River Restoration Toolbox
Practice Guide 3

Riparian Buffering

Iowa Department of Natural Resources

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Executive Summary

Riparian buffers provide a link between terrestrial and aquatic ecosystems. They provide numerous benefits including bank stability, improved aquatic and terrestrial habitat, improved biodiversity, and improved water quality. Riparian buffers are important to native stream fish because they provide cover, reduce sediment and nutrient delivery, and provide channel roughness during flood events. Generally, wider riparian buffers provide more benefits; buffers should be at least 100 ft. wider than the stream's belt width (50 ft. on each side of belt width). The information provided in this practice focuses on the functions of bank stability and erosion resistance provided by riparian buffers. Riparian buffers provide several functions in addition to bank stability related to chemical and biological functions; those functions are not covered in depth in this guide. A general graphical overview of riparian buffering is provided in Drawing 1 and Drawing 2.

The *River Restoration Toolbox Practice Guide 3: Riparian Buffers* (Practice Guide) has been developed to assist with the presentation of design and construction information for stream restoration in Iowa. It is intended to provide guidance to:

- Those responsible for reviewing and implementing stream restoration,
- Professionals responsible for the design of stream restoration projects,
- Others involved in stream restoration at various levels who may find the information useful as a technical reference to define and illustrate riparian buffers.

The information in the Practice Guide is intended to inform practitioners and others, and define typical information required by the State of Iowa to be included with the use of riparian buffers. The information and drawings are not meant to represent a standard design method for any type of technique and shall not be used as such. The Practice Guide neither replaces the need for site-specific engineering and/or landscape designs, nor precludes the use of information not included herein.

The Practice Guide may be updated and revised to reflect up-to-date engineering, science, and other information applicable to Iowa streams and rivers.

1.0 INTRODUCTION

Riparian buffers are strips of vegetated land adjacent to a body of water (e.g., stream, lake, wetland, etc.). They serve important stream functions including sediment trapping, nutrient cycling, stream shading, energy dissipation, natural moderation of floods, bank stability, natural wetland development, and delivery of organic matter to aquatic systems (Iowa DNR 2015).

Stream buffers can slow flood flows, eliminating surface erosion and allowing water to infiltrate the soil and recharge ground water supplies (NRCS and Wildlife Habitat Council 2007). The slowing of surface water also allows for nutrient uptake by riparian vegetation and degradation of pesticides (Bongard and Wyatt 2010), keeping these pollutants out of sensitive aquatic ecosystems. Vegetation also reduces sediment inputs to the stream both by filtering sediment from overland flow and catching sediment during flood events that would otherwise end up in the channel downstream (NRCS and Wildlife Habitat Council 2007). A forested stream buffer provides shade which contributes toward cooler water temperatures critical for fish and other aquatic species, particularly trout. Trees also provide woody habitat for aquatic species and shade reduces primary productivity thereby diminishing nuisance overgrowth of algae (Morgan et al. 2006).

The benefits of stream buffers include not only ecological benefits but community benefits as well. Stable streams surrounded by intact riparian buffers enhance aesthetics and recreational activity opportunities such as swimming, boating, and angling; local communities can benefit economically from these opportunities.

Riparian buffering techniques include preservation as well as implementing physical augmentation (e.g., restoration/establishment and enhancement) of the buffer to improve water quality and/or ecosystem function. All techniques should strive to mimic the native composition, density, and structure of fully functional stream buffers situated within the same watershed. When developing a riparian buffer plan, resource professionals should consider stream size, stream slope, drainage area, need for filtering runoff, stability of the stream, life history requirements of resident species, potential for stream bank erosion, longitudinal and horizontal migration, and floodplain interaction frequency.

In most cases, stream buffer projects are not intended to stand alone as a restoration project; rather they should be included as a ***component*** of a comprehensive stream restoration plan designed by a professional. Streams that are recognizably unstable, entrenched, incised, or otherwise disconnected from their floodplains, and which require extensive stream bed and/or bank restoration necessitate a restoration plan including techniques that address the processes causing instability. Under some circumstances, if stream restoration is not possible, it may be appropriate to establish a buffer to accommodate anticipated adjustments in the stream’s dimension, pattern, and profile caused by continued stream instability and other watershed changes.

However, riparian buffering can be as simple as implementing relatively inexpensive revegetation activities and in these cases, requires little to no training to implement. Such activities are a good option for landowners.

The guidelines and specifications provided in this document are general and not a comprehensive design manual. It is the responsibility of the designer to understand the design approach and the feasibility of using riparian buffering techniques on a case-by-case basis. The following criteria in no way replaces design discretion, experience, and training, and cannot incorporate every scenario. They are intended to flag common errors, promote empirically stable design ranges, assist designers and reviewers in communication, and adapt tested designs to Iowa conditions.

2.0 BUFFER WIDTH

There is not a one-size-fits-all riparian buffer width; local conditions such stream size, geomorphology, local land use, native riparian plants and animals, and landowners' expectations must be examined. A buffer width intended to meet the objectives of the stream restoration project (e.g., stream bank stability, water quality, habitat, etc.) should be a minimum starting point; buffer width may require expansion to provide other benefits provided by riparian ecosystems. In Iowa, riparian buffers should be wide enough to encompass the stream's belt width with a minimum of 50 additional feet on each side of the belt width to provide buffering of the outsides of meander bends at the edges of the belt width. Smaller buffer widths may be appropriate on a case-by-case basis for small streams; consideration of reduced buffer width should be based on issues related to construction constraints, land ownership, and land use activities.

2.1 BUFFER WIDTH RELATIONSHIP TO GEOMORPHOLOGY

Encroachment on channels (e.g., from soil fill, buildings, farm fields, clearing vegetation, etc.) can cause instability, affect a stream's lateral containment (confinement), and result in channel enlargement, lateral accretion, stream bank erosion, and sediment transport problems (Rosgen 2006). The presence of a vegetated buffer adjacent to a stream reduces the potential for encroachments, thus reducing the potential for instability. Stable streams exist in a state of dynamic equilibrium and may naturally adjust their lateral and vertical positions over time; riparian buffers should be wide enough to accommodate these movements to ensure protection of the stream.

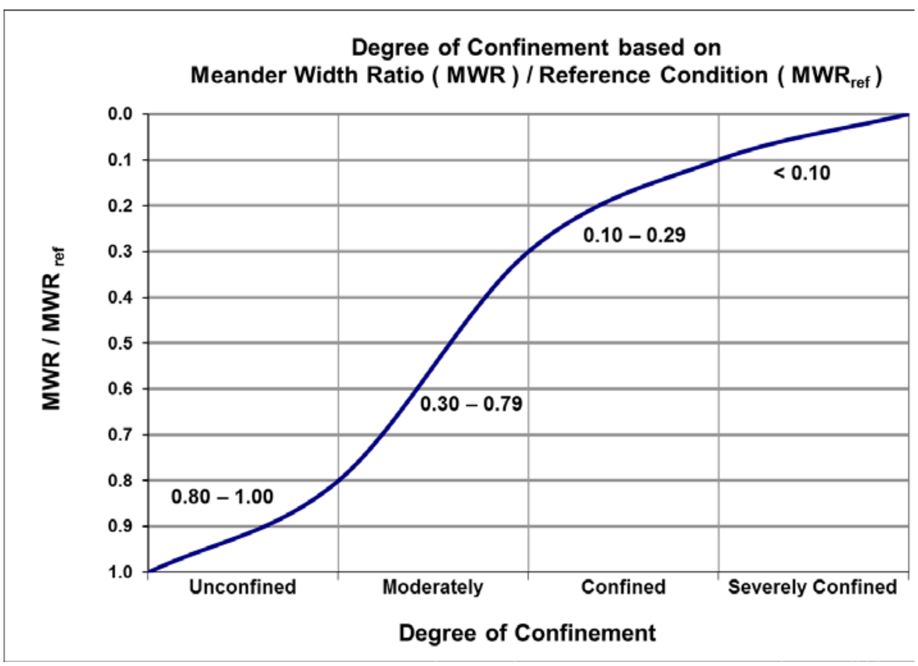
Lateral containment, also called confinement, is quantified by the Meander Width Ratio (MWR), which is defined as the belt width of the channel divided by the bankfull width of the channel (see Drawing 1). Some aspects of stream stability can be predicted by examining MWR. For example, the EPA's Stream Function Pyramid (Harman et al. 2012) – Geomorphology Performance Standard for a Rosgen C or E stream type is "Functioning" if MWR ≥ 3.5. This ratio is an absolute minimum however, and in certain settings a MWR between 4 and 40 is required to maintain geomorphic stability. Table 1 presents MWR for all Rosgen stream types.

Table 1. MWR by Stream Type (Rosgen 1996)

Rosgen Stream Type	Average MWR	MWR Range
A	1.5	1-3
D	1.1	1-2
B and G	3.7	2-8
F	5.3	2-10
C	11.4	4-20
E	24.2	20-40

The potential for instability resulting from the stream being too confined can often be prevented when the stream can meander freely in a riparian buffer at least as wide as the stream's average belt width (i.e., average MWR x bankfull width). This guidance is not applicable in every scenario and the minimum required MWR may need to differ from the average MWR; thus, each stream should be examined against the characteristics of stable reference conditions. In Watershed Assessment of River Stability and Sediment Supply (WARSSS, Rosgen 2006) degree of lateral confinement is expressed as the stream's MWR divided by the MWR of a reference reach/condition (see Figure 1); streams are considered confined when the degree of confinement is less than 0.30 (i.e., $MWR/MWR_{ref} < 0.3$).

Figure 1. Degree of Confinement as Function of MWR



2.2 OTHER BUFFER WIDTH RELATIONSHIPS

Studies addressing the effectiveness of buffers of various widths show, in general, wider buffers provide more water quality improvements and habitat value (NCIRT 2010). The relationship is not linear however; the increased benefits of wider buffers tend to increase at a slower rate once the buffer width exceeds 50 feet (NC Division of Water Quality 2007).

The USDA's Conservation Buffers website (www.bufferguidelines.net) offers resources for planning and designing buffers in rural and urban landscapes, including *Conservation Buffers: Design Guidelines for Buffers, Corridors, and Greenways* which provides illustrated design guidelines developed from extensive literature review. A variety of goals are considered as they relate to the characteristics of vegetated stream buffers, including buffer width. Goals include soil protection, air and water quality improvement, fish and other wildlife habitat, economic product production, recreation, and beautification.

3.0 BUFFER ZONES

Riparian buffers will function best when they include multiple zones relating to the hydrology and hydraulics of the stream, vegetation, and valley topography. Riparian buffers equaling at least the stable belt width of the stream plus an additional 50 feet on each side are likely to provide the greatest physical, hydrological, biological, and chemical benefits to the stream. Additional efforts to protect land and establish regionally-appropriate native vegetation within the broad floodplain and even on steeper valley sides can provide additional benefits to the stream. When possible, buffer vegetation should be perennial in order to optimize the bank stabilizing and erosion-resistance functions. See below drawings for the illustrated representation of these zones.

- **Near-Stream Zone (Belt Width):** The near-stream zone is located adjacent to the stream. This zone is the belt width, the corridor where the stream flows measured between the outsides of opposing meander bends. This zone may be shifted to one side of the stream when a valley side restricts the stream corridor.

- **Broad Floodplain Zone:** The broad floodplain zone is located between the near-stream zone and the valley sides; it is a low terrace that is sometimes flooded. If floodplain data are available, the area below the 500-year flood elevation may be considered part of this zone.

- **Valley Side Zone:** The valley walls are located outside of the floodplain as determined by a distinct break in slope in the valley profile. The valley side zone is characterized by steeper slopes than in the other zones.

4.0 BUFFER VEGETATION

A mixture of woody and herbaceous vegetation that incorporates a variety of native perennial species is ideal for a riparian buffer to provide streambank stability and other riparian functions. Vegetation can provide both mechanical stability through soil reinforcement and hydrologic stability through the reduction of soil moisture content. Riparian systems in Iowa are divided into four plant zones corresponding to elevations along the stream bank profile - water's edge, bankfull, side slope, and top of bank (Iowa DNR 2015). All four planting zones may occur in the near-stream buffer zone or they may be spread throughout the near-stream, broad floodplain, and valley side buffer zones. The Iowa Riverside Plant Selection (rev. 12/15/2016) should be consulted, along with River Restoration Toolbox Practice Guide 2: Vegetative Restoration, to aid in selecting plants and planting methods for use in riparian buffers.

Riparian buffer vegetation should be adapted to the specific hydrologic conditions in both the buffer zone(s) and planting zones and be designed to perform specific ecological functions. The streambanks typically consist of the water's edge and bankfull zones; often the side slope planting zone is also considered part of the stream bank. Stream bank vegetation should consist of water tolerant species and is primarily responsible for streambank stability. Ideally, riparian vegetation will mostly consist of native perennial, deep-rooted plants, such as trees. Trees can provide important shade, recruitment of woody habitat into streams, leaf litter and large roots to stabilize the bank. In prairie ecosystems, however, trees may not be part of the natural riparian system. In these systems, native riparian prairie grass and forb species, especially species with dense, vertically-distributed root systems, will be better suited. However, it is still common in these systems to find occasional riparian trees and shrubs such as willow and cottonwood. Vegetation on the stream banks functions best at maturity and should not be disturbed.

Vegetation in the top of bank planting zone is adjacent to and up-gradient from the stream banks. Top of bank vegetation can consist of trees, shrubs, vines, forbs, rushes, sedges, or grasses, designed to catch surface runoff and increase infiltration (NRCS 2007). Vegetated stream buffers provide a wealth of habitat for wildlife; the larger the riparian area the more wildlife species expected to benefit (Bongard and Wyatt 2010).

5.0 BUFFER SHAPES

Riparian buffers are not required to be uniformly wide and run parallel to the stream bank. Buffer width can be measured perpendicular to flow, usually from the top of bank on each side of the stream. Strict adherence to this method of establishing buffer width can result in an irregularly-shaped buffer that meanders with the stream across the valley. Irregular buffers can be difficult to survey and manage; as the channel meanders the buffer boundary changes direction (bearing) as well.

Another option is to measure the buffer width across the entire corridor (belt width plus additional buffer at outsides of meander bends). This creates a straighter, more uniform-width buffer; the stream meanders back and forth within the buffer boundary. In this case care should be taken to ensure that a minimum width is maintained as a buffer along the outside of each meander bend.

6.0 RIPARIAN BUFFER TECHNIQUES

Riparian buffering techniques include preservation of land and vegetation, as well as preservation of land and implementing physical augmentation of vegetation. The techniques differ based how much existing vegetation is maintained and how much new vegetation is installed. More than one technique may be used; for example, existing native vegetation adjacent to the channel may be preserved and additional riparian vegetation may be planted to establish the desired buffer width. All riparian buffer techniques should have a minimum width equal to the stream's belt width plus an additional 50 feet on each side of the belt width.

6.1 RESTORATION/ESTABLISHMENT

Riparian buffer restoration/establishment includes removal of undesirable vegetation and installation of regionally-appropriate native vegetation in >50% of the buffer area.

Mature riparian buffers are better at resisting bank erosion than newly planted buffers, (Simon and Collison 2002; Zaimes et al. 2004). Newly established/restored buffers need to incorporate additional width to accommodate predicted channel migration and stream bank erosion while the vegetation matures (Abernethy and Rutherfurd 1999; Wenger 1999; U.S. Forest Service 2008).

6.2 ENHANCEMENT

Riparian buffer enhancement includes removal of undesirable vegetation and installation of regionally-appropriate native vegetation in 10-50% of the buffer area.

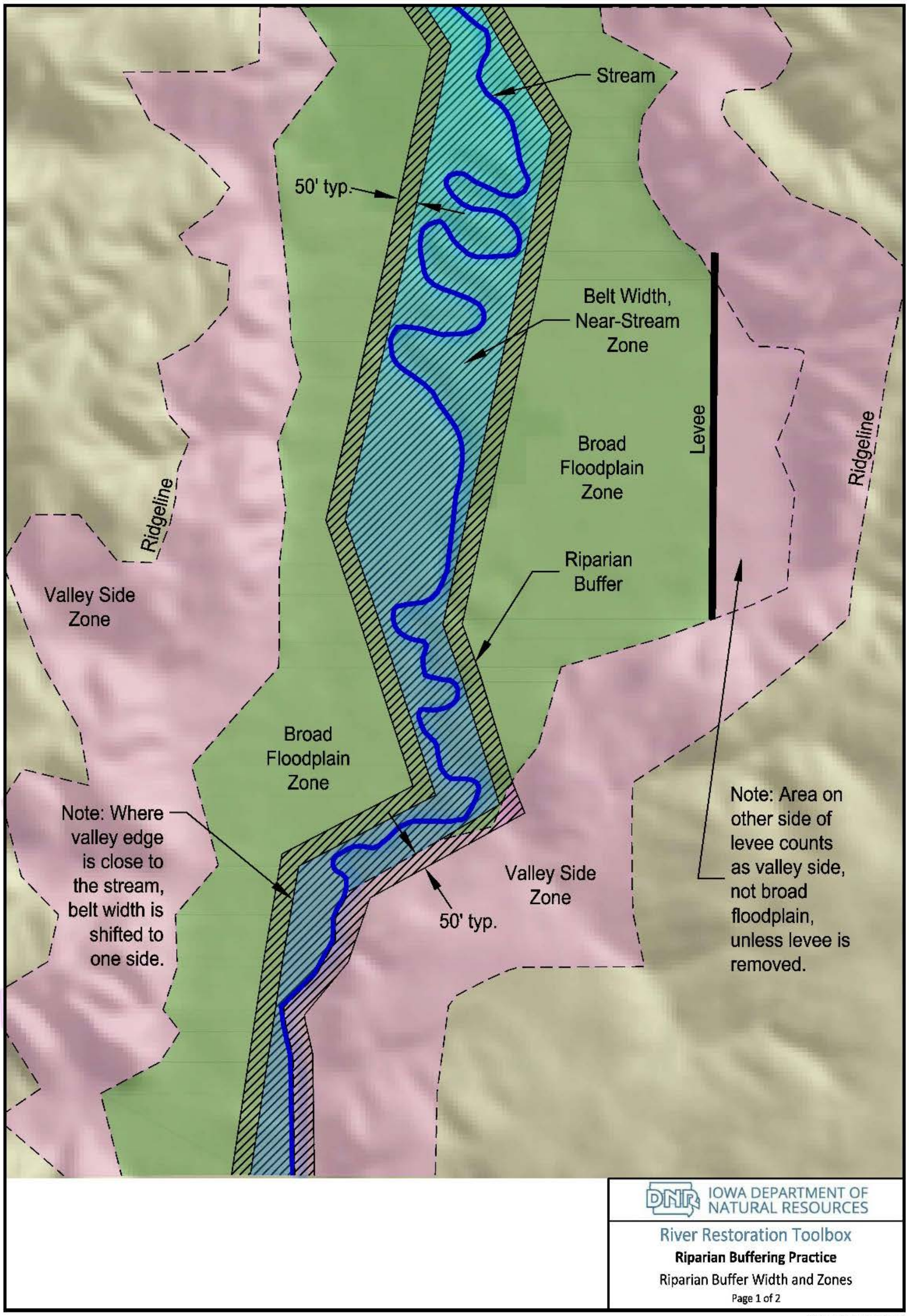
6.3 PRESERVATION

Riparian buffer preservation includes the conservation of the riparian area in its naturally-occurring or present condition to prevent its destruction, degradation, or alteration to prevent the decline of functions within the stream it is buffering. An area will be considered as riparian buffer preservation if <u>less than 10%</u> of the area would require planting of vegetation to maintain important aquatic resource functions.

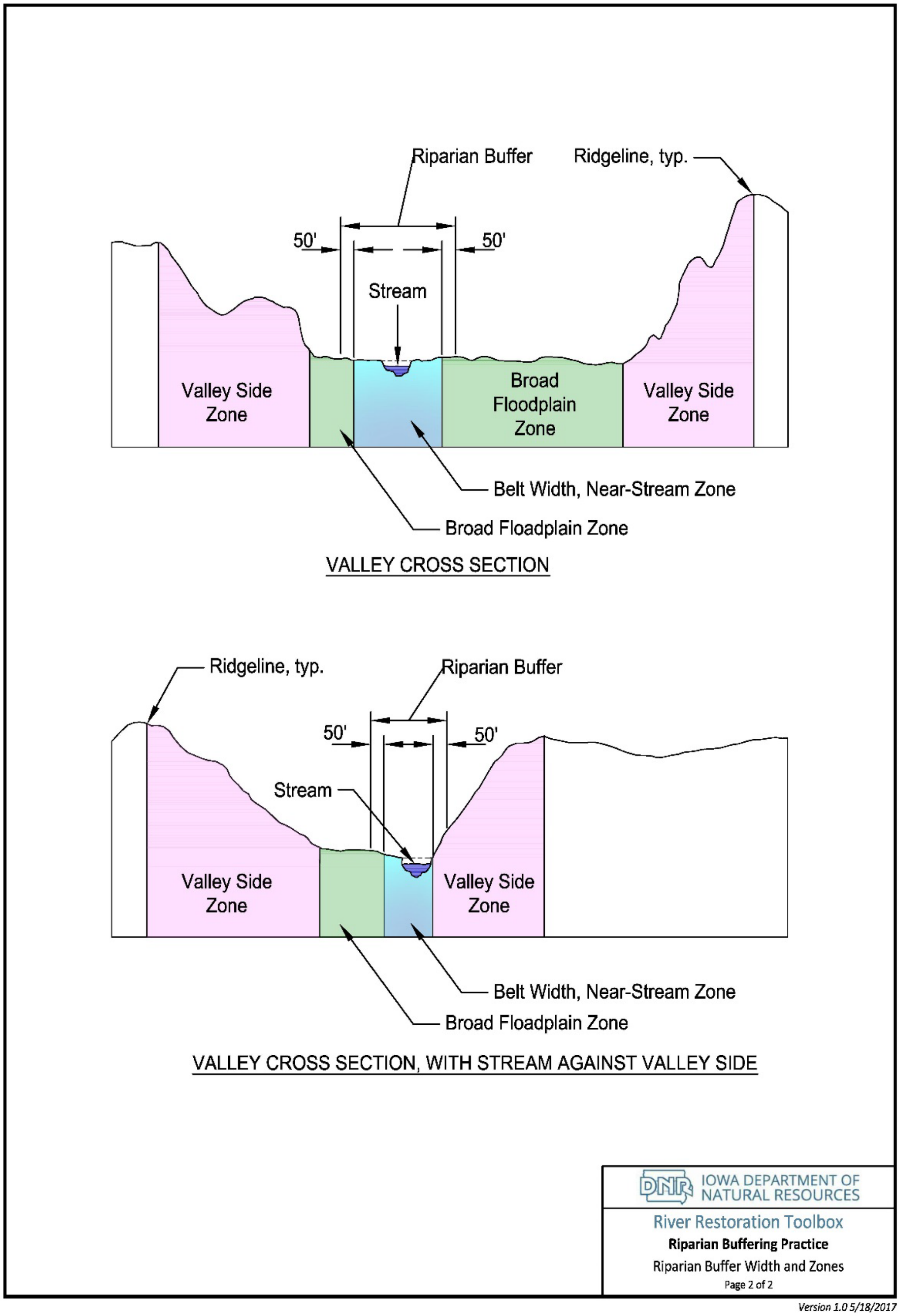
6.4 RIPARIAN BUFFER ILLUSTRATIONS

The following drawing illustrates riparian buffer width and zones.

Drawing 1. Riparian Buffering



Drawing 2. Riparian Buffering (continued)



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