

RIPARIAN FOREST BUFFER GUIDANCE

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Section I: Introduction and Summary

A Riparian Forest Buffer is an area of permanent vegetation consisting of native trees, shrubs, and forbs along surface waters that is maintained in a natural state or sustainably managed to protect and enhance water quality, stabilize stream channels and banks, and buffer land use activities from surface waters.

Riparian Forest Buffers are crucial to the protection and enhancement of the water resources in Pennsylvania. They are extremely complex ecosystems that help provide optimum food and habitat for stream communities as well as being useful in mitigating or controlling point and nonpoint source pollution by both keeping the pollutants out and increasing the level of instream pollution processing. Riparian Forest Buffers serve as a barrier to prevent most pollutants from getting into aquatic environments. They also provide enhanced instream contaminant sequestration and degradation primarily due to increased biological activity (Sweeney et. al, 2004). Used as a component of an integrated management system including nutrient management and sediment and erosion control practices, Riparian Forest Buffers can produce a number of beneficial effects on the quality of water resources (Welsch, 1991). Riparian Forest Buffers can be effective in removing excess nutrients and sediment from surface runoff and shallow groundwater, stabilizing streambanks, and shading streams and rivers to optimize light and temperature conditions for aquatic plants and animals. Riparian Forest Buffers also ameliorate the effects of some pesticides, and directly provide dissolved and particulate organic food needed to maintain high biological productivity and diversity in the adjoining stream. (Sweeny et. al, 2007) Riparian Forest Buffers provide significant flood attenuation and storage functions within the watershed. Finally, the protection of existing Riparian Forest Buffers coupled with the establishment of new buffers can have a significant impact on moderating the effects of climate change on aquatic ecosystems, particularly in our headwater streams.

Riparian Forest Buffers can be in place as:

- Existing, where protection is critical.
- Newly established

The primary purpose of this guidance is to assist Pennsylvania Department of Environmental Protection (DEP) staff in providing and further developing general buffer recommendations for regulatory, voluntary and grant programs. It will also serve to assist any interested entities (municipal, regional, state, federal and others) in understanding the functions and values of Riparian Forest Buffers, the importance of sustaining and enhancing Riparian Forest Buffers, and in developing appropriate science-based guidelines or policies.

Detailed recommendations for the establishment of Riparian Forest Buffers, and the protection, maintenance and enhancement of both newly established and existing Riparian Forest Buffers can be found in *Pennsylvania Stream ReLeaf Forest Buffer Toolkit*, available through the Pennsylvania Department of Environmental Protection, Bureau of Watershed Management. <http://www.dep.state.pa.us/dep/deputate/watermgt/wc/Subjects/StreamReleaf/Forestbufftool/default.htm>

Section II: Guidance

1. Conditions Where Practice Applies

Riparian Forest Buffers should be located on stable areas adjacent to perennial or intermittent streams, rivers, lakes, ponds and reservoirs. Prior to establishing a new buffer, the project sponsor should assess any vegetation within the riparian area to determine whether or not there is an existing Riparian Forest Buffer. If the area in question has no woody vegetation, a Riparian Forest Buffer should be established according to the following recommendations

2. Composition of existing Riparian Forest Buffers

If there is woody vegetation in the area adjacent to the perennial or intermittent stream, river, lake, pond, or reservoir, see Appendix B: The Evaluation and Classification of Existing Buffers (pp. 16-23).

Existing buffers can be classified as follows:

Class 1

- Width of area with woody vegetation is 100 feet or greater as measured from top of streambank or lake shoreline
- Minimum 60% uniform canopy cover (area of ground covered by a vertical projection of the canopy of all native shrubs and trees)
- 0% Pennsylvania Noxious Weeds
- Less than 25% invasive species

Class 2

- Width of area with woody vegetation is 100 feet or greater as measured from top of streambank or lake shoreline
- **Less than** 60% uniform canopy cover (area of ground covered by a vertical projection of the canopy of all native shrubs and trees)
- 0% Pennsylvania Noxious Weeds
- Less than 25% invasive species

Class 3

- Width of area with woody vegetation is **less than** 100 feet as measured from top of streambank or lake shoreline
- **Less than** 60% uniform canopy cover (area of ground covered by a vertical projection of the canopy of all native shrubs and trees)
- Pennsylvania Noxious Weeds **present**
- **More** than 25% invasive species

Existing buffers in Class 2 should be enhanced by additional plantings in open spaces around existing native trees and shrubs. In Zone 1 immediately adjacent to the top of streambank or lake shoreline, native trees should be planted on 10 foot centers

(approximately 435 stems per acre). In Zone 2, a mix of native trees and shrubs should be planted on 10 foot centers (approximately 435 stems per acre).

Existing buffers in Class 3 should be enhanced **and widened** by additional plantings in open spaces around existing native trees and shrubs. In Zone 1 immediately adjacent to the top of streambank or lake shoreline, native trees should be planted on 10 foot centers (approximately 435 stems per acre). In Zone 2, a mix of native trees and shrubs should be planted on 10 foot centers (approximately 435 stems per acre).

All noxious weeds in Class 3 buffers should be removed and the amount of invasive species should be decreased so that they total less than 25% cover. See page 19 of this document for lists of noxious weeds and invasive species commonly found in riparian buffers in Pennsylvania. You can also find the *Pennsylvania Field Guide to Common Invasive Plants in Riparian Areas* at <http://www.acb-online.org/pubs/projects/deliverables-145-1-2004.pdf>

Concentrated flow and accelerated erosion and sedimentation should be controlled in the area up grade and immediately adjacent to the existing Riparian Forest Buffer. Since concentrated flow may erode the forest floor and impede the ability of the buffer to intercept pollutants, an herbaceous strip or appropriate Best Management Practice (Rocco, 2007) may be needed to protect the existing Riparian Forest Buffer (Welsch, D. 1991).

See the *Pennsylvania Stream ReLeaf Forest Buffer Toolkit* for additional information on enhancing and maintaining existing Riparian Forest Buffers

If there is no woody vegetation in the area adjacent to the perennial or intermittent stream, rivers, lake, ponds or reservoir, a Riparian Forest Buffer should be established according to the recommendations below.

3. Composition of newly established Riparian Forest Buffers

DEP recommends that newly established Riparian Forest Buffers be composed of two distinct zones (Zones 1 and 2) and be designed to filter surface runoff as sheet flow and down slope subsurface flow which occurs as shallow groundwater.

Concentrated flow and accelerated erosion and sedimentation should be controlled in the area up grade and immediately adjacent to the area where a Riparian Forest Buffer will be established. Since concentrated flow may erode the forest floor and impede the ability of the buffer to intercept pollutants, an herbaceous strip or appropriate Best Management Practice (Rocco, 2007) may be needed to protect the newly established Riparian Forest Buffer. (Welsch, D. 1991)

A. Zone 1 – Undisturbed Forest (Trees)

i. Location

Zone 1 should begin at the top of the streambank or normal pool elevation of a lake, pond or reservoir and occupy a strip of land with a **minimum** width, consistent with subsection 4, that is measured horizontally on a line perpendicular to the streambank or lake shoreline.

ii. Purpose

The purpose of Zone 1 is to create a stable ecosystem adjacent to the water's edge, provide soil/water contact area to facilitate nutrient buffering processes, provide shade to moderate and stabilize water temperature encouraging the production of beneficial algal forms and to contribute necessary detritus and large woody debris as food to the ecosystem. Zone 1 stabilizes stream banks and shorelines and reduces flooding impacts by providing a wider, more natural stream channel and flood prone area.

iii. Recommendations

- (1) Runoff to be filtered by Zone 1 should be limited to sheet flow or natural subsurface flow only. Concentrated flow and accelerated erosion and sedimentation shall be controlled in the area up grade and immediately adjacent to the riparian forest buffer. Outflow from subsurface drains must not be allowed to pass through the Riparian Forest Buffer in pipes or tile drains.
- (2) Dominant vegetation should be composed of a variety of native riparian tree species.
- (3) Management of Zone 1 should be limited to bank stabilization and removal of noxious weeds and invasive species. All noxious weeds should be removed from Zone 1. The amount of invasive species should be decreased so that they total less than 25% of all cover in Zone 1. See page 19 of this document for lists of noxious weeds and invasive species commonly found in riparian buffers in Pennsylvania. You can also find the *Pennsylvania Field Guide to Common Invasive Plants in Riparian Areas* at

<http://www.acb-online.org/pubs/projects/deliverables-145-1-2004.pdf>

- (4) Livestock should be excluded from Zone 1 except for designated stream crossings.

- (5) See the *Pennsylvania Stream ReLeaf Forest Buffer Toolkit* for additional information on planting and maintaining Zone 1 of a Riparian Forest Buffer.

B. Zone 2 – Managed Forest (Combination of Trees and Shrubs)

i. Location

Zone 2 should begin at the landward edge of Zone 1 and occupy an additional strip of land with a **minimum** width, consistent with subsection 4, that is measured horizontally on a line perpendicular to the streambank or lake shoreline.

ii. Purpose

The purpose of Zone 2 is to remove, transform or store sediment, nutrients and other pollutants and provide long term storage of nutrients in the biomass of trees and shrubs. It also provides habitat and corridor for wildlife habitat and economic benefits to the landowner if the forest resource is sustainably harvested.

iii. Recommendations

- (1) Concentrated flow and accelerated erosion and sedimentation should be controlled in the area up grade and immediately adjacent to the Riparian Forest Buffer. Since concentrated flow may erode the forest floor and impede the ability of the buffer to intercept pollutants, an herbaceous strip or appropriate Best Management Practice (Rocco, 2007) may be needed to protect the Riparian Forest Buffer in the area upgradient to Zone 2. (Welsch, D. 1991)
- (2) Dominant vegetation should be composed of a variety of native riparian tree and shrub species.
- (3) Some management, such as sustainable harvesting in keeping with a Forest Stewardship Plan for that activity that maintains 60% canopy cover is allowed in Zone 2. Removal of invasive species and habitat improvement should be allowed in this zone. All noxious weeds should be removed from Zone 2. The amount of invasive species should be decreased so that they total less than 25% of all cover in Zone 2. See page 19 of this document for lists of noxious weeds and invasive species commonly found in riparian buffers in Pennsylvania. You can also find the *Pennsylvania Field Guide to Common Invasive Plants in Riparian Areas* at

<http://www.acb-online.org/pubs/projects/deliverables-145-1-2004.pdf>

- (4) Livestock should be excluded from Zone 2 except for designated stream crossings.
- (5) See the *Pennsylvania Stream ReLeaf Forest Buffer Toolkit* for additional information on planting and maintaining Zone 2 of a Riparian Forest Buffer.

4. Width

Regardless of all other factors, 100 feet is the **minimum** Riparian Forest Buffer width that DEP recommends be maintained for all regulatory, voluntary and grant activities. This width applies to perennial or intermittent streams, rivers (**minimum** 100 feet on both sides of the stream or river), lakes, ponds, wetlands, wellheads, and areas of critical groundwater recharge (Wenger, 1999 and Mayer, 2005)

The width shall be extended to a **minimum** of 150 feet (75 feet Zone 1 and 75 feet Zone 2) adjacent to streams designated as Exceptional Value Waters (Sweeney, 1993; Meyer et.al, 2003, and Mayer, 2005).

When applicable, the width shall be extended to a **minimum** of 150 feet (75 feet Zone 1 and 75 feet Zone 2) adjacent to streams designated as High Quality Waters.

The width should be extended on a case by case basis in areas known to be sources of sediment and in areas of known high nutrient content, or where fertilizer, manure, or animal waste or sludge application occurs. The width should be extended in areas where railroads or major highways parallel the water body or where there are steep slopes or soils of very low permeability or high erosion potential, steep stream gradients or anywhere that specific goals, conditions, and evidence are interpreted to indicate that additional width is needed to achieve the desired environmental functions and benefits.

5. Management of Existing and Established Riparian Forest Buffers.

DEP recommends that both existing and newly established Riparian Forest Buffers be managed to enhance and maximize the unique value of these resources. For detailed information on management of Riparian Forest Buffers see *the Pennsylvania Stream ReLeaf Buffer Toolkit*. Management includes specific limitations on alteration of the natural conditions of these resources. General recommendations on practices and activities within Zones 1 and 2 of the Riparian Forest Buffer include:

- A. The native vegetation within the Riparian Forest Buffer should not be disturbed. There should be no clearing, mowing, burning, spraying, or grazing in Zone 1. Sustainable forestry in accordance with a Forest Stewardship Plan for that activity

that maintains 60% canopy cover is allowed in Zone 2. All noxious species should be removed from Zones 1 and 2 within the buffer. Invasive species should be reduced to less than 25% of cover in all Zones within the buffer. See page 19 of this document for lists of noxious weeds and invasive species commonly found in riparian buffers in Pennsylvania. You can also find the *Pennsylvania Field Guide to Common Invasive Plants in Riparian Areas* at <http://www.acb-online.org/pubs/projects/deliverables-145-1-2004.pdf>

- B. Soil disturbance should not take place within the Riparian Forest Buffer by grading, stripping of topsoil, plowing, cultivating, or other practices.
- C. Filling or dumping should not occur within the Riparian Forest Buffer.
- D. Except as permitted by DEP, the Riparian Forest Buffer should not be drained by ditching, under drains, or other drainage systems.
- E. Animals should not be housed, grazed, or otherwise maintained within the Riparian Forest Buffer.
- F. Motorized vehicles should not be stored or operated within the Riparian Forest Buffer.
- G. Materials should not be stored within the Riparian Forest Buffer.
- H. Stream restoration projects, facilities and activities approved by DEP are permitted within the Riparian Forest Buffer.
- I. Scientific studies approved by DEP, including water quality monitoring, biological stream surveys, and stream gauging, are permitted within the Riparian Forest Buffer.
- J. Individual trees in the Riparian Forest Buffer may be removed which are in danger of falling, causing damage to dwellings or other structures, or causing the blockage of streams.
- K. Selective herbicide application by a qualified professional is permitted as one of the tools to control noxious weeds and invasive species of plants.

6. Protection of Riparian Forest Buffers

The best way to ensure a buffer's longevity is to protect it with a Permanent Easement, such as the model Riparian Forest Buffer Protection Agreement (Agreement) developed by DEP and the Pennsylvania Land Trust Association. The Agreement is a tool to help private landowners and conservation organizations work in partnership to establish permanent Riparian Forest Buffers along Pennsylvania's perennial or intermittent

streams, rivers, lakes, ponds and reservoirs. The purpose of establishing Riparian Forest Buffers is to:

- Maintain and improve the quality of water resources associated with the waterway;
- Perpetuate and foster the growth of healthy forest (or if natural conditions are not conducive to forest growth, then healthy marsh, shrub land, etc.);
- Preserve habitat for native species dependent on water resources or forest; and
- Ensure that activities and uses in the Riparian Forest Buffer are sustainable, neither diminishing the biological integrity nor depleting the soil, forest and other natural resources within the riparian forest buffer over time.

The Agreement achieves these conservation objectives while keeping the property in the landowner's ownership and control. The Agreement is between the landowner (the "Owner") and the conservation organization (the "Holder"). In the Agreement, the Owner places permanent restrictions on activities that would harm the water, forest, or soil, and the Holder commits to watch over the land and enforce the restrictions.

The Agreement and guiding commentary can be found at the following website http://conserveland.org/model_documents/#riparian or by contacting the Bureau of Watershed Management at 717-772-5807. There is additional information on other protection measures in Appendix B of this guidance.

Section III: How to Apply the Guidance

1. Measuring Riparian Forest Buffer Widths

Buffers are measured horizontally from the normal pool elevation for lakes, ponds and reservoirs and from the top of streambank or top of slope for intermittent and perennial streams and rivers, depending on site characteristics as described below, to the edge of project activity.

A. Lakes, Ponds, and Reservoirs

Riparian Forest Buffers on lakes, ponds and reservoirs are measured inland perpendicular to the shoreline beginning at the normal pool elevation.

B. Intermittent and Perennial Streams and Rivers

Riparian Forest Buffers on intermittent and perennial streams and rivers are measured inland from either the top of streambank or top of slope, depending on the physical stream channel characteristics. The most common scenarios are:

- i. Channels where the break in bank slope represents the stage at which bankfull flow accesses a relatively flat and wide floodplain; Riparian Forest Buffers are measured from the top of bank if no contiguous wetlands are present or from the upland edge of the wetland if contiguous wetlands are present.
- ii. Channels contained in a narrow V-shaped valley that has steep side slopes and little or no floodplain; Riparian Forest Buffers are measured from the top of slope.
- iii. Channels that have an accessible floodplain on one side of the channel but run adjacent to the steep side slope of a valley or high terrace on the other; Riparian Forest Buffers are measured from the **top of slope** where the channel runs adjacent to the valley wall or high terrace and the **top of bank** where the channel has access to the floodplain.
- iv. Channels that have recently abandoned their floodplain as a result of a lowering of the streambed and are creating a new floodplain at a lower elevation; Riparian Forest Buffers are measured from the **top of slope**, defined as the edge of the most recently abandoned floodplain.

APPENDIX A: Functions and Benefits of Riparian Forest Buffers

Riparian Forest Buffers serve many functions and provide many benefits including:

1. Functions

A. Protection of Water Quality

- i. Water temperature and light control:** Shading maintains cool summer water temperatures and moderates harsh winter temperatures; also, lower light levels inhibit the growth and production of nuisance algae and help maximize stream width. Both factors maximize dissolved oxygen content in the water and the amount of ecosystem per unit stream length available to process pollutants.
- ii. Filtration of sediments, nutrients, pathogens and toxics in runoff:** Riparian Forest Buffers slow overland runoff, allowing the buffer to filter out pollutants originating from upland areas.
- iii. Infiltration and maintenance of streamflow:** Riparian Forest Buffers slow overland runoff allowing for infiltration of surface water that helps to maintain base flow in streams.
- iv. Lakeshore, channel and floodplain stability:** Riparian Forest Buffers minimize lakeshore erosion, instream scour, bank erosion, and sedimentation associated with channel instability, reducing sediment loads to receiving waterbodies.

B. Protection of Aquatic Habitat

- i. Water quality:** The water quality functions described in Section 1.A of this appendix are important in the protection of aquatic habitat and aquatic biota. Moderating water temperatures and light levels in both summer and winter and maintaining sufficient dissolved oxygen levels and stream width are essential to a healthy ecosystem capable of in-stream processing of pollutants. Removing pollutants from runoff helps to ensure clean water and oxygen for aquatic organisms and maintaining stream flows ensures flowing water even during the driest months. Reducing the amount of sediment entering a waterbody protects the eggs and young of fish, amphibians, aquatic insects, and other aquatic invertebrates from suffocation and helps maintain the interstitial spaces in stream substrates, which provide important habitat for aquatic biota.
- ii. Bank Stability and Stream Width:** Tree roots stabilize the banks and shade prevents stream narrowing due to riparian grasses.

- iii. **Food supply:** Organic material (leaves, twigs, and other detritus) derived from Riparian Forest Buffers is a primary source of the energy for supporting aquatic food chains in most aquatic ecosystems.
- iv. **Woody debris:** Large woody debris (LWD) is recruited from the Riparian Forest Buffers by trees falling into the stream channel or lake or delivered to the waterbody via floodwaters. LWD provides velocity refuge and overhead cover for fish, substrate and food for aquatic invertebrates, and substrate for plants. LWD influences the formation of pools, backwaters, and shallow slack water, increasing the complexity of aquatic habitat and influencing the storage and transport of aquatic food sources. It also traps sediments and retards scouring of the channel bed and banks during high flows and reduces the effects of wave action on lakeshores, maintaining habitat for aquatic biota.
- v. **Lakeshore, channel, and floodplain stability:** Dissipating floodwater is as important for aquatic biota as it is for the channel or lakeshore itself. Floodwaters that are not allowed to dissipate horizontally over a floodplain build up energy within the channel, often causing excessive scour of the channel bed that can cause direct mortality of fish and amphibians due to mobilization of large substrates in the channel bed. Riparian vegetation stabilizes both streambanks and lakeshores preventing the collapse of undercut banks that provide cover and cool water refuge for fish, reptiles, and amphibians.

C. Moderation of the Effects of Climate Change

- i. **Aquatic ecosystem adaptation.** Riparian Forest Buffers maintain or enhance in-stream ecological health. Keeping the aquatic system as healthy as possible will help to keep the ecosystem stable and better able to adapt to a changing climate. Mature Riparian Forest Buffers contribute significantly to the energy source for the ecosystem, and provide habitat and ecological niches leading to a diverse and stable aquatic community.
- ii. **Temperature moderation.** Mature Riparian Forest Buffers, properly sized, provide a significant temperature moderating effect, keeping water and riparian temperatures cooler and diurnal temperature fluctuations less extreme.
- iii. **Reduction in suspended sediment.** Riparian Forest Buffers stabilize stream banks leading to less suspended sediment entering the water column. Suspended sediment will lead to increased stream temperatures and a depressed aquatic community.
- iv. **Reduction of carbon source (footprint).** Riparian Forest Buffers reduce the carbon source of the ecosystem due to their fallow nature. Also carbon

sequestration values could be attributed to the mature trees within a Riparian Forest Buffer.

D. Protection of Terrestrial Habitat

- i. Habitat for wildlife and vegetation:** A large part of the life cycles of amphibians and reptiles occur in riparian corridors. The same is true for many aquatic insects, which use riparian vegetation as reproductive swarming sites, nymph emergence sites, and food. In addition, the majority of Pennsylvania's birds and mammals are dependent on riparian areas for a portion of their life cycle. Many species of plants can survive only in areas near water.
- ii. Maintenance of aquatic food webs as they relate to terrestrial food webs:** Vegetation, such as fallen leaves and branches, are important in providing food and cover for aquatic insects and fish. These insects and small fish, in turn, provide food for many mammals and birds.
- iii. Habitat for rare, threatened and endangered species:** Many of Pennsylvania's rare species of plants and animals are dependent on Riparian Forest Buffers for at least a part of their life cycle.
- iv. Preventing the spread of exotic or invasive species:** Non-native invasive or exotic species can easily establish in disturbed areas that were formerly Riparian Forest Buffers and then significantly disrupt natural communities. Maintaining and restoring Riparian Forest Buffers is a key component in controlling the spread of these species.
- v. Travel corridors for migration and dispersal:** Many wildlife species in Pennsylvania are dependent on Riparian Forest Buffers that act as connective habitat through otherwise uninhabitable regions during periods of food shortage, for seasonal or diurnal movements within their home ranges, and as dispersal routes for juveniles.
- vi. Breeding habitat:** Many wildlife species, especially waterfowl, shore birds, many songbirds, and most amphibians and reptiles require the habitat provided by Riparian Forest Buffers as conditions for breeding and for raising their young.
- vii. Genetic interchange:** Riparian Forest Buffers around waterbodies may provide important dispersal routes for juveniles and breeding adults of some wildlife species, thereby assisting in genetic interchange with other local populations.

E. Protection of Channel, Lakeshore, and Floodplain Stability

- i. Flood attenuation:** Riparian Forest Buffers provide space for channel meanders and floodwaters to spread out horizontally, dissipating stream energy and protecting channel stability and lakeshores during floods.
- ii. Reduced effects of storm events:** Riparian Forest Buffers can slow the speed and reduce the volume of surface runoff from upland areas, protecting lakeshores and stream channel beds and banks from “flashy” powerful flows that can scour and erode the channel.
- iii. Ice damage control:** Riparian Forest Buffers trap ice slabs during spring breakup, reducing the potential of jamming at downstream constrictions. Jamming can result in backwater and flooding upstream, which can lead to channel instability. Vegetated lakeshore buffer zones are able to absorb the pressures of mid-winter ice push, protecting upland development from ice damage.
- iv. Bank and shoreline stabilization:** The vegetation in Riparian Forest Buffers binds soil increasing the strength of the soil matrix and thereby increasing streambank and lakeshore stability. Bank and shoreline stability are important for reducing soil and property loss from the bank or shore, reducing sediment input to the waterbody, and maintaining overall channel stability. Riparian vegetation also protects lakeshores from wave action.
- v. Maintenance of sediment transport and channel morphology:** Riparian Forest Buffers help maintain channel width-to-depth ratios and meander geometry (belt width) resulting in a channel slope that ensures consistent movement of sediments and water through stream systems.

E. Social and Economic Benefits

- i. Flood control:** Riparian Forest Buffers mitigate floodwaters and protect human land use and investments from hazards associated with stream dynamics and shore erosion.
- ii. Ice damage control:** The trees in Zone 1 of a Riparian Forest Buffer insulate and warm the waters on the near shore/bank area. This protects human land use and investments from ice damage on the near shore/bank and from effects of ice jamming and subsequent upstream flooding.
- iii. Maintenance of optimal water quality for drinking water and recreation:** This would include protection of water quality for activities such as boating, swimming, fishing, and wildlife viewing.

- iv. **Maintenance of wastewater assimilation capacity of streams for reducing wastewater treatment costs.** Riparian Forest Buffers lower water temperature thereby increasing dissolved oxygen; this increases the waterbody's capacity to assimilate organic wastes, such as from wastewater treatment plants.
- v. **Aesthetics:** Clear, clean waters and Riparian Forest Buffers enhance the sensory and recreational qualities of the waterbody, the watershed, communities, and individual properties. Aesthetic values often have economic benefits and contribute to a sense of pride and well being for communities and property owners.
- vi. **Intrinsic values:** This would include the preservation of natural functioning ecosystems and biological diversity.

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Appendix B: Evaluation and Classification of Existing Buffers

This evaluation should be performed by a Certified Forester or professional trained in the use of this form and procedure.

Introduction

The objective of this procedure is to determine the classification of existing riparian buffers through sampling. The sample consists of milliacre plots (3 feet 9 inch radius) taken at a frequency of at least 10 plots per acre (Figure 1.). Each plot will cover approximately 43.47 square feet. The buffer will be classified by the following characteristics: canopy cover, noxious weeds, and invasive plant species. Upon completion, the cruise will have sampled approximately 1% of the buffer and, along with other observations, will provide an estimate of the classification of the buffer.

Definitions

Canopy Cover – area of ground covered by the crowns of trees or woody vegetation as delineated by the vertical projection of crown perimeters. It is commonly expressed as a percent of total ground area.

Invasive Plant Species - non-native species that can thrive in areas beyond their natural range of dispersal. They are characteristically adaptable, aggressive, and have a high reproductive capacity. See Table 2 for a list of invasive plant species that are commonly found in Riparian Forest Buffers in Pennsylvania. For a *Pennsylvania Field Guide to Common Invasive Plants in Riparian Areas* go to:

<http://www.acb-online.org/pubs/projects/deliverables-145-1-2004.pdf>

Milliacre Plot - sample plot with a radius of 3' 9" covering 43.47 square feet or approximately 1/1,000 of an acre. A cruise consisting of ten milliacre sample plots per acre samples 1% of the population which can be used to estimate the entire population.

Noxious Weeds - A plant determined by Pennsylvania law to be injurious to public health, crops, livestock, agricultural land or other property. See Table 1 for a list of Pennsylvania Noxious Weeds.

Equipment

- 100-foot Measuring Tape
- Yardstick
- 66 foot line – chain (optional)
- Compass (optional)
- Handheld Global Positioning System (GPS) Unit
- Topographic Map or aerial photo of area
- Clip Board
- Site Monitoring summary form

- Plot Sample Sheets
- Calculator
- Pencils
- Flagging
- Densimeter (Optional)

Procedure

1. Use a topographic map or aerial photograph showing site and handheld GPS unit to record location of buffer sampling plots.
2. Determine the boundary of your buffer area using features such as fences, field edges, woodland edges, streams, marked changes in land use, or the landowner's property line, if applicable.
3. Map the perimeter of the buffer either by recording a minimum of 4 latitude/longitude points with the handheld GPS unit, pacing off the area, or using a measuring tape. Record on the site map the location of the buffer relative to the stream and other key landscape features.
4. Calculate the area and acreage of the buffer and record the acreage.

To determine the area in square feet, multiply the average length of the buffer by the average width: $\text{Area (ft}^2\text{)} = \text{Average Length (ft)} \times \text{Average Width (ft)}$

To determine the acreage, divide the area by 43,560.

$\text{Acreage (ac)} = \text{Area (ft}^2\text{)} / (43,560 \text{ ft}^2\text{/ac)}$

5. Using a compass or handheld GPS unit, determine the azimuth or direction, of a baseline that is approximately in line with the long axis of the riparian buffer.
6. The milliacre sample plots should be taken at a minimum frequency of ten plots per acre or every 66 feet (1 chain). Determine the location of the sample plots for the given area by walking the baseline and marking 66 foot intervals. At the end of the baseline, turn 90 degrees and walk in a line perpendicular to the baseline for 66 feet. Turn 90 degrees again and walk parallel to the baseline marking 66 foot intervals.
7. At each plot estimate percent Canopy Cover for Trees and Shrubs by randomly placing the five by five inch grid (found on page 8) on the ground - face up - within the sample plot. Count the number of squares shaded and multiply that number by 4 to estimate percent canopy cover. Alternatively, you can use a Densimeter to estimate percent Canopy Cover.
8. At each plot estimate the percent cover of noxious (Table 1.) and/or invasive (Table 2.) species.
9. At each plot, record the following: percent cover of Noxious (Table 1.) and/or Invasive (Table 2.) species, and percent Canopy Cover of trees and shrubs. ******In order for Noxious and/or Invasive species to be recognized, the survey should be done during the growing season. For percent canopy cover to be estimated properly, the survey should be done near mid-day, when the shade is direct.***

10. See attached Plot Sample Sheet and Summary Sheet to complete the cruise and summarize the data for the buffer. Next, see information below to classify the buffer according to the data on the Summary Sheet.

Existing Buffer Classification

Class 1

- Width of area with woody vegetation is 100 feet or greater as measured from top of streambank or lake shoreline
- Minimum 60% canopy cover (area of ground covered by a vertical projection of the canopy of all native shrubs and trees)
- 0% Pennsylvania Noxious Weeds
- Less than 25% invasive species

Class 2

- Width of area with woody vegetation is 100 feet or greater as measured from top of streambank or lake shoreline
- Less than 60% canopy cover (area of ground covered by a vertical projection of the canopy of all native shrubs and trees)
- 0% Pennsylvania Noxious Weeds
- Less than 25% invasive species

Class 3

- Width of area with woody vegetation is less than 100 feet as measured from top of streambank or lake shoreline
- Less than 60% canopy cover (area of ground covered by a vertical projection of the canopy of all native shrubs and trees)
- Pennsylvania Noxious Weeds present
- More than 25% invasive species

Figure 1
Milli-acre Plots per Acre to Meet 1% Cruise

2 acres = 20 plots

1¾ acres = 18 plots

1½ acres = 15 plots

1¼ acres = 13 plots

1 acre = 10 plots

¾ acre = 8 plots

½ acre = 5 plots

¼ acre = 3 plots

Table 1
Pennsylvania Noxious Weeds List

<i>Cirsium arvense</i>	Canada Thistle
<i>Rosa multiflora</i>	Multiflora Rose
<i>Sorghum halepense</i>	Johnsongrass
<i>Cannabis sativa</i>	Marijuana
<i>Polygonum perfoliatum</i>	Mile-a-Minute
<i>Pueraria lobata</i>	Kudzu-vine
<i>Cirsium vulgare</i>	Bull or Spear Thistle
<i>Carduus nutans</i>	Musk or Nodding Thistle
<i>Sorghum bicolor</i> ssp. <i>drummondii</i>	Shattercane
<i>Datura stamonium</i>	Jimsonweed
<i>Lythrum species</i> (non-native)	Purple loosestrife, all cultivars
<i>Heracleum mantegazzianum</i>	Giant hogweed
<i>Galega officinalis</i>	Goatsrue

Table 2
Pennsylvania Invasive Species List

Shrubs	
<i>Berberis thunbergii</i>	Japanese barberry
<i>Berberis vulgaris</i>	European barberry
<i>Elaeagnus angustifolia</i>	Russian olive
<i>Elaeagnus umbellata</i>	Autumn olive
<i>Euonymus alatus</i>	Winged Euonymus
<i>Ligustrum obtusifolium</i>	Border privet
<i>Ligustrum vulgare</i>	Common privet
<i>Lonicera maackii</i>	Amur honeysuckle
<i>Lonicera morrowii</i>	Morrow's honeysuckle
<i>Lonicera morrowii</i> x <i>tatarica</i>	Bell's honeysuckle
<i>Lonicera standishii</i>	Standish honeysuckle
<i>Lonicera tartarica</i>	Tartarian honeysuckle
<i>Rhamnus catharticus</i>	Common buckthorn
<i>Rhamnus frangula</i>	Glossy buckthorn
<i>Rubus phoenicolasius</i>	Wineberry
<i>Rosa multiflora</i>	Multiflora rose
<i>Spiraea japonica</i>	Japanese spiraea
<i>Viburnum opulus</i> var. <i>opulus</i>	Guelder rose
Trees	
<i>Acer platanoides</i>	Norway maple
<i>Acer pseudoplatanus</i>	Sycamore maple
<i>Ailanthus altissima</i>	Tree-of-heaven
<i>Paulownia tomentosa</i>	Princess tree
<i>Pyrus calleryana</i>	Callery pear
<i>Ulmus pumila</i>	Siberian elm

SUMMARY SHEET

Buffer Coordinates _____
Stream Name _____
Date _____
Area _____
Evaluator's Name _____

A. Total Number of Plots _____

B1. Percent Canopy Cover of Native Trees and Shrubs per plot, Total _____

B2. Percent Canopy Cover of Native Trees and Shrubs per plot, Average (B1 ÷ A) _____

B3. Percent Canopy Cover of Native Trees and Shrubs per plot (B2 x 100) _____

C1. Estimated Percent Cover Invasive Species per Plot, Total _____

C2. Estimated Percent Cover Invasive Species per Plot, Average (C1 ÷ A) _____

C3. Estimated percent Cover Invasive Species (C2 ÷ B2) x 100) _____ %

D1. Estimated percent Cover Noxious Species cover per Plot, Total _____

D2. Estimated percent Cover Noxious Species cover per Plot, Average (D1 ÷ A) _____

D3. Estimated percent Cover Noxious Stems per Acre (D2 x 100) _____

E1. Percent Canopy Cover of Native Trees and Shrubs, Total _____ %

E2. Percent Canopy Cover of Native Trees and Shrubs, Average (E1 ÷ A) _____ %

Are there any other invasive species or noxious weeds in proximity to the buffer that may be of concern to land management? If yes, please explain.

Are there signs of wildlife damage to plants within, or in proximity to, the buffer that may delay the establishment of the buffer? If yes, please explain.

Are there any tree or shrub diseases or insect pests present within, or in proximity to, the buffer that may delay or cause failure of buffer establishment?

If there is less than 60% Canopy Cover of Trees and Shrubs on average throughout the site, are there enough native trees and shrubs to provide seed source to achieve 60% Canopy Cover of Trees and Shrubs in 5 years? _____

***Please provide a sketch of the buffer on the back of this paper.**

Sketch of Buffer

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PLOT SAMPLE SHEET

Buffer Name _____
 Owner _____
 Date _____
 Plot # _____
 Plot Coordinates _____

Name _____

Total Cover _____

Estimated Invasive Species Cover _____

Estimated Noxious Weeds Cover _____

Percent Canopy Cover of Native Trees and Shrubs _____

- Estimate percent Canopy Cover for native trees and shrubs by randomly placing the five by five inch grid, on the back of this paper, on the ground - face up - within the sample plot. Count the number of squares shaded and multiply that number by 4 to estimate percent canopy cover. Alternatively, use a Densitometer to estimate percent Canopy Cover for native trees and shrubs.

Species Present, Observations, and Other Notes:

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Appendix C: Riparian Forest Buffer Protection

1. Model Riparian Forest Buffer Protection Agreement

Refer to Section II.6 of this guidance.

2. Municipal Protection

Under the Pennsylvania Municipal Planning Code (MPC), land can be zoned and designed for appropriate uses. Zoning establishes legally tenable land use options. Section 603 of the MPC authorizes local governments to regulate, permit, prohibit, restrict, and determine uses of land, including wetland and riparian corridor.

The “Environmental Rights Amendment” of the Pennsylvania Constitution (Act 1 Section 27) has been interpreted by the courts as a responsibility equally shared by DEP and municipalities. Pennsylvania’s municipalities have the responsibility to apply Section 27 in planning and regulation of land use.

Some of the major riparian corridor protection strategies are:

- A. Fee Simple Acquisition:** The municipality or conservation organization purchases the riparian area outright, guaranteeing its protection and public access.
- B. Easement Purchase:** The municipality and/or land conservation organization purchases limited rights to the riparian area, and the landowners receive tax benefits. This is cheaper than acquisition, but the municipality must ensure that it gets the rights it needs to ensure protection and public access.
- C. Overlay Zoning:** Overlay zones are a type of resource protection zoning that are superimposed on traditional zoning to protect riparian areas, while still allowing the underlying use in suitable forms. As an example, a municipality produces and adopts an official map that complies with the Federal Flood Insurance Program and regulates what can be done in the riparian area. The map delineates the area known as an Overlay District. Several riparian corridor protection standards are written into a zoning ordinance to regulate use and intensity of riparian area activities. This strategy gives the municipality legal control of the area without property ownership.
- D. Transfer of Development Rights:** A transfer of development rights (TDR) program allows municipalities to preserve unique and environmentally sensitive riparian areas. This is a form of overlay zoning that targets specific segments of a riparian corridor for preservation. Landowner property values are protected because they are permitted to transfer their right to develop, based on the underlying zoning district, to a portion of the municipality designated for more

intensive development. This allows the riparian corridors to be permanently deed-restricted from development, while maintaining the land's value.

- E. Bonus/Incentive Zoning:** Bonus zoning is similar to transferable development rights, except that the additional development rights are generated and used by the developer rather than purchased from another landowner. Incentive zones set both a standard set of conditions and an optional set of incentives that the developer may choose to meet in exchange for greater flexibility. For example, an incentive zoning law may allow a developer in a zone to build at a higher density than is normally allowed if the developer agrees to set aside more open space or adopt certain energy saving or transportation measures.
- F. Streambank Setback or Resource Protection Zones:** The municipality can protect riparian areas through use of an established Riparian Forest Buffer. The buffer is similar to a utility right-of-way. The width of the setback is determined before construction of the subdivision begins. Zoning ordinances use two approaches—a fixed buffer or a floating buffer. A fixed buffer may prohibit development within 200 feet of the high water line of a perennial stream.

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Appendix D: References

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