SPECIFICATION GUIDE SHEET
for Riparian Forest Buffer (391)

SCOPE:

This work will consist of establishing adapted and compatible native trees and shrubs adjacent to and up gradient from watercourses or waterbodies. The purpose for this practice may include creating shade to improve aquatic habitat, provide riparian habitat, provide for a source of detritus and large woody debris, reduce excess sediment and other pollutants in surface and shallow groundwater, reduce pesticide drift, restore riparian plant communities, and increase carbon storage.

GENERAL SPECIFICATIONS APPLICABLE TO ALL PURPOSES

To be able to plan for the restoration of a riparian area one must understand what its functions are and where it lies in the landscape. A good definition defines the **riparian area** as "the aquatic ecosystem and the portions of the adjacent terrestrial ecosystem that directly affect or are affected by the aquatic environment. This includes streams, rivers, lakes, and bays and their adjacent side channels, flood plain, and wetlands. In specific cases, the riparian area may also include a portion of the hillslope that directly serves as streamside habitats for wildlife."

The Three Zone System

A three-zone system has been developed to help plan riparian forest buffers. This three-zone concept is intended to be flexible in order to achieve both resource protection and landowner objectives.

All buffers, as a minimum, will consist of Management Zones 1and 2. The minimum width of these combined 2 zones, for all purposes, is 35 feet. Wider buffers are encouraged and may be required depending on the purpose. Wider buffers will provide more functions and values than narrow strips. Forested buffers that will connect two or more forested patches are considered corridors for wildlife. Minimum widths for travel corridors for wildlife are 50 feet where it is an identified objective of the practice.

Zone 1

This zone begins at top of bank and will contain trees and shrubs needed to provide aquatic shade, bank stability, detritus, large woody debris, and retain nutrients bound to soils. Large woody debris and tree roots in the water create habitat complexity and niches for invertebrates and aquatic organisms. Detritus such as leaves, twigs and fruit seeds entering the water and held by woody debris provide a base to the aquatic food chain.

Zone 1 is most subject to inundation. Species with the greatest tolerance to these conditions are listed in VT Forestry Technical Note 2 – VT Tree and Shrubs for Conservation. Silver maple, black willow, boxelder, alder, dogwood, and eastern cottonwood have evolved in and are best suited for these conditions in most locations throughout Vermont floodplains. Silver maple floodplain forests and alluvial shrub swamps are two natural community types that are commonly the target for restoration with this practice. The fast growth rate and brittle habit of these species withstand the periodic trauma of heavy floods. Instead of washing away and exposing unstabilized banks, these species shed branches, regrowing from the remaining trunk. Because of their fast growth rate, they are established relatively easily and rapidly reach canopy closure. These species facilitate the important goal of stream shading and promote establishment of the riparian forest buffer.

The minimum width for this zone for all purposes is 15 feet from top of bank.

Zone 2

This zone is landward of Zone 1 and will contain the trees and shrubs and other vegetation needed to filter runoff and provide uptake of nutrients and pollutants. Together, Zone 1 and 2 will provide a travel corridor and habitat for wildlife in addition to providing shade and a source of woody debris.

Zone 2 can include commercially viable canopy species such as red oak and sugar maple where site conditions permit; areas with high terraces and drier conditions. More flood and wet soil tolerant species, similar to Zone 1, will likely be necessary in Zone 2 depending on the natural community and soil moisture. Generally, for most buffers being planned and implemented in Vermont, Zone 2 is functionally an extension of Zone 1. Except in very wide buffers or near abrupt slope breaks, the species used for both zones will be essentially the same. An understory of shrubs will provide additional shade and structure to Zone 2. Where shading needs for the water body are met, the transition from Zone 2 to 3 can be planted with early successional species such as elderberry, dogwoods, and viburnums to limit the encroachment of invasive plants into Zone 2 and to provide a soft edge between the grass and forest

habitats. **The minimum width for this zone for all purposes is 20 feet.**

Zone 3

This zone is landward of Zone 2 and consists of a strip of grass or herbaceous cover to spread, slow and filter runoff which may be transporting sediment, nutrients, and pesticides off cropland or other erosive areas. **The minimum width for this zone, where necessary, is 15 feet.**

Additional Specifications to Reduce Excess Amounts of Sediment, Organic Material, Nutrients and Pesticides in Surface Runoff and Reduce Excess Nutrients and Other Chemicals in Shallow Ground Water Flow

The riparian forest buffer will consist of Zones 1, 2 and, in some cases, Zone 3. Establishment of Zone 3 filter area will be required where there is sheet flow from cropland toward the forest buffer and stream. A hundred foot buffer has been shown to provide even greater water quality benefits and may be necessary depending on site conditions.

Fast growing species with high nutrient uptake potential should be favored for Zone 2. Zone 2 width will be expanded beyond the 20 foot minimum where necessary to capture excess nutrients, accommodate topography (slope) of the site and or accommodate stream adjustment processes (see Unstable River Channels section).

Where Zone 3 is required, the total combined buffer width shall be no less than 50 feet. Zone 3 will be established and managed according to the Filter Strip Specification Sheet 393.

Unstable River Channels

Planning buffers on unstable river channels requires a greater level of analysis. Many rivers in Vermont are undergoing adjustments due to past and current alterations and managements. Establishing a riparian forest buffer must account for the nature of these systems and for the extent of adjustment and change that could be expected. This will require using geomorphic assessment data and consultations with river scientists or other resource professionals. This consultation will help verify the form and extent of the instability.

Where an unstable channel exists on a project area and where Phase 1 assessments have been completed, use the defined river corridor from the internet based **River Management Stream Geomorphic Assessment Data Viewer** (Mapserve) as the potential foot print of the buffer area which may be refined with site visits. The corridor is intended to include the area that will allow for stream equilibrium condition to develop and stabilize over the long term.

Where there is no phase 1 data, a river corridor can be defined using the belt-width approach. See the DEC River Management 'Defining River Corridors Fact Sheet.' Adding an additional channel width on each side of the stream belt-width will approximate the river corridor for planning purposes.

Plantings should be set back from the top of bank and eroding channel commensurate with the rate of erosion. Bioengineering using stakes and wattles may help to slow the rate of erosion and aid in woody establishment on the buffer.

Additional Specifications to Maintain or Restore Water Temperatures and Provide Large Woody Debris

The riparian forest buffer will consist of Zones 1 and 2 and the total combined width will be a minimum of 35 feet. Zone 1 will be planted to fast growing, tall species that will quickly address the lack of shading and provide large woody debris. Canopy density should be kept at least at 80 percent coverage. Maximum shading ability is reached within a width of 80 feet, with 90 percent of the maximum reached within 55 feet.

Large woody debris (>4 inch diameter) usually originates within 60 feet of the stream. Ideally, streams supporting fish should have 75 to 200 pieces of large woody debris per stream mile.

Additional Specifications to Provide Fish and Wildlife Habitat

The riparian forest buffer will consist of Zones 1 and 2 and the total combined buffer width shall be no less than 50 feet. This will require that Zone two be expanded beyond the minimum to 35 feet. Zone 3 will be used in addition to Zones 1 and 2 where excess nutrients, sediments, etc. are also a concern. Buffers more 100 feet wide or more are recommended as they provide the most fish and wildlife habitat value. See Table 1 for more information about species or groups and buffer requirements. Design buffers to meet or exceed the minimum requirements of local species of concern.

Design buffers to connect upland habitats and wetlands if possible. Numerous species that use aquatic and riparian/wetland habitats will also use upland habitats at some point of their life cycle (e.g. wood turtle).

Planting Plan

The planting plan will be recorded on the approved VT NRCS 391 Job Sheet and will include the natural community type, species and sizes, numbers to be planted for the restoration, spacing, specifications for protection if applicable, and any associated bioengineering that will compliment the tree and shrub establishment. A pre-planting meeting will be held on site with the planters to ensure that the planting plan is properly followed based upon the site conditions.

Riparian forest buffers will be designed to meet the intended purpose of the practice and will also mimic natural plant communities native to the site. Locally developed, native Vermont plant materials or seeds should be considered for planting. See VT Forestry Technical Note 2 – VT Trees and Shrubs for Conservation for more information. Do not order or plant species developed outside of Vermont which are uncommon or rare in the State. This will maintain the genetic integrity of this species in Vermont. Plant a minimum of 5 species of trees and or shrubs for each site. For specifications on tree and shrub planting see Tree and Shrub Establishment (612) Specification Guide Sheet.

Determining Natural Plant Community

Various tools are available to assist in determining the natural community type and species typical of a specific site. The primary reference for determining natural community and species composition is Wetland Woodland Wildland – A Guide to the Natural Communities of Vermont. The companion reference is the Vermont NRCS Soil Series of Vermont and their associated Natural Communities found within section IIA of the electronic Field Office Technical Guide (eFOTG).

Steps: For a given site, the planner may determine the soil series from the County Soil Survey or onsite review. Next, refer to the Soil Series Natural Community guide and find the soil series; read across the table to find the natural community typical of that soil series. Refer to Wetlands Woodlands Wildland for more information about the natural communities including tree and shrub species.

It is also important for the planner to evaluate nearby plant communities on similar site conditions to determine what is appropriate or typical for the specific site. There may be inclusions of other non-forested communities such as emergent shallow marsh or sedge meadows which may provide good habitat diversity in concert with the forested areas. These naturally open communities should not be planted to trees without consideration.

Finally, the planting plan will also need to account for the availability of plant materials. Some species are difficult to grow locally and may be better established through natural regeneration on site.

Note: Be aware of local potential pathogens or pests known to be associated with plant materials that may be ordered from outside Vermont. For example, hemlock should generally not be imported due to wooly adelgid concerns.

Site Planning

Once the appropriate natural community and species are determined for the site, it is important to have a planting plan that specifies how and where different species will be planted based upon site conditions. It is not a good practice to indiscriminately plant species, regardless of habit, across the entire buffer area unless site conditions are uniform. There may be a good amount of variability in soil moisture, herbaceous vegetation height, and topography across this buffer area that should be planned for in the planting plan. For example, if there is a low floodplain or depressions within the buffer area, the planner will need to specify that species adapted to wet soils and inundation be planted in these locations and more upland species at the higher sites. Live stakes and wattles may be a good alternative to tree planting in very wet sites that are frequently flooded. This specific planting information should be made clear to the contracted planters at the pre-planting meeting on site. For information about tree species habits and characteristics and species suitable for bioengineering refer to VT Forestry Technical Note 2 – VT Trees and Shrubs for Conservation and the Tree and Shrub Establishment (612) Specification Guide Sheet.

Natural Regeneration

Natural regeneration can be a cost effective way to allow riparian forest buffer establishment and plant succession to occur on site. It is a slower process than planting but it is one that will select the most suitable species for the site and there is no concern about origins of the growing stock. However, it may not provide uniform stem density and closed canopy coverage for the site in as short a period of time as planting.

Determine if natural regeneration can successfully meet the purpose of the riparian forest buffer. If closed canopy conditions throughout the entire buffer area are required in a short period of time; then natural regeneration may not be the best choice. Recognize that natural regeneration has limitations and that certain buffer functions such as shading, nutrient uptake, habitat corridors, natural communities may need to be met with a planted buffer.

The first step in determining if natural regeneration will meet the purpose of the buffer is to determine how many stems per acre and what species are currently present. This can be done by using the Systematic Line Plot Cruise developed by the Maryland Department of Natural Resources Forest Service or other methods. For detailed description of this process see VT Forestry Technical 1 – Stems per Acre Line Plot.

Natural Regeneration Specifications

Where other buffer functions have been accounted for within the zones, then 150 existing woody stems per acre on site will be considered an established riparian forest buffer. Invasive plants will not be included in this count. This number of stems will approximate the number of stems that are expected to survive from a minimum planting of 200 stems per acre (see Plant Spacing and Density). Generally 75% survival is expected for a planted riparian forest buffer.

Once woody stems have been established it should lead to further regeneration through changes in the site condition (shading favoring trees and shrubs), seed dispersal by birds and mammals and root suckering. This additional regeneration will meet or exceed stems/acre on many planted buffers in Vermont.

Pay careful attention to Zone 1 of the Buffer when considering using natural regeneration instead of planting. This is a critical zone for development of favorable aquatic habitat and conditions. There should be very good evidence of natural regeneration in this Zone. Where there is not, plant accordingly even if the minimum numbers of stems per acre are present.

When considering potential establishment through natural regeneration, consider the site conditions and potential for establishment. Dense sod will likely need to be harrowed while idle crop fields or pastures may be well suited. Often pastures have some woody component that has been suppressed.

Consider the surrounding riparian areas or forest areas for seed sources. Natural regeneration is not a good option if the buffer area is surrounded by agricultural land with no favorable seed sources or potential for vegetative reproduction. Where there are perches for birds (e.g. fence posts, trees on site, etc.) there is a better likelihood of colonization for some woody species; in particular, shrubs whose fruits are fed upon by birds will be seeded into these areas.

When planning for natural regeneration to occur in the buffer, consider mode of dispersal, distance between seed source and target area, seed source strength (number and size of mature seed bearing specimens) and seed size. Generally, heavy seeded species will disperse short distances (one study found 150 feet or less) while wind and bird dispersed seeds may travel greater distances (same study found 450 feet or less). Obviously all seeds can travel greater distances but the probabilities are less. See Tree and Shrub Establishment Specification Sheet 612 (Table 1) for examples of seed sizes and dispersal mechanisms for various trees and shrubs.

Wind and bird dispersed seeds will be most likely to colonize a site with some stems present. Where there are no perching sites in a buffer, wind dispersed seeds will be the primary form of regeneration. Heavy seeded species such as oak and hickory will take longer to naturally establish; particularly over longer distances. Consider planting species such as oak and hickory in regenerating buffers to aid in establishment where they are a component of the targeted natural community.

Buffers that are not planted may persist in an early successional state for decades. This may provide good habitat for certain species of concern in the Northeast (e.g. shrubland birds) but it can also provide favorable conditions for invasive plants such as buckthorn and honeysuckle. Monitoring is important to prevent their initial establishment.

Plant Spacing and Density

In mature riparian floodplain forests, canopy tree stem density is roughly 150 stems per acre, indicating a tree spacing of 16 to 18 feet. Conversely, in an alluvial shrub swamp there may be thousands of stems per acre. Determine what plant spacing and density best meets the purpose of the buffer and best matches the natural community. It is likely that in many cases it is not feasible to plant to meet the natural condition stems per acre in some shrub natural communities so the goal should be to plant in a manner that will allow for succession to this natural community condition.

Initial plant to plant densities for trees and shrubs will depend on their potential height at 20 years of age. Riparian forest buffers are expected to reach crown closure at 10-20 years when stocked at the minimal level of 200 tall trees an acre (greater than 25 feet). Heights may be estimated based on:

- Performance of the individual species (or comparable species) in nearby areas on similar sites.
- Predetermined and documented heights from VT Forestry Technical Note 1 – VT Trees and Shrubs for Conservation.

When establishing a new planted buffer, a minimum of two staggered rows of trees and or shrubs will be established along the water body. Generally this will be within Zone 1. Favor species that will provide shading in a short amount of time. See VT Forestry Technical Note 2 – VT Trees and Shrubs for Conservation.

Planting density should be higher than the final stem density desired, to allow for losses due to competition, stress, and animal damage. Generally, 75% is the expected survival rate for planted buffers. For a floodplain forest, a minimum of 200 plants are needed to be planted per acre to ensure 150 stems per acre. Natural regeneration is also expected to contribute trees and shrubs. In a study in Maryland of 130 buffer sites, 36% of total stocking of woody species was from natural regeneration.

Plant Types/ Community	Plants per Acre	Plant-to-Plant Spacing (Feet)
Shrub Community – shrub dominated, mostly shrubs	450 to 300	10 to 12
Forest Community – tree dominated, mix of trees and shrubs	300 to 200	12 to 15

Plant a mix of trees and shrubs to add habitat value; even when planting the minimum 200 stems per acre. When planting the minimum number of trees and shrubs together in a forest community, do not exceed 25% shrubs in the planting plan. Except in narrow buffers (35-50 feet), it is unlikely necessary to have tall trees for shading on the entire buffer. Adding shrubs to the planting will provide a successional component and important habitat value for wildlife. Adding vertical strata (shrub layer) to the vegetative community will increase the available niches to be used by more species of wildlife. For buffers greater than 50 feet, up to 25% of the buffer area may be left open and intermixed with planting areas. This approach would work well with planting clumps of shrubs. Individual open areas should not exceed 1/10 acre in size. Species of concern such as wood turtles will use open areas for foraging or basking; particularly in or near alluvial shrub swamps.

Establishment Period

The riparian forest buffer will be considered established when 75% of the planted trees and shrubs are alive after 2 growing seasons. If, after 2 growing seasons, there are less than 75% live planted trees on site and natural regeneration has not made up the loss of stems, then re-planting will be necessary.

For Natural Regeneration, assuming other buffer purposes have been accounted for, then 150 existing woody stems per acre on site will be considered an established riparian forest buffer. No additional planting will be necessary unless specified by the planner.

Planting trees and shrubs is not required in all cases where existing stem density is less than 150 per acre. Sites that have evidence of regeneration, where there is a high likelihood of attaining the minimum 150 stems per acre in two growing seasons do not require planting. For instance, a crop field that has initial establishment of silver maple seedlings (not required density) adjacent to mature silver maples will likely exceed the minimum 150 stems per acre through natural regeneration in two growing seasons simply by stopping tillage and herbicide application. Also, a heavily grazed pasture with a 100 native woody stems per acre may easily reach 150 stems per acre in two growing seasons simply by removing livestock. If, after 2 growing seasons, there are less than 150 live native woody stems per acre on site then planting will be necessary.

Direct Seeding Guidelines

Refer to Tree and Shrub Establishment (612) Specification Guide Sheet for information regarding direct seeding. Plant enough seeds to reach the desired stems per acre. Be aware that mortality is generally much higher when direct seeding.

Site Preparation/Weed Control for Buffer Establishment

Refer to Tree and Shrub Establishment (612) Specification Guide Sheet for information regarding site preparation and weed control.

Planting Dates

Refer to Tree and Shrub Establishment (612) Specification Guide Sheet for information regarding planting dates for seeds, seedlings, cuttings and larger planting stock.

Planting Requirements/Techniques

Refer to Tree and Shrub Establishment (612) Specification Guide Sheet for information regarding planting requirements and techniques.

Plant Protection

Refer to Tree and Shrub Establishment (612) Specification Guide Sheet for information regarding protection for planting stock.

REFERENCES:

Buffers for Habitat - Riparian Buffers for the Connecticut River Watershed Fact Sheet Number 4 1998. Connecticut River Joint Commission (CRJC). http://www.crjc.org/riparianbuffers.htm

Buffer Maintenance and Monitoring. 2004. Alliance for the Chesapeake Bay. http://www.acb-online.org/pubs.cfm

Chesapeake Bay riparian handbook: a guide for establishing and maintaining riparian forest buffers. 1997. Palone, R.S. and A.H. Todd (editors.) USDA Forest Service. NA-TP-02-97. Radnor, PA.

Riparian Buffers and Corridors – Technical Papers. 2005. VT Agency of Natural Resources.

Riparian Forest Buffers - Function and Design for Protection and Enhancement of Water Resources, NA-PR-07-91. 1991 David J. Welsch. USDA Forest Service, Northeastern Area State and Private Forestry, St. Paul,MN. http://www.na.fs.fed.us/spfo/pubs/n_resource/buffer/cover.htm

Riparian Forest Buffer Success and Survival in Maryland. 2001. Maryland DNR Forest Service. Research Report DNR/FS-01-01.

Tree dispersal among forest fragments: II – Dispersal abilities and biogeographical controls. 2002. Nina Hewitt and Martin Kellman. Journal of Biogeography, 29:351-363.

Table 1. Riparian Forest Buffer Widths for Fish and Wildlife

SPECIES	DESIRED WIDTH (in feet)
Wildlife dependent on wetlands or watercourses	**30-600'**
Bald eagle, nesting heron, cavity nesting ducks	600
Pileated woodpecker	450
Beaver, dabbling ducks, mink	300
Bobcat, red fox, fisher, otter, muskrat	330
Amphibians and reptiles	100-330
Belted kingfisher	100-200
Songbirds	**40-660**
Scarlet tanager, American redstart, rufous-sided towhee	660
Brown thrasher, hairy woodpecker, red-eyed vireo	130
Blue jay, black capped chickadee, downy woodpecker	50
Cardinal	40
Cold water fisheries	**100-300**

Source - Connecticut River Joint Commission (CRJC) Buffers for Habitat - in the series *Riparian Buffers for the Connecticut River Watershed*

Table 2. Natural Community types associated with rivers and lakes.

Open Upland Shores	Open Wet Shores	Marshes and Sedge Meadows	Shrub Swamps	Floodplain Forests and Swamps
Riverside Outcrop	Outwash Plain Pondshore	Shallow Emergent Marsh	Alluvial Shrub Swamp	Lakeside Floodplain Forest
Erosional River Bluff	River Mud Shore	Sedge Meadow	Sweet Gale Shoreline Swamp	Red or Silver Maple-Green Ash Swamp
Lake Shale or Cobble Beach	River Sand or Gravel Shore	Cattail Marsh		Red Maple-Northern White Cedar Swamp
Lake Sand Beach	River Cobble Shore	Deep Broadleaf Marsh		Silver Maple-Ostrich Fern Riverine Floodplain Forest
Sand Dune	Calcareous Riverside Seep	Wild Rice Marsh		Silver Maple-Sensitive Fern Riverine Floodplain Forest
	Rivershore Grassland	Deep Bulrush Marsh		Sugar Maple-Ostrich Fern Riverine Floodplain Forest
	Lakeshore Grassland			

Source – Riparian Buffers and Corridors – VTANR

Table 3.

Number of Trees per Acre by Various Methods of Spacing

Spacing (feet)	Trees (number)	Spacing (feet)	Trees (number)	Spacing (feet)	Trees (number)
2x2	10,890	7x9	691	12x15	242
3x3	4,840	7x10	622	12x18	202
4x4	2,722	7x12	519	12x20	182
4x5	2,178	7x15	415	12x25	145
4x6	1,815	8x8	681	13x13	258
4x7	1,556	8x9	605	13x15	223
4x8	1,361	8x10	544	13x20	168
4x9	1,210	8x12	454	13x25	134
4x10	1,089	8x15	363	14x14	222
5x5	1,742	8x25	218	14x15	207
5x6	1,452	9x9	538	14x20	156
5x7	1,245	9x10	484	14x25	124
5x8	1,089	9x12	403	15x15	194
5x9	968	9x15	323	15x20	145
5x10	871	10x10	436	15x25	116
6x6	1,210	10x12	363	16x16	170
6x7	1,037	10x15	290	16x20	136
6x8	908	10x18	242	16x25	109
6x9	807	11x11	360	18x18	134
6x10	726	11x12	330	18x20	121
6x12	605	11x15	264	18x25	97
6x15	484	11x20	198	20x20	109
7x7	889	11x25	158	20x25	87
7x8	778	12x12	302	25x25	70

Source - Chesapeake Bay riparian handbook