in 1955, with the construction of the Shepaug Station and its dam in Southbury and Newtown. The southernmost reservoir, this hydroelectric station is the newest and largest hydrogenerator in the state with the capacity to generate 43,000 kilowatts of energy. Lake Lillinonah has a surface area of 1,870 acres and 35 miles of shoreline.



Lake Lillinonah Historic Map



Historic Aerial of Lake Lillinonah

## Lake Zoar

The construction of the Stevenson Station in 1917 followed the construction of Falls Village, which flooded the Housatonic River Valley and created the first of the lake reservoirs now named Lake Zoar. This southernmost impoundment provided a new area for lake recreation. Lake Zoar has a water surface area of about 1,063 acres. Today, with a fourth turbine that was added in 1936, the Stevenson station has the capacity to generate 28,900 kilowatts of power.

At the time when these individual hydro projects were established, a **project boundary** was determined. The project boundary is a geographic and administrative boundary line that defines the lands necessary for operation and maintenance of the project(s). The area within the boundary encompasses both the lands under the waters of the reservoirs and land areas that may never have been submerged since the projects were constructed. FirstLight has established surface water elevations for the normal operating range of each project. Additionally, above this range, FirstLight has either fee title or water flowage rights that extend to the project boundary. Along each impoundment, the project boundary corresponds to specific topographic elevations (see Table on the following page).



# INTRODUCTION

**Table 1 - Project Boundary & Operating Range Elevations (Feet) NGVD\***

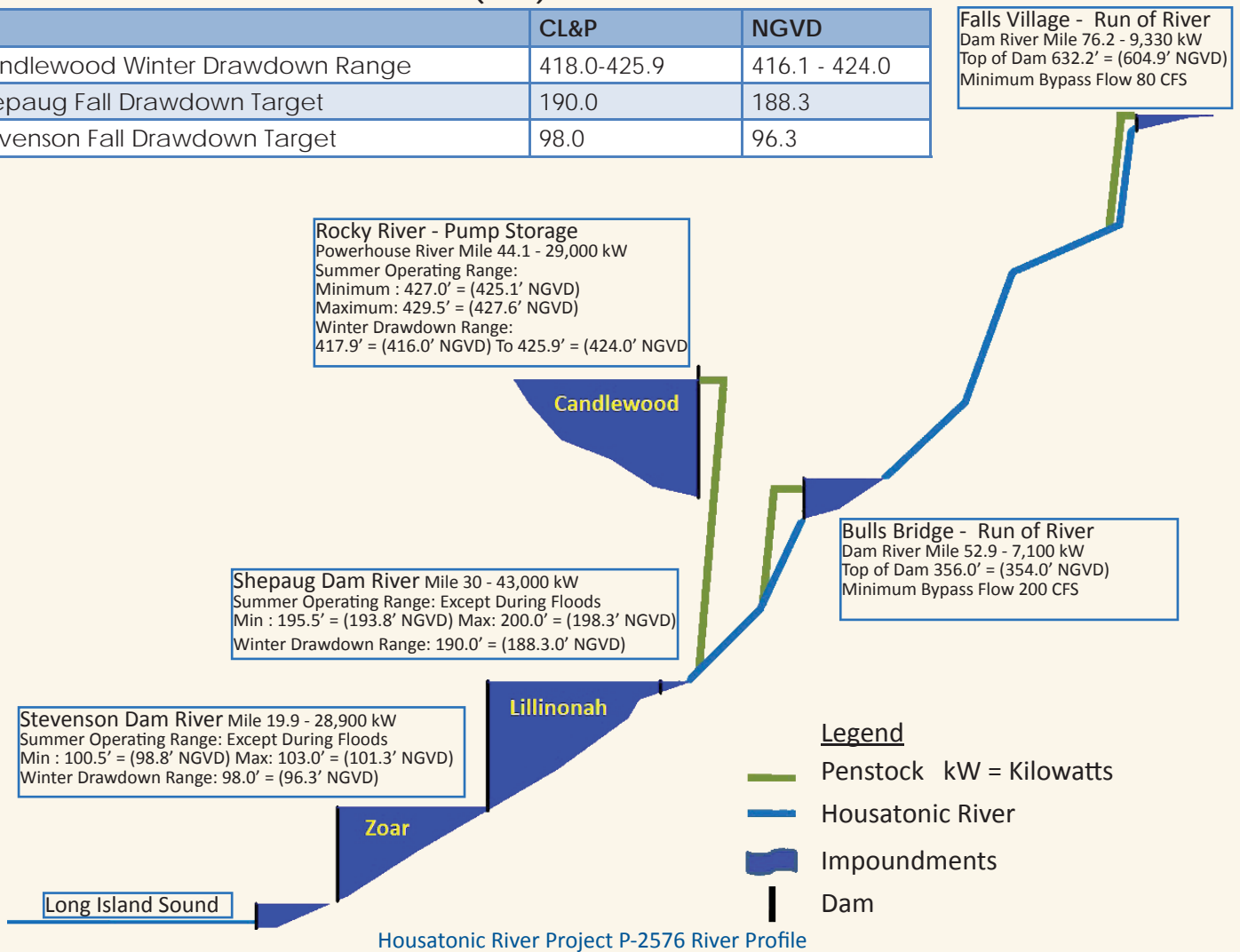
Station Name-Impoundment	CL&P Datum	NGVD	Project Boundary CL&P	Project Boundary NGVD
Falls Village-Housatonic River	631.7-632.2	604.4-604.9	660.5	633.2
Bulls Bridge-Housatonic River	355.5-356 .0	353.5-354.0	356	354
Rocky River-Candlewood Lake	427.0-429.5**	425.1-427.6 **	440	438.1
Shepaug Station-Lake Lillinonah	195.5-200*	193.8-198.3	210	208.3
Stevenson Station-Lake Zoar	100.5-103.0*	98.8-101.3	110	108.3

\* Note - National Geodetic Vertical Datum (NGVD)

\*\* Normal Summer Operating Range Memorial Day to October 15

**Table 2 - Seasonal Drawdown Elevations (Feet) NGVD\***

	CL&P	NGVD
Candlewood Winter Drawdown Range	418.0-425.9	416.1 - 424.0
Shepaug Fall Drawdown Target	190.0	188.3
Stevenson Fall Drawdown Target	98.0	96.3



# INTRODUCTION

Over the subsequent century, since these hydroelectric projects were first constructed, the surrounding lands have been developed and there are many adjacent residential lake communities, and commercial landowners around these impoundments and lakes. Many of FirstLight's neighbors have access and use of the project lands and waters of these impoundments. Under FirstLight's FERC License, it has the authority and responsibility to manage all "project" and "non-project" uses within the project boundary. FirstLight must ensure that all permitted uses on lands within the project boundary are protecting and enhancing the scenic, recreational, and other environmental values of the project.

As developmental pressure and multiple uses along the shorelines of hydroelectric impoundments and reservoirs have increased over recent years, the FERC has required hydroelectric licensees (FirstLight) to develop Shoreline Management Plans (SMP) as part of the relicensing of the projects. A SMP is a comprehensive plan to manage the multiple resources and uses of the project shorelines in a manner that is consistent with FERC license requirements and project purposes and addresses the needs of the public.

FirstLight's SMP was approved on March 27, 2013 and provides guidance on permissible uses of lakefront lands within the project boundary. Key components of the SMP are the requirements for the preservation and establishment of vegetated buffer areas and the use of alternative types of shoreline stabilization. As part of the SMP, FirstLight was required to develop a shoreline management manual for its impoundments. (<http://www.firstlightpower.com/generation/documents/SMP3-27-2013.pdf>)

The results of stabilizing shorelines and re-establishing a vegetated buffer zone within the project boundary are providing natural shoreline stabilization (i.e., replacing seawalls with a more natural shoreline), reducing the effects of polluted stormwater runoff to the lakes, and protecting water quality. This shoreline management manual is intended to provide FirstLight and the shoreline homeowners who live along these lakes a guide for the preservation, establishment, enhancement, and maintenance of productive, successful shoreline stabilization and vegetated buffer zones. This manual provides an introduction to the functional importance of shoreline management through bank stabilization and vegetated buffer zones; describes how to plan for and establish stable banks and vegetated buffers; explores alternative shoreline protection measures; examines how to maintain new and/or established buffers over the long term; identifies appropriate plant species and densities; and provides guidance on where native plants can be purchased. While the primary focus

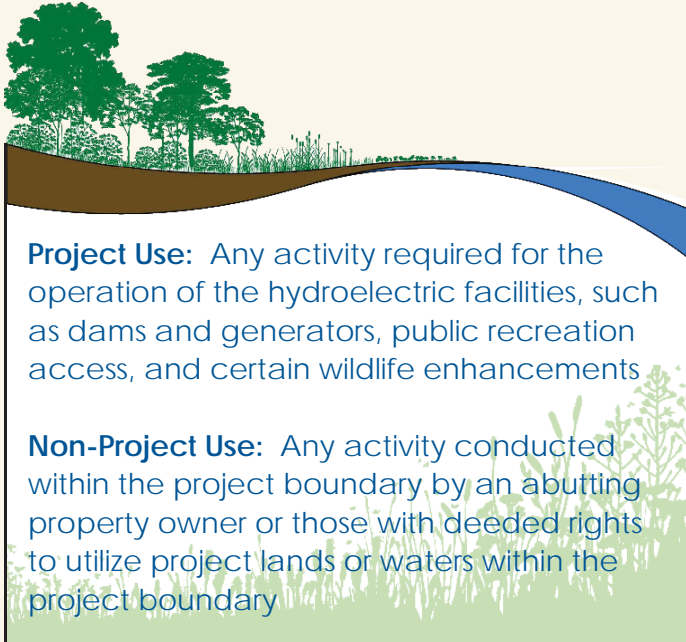


**Fee Title Project Lands:** These are lands that were acquired in full ownership prior to the construction and flooding of the impoundments.

**Flowage Rights Project Lands:** These lands are not owned in fee title by FirstLight; however, they are subject to FirstLight's deeded rights to flow water and place ice on the lands to which others have retained fee title.



# INTRODUCTION



**Project Use:** Any activity required for the operation of the hydroelectric facilities, such as dams and generators, public recreation access, and certain wildlife enhancements

**Non-Project Use:** Any activity conducted within the project boundary by an abutting property owner or those with deeded rights to utilize project lands or waters within the project boundary

of this manual is on those land areas located within the project boundary, the concepts and guidance provided herein can be generally applied to many areas throughout the region and throughout a watershed that contributes to a watercourse and/or waterbody.

The operation of hydroelectric projects is regulated by the Federal Energy Regulatory Commission (FERC) under the authorization of the Federal Power Act of 1920, as subsequently amended by the Federal Power Act of 1935(FPA).

FirstLight was issued a new license from the FERC on June 23, 2004 for the Housatonic River Project License P-2576. The project license is valid through 2044.

## Shoreline Stabilization and Vegetated Buffer Zones

Both shoreline stabilization and vegetated buffer zones are critical to preserving, enhancing, and maintaining a waterbody's shoreline. Waterbodies may consist of ponds, lakes, impoundments, and/or reservoirs.

- A lake is defined as a large body of water surrounded by land.
- An impoundment is defined as a large body of water that is impounded (i.e., formed) by a structure (i.e., dam, dike, levee, or other structures) and surrounded by land.
- A reservoir is defined as a large natural or artificial lake used for collecting and storing water for human consumption or agricultural use.



Natural Vegetated Shoreline

The shoreline of a waterbody and/or watercourse is a dynamic environment with many complex ecosystem relationships. The shoreline of a lake is the single most important aspect of lake ecology. The shoreline is the interface between the water and the surrounding landscape. However, most of our lakes have a significant level of shoreline development. The U.S. Environmental Protection Agency (USEPA) 2009 National Lakes Assessment: A Collaborative Survey of

A "Vegetated Buffer Zone" is an area that is intended to provide for the establishment of native vegetated cover plants.

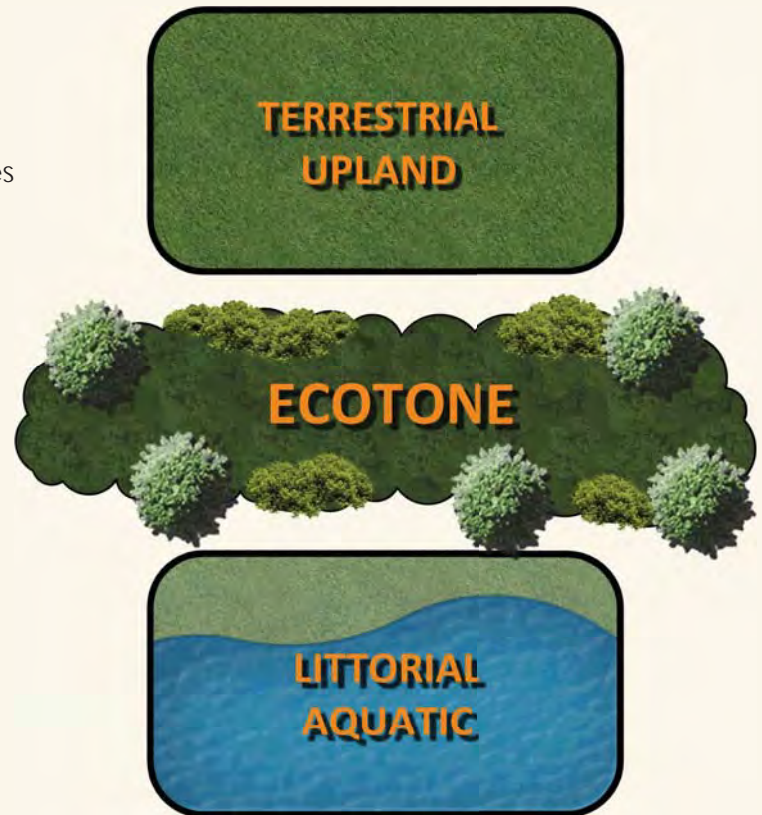
# INTRODUCTION

the nation's lakes found that nationally, poor lakeshore habitat is the biggest problem in the nation's lakes with over one-third exhibiting poor shoreline habitat condition. Degraded biological health is three times more likely in lakes with poor lakeshore habitat.

A vegetated buffer or riparian buffer is the ecotone between terrestrial upland and littoral aquatic habitats. The maintenance and enhancement of riparian vegetated buffers are essential for preserving, protecting, and enhancing the scenic, recreational, and other environmental resources of a waterbody and/or watercourse. Riparian buffer corridors along the water's edge from 50 to 200 feet play a significant role as a watercourse's and waterbody's first line of defense against the watershed that contributes nutrients to these important resources.

Vegetated buffers are essential in:

- Stabilizing shoreline soil and slope
- Collecting, treating, and filtering polluted stormwater runoff into lakes
- Protecting and enhancing the water quality of our lakes
- Providing food and shelter for fish, reptiles, birds, insects, and other wildlife
- Providing privacy for lakefront residences thus increasing property values
- Reducing maintenance needs and costs on lakefront properties.



If you are adding a new use or making modification to an existing use, a compliant vegetated buffer will be required.

If you are a new lake resident who recently purchased a home that abuts the project boundary, a compliant vegetated buffer will be required within 5 years of the change in ownership.

Failure to obtain permits from FirstLight for uses and activities within the project boundary may result in FirstLight's exercise of all enforcement rights. (These are defined in Exhibit E of the SMP.)

- Fines up to \$1,000 per violation per month
- Trespass action
- Exercise of federal right of eminent domain under Sec 21 of the FPA
- Suspension of permits for any uses
- Requiring project lands to be restored to original condition
- Recovery of cost of removal of unpermitted structures and uses
- Recovery of enforcement-related legal costs



# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## A. THE IMPORTANCE OF VEGETATIVE BUFFER ZONES

A vegetated buffer zone serves many critical and important functions within a lake system. Each of these functions is described below:

### Shoreline Stabilization

FirstLight's impoundments create lakes that provide the recreational boating public with opportunities to operate watercraft. Boat wakes from motorized watercraft generate significant unnatural wave energy that causes severe erosion along the natural shoreline. A vegetated buffer can absorb this energy and prevent erosion of the shoreline. Shorelines that consist of maintained lawn to the water's edge typically do not have sufficient root structure to bind the underlying soils and prevent even natural erosion. Having a mixture of deeper rooted plants, including a combination of trees, shrubs, and herbaceous plants, creates a shoreline that is more resistant to erosion. The re-establishment of a productive aquatic littoral zone that includes emergent plants that produce a wetland shelf is ideal. The upland shoreline above the seasonal high water line is an important transition zone that plays a critical role in absorbing wave energy and protecting the shoreline soils from erosion.



Example of naturally vegetated, stabilized shoreline using hay scented fern and native groundcovers

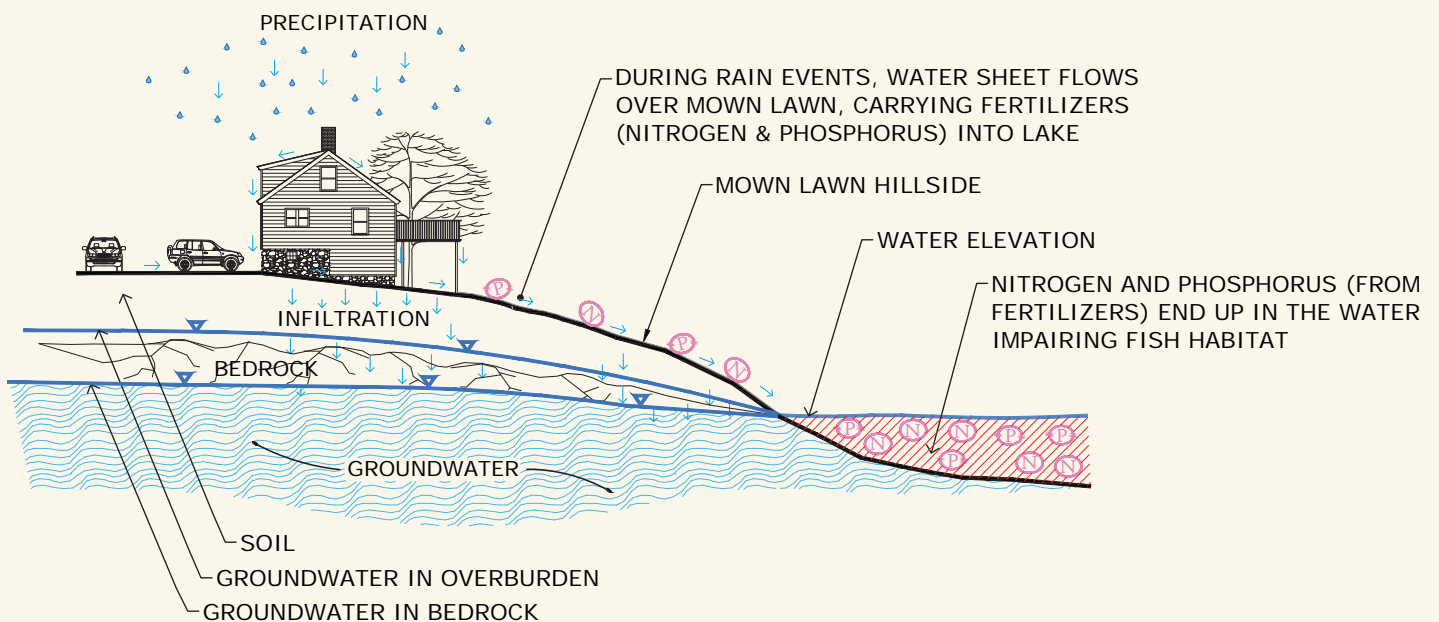
# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## A. THE IMPORTANCE OF VEGETATIVE BUFFER ZONES

### Stormwater Runoff Filtering

Diminishing water quality and clarity within our lakes have become increasing concerns for lake managers and lake users as they relate to bacteria and nutrient levels, algae blooms, and excessive submerged aquatic plant growth. Fertilizers and pesticides that are applied to maintained lawns contribute to reductions in water quality and clarity. Conventional grass lawn species do not completely absorb or filter fertilizers and pesticides that are commonly applied to them, as most planted lawn grasses have a shallow rooting depth ranging from 3 to 5 inches. However, native grasses maintain deeper rooting zones. Some native species can reach depths greater than 12 inches and therefore capture more of these nutrients.

Nutrients and pesticides often attach themselves to sediments that can become suspended within stormwater and overland runoff. The dense vegetation found in a healthy vegetated buffer zone intercepts rainfall, promotes infiltration, and slows down stormwater runoff, allowing for increased nutrient absorption by the vegetation. Vegetated buffer zones that have a diverse community of plant species, variable plant stratum, and greater plant density provide increased stormwater filtering opportunities for the nutrients found in fertilizers, such as nitrogen and phosphorus, as the stormwater travels toward the lake.

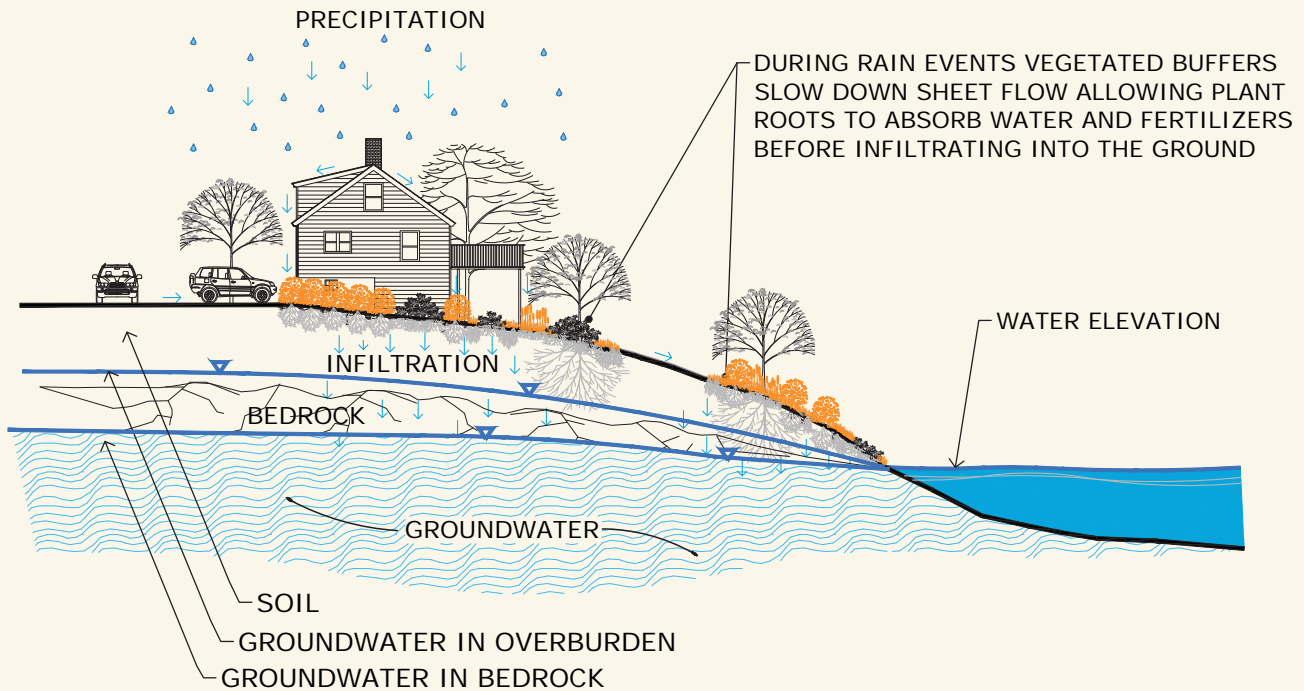


Stormwater runoff with no vegetated buffer



# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## A. THE IMPORTANCE OF VEGETATIVE BUFFER ZONES



Stormwater runoff with vegetated buffer

### Wildlife Habitat

Vegetated buffer zones are a key ecotone for most endangered and rare species of wildlife. They provide essential resources such as shade, shelter, and food sources for a variety of fish and wildlife species that utilize the shoreline. For example, the fruits of many of our native shrubs including red osier dogwood, silky dogwood, high bush, and northern arrowwood are eaten by a variety of resident and migratory songbirds and waterfowl.

Low, dense-growing shrubs provide additional habitat to protect wildlife. The leaves and woody materials from trees and shrubs that fall into the water also provide essential food sources (called allochthonous material) for aquatic macroinvertebrates (insects), which are the primary food sources at the base of the food chain for fish and other small vertebrates. Densely vegetated buffers have also been found to deter nuisance waterfowl such as the Canada geese from feeding on lawns adjacent to the shoreline. Maintaining a dense shoreline buffer at the water's edge will invoke a natural predatory response of fear in geese and other waterfowl as the geese are unsure as to what is hiding in the vegetation. Waterbodies with naturally vegetated



Eastern Redwing black bird within existing vegetated buffer area

# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## A. THE IMPORTANCE OF VEGETATIVE BUFFER ZONES

shorelines and no lawn have lower populations of resident nuisance waterfowl (Canada geese).

### Establishing Water Views

Carefully selected view corridors can actually refine and frame waterfront views. The lower branches on existing healthy trees can be limbed up to provide openings for views from one's home. The topping of trees (i.e., removing the upper branches) can also serve the same function. However, trees must be pruned properly, and not all trees will tolerate topping. FirstLight requires a written evaluation from an arborist along with a FirstLight permit before such pruning of vegetation can be done. All tree work must be performed by a Connecticut Licensed Arborist.



Limbed trees provide shade while maintaining lake views, privacy, & vegetation along both sides of the property

### Enhancing Privacy and Property Value

Mixed plantings also furnish an attractive living screen against visual intrusion. The creation of natural outdoor living spaces that are integrated within a vegetated buffer allows for an opportunity for individuals to interact with nature and entertain while immersed in the natural lake scenery-making the property desirable to property owners. A well designed vegetated buffer will also increase property values.

### Protecting Lakefront Residents from Wind and Sun

Properly placed vegetation has been shown to divert chilling winds during the cooler months and provide shade during the warmer months, making a home more comfortable and energy efficient throughout the year. Ground cover not only protects and stabilizes bare soil, but it has been shown to deflect heat as well.

### Provide Sustainability and Low Cost Maintenance

Properly designed and installed vegetated buffers provide long-term sustainability. They can be implemented at relatively low initial installation costs and require minimal maintenance costs over the long term. Vegetated buffers require less maintenance, including reduced thatching, mowing, weed whacking, fertilizing, mulching, and raking in the fall, saving you both time and money.



# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## B. IMPACTS ASSOCIATED WITH CLEARING THE VEGETATED BUFFER ZONE

There are critical and sensitive ecological and social functions and values that are impacted when vegetated buffer zones are removed, not properly preserved, restored, enhanced, and maintained including:

- Reduction in terrestrial insect food chain for fish, which can comprise a large fraction of food for fish where riparian vegetation is undisturbed
- Significantly change or reduce native bird populations or species assemblages leading to an overall decline in avian diversity and lower bird foraging guild diversity
- Reduced capacity to absorb rain energy and infiltrate and collect rainwater, which greatly increases erosion and stormwater runoff during storm events causing increased nutrient and sediment transport
- Developed residential shorelines have increased impervious surfaces including driveways, rooftops, walkways, decks, and patios, which generate increased stormwater runoff volumes and velocities, leading to the transport of sediments, fertilizers, and other nutrients from the landscape into the lake.
- The maintenance of conventional lawns and non-native ornamental landscapes requires the addition of fertilizers, which often leach through soils into adjacent waterbodies.
- An overall decline in habitat heterogeneity, which leads to a decline in species diversity
- The Wisconsin Department of Natural Resources has estimated that developed sites that do not contain vegetated buffers contribute five times more runoff, seven times more phosphorus, and 18 times more sediment to a lake than the naturally forested sites.
- An overabundance of nutrients reaching a lake contributes to excess algal and aquatic plant growth, which negatively impacts swimming, boating, and other recreational activities in and around the lakes.
- Properties surrounding lakes with better water quality have increased property values.



Great Blue Heron



Damselfly



Blue Green Algae Mats from an overabundance of nutrients



# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

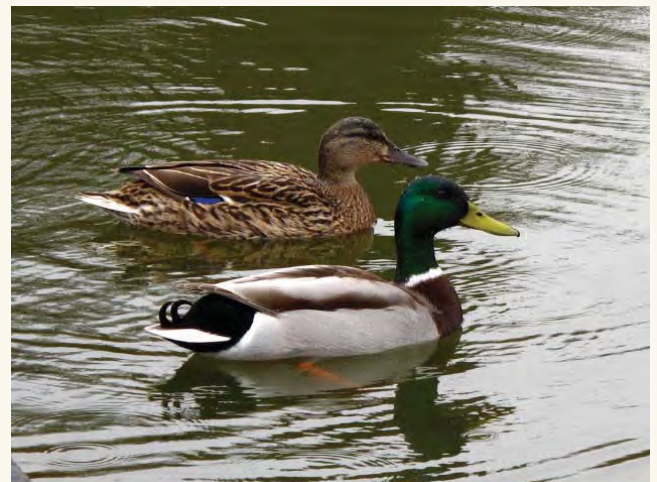
## C. IMPORTANCE OF LITTORAL HABITAT ZONE

The littoral zone begins in the lake at the depth penetrated by sunlight beneath the surface and continues onto the land. It contains both aquatic and emergent plants in the water and adjacent upslope terrestrial vegetation. The littoral zone is an important food, shelter, and resource area for aquatic organisms including insects, fish, reptiles, mammals, and birds. Clearing of vegetation and woody debris (i.e., woody snags, stumps, etc.) adjacent to and within the littoral zone will impact the following:

- Turtles lose sun basking sites.
- Significant decline in shelter for snails, Bryozoans, fish, frogs, turtles, water birds, and mammals
- Populations of some fish species are significantly reduced over time due to loss of woody debris that provides shade and sheltering.
- Indirectly affects energy flow through macroinvertebrate communities, which leads to shifts in species composition by removing critical material used by macroinvertebrates, which are eaten by fish or hatch into mosquito-eating dragonflies
- Loss of downed trees near shore also results in increased wave energy and ice action along the lakeshore.
- Significant decline in habitat heterogeneity causing an overall decrease in species diversity in invertebrate, young fish, frogs, dragonfly, and damselfly populations
- Loss of littoral habitat heterogeneity can lead to a decline in energy transfer to pelagic fish, causing stunted population growth.



Typical vegetated littoral zone



Mallards



Painted Turtles on sunning logs



# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## D. TYPES OF SHORELINE BUFFER ZONES

A four-zone shoreline buffer provides a zone through which water quality and habitat can be improved along with shoreline soil stability.

**Zone 1 (Littoral)** - This buffer zone begins in the lake at the depth to which sunlight penetrates the surface to lakebed sediments. It contains the habitat for both aquatic and emergent vegetation and continues up onto the land immediately adjacent to the water body with shrubs and herbaceous plants. This zone of transition is a key ecotone that in nature contains aquatic plants that absorb natural wind-driven wave energy and provide shoreline soil stabilization and habitat for both aquatic and terrestrial organisms while the shoreline shrubs provide shade and detritus and anchor large natural woody debris at the water's edge. The upper limit of this zone ends at the point where wave action forces no longer dominate the landscape. This shallow water ecotone environment is the engine of a lake where the majority of both plant and animal life interact. The health and diversity within this community establish the energy flow dynamics of the deeper water environments. Think of this buffer zone as the skin of the lake.



Example of four-zone shoreline buffer

# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## D. TYPES OF SHORELINE BUFFER ZONES

**Zone 2 (Riparian)** -This section of the buffer zone extends inland from Zone 1 (littorial zone) for a minimum of 10 feet up to several hundred feet, depending on the lake type, soil type, slope or topography, and historical or current land use. This zone provides a natural transitional area between terrestrial and aquatic environments. The composition and characteristics of vegetation in this zone are similar to that of other natural adjacent upland forested areas, yet it functions as the outer edge of a lake's transition to the watershed that supports it. Think of this zone as the hair on top of your skin.

**Zone 3 (Floodplain Zone)**- This buffer zone in a natural environment is typically a native meadow and/or forested floodplain and/or upland dominated by plants that serve as a filter strip. The minimum recommended width of Zone 3 is 15 to 20 feet. Greater widths will increase the amount of runoff that soaks into the ground and is cooled and filtered before reaching the lake. The primary function of this zone is initial protection of the lake from overland flow of nonpoint source pollutants such as fertilizers and pesticides applied to lawns and ornamental planting beds. Properly designed native tall grass and herbaceous buffer strips can provide quality habitat for several upland wildlife species. Typically, on FirstLight's lands this area is the upper limit of the project boundary and, due to the impoundment, the original river floodplain is submerged under 20 to 40 feet of the reservoir water. Therefore, this zone is eliminated, and the project lands are composed of what would have naturally been upland hillsides.

**Zone 4 (Upland)** – This buffer zone exists above the seasonal high water table in a drier environment and is the edge leading from the riparian zone to the forest, dominated by large canopy trees, it provides full shade, and limited understory. In many instances due to FirstLight's impoundment and creation of the reservoirs, this zone meets the water's edge today and, therefore, the soil characteristics are critical when attempting to recreate the natural resource values of Zones 1 through 3 as buffers are enhanced.



# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

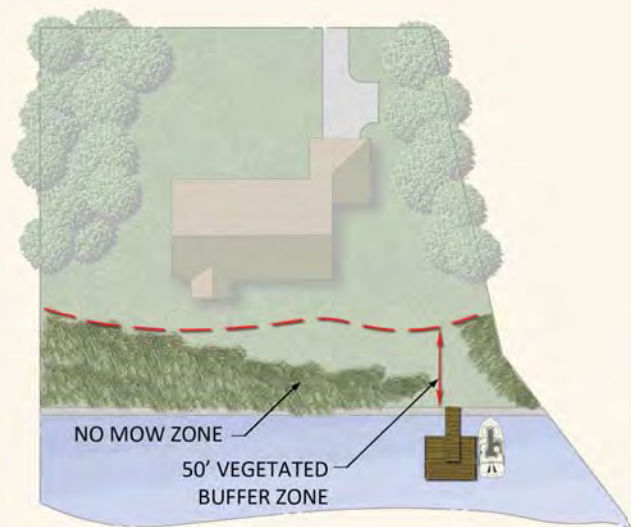
## E. PRESERVING AND ENHANCING THE VEGETATED BUFFER ZONE

Preserving and protecting the existing natural buffers should always be considered before establishing new, enhanced, and/or landscaped buffers on a site. A good natural buffer provides a diverse, healthy aquatic, transitional, or upland zone and has strong plant and animal community diversity. Invasive plant species are minimal, and water quality appears good within the littoral zone. The following provides a breakdown of the types of vegetated buffers that a homeowner may consider when preserving and protecting an existing natural buffer.

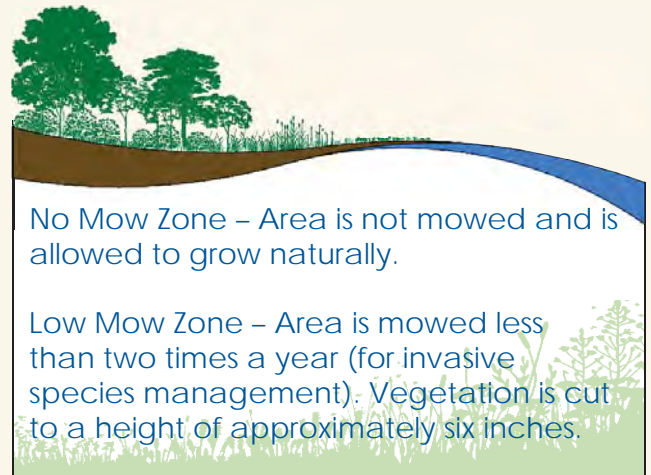
### Natural Buffer

A natural buffer is the simplest and least expensive buffer zone to establish. Natural buffers can be established simply by not mowing a specific width along the shoreline. This method is often referred to as the "No mow, let it grow" technique. This approach requires patience to allow the re-establishment and growth of native vegetation through natural succession. The success of this method is often determined by the existing native plant seed bank in the soils and/or the adjacent native plants' ability to spread seeds into the no mow zones. Vegetative communities change over time, and many vegetative communities must go through succession (i.e., transition from lawn to meadow to shrubs to a forested area), which will take several years. An advantage to allowing the buffer zone to establish naturally is that the native plants that begin to grow are tougher and more resilient to site conditions and are most likely already found along other parts of the lake shoreline. This type of buffer also minimizes the homeowner's capital investment. Identification of and removal (i.e., weeding) of invasive plant species may be required to establish and maintain a native plant community over time.

### Natural Buffer After 1 year



Natural buffer - Layout View



No Mow Zone – Area is not mowed and is allowed to grow naturally.

Low Mow Zone – Area is mowed less than two times a year (for invasive species management). Vegetation is cut to a height of approximately six inches.

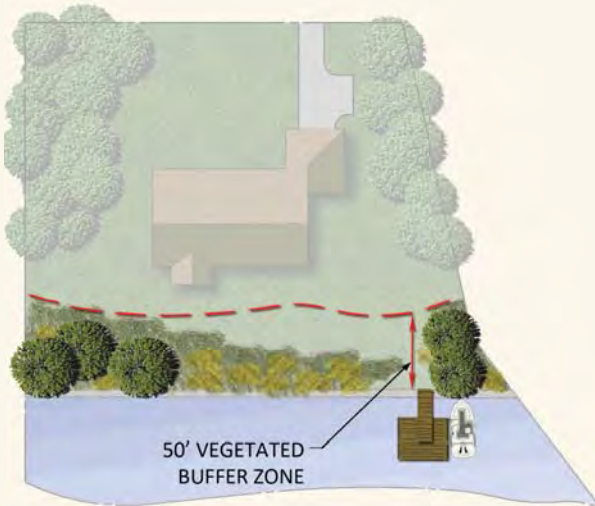


Natural buffer "No-Mow" zone with grasses establishing

# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## E. PRESERVING AND ENHANCING THE VEGETATED BUFFER ZONE

### Natural Buffer After 10 years

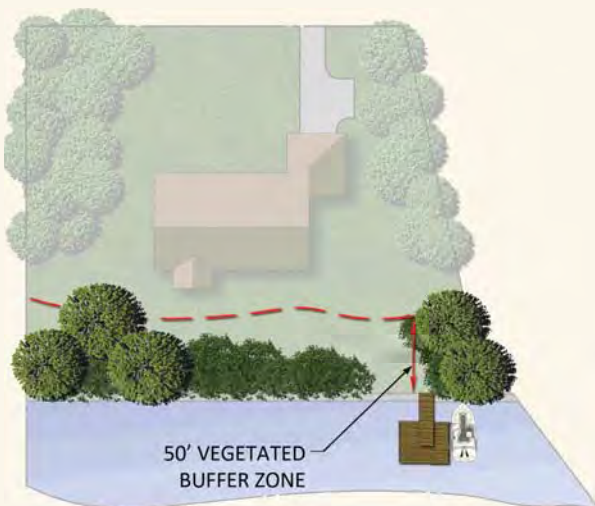


Natural buffer - Layout View



Natural buffer "No-Mow" zone with shrubs and small trees establishing

### Natural Buffer After 20 years



Natural buffer - Layout View



Natural buffer "No-Mow" zone with larger established trees, shrubs, and herbaceous vegetation



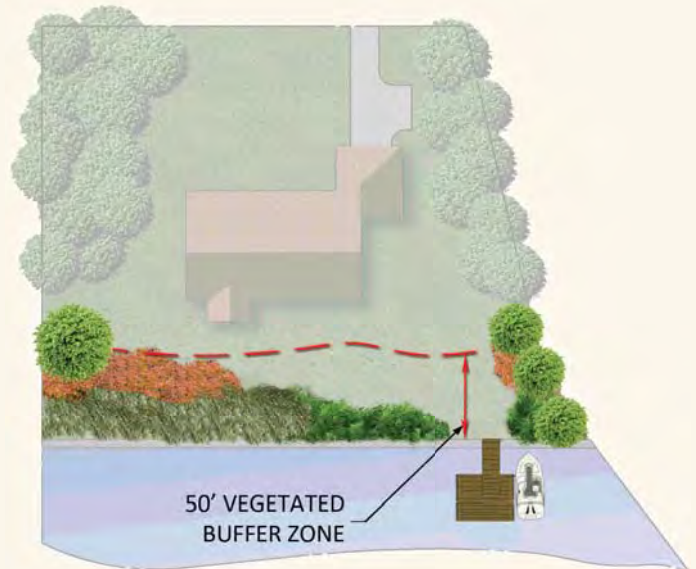
# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## E. PRESERVING AND ENHANCING THE VEGETATED BUFFER ZONE

### No-Mow Enhanced Buffer

An enhanced buffer includes keeping areas as no-mow as well as supplementing areas; purchasing those plants from nurseries; and proper installation of the chosen plants (ground cover, understory shrubs, and trees) and, therefore, requires greater initial capital investment than a natural buffer.

Monitoring and removal of invasive plant species may be required to maintain a native plant community over time.



Enhanced buffer - Layout View



Enhanced buffer "No-Mow" zone & native supplemental planting



# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## E. PRESERVING AND ENHANCING THE VEGETATED BUFFER ZONE

### Landscaped Buffer

Landscaped buffers require site design and planning to ensure proper spacing of mature plants; the selection of the proper native species for the site's sun exposure and soil conditions; purchasing of nursery-grown plant stock; proper site preparation including soil testing and fertilization for the installation of the chosen plants (ground cover, understory shrubs, and canopy trees); and long-term fertilization and irrigation requirements during establishment or times of drought and, therefore, require greater initial capital investment than a natural buffer. Monitoring and removal of invasive plant species may be required to maintain a native plant community over time.



Landscaped buffer - Layout View



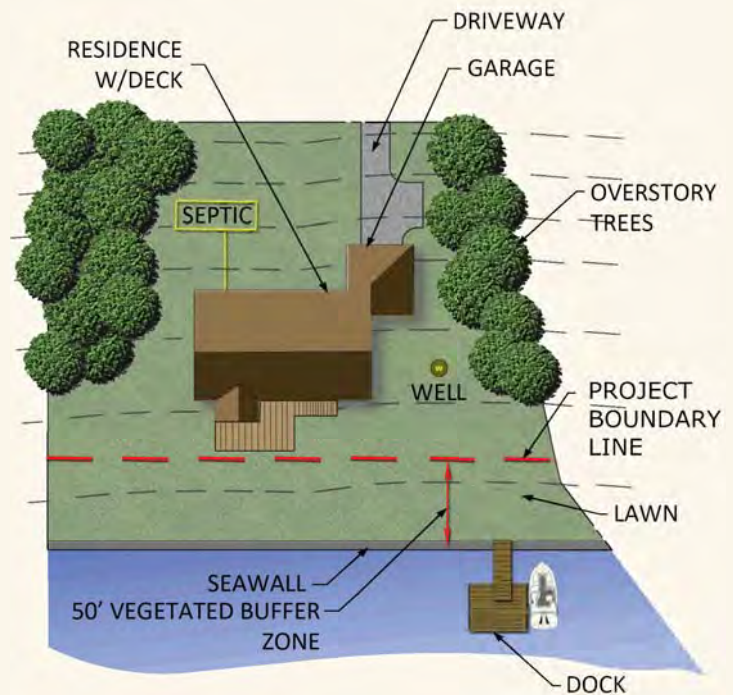
Landscaped buffer of formalized native plantings

# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## F. FIRSTLIGHT VEGETATED BUFFER ZONES; LOCATIONS AND WIDTHS

The Shoreline Management Plan (SMP) establishes the locations of the vegetated buffer zones around reservoir and riverfront lands up to 200 feet from the high water mark on lands that FirstLight owns within the project boundary in Exhibit D and referred to herein as Appendix A within this manual. FirstLight has defined the two buffer zones as 50 feet or 200 feet as shown in Appendix A. On undeveloped project land, a vegetated buffer zone of 200 feet measured horizontally from the high water mark is established. FirstLight will manage these lands through limiting shoreline vegetation removal. FirstLight has also defined a 50-foot vegetated buffer zone adjacent to residential lands. These lands are characterized by existing or potential future waterfront development such as docks, seawalls, and retaining walls. As a requirement of the SMP, over time adjacent landowners occupying FirstLight's lands within the project boundary will be required to establish, enhance, and maintain vegetated buffers as a condition of permitting. In order to install a compliant vegetated buffer, a homeowner must establish 50 percent of the area within the first 50 feet of the vegetated buffer zone in approved plantings to meet the project goal. FirstLight has also identified and mapped its lands that have the potential for revegetation and has developed provisions for revegetating these areas within the project boundary (see Appendix D).

The optimal width of a vegetated buffer zone often depends on the reason for its establishment. Ideally, the larger a buffer zone width, the greater the protection for shoreline stabilization, water quality, aesthetic benefit, wildlife enhancement, and property privacy. Studies have also shown that buffer widths that are greater than 100 feet wide provide better opportunities for stormwater runoff filtering and wildlife habitat. FirstLight does not regulate lands above the project boundary. However, establishing vegetated buffer areas that extend above the project boundary would potentially increase a buffer's overall effectiveness. Additionally, landowners should be aware that the regulated area established by a municipality's Inland Wetlands Regulations may extend beyond the project boundary. Recognizing that many of the lots that surround the FirstLight lakes are not deep or wide, establishing wide vegetated buffer zones may prove difficult. FirstLight realizes that it may be unrealistic to expect that homeowners will not clear or remove vegetation along the lakefront or within the project boundary. However, FirstLight requires that a homeowner develop a vegetated buffer plan for the project boundary that substantially maintains the functions of a buffer while recognizing the need for recreational water access, shoreline erosion



Established vegetated buffer zone for residential properties



# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## F. FIRSTLIGHT VEGETATED BUFFER ZONES; LOCATIONS AND WIDTHS

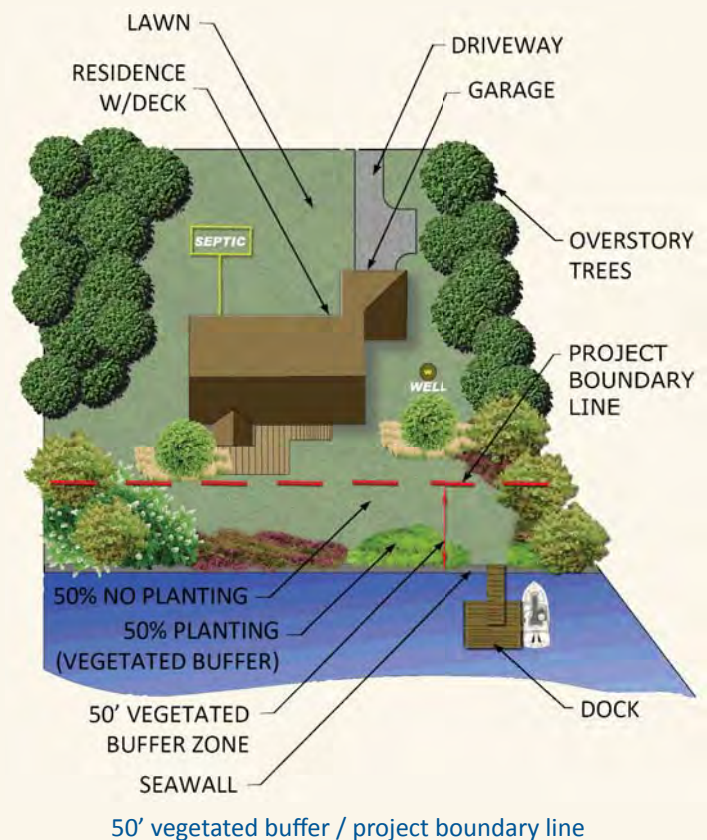
protection, and view of the reservoirs. It is always better to have a partial naturalized vegetated buffer rather than no buffer at all. As part of the SMP, FirstLight has defined and established its buffer zones within the project boundary to be the following:

- FirstLight defines vegetated buffer zones as an area within the project boundary adjacent to the water intended to provide for the establishment of native vegetated cover plants over time to the extent reasonable and practicable. The area may not currently support native vegetated cover.
- FirstLight defines a vegetated buffer as an area of native vegetation created through natural succession (i.e., stop mowing grass) or the planting of native trees, shrubs, ground covers, or herbaceous plants that occupy between 5 percent and 50 percent of the vegetated buffer zones mapped in Exhibit D of the SMP and attached hereto in Appendix A.
- To the extent reasonable and feasible, 200-foot vegetated buffer zones are established for all undeveloped lands within the project boundary, and 50-foot vegetated buffer zones are established for all other shoreline designations. In areas such as Squantz Pond and elsewhere, where many existing residences are very close to the water, the vegetated buffer zone will be adjusted to take this into account. In these areas, abutting landowners with residences may not be required by FirstLight to install vegetated buffers that occupy more than 5 percent of lands within the project boundary occupied by such landowner.

### Locating a Compliant Buffer

Preferably for residential properties around impoundments owned by FirstLight, the vegetated buffer zone should be installed at the water's edge. This buffer should cover a minimum of 50 percent of the total area extending from the high water mark to at least 50 feet upslope or greater from the water's edge toward the project boundary. The illustration shows the location of a standard vegetated buffer and how it relates to the project boundary.

At Firstlight's discretion, alternative buffer locations and designs may be considered and permitted. In some circumstances where there is a hardship due to unique site characteristics, conditions, and/or limitations, FirstLight may be amenable to granting variances allowing homeowners to install alternative buffer designs within the project





# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## F. FIRSTLIGHT VEGETATED BUFFER ZONES; LOCATIONS AND WIDTHS

boundary. Additionally, with the incorporation of a comprehensive stormwater management plan and/or alternative shoreline stabilization techniques, a variance may also be granted.

### Vegetated Buffer Variances

#### A. No Vegetated Buffer Zone

In some areas on FirstLight's impoundments, the project boundary does not extend above the water's edge. As FirstLight does not regulate the area above the project boundary, a vegetated buffer is not required by FirstLight. However, any shoreline stabilization that may occur at or below the project boundary is reviewed and permitted by FirstLight.

#### B. Standard Vegetated Buffer

Residential areas within a FERC project boundary that is approximately 50 feet or greater in length are required to vegetate at least 50 percent of the first 50 feet of that project boundary.

#### C. Depth of Buffer Zone Less Than 50 Feet

In many locations, the lands surrounding FirstLight's impoundments are characterized by steep slopes. In these areas, the project boundary extends less than 50 feet inland from the water's edge. With this circumstance, the goal is that 50 percent of the total area below the project boundary be established and maintained as a vegetated buffer.

#### D. Pre-Existing Nonconforming Uses Within the Project Boundary

Many residential areas within the project boundary have existing nonconforming uses such as patios, pathways, sheds, or other uses. Therefore, FirstLight has set the vegetated buffer zone goal as 50 percent of the first 50 feet upslope from the water's edge in the area within the project boundary.

In the event that FirstLight determines that historical high density residential uses exist within the first 50 feet of the project boundary or that the site does not facilitate the adequate soil conditions for the successful installation of a compliant vegetated buffer, then the percentage of enhanced buffer area required for compliance can be lowered at the discretion of FirstLight to a minimum of 5 percent.



Typical pre-existing nonconforming use along lake

# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## F. FIRSTLIGHT VEGETATED BUFFER ZONES; LOCATIONS AND WIDTHS

### **E. Upslope Buffer**

This design approach allows portions of the shoreline to remain as maintained lawn or level sitting areas for recreational access, with the vegetated buffer area located directly upslope of these areas. The vegetated buffer may be located above the first 50 feet from the water's edge but still fall within the project boundary. FirstLight, at its discretion, can determine if the entire area within the project boundary can be considered for approval to meet the total planting area requirements set forth in the vegetated buffer goals.

### **F. Incorporation of Low Impact Development (LID Stormwater Management)**

If a homeowner develops a comprehensive stormwater management control plan within the project boundary that may include infiltration of upslope drainage rather than directly discharging it to the lake, or provides for a rain garden or vegetated swale to reduce existing erosion, then these or other approved stormwater management designs could reduce the required areas of planting within the project boundary.

### **G. Incorporation of Shoreline Stabilization Alternatives**

If an adjacent owner seeks to stabilize a shoreline and incorporates structural bioengineering and biotechnical designs as an alternative to structural shoreline stabilization, these areas may, at FirstLight's discretion, be considered as a portion of the required vegetated buffer area.

The following illustrations show how these variances may apply and how they relate to the project boundary.

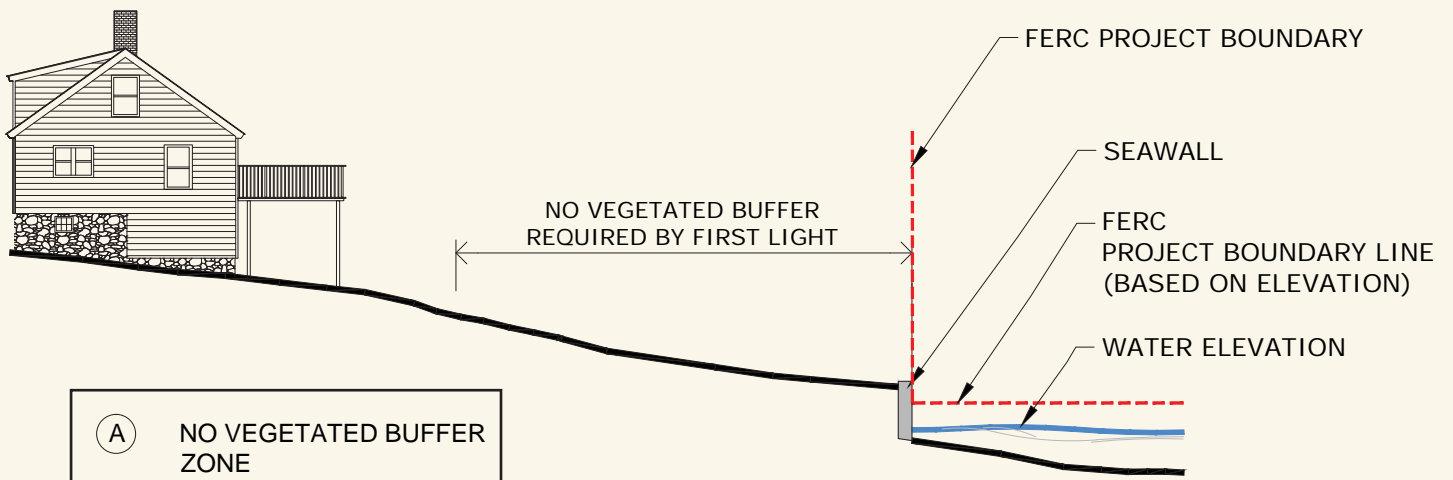
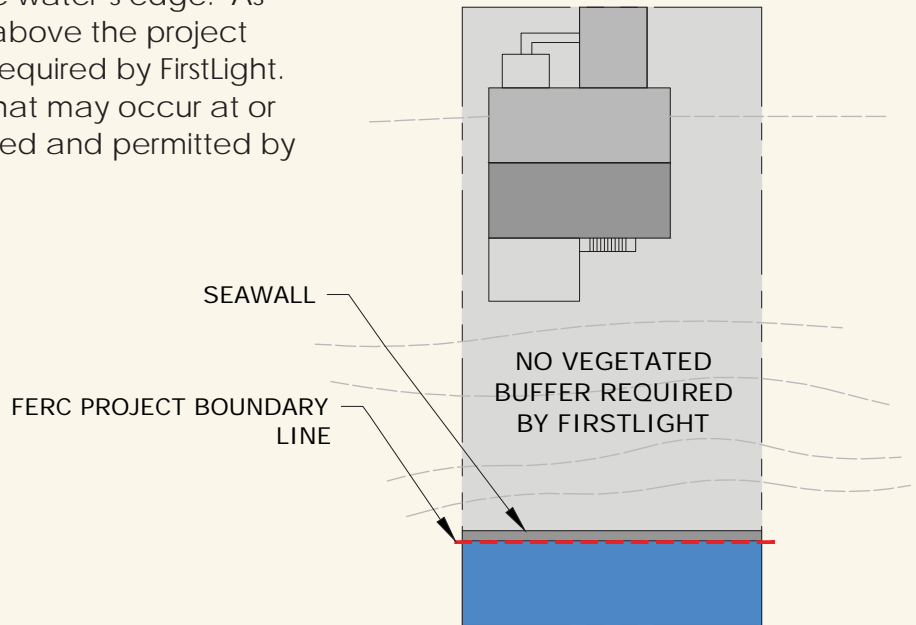


# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## F. FIRSTLIGHT VEGETATED BUFFER ZONES; LOCATIONS AND WIDTHS

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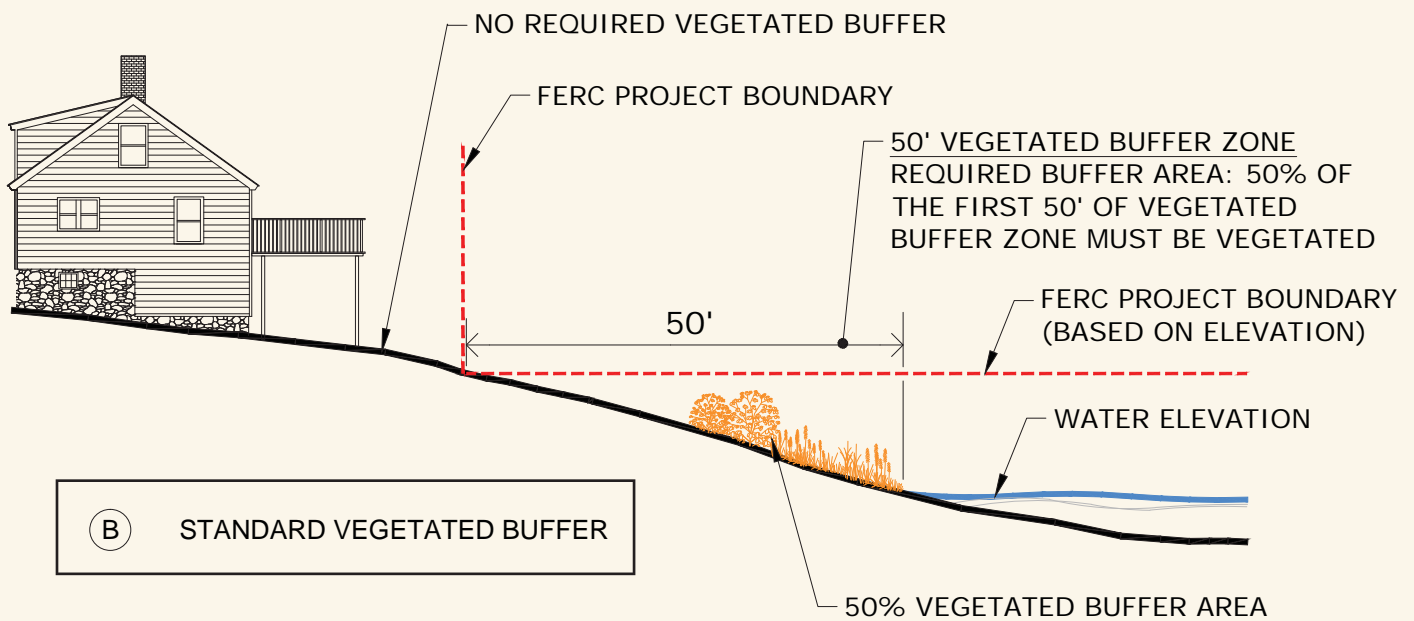
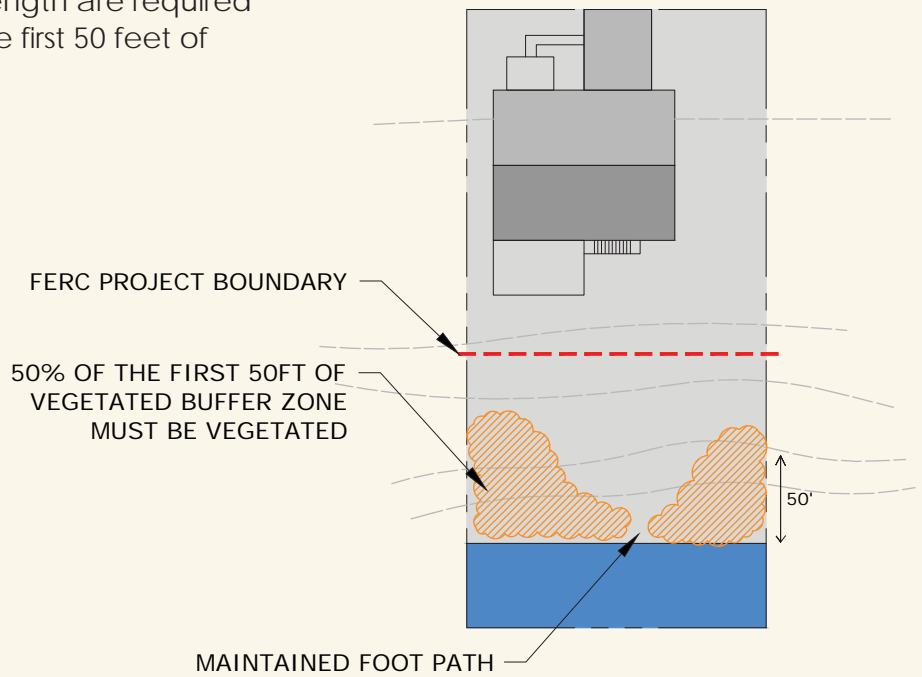


# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## F. FIRSTLIGHT VEGETATED BUFFER ZONES; LOCATIONS AND WIDTHS

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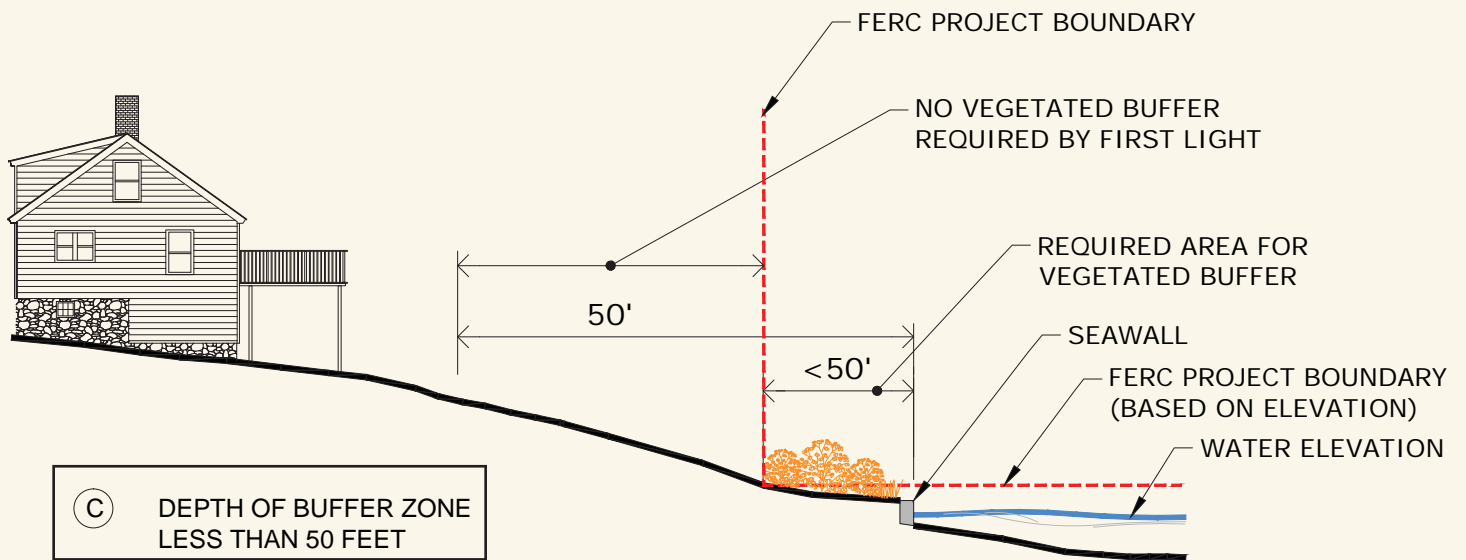
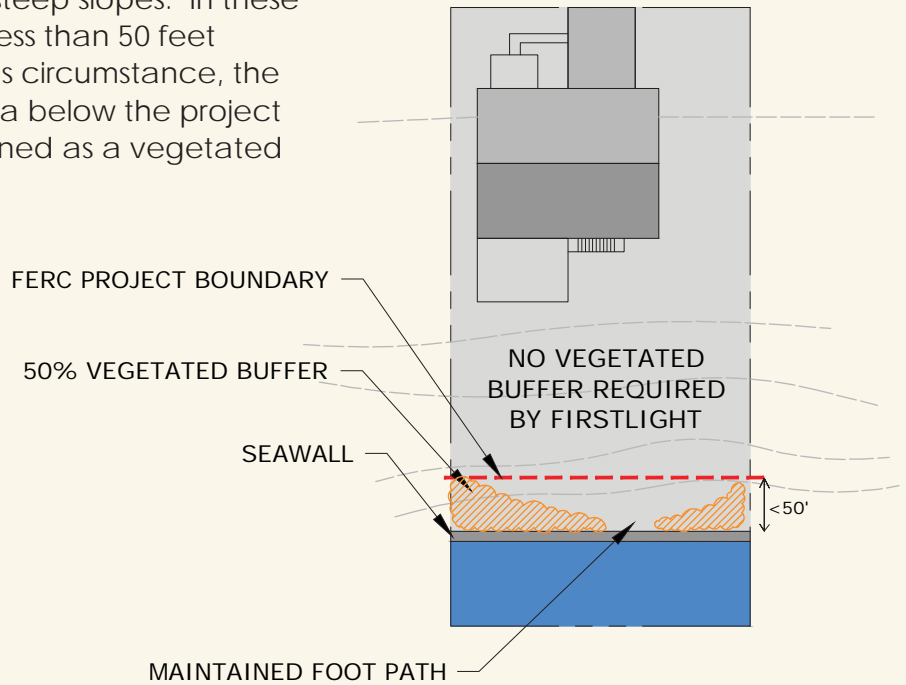


# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## F. FIRSTLIGHT VEGETATED BUFFER ZONES; LOCATIONS AND WIDTHS

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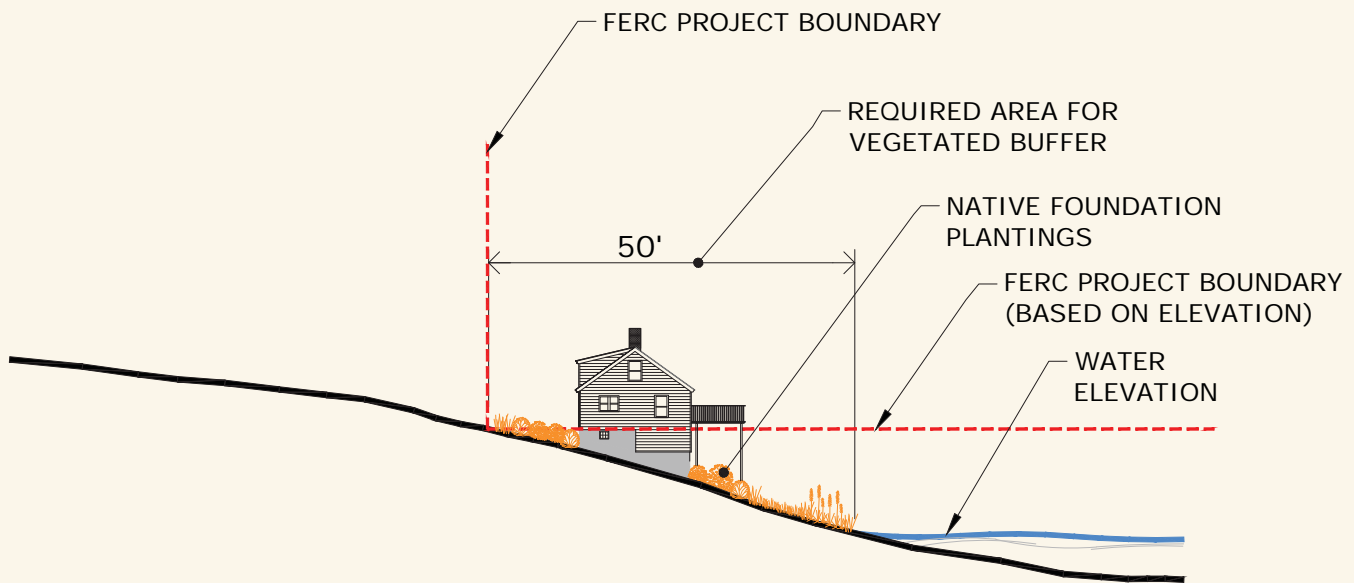
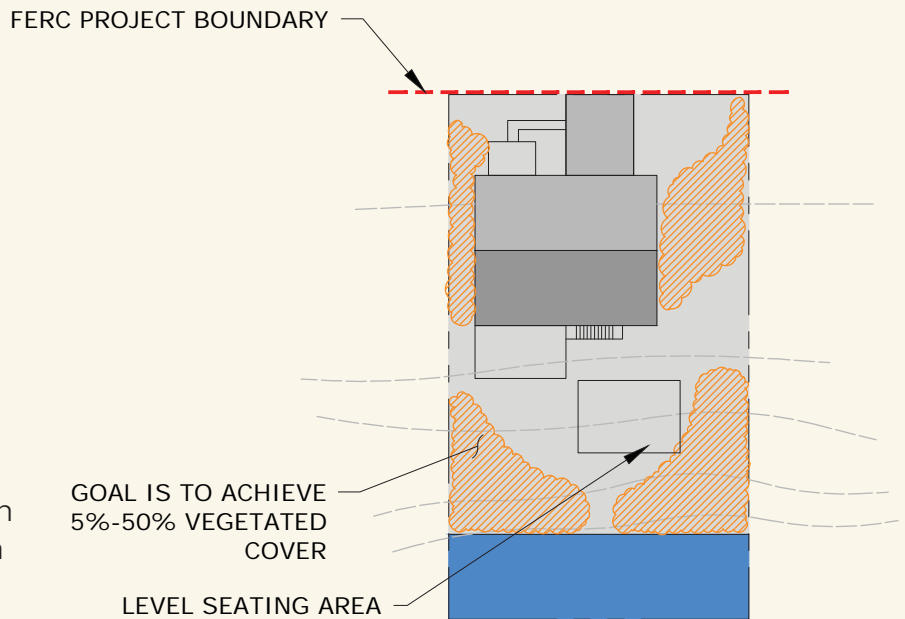


# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## F. FIRSTLIGHT VEGETATED BUFFER ZONES; LOCATIONS AND WIDTHS

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**(D) PRE-EXISTING NON-CONFORMING USES WITHIN PROJECT BOUNDARY**

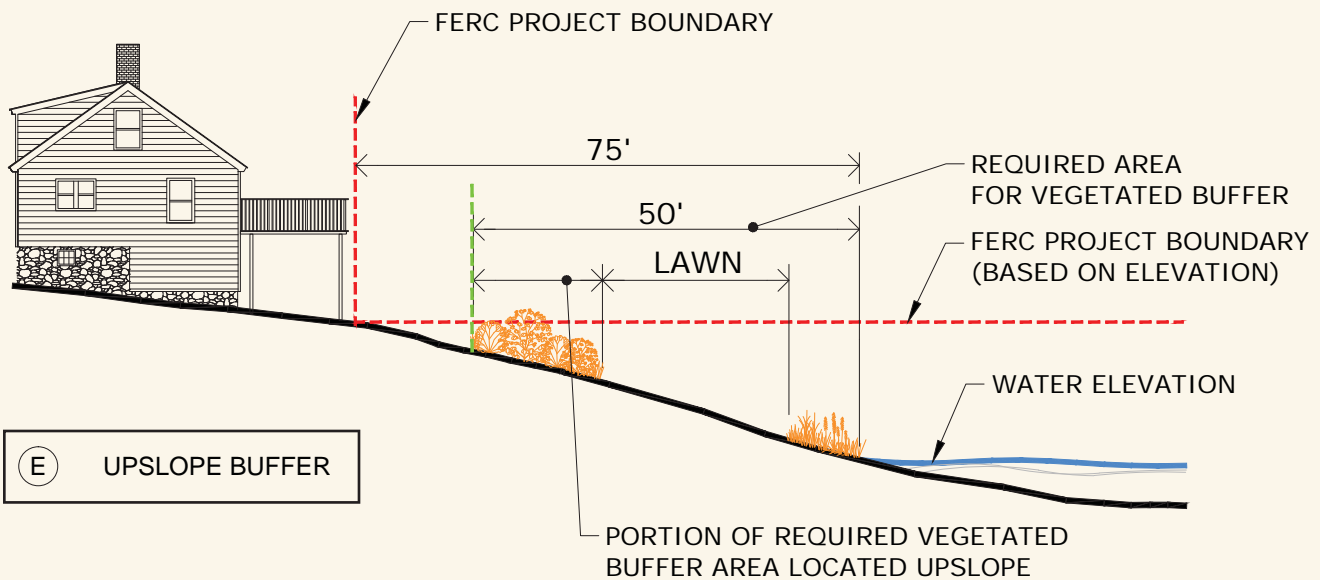
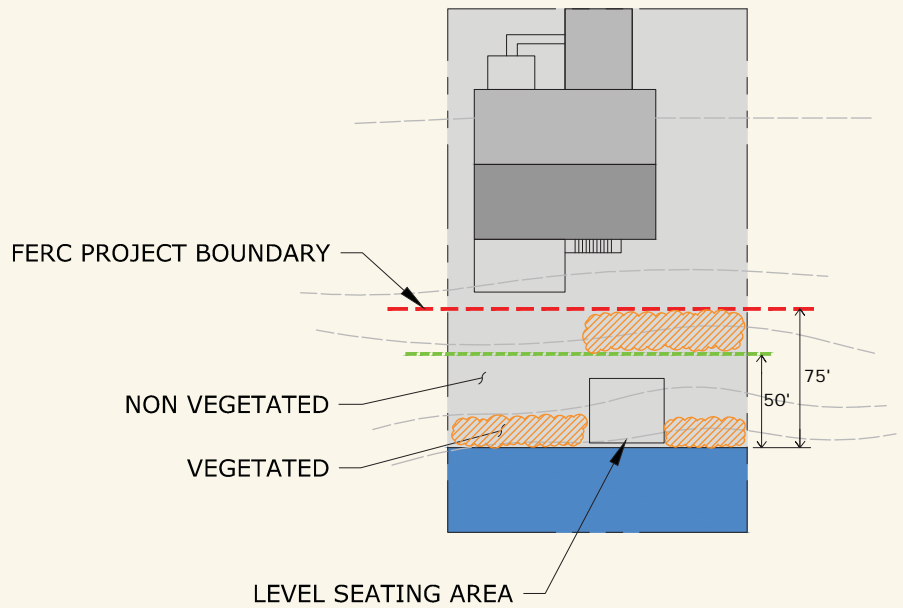


# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## F. FIRSTLIGHT VEGETATED BUFFER ZONES; LOCATIONS AND WIDTHS

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# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## F. FIRSTLIGHT VEGETATED BUFFER ZONES; LOCATIONS AND WIDTHS

### Low Impact Development (LID) Stormwater Management

The stormwater flow, drainage patterns, contributing drainage area, and collection areas on a given site need to be considered when designing the vegetated buffer zone. FirstLight encourages homeowners to select the proper LID stormwater management practices in new use projects and/or when establishing the vegetated buffer zone. FirstLight will review and potentially approve reductions in the percentage of proposed enhanced buffer area within the required vegetated buffer zone. The goal for a compliant vegetated buffer zone for residential properties is "50% of the area in the first 50 feet upslope from the water's edge." FirstLight will determine as part of the permit application review process where such LID stormwater measures are incorporated into the design whether a reduction planting area is applicable. Several commonly employed LID measures include bioswales, rain gardens, vegetated swales, and infiltration galleries. Furthermore, FirstLight recommends that homeowners terminate existing and/or proposed stormwater point discharges outside of the project boundary. Direct point stormwater discharges into the lake should be eliminated.



Rain garden/bioswale



Rain garden



Rain garden



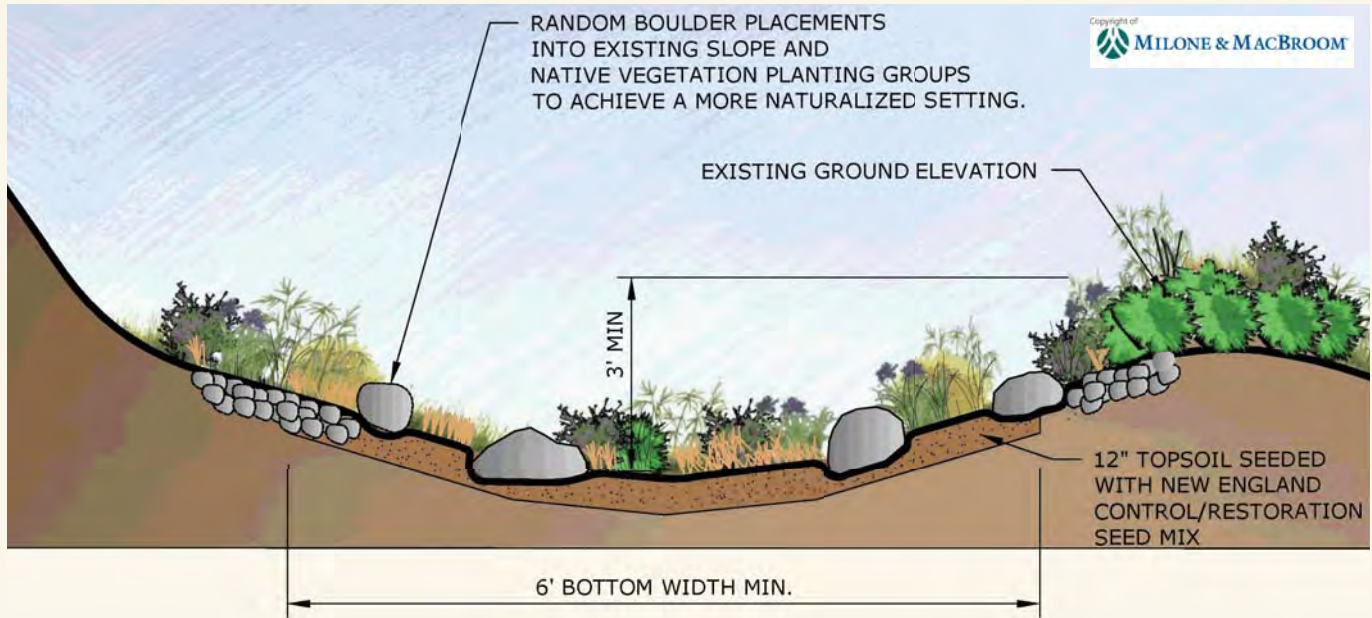
Bioswale



# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## F. FIRSTLIGHT VEGETATED BUFFER ZONES; LOCATIONS AND WIDTHS

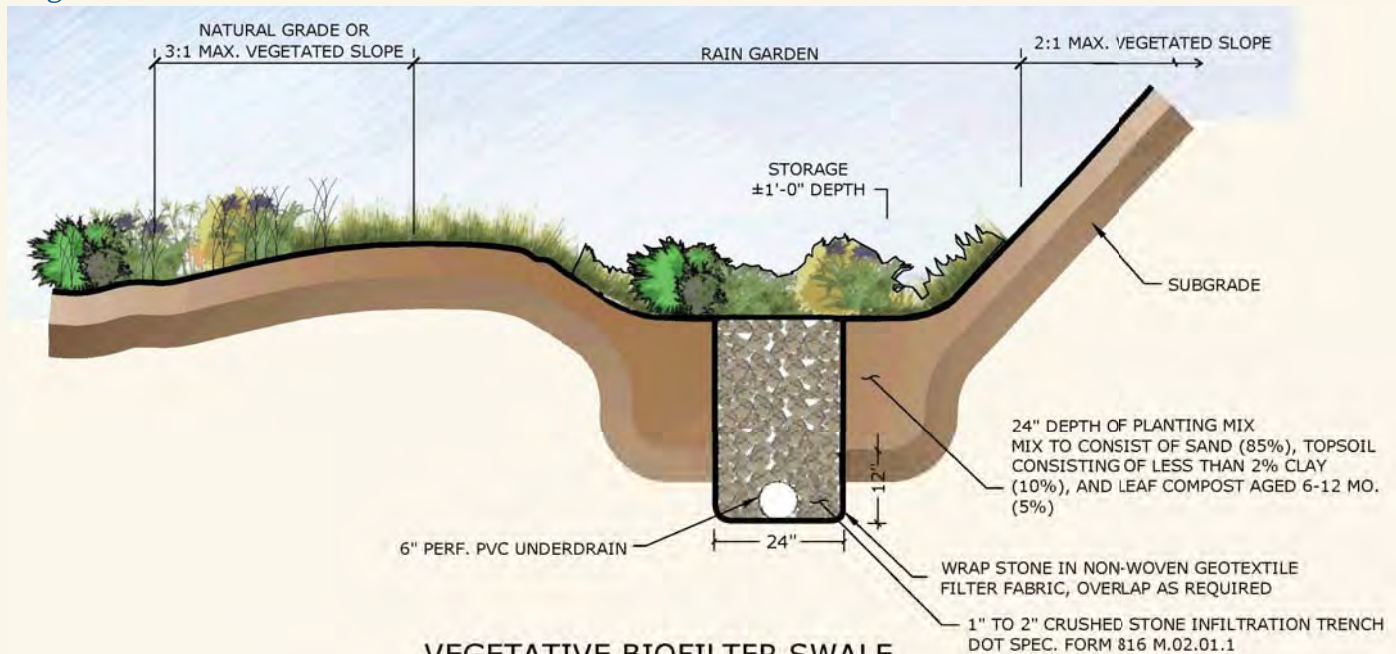
### Rain Garden



### RAIN GARDEN

N.T.S.

### Vegetated Biofilter Swale



### VEGETATIVE BIOFILTER SWALE

N.T.S.

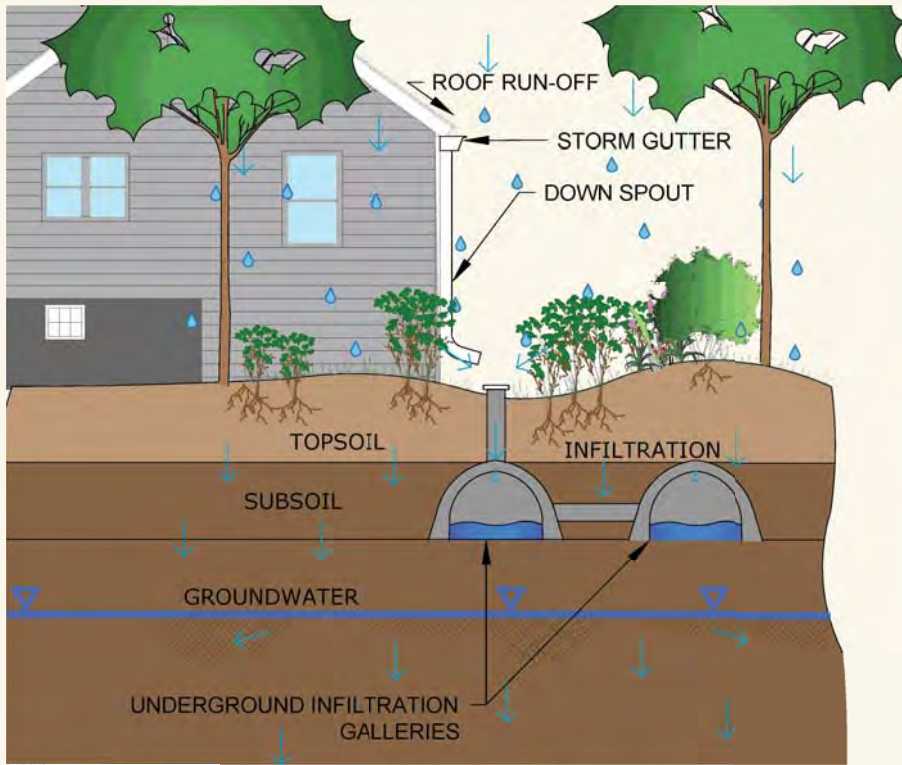
NOTE: RAIN GARDENS ARE TO BE CONSTRUCTED AND PLANTED IN CONFORMANCE WITH "RAIN GARDENS IN CONNECTICUT A DESIGN GUIDE FOR HOMEOWNERS" AS PREPARED BY THE UCONN COOPERATIVE EXTENSION SYSTEM.



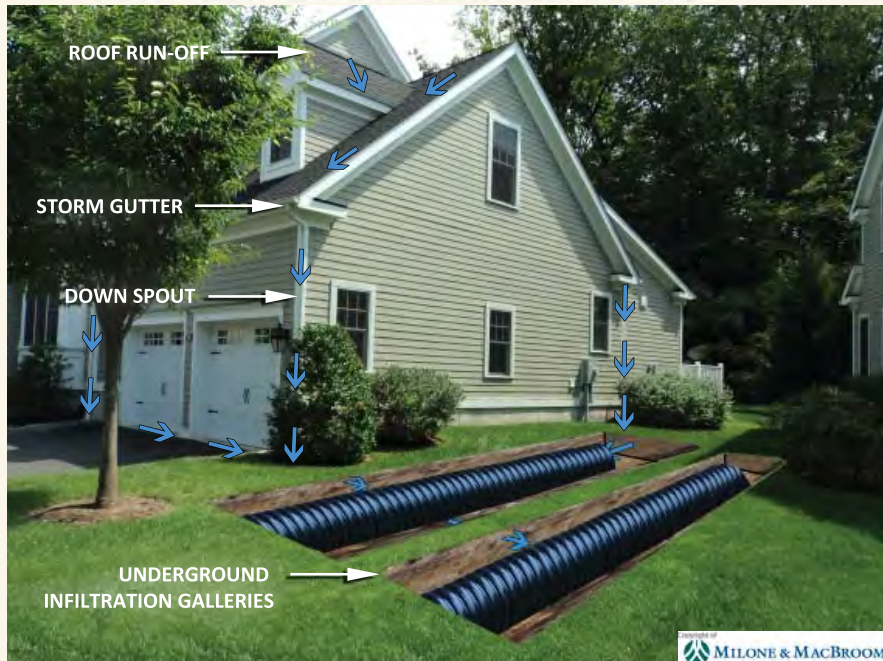
# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## F. FIRSTLIGHT VEGETATED BUFFER ZONES; LOCATIONS AND WIDTHS

### *Infiltration Galleries*



### **STORMWATER INFILTRATION GALLERY**



Typical infiltration gallery layout for residential properties

# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## F. FIRSTLIGHT VEGETATED BUFFER ZONES; LOCATIONS AND WIDTHS

### Professional Titles and Work Product Capabilities

*FirstLight requires that for all permitted activities on lands that it owns, any contractors or vendors performing work on company lands receive prior approval from FirstLight and have named the company as additionally insured as defined in the permit application.*

**Licensed Land Surveyor** – A person who holds a license to perform surveying, whose occupation is to establish the distances and directions of existing boundary lines and to establish any new boundaries resulting from division of a land parcel. A licensed land surveyor provides title and deed research. They can create topographic maps, define and locate legal property line boundary maps, stake those limits out, provide construction stakeouts, and generate as-built maps.

**Licensed Professional Civil Engineer** – A person who holds a license to practice civil engineering in the state of Connecticut. Civil engineers provide consultation, investigation, and design; preparation of drawings, specifications, contract documents, and reports; construction supervision; septic system design; stormwater management; siting of buildings and structures or other improvements; setting of grades; shaping and contouring of land; determination of drainage and provision for storm drainage; and the design of such tangible objects as seawalls, retaining walls, gazebos, roads, etc.

**Licensed Professional Structural Engineer** – A person who holds a license to practice structural engineering in the state of Connecticut. Structural engineers provide consultation, investigation, and design; preparation of drawings, specifications, contract documents, and reports; construction supervision; and seawall and retaining wall design.

**Registered Landscape Architect** – A person who holds a license to practice landscape architecture in the state of Connecticut. Landscape architects provide consultation, investigation, research, planning, and design; preparation of drawings, specifications, contract documents, and reports; construction supervision; and landscape management, to the extent that the dominant purposes of such services or creative works are the preservation, conservation, enhancement, or determination of proper land uses, natural land features, ground cover and plantings, or naturalistic and aesthetic values; the determination of the grounds and approaches for and the siting of buildings and structures, outdoor areas, or other improvements; setting of grades; shaping and contouring of land and water forms; determination of drainage and provision for storm drainage and irrigation systems; and the design of such tangible objects as retaining walls, gazebos, fences, etc. and features such as waterfalls, ponds, etc.

**Qualified Landscape Designer** – A landscape designer is a person who is consulted for the preparation of planting plans, including specifications and installation details for plant materials, soil amendments, mulches, edging, gravel, and other similar materials. Unlike landscape architecture, landscape designers are not a licensed profession.

**Licensed Arborist** – A person who holds a license to practice arboriculture, which includes the cultivation, pruning, management, pesticide application, and installation of trees. Arborists can also provide an assessment of the health, vigor, pruning requirements, and value of individual trees, shrubs, and other perennial woody plants.



# CHAPTER 1: INTRODUCTION TO VEGETATED BUFFERS & SHORELINE STABILIZATION

## F. FIRSTLIGHT VEGETATED BUFFER ZONES; LOCATIONS AND WIDTHS

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**Professional Wetland Scientist** – A person who has been certified by the Society of Wetland Scientists that is experienced in wetland delineation, wetland functions and assessment, wetland mitigation, and wetland and upland invasive species management.

**Professional Certified Soil Scientist** – A person who is experienced in the mapping of soil types, reading of test pits, completion of percolation and infiltration tests, and wetland delineations.



Contractor installing boulder wall revetment



Wetland Scientist inspecting new littoral zone planting



# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

## A. GENERAL CONSIDERATIONS IN VEGETATIVE BUFFER ZONE RE-ESTABLISHMENT

Establishing a natural vegetated buffer zone is not a difficult task as long as the homeowner performs a site resources inventory and understands the site's soil characteristics and slopes of the shoreline prior to implementing or purchasing plant material. There are several general considerations that a homeowner must consider for a vegetated buffer zone including:

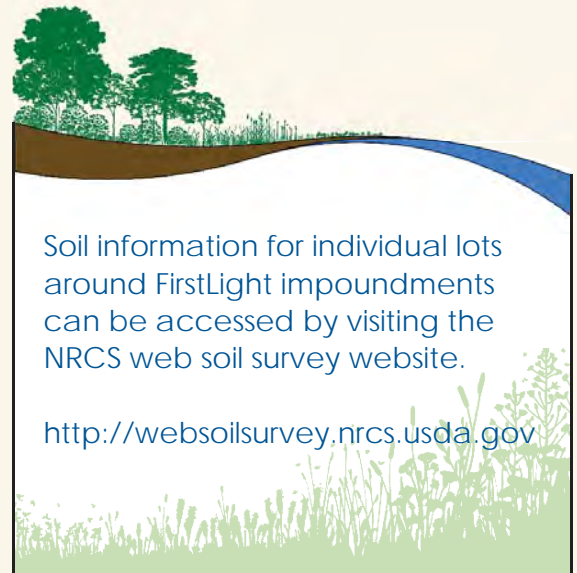
- Soil types and conditions
- Degrees of slope
- Wind and wave exposure
- Sunlight exposure
- Accessibility of the site for construction materials
- Erosion and sediment controls required
- Permits required to proceed

### Soil Type and Conditions

Soil type and condition are critical when considering the erodibility of a bank and the type of vegetation that can be supported. Soil textures can range along the FirstLight impoundment shorelines from sandy loams to coarse sands intermixed with silt. The predominant drainage classes for soils around FirstLight impoundments are upland soils due to impoundment at the creation of the reservoirs. These soils are characterized by the speed through which water drains through them and include excessively drained, well drained, and moderately well drained soils. Poorly and very poorly drained soils occur at lesser frequencies in shallower areas of the impoundments and are underneath the normal operating water level of the impoundment adjacent to the mouths of streams and rivers or perched wetlands that preceded the creation of the lakes. The excessively drained, well drained, and moderately well drained soils are considered dry upland soils. Dry soils will require upland plants, and wet soils will require wetland plants. Soil information for individual lots around FirstLight impoundments can be accessed by visiting the Natural Resources Conservation Service (NRCS) web soil survey website. (<http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx>)

Soil depth to bedrock is another consideration; shallow steep upland soils may limit the use of plant species that require deep tap roots. Shallow upland soils are more prone to erosion due to disturbance such as excavation or grading. These soils may also preclude the use of soil for stormwater infiltration techniques because there may be no water storage capacity above the bedrock and shallow depths of soil.

Additionally, many lakefront properties may contain soils that have been historically disturbed over time from farming, forestry, grazing, and eventually the current use as residential development. Residential development soil disturbances can include the excavation, grading, and filling associated with the construction of house foundations, seawalls, retaining walls, septic systems, roads, and other uses. These disturbances result in the compaction of native soils, altering of the soil structure. These areas may have characteristics that differ from the soils on an undisturbed



# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

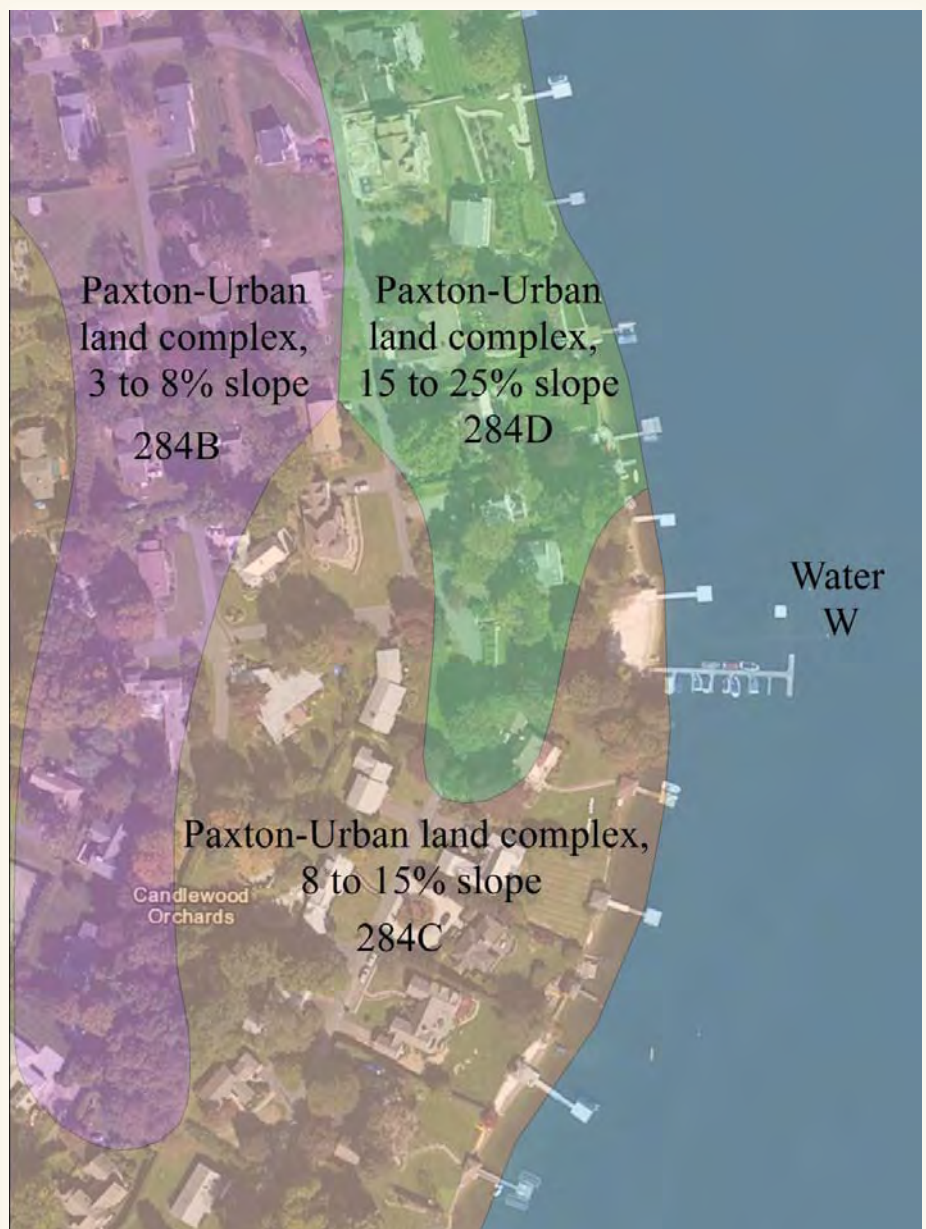
## A. GENERAL CONSIDERATIONS IN VEGETATIVE BUFFER ZONE RE-ESTABLISHMENT

shoreline in the same area. All of these factors need to be considered in developing a plan for the enhancement of a vegetated buffer.

Understanding soil pH is important as well. Low pH (acidic) conditions are more conducive to certain plants such as low bush blueberry, maple leafed viburnum, northern arrowwood, and mountain laurel whereas higher pH (alkaline) conditions are more conducive to other plants such as American basswood, eastern redbud, and green ash. Understanding soil pH is critical to the long-term health and productivity of the selected native plant species and will minimize fertilization and irrigation needs.

Knowing the available nutrients within the existing soil is important for plant health and sustainability. Soil testing can be easily completed by a homeowner, and low-cost soil samples can be sent for laboratory analysis to the UConn Soil Nutrient Analysis Lab (<http://www.soiltest.uconn.edu/sampling.php>) or other approved laboratory.

Understanding your soils and their characteristics will greatly reduce the risk of installing a native plant that cannot tolerate its environment or requires regular fertilization and irrigation, reducing the maintenance and cost benefits of a buffer. Soil acts as the first line of defense in protecting lake water quality and clarity.



Example of NRCS soil types and slopes

# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

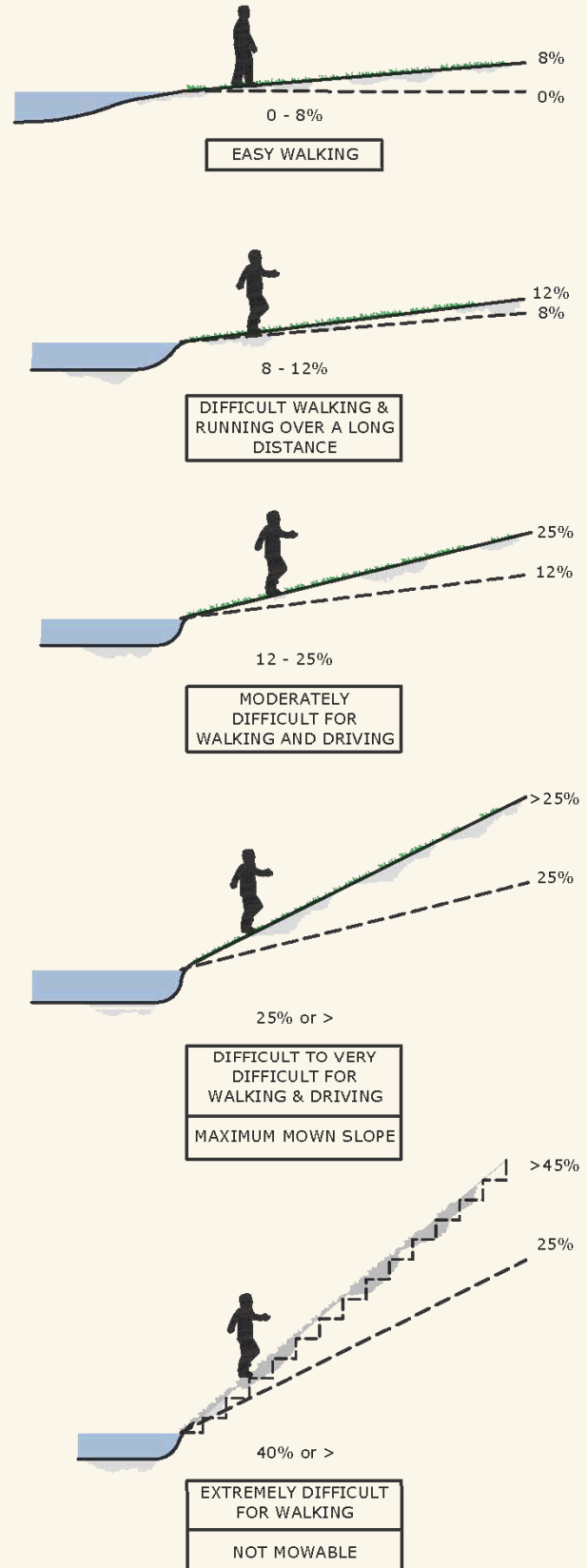
## A. GENERAL CONSIDERATIONS IN VEGETATIVE BUFFER ZONE RE-ESTABLISHMENT

### Degree of Slope

The slope of a specific shoreline/bank often dictates the proper selection of the plant species required by a site to support a stable shoreline of native plants. Steep slopes (greater than 25 percent) may not be able to support large canopy trees whereas more gentle slopes (less than 15 percent) can support a diverse assemblage of trees, shrubs, and herbaceous plants. Steeper areas are more sensitive to exposure from impact, wind, and surface runoff erosion and sediment transport. Steep sites may require a variety of rooting plants or detailed design or even an engineered stabilization method. Steeper slopes benefit the most from wider buffer zones that can absorb, filter, and slow the velocities of fast-moving upland runoff. Steep slopes are also more quickly impaired and have a higher potential of shoreline wave impact erosion.

### Exposure

Exposure is the orientation and location of a site with regard to the forces of nature. Forces such as wave action, ice impact, and prevailing wind direction must be considered in the establishment of any vegetated buffer zone. The vegetation must be capable of sustaining and dissipating both natural and man-made wave action and ice impact energy. The selected vegetation must not be susceptible to regular or severe wind storm damage, which is higher at lake edges due to the open water reaches that allow the wind to gain speed rather than in upland contiguous forest areas where the wind is diffused by the contiguous tree canopy. Ground cover vegetation or mulches can provide protection from soil surface moisture loss due to wind-driven and solar evaporation, reducing the frequency of irrigation requirements for establishing new plants.



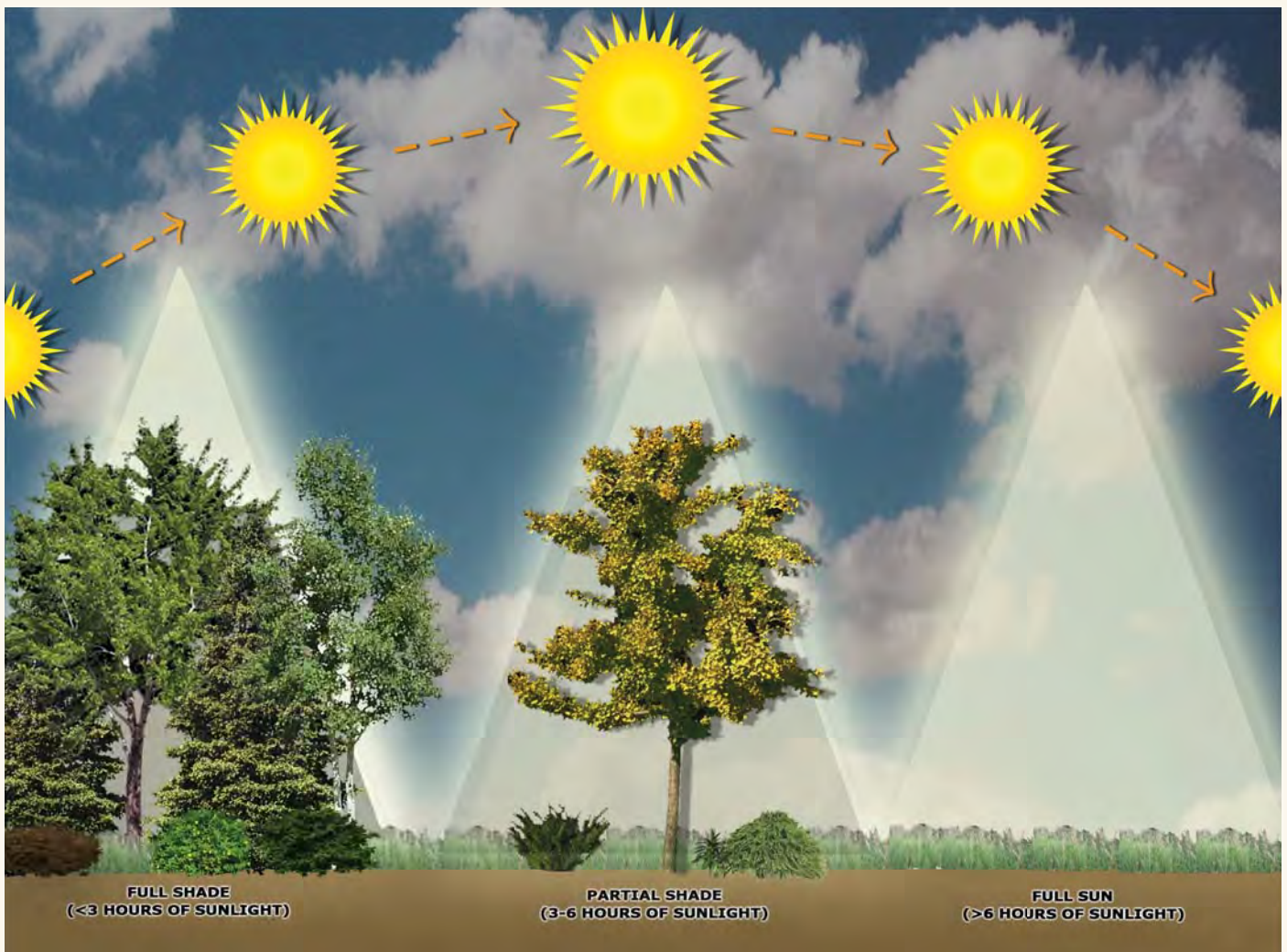


# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

## A. GENERAL CONSIDERATIONS IN VEGETATIVE BUFFER ZONE RE-ESTABLISHMENT

### Sunlight

The amount of sunlight that an area receives is critical to the type of plants to be selected and the plant's successful growth. If large trees are already present with less than six hours of direct sun, then shade-tolerant trees, understory shrubs, and herbaceous perennial material should be used within the buffer design. If the area receives more than six hours of direct sun, then sun-tolerant trees, understory shrubs, and herbaceous material should be used within the design. Ground covers or mulches can provide protection from sun-driven evaporation of the soil surface moisture and provide a cooling effect thereby reducing the frequency of irrigation requirements for establishing new plants. Over time, the sunlight conditions of a site will evolve as small planted canopy trees, understory, and ground cover species grow to maturity. These plants will continue to develop microclimates that improve their productivity, and some full-sun plantings may need to be transplanted to more conducive locations.



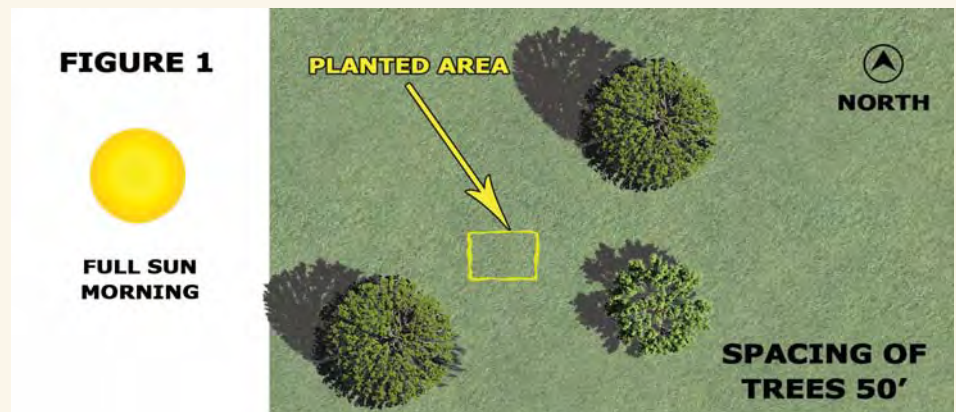
Typical sunlight condition parameters that must be considered when determining what types of native plants to be placed within vegetated buffer zone.

# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

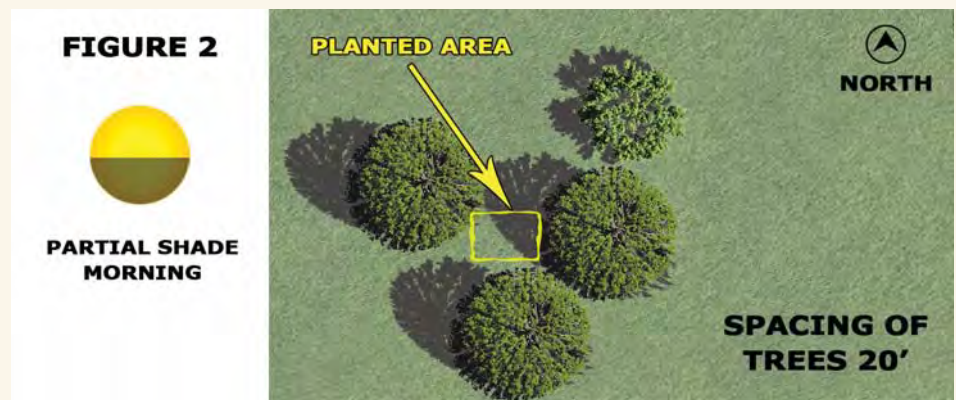
## A. GENERAL CONSIDERATIONS IN VEGETATIVE BUFFER ZONE RE-ESTABLISHMENT

Determining sunlight and shade conditions within a yard is relatively easy. One has to visually monitor sunlight conditions periodically throughout the course of a summer day to determine into which category the potential planting area would fall into when selecting plant materials for a given project site. A series of sun and shadow interaction illustrations has been developed to help the homeowner understand a site's sun to shade conditions. The following figures depict how the sun and shadows from vegetation interact within a planned buffer planting area during the course of a summer day.

**Figure 1:** The planting area receives direct sunlight for more than six hours during the day; therefore, this planting area would be classified as a full-sun area.



**Figure 2:** The planting area receives partial sun/shade, receiving between three to six hours of direct sunlight during the day; therefore, this planting area would be classified as a partial sun.



**Figure 3:** The planting area receives less than three hours of direct sunlight during the day; therefore, this planting area would be classified as a full shade.





# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

## B. GENERAL CONSIDERATIONS IN BANK STABILIZATION

When considering the best method for stabilizing a bank and/or replacing a failing seawall, the homeowner will need to assess and evaluate specific site characteristics including the sites topography, geology, soils, vegetation, and hydrology. Additionally, groundwater movement and exposure to wave action, ice, and periodic drawdown can all affect bank stability.

**Topography** – The degree of slope of the site will affect the choice and stability of bank stabilization measures. Very steep slopes will in general require more structural measures, such as log crib, boulder, or concrete walls. Vegetated engineering techniques such as soil wraps and revegetation work well on shallower slopes and even on moderately steep slopes that experience low wave action. It may be necessary to flatten a slope to some degree to achieve stability. The stable degree of slope is dependent on the soil type.

**Geology and Soils** – The geologic history of the site will determine the underlying soil types at the site. Soil type determines both the moisture retention capacity as well as slope drainage characteristics and will therefore affect the stability of the soil as well as the ability of the soil to support and maintain various types of vegetation.

**Vegetation** – Vegetation provides protection against surface erosion and shallow slope failure. Removal of existing vegetation should be limited as much as possible. The duration of disturbance to a slope should be limited and scheduled for periods of low precipitation.

**Hydrology and Groundwater Interactions** – Surface flow of water can often cause or worsen slope erosion problems. Bank stabilization techniques should be designed to either divert flow from or control flow over and through the problem area. Groundwater seeps can often destabilize a slope or bank stabilization measure. If it is not possible to divert the source of the seep, then the appropriate bank stabilization needs to be designed to allow for and withstand groundwater movement without loss of slope soils and/or destabilization.

**Exposure** – Wave Action, Ice Movement, and Lake Drawdown – Wave action is a critical component for understanding a site's shoreline stability. Large wakes caused by recreational boating and existing lake fetch (during large storm events) can result in waves of over four feet along some of the shorelines on FirstLight impoundments. The wave zone and its magnitude and intensity need to be evaluated for any bank stabilization method. In general, more structural techniques such as boulder revetment or structural walls are required in areas that experience heavy wave action.



Example of Dry Stacked Block Seawall Failure. Avoid using block walls in high wave and ice scour prone areas



Example of Emergency Boulder Armoring Repair to Dry Stacked Block Seawall



# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

## B. GENERAL CONSIDERATIONS IN BANK STABILIZATION

Each of FirstLight's impoundment's water surface elevations is lowered during the fall (i.e., drawdown) for homeowner shoreline maintenance projects and submerged invasive aquatic vegetation control.

Late winter and early spring ice sheets on the lake can threaten the shoreline stability.

Large ice sheets moving across open water can be and have been observed on FirstLight impoundments to shear seawalls and jeopardize bank stability.

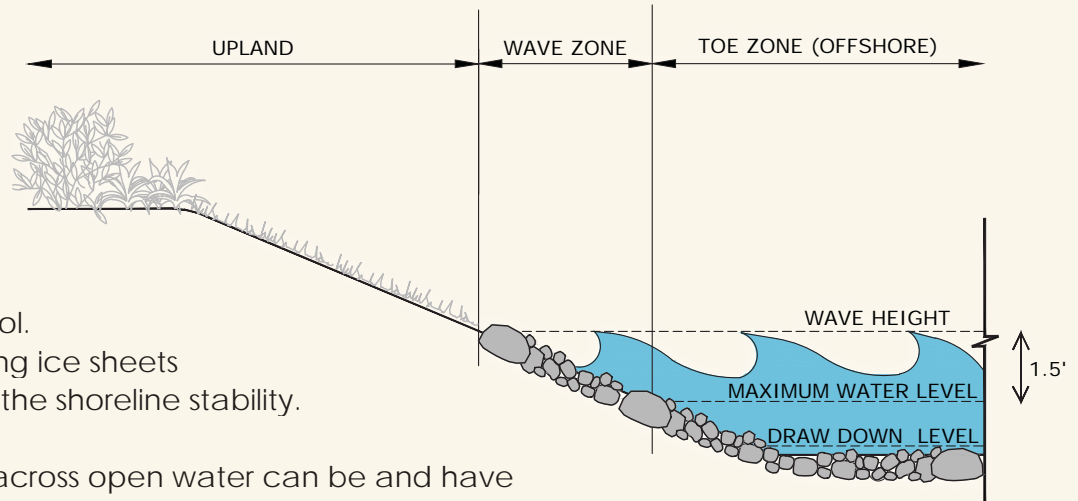
The lakeshore bank zone can be broken in to three distinct zones from an engineering design perspective. Moving from the water upward, these are the toe (offshore zone), wave zone, and the upland. These zones fluctuate because of daily and seasonal fluctuation in wave activity and water level. These three zones are explained in the following paragraphs.

The **toe (off-shore) zone** is the area between the lakebed and the average normal water surface elevation. From an engineering perspective, this zone extends to the highest normal water surface elevation irrespective of seasonal lake drawdown. This zone is under water more than six months of the year. This is a zone of high stress, which is susceptible to undercutting and scour that can result in bank failure.

The **wave zone** is located between the normal average water surface elevation and the highest point on the bank that experiences wave activity. It is under water much of the year or exposed periodically to wave action. This zone is also a zone of high stress. This zone is usually influenced by a shallow water table. Flood-tolerant species such as grasses, willow, and alders do well in this zone.

Additional stress is added in both the toe zone and the wave zone by ice and debris movement, wet-dry cycles, water-level fluctuations, and freeze-thaw cycles. Because these two zones are the zones of highest stress, they are often treated as one zone with respect to bank stabilization design. More hardened or structural treatments, such as log crib walls, boulder revetments, or structural walls, are required to combat the high erosive forces experienced in these zones.

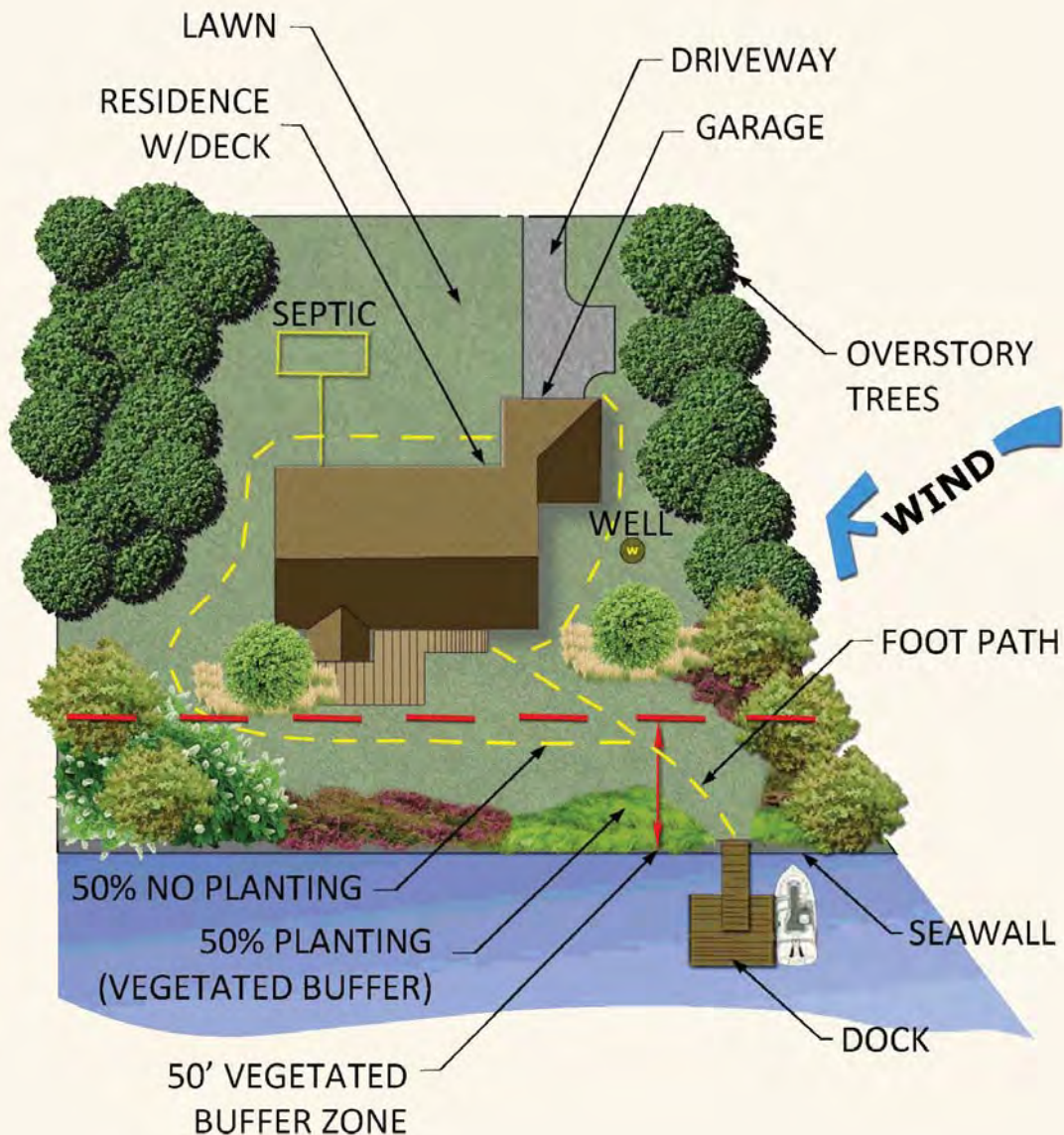
The **upland zone** is located above the average normal water surface and the wave zone. This zone is usually not subjected to erosive forces except during occasional flooding. Vegetation in this zone is extremely important for intercepting site runoff, binding soils together, reducing supersaturation of the bank, and decreasing the weight of unstable banks due to evapotranspiration.



# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

## C. DESIGNING THE BANK STABILIZATION AND VEGETATED BUFFER ZONE

Numerous factors should be considered when designing a vegetated buffer zone. An understanding of how the buffer will fit with the lot characteristics, including buildings, patios, pathways, and docks, is key as is budget for both the initial installation and long-term maintenance. Other important considerations when designing a vegetated buffer zone include the existing traffic patterns in your yard, pathways to the shoreline, desire for privacy, aesthetics, recreation, and effects of wind and weather. A homeowner may elect to complete the design of a vegetated buffer zone on his/her own; however, seeking professional services from a landscape architect, landscape contractor, landscape designer, and/or certified arborist can help a homeowner understand site constraints, provide useful guidance on plant material selection, and allow a greater number of design alternatives to be explored.



# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

## D. VEGETATED BUFFERS AND SHORELINE/BANK STABILIZATION MEASURES

Vegetated buffers and bank stabilization are interconnected. Choosing the appropriate vegetated shoreline protection and stabilization method that will work best for a particular site is the most difficult step in implementing a vegetated buffer zone project. It requires an understanding of the causes of shoreline erosion and the physical characteristics that make up the shoreline at a specific site. In some cases, shoreline erosion problems may be attributed to stabilization measures that were previously implemented by an adjoining neighboring property or a neighbor further up, down, or across the entire lake.

To successfully implement shoreline protection measures, it is important to consider all available options. In many cases, site-specific conditions may determine that a matrix of methods is the best choice for a site. Site conditions such as accessibility to a site for machinery or materials, slopes, soils, existing seawalls or retaining walls, and costs may lead to different options. Methods typically used for shoreline protection and stabilization include:

- Structural
- Bioengineering
- Biotechnical



Wave action has destabilized the vegetated bank leading to erosion.



Severe foot traffic and loss of vegetation has increased erosion.

**Structural:** Use of inert structural materials (i.e. concrete, boulders, gabions, stone blocks) to reinforce soil and stabilize banks.

**Bioengineering:** Use of living plant material as the primary structural component to reinforce soil and stabilize banks.

**Biotechnical:** Combines the use of living plant material and inert structural materials (i.e. boulders, woody debris, coir logs) to reinforce soil and stabilize banks.

It is advisable that when undertaking a structural, bioengineering, and/or biotechnical shoreline and project that a professional engineer with experience working on lakes and/or rivers be consulted prior to any installations by the homeowner. Contractors who have experience working in upland areas may not understand the dynamic forces of waves, wind, ice impact, lake drawdown, and frost.

Descriptions of individual stabilization techniques are provided in the following paragraphs. Typical details for a variety of stabilization techniques are included in Appendix B.



# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

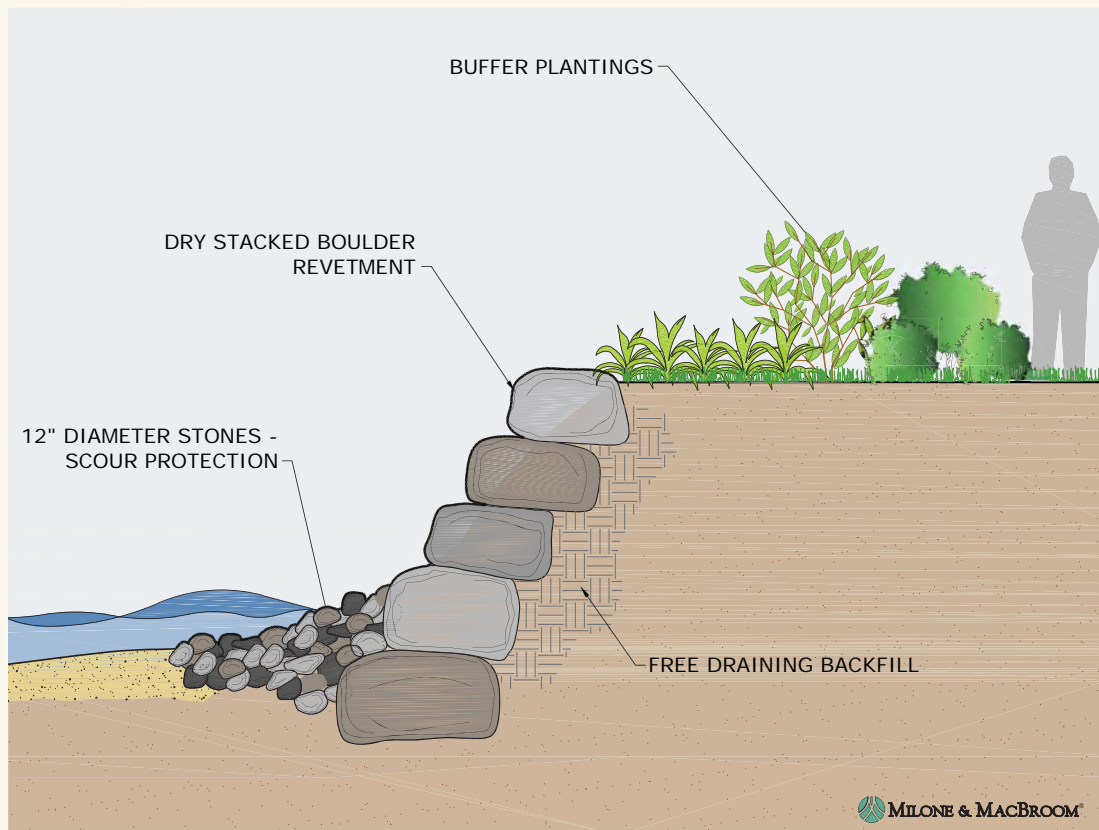
## D. VEGETATED BUFFERS AND SHORELINE/BANK STABILIZATION MEASURES

### Structural Stabilization Measures

Structural installations have been the traditional choice amongst lakefront homeowners due in part to the familiarity of this stabilization method. This design is similar in many ways to a common house foundation. Structural systems consist of inflexible vertical surfaces that secure the shoreline. These systems have been used across the United States with success, but these systems are often expensive, need replacement over time, and have severe detrimental environmental impacts to the lake if not designed and constructed properly. A commonly used structural shoreline protection system is a vertical seawall, which occurs along numerous shorefront properties of FirstLight's impoundments. The majority of these walls were installed from 1945 to the 1970s and with little or no engineering. Many of these walls were constructed using materials from the lakebed, and the walls have little or no footings. These older walls have typically been subjected to numerous repairs.



Example of dry staked boulder seawall



Typical cross section of dry staked boulder seawall

# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

## D. VEGETATED BUFFERS AND SHORELINE/BANK STABILIZATION MEASURES

### *Seawalls*

A seawall is any hard surfaced wall installed along the shore to block waves from reaching and eroding the upland soils. Seawalls are installed parallel to the shore/bank and have a vertical face. They can be made out of materials including poured concrete, concrete blocks, modular blocks, steel sheeting, wood timbers/cribbing, gabions (wire baskets filled with stone), and native stone and mortar walls. Many people believe that seawalls are a more stable form of protecting the shoreline; however, seawalls are actually considered less stable than bioengineered shorelines. Seawalls do not have the ability to absorb and process wave energy. They serve as deflectors, like a drum, meaning that the wave energy like sound energy that hits the wall is immediately deflected back out onto the water surface and down ward, scouring sediments at the base and to the ends of the wall, which can ultimately cause wall failure. Constant scouring also causes the resuspension of lakebed sediments into the water, decreasing water clarity, which has negative implications on fish, wildlife, and aquatic plants near the shoreline in the littoral zone.



Example of stone masonry seawall

Seawalls are appropriate in areas with extremely high wave energy, vertically eroded steep banks or bluffs, and in areas where site exposure or intense boat traffic occurs. The installation of a new or replacement of an existing seawall within FirstLight's project boundary requires an evaluation and written documentation by a Connecticut Licensed Engineer determining that alternative shoreline stabilization techniques would not be effective and that the construction of a seawall is necessary for the stabilization of the shoreline. This must be supplied to FirstLight before proceeding with proper permitting. Properly engineered and constructed seawalls are typically the most expensive method for stabilizing an embankment and have a life expectancy of approximately 20 to 25 years. The costs associated with the installation of a steel reinforced concrete seawall fall within the range of \$100 to \$1,000 per linear foot and vary depending upon the complexity of the design, thickness of the structure, slope of the upslope soils to be retained, and depth of footing excavation required. FirstLight requires that seawalls be designed by a licensed engineer in the State of Connecticut and be installed by a qualified contractor. Many seawalls require maintenance over time, including repairs of spalling concrete, stress cracking, and resurfacing. All seawalls on

Properly engineered and constructed seawalls are typically the most expensive method for stabilizing an embankment and have a life expectancy of approximately 20 to 25 years.

FirstLight's impoundments must be located at the existing shoreline and constructed to prevent direct runoff and filter out contaminants and pollutants before they enter project waters. All seawalls must be constructed to dissipate and/or absorb wave action energy and prevent any subsequent erosion of the adjacent or natural shoreline areas.

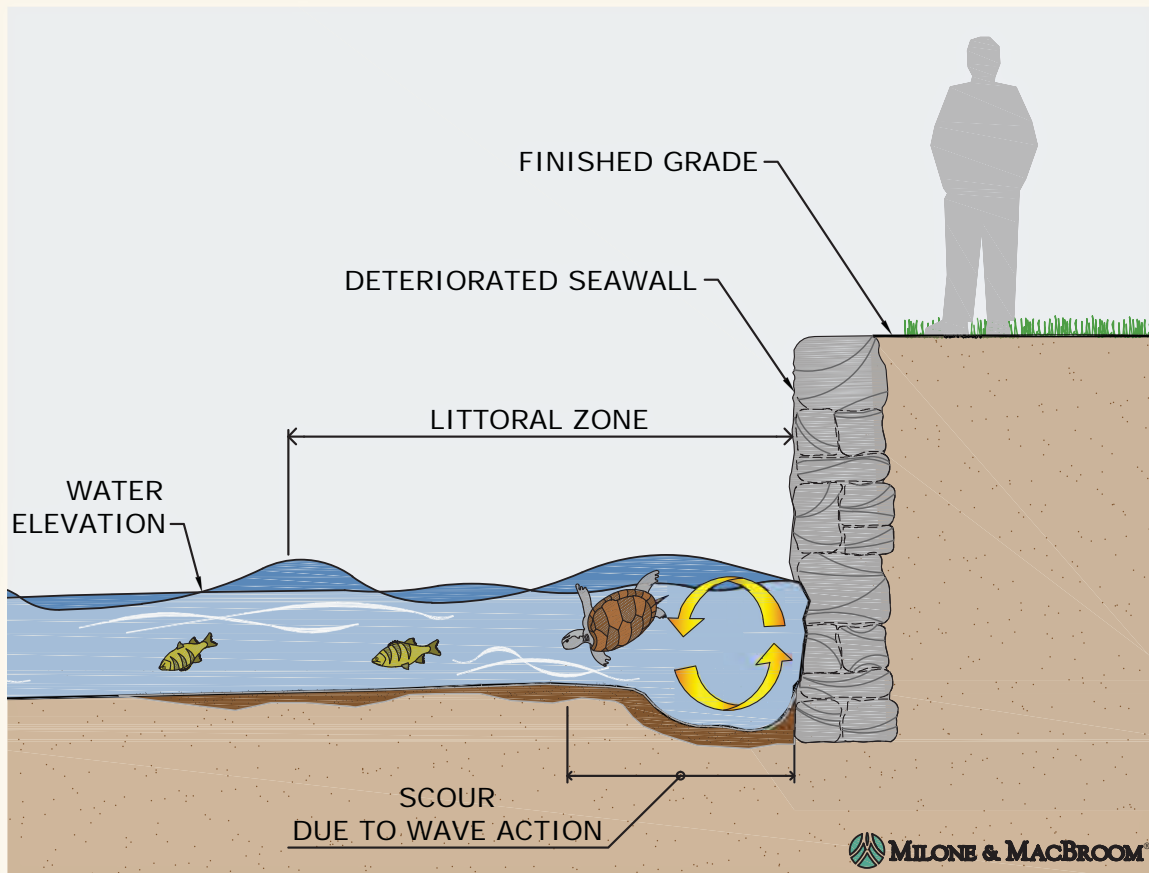
# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

## D. VEGETATED BUFFERS AND SHORELINE/BANK STABILIZATION MEASURES

### Impacts of Seawalls on Lake Habitat

Seawalls have detrimental impacts on the littoral zone habitat for all aquatic species of reptiles, fish, invertebrates, mammals, and most plant species. The wave action that seawalls encounter is typically reflected water ward, causing scouring within the littoral zone of the lake. The scouring does not allow emergent wetland vegetation to become rooted and/or allow for the establishment of appropriate fish spawning and nursery habitat to develop along the shoreline. Near-shore aquatic vegetation will be reduced or eliminated completely by scouring from the reflected wave energy from a seawall. In addition, the loss of near-shore vegetation reduces the quantity and quality of the wildlife habitat, both at the site and cumulatively for the entire lake. Affected wildlife would include migratory birds (neotropical and waterfowl), shore birds, reptiles, fur bearers, invertebrates, amphibians, and reptiles. Emergent aquatic vegetation serves as cover and food for waterfowl and other water birds while the invertebrates and insects (caddisfly, dragonfly, damselfly nymphs) that colonize aquatic vegetation also serve as the base of the food chain for fish and waterfowl. The use of bioengineering

**Scour:**  
Removal of underwater materials by waves



Wave energy that is deflected off a seawall can cause erosion (scour) and severely impact fish and wildlife habitat.

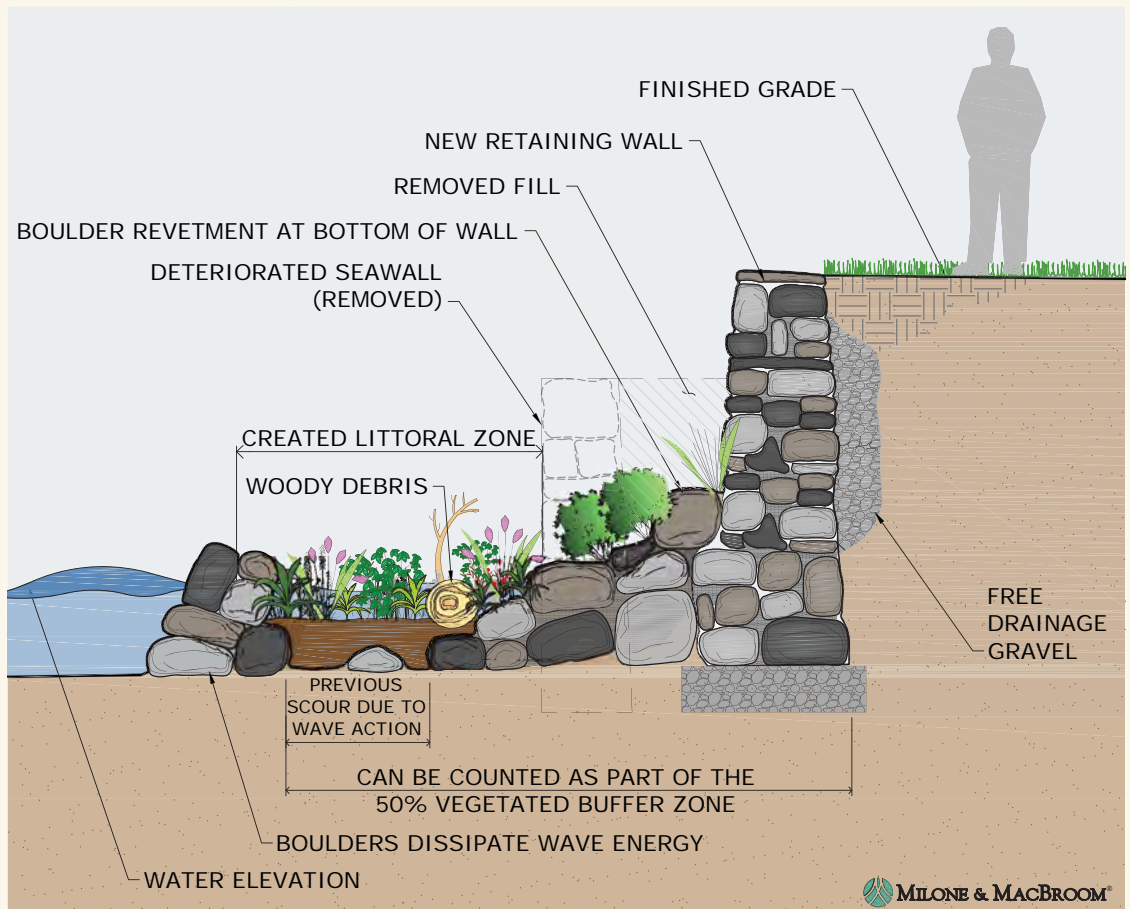


# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

## D. VEGETATED BUFFERS AND SHORELINE/BANK STABILIZATION MEASURES

and biotechnical methods encourages near-shore growth of aquatic vegetation and decreases near-shore erosion, benefiting aquatic and wildlife habitat. This barren sterile environment devoid of natural site conditions and diversity of native species provides a barren area on the lakebed, providing suitable habitat for the establishment of monoculture invasive aquatic species such as Eurasian watermilfoil below the wave action energy zone. The lack of suitable habitat for native aquatic plant species reduces the natural competition for invasive species. Additional impacts include:

- Seawalls, beaches, and riprap result in lower diversity of macroinvertebrates as compared to natural littoral zones that have natural shorelines and substrates. Biological impacts appear to be due to reduced habitat structural complexity and heterogeneity of littoral habitats.
- Wave energy is no longer dampened naturally.
- Bank and shoreline stabilization is now accomplished by an artificial structure requiring regular and continued maintenance.
- Reduced or eliminated dissipation of ice and wave damage
- Increased shoreline erosion in natural areas and scour of sediments at the toe of the seawall due to reflected wave energy
- Transference of wave energy into long shore currents that cause sediment migration, siltation, and backscouring of unarmored shoreline
- Increases in residual reflected wave energy and turbulence creating an inhospitable high-energy environment in the littoral zone
- Loss of available habitat for spawning, rearing, shelter



Homeowner has potential to move a retaining wall landward and create littoral zone within former seawall location. This creation of littoral zone would count towards the 50' vegetated buffer zone reestablishment.

# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

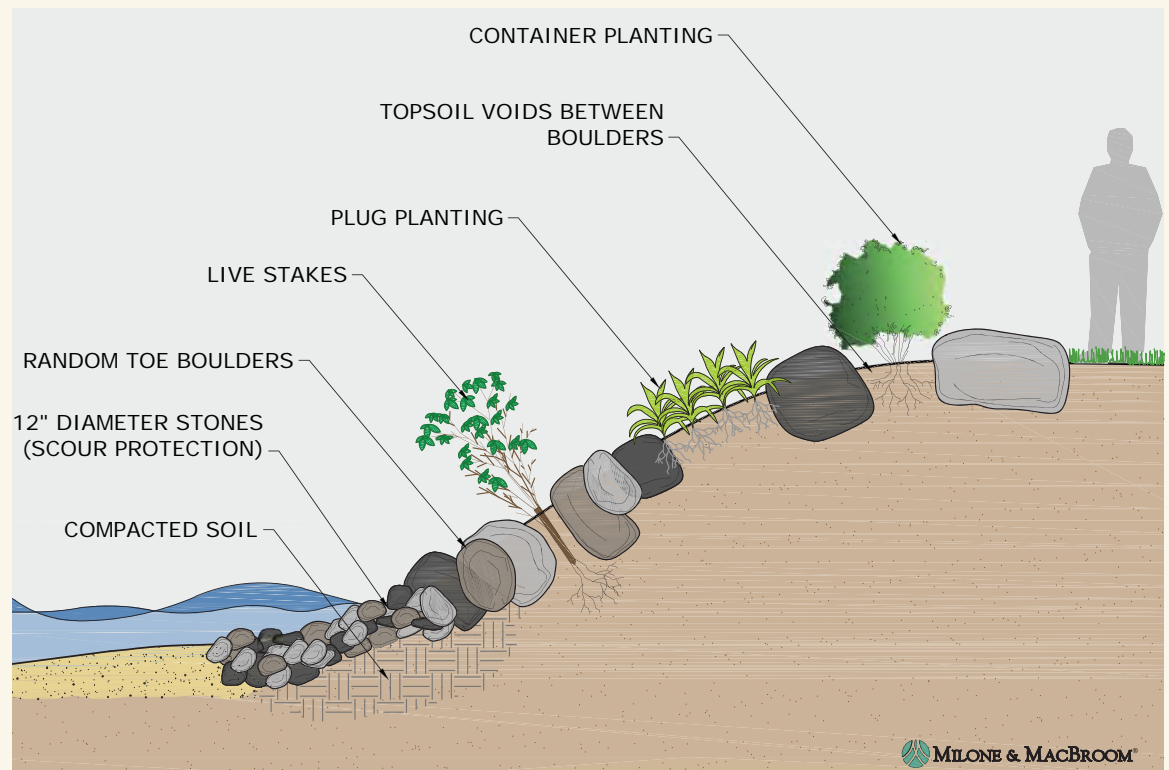
## D. VEGETATED BUFFERS AND SHORELINE/BANK STABILIZATION MEASURES

from predation, and forage areas for a variety of fish

- Eliminates shallow-water habitat, which is a critical refuge and foraging habitat for juvenile and other small fish
- Significantly decreases fish species diversity and aggregates of fish
- The nesting success and diversity of fish species also declines, with sensitive native species being replaced by more tolerant or invasive species.
- Prevents recruitment of native sediments to a lake, resulting in a loss of heterogeneous substrate
- Can lead to sediment embeddedness, resulting in loss of interstitial space required by macroinvertebrates and refuge and foraging spaces for various life stages of fish. Also leads to oxygen-poor sediments, which will cause anaerobic conditions to develop in near-shore sediments.

### Bioengineering Stabilization Measures

Bioengineering is often called “softshore engineering” or “lakescaping” and is a method of using native plants, biodegradable products, and other natural materials (i.e., boulders, coir logs, large woody logs, and stumps) to recreate a stable natural shoreline environment. The goal of bioengineering is to create a more naturalistic shoreline environment while protecting adjacent land from waves and erosion. Bioengineering techniques use a combination of materials including natural boulders interplanted with vegetation, live stakes wattles, coir logs with herbaceous plantings, and erosion control matting. Bioengineered shorelines have the ability to absorb some or all of the wave energy that is directed toward the shoreline, help minimize shoreline soil erosion, and protect water quality through natural runoff filtration.



Dry laid boulders interlaced with live stakes, plugs and container plants

# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

## D. VEGETATED BUFFERS AND SHORELINE/BANK STABILIZATION MEASURES

Bioengineered solutions are most appropriate on slopes that experience little to modest wave energy. Depending on application and chosen plant species, they can be used on steep slopes, even in excess of 40 percent. Natural plantings will be most successful in areas where the soils have adequate moisture and sufficient sunlight and drainage throughout the growing season such that live vegetation can become established. It is recommended that bioengineering methods be installed during low water or seasonal fall drawdown on the lake and during the dormant growing season for the plants being used. A few of the most common bioengineering techniques used include the following:

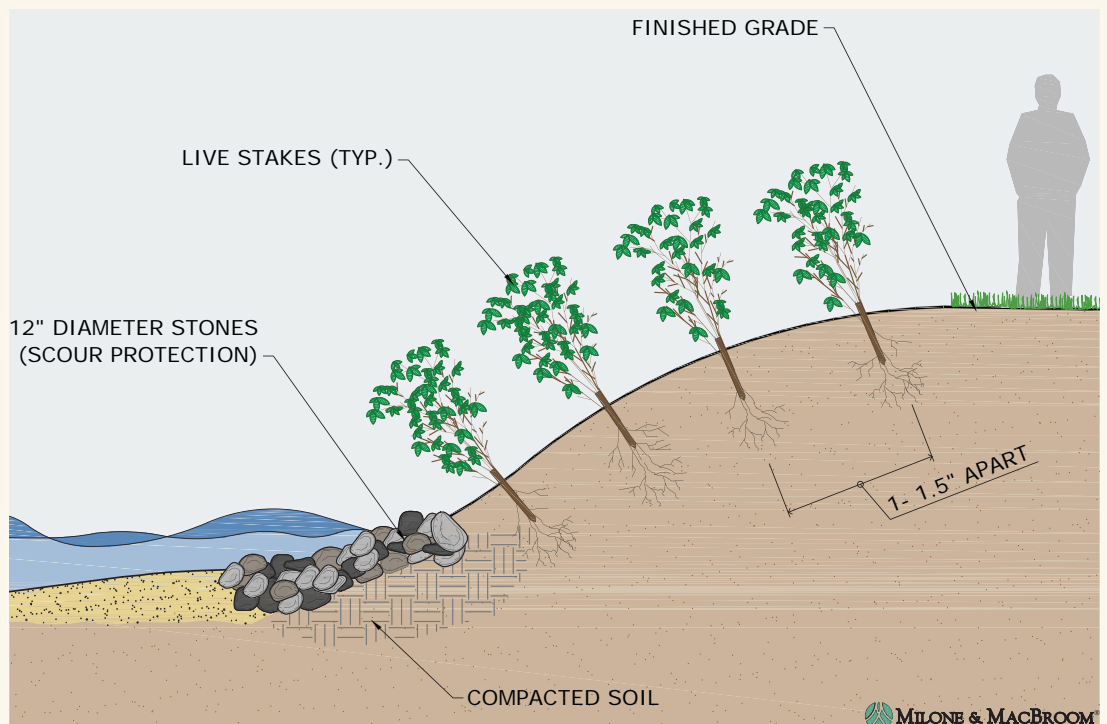
### *Live Staking*

Live staking is usually the easiest and least expensive method to install. Live cuttings from speckled alder, silky dogwood, and/or willow are inserted into the soil on a slope and/or shoreline, where the stakes will begin to sprout roots at former leaf nodes of the stakes, eventually forming new branches and mature woody vegetation. Live stakes can be installed between rock voids where there is ample stake-to-soil contact. Placement of topsoil between the interstitial spaces or voids along natural boulders will allow for placement of live stakes between boulders. This method does not require skilled labor to install. Live stakes should be 0.25 to 1.5 inches in diameter and 2 to 4 feet long. Pilot holes for live stakes can be completed by pressing or driving in a long pry bar. Once an adequate hole has been formed, the live stake is inserted into the hole, backfilled, and compacted.

Live stakes are commercially available at the sources listed in



Installation of live stakes



Cross section of live stake plantings on slope



# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

## D. VEGETATED BUFFERS AND SHORELINE/BANK STABILIZATION MEASURES

Appendix C. Live stakes can be shipped via mail. Natural harvesting can be used; however, the homeowner must be familiar with identifying appropriate plant species without leaves and must receive permission to gather the stakes on public or private property. Typical costs for installing live stakes range between \$2 to \$6 per stake.

Although it does not require skilled labor to install live stakes, the general slope design based on determination of site suitability, nature of disturbance, need for toe protection, and other site factors is best done by a professional. A homeowner could easily install live stakes on a slope once all slope stabilization issues were addressed and a design developed by a professional engineer or landscape architect is completed.

### *Live Fascines*

Fascines are branches from live dormant woody plants that are tied together to form bundles. Typical species used for fascines include silky dogwood, willow, and speckled alder. The bundles are laid in a trench that parallels the slope. The fascine bundles are held in place by wood stakes. They are suitable for protecting the toe and face of a slope. The installation of fascines requires skilled experience for the installation to be successful. Fascine bundles should be constructed using branches that are 0.25 to 1.5 inches in diameter and 5 to 30 feet long. The bundles should have a total diameter of approximately 6 to 8 inches and be secured tightly. The bundles should be placed within the trench and secured with a wood stake approximately 2 to 3 feet long. The bundles should then be backfilled with topsoil, leaving approximately 2 to 3 inches of the bundle exposed above the soil surface. Typical costs for installing a live fascine bundle range between \$10 to \$30 a linear foot.

The design for and installation of live fascines should be completed by a skilled professional. A typical installation would include design by a licensed engineer or landscape architect, with subsequent installation by a qualified contractor.



Bioengineered shoreline protection of dry staked boulders, and live fascines

# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

## D. VEGETATED BUFFERS AND SHORELINE/BANK STABILIZATION MEASURES

### *Brush Matting*

Brush mattresses are made of interwoven layers of live cut branches from woody plants. The layering of brush along a slope is called matting. Mats are secured along a lake bank by wood stakes and twine. Matting is typically formed with dormant cuttings from speckled alder, silky dogwood, and/or willow. Brush matting branches should be multistemmed cuttings that are 0.25 to 1.5 inches in diameter and 3 to 8 feet long. Matting can be used in areas with low to moderate wave action and are an alternative to using gabions and/or stone riprap. The installation of brush matting requires skilled experience for the installation to be successful. Typical costs for installing brush matting range from \$18 to \$24 a square yard.



Laying of brush matting above boulder seawall

### *Blueberry and Fern Sod*

The use of low bush blueberry and fern sods has become increasingly popular for providing instant stabilization of slopes and aesthetic appeal. The sods are harvested in similar fashion to grass sod; however, the blueberry and fern sods are thicker in width and have larger rooting structures. These sods are ideal for shady areas and rocky slopes. The sods are relatively drought-tolerant species, making them ideal for upland areas. The sod is laid onto the soil surface and is staked with sod spikes. Watering is necessary for the first few weeks until roots have become established. The cost of installing blueberry and/or fern sods can range from \$4 to \$8 a square foot. Blueberry and fern sods can be installed by a homeowner with a moderate level of skill. Selection of the appropriate location to ensure successful establishment of the sod can be more difficult and is best left to a professional.



Lowbush blueberry sod used on bank to control erosion - 1 week after installation

### Biotechnical Stabilization Measures

Biotechnical methods of shoreline stabilization combine structural and bioengineering methods. The structural and softshore shoreline techniques work together to dissipate wave energy and maintain valuable shoreline habitat. These designs can be aesthetically appealing and have longevity and sustainability if properly designed and installed. Biotechnical methods can effectively protect highly vulnerable shorelines with lower initial construction and long-term maintenance costs than seawalls or retaining walls. These techniques are effective on slopes of from 5 to 25 percent and even on steep bluffs or where high wave energy makes it difficult to establish or maintain shoreline soft armor and vegetation. Some of the biotechnical stabilization measures described in the ensuing text may be completed by a homeowner; however, professional consultations may be required.



# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

## D. VEGETATED BUFFERS AND SHORELINE/BANK STABILIZATION MEASURES

### *Erosion Control Matting*

Erosion control matting consists of lightweight photodegradable and/or biodegradable coir filaments that come in rolls that can be easily installed along slopes. Erosion control matting can be applied directly to an eroding bank after grading or can be applied over newly placed topsoil. Costs associated with installing erosion control matting typically range from \$1.50 to \$3.00 per square yard. These techniques can be employed on slopes ranging from 1 to 25 percent above the wave action zone. Installation must be done consistent with the manufacturer's specifications.

Erosion control matting is available as a number of different products to address specific erosion control and scour protection issues. Selection of the appropriate product should be done by a professional familiar with erosion control matting and its application. Installation of the erosion control matting could be completed by a moderately skilled homeowner.



Erosion control netting placed on steep slopes stabilizes soil after grading

### *Coir Logs*

Coir logs are a reliable erosion control product that is composed of coconut fiber or jute material and is biodegradable. The logs are designed to aid in the initial stabilization and revegetation of hillsides, banks, shorelines, and other areas prone to erosion. The logs are constructed with compact interior cores that have been densely packed with coconut or jute fibers. The fibers are then covered with an exterior coir mesh netting that helps to keep fibers in place. Coir logs can be filled with topsoil and/or wood mulch and can be used as effective erosion control measures. Coir logs filled with topsoil can be planted with herbaceous plugs and/or tubelings. These techniques can be employed on slopes of between 1 to 25 percent above the wave action zone. The cost of installing coir logs with topsoil can range from \$4 to \$10 a linear foot dependent on the diameter of coir log required. Coir logs can be easily installed by a homeowner, but selection of usage and design of installation should be completed by a professional.



Coir logs stabilization with native plugs



# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

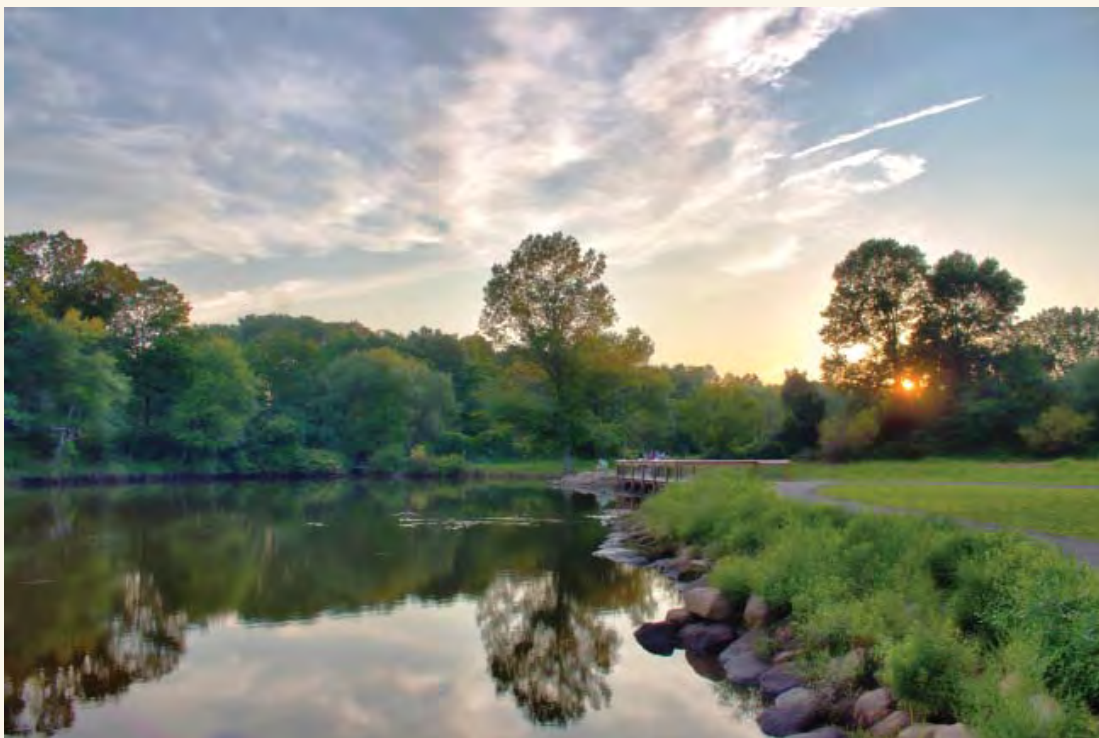
## D. VEGETATED BUFFERS AND SHORELINE/BANK STABILIZATION MEASURES

### *Vegetated Riprap or Natural Boulders*

Vegetated riprap or native boulders are often referred to as joint plantings because this method combines the use of a native stone revetment structure with live plantings. The voids between the native boulders and stones are typically filled with topsoil to provide a growing medium for the placement of live stakes, tubelings, and/or herbaceous plugs. Live stakes should be 0.25 to 1.5 inches in diameter and 2 to 4 feet long. Pilot holes for live stakes can be completed by pressing or driving in a long pry bar. Once an adequate hole has been formed, the live stakes are inserted into the hole and backfilled and compacted as necessary. The riprap and/or native boulders must be sized appropriately so that they are not washed or moved away by wave action. The cost of installing a vegetated stone revetment system typically ranges from \$75 to \$200 per linear foot. These techniques can be employed on slopes of from 1 to 25 percent beginning at the wave action zone and rising upslope. This treatment is best designed and installed by a professional.



Natural boulder / native plug revetment



Natural boulder revetment with vegetation

# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

## D. VEGETATED BUFFERS AND SHORELINE/BANK STABILIZATION MEASURES

### *Vegetated Cribbing*

Vegetated cribbing involves a combination of live stakes or brush matting being interplanted within a timber cribbing structure. The live stakes are planted between the cells of a timber crib structure. Live cuttings from speckled alder, silky dogwood, and/or willow are typically used in this system. Live stakes should be 0.25 to 1.5 inches in diameter and 2 to 4 feet long. Using a combination of live planting and timber creates a very natural appearance. This system works in moderate wave action areas. It must be designed by a professional and installed by a qualified contractor. These techniques can be employed on slopes of from 1 to 25 percent above the wave action zone.



Live brush matting placed within wood cribbing



Vegetated buffer zone installed on top of wood cribbing wall



Live brush matting being placed on wood cribbing



# CHAPTER 2: DESIGN OF VEGETATED BUFFER AREAS & SHORELINE STABILIZATION

## D. VEGETATED BUFFERS AND SHORELINE/BANK STABILIZATION MEASURES

Comparison of Shoreline Stabilization Methods

	Effectiveness	Maintenance	Appearance	Habitat Value	Can Be Installed By
<b>Bioengineering</b>	Appropriate for flat or moderate slopes and near shore water depths of 1 foot with erosion rates of less than 2 feet per year.	Usually little maintenance required after established. Varies depending on specific location and plantings.	Preserves natural appearance of shoreline. Can provide a privacy screen for lake residents.	Reduces soil erosion and sediment contamination of lake. Excellent habitat for fish and wildlife.	Skilled individuals
<b>Biotechnical</b>	Dissipates moderate wave energy, controls erosion, and stabilizes most slopes. Appropriate for near shore water depths of 1 to 4 feet, with erosion rates of 2 to 8 feet per year.	Requires little maintenance beyond aesthetic management, if installed properly.	Supports natural vegetation and scenic value.	Dampens wave action. Can provide excellent habitat for fish and wildlife; value increases over time as vegetation is established.	Skilled Individual for simple designs; otherwise
					Design - Engineer
					Installation - Professional Contractor
<b>Stone or riprap</b>	Dissipates moderate wave energy, can stabilize slopes up to 2H:1V. For near shore water depths of 1 to 4 feet, with erosion rates of 2 to 8 feet per year.	Occasional maintenance necessary to move and replace rocks.	Provides a natural appearance of a rocky shoreline. Allows native vegetation to grow between stones.	Dampens wave action, improving habitat for fish and wildlife. Best when allowed to vegetate.	Design - Engineer
					Installation - Professional Contractor
<b>Structural</b>	Structural barrier against strong waves and ice. May stabilize steep, vertical slopes and bluffs. Increases erosion along shoreline. For near shore water depths greater than four feet.	Requires regular maintenance to repair cracks and check for toe erosion. Must be completely replaced or replaced upon breaking.	Permanently alters shoreline contour and prevents establishment of native vegetation along shoreline.	Poor habitat value. Increases wave action. Reduces diversity and quality of feeding and spawning areas for fish and other aquatic species.	Design - Engineer
					Installation - Professional Contractor



# CHAPTER 3: IMPLEMENTATION

## A. IMPLEMENTING YOUR SHORELINE STABILIZATION AND VEGETATED BUFFER ZONE (STEPS AND TECHNIQUES)

Implementing a vegetated buffer zone along the shoreline does not have to be a difficult task or burden. The extensive benefits to the lake water quality and adjacent property values are significant. A homeowner must develop an understanding of the site conditions and constraints on their or FirstLight's property, develop a project budget, and identify long-term outcome goals. Some things that a homeowner may want to consider or that may be required as part of the shoreline stabilization and vegetated buffer zone implementation are:

### Analysis

- A homeowner may be required to obtain a licensed surveyor to determine property lines along the lakefront and topography for future design of a vegetated buffer zone and/or bank stabilization project.
- The homeowner may also need to identify other site features which may include existing uses and structures, septic and well location, utilities, trees, and existing areas of vegetation.
- Undertake soil testing for hydrology, soil texture, pH, and nutrients levels. Determine soil bank type and bank foundation materials.
- Determine the bank slope and off-shore depth and wave height. Determine degree of existing vegetation, and vulnerability of adjacent shoreline and structures.

### Design

- Retain qualified professionals such as a licensed landscape architect, professional engineer, and/or qualified landscape

contractor for design of complicated bioengineered, biotechnical, or structural solutions.

- Simple bioengineering methods may be designed by the homeowner with input from FirstLight or other technical resources.
- Grade the slope face back to a stable angle and shape.
- Protect the toe of slope against erosion. Create an irregular natural shoreline using vegetation, rocks, and woody debris to synthesize a natural littoral zone.
- Select plants based on existing site conditions.
- Obtain all the necessary permits.

### Permitting Requirements

Any work along the lakefront/shoreline within the FERC, Housatonic River project boundary P-2576 will require the homeowner to obtain a permit from FirstLight and possibly local regulatory agencies. The following process shall be used to address any request for any new uses or bank stabilization and/or vegetated buffer zone regarding establishment projects:

- (a) Homeowner shall contact FirstLight and the homeowner shall be provided with an application packet and can schedule a site visit if necessary.
- (b) Following receipt of an application, FirstLight shall review to determine whether the proposed use may be permitted under FERC License Article 413 of the project license and whether adequate information is provided.

### Local Regulatory Agencies

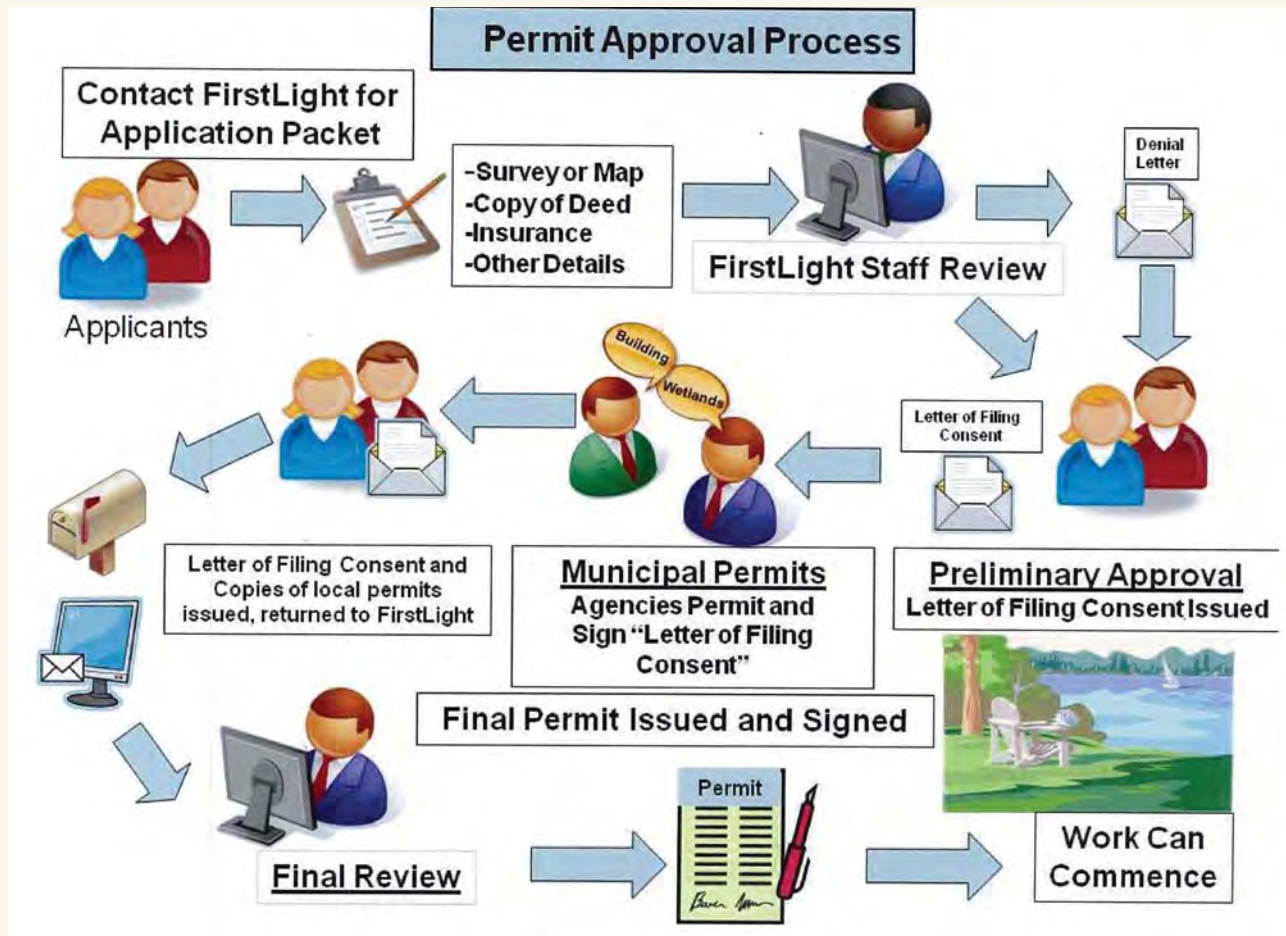
- Inland Wetland and Watercourses
- Planning and Zoning

For more information regarding FirstLight permitting, please visit

<http://www.firstlightpower.com>

# CHAPTER 3: IMPLEMENTATION

## A. IMPLEMENTING YOUR SHORELINE STABILIZATION AND VEGETATED BUFFER ZONE (STEPS AND TECHNIQUES)



If you would like to do something on your property, please contact FirstLight Power at (860) 350-3294.

- (c) If adequate information is provided and a preliminary determination has been made that the proposed use is permissible under License Article 413, FirstLight shall issue a "Letter of Filing Consent" to the applicant, authorizing the applicant to seek any and all applicable wetland, zoning, health, and building permits.
- (d) If adequate information is not provided and/or the proposed use is not permissible under License Article 413, the application shall be denied by FirstLight.
- (e) Following receipt of a "Letter of Filing Consent", the applicant shall apply for all required permits, including wetland, zoning, building, and health permits.
- (f) If required permits are denied, FirstLight shall not approve the application.

Additionally if more than 200 linear feet of bank is disturbed along the shorefront or fill exceeding an average of 1 cubic yard per linear foot is placed below ordinary high water, then United States Army Corps of Engineers and Connecticut Department of Energy & Environmental Protection permits may be required.

## CHAPTER 3: IMPLEMENTATION

### A. IMPLEMENTING YOUR SHORELINE STABILIZATION AND VEGETATED BUFFER ZONE (STEPS AND TECHNIQUES)

#### Permit Application Submittal Calendar

Homeowners need to plan ahead with regard to obtaining the necessary permits for implementing bank stabilization and/or vegetated buffer zone projects during annual lake drawdowns. FirstLight's permit applications must be received by late summer of a given year for a homeowner to complete shoreline improvements related to the wave zone impacts during that year's drawdown.

Improvements related to upland revegetation and/or erosion control must be submitted by early fall of a given year to FirstLight for a homeowner to complete upland area shoreline improvements. Exceptions to the above permit submittal schedule may be considered by FirstLight under emergency circumstances.

#### Construction

Installation of bank stabilization measures should be completed during low water and/or drawdown conditions if feasible. Revegetation of a buffer zone typically should be completed during the spring between March 15 and June 15 or during the fall between September 15 and November 15. These are the optimal times for the establishment of new plants.

- Retain a qualified landscape and/or construction contractor.
- Determine if it is necessary to clear existing vegetation or invasive species. Existing vegetation should be retained wherever possible.
- Determine if bank regrading is necessary. Steep slopes may benefit from regrading if establishment of vegetation is preferred.
- Cut slopes should be rounded at the top and sides and should be smoothed to remove gullies or rills. Installation of terraces will slow upland runoff and promote infiltration.
- Install sedimentation and erosion control measures, especially if bank regrading is necessary.

Prior to any grading, removal of seawalls, or clearing of vegetation, the homeowner shall install appropriate sediment and erosion control measures along the shoreline. These measures may include silt fence, staked hay bales, straw wattles, coir logs, silt socks, and/or a combination of the above-mentioned measures. Additional information regarding the selection of the proper sediment and erosion control measures can be found within the Connecticut Department of Energy & Environmental Protection *2002 Connecticut Guidelines for Soil Erosion and Sediment Control* (<http://www.ct.gov/deep/cwp>).



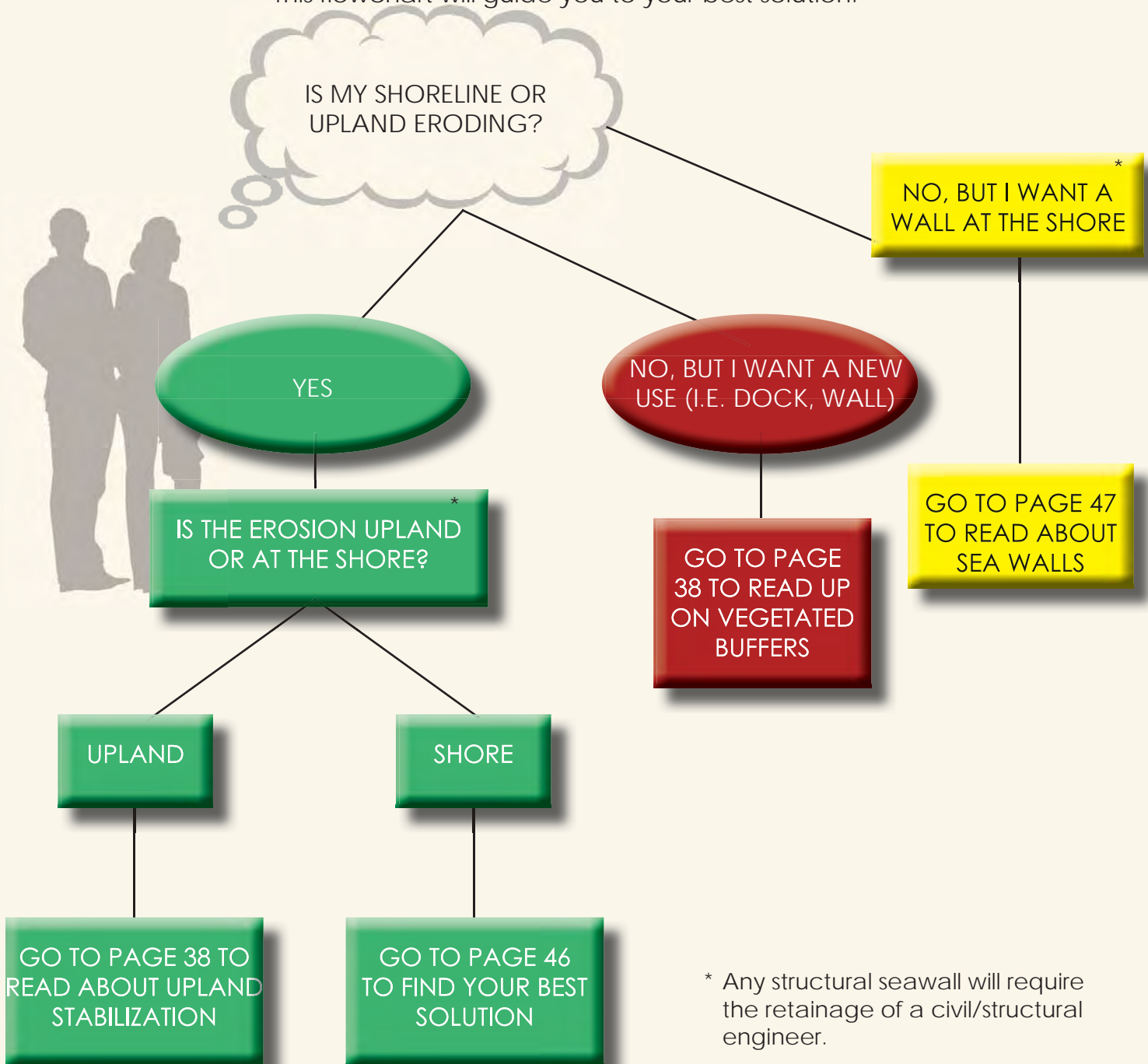
# CHAPTER 3: IMPLEMENTATION

## A. IMPLEMENTING YOUR SHORELINE STABILIZATION AND VEGETATED BUFFER ZONE (STEPS AND TECHNIQUES)

### NEW USES

#### A GUIDE FOR CHOOSING THE BEST PROJECT FOR YOU

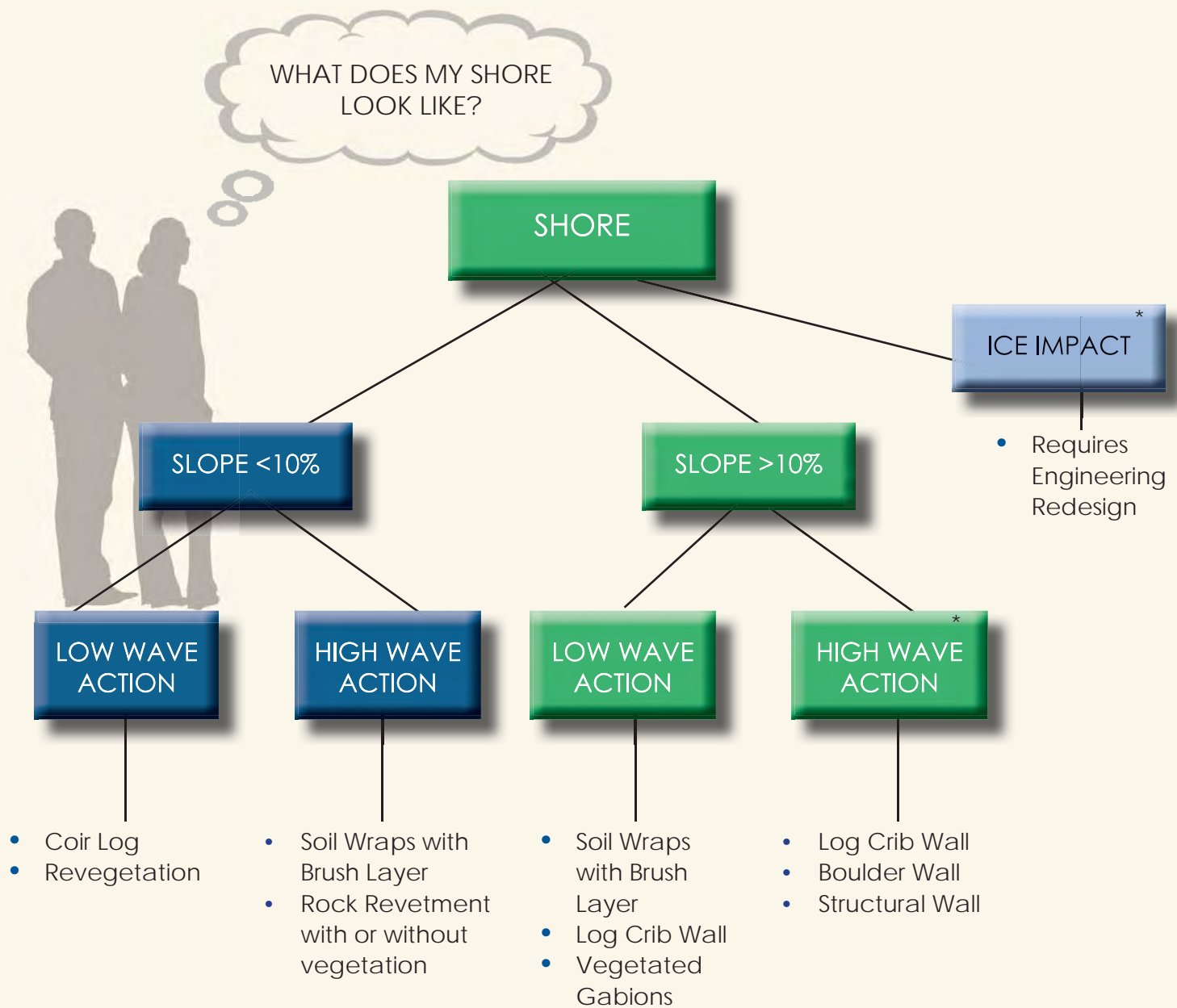
This flowchart will guide you to your best solution.



\* Any structural seawall will require the retainage of a civil/structural engineer.

# CHAPTER 3: IMPLEMENTATION

## A. IMPLEMENTING YOUR SHORELINE STABILIZATION AND VEGETATED BUFFER ZONE (STEPS AND TECHNIQUES)



Please see Appendix B for Typical Details for Designing Shoreline Stabilization.

\* Any structural seawall will require the retainage of a civil/structural engineer.

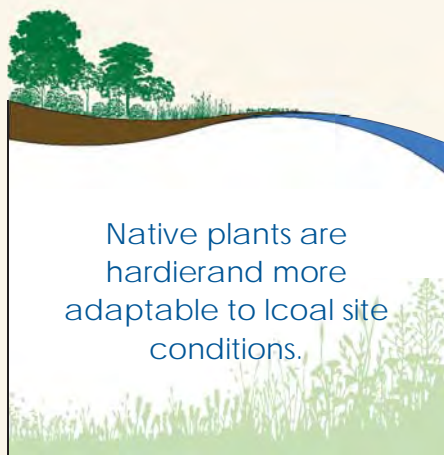
# CHAPTER 3: IMPLEMENTATION

## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Determining the types of plants to be used within a vegetated buffer depends on a variety of factors including:

- Soil types and conditions (pH, available nutrients, organic content)
- Hydrologic regime
- Degree of slope
- Exposure (wave action, water mist, wind)
- Sunlight/shade

Consulting with a local nursery, garden club, professional landscape contractor, and/or licensed landscape architect is recommended before purchasing plants and implementing the vegetated buffer plan. Wetland plants will not survive on dry sunny sloped soil areas and, conversely, upland plants will not survive if planted in the water and/or in wet soils. Understanding the site's conditions is critical for a successful implementation of a vegetated buffer zone. Native plants should be used in all vegetated buffer zone areas. The use of non-native invasive plants should be avoided.



A **native plant** is a species that occurs naturally in a particular region, state, ecosystem, and habitat without direct or indirect human actions.



Purple Loosestrife - looks great but is invasive

An **ornamental plant** or **Cultivar** is a species that may occur naturally in another location but is selected for its unique attributes visually, structurally, or because it is easy for nurseries to mass produce.

An **invasive plant** is a species non-native to the ecosystem under consideration and whose introduction, whether accidental or intentional, causes or is likely to cause harm to the environment, economy, or human health.

Most native plants are green leaved during the growing season and have flowering and fruiting properties that may be quite colorful during the growing season. For some homeowners, having a mass planting of green-foliaged native plants may not be aesthetically appealing. Over the past 25 years, the nursery trade has seen an influx of new hybrids and plant sports that are native but have been hybridized, modified or enhanced over their native parents.



Native Summersweet -  
*Clethra alnifolia*  
(white flowers)



Native Hybridized  
Summersweet - Ruby Spice  
(pink flowers)









# CHAPTER 3: IMPLEMENTATION

## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Many of these hybrids and/or sports have become commercially available and are considered native ornamentals. The use of native ornamentals is considered appropriate for vegetated buffer zones. However, it should be noted that some ornamentals may not grow as well as the true native species. Some examples of native ornamentals include variegated silky and/or red osier dogwood, variegated pagoda dogwoods, variegated flowering dogwoods, variegated false Solomon’s seal, of which are native but are classified as ornamental. Using a combination of true native plants and native ornamental plants is appropriate for reestablishing vegetated buffer zones. A list of native plants that are appropriate for vegetated buffer zones is provided. Sources for native plants are provided in Appendix 3.

### Native Plant List

Full Sun 	Partial Shade 	Full Shade 
Wet Soils 	Very Moist Soils 	CT Native 
Somewhat Moist Soils 	Slightly Moist Soils 	Bio-Engineering 

<b>OBL: Obligate Wetland Species</b>	Plants that almost always grow in wetlands (estimated probability >99%), under natural conditions.
<b>FACW: Facultative Wetland Species</b>	Plants that usually grow in wetlands (estimated probability 67%-99%), but are occasionally found in non-wetlands areas.
<b>FAC: Facultative Species</b>	Plants equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66% in wetlands).
<b>FACU: Facultative Upland Species</b>	Plants usually found in non-wetlands (estimated probability 67%-99%), but occasionally found in wetlands (estimated probability 1%-33%).
<b>UPL: Upland Species</b>	Plants almost always found in non-wetlands or upland sites (estimated probability >99%).

For additional plant information, please visit <http://www.hort.uconn.edu/plants>.



Native Blue Flag Iris



Native Sweet Pepperbush

# CHAPTER 3: IMPLEMENTATION

## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Common Name <i>Scientific Name</i>	Mature Heights (feet)	Mature Widths (feet)	Habitat	Hardiness Zone	Shade Tolerance	Descriptive Information	CT Native	Suitable for Bio-Engineering
<b>CANOPY TREES</b>								
Red Maple <i>Acer rubrum</i> Cultivars ( <i>Autumn Flame, October Glory, Red Sunset, Autumn Radiance</i> )	60-75'	35-45'	FAC	3 - 9		Fast growing, orange-red to red fall foliage, smooth grey bark, very hardy.		
Silver Maple <i>Acer saccharinum</i>	60-80'	45-55'	FACW	3 - 9		Fast growing, very adaptable, yellow fall foliage.		
Sugar Maple <i>Acer saccharum</i> Cultivars ( <i>Commemoration, Green Mountain, Majesty, Fall Fiesta</i> )	60-80'	35-45'	FACU	3 - 8		Yellow, orange, and red fall foliage. Bright green leaf coverage in spring.		
Yellow Birch <i>Betula alleghaniensis</i>	60-70'	25-35'	FAC	3 - 7		Golden yellow foliage, exfoliating bark, resistant to leaf miner.		
Black Birch <i>Betula Lenta</i>	40-60'	30-40'	UPL	3-7		Great for naturalizing. Yellow fall color.		
Bitternut Hickory <i>Carya cordiformis</i>	50-80'	30-50'	FAC	4 - 9		Found in low lying woodlands not eaten by birds and small mammals.		
Pignut Hickory <i>Carya glabra</i>	50-80'	25-40'	FACU	4 - 9		Grey bark with scales yellow fall color.		
Shagbark Hickory <i>Carya ovata</i>	70-90'	50-70'	FACU	4 - 8		Wonderful exfoliating bark. Straight trunk.		
American Yellowwood <i>Cladrastis kentukea</i>	30-50'	40-55'	FAC	4 - 8		Fragrant creamy pendulous flowers. Smooth grey bark with yellow fall foliage.		
American Beech <i>Fagus grandifolia</i> Cultivar ( <i>Cimmaron</i> )	50-70'	40-70'	FACU	3 - 9		Wonderful native woodland tree with smooth bark. Winter interest		
White Ash <i>Fraxinus americana</i> Cultivar ( <i>Cimmaron</i> )	50-80'	35-45'	FACU	3 - 9		Yellow, red, and purple fall color. Large canopy. Susceptible to ash borer. Current bans on moving in CT.		
Green Ash <i>Fraxinus pennsylvanica</i>	50-60'	35-50'	FACW	3 - 9		Superb yellow fall color medium to dark green leaves. Susceptible to ash borer. Current bans on moving in CT.		
Sweet Gum <i>Liquidambar styraciflua</i> Cultivar ( <i>Slender Silhouette</i> )	60-75'	40-50'	FAC	5 - 9		Great for most soils. Spiked fruit yellow-orange-red-purple fall color.		
Tulip Tree <i>Liriodendrum tulipifera</i>	80'	35-55'	FAC	4 - 9		Interesting foliage. Yellow fall color. Beautiful tulip-like flowers.		

# CHAPTER 3: IMPLEMENTATION











































## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Common Name <i>Scientific Name</i>	Mature Heights (feet)	Mature Widths (feet)	Habitat	Hardiness Zone	Shade Tolerance	Descriptive Information	CT Native	Suitable for Bio-Engineering
Black Gum <i>Nyssa sylvatica</i>	40-80'	20-30'	FAC	4 - 9		Red fall foliage. Thick ridges in bark, highly adaptable.		
American Sycamore <i>Platanus occidentalis</i>	75-100'	75-100'	FACW	3 - 8		Grows along streams and rivers. Attractive bark, rounded fruit.		
Hop Hornbeam <i>Ostrya virginiana</i>	30-50'	20-30'	UPL	4 - 9		Grey and brown exfoliating bark and interesting lime green - white hanging fruit.		
White Oak <i>Quercus alba</i>	100'	30-50'	FACU	3 - 8		Stately form. Red fall color, acorns, and adaptable.		
Swamp White Oak <i>Quercus bicolor</i>	50-80'	30-50'	FACW	3 - 9		Wet soils. Yellow, brown, to red fall color, and acorns.		
Scarlet Oak <i>Quercus coccinea</i>	50-80'	30-50'	UPL	4 - 8		Dark green leaves turning brilliant red in the fall.		
Bur Oak <i>Quercus macrocarpa</i>	50-80'	30-50'	FAC	3 - 8		Adaptable, found on sandy plains and moist low lying areas.		
Chinkapin Oak <i>Quercus muehlenbergii</i>	40-50'	40-50'	FACU	4 - 7		Large oak seldom found in Connecticut difficult to transplant. Dark serrated green leaves.		
Red Oak <i>Quercus rubra</i>	80-100'	30-50'	FACU	4 - 7		Rounded growth habit, red fall color. New growth is bronze / red. Adaptable to different soils.		
Pin Oak <i>Quercus palustris</i>	60-70'	30-50'	FACW	4 - 7		Lower branches are pendulous and hang down, brown - red fall color.		
Willow Oak <i>Quercus phellos</i>	40-60'	30-40'	FACW	6 - 9		Large oak with narrow foliage turning yellow in the fall.		
Black Oak <i>Quercus velutina</i>	50-60'	30-50'	UPL	4 - 7		Common on upper slopes and produces acorns.		
Basswood <i>Tilia americana</i>	60-80'	30-50'	FACU	4 - 9		Cream - yellow fragrant flowers		
American Elm <i>Ulmus americana</i> Cultivar (Princeton)	60-80'	30-40'	FACW	4 - 7		New disease resistant cultivars. Majestic tree, yellow fall color.		
<b>CONIFEROUS &amp; EVERGREEN TREES</b>								
Balsam Fir <i>Abies balsamea</i>	45-75'	20-30'	FACU	3 - 6		Dark green needles, dark violet cones when young, require well drained soil. Protect from desiccating winds.		











































# CHAPTER 3: IMPLEMENTATION

## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Common Name <i>Scientific Name</i>	Mature Heights (feet)	Mature Widths (feet)	Habitat	Hardiness Zone	Shade Tolerance	Descriptive Information	CT Native	Suitable for Bio-Engineering
American Holly <i>Ilex opaca</i>	15-30'	20-30'	FACU 	5 - 9		Glossy dark green foliage with red berries in the fall, slow growing - protect from winter winds.		
Eastern Red Cedar <i>Juniperus virginiana</i>	30-45'	25-35'	FACU 	3 - 9		Very hardy, use in groupings, foliage turns brown - green in winter. Blue cones are highly valued by birds.		
Eastern Larch <i>Larix laricina</i>	40-80'	25-30'	FACW 	2 - 6		Dark Brown attractive bark with bright green needles turning yellow - copper in fall. Excellent plant for moist soils.		
White Spruce <i>Picea glauca</i>	100'+	20-30'	FACU 	2 - 6		Great for use as screening.		
White Pine <i>Pinus strobus</i>	80-100'	25-35'	FACU 	3 - 8		Soft needles wide spreading habit. Loses lower limbs with maturity, fast growing.		
Eastern Hemlock <i>Tsuga Canadensis</i> <i>Cultivar (Pendula)</i>	80-100'	25-35'	FACU 	3 - 7		Soft needles, used in groupings. Susceptible to wooly adelgid. Small cones used for hedges/ screening.		
<b>UNDERSTORY TREES</b>								
Striped Maple <i>Acer pensylvanicum</i>	15-25'	12-20'	FACU 	3 - 7		Shade tolerant large leaved maple with beautiful striped bark.		
Downy Serviceberry <i>Amelanchier arborea</i>	15-25'	15-25'	FAC 	4 - 9		White flowers. Berries eaten by birds. Use for naturalizing areas.		
Serviceberry <i>Amelanchier canadensis</i> <i>Cultivars (Iamarckii, Autumn Brilliance)</i>	15-20'	15-25'	FAC 	4 - 9		Adaptable, but loves to be on the lake edge. White star-like flowers in spring pink-red-orange fall color.		
Allegheny Serviceberry <i>Amelanchier laevis</i>	15-30'	15-25'	FAC 	4 - 8		Adaptable, but loves to be on the lake edge. White star-like flowers in spring pink-red-orange fall color.		
River Birch <i>Betula nigra</i> <i>Cultivars (Dura-Heat, Heritage)</i>	45-60'	25-35'	FACW 	4 - 9		Cream colored and exfoliated bark. Cultivars have very high wildlife value, heat resistant.		
Paper Birch <i>Betula papyrifera</i>	45-60'	25-35'	FACU 	2 - 7		White bark, great when planted in groupings. Yellow fall foliage.		
Gray Birch <i>Betula populifolia</i>	20-40'	15-25'	FAC 	3 - 7		Very adaptable to different soils. Best used in cooler areas of North America.		
American Hornbeam <i>Carpinus caroliniana</i>	20-30'	15-20'	FAC 	3 - 9		Yellow - reddish purple fall color. Grows naturally along woodland edges and streams.		

# CHAPTER 3: IMPLEMENTATION

## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Common Name <i>Scientific Name</i>	Mature Heights (feet)	Mature Widths (feet)	Habitat	Hardiness Zone	Shade Tolerance	Descriptive Information	CT Native	Suitable for Bio-Engineering
Eastern Redbud <i>Cercis canadensis</i>	20-30'	25-35'	FACU 	4 - 9		Dark to light pink spring flowers attractive heart shaped blueish green leaves that turn yellow in fall.		
Fringe Tree <i>Chionanthus virginicus</i>	12-20'	15-20'	FAC 	4 - 9		Fragrant. Four to five petal led white flowers in spring, great tree for naturalizing.		
Pagoda Dogwood <i>Cornus(Swida)alternifolia</i>	15-25'	20-35'	UPL	3 - 7		Graceful branching. White fragrant flowers in the spring. Blue-black fruit.		
Flowering Dogwood <i>Cornus(Benthamidia) florida (Many Cultivars)</i>	20-30'	20-30'	FACU 	5 - 9		Red to purple and pink fall color, white, and pink flowers, red fruit in September.		
Persimmon <i>Diospyros virginiana</i>	35-40'	25-35'	FAC 	4 - 9		Yellow-reddish-purple fall colors. Fragrant white flowers and yellow-orange edible berries.		
Sourwood <i>Oxydendron arboreum</i>	20-30'	15-20'	FACU 	5-9		Shiny green foliage that changes brilliant red in fall. Summer blooming.		
Black Cherry <i>Prunus serotina</i>	30-40'	20-30'	FACU 	3 - 9		Yellow - red fall color. Profuse white flowers in spring.		
Chokecherry <i>Prunus virginiana</i>	20-30'	15-20'	FACU 	2 - 7		Showy white fragrant flowers. Attracts song birds.		
Sweet Bay Magnolia <i>Magnolia virginiana</i>	10-35'	10-35'	FACW 	5 -10		Fragrant cup shaped creamy white flowers. Shiny green foliage.		
Sassafras <i>Sassafras albidum</i>	20-35'	20-25'	UPL 	4 - 8		Interesting foliage yellow, pink, to red-orange fall color. Very difficult to transplant.		
<b>Large Shrubs</b>								
Speckled Alder <i>Alnus incana</i>	15'	15-20'	FACW 	3 - 6		Thicket forming - great for screening - grows in moist conditions & full sun but very adaptable. Fast growing great for bank stabilization.		
Gray Dogwood <i>Cornus(Swida) racemosa Cultivar (Geauge)</i>	10-15'	10-15'	FAC 	4 - 8		Blue green foliage turns maroon in the fall. White-cream flowers and purple berries, great massing/ border shrub.		
American Hazelnut <i>Corylus americana</i>	8-15'	10-15'	FACU 	4 - 9		Naturalizing shrub. Provides seasonal interest and adaptable.		
Common Witchhazel <i>Hamamelis virginiana</i>	15-20'	8-12'	FAC 	3 - 8		Beautifully shaped light green leaves turning yellow in fall. Yellow star flowers in the fall. Great branching form.		

# CHAPTER 3: IMPLEMENTATION

## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Common Name <i>Scientific Name</i>	Mature Heights (feet)	Mature Widths (feet)	Habitat	Hardiness Zone	Shade Tolerance	Descriptive Information	CT Native	Suitable for Bio-Engineering
Rose Bay Rhododendron <i>Rhododendron maximum</i>	8-15'	8-15'	FAC	3 - 7		Broadleaf Evergreen. Pink-white flowers great for naturalizing. Avoid exposed site.		
Flameleaf Sumac <i>Rhus copallina</i>	20-30'	20-30'	UPL	4 - 9		Largely adaptable to everything but moist soils. Cream flowers with red fall foliage.		
Smooth Sumac <i>Rhus glabra</i>	10-15'	10-15'	UPL	2 - 9		Colonizer. Yellow flowers in late spring brilliant red fall color use for naturalizing.		
Staghorn Sumac <i>Rhus typhina(hirta)</i>	15'	4-8'	UPL	3 - 8		Large shrub used for screening. Red- orange fall color. Red cone shaped fruit.		
Pussy Willow <i>Salix discolor</i> Cultivar (Pendula)	20'	10-15'	FACW	2 - 9		Fuzzy cotton like flowers in early spring. Early pollen source for bees. Butterfly larval food source.		
Northern Arrowwood <i>Viburnum dentatum</i> Cultivar (Blue Blaze, Blueberry Muffins)	6-15'	6-10'	FAC	2 - 8		Very adaptable shrub with long vertical branches and white fuzzy flowers in spring. Red fall color. Use in masses.		
Blackhaw Viburnum <i>Viburnum prunifolium</i>	8-15'	8-12'	FAC	3 - 9		Dark green leaves that turn shiny maroon in the fall. White flowers in spring. Blue-black fruit attract birds.		
Nannyberry <i>Viburnum lentago</i>	12-15'	12-15'	FAC	2 - 8		Glossy dark green leaves turning purple-red in fall. Pink fruit that turns dark purple, great for naturalizing.		
American Cranberrybush <i>Viburnum trilobum</i> Cultivar (Wentworth)	8-12'	8-12'	FACW	2 - 7		Likes moist, cool locations. White flower clusters. Red berries and red fall color, quick grower.		
<b>Medium Shrubs</b>								
Red Chokeberry <i>Aronia arbutifolia</i> Cultivars (Brilliantissima)	6-10'	3-5'	FACW	4 - 9		Bright red fruits, white flower clusters, red fall color. Colonizes and spreads with an open upright growth habit. Good for bank stabilization.		
Black Chokeberry <i>Aronia melanocarpa</i>	4-8'	4-6'	FAC	3 - 8		Long lasting black berries. Dark green summer foliage with yellow, orange, red fall color. Suckers forming dense plant colonies.		
Eastern Sweetshrub <i>Calycanthus floridus</i>	6-10'	6-12'	FACU	4 - 9		Fragrant deciduous woodland shrub brown-red flowers. Yellow fall color.		
Buttonbush <i>Cephalanthus occidentalis</i>	6-10'	6-8'	OBL	5 - 10		Fast growing small creamy white flowers. Rounded shrub for wet areas.		



# CHAPTER 3: IMPLEMENTATION

## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Common Name <i>Scientific Name</i>	Mature Heights (feet)	Mature Widths (feet)	Habitat	Hardiness Zone	Shade Tolerance	Descriptive Information	CT Native	Suitable for Bio-Engineering
Sweet Pepperbush <i>Clethra alnifolia</i> Cultivars (Hummingbird, Sixteen Candles, Ruby Spice)	5-8'	4-6'	FAC	4 - 9		Fragrant long lasting white flowers in summer. Yellow fall foliage, great in masses.		
Silky Dogwood <i>Cornus (Swida) amomum</i> Cultivar (Indigo)	6-12'	6-12'	FACW	5 - 8		Flat topped cream flowers in June. Red- purple fall color. White-blue berries attract birds		
Redosier Dogwood <i>Cornus(Swida) sericea</i> Cultivar (Cardinal)	6-10'	6-10'	FACW	2 - 7		White flowers and red stems. Prune to maintain stem color. White berries and purple- red fall foliage.		
Beaked Hazelnut <i>Corylus cornuta</i>	4-8'	4-8'	FACU	4 - 8		Thicket forming great for naturalizing.		
Large Fothergilla Fothergilla major Cultivar (Mt. Airy)	6-10'	6-10'		5 - 8		Large deciduous shrub with white bottle brush flowers and orange-red-pink fall color.		
Inkberry <i>Ilex glabra</i> Cultivar (Shamrock, Densa)	4-8'	4-6'	FACW	4 - 9		Evergreen mounding shrub, grows in dry and wet soils. Small flowers and berries. Protect from harsh winter sun/ wind.		
Common Winterberry <i>Ilex verticillata</i> Cultivars (Jim Dandy, Red Sprite, Winter Red)	6-10'	6-8'	FACW	3 - 9		Bright red berries lasting into winter. Use in grouping for best show. Suckering		
Oak Leaved Hydrangea <i>Hydrangea quercifolia</i> Cultivars (Alice, Snowqueen, Pee Wee)	6-12'	6-10'	UPL	5 - 9		Impressive leaf shape large white flowers throughout the summer marginally hardy in the north.		
Common Juniper <i>Juniperus communis</i> Cultivar (Effusa)	5-10'	8-12'	FAC	2 - 6		Evergreen shrub coarse texture. Smaller 3/4" needles.		
Mountain Laurel <i>Kalmia latifolia</i> (Many Cultivars available)	4-12'	4-12'	FACU	4 - 9		Broadleaf evergreen woodland shrub with showy white-pink flowers. Avoid exposed sites.		
Common Spicebush <i>Lindera benzoin</i>	6-12'	6-12'	FACW	5 - 9		Great wetland shrub/ small tree. Yellow fall foliage.		
Bayberry <i>Myrica pensylvanica</i> (Morella caroliniensis)	5-10'	5-10'	FAC	2 - 6		Semi-evergreen shrub found in sandy soils. Small flowers and berries.		
Common Ninebark <i>Physocarpus opulifolius</i> Cultivars (Diablo, Coppertina)	6-12'	4-8'	FACU	2 - 7		White globe flowers. Green to red fruit with yellow-bronze fall foliage. Use in masses.		
Pasture Rose <i>Rosa carolina</i>	6-7'	5-6'	FACU	4 - 9		Dark green summer foliage that turn red in the fall. Pink flowers are followed by fruit that lasts through the winter.		

# CHAPTER 3: IMPLEMENTATION

## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Common Name <i>Scientific Name</i>	Mature Heights (feet)	Mature Widths (feet)	Habitat	Hardiness Zone	Shade Tolerance	Descriptive Information	CT Native	Suitable for Bio-Engineering
Pinxterbloom Azalea <i>Rhododendron nudiflorum (periclymenoides)</i>	4-7'	4-6'	FAC	4 - 8		Fragrant white to pink flowers. Deciduous shrub.		
Roseshell azalea <i>Rhododendron prinophyllum</i>	4-8'	4-8'	FAC	4 - 8		Fragrant deciduous shrub with pink flowers in spring. Bright green foliage.		
Swamp Azalea <i>Rhododendron viscosum</i>	5-9'	4-6'	OBL	3 - 9		Fragrant white flowers and delicate bright green leaves. Good fall foliage.		
Heart-leaved Willow <i>Salix cordata</i>	3-12'	6-10'	FACW	3 - 8		Fast growing colonized for on river banks and sandy lake shores.		
Sand Bar Willow <i>Salix exigua</i>	4-7'	5-7'	FACW	4 - 8		Suckering thin leaved deciduous fast growing shrub		
American Elderberry <i>Sambucus canadensis(nigra)</i> Cultivars ( <i>York, Laciniata</i> )	6-12'	6-12'	FACU	3 - 9		Large white flowers and purple-black edible fruit.		
Highbush Blueberry <i>Vaccinium corymbosum</i>	6-12'	8-12'	FACW	3 - 7		Small white bell shaped flower clusters. Edible blueberries and brilliant red fall foliage.		
<b>Small Shrubs</b>								
Running Serviceberry <i>Amelanchier stolonifera (spicata)</i>	3-4'	4-5'	FACU	4 - 8		Early white flowering deciduous shrub. Purple-red berries attract birds.		
Bearberry <i>Arctostaphylos Uva-Ursi</i> Cultivars ( <i>Massachusetts</i> )	5-1'	2-4'	UPL	2-6		Ground cover evergreen shrub with dark green leaves, pinkish flowers, red fruits that can persist into the winter.		
New Jersey Tea <i>Ceanothus americanus</i>	3-4'	3-5'	UPL	4 - 9		Fast spreading, white flowers on tall stems, great massing plant.		
Sweet fern <i>Comptonia peregrina</i>	2-4'	3-5'	UPL	4 - 9		Fast spreading, fern like foliage, great massing plant.		
Bush Honeysuckle <i>Diervilla lonicera</i>	2-4'	3-5'	UPL	3 - 7		Dense suckering shrub. Yellow trumpet shaped flowers and yellow-orange fall color.		
Eastern Leatherwood <i>Dirca palustris</i>	3-6'	3-6'	FAC	4 - 9		Prefers shade. Yellow flowers in March-April, bright green leaves turn yellow in fall. Perfect for woodland gardens.		
Smooth Hydrangea <i>Hydrangea arborescens</i> Cultivars ( <i>Annabelle, Incrediball, Invincibelle Spirit</i> )	3-6'	4-7'	FACU	3 - 9		Large white flowers in late spring that last for weeks. Use in masses wonderful cultivars.		

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## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Common Name <i>Scientific Name</i>	Mature Heights (feet)	Mature Widths (feet)	Habitat	Hardiness Zone	Shade Tolerance	Descriptive Information	CT Native	Suitable for Bio-Engineering
Dwarf Fothergilla <i>Fothergilla gardenii</i> Cultivar (Blue Mist)	3-6'	3-6'	UPL	5 - 8		Blue-green foliage turning brilliant orange-red-pink in the fall. White bottle brush flowers.		
Wintergreen <i>Gaultheria procumbens</i>	<1'	2-3'	UPL	3 - 6		Evergreen woodland groundcover with red fall berries.		
Virginia Sweetpire <i>Itea virginica</i> Cultivars (Henry's Garnet, Little Henry)	3-5'	3-5'	FAC	5 - 9		Hardy shrub with white pendulous flowers, Dark red fall foliage.		
Creeping Juniper <i>Juniperus horizontalis</i> Cultivars (Bar Harbor, Wiltoni, Ice Blue)	1-2'	5-8'	UPL	3 - 9		Blue green needles turning purple in the winter.		
Sheep laurel <i>Kalmia angustifolia</i>	1-3'	3-5'	FAC	2 - 9		Low broadleaf evergreen shrub. Avoid exposed sites.		
Sweetgale <i>Myrica gale</i>	2-3'	4-6'	OBL	2-6		Dark green aromatic foliage. Fruits attract birds.		
Andromeda <i>Pieris florabunda</i>	2-6'	4-6'	FACU	4 - 6		Evergreen leaves with bell shaped white to cream flowers. Protect from harsh winter sun/ wind.		
Bush Cinquefoil <i>Potentilla fruticosa</i> (Dasiphora floribunda)	2-4'	3-4'	UPL	3 - 7		Vigorous deciduous shrub. Yellow flowers in summer.		
Fragrant Sumac <i>Rhus aromatica</i> Cultivars (Gro-Low)	2-5'	3-5'	UPL	3 - 9		Glossy green foliage. Red berries and red fall foliage. Low spreader.		
Swamp Rose <i>Rosa palustris</i>	3-6'	4-6'	OBL	4 - 9		naturally occurring in wet areas. Red arching stems and fragrant pink flowers. Red hips.		
White Spirea <i>Spiraea betulifolia</i> Cultivars (Tor)	2-3'	2-3'	UPL	4 - 8		Small white flowers attract butterflies. Tolerant of different soils. Use as hedge.		
Meadowsweet <i>Spiraea latifolia</i>	2-4'	3-5'	FAC	4 - 9		White - pink fuzzy flower cluster. Yellow-orange fall color.		
Steeplebush <i>Spiraea tomentosa</i>	2-4'	3-5'	FACW	3 - 8		Suckering shrub with pink spiked flowers.		
Lowbush Blueberry <i>Vaccinium angustifolium</i>	1.5-2'	3-5'	FACU	2 - 5		Clump forming groundcover. Small bell shaped white flowers and sweet edible blue berries. Brilliant orange-red fall foliage		
<b>FERNS</b>								
Maidenhair Fern <i>Adiantum pedatum</i>	2'	2-3'	FAC	3 - 8		Ornamental fine textured fan-like fronds spread slowly.		




























































































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## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Common Name <i>Scientific Name</i>	Mature Heights (feet)	Mature Widths (feet)	Habitat	Hardiness Zone	Shade Tolerance	Descriptive Information	CT Native	Suitable for Bio-Engineering
Lady Fern <i>Athyrium filix-femina (angustum)</i> Cultivars (Lady in Red, Ghost)	2-3'	2-3'	FAC	4 - 8		Light green feathery fronds grows in clumps.		
Eastern Hayscented Fern <i>Dennstaedtia punctilobula</i>	1-3'	1-3'	FACU	3 - 8		Fast growing colonizers bright green upright fronds. Can tolerate some sun.		
Goldie's Wood Fern <i>Dryopteris goldiana</i>	2-3'	2-3'	FAC	3 - 8		Slow spreader forming arching fronds with a heart of gold.		
Evergreen Wood Fern <i>Dryopteris marginalis</i>	1'	1'	FACU	3 - 8		Clumping. Semi-evergreen use in dry shade.		
Ostrich Fern <i>Matteuccia struthiopteris</i> Cultivar (The King)	3-5'	3-5'	FACW	3 - 7		Tallest of the ferns. Large upright fronds. Requires rich moist soil.		
Sensitive Fern <i>Onoclea sensibilis</i>	2-3'	2-3'	FACW	4 - 8		Large bright green fronds.		
Cinnamon Fern <i>Osmunda cinnamomea</i> ( <i>Osmundastrum cinnamomeum</i> )	3-6'	3-6'	FACW	3 - 9		Vase shaped fronds with brown.		
Royal Fern <i>Osmunda regalis</i>	2-5'	2-5'	OBL	2 - 10		Graceful appearance. Use in wet locations.		
Christmas Fern <i>Polystichum acrostichoides</i>	1-2'	1-2'	FACU	3 - 9		Semi-evergreen, dark green foliage with new growth emerging light green.		
New York Fern <i>Thelypteris noveboracensis</i>	1-2'	1-2'	FAC	4 - 8		Grows in Colonies as hundreds of individual plants. Light green foliage.		
Marsh Fern <i>Thelypteris palustris</i>	1-2'	1-2'	FACW	5 - 8		Grows in wet meadows and marshes. Pale green fronds.		
<b>Vines</b>								
Virginia Creeper <i>Parthenocissus quinquefolia</i>	Ground cover	Ground cover	FACU	4 - 8		Fast growing deciduous vine turning brilliant red in the fall. Can be used as groundcover.		
Common Trumpet Creeper <i>Campsis radicans</i>	Ground cover	Ground cover	FAC	4 - 9		Aggressive suckering vine. Orange - scarlet trumpet shaped flowers.		
Purple Virgin's Bower <i>Clematis verticillaris</i>	Ground cover	Ground cover	FACU	3 - 8		Sprawling vine with light violet flowers which are poisonous.		
Woodbine <i>Clematis virginiana</i>	Ground cover	Ground cover	FACU	3 - 8		Produce white star-like flowers. Self seeding and suckering.		
Trumpet Honeysuckle <i>Lonicera sempervirens</i>	Ground cover	Ground cover	FACU	4 - 9		Adaptable. Showy scarlet-orange-yellow trumpet shaped flowers.		



































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## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Common Name <i>Scientific Name</i>	Mature Heights (feet)	Mature Widths (feet)	Habitat	Hardiness Zone	Shade Tolerance	Descriptive Information	CT Native	Suitable for Bio-Engineering
Fox Grape <i>Vitis labrusca</i>	Ground cover	Ground cover	FACU 	5 - 8	 	Twisting woody vine with exfoliating bark large leaves and fragrant edible purple fruit.		
<b>Grasses, Sedges, and Rushes</b>								
Sweet Flag <i>Acorus americanus</i>	3-4'	2-3'	OBL    	3 - 6		Sword like foliage with white flowers in spring.		
Broom Sedge Bluestem <i>Andropogon virginicus</i>	3'	3'	FACU 	5 - 8		Fast growing meadow grass.		
Big Bluestem <i>Andropogon gerardii</i>	4-7'	4-5'	FAC  	4 - 10		Tall meadow grass great for naturalizing open areas.		
Fringed Sedge <i>Carex crinita</i>	2-4'	2-4'	OBL    	3 - 9	 	Shade tolerant grass-like leaves interesting flowers and seed pods. Wet woodlands.		
Lurid Sedge <i>Carex lurida</i>	3'	3'	OBL    	5 - 9	 	Pioneer species. Common along lake front areas and colonizing		
Pennsylvania Sedge <i>Carex pensylvanica</i>	1'	1'	UPL	3 - 8	 	Shade tolerant low growing woodland "grass".		
Pointed Broom Sedge <i>Carex scoparia</i>	1-3'	2-3'	OBL    	6 - 10	 	Flowers in summer and adaptable.		
Tussock Sedge <i>Carex stricta</i>	1-3'	2-3'	OBL    	5 - 8	 	Clump forming. Summer flowering found in wet areas.		
Fox Sedge <i>Carex vulpinoidea</i>	1-3'	1-3'	OBL    	3 - 7	 	Meadow forming yellow fall color.		
Northern Sea Oats <i>Chasmanthium latifolium</i>	2-3'	2-3'	FAC 	3 - 8		Clump forming flat oat-like seed heads rich red-bronze winter color.		
Purple Lovegrass <i>Eragrostis spectabilis</i>	2'	2-3'	UPL	5 - 9		Low reseeding grass with fuzzy purple flower heads. Plant in masses.		
Soft Rush <i>Juncus effusus</i>	2-5'	2-3'	OBL    	2 - 9		Mat forming dark green foliage that is spike-like.		
Path Rush <i>Juncus tenuis</i>	0.5-2'	1-2'	FAC 	3 - 9		Low growing and colonizer.		
Switchgrass <i>Panicum virgatum</i>	5-7'	5-7'	FAC  	2 - 9		Upright stately grass. Airy flowers.		
Little Bluestem <i>Schizachyrium scoparium</i>	2-4'	2-4'	FACU 	3 - 8		Great for massing in open areas and meadows.		
Hardstem Bulrush <i>Schoenoplectus acutus</i>	5-8'	2-3'	OBL    	3 - 9		Dark green sword-like foliage good in standing water.		
Softstem Bulrush <i>Schoenoplectus tabernaemontani</i>	3-9'	2-3'	OBL    	3 - 9	 	Blue green sword-like foliage.		

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## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Common Name <i>Scientific Name</i>	Mature Heights (feet)	Mature Widths (feet)	Habitat	Hardiness Zone	Shade Tolerance	Descriptive Information	CT Native	Suitable for Bio-Engineering
Common Bulrush <i>Scirpus atrovirens</i>	4 -5'	2-3'	OBL 	3 - 9		Brown flowering seed heads and dark green foliage.		
Prairie Dropseed <i>Sporobolus heterolepis</i>	2'	2'	FACU 	3 - 8		Mat forming with interesting fragrant flowers and low maintenance.		
<b>Herbaceous</b>								
Black Cohosh <i>Actaea racemosa</i> Cultivars ( <i>Atropurpurea</i> , <i>Pink Spike</i> )	4-6'	2-3'	FACU 	3 - 8		Fluffy bottle brush flowers in late summer through fall.		
Dolls Eyes, Baneberry <i>Actea pachypoda</i> Cultivars(Misty Bue)	1-3'	1-2'	UPL	3-8		Woodland perennial that produces white flowers followed by white berries in late summer and fall.		
Red Baneberry <i>Actaea rubra</i>	1-3'	1-2'	UPL	4 - 8		Woodland perennial produces white flowers and poisonous red berries.		
Water Plantain <i>Alisma plantago-aquatica</i>	1-3'	1-2'	OBL 	5 - 10		Tropical looking foliage with feathery purple-white flowers.		
Blue Star <i>Amsonia hubrichtii</i>	2-3'	2-3'	UPL	3 - 9		Star shaped blue flowers in summer tolerant of drier soils. Fine textured foliage with yellow- orange fall color.		
Eastern Blue Star <i>Amsonia tabernaemontana</i> Cultivars(Montana, x. Blue Ice)	1-3'	1-2'	FACU 	3-9		Light blue flowers in late spring. Yellow foliage and seed pods in the fall.		
Columbine <i>Aquilegia canadensis</i>	1-2'	1'	UPL	3-8		Grows on naturally on ledges. Red flowers with yellow centers in spring. Attracts Hummingbirds.		
Goatsbeard <i>Aruncus dioicus</i>	4-6'	6'	FACU 	3-8		Feathery white plumes in early summer.		
Wild Ginger <i>Asarum canadense</i>	<1'	1-2'	FACU 	4-6		Spreading ground cover with dark green heart shaped foliage.		
Swamp Milkweed <i>Asclepias incarnata</i> Cultivars ( <i>Ice Ballet</i> )	4'	4'	OBL 	3 - 9		Pink flowers that attract butterflies and needs moist conditions.		
Common Milkweed <i>Asclepias syriaca</i>	2-4'	4'	FACU 	4-9		Food for larval Monarch Butterflies. Fragrant pink flowers in summer, seed pods in fall.		
Butterfly Weed <i>Asclepias tuberosa</i>	2'	2-3'	UPL	3 - 9		Low growing orange flowers attracts butterflies.		



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## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Common Name <i>Scientific Name</i>	Mature Heights (feet)	Mature Widths (feet)	Habitat	Hardiness Zone	Shade Tolerance	Descriptive Information	CT Native	Suitable for Bio-Engineering
Blue Wood Aster <i>Aster cordifolius</i> ( <i>Symphyotrichum lanceolatum</i> )	2-3'	2-3'	UPL	3 - 8	 	Dry woodland colonizer with blue flowers.		
Common Wood Aster <i>Aster divaricatus</i> ( <i>Eurybia divaricata</i> )	2-3'	2-3'	UPL	3 - 8	 	Dry woodland with white flowers. Aggressive spreader.		
Smooth Aster <i>Aster laevis</i> ( <i>Symphyotrichum laeve</i> ) Cultivars ( <i>Bluebird</i> )	1-3'	2-3'	UPL	4 - 8	 	Blue gray leave with purple flowers in the fall.		
New England Aster <i>Aster novae-angliae</i> ( <i>Symphyotrichum novae-angliae</i> ) Cultivars ( <i>Purple Dome, Vibrant Dome</i> )	2-6'	2-3'	FACU 	3 - 8		Pink to purple flowers in late summer. Pinch or cut back in early summer to encourage shorter denser habit.		
False Indigo <i>Baptisia australis</i>	4'	4'	FACU 	3 - 9	 	Tall blue flowering perennial interesting seed pods.		
False Aster <i>Boltonia asteroides</i> Cultivar ( <i>Jim Crockett, Pink Beauty</i> )	4'	4'	FACU 	4 - 9	 	Tolerates dry soils with white to pink ater like flowers. Attracts butterflies.		
Marsh Marigold <i>Caltha palustris</i>	1-2'	1-2'	OBL   	3 - 7		Shiny green foliage early yellow flowers. Clump forming in moist soils.		
Bellflower <i>Campanula rotundifolia</i>	1-3'	1-2'	UPL		 	Lavender blue bell shaped flowers in summer. Good rock garden plant.		
Blue Cohosh <i>Caulophyllum thalictroides</i>	2-3'	2-3'	FAC  	3 - 8	 	Blue-green foliage. Spring ephemeral in moist rich woodlands.		
Turtlehead <i>Chelone glabra</i>	1-3'	2-3'	OBL   	3 - 8	 	Upright plant with interesting turtle head shaped white flowers.		
Pink Turtlehead <i>Chelone lyonii</i> Cultivars ( <i>Hot Lips</i> )	2-3'	1-2'	FACW   	4-7	 	Rose pink turtle head shaped flowers in late summer. Lustrous green foliage.		
Golden Star <i>Chrysogonum virginianum</i>	<1'	1'	FACU 	5-9	 	Fast growing semi-evergreen ground cover with golden yellow flowers in spring.		
Blue Mist Flower <i>Conoclinium coelestinum</i> ( <i>Eupatorium coelestinum</i> )	1.5-3'	1.5-3'	FAC  	5-10	 	Fluffy blue flowers in late summer. Spreads by rhizomes. Cut back in summer for a denser habit.		
LargeFlowered Tickseed <i>Coreopsis grandiflora</i> Cultivars ( <i>Early Sunrise, Full Moon, Red Shift</i> )	2'	1.5-2'	UPL	4 - 9		Larger yellow flowers in the summer.		

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## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

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Lanecleaved Tickseed <i>Coreopsis lanceolata</i>	1-3'	1'	UPL	5-8		Yellow flowers in early summer that attract butterflies.		
Tickseed <i>Coreopsis verticillata</i>	1.5-2'	1'	UPL	5-8		Fine textured foliage. Bright yellow flowers in summer.		
Bunchberry <i>Cornus canadensis</i> ( <i>Chamaepericlymenum canadensis</i> )	3-6"	<1'	FAC	2 - 7		Delicate mat forming woodland ground cover with white flowers and red berries.		
Wild Bleeding Heart <i>Dicentra eximia</i>	1-1.5'	1-1.5'	FACU	4-8		Fern like foliage with delicate pink flowers spring through summer.		
Purple Coneflower <i>Echinacea purpurea</i> Cultivars ( <i>Happy Star, Magnus, Ruby Star</i> )	2-5'	3'	UPL	4 - 8		Purple summer flowers attract butterflies.		
Fleabane <i>Erigeron pulchellus</i> Cultivars ( <i>Lynnhaven Carpet</i> )	1-1.5'	1-1.5'	FACU	4-9		Aster like pale purple flowers with yellow eye in spring.		
Boneset <i>Eupatorium perfoliatum</i>	3-6'	3-5'	FACW	3 - 8		Tall white flowers with fuzzy leaves attract butterflies.		
Spotted Joe-Pye Weed <i>Eutrochium (Eupatorium) maculatum</i> Cultivar ( <i>Gateway</i> )	4-6'	3-5'	FACW	4 - 9		Huge pink flowers in late summer through September attract butterflies.		
Coastal Joe Pye Weed <i>Eutrochium (Eupatorium) dubium</i> Cultivars( <i>Baby Joe, Little Joe</i> )	4-5'	3-5'	FACW	5-9		Similar to spotted Joe Pye Weed with shorter cultivars.		
Tall Meadowsweet <i>Filipendula rubra</i> Cultivar ( <i>Venusta</i> )	4-6'	3-5'	FACW	3 - 8		Tall pink fuzzy fragrant flowers that attract butterflies.		
Wood Strawberry <i>Fragaria vesca americana</i>	<1'	1'	UPL	3-8		Use as ground cover. Bears small fruits.		
Blanket Flower <i>Gaillardia aristata</i>	1'	1'	UPL	4-9		Bright red and yellow blooms in summer.		
Crimsoneyed Rosemallow <i>Hibiscus moschuetos</i>	4-6'	3-5'	OBL	4 - 9		Wetland plant. Disk shaped pink flowers.		
Meadow Bottle Gentian <i>Gentiana clausa</i>	1-2'	1'	FACW	3 - 7		Tightly clustered deep blue flowers in late summer.		
Cranesbill <i>Geranium maculatum</i>	1-2'	1-2'	UPL	4 - 8		Groundcover with purple and pink flowers.		

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## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Common Name <i>Scientific Name</i>	Mature Heights (feet)	Mature Widths (feet)	Habitat	Hardiness Zone	Shade Tolerance	Descriptive Information	CT Native	Suitable for Bio-Engineering
Common Sneezeweed <i>Helenium autumnale</i>	3-5'	2-3'	FACW	3-8		Erect plant with daisy like yellow flowers tinged with orange or mahogany. Blooms in late summer early fall. Named sneezeweed as it was once used for snuff.		
Sneezeweed <i>Helenium flexuosum</i> Cultivars ( <i>Tiny Dancer</i> )	1-3'	1-2'	FAC	5-9		Daisy like yellow flowers in mid to late summer. Tolerant of varied conditions.		
Willowleaf Sunflower <i>Helianthus salicifolius</i> Cultivars ( <i>First Light</i> )	4-10'	1-3'	FAC	5-9		Golden yellow flowers in early fall. First Light reaches 4' in height.		
False Sun Flower <i>Heliopsis helianthoides</i> Cultivar ( <i>Summer Nights</i> )	3-5'	3-5'	FACU	3 - 9		Yellow summer flowering tall perennial likes dry soils.		
Coral Bell, Common Alumroot <i>Heuchera americana</i> Cultivars ( <i>Dales Strain</i> )	1-2'	1-1.5'	FACU	4-7		Interesting foliage plant with small bell shaped panicles of flowers on upright stems.		
Crested Iris <i>Iris cristata</i>	<1'	<1'	UPL	5-8		Woodland rock garden plant with white or blue to purple flowers in spring.		
Blue Flag Iris <i>Iris versicolor</i>	2-3'	1-2'	OBL	4 - 9		Early summer flowering tall perennial likes dry soils.		
Marsh Blazing Star <i>Liatris spicata</i> Cultivars ( <i>Alba, Kobold</i> )	4'	2-3'	FAC	3 - 8		Pink-purple or white spiked flowers in summer.		
Canada Lily <i>Lilium canadense</i>	4-6'	<1'	FAC	5-9		Showy lily with yellow to orange nodding flowers. Pollinated by ruby throated hummingbird.		
Turk's Cap Lily <i>Lilium superbum</i>	4-7'	<1'	FACW	5-8		Largest native lily with yellow to orange nodding flowers. Pollinated by Eastern Tiger Swallowtail Butterfly.		
Cardinal Flower <i>Lobelia cardinalis</i>	1-6'	1-2'	FACW	4 - 9		Scarlet red flowers that attract hummingbirds. Prefers moist soil.		
Great Blue Lobelia <i>Lobelia siphilitica</i>	2-3'	1-2'	FACW	4-8		Tubular blue flowers in late summer. Will self sow in good growing conditions.		
Wild Blue Lupine <i>Lupinus perennis</i>	1-3'	2-3'	UPL	4 - 8		Clump forming with purple flowers in early summer.		
False Lily of the Valley <i>Maianthemum canadense</i>	<1'	<1'	FAC	3-8		Woodland ground cover with berries that are food source for birds.		















































# CHAPTER 3: IMPLEMENTATION

## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Common Name <i>Scientific Name</i>	Mature Heights (feet)	Mature Widths (feet)	Habitat	Hardiness Zone	Shade Tolerance	Descriptive Information	CT Native	Suitable for Bio-Engineering
False Solomon's Seal <i>Maianthemum racemosum</i>	3'	2-3'	FACU 	3 - 8	 	Upright / arching form, Great woodland massing perennial.		
Meehan's Mint <i>Meehania cordata</i>	<1'	1'	FACU 	5-8	 	Native substitute for ajuga and lamium. Forms a green carpet with blue flowers in late spring.		
Allegheny Monkey Flower <i>Mimulus ringens</i>	3'	2'	UPL	3 - 8		Purple flowering in summer and prefers moist conditions.		
Partridgeberry <i>Mitchella repens</i>	.25'	.5-1'	FACU 	3-8	 	Mat forming woodland perennial with red berries that persist in the winter.		
Scarlet Bee Balm <i>Monarda didyma</i>	2-4'	2-3'	FACU 	4-9	 	Red flowers in summer that attract bees, butterflies, and hummingbirds.		
Wild Bergamont <i>Monarda fistulosa</i>	2-4'	2-3'	FACU 	3 - 9	 	Lavender flowers attract hummingbirds and butterflies.		
Sundrops <i>Oenothera fruticosa</i>	1-1.5'	1-2'	FACU 	4-8		Bright yellow flowers in late spring.		
Beard Tongue <i>Penstemon digitalis</i> Cultivar (Husker's Red)	3'	3'	FACU 	3 - 8	 	Tall upright perennial with white or light pink tubular flowers.		
Wild Blue Phlox <i>Phlox divaricata</i>	1'	1'	FACU 	3-8	 	Spreading woodland phlox with fragrant blue flowers in late spring.		
Mountain Pinks <i>Phlox subulata</i> Cultivars (Blue Emerald, Candystripe, Drummond's Pink)	<1'	2-3'	FACU 	2 - 9	 	Ground hugging mat with pink-purple spring flowers.		
Obedient Plant <i>Physotegia virginiana</i>	2-3'	2-3'	FACU 	3-9		White to pink snap dragon like summer blooms on erect plant. Can be aggressive in the garden.		
May Apple <i>Podophyllum peltatum</i>	1-1.5'	1'	FACU 	3-8	 	Umbrella like leaves provide foliage interest in spring. Plant with ferns. Will go dormant in summer.		
Jacobs Ladder <i>Polemonium reptans</i> Cultivars (Stairway to Heaven)	1-2'	1-1.5'	FACU 	3-8	 	Light blue bell shaped flowers in spring. Can be used as ground cover.		
Wild Solomon's Seal <i>Polygonatum biflorum</i>	3'	3'	FACU 	4 - 9	 	Arching woodland plant with white bell shaped flowers.		
Pickeralweed <i>Pontederia cordata</i>	3'	3'	OBL   	3 - 10	 	Large tropical-like foliage. Purple flowers in summer and needs standing water.		



































# CHAPTER 3: IMPLEMENTATION

## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Common Name <i>Scientific Name</i>	Mature Heights (feet)	Mature Widths (feet)	Habitat	Hardiness Zone	Shade Tolerance	Descriptive Information	CT Native	Suitable for Bio-Engineering
Mountain Mint <i>Pycnanthemum tenuifolium</i>	1-3'	1.5-2'	FACU 	4-8		Delicate airy plant with slender foliage and white flowers.		
Orange Coneflower <i>Rudbeckia fulgida</i> <i>Cultivars (Goldsturm)</i>	2-3'	2-3'	FACU 	5-7		Black-eyed susan with gold flowers and brown centers blooming mid to late summer.		
Black-eyed Susan <i>Rudbeckia hirta</i>	1-3'	2-3'	FACU 	4 - 10		Yellow flowers with brown eyes. Tolerates dry soils. Plant as annual or biennial.		
Green-headed Coneflower <i>Rudbeckia laciniata</i>	5-8'	1-2'	FACU 	3-9		Meadow and stream side native. Yellow flowers in late summer with green cones in center.		
Duck Potato <i>Sagittaria latifolia</i>	3'	2-3'	OBL   	5 - 10		Tropical-like foliage with white flowers, needs standing water.		
Lyre-leaved Sage <i>Salvia lyrata</i>	1-2'	1'	FACU 	5-8		Forms a dense ground cover. Good native substitute for ajuga with purplish flowers. Will self sow.		
Bloodroot <i>Sanguinaria canadensis</i>	<1'	<1'	FACU 	3-8		Woodland spring ephemeral with round leaves and white petaled flowers in spring.		
Downy Skullcap <i>Scutellaria incana</i>	2-3'	1.5-2'	FACU 	4-9		Meadow native with small purplish blue flowers.		
Heartleaf Skullcap <i>Scutellaria ovata</i>	1-2'	1'	FACU 	4-9		Nice foliage with small purplish blue flowers. Tolerates drought. Spreads by rhizomes and may self sow.		
Wild Pink <i>Silene caroliniana</i>	<1'	<1'	FACU 	5-8		Rose-pink spring flowers over mounded foliage. Prefers sandy gravelly location.		
Blue-stemmed Golden Rod <i>Solidago caesia</i>	2-3'	1.5-2'	FACU 	4-8		September bloomer with arching golden flowers. Attracts bees and butterflies.		
Anise Scented Goldenrod <i>Solidago odora</i>	2-4'	1-2'	FACU 	4-9		Licorice scented. Golden blooms in August to September Attracts bees and butterflies.		
Stokes Aster <i>Stokesia laevis</i> <i>Cultivars (Blue Danube)</i>	1-2'	1-2'	FAC  	5-9		Large cornflower blue flowers in early summer. Plant in a well drained area.		
Wood Sage <i>Teucrium canadense</i>	1.5-3'	1.5-3'	FACU 	4-9		Purplish pink flower spikes in summer. Clump forming spreads by rhizomes.		
Early Meadow Rue <i>Thalictrum dioicum</i>	1-2'	1'	FACU 	4-7		Gray green foliage similar to columbine with panicles of greenish white flowers in spring.		

# CHAPTER 3: IMPLEMENTATION

## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

Common Name <i>Scientific Name</i>	Mature Heights (feet)	Mature Widths (feet)	Habitat	Hardiness Zone	Shade Tolerance	Descriptive Information	CT Native	Suitable for Bio-Engineering
Meadow Rue <i>Thalictrum pubescens</i>	3-7'	2-3'	FACU 	3-8	 	Tall meadow rue with gray green foliage similar to columbine. Panicles of white flowers in summer.		
Foamflower <i>Tiarella cordifolia</i> <i>Cultivars (Brandywine, Running Tapestry)</i>	<1'	<1'	FACU 	4 - 8	 	Woodland groundcover with interesting heuchera like leaves. Fluffy white flower spikes in spring. Spreading. Easy to grow.		
Purple Wake Robin <i>Trillium erectum</i>	1-1.5'	<1'	FACU 	4-8	 	Three petaled spring flowering woodland plant. Flowers range from white to yellow to red. Berry like capsules follow flowers.		
Wake Robin <i>Trillium Grandiflorum</i>	1-1.5'	<1'	FACU 	4-8	 	Larger three petaled spring flowers. Berry like capsules follow flowers.		
Spiderwort <i>Tradescantia virginiana</i>	1-2'	1-1.5'	FACU 	4-9	 	Iris like blue green leaves with three petaled violet blue flowers in late spring to early summer. Mid summer foliage can be unattractive and requires cutting back..		
BlueVervain <i>Verbena hastata</i>	2-5'	2'	FACU 	3 - 8	 	Meadow perennial with purple flowers.		
New York Ironweed <i>Vernonia noveboracensis</i>	4-8'	3'	FACU 	5 - 9		Tall meadow perennial. Purple flowers attract butterflies.		
Culver's Root <i>Veronicastrum virginicum</i> <i>Cultivars (Rosea, Fascination)</i>	4-7'	2-4'	FACU 	3-8	 	Dramatic plant with tall spikes of white to pale blue flowers. Prefers moist soils.		
Barren Strawberry <i>Waldsteinia fragarioides</i> <i>(Geum fragarioides)</i>	.5'	.5-1'	FACU 	4-7	 	Strawberry like spreading ground cover with yellow flowers.		



# CHAPTER 3: IMPLEMENTATION

## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

### Recommended Vegetation Spacing and Plant Sizes

High quality plant material will establish more readily in the landscape; therefore, purchasing healthy plant material is important to the future success of the vegetated buffer zone.

Plant Material	
<b>Trees</b>	Tree size, mature height, diameter and final structure may depend on site conditions and site accessibility as well as long term goals.
<b>Deciduous Trees</b>	Within the the buffer zone an effort should be made to provide a variety of sizes and species. Sizes should range from a minimum of 1-inch to 3-inch caliper as specified by American Standards for Nursery Stock. Multi-stemmed deciduous trees such as <i>Betula nigra</i> (River birch) and <i>Amelanchier canadensis</i> (Americian shadblow) should be of a comparable height (8' to 10') to a 1"-3" caliper tree.
<b>Evergreen Trees</b>	Evergreen trees should be at varying heights ranging from five to ten feet at the time of planting.
<b>Shrubs</b>	The minimum shrub size of planting material varies according to species, but most can be purchased within the 2 to four foot height range. The plants should cover the dimensions of the container. The spacing of the plant material shall be appropriate to the chosen species, based on an approved landscape plan. Most shrubs will be planted approximately three to five feet on center. However in some cases some shrub species may be planted closer. Inclusion of a variety of species is recommended.
<b>Seed Mixes</b>	Some larger areas and or slopes can be re-established using native meadow, riparian or other seed mixes. These must be applied consistent with manufacturers specifications.
<b>Sods</b>	These mats of preestablished carpet like beds of plantings can be used to immediately stabilize a site and must be installed per manufacturers specs.
<b>Plugs</b>	These smaller plants can be purchased in larger volumes for lower costs and must be designed and installed ensure long term spacing and densities are achieved as they mature.

Where appropriate, living groundcover (i.e., herbaceous understory) planting material should be provided and maintained beneath trees in all plantings. Groundcover will be spaced in a manner to achieve complete coverage within 2 years. Where a 4-inch container is used, groundcover should be spaced at a maximum of 12 inches on center. Where a 1-gallon container is used, groundcover should be spaced at a maximum of 24 inches on center. Groundcover is not typically required beneath the drip line of shrubs.

# CHAPTER 3: IMPLEMENTATION

## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

### Determining Plant Spacing Requirements

The following graphics and tables are intended to assist homeowners to determine plant spacing requirements associated with establishing a vegetated buffer area.

**SMALL UNDERSTORY TREE**  
(Example: Flowering Dogwood)

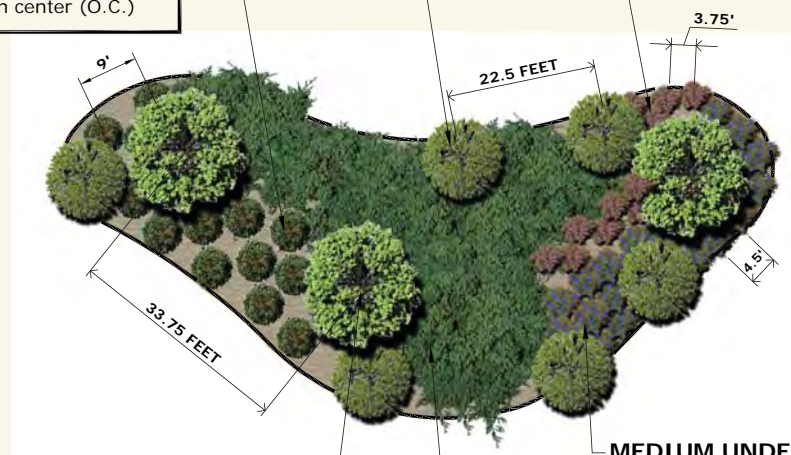
Based on the Native Plant List, Flowering Dogwoods grows to a width of 30 feet.  
 $30' \times 0.75 = 22.5'$   
 So the minimum spacing for Flowering Dogwood should be 22.5 feet on center (O.C.)

**LARGE SHRUB**  
(Example: Northern Arrowwood)

Based on the Native Plant List, Northern Arrowwood grows to a width of 12 feet.  
 $12' \times 0.75 = 9'$   
 So the minimum spacing for Northern Arrowwood should be 9 feet on center (O.C.)

**SMALL SHRUB**  
(Example: Steeplebush)

Based on the Native Plant List, Steeplebush grows to a width of 5 feet.  
 $5' \times 0.75 = 3.75'$   
 So the minimum spacing for Steeplebush should be 3.75 feet on center (O.C.)



**LARGE OVERSTORY TREE**  
(Example: Red Maple)

Based on the Native Plant List, Red Maples grows to a width of 45 feet.  
 $45' \times 0.75 = 33.75'$   
 So the minimum spacing for Red Maples should be 33.75 feet on center (O.C.)

**MEDIUM UNDERSTORY SHRUB**  
(Example: Highbush Blueberry)

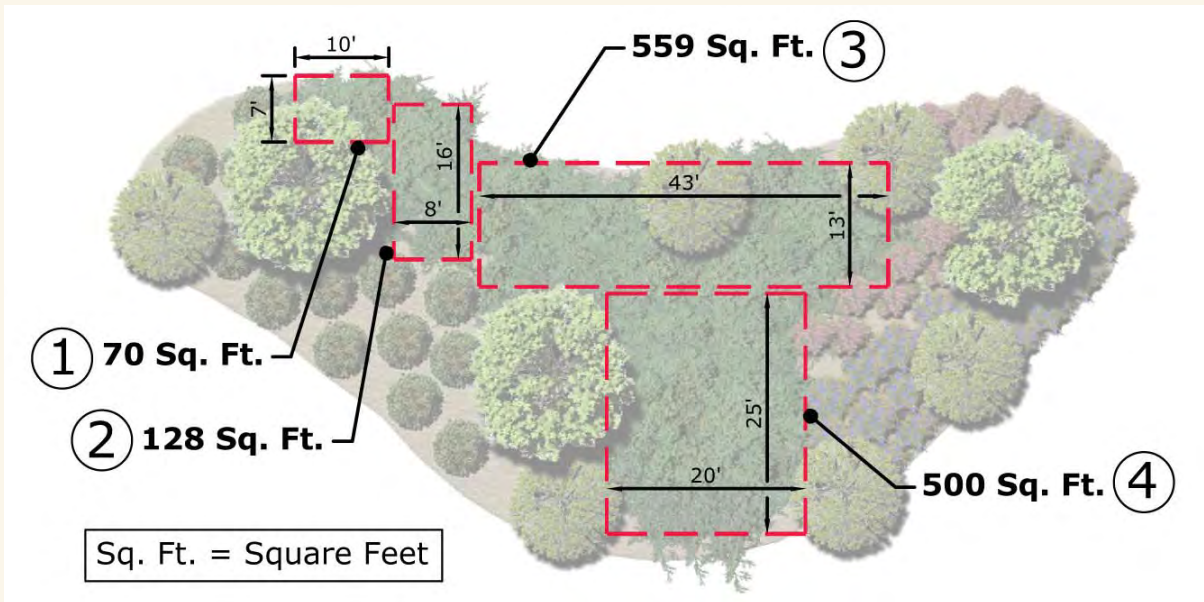
Based on the Native Plant List, Highbush Blueberry grows to a width of 6 feet.  
 $6' \times 0.75 = 4.5'$   
 So the minimum spacing for Highbush Blueberry should be 4.5 feet on center (O.C.)

**GROUNDCOVER AND PERENNIALS**  
(Example: Wintergreen)

Based on the Native Plant List, Gaultheria procumbens grows to a width of 3 feet.  
 Identify Square Foot of the planting areas (Below) and refer to the Groundcover & Perennial Spacing Chart to determine plant quantities.

# CHAPTER 3: IMPLEMENTATION

## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES



### Calculating the Square Footage of a Planting Area

(Example: Wintergreen)

Start by taking the area you intend to plant. Divide up the space using squares or rectangles (as shown above). Use the Length x Width equation to calculate the planting "Area" of each box. Add up the boxes to determine the total area of planting.

Example:

- Box 1 = 70 Square Feet
- Box 2 = 128 Square Feet
- Box 3 = 559 Square Feet
- Box 4 = 500 Square Feet

TOTAL = 1,257 SQUARE FEET (SF)

Based on the Groundcover & Perennial Spacing Chart for a plant spaced at 3'-0" (36"), first take 1,000 SF. You will need 110 plants. Take the remaining 257 (round to 250) and match it up with the same 36" column and you get 28 plants.

$$110 + 28 = 138$$

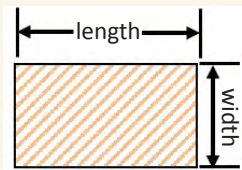
So you will need 138 Wintergreen plants (spaced at 36" on center) to fill the area (rectangles) shown above.



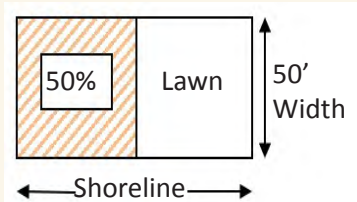
# CHAPTER 3: IMPLEMENTATION

## B. REVEGETATION WITH NATIVE AND ORNAMENTAL PLANT SPECIES

### 50% Vegetated Area



To determine the square footage of an area; measure length times width



FirstLight requires that 50% of the first 50' upslope from the shoreline be vegetated with native plant material.

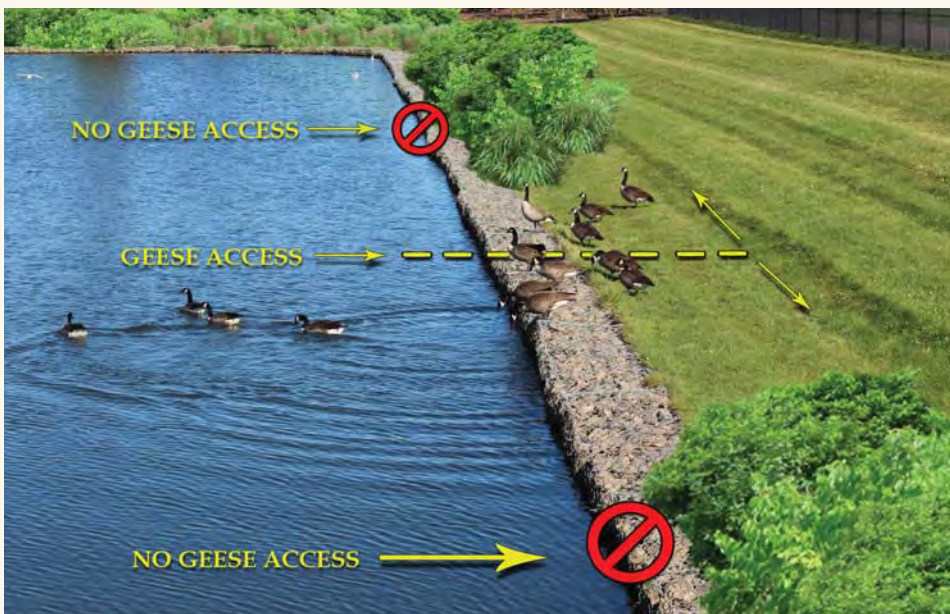
### Groundcover & Perennial Spacing Chart

Total Square Feet of Bed	Spacing - On Center										
	4"	6"	8"	10"	12"	18"	24"	36"	48"	60"	72"
50	450	200	113	73	50	22	13	6	3	2	1
100	900	400	225	145	100	44	25	11	6	4	3
150	1350	600	338	218	150	66	38	17	9	6	4
200	1800	800	450	290	200	88	50	22	13	8	6
250	2250	1000	563	362	250	110	63	28	16	10	7
300	2700	1200	675	435	300	132	75	33	19	12	8
400	3600	1600	900	580	400	176	100	44	25	16	11
500	4500	2000	1125	725	500	220	125	55	31	20	14
600	5400	2400	1350	870	600	264	150	66	38	24	17
700	6300	2800	1575	1015	700	308	175	77	44	28	19
800	7200	3200	1800	1160	800	352	200	88	50	32	22
900	8100	3600	2025	1305	900	396	225	99	56	36	25
1000	9000	4000	2250	1450	1000	440	250	110	63	40	28

# CHAPTER 3: IMPLEMENTATION

## C. VEGETATED BUFFERS AND CANADA GEESE MANAGEMENT

The establishment or restoration of vegetated buffers has been found to be an effective method at managing a lake's resident Canada goose population. Canada geese are grazers and are particularly fond of cool-season grasses grown adjacent to water bodies. Water bodies surrounded by large residential expanses of maintained, cool-season grasses/lawn right down to the water's edge provide expanded habitat for resident geese during the summer months, and they will be visited by geese often. One key method of limiting these visitations is to alter the shoreline vegetation. Geese do not like water bodies where their visual line of sight between the water and the adjacent grass area is broken by vegetation. A good conflict-prevention strategy is to allow the shorelines to grow with a diversity of tall, wetland, and terrestrial plants such as sedges, rushes, ferns, shrubs, and warm-season grasses. The wider this zone of tall vegetation, the more effective it will be at deterring geese. Geese respond to this area with a natural predator-prey response, not knowing what predator is on the other side of the tall shoreline vegetation or whether they are sitting on the water or up on the grass. Geese cannot determine whether a predator is lurking within the tall vegetation, and typically they choose to stay away from vegetated buffer zones. A good strategy is to aim for a vegetation height of at least 24 inches and a zone width of at least 20 feet. Mid-level shrub canopy and upper tree canopy also deter geese from entering the buffer.



Seawalls and maintained lawn provides ideal foraging habitat for geese.

### Grasses to consider for Canada Geese Management

- Switch grass (*Panicum virgatum*)
- Indian grass (*Sorghastrum nutans*)
- Big blue stem (*Andropogon gerardii*)
- Little bluestem (*Andropogon scoparius*)

### Grassed to avoid for Canada Geese Management

- Kentucky bluegrass (*Poa pratensis*)
- Brome grass (*Bromus species*)
- Canary grass (*Phalaris aruclinacea*)
- Colonial bentgrass (*Agrostis tenuis*)
- Perennial ryegrass (*Lolium perenne*)
- Quackgrass (*Agropyron repens*)
- Red fescue (*Festuca rubra*)

## CHAPTER 3: IMPLEMENTATION

### D. SUSTAINABILITY AND LONG TERM MAINTENANCE OF VEGETATED BUFFER ZONE

The long-term goals of any vegetated buffer zone are to protect, preserve, enhance, and maintain the functions and values of the buffer zone. To maintain a buffer zone's function, a homeowner may need to provide routine maintenance. Maintenance is typically required during the early stages of the buffer zone establishment. The propensity for non-native invasive species to colonize recently disturbed soils and habitats is highest during the first three years of any enhanced vegetated buffer zone establishment project. Required maintenance activities that are appropriate within a buffer zone and that may need approval by FirstLight include:

- Selective removal of non-native invasive plant species, which may be required to enhance the native plant growth within the buffer zone.
- Selective tree removal and pruning and thinning of natural vegetation, which may be allowed within a defined corridor in order to promote lake and shoreline views
- Selective tree removal, pruning, and thinning of natural vegetation within a vegetated buffer zone on a case-by-case basis for proven safety and welfare concerns (e.g., removal of dead, diseased, dying, or damaged trees in close proximity to a dwelling).

#### Other Site Conditions

The use of best management practices (BMPs) can stabilize areas of minor to moderate erosion and complement the performance of a vegetated buffer zone. The following is a brief list of simple BMPs that can be useful for homeowners:

- Rock-lined drip edges – Installed beneath the roof edge drip line, these can be very helpful for controlling erosion and reducing splash.
- Stabilize pathways – Paths should be winding, not straight, to discourage channel formation by runoff. Paths should be mulched, seeded with grass mix, or made from pavers or boardwalk. These practices slow runoff and increase absorption and filtration.
- Water diversion for roads and driveways – Where possible, runoff should be diverted to stable, vegetated areas. Several types of diversions can be installed, including open-box culverts, “rubber razor” water bars, or broad-based drainage dips. These methods are much less expensive to install than frequent resurfacing of a road or driveway due to erosion.



# GLOSSARY

allochthonous	Organic material that falls into a lake or stream from the surrounding land
arborist	A specialist in the care of woody plants, especially trees
bedrock	The solid rock that underlies loose material, such as soil, sand, clay, or gravel
bioengineering	Use of living plant material as the primary structural component to reinforce soil and stabilize banks
bioswale	Landscape elements designed to remove silt and pollution from surface runoff water
biotechnical	Combines the use of living plant material and inert structural materials (i.e. boulders, woody debris, coir logs) to reinforce soil and stabilize banks
bryozoan	Any of the various small aquatic animals of the phylum Bryozoa that reproduce by budding and form colonies attached to stones or seaweed
bulkhead	A manmade retaining wall commonly used to protect shorelines
coir log	A coconut based fiber roll that is shaped as a log that can be filled with natural wood chips and/or soil and used to stabilize slopes and/or hold back soil
detritus	Is non-living particulate organic material (as opposed to dissolved organic material) that is derived from organic materials (leaves, sticks, stems, etc)
ecology	The science of the relationships between organisms and their environments
ecosystem	An ecological community together with its environment, functioning as a unit
ecotone	The transition zone between two different plant communities
fetch	The distance traveled by waves with no obstruction
floodplain	A plain bordering a river and subject to flooding
foraging	The act of looking or searching for food or provisions
gabion	Is a cage, cylinder, or box filled with rocks, concrete, or sometimes sand and soil for use in civil engineering, road building, and bank stabilization
geologic	Pertaining to the scientific study of the origin, history, and structure of the earth
guild	A group of species that exploit the same class of environmental resources in a similar way
herbaceous	A herbaceous plant is a plant that has leaves and stems that die down at the end of the growing season to the soil level
heterogeneity	The quality or state of consisting of dissimilar elements or parts; not homogeneous
impervious	Not allowing fluid (i.e. water) to pass through
impoundment	A place of storage or accumulation in a reservoir
infiltration	The act or process of causing water to permeate by passing through interstices or pores
interstitial	Relating to, occurring in, or affecting a space, esp. a small or narrow one, between things or parts
invasive	Flora and/or fauna that tend to spread prolifically and are considered undesirably or harmful

# GLOSSARY

irrespective	Characterized by disregard; heedless
littoral	Zone of high and low water of the shoreline of a lake
live stake	Stakes are dormant live woody cuttings of a species with the branches trimmed off. Live staking performs an important function, creating a root mat that stabilizes the soil by reinforcing and binding soil particles together
macroinvertebrates	An invertebrate that is large enough to be seen without the use of a microscope
meadow	A tract of grassland, in its natural state, as pasture, or for growing hay
native	An animal or plant that originated in a particular region
non-native	An animal or plant not originating in a particular region
overburden	Material overlying a useful mineral deposit
overland flow	Non-channelized sheet flow that usually occurs during and immediately following a rainfall or spring thaw
overstory	The uppermost layer of foliage that forms a forest canopy
phosphorous	Of, relating to, or containing a highly reactive poisonous nonmetallic element occurring naturally in phosphates and is harmful in high concentrations to lake systems
propensity	An innate inclination; a tendency
revetment	A facing, boulders, wall, large woody debris used to support an embankment
rill	A small brook; a rivulet
riparian	Of, on, or relating to the banks of a natural course of water
scour	Removal of under materials by waves
sediment	Material that settles to the bottom of water and often found as the substrate material at the bottom of a lake.
spalling	Breaking up into chips or fragments or cracking of concrete
spring ephemeral	Any of various woodland wildflowers that appear aboveground in early spring, flower and fruit, and die in a short two-month period
structural	Use of inert structural materials (i.e. concrete, boulders, gabions, stone blocks) to reinforce soil and stabilize banks
synthesize	To combine so as to form a new, complex product
topography	Detailed precise elevations on a given landscape or place
tubelings	Young seedling trees (or bushes) that are only 6–10 inches tall
understory	In forestry and ecology refers to plant life growing beneath the forest canopy without penetrating it to any extent
vertebrates	Organisms that have a backbone or spinal column

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### **Photo Credits**

*Page 31 Rain Garden Photo: Lower left hand corner – Maplewood Minnesota*

*Page 31 Bioswale Photo: Lower right hand corner – Bellewood Gardens*

*Page 52 Installation of Live Stakes Photo – Intervale Conservation Nursery*

*Page 53 Live Fascine Photo – Ernst Seed Company*

*Page 54 Brush Mattress Photo – Ernst Seed Company*

*Page 56 Lower Duck Pond Photo – Chris Randall*

# APPENDIX A

## Vegetated Buffer Zone Maps of FirstLight Impoundments

The following vegetated buffer zone maps were developed and approved under the SMP and represent the 50' and 200' vegetated buffer zone areas around FirstLight impoundments.

- Falls Village Development
- Bulls Bridge Development
- Rocky River Development / Candlewood Lake
- Shepaug Development / Lake Lillinonah
- Stevenson Development / Lake Zoar

# APPENDIX B

Bioengineering techniques have environmental benefits including creation of diverse and productive riparian habitats, shade, addition of organics to the lake, cover for fish, improvements to water quality and aesthetics.

## UPLAND:

- LIVE FASCINES
- LIVE STAKING
- BRANCH PACKING
- BRUSH MATTING
- EROSION CONTROL MATTING
- REVEGETATION



Dormant Live Stakes



Live Stakes Leave Out (4 weeks later)

## WAVE ZONE:

### LOW WAVE:

- REVEGETATION
- COIR LOGS

### HIGH WAVE:

- SOIL WRAPS WITH BRUSH LAYER
- LOG CRIB WALL
- BOULDER WALL
- VEGETATED GABIONS
- VEGETATED RIPRAP AND ROCK REVETMENT
- STRUCTURAL SEAWALLS



Live Stakes Growing (eight weeks later)

## LOW IMPACT DEVELOPMENT/ STORMWATER MANAGEMENT FEATURES:

- BIOSWALE
- RAIN GARDEN
- INFILTRATION GALLERIES

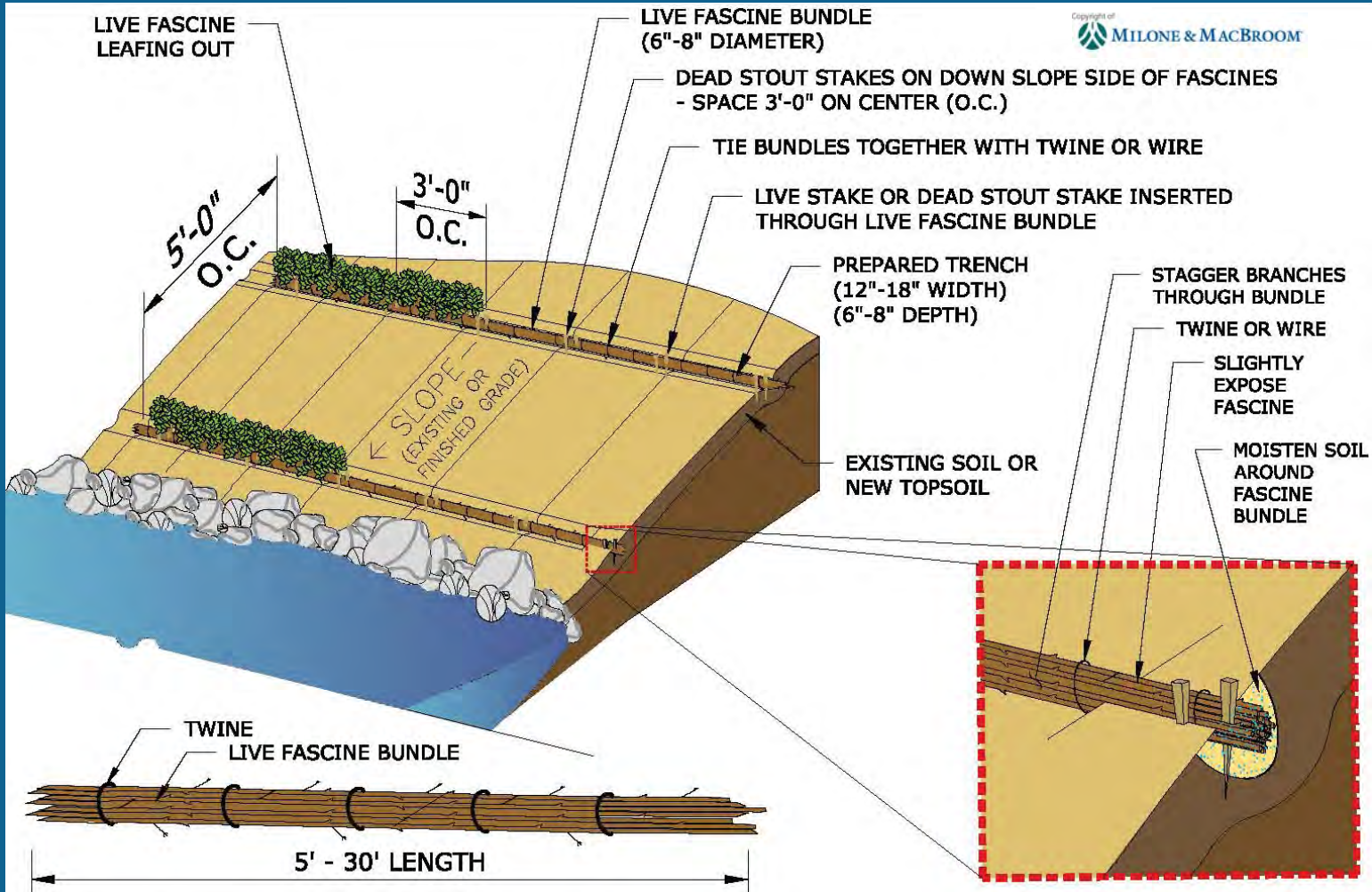


Growing Live Fascines



# APPENDIX B - LIVE FASCINES

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### WHAT IS IT?

Long bundles of branch cutting bound together in cylinders. Cuttings are from willows or dogwoods that root easily and have long, straight branches.

### BEST USED:

On all slopes, max steepness 1:1

### BEST USES:

On upland, above waterline.  
On sunny slopes.  
When shallow slides on slopes from upland drainage are a problem.

### COST:

Relatively inexpensive.

### SKILL LEVEL:

Moderate when appropriately trained.

### ADVANTAGES:

1. Offers immediate protection where installed.
2. Can be installed with minimal site disturbance.
3. Assists upland drainage when installed at an angle.

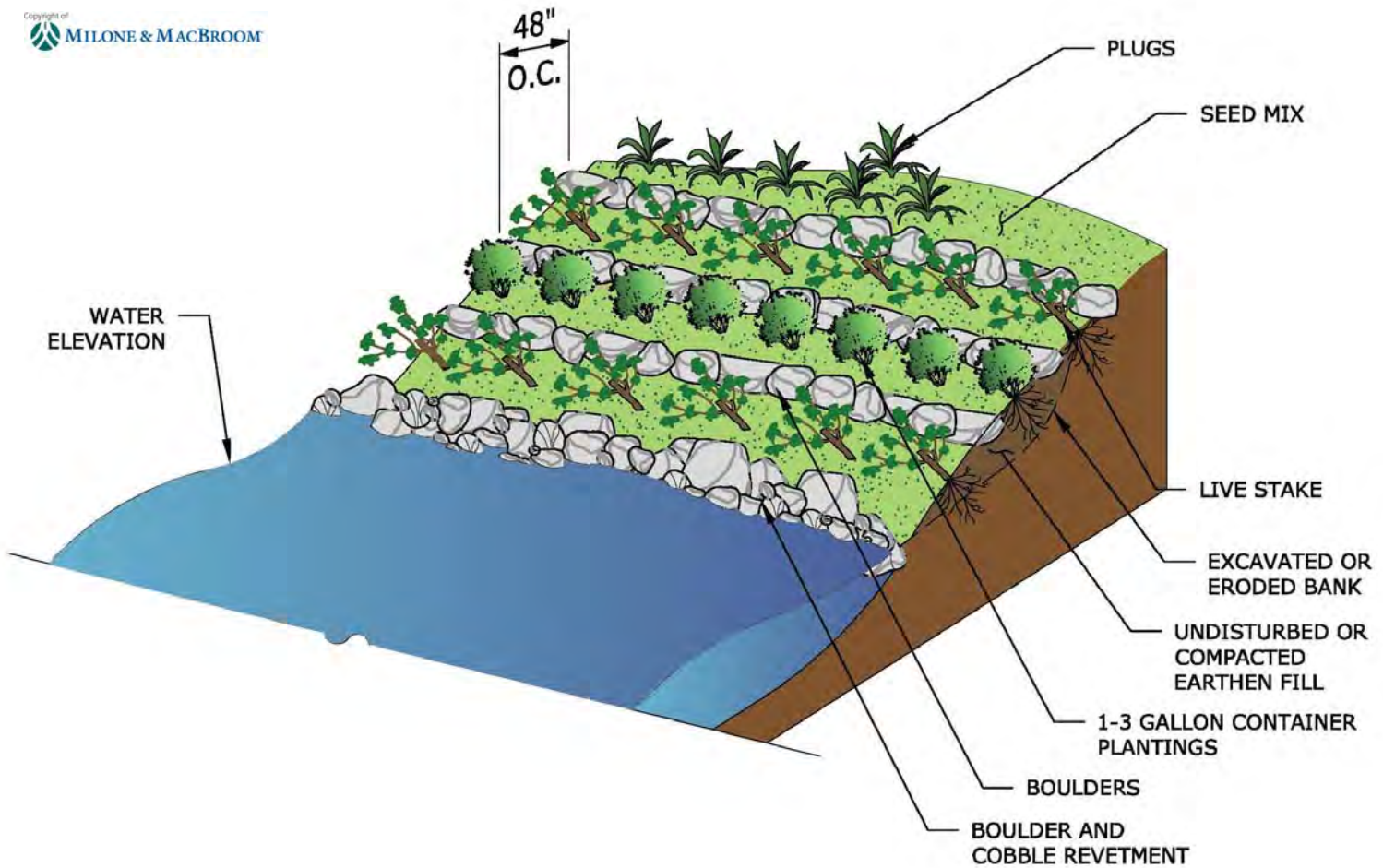
### DISADVANTAGES:

1. Slope between fascines needs to be protected with geotextile or other technique until vegetation establishes.
2. Needs to be installed within a day or two of being prepared.
3. Should only be installed during the dormant season, generally October to March.

### MAINTENANCE:

Following planting the soil around live fascines shall be kept moist until bud emergence. Live fascines do not require fertilizer; however the topsoil that fascines are being planted within should have a minimum total organic content of six percent and pH between 6.0 and 8.0. Invasive shrub and/or herbaceous plant species that sprout within project area should be removed. If fascine plantings become overgrown the plants can be cut (ie. pruned) back in the fall and/or early spring.

# APPENDIX B - LIVE STAKING



## WHAT IS IT?

Live, rootable vegetative cuttings that are inserted in to the slope. Can be inserted in to soil (shallow slopes) or rock (steep slopes). Cuttings are from willows or dogwoods that root easily and have long, straight branches. Roots create a fibrous mat that resist sliding.

## BEST USED:

On all slopes, max steepness 1:1

## BEST USES:

On upland, above waterline.  
On sunny slopes.  
Best for small earth failures on slopes that are usually wet.  
Best for uncomplicated sites that lack vegetation.

## COST:

Inexpensive to expensive, depending on size of installation and use of rock.

## SKILL LEVEL:

Moderate when appropriately trained.

## ADVANTAGES:

1. Fast installation.
2. Can be installed with minimal site disturbance.
3. Dissipates energy along bank.
4. Produce lakeside habitat.

## DISADVANTAGES:

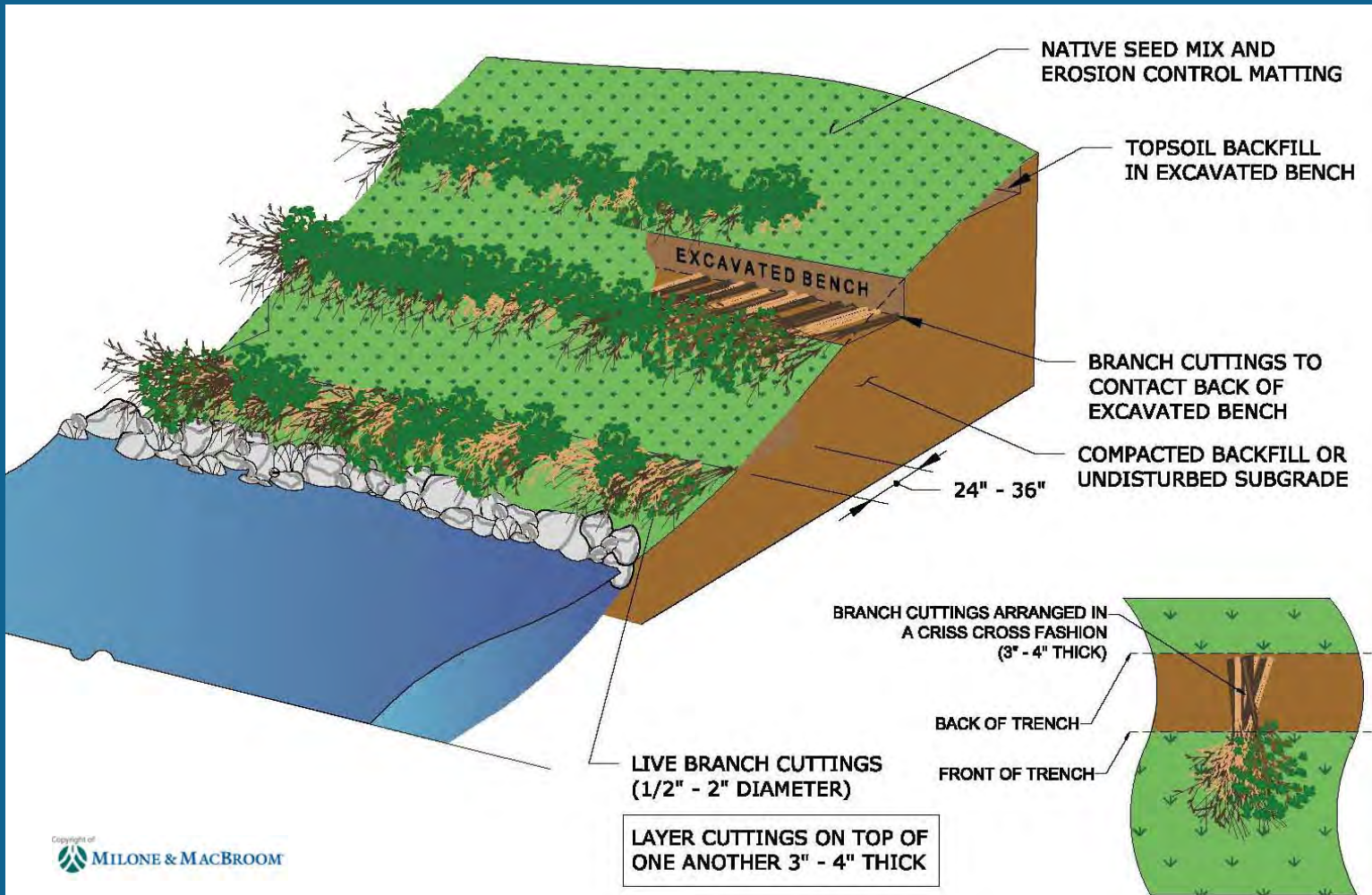
1. Needs to be installed within a day or two of being prepared.
2. Should only be installed during the dormant season, generally October to March.

## MAINTENANCE:

Following planting the soil around live stakes shall be kept moist until bud emergence. Live stakes do not require fertilizer; however the topsoil that stakes are being planted within should have a minimum total organic content of six percent and pH between 6.0 and 8.0. Invasive shrub and/or herbaceous plant species that sprout within project area should be removed. If stake plantings become overgrown then the plants can be cut (ie. pruned) back in the fall and/or early spring.



# APPENDIX B - BRANCH PACKING



## WHAT IS IT?

Alternating layers of live branches and compacted soil to repair small, localized slumps and holes.

## BEST USED:

On all slopes, max steepness 1:1

## BEST USES:

On upland, above waterline.  
On sunny slopes.  
For slumps and holes, 2 to 4 feet in height and depth.

## COST:

Inexpensive

## SKILL LEVEL:

Moderate when appropriately trained.

## ADVANTAGES:

1. Prevents future erosion.
2. Rapidly vegetates.

## DISADVANTAGES:

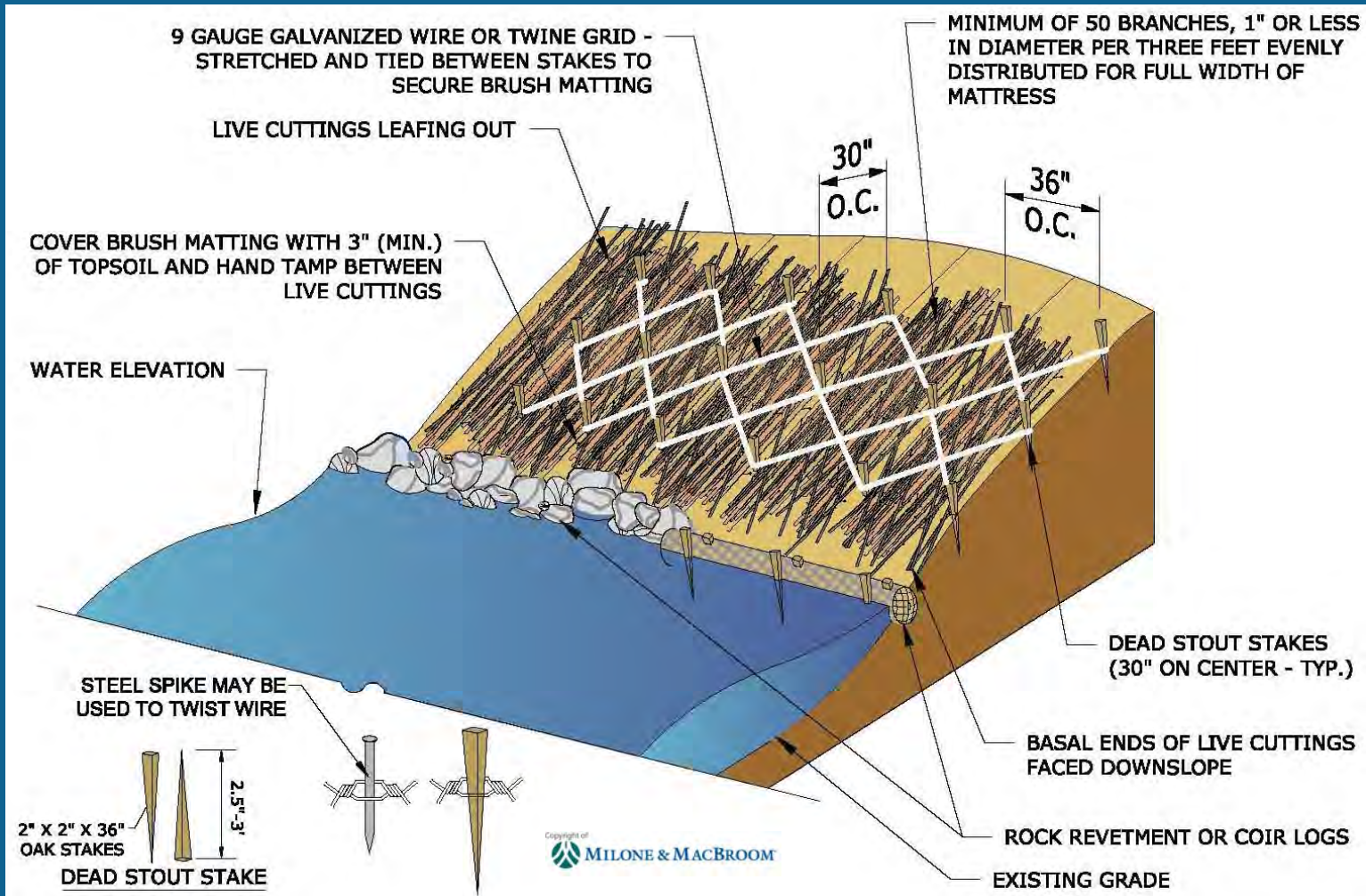
1. Not appropriate for large eroded areas.
2. Should only be installed during the dormant season, generally October to March.

## MAINTENANCE:

Following planting the soil around live branch packing shall be kept moist until bud emergence. Branch packs do not require fertilizer; however the topsoil that the packs are being planted within should have a minimum total organic content of six percent and pH between 6.0 and 8.0. Invasive shrub and/or herbaceous plant species that sprout within project area should be removed. If branch packing plantings become overgrown then the plants can be cut (ie. pruned) back in the fall and/or early spring.



# APPENDIX B - BRUSH MATTING



## WHAT IS IT?

Combination of live stakes, live fascines, and branch cuttings installed on bank.

## BEST USED:

Shallow to moderate slopes

Max steepness 3:1

## BEST USES:

Above waterline.

## COST:

Expensive

## SKILL LEVEL:

Moderate to complex

## ADVANTAGES:

1. Produces a well-reinforced shoreline.
2. Provides immediate bank protection.
3. When vegetated, produces a natural shore appearance with high structural integrity.

## DISADVANTAGES:

1. Needs to be installed within a day or two of being prepared.

## MAINTENANCE:

Following planting the soil around brush matting shall be kept moist until bud emergence. Brush matting does not require fertilizer; however the topsoil that the brush mats are being planted within should have a minimum total organic content of six percent and pH between 6.0 and 8.0. Invasive shrub and/or herbaceous plant species that sprout within project area should be removed. If brush mattings become overgrown then the plants can be cut (ie. pruned) back in the fall and/or early spring.

# APPENDIX B - EROSION CONTROL MATTING

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**START AT THE TOP BY ANCHORING THE  
BLANKET IN 6" WIDE X 6" DEEP TRENCH.  
BACKFILL AND COMPACT. STAPLE BLANKET  
AS SHOWN**

**INSTALL STAPLES (12" ON CENTER) THROUGH BOTH  
BLANKET ENDS-AS SHOWN**

**OVERLAP PARALLEL BLANKETS  
A MINIMUM OF 2"**

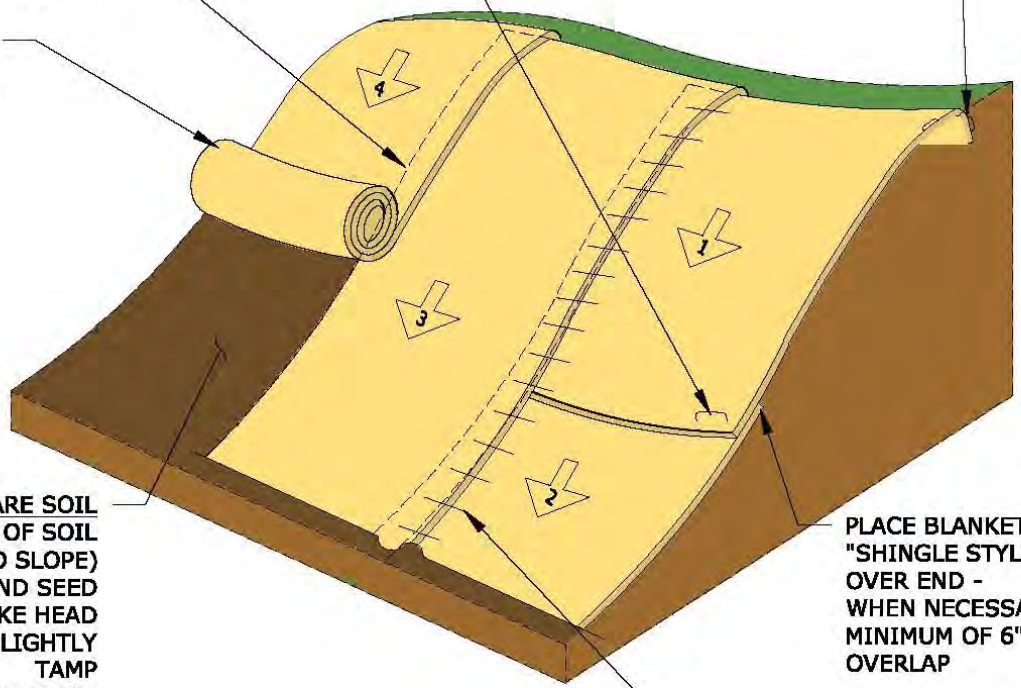
**ROLL BLANKET DOWN SLOPE IN  
THE DIRECTION OF  
WATER FLOW**

**PREPARE SOIL  
RAKE GROOVES IN TOP 1" OF SOIL  
(PERPENDICULAR TO SLOPE)**

- ADD LIME, FERTILIZER, AND SEED
- USING THE BACK SIDE OF RAKE HEAD  
SMOOTH SOIL OVER SEED AND LIGHTLY  
TAMP
- WATER THOROUGHLY TO ENCOURAGE  
SEED GERMINATION

**PLACE BLANKETS  
"SHINGLE STYLE" END  
OVER END -  
WHEN NECESSARY A  
MINIMUM OF 6"  
OVERLAP**

**STAPLE EDGES OF BLANKET  
OVERLAP**



## WHAT IS IT?

Synthetic or natural fiber blankets placed on a slope to provide immediate erosion protection. A variety of products are suitable for shallow to steep slopes, low wave to high wave action environments.

## BEST USED:

Shallow to steep slopes

## BEST USES:

Above waterline

## COST:

Expensive

## SKILL LEVEL:

Easy to moderate

## ADVANTAGES:

1. Conform to the shape of the slope.
2. Provides immediate bank protection.
3. Support growth of vegetation.

## DISADVANTAGES:

1. Can be undermined by surface runoff and erosion.
2. Expertise is needed to choose the correct product for a given project.

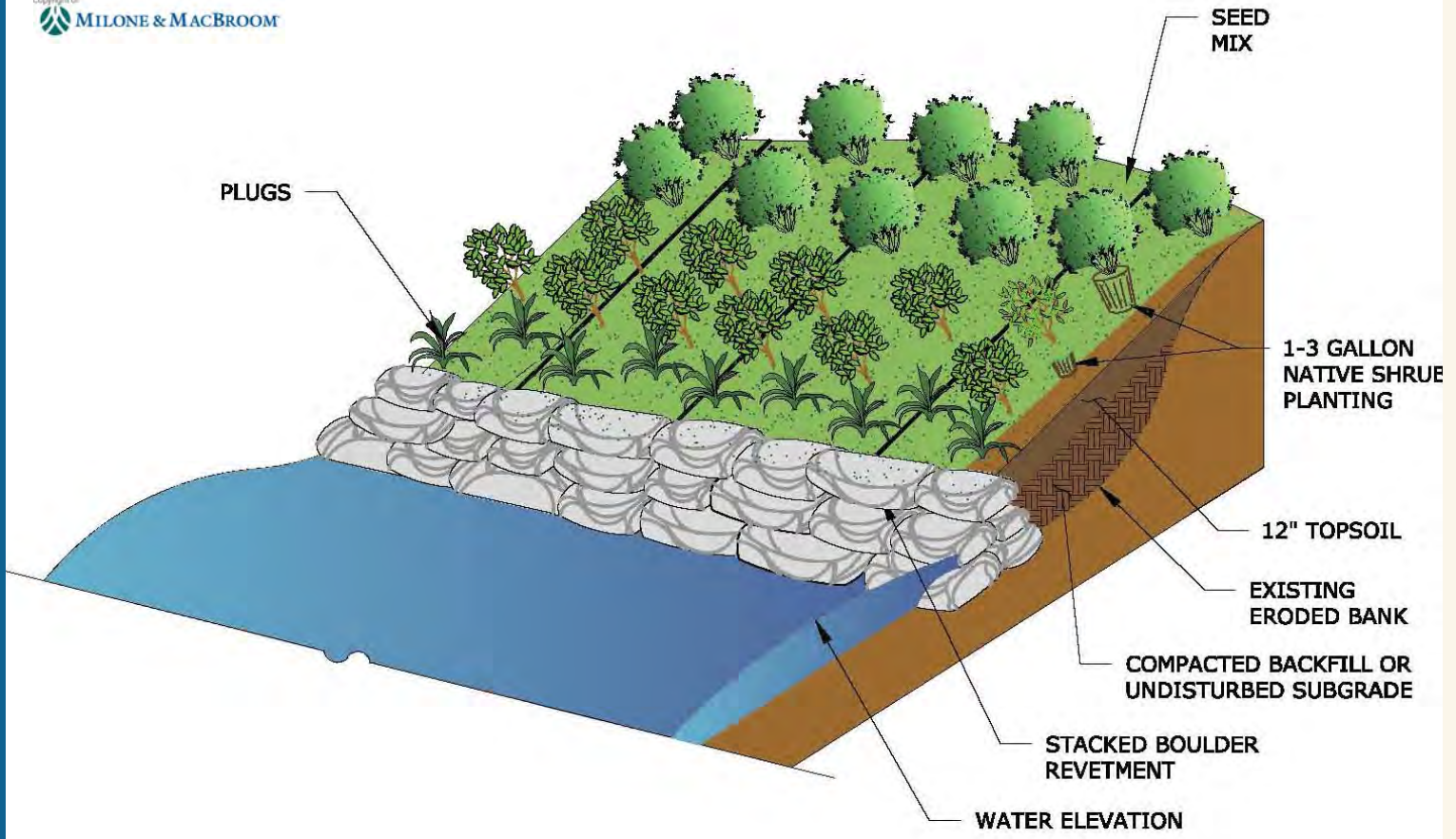
## MAINTENANCE:

When properly installed maintenance with erosion control matting is minimal. After installation the matting should be periodically checked for typical issues such as staple popping, soil undermining, rill formation, and wind and/or waterflow damage.



# APPENDIX B - UPLAND REVEGETATION

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## WHAT IS IT?

Conventional plantings of vegetation used alone.

## BEST USED:

Max steepness 2:1

## BEST USES:

Above waterline  
Slopes with only marginal erosion  
Can be used in combination with more structural measures

## COST:

Inexpensive

## SKILL LEVEL:

Easy

## ADVANTAGES:

1. Relative easy and inexpensive to install.

## DISADVANTAGES:

1. Bank protection is not immediate, requires time for vegetation to establish.
2. Protection and maintenance may be required until vegetation is established.

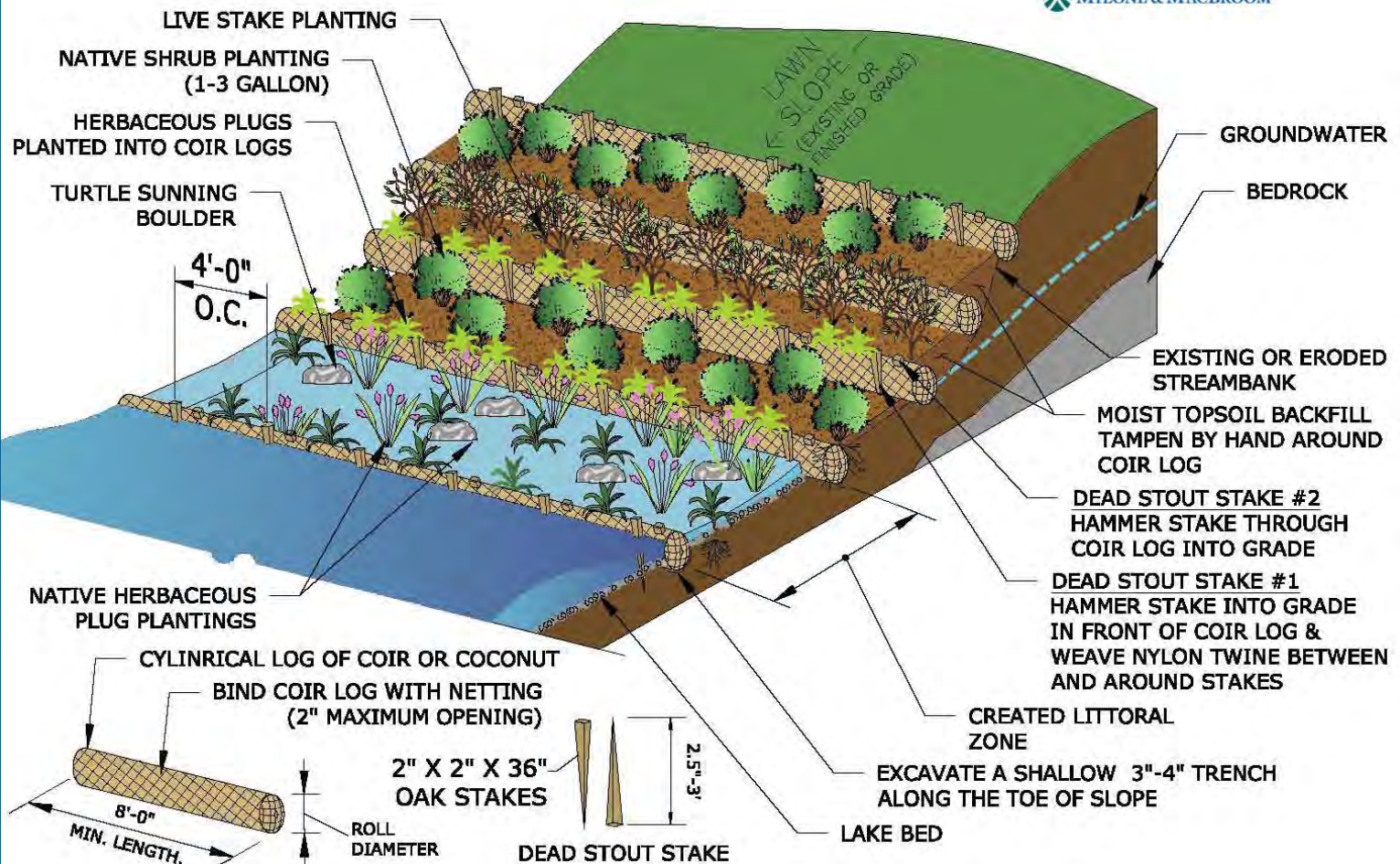
## MAINTENANCE:

Following planting the soil around new plantings and/or seeds shall be kept moist until seed germination and/or sufficient plant establishment. New plantings do not typically require fertilizer; however the topsoil that the plantings are being planted within should have a minimum total organic content of six percent and pH between 6.0 and 8.0. Seeding of areas may require some starter fertilizer and those rates should be determined by a local landscape contractor, nurseryman, and/or UConn soil testing laboratory. Invasive shrub and/or herbaceous plant species that sprout within project area should be removed. If revegetated area becomes overgrown then certain plants can be cut (ie. pruned) back in the fall and/or early spring.



# APPENDIX B - COIR LOGS

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## WHAT IS IT?

Cylindrical structures composed of biodegradable materials (usually coconut fiber) bound together with twine.

## BEST USED:

At the toe of slope (stabilization)  
In shallow off-shore zones (re-establish vegetation)  
NOT for use in high wave zones

## COST:

Expensive

## SKILL LEVEL:

Easy

## ADVANTAGES:

1. Flexible, can mold to an existing shoreline.
2. Minimal site disturbance.
3. Can be rooted with plants to provide additional protection and energy dissipation.

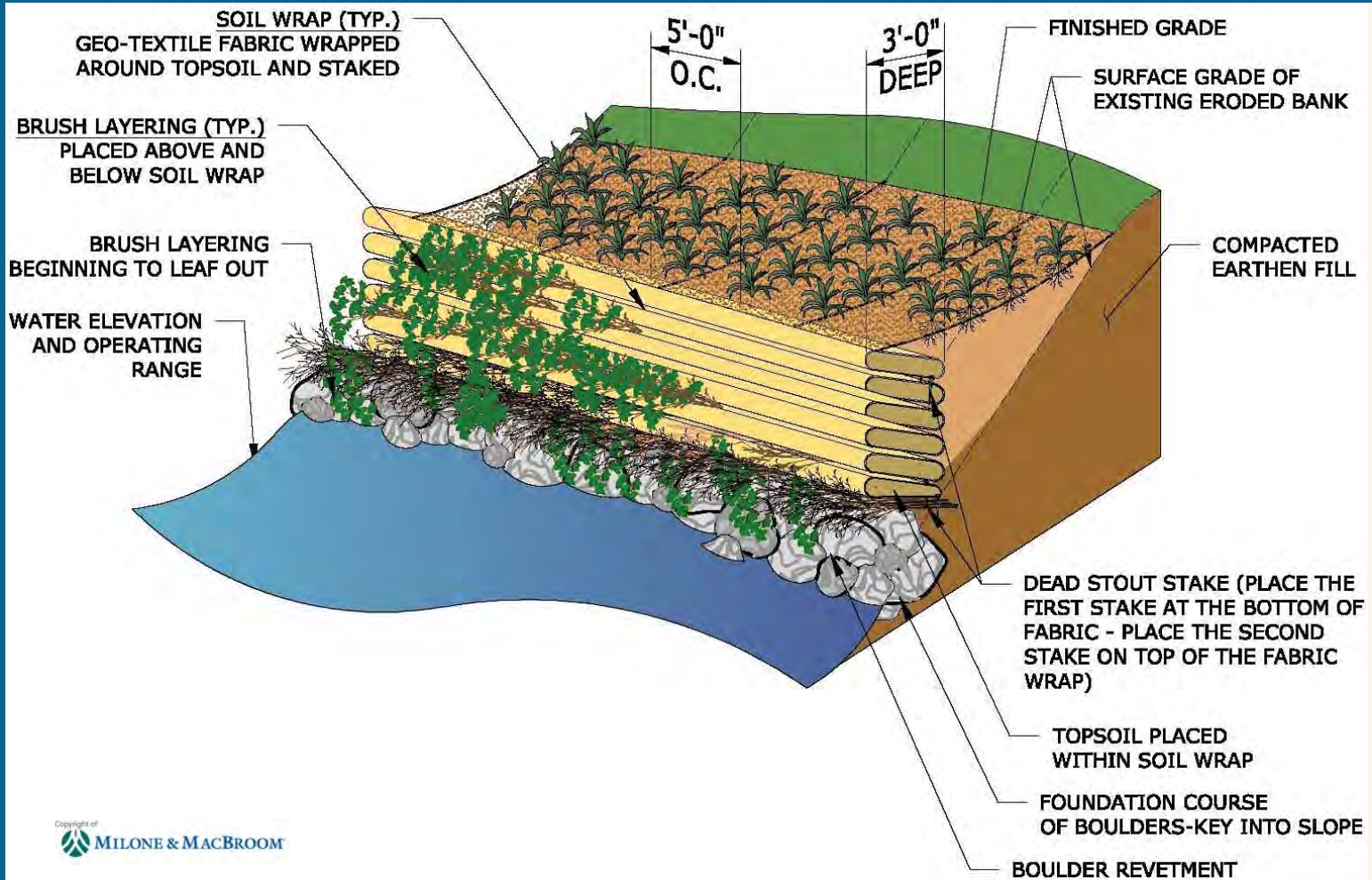
## DISADVANTAGES:

1. Effective life of only 6 to 10 years.

## MAINTENANCE:

The interior of the coir log should be filled with a topsoil and/or heavily decomposed wood mulch material that has a minimum total organic content of six percent and pH between 6.0 and 8.0. Herbaceous plugs and/or seed mixes can be interplanted within the coir log to establish vegetation. Fertilizer is not typically required for this product. Watering is necessary for plant establishment. Invasive shrub and/or herbaceous plant species that sprout within project area should be removed.

# APPENDIX B - SOIL WRAPS WITH BRUSH LAYER



## WHAT IS IT?

Soil lifts wrapped in geotextile fabric with alternating layers of live branch cuttings.

## BEST USED:

On all slopes, excellent for steep slopes including >1:1

## BEST USES:

Above and below waterline in low wave action areas.  
On sunny slopes.  
For slumps and holes, 2 to 4 feet in height and depth.

## COST:

Expensive (due to labor for installation)

## SKILL LEVEL:

Moderate to complex

## ADVANTAGES:

1. Produces a well-reinforced shoreline.
2. Rapid vegetation growth.

## DISADVANTAGES:

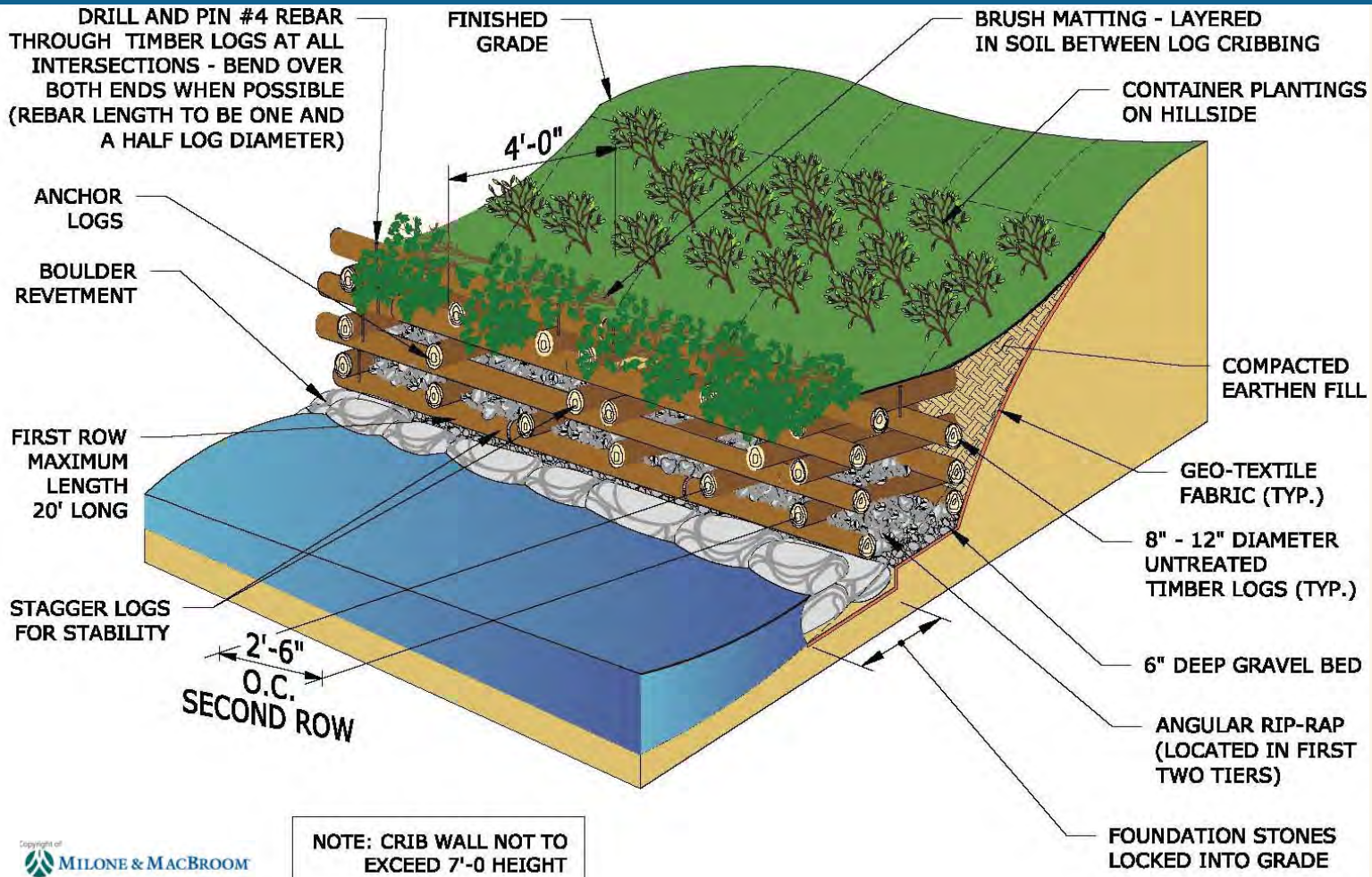
1. Requires greater site disturbance than live staking, live fascines, or branch packing.
2. Should only be installed during the dormant season, generally October to March.
3. Should not exceed maximum height of 8 feet, should not exceed 20 feet along length of shore.

## MAINTENANCE:

Following planting the soil around live brush layers shall be kept moist until bud emergence. Brush layers do not require fertilizer; however the topsoil that the brush layers rooting zone are being planted within should have a minimum total organic content of six percent and pH between 6.0 and 8.0. Invasive shrub and/or herbaceous plant species that sprout within project area should be removed. If brush layer plantings become overgrown then the plants can be cut (ie. pruned) back in the fall and/or early spring.



# APPENDIX B - LOG CRIB WALL



## WHAT IS IT?

Box-like interlocking arrangement of untreated logs or timbers filled with earth or rock fill. May be layered with live branch cuttings that extend back in to the slope. If vegetated, the vegetation eventually takes over the structural integrity of the timber members.

## BEST USED:

Steep to vertical slopes

## BEST USES:

Above and below waterline.  
Can be used at the base of the slope for toe protection.  
High wave action areas.

## COST:

Expensive

## SKILL LEVEL:

Moderate to complex

## ADVANTAGES:

1. Produces a well-reinforced shoreline.
2. Provides immediate bank protection.
3. When vegetated, produces a natural shore appearance with high structural integrity.

## DISADVANTAGES:

1. Fairly extensive site disturbance.
2. Requires large nails or rebar to secure the logs or timbers.
3. Should not exceed maximum height of 7 feet, should not exceed 20 feet along length of shore.

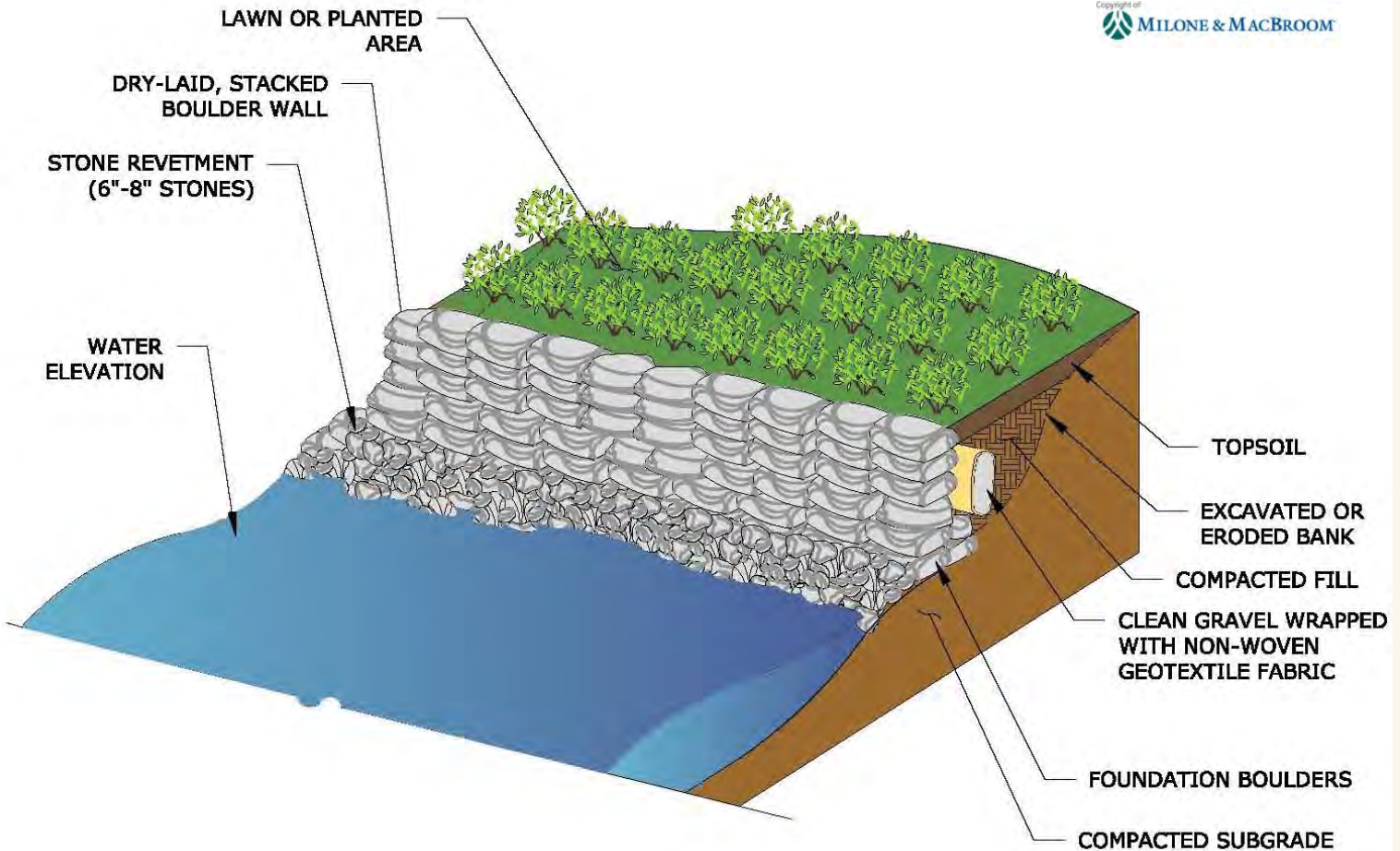
## MAINTENANCE:

Following planting the soil around live branch packing shall be kept moist until bud emergence. Branch packs do not require fertilizer; however the topsoil that the packs are being planted within should have a minimum total organic content of six percent and pH between 6.0 and 8.0. Invasive shrub and/or herbaceous plant species that sprout within project area should be removed. If branch packing plantings become overgrown then the plants can be cut (ie. pruned) back in the fall and/or early spring.



# APPENDIX B - BOULDER WALL

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## WHAT IS IT?

Stacked large stone along the toe and up a slope.

## BEST USED:

Steep slopes

## BEST USES:

Above and below waterline.

## COST:

Expensive

## SKILL LEVEL:

Moderate to complex

## ADVANTAGES:

1. Typically more aesthetically pleasing than a structural wall.
2. Produces a well-reinforced shoreline.
3. Provides immediate bank protection.

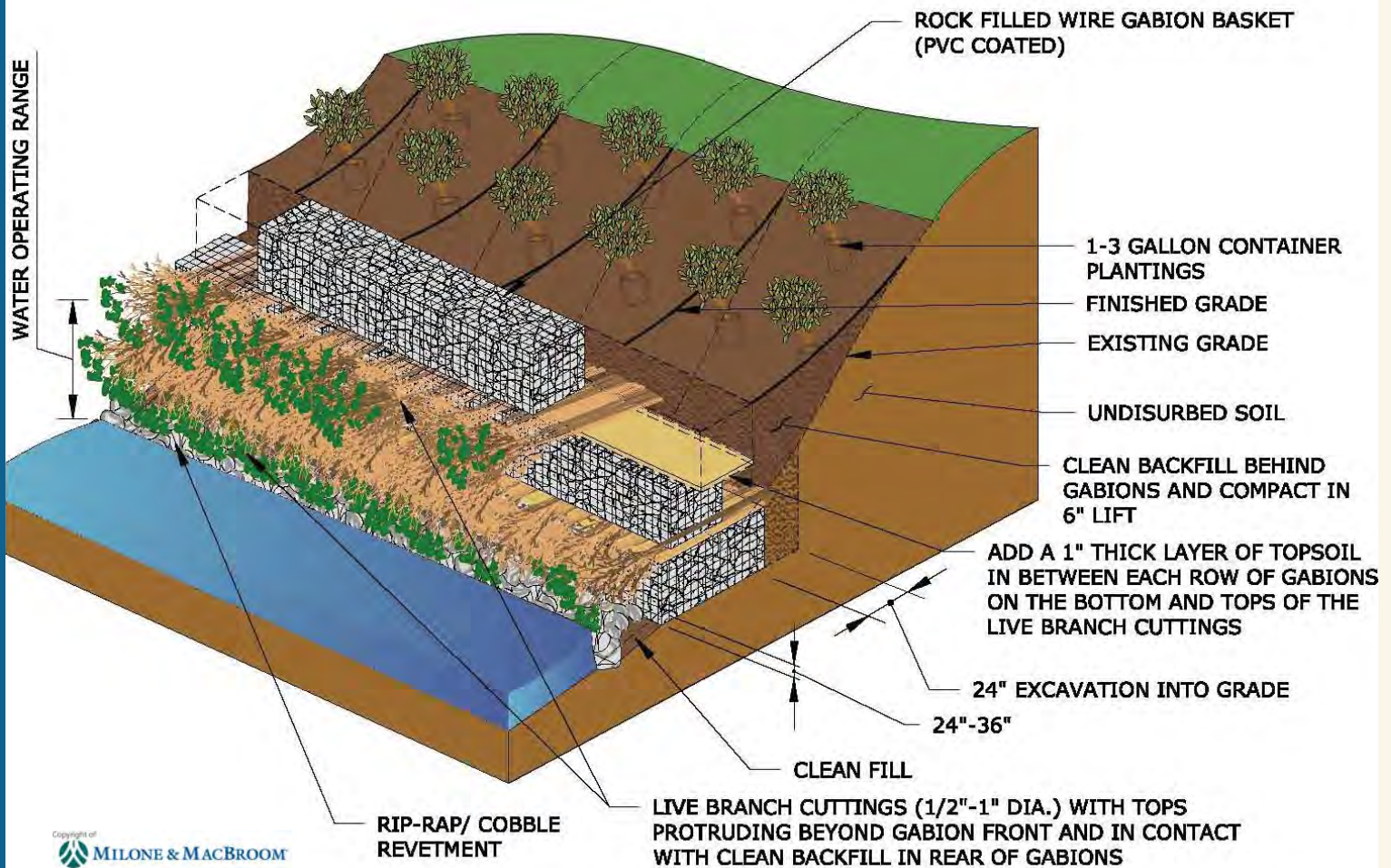
## DISADVANTAGES:

1. Can be undermined if the off-shore zone is too steep.

## MAINTENANCE:

If installed properly boulder walls are maintenance free. Periodic inspections of the wall should be completed following ice melt, after large storm events, and/or severe wave action.

# APPENDIX B - VEGETATED GABIONS



## WHAT IS IT?

Wire baskets filled with stone placed along the toe of a slope. Baskets can be stacked up the face of a slope. Vegetation can be incorporated by layering between layers of baskets.

## BEST USED:

Steep slopes, typically greater than 1.5:1

## BEST USES:

Above and below waterline. Typically used along the toe of slope.

## COST:

Expensive, but lower cost than concrete

## SKILL LEVEL:

Moderate to complex

## ADVANTAGES:

1. Use where a wall would be required. Generally less expensive than concrete or masonry walls.
2. Provides immediate bank protection.
3. Vegetation increases stability.
4. When vegetated, produces a natural shore appearance with high structural integrity.

## DISADVANTAGES:

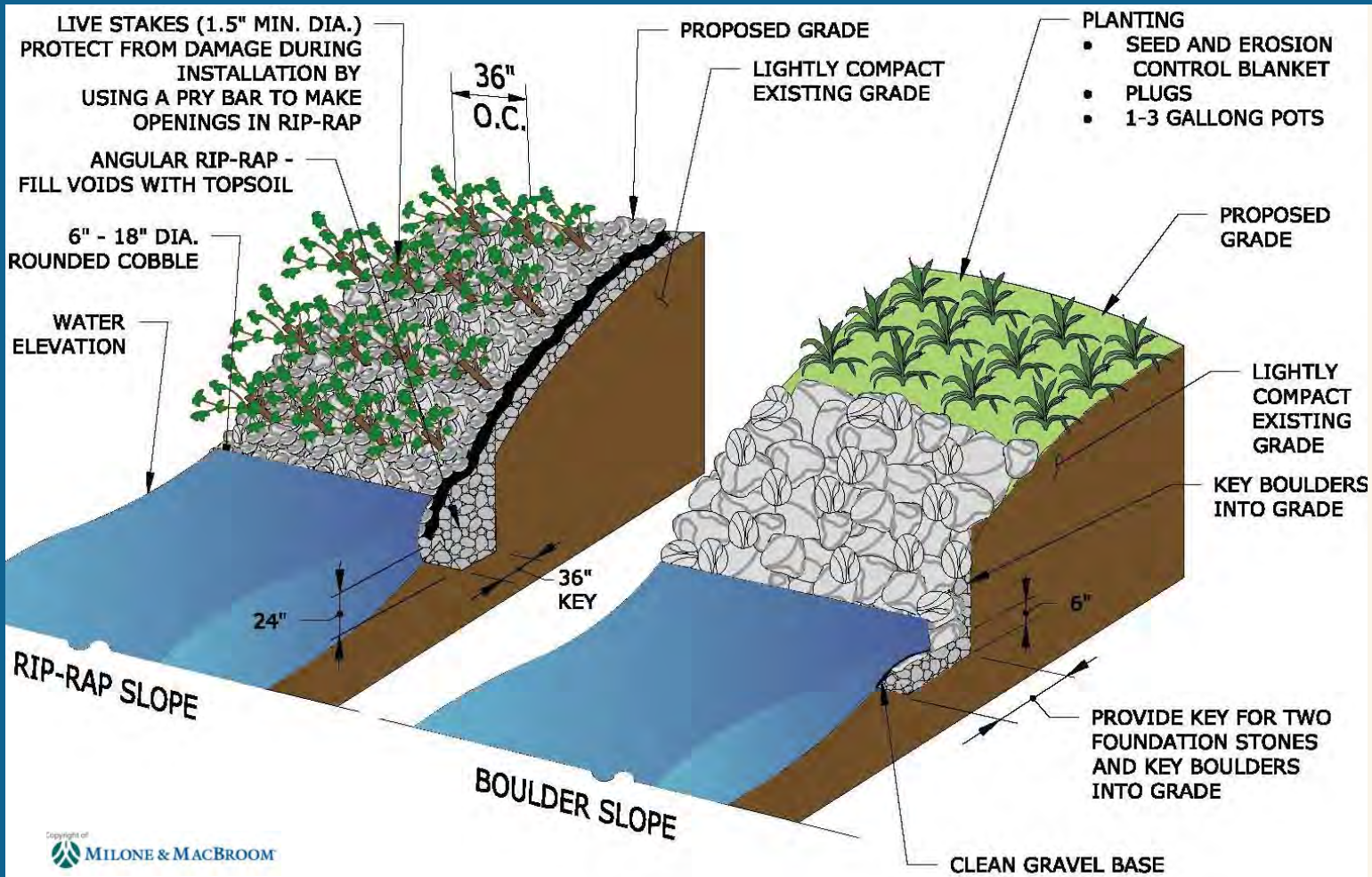
1. Should not exceed maximum height of 5 feet.
2. Wire can rust and break, creating safety hazard.
3. Gabions may only last 20 to 25 years.

## MAINTENANCE:

Following planting the soil around live branch packing shall be kept moist until bud emergence. Branch packs do not require fertilizer; however the topsoil that the packs are being planted within should have a minimum total organic content of six percent and pH between 6.0 and 8.0. Invasive shrub and/or herbaceous plant species that sprout within project area should be removed. If branch packing plantings become overgrown then plants can be cut (ie. pruned) back in the fall and/or early spring.



# APPENDIX B - VEGETATED RIPRAP & ROCK REVETMENT



## WHAT IS IT?

Protective layer of rock interspersed with vegetation placed above the toe of slope that conforms to the shape and slope of the shoreline.

## BEST USED:

All slopes

## BEST USES:

On slopes that experience heavy wave action.

## COST:

Moderate

## SKILL LEVEL:

Easy

## ADVANTAGES:

1. Flexible and not impaired by slight movements.
2. Use of vegetation creates a natural shoreline appearance.
3. No special equipment required for construction.

## DISADVANTAGES:

1. Size and thickness must be designed by Engineer to resist wave action.

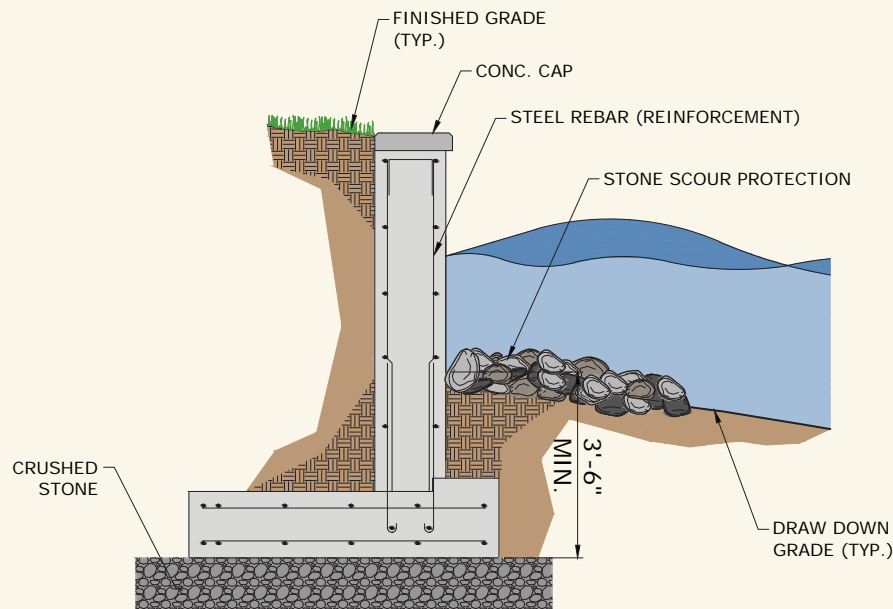
## MAINTENANCE:

If planting pockets are used within the riprap then the following maintenance requirements are recommended. Following planting the soil around new plantings and/or seeds shall be kept moist until seed germination and/or sufficient plant establishment. New plantings do not typically require fertilizer; however the topsoil that the plantings are being planted within should have a minimum total organic content of six percent and pH between 6.0 and 8.0. Seeding of areas may require some starter fertilizer and those rates should be determined by a local landscape contractor, nurseryman, and/or UConn soil testing laboratory. Invasive shrub and/or herbaceous plant species that sprout within project area should be removed. If revegetated area becomes overgrown then certain plants can be cut (ie. pruned) back in the fall and/or early spring.



## APPENDIX B - STRUCTURAL SEAWALLS

The following details are graphical in nature and must be designed by a professional structural engineer.



**REINFORCED CONCRETE WALL - SECTION**  
NOT TO SCALE

### WHAT IS IT?

Protective wall constructed of concrete, boulders, stone, and/or modular blocks.

### BEST USED:

Shallow to steep slopes.

### BEST USES:

Generally used where riprap or other rigid revetment would normally be used. Effective against moderate to high wave attack. Subject to ice shearing.

### COST:

Very Expensive

### SKILL LEVEL:

Hard

### ADVANTAGES:

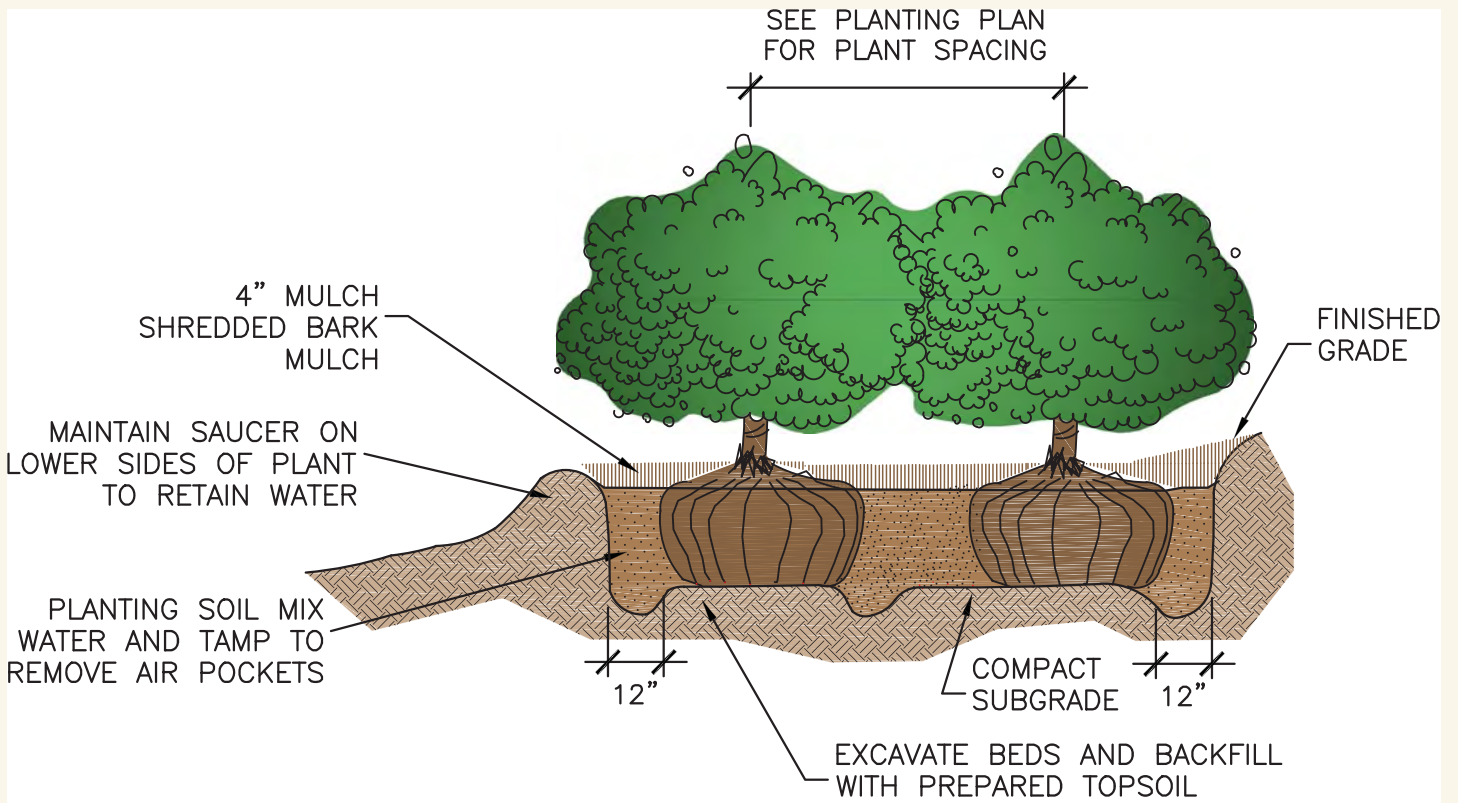
1. Conform to the shape of the slope.
2. Provides immediate shoreline protection.

### DISADVANTAGES:

1. Can be undermined by scour and wave action
4. Can be sheared by large ice sheets
5. Expertise is needed to properly design the seawall for a given project.
6. Life expectancy of approximately 20 to 25 years

### MAINTENANCE:

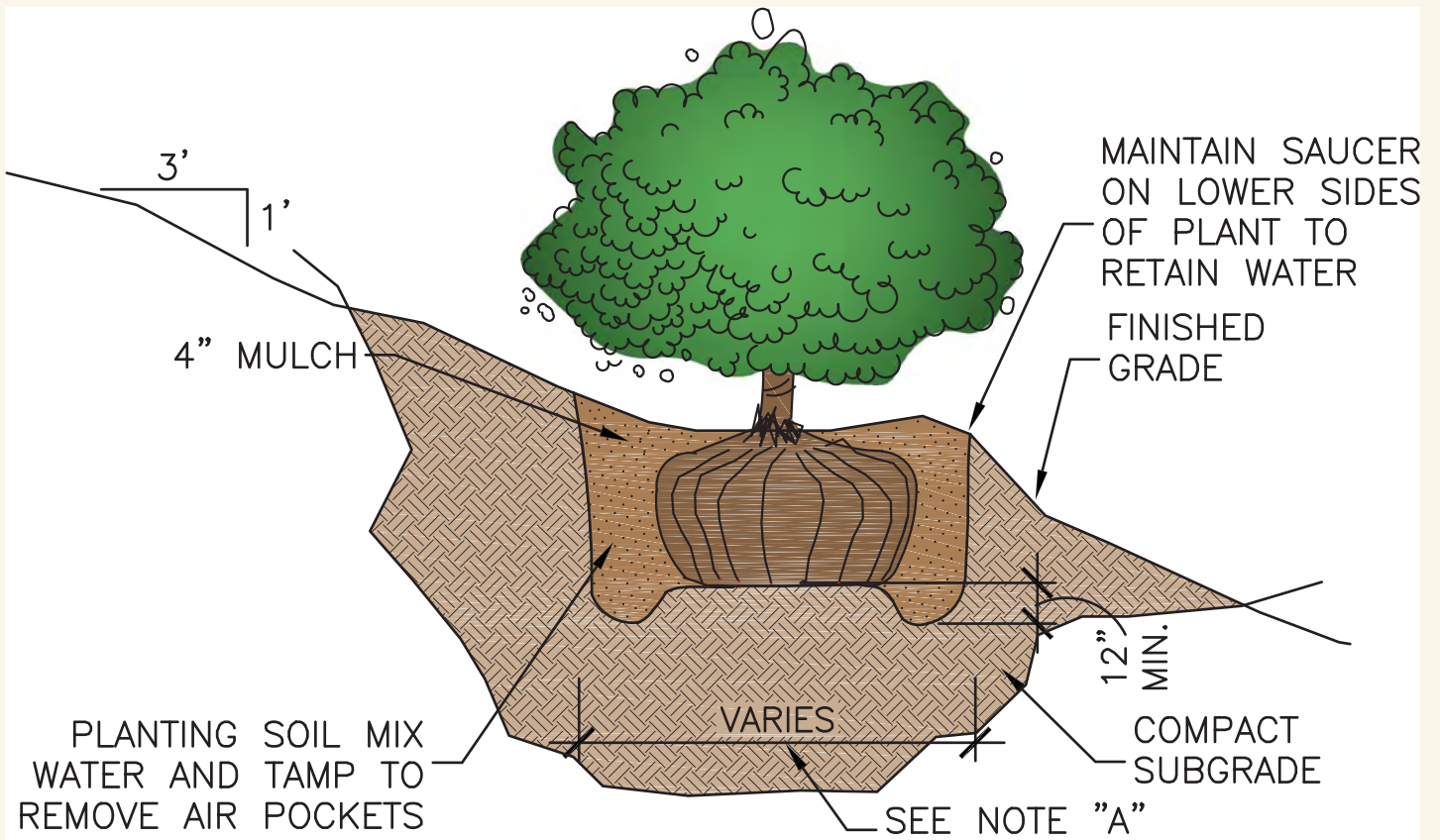
Repointing and/or repair of surface cracking may be required. Inspection of the seawall should be completed yearly.



MULCHING OF PLANT BEDS:  
UNLESS OTHERWISE DIRECTED SHREDDED  
MULCH SHALL BE PLACED TO A LIMIT OF  
ONE FOOT BEYOND THE CENTER OF THE  
OUTERMOST SHRUBS IN SHRUB BED.

PLANTING BED SHRUB DETAIL

N.T.S.

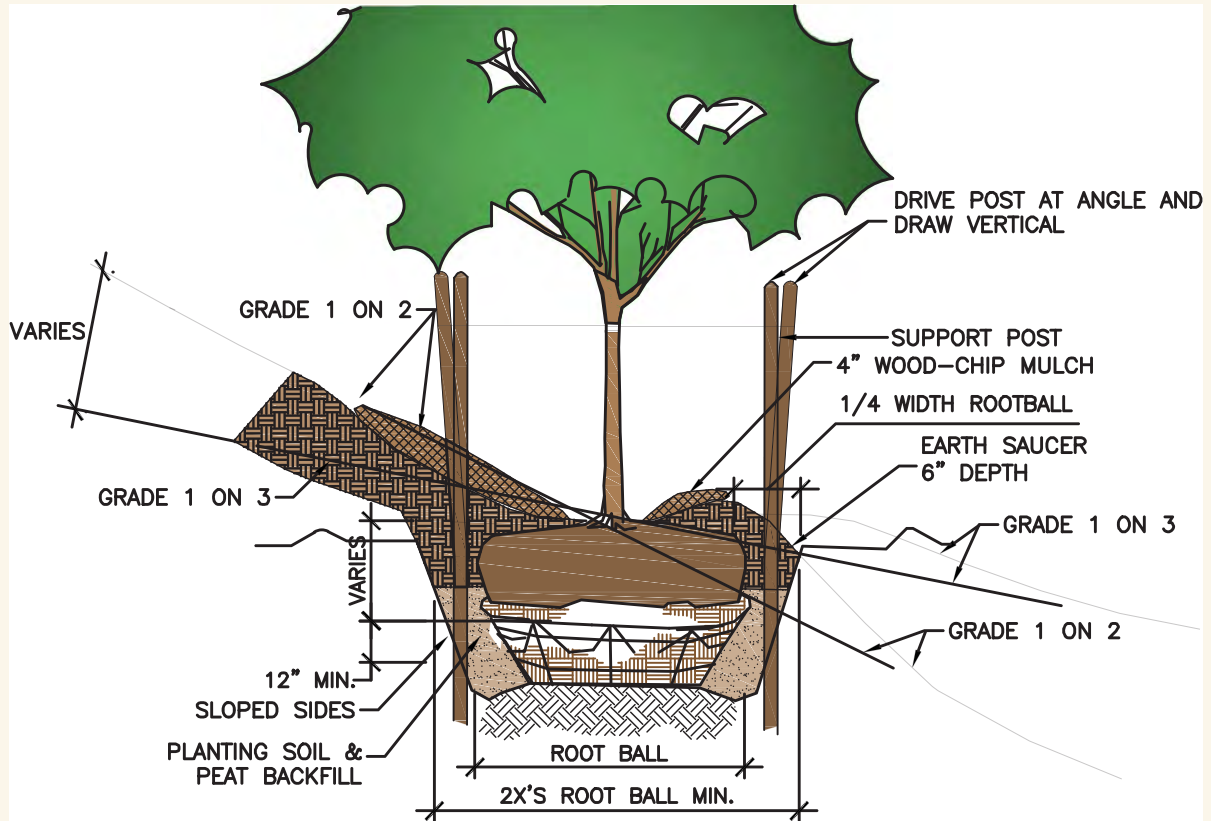


MULCHING OF PLANT BEDS:  
UNLESS OTHERWISE DIRECTED SHREDDED  
MULCH SHALL BE PLACED TO A LIMIT OF  
ONE FOOT BEYOND THE CENTER OF THE  
OUTERMOST SHRUBS IN SHRUB BED.

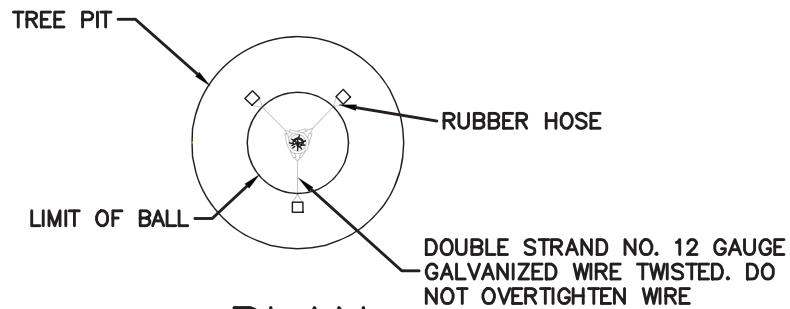
## SHRUB ON SLOPE DETAIL

N.T.S.





**SECTION**  
GRADING FOR TREE ON SLOPE

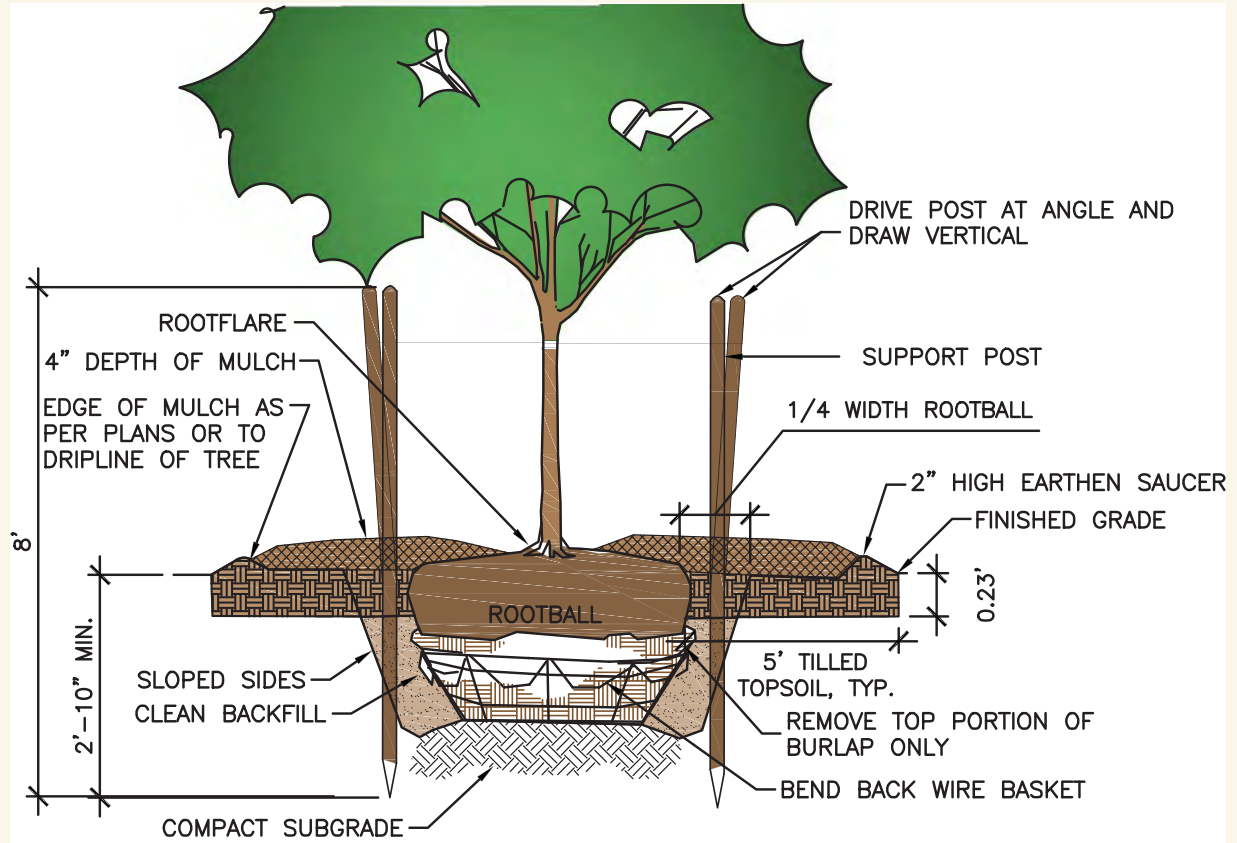


**PLAN**

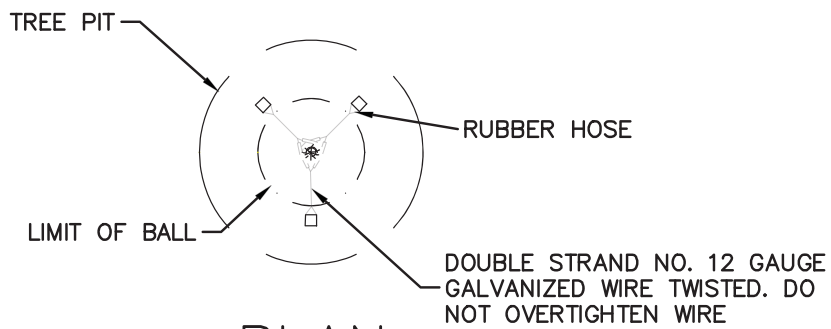
- NOTES:  
1. SUPPORT STAKES SHALL BE REMOVED BY THE CONTRACTOR ONE YEAR AFTER INSTALLATION

**TREE ON SLOPE DETAIL**

N.T.S.



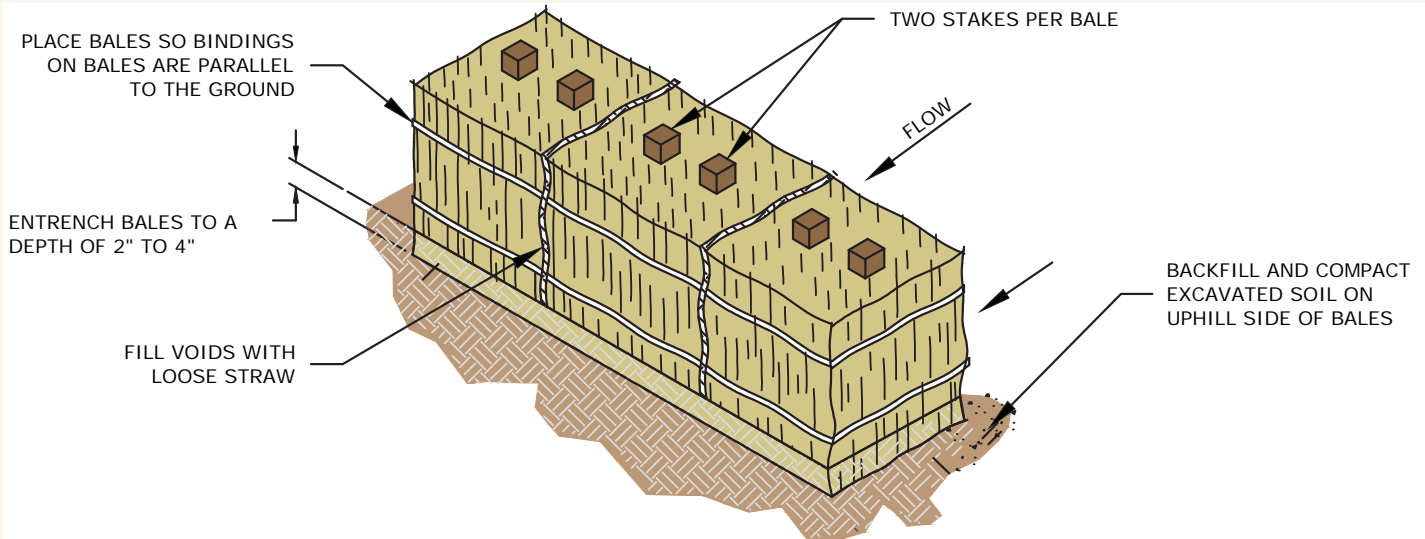
SECTION



PLAN

- NOTES:  
 1. SUPPORT STAKES SHALL BE REMOVED BY THE CONTRACTOR ONE YEAR AFTER INSTALLATION

TREE DETAIL

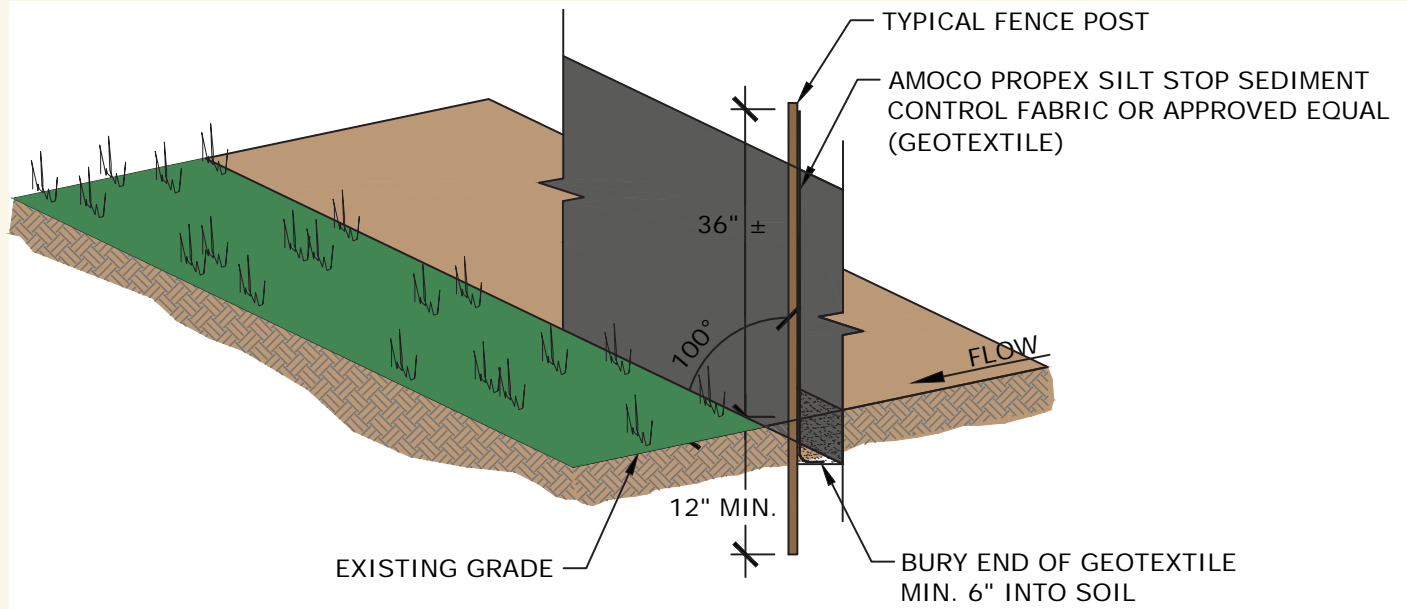


1. IDEALLY, BALES SHOULD BE ENTRENCHED 2 TO 4 INCHES AND TIGHTLY BUTTED TOGETHER. BALES CAN BE SUCCESSFULLY PLACED WITHOUT A TRENCH IF GOOD GROUND CONTACT IS MADE. REMOVE HEAVY BRUSH AND FILL ALL VOIDS WITH LOOSE STRAW.
2. BALES SHALL BE ONLY USED AS A TEMPORARY BARRIER AND FOR NO LONGER THAN 60 DAYS.
3. WHEN SEDIMENTATION DEPOSITS REACH WITHIN 3" OF THE TOP OF BALES, REMOVE SEDIMENTATION OR ADD ADDITIONAL BALES ON SEDIMENTATION DIRECTLY BEHIND FIRST ROW OF BALES AS DIRECTED BY THE ENGINEER.
4. UPON ESTABLISHMENT OF GROUND COVER ON DISTURBED AREAS AND WHEN DIRECTED BY THE ENGINEER, HAY BALES WILL BE REMOVED AND USED AS MULCH. ANY SEDIMENTATION WILL BE THINLY SPREAD UPON ESTABLISHED GROUND COVER.

## HAYBALE BARRIER PROTECTION

N.T.S.





SEDIMENT FILTER FENCE  
N.T.S.

# APPENDIX C

**Table 3 - List of Nurseries Where Plants may be Purchased**

Plant Nurseries			
Company	Location	Phone Number	Websites
Meadowbrook Gardens, LLC	228 Danbury Road New Milford, CT 06776	860-350-4200	<a href="http://www.meadowbrookgardens.net">www.meadowbrookgardens.net</a>
Scott's Landscaping & Nursery	322 Kent Road New Milford, CT 06776	860-350-8295	<a href="http://www.scottslandscapingandnursery.com">www.scottslandscapingandnursery.com</a>
Prospero Nursery	1120 Knollwood Road White Plains, NY 10603	914-592-3748	<a href="http://www.prosperonursery.com">www.prosperonursery.com</a>
Hollandia Nurseries	103 Old Hawleyville Road Bethel, CT 06801	203-743-0267	<a href="http://www.hollandianurseries.com">www.hollandianurseries.com</a>
New England Tree Movers	7 Walnut Hill Road Bethel, CT 06801	203-748-3388	<a href="http://www.netreemovers.com">www.netreemovers.com</a>
Steck Nursery	100 Putnam Park Road Bethel, CT 06801	203-748-1385	<a href="http://www.stecks.us">www.stecks.us</a>
Redding Nursery	73 Hill Road Redding, CT 06896	203-938-3297	<a href="http://www.reddingnursery.com">www.reddingnursery.com</a>
BF Burton Landscapes	95 Botsford Hill Road Roxbury, CT 06783	860-350-9022	<a href="http://www.bfburtonlandscapesinc.com">www.bfburtonlandscapesinc.com</a>
Planter's Choice	140 Huntingtown Road Newtown, CT 06470	203- 426-4037	<a href="http://www.planterchoice.com">www.planterchoice.com</a>
New England Wetland Plants	820 West Street Amherst, MA 01002	413-548-8000	<a href="http://www.newp.com">www.newp.com</a>
Fred's Wild Sod Inc.	205 Ellsworth Road Blue Hill, ME 04614	207-374-5237	<a href="http://www.freds-wild-sod.com">www.freds-wild-sod.com</a>
Pride Corner Farms	122 Waterman Road Lebanon, CT 06249	860-642-3974	<a href="http://www.pridescorner.com">www.pridescorner.com</a>
North Creek Nurseries	388 North Creek Road Landenberg, PA 19350	610-255-0100	<a href="http://www.northcreeknurseries.com">www.northcreeknurseries.com</a>
Spring Meadow Nursery	12601 120th Avenue Grand Haven, MI 49417	616-846-4729	<a href="http://www.springmeadownursery.com">www.springmeadownursery.com</a>
Dietrich Gardens	155 Main Street North Woodbury, CT 06798	203-266-4439	<a href="http://www.dietrichgardens.com">www.dietrichgardens.com</a>
Falls Village Flower Farm	27 Kellogg Road Falls Village, CT 06031	860-824-0077	<a href="http://www.freds-wild-sod.com">www.freds-wild-sod.com</a>
Earth Tones LLC	212 Grassy Hill Road Woodbury, CT 06798	203-263-6626	<a href="http://www.earthtonesnatives.com">www.earthtonesnatives.com</a>
Project Native	342 North Plain Road (Rt 41) Housatonic, MA 01236	413-274-3433	<a href="http://www.projectnative.org">www.projectnative.org</a>

**Table 3 - List of Nurseries Where Plants may be Purchased**

Plant Nurseries			
Company	Location	Phone Number	Websites
Shemin Nursery	1081 King Street Greenwich, CT 06831	203-531-7352	<a href="http://www.shemin.net">www.shemin.net</a>
New England Flower Society	180 Hemenway Road Framingham, MA 01701	508-877-7630	<a href="http://www.newenglandwild">www.newenglandwild</a>
Millane Nurseries, Inc.	604 Main Street Cromwell, CT 06416	860-635-5500	<a href="http://www.millane.com">www.millane.com</a>
Sunny Border Nurseries, Inc.	1709 Kensington Road Kensington, CT 06037	800-732-1627	<a href="http://www.sunnyborder.com">www.sunnyborder.com</a>
Prairie Moon Nursery	32115 Prairie Lane Winona, MN 55987	866-417-8156	<a href="http://www.prairiemoon.com">www.prairiemoon.com</a>
Ernst Conservation Seeds	8884 Mercer Pike Meadville, PA 16335	203-748-1385	<a href="http://www.ernstseed.com">www.ernstseed.com</a>



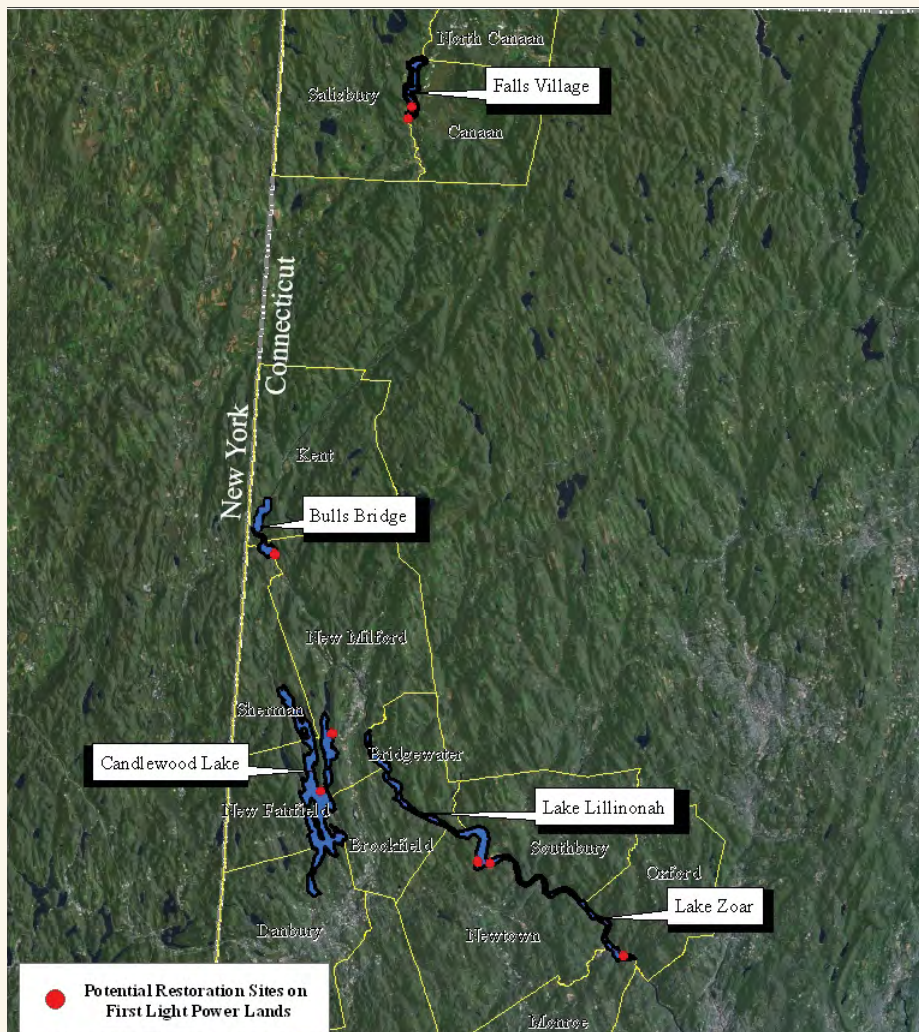
# APPENDIX D

## FirstLight Recreational Area Targeted Revegetated Sites

Appendix D addresses the SMP requirement for the need to identify on maps disturbed FirstLight-owned lands with the potential for revegetation within the project boundary. These sites are referred to as the Targeted Revegetation Sites. The targeted revegetation sites include the following:

- Bulls Bridge boat ramp/shoreline area
- Falls Village boat ramp
- Rocky River Candlewood Lake –Veterans Park shoreline
- Stevenson Dam Canoe Portage
- Lower Shepaug Canoe Portage.

The following figure illustrates the locations of each potential revegetation site. In addition a brief description and aerial photo of each targeted revegetation sites is included.



## APPENDIX D

As part of this manual, FirstLight has prepared a conceptual rendering and layout for the potential restoration of the Bull's Bridge Recreational Site. The following illustrations depict existing conditions, proposed biotechnical stabilization measures and vegetation planting plan for this recreational site.





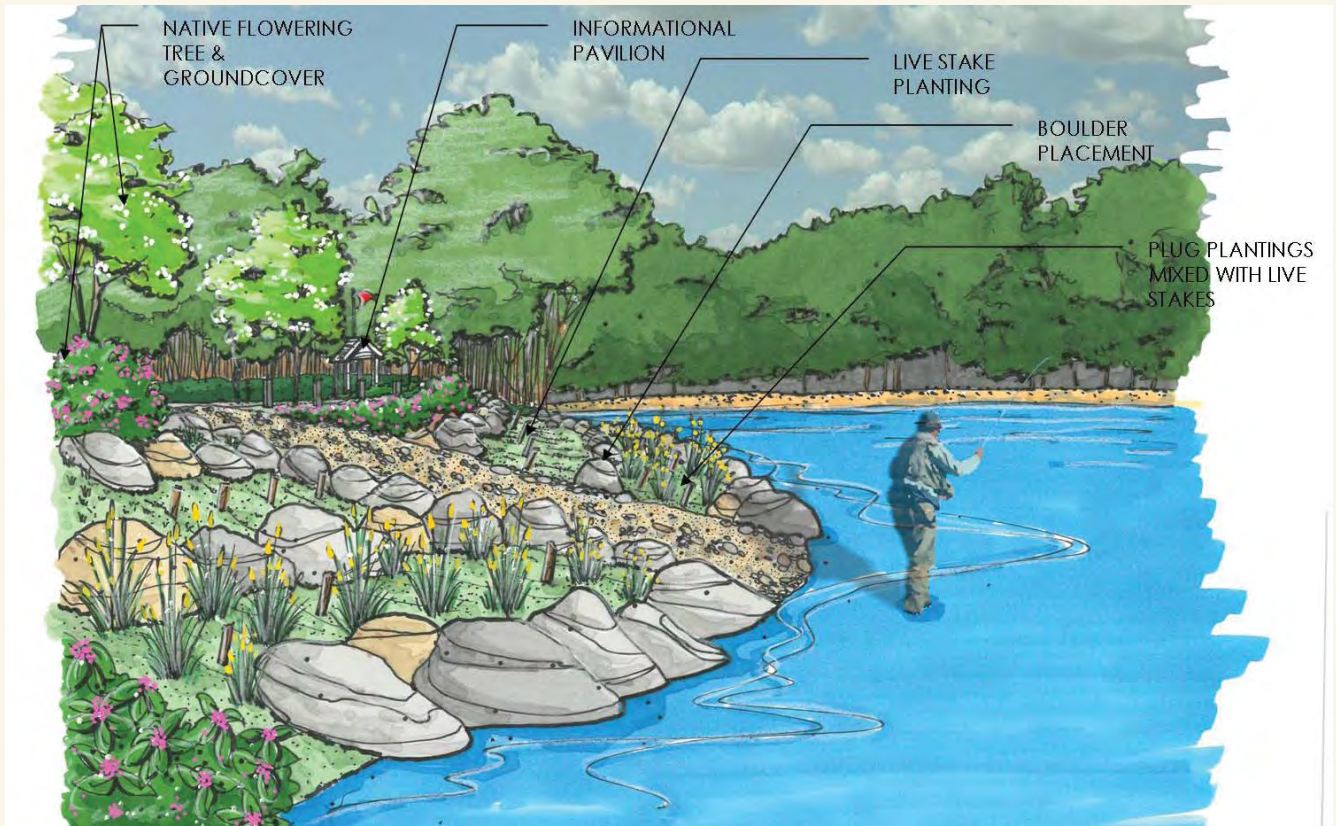








Before Restoration



After restoration



Falls Village Targeted Revegetation Site



Falls Village Shoreline Stabilization Site



Rocky River Candlewood Lake – Veteran’s Park – Targeted Revegetation Site



Veteran’s Park Shoreline Stabilization Site

Stevenson Dam – Targeted Revegetation Site



Stevenson Dam Shoreline Stabilization Site



Lower Shepaug Dam – Targeted Revegetation Site



Lower Shepaug Shoreline Stabilization Site



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