TECHNICAL NOTE

USDA-Natural Resources Conservation Service
Boise, Idaho

PLANT MATERIALS TN NO. 5 **JUNE 2007**

RIPARIAN BUFFER DESIGN

AND SPECIES CONSIDERATIONS

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The purpose of this technical note is to provide information on design and implementation of riparian buffers to improve water quality on Winter Feeding Operations (WFO) and Winter Pasture Operations (WPO). This technology is very effective at minimizing water quality impacts and improving and providing wildlife habitat. This technology is not considered "zero discharge" and is therefore not applicable for Animal Feeding Operations (AFO) or Confined Animal Feeding Operations (CAFO).

A riparian buffer is land adjacent to streams, lakes and wetlands that is predominantly perennial vegetation (grasses, grass-like plants, forbs, shrubs and/or trees) and managed to enhance and protect aquatic resources from adverse impacts of agricultural practices.

This practice is partially covered under the following NRCS Standards

- **393 Filter Strip**
- **390 Riparian Herbaceous Cover**
- **391 Riparian Forest Buffer**

Riparian buffers are partially used to assist with the following purposes that will be covered under this technical note and design information:

- Assist with stabilization of eroding streambanks
- Filter sediment and organic material from agricultural runoff
- Filter nutrients, pesticides, other chemicals and animal waste from agricultural runoff
- Provide wildlife habitat and establish wildlife corridors

Other purposes from Standards not discussed in this document include:

- Create shade to maintain or water temperatures to improve habitat for aquatic organisms
- Provide a source of detritus and large woody debris for aquatic and terrestrial organisms
- Produce a timber, fiber, forage, fruit, or other crop consistent with other intended purposes
- Provide protection against scour erosion within the floodplain
- Restore natural riparian plant communities
- Moderate winter temperatures to reduce freezing of aquatic over-wintering habitats
- To increase carbon storage

Stabilize Eroding Streambanks

Buffers can be effective in stabilizing eroding streambanks on small (low order) streams. Vegetation in the buffer will minimize the high velocity and erosive forces of flowing water and wave action. Species with deep fibrous root systems are recommended for this purpose. Vegetation located within 25 ft of the stream channel aid in riparian and streambank stabilization. The effectiveness of a buffer at stabilizing eroding streambanks will begin to diminish with increasing stream order. Buffers will be ineffective at stabilizing eroding streambanks on large unstable streams with high stream velocities and severe bank erosion. Structural measures may be needed on streams with velocities above 8 ft per second (fps) and where severe bank erosion is occurring.

Filter Sediment from Agricultural Runoff

Buffers are very effective at filtering larger sediments and crop residue. Properly designed riparian buffers can filter up to 90% of sediment carried by runoff. Reductions of 40 to 70% in soil sediments reaching surface water are typical. Vegetation and organic litter slow the velocity of runoff to allow sediments and larger particles to settle out of the flow. Some fine sediment will also be removed due to the higher infiltration rate of the undisturbed soil in the buffer, but because fine sediments fall out very slowly in the water column, it is not an efficient method of removal. Roots will stabilize the trapped sediment and hold the new soil in place. Buffers with higher plant diversity including grasses, grass-like plants, forbs and shrubs do a better job of filtering sediments compared to buffers composed of only grasses. Diverse plant community buffer strips also tend to have a longer sediment trapping life span.

Filter Nutrients, Pesticides, and Animal Waste from Agricultural Land Runoff
Buffers are very effective at removing particulate wastes and sediment-attached microbes, nutrients, and pesticides through immobilizing, storing, and transforming chemical inputs from upland runoff. Treatment of nutrients through buffers is achieved by a combination of the following:

- Sediment deposition
- Infiltration
- Dilution by incoming rainfall
- Adsorption / desorption reaction with buffer soil and litter
- Nutrient uptake by vegetation

Studies show that concentrations of pollutants treated with a buffer were reduced by a factor of three or four in most cases (Palone and Todd 1998). Nearly 90% of inorganic phosphorus is carried to streams attached to soil particles or organic matter. Therefore reducing sediment transport will reduce inorganic phosphorus loads. Because the majority of inorganic phosphorus is adsorbed onto finer fractions of soil and it takes long periods of time for fine sediments to drop out of the runoff, inorganic phosphorus is usually reduced by a factor of one and a half to two after treatment by a buffer. A buffer's ability to retain dissolved phosphorus, especially under high loading conditions is limited.

Riparian forests buffers will reduce nitrogen by 40 to 100% and grass buffers will reduce nitrogen by 10- 60% (Schuetz et.al. 1994). If shallow groundwater is present below the buffer, soluble contaminants may be removed before the water enters the water table. Buffers are generally less effective at treating pesticides. However, excellent nitrate removal can be achieved from shallow groundwater when wetland plant roots make contact with it. Studies have shown winter nitrate removal at sites where the vegetation is deciduous forest. Groundwater passing through the buffer may be cleansed of nitrate and acidity due to a combination of denitrification, biostorage and changes in soil composition. Grass and dense vegetation are more effective at trapping particulates from runoff, but woody vegetation is a necessary component for removing soluble nutrients.

Provide Wildlife Habitat and Establish Wildlife Corridors

Buffers placed along small first and second order streams will provide shade and habitat. Leaf foliage shades water and helps maintain or reduce the temperature of the stream. Plant litter and insects supply food for fish, while perennial vegetation supplies diversity of cover and food for wildlife. Larger plant debris and root systems also provide shelter for fish. However, the effectiveness of the buffer to meet these goals minimizes as the surface water increases in size.

Buffer Components
Buffers can be designed as grass filters, forest buffers, or a combination of both based on the treatment desired and the site considerations. A brief discussion on the main components of a buffer and the benefits associated with each component follows.

Trees (Planted Next to the Surface Water)
Primary purpose is to stabilize streambanks and provide habitat for aquatic organisms as well as terrestrial species. Trees aid in filtering surface runoff and, in some landscapes, can help remove nutrients carried to the groundwater.

Trees, Grasses, Grass-like plants, Forbs and Shrubs
The primary function of the trees, grasses, grass-like plants, forbs and shrubs is to remove, transform, or store nutrients, sediments and other pollutants flowing over the surface and through to the groundwater. Buffers help remove surface borne pollutants. Debris from the trees slows and traps sediments in the runoff, giving the nutrients time to infiltrate into the ground where they may be stored or removed or utilized by vegetation. Studies have found that buffers can remove 50- 80% of the sediment in runoff from upland fields. Microbes in the soil can uptake, store and/or breakdown nutrients. Denitrification can also take place under the proper conditions by microbial populations found in the root zones of many wetland and riparian plants.

Grass Filter Strips
Grass filter strips slow runoff, filter sediment and its associated nutrients and chemicals, allow plant water and nutrient uptake, and encourage water to infiltrate into the ground. Effective sediment trapping requires that runoff entering the buffer be in the form of sheet flow. Several studies show that grass filter strips are highly effective at reducing sediment runoff, with removal rates of 50% or more. Also, the filter strips are highly effective at removing sediment-bound nutrients such as phosphorus, but less effective at removing dissolved nutrients. Periodic maintenance may be required to remove sediment, reestablish vegetation, and remove channels.

Design Considerations
Narrow buffers may be adequate when the stream system is small, the riparian area is in good condition, the resource risk to surface water is low, and/or the desired buffer functions are few. Conversely, wider buffers are necessary when the stream system is larger, the buffer quality is poor, resource risk to surface water is great and multiple buffer functions are desired.

Buffers have the greatest potential to improve water quality when adjacent to low-order streams. However, the importance of the buffer in floodwater detention and storage will increase with stream order.

Soil characteristics are important in determining potential for removal of nitrogen and pollutants carried by sediment such as phosphorus and some pesticides. Primary considerations are soil texture, depth to water table, and organic matter content of soils.

The following table indicates factors that will affect the effectiveness of a buffer strip.

Factors that Enhance Effectiveness	Factors that Reduce Effectiveness
Slopes less than 5 percent	Slopes greater than 5 percent
Contributing flow length < 150 ft	Contributing flow length over 300 ft
Seeps, high water table - subsurface flow	Flow path to deep or regional groundwater
Permeable, but not highly sandy soils	Compacted soils
Level spreaders or flow dispersal	Concentrated flow
Organic matter, humus, or mulch layer	Snowmelt, ice conditions, low organic soil
Entry runoff velocity less than 1.5 fps	Entry runoff velocity more than 5 fps
Routine maintenance	Sediment buildup at entrance
Poorly-drained soils, deep roots	Shallow root system
Forest and dense grass cover (6 in)	Tall bunch grass; Sparse vegetative cover

*Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers

Upland conditions will determine sediment loading on the buffer. The following table indicates possible sediment loads based on watershed characteristics.

Relative Loading from Upland Sources According to Upland Conditions			
Site Condition	Low Loading	Medium Loading	High Loading
Upland Loading	<1,000 lbs. sediment/acre	1,000 - 10,000 lbs. sediment/acre	>10,000 lbs. sediment/acre
Upland Slope Length	<150 ft	150-300 ft	<300 ft
Upland Slope Percent	1-5 percent	5-15 percent	>15 percent
Upland Soil Credibility	K<0.22	K=0.22-0.36	K<0.36
Upland Cover	Forest or hayfields	Pastures	Cultivated crops
Upland Practice	No-till or no earth disturbance	Till-plant, strip and contour cropping	Conventional plowing, not along contour

*Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers

At acceptable loading rates (generally where sediment delivery is less than 5,000 pounds per acre), the outermost area of the buffer should be planted in grasses or mixtures that can be mowed or harvested to allow for periodic removal or smoothing of accumulated sediments. Where loading rates are low enough such that routine sediment removal is not required (generally below 1,000 pounds per acre), herbaceous forbs and shrubs could be included.

A sustainable width is essential for buffers to minimize water quality impacts from adjacent land use. Buffers of less than 50 ft have proven difficult to maintain as effective filters in the field, except on small drainages. Very narrow buffer strips of 15 to 25 ft are generally inadequate for sediment or nutrient reductions, except on small streams. Buffers of less than 35 ft cannot sustain long-term protection of water quality. Cropped or grass vegetated filter strips have also been shown to trap sediment effectively at a width of roughly 25 ft if located on slopes less that 16%. Narrow forest strips may provide soil and bank stability, but may not accumulate organic matter and provide the water storage necessary for nitrogen removal. Larger buffer widths are likely to provide more physical, chemical, and biological protection of surface water.

Slope has the greatest influence over sediment removal and is a factor in the rate and deliver of water flow. It is recommended that a 50 ft buffer width be used on slopes less than 6%. Buffer width is increased by 4 ft for each percent of slope over 6%.

Concentrated Channelized Flow

The efficiency of a buffer at removing sediment is directly correlated to runoff water entering the buffer in sheet flow verses concentrated flow. Channelized flows are likely to form when the slope length is over 250 ft, the upland slope is over 10% and the landform is concave. An engineered biofiltration swale is one tool that can be used to disperse concentration flow. Engineered swales intercept the channelized flows from the upslope areas and direct them parallel to the riparian corridor. They are typically 15 to 25 ft wide and 1 to 2 ft deep, located at the beginning of the buffer. Biofiltration swales have been shown to reduce sediment delivery up to 80%. Biofiltration swales are designed so that the flow depth is very shallow, less than two-thirds the height of the grass (typically 6 in), resulting in a flow velocity of less than 2 ft per second (fps). NRCS TR-55, Urban Hydrology for Small Watersheds, can be used to calculate the runoff for the 2- year 24- hour design flow. The one hundred year flood event should also be determined to ensure that the banks of the swale are not overtopped. Where calculations indicate that peak flow velocities will exceed 2 fps, check dams should be installed. Where peak velocities over 5 fps are projected, check dams should be installed in intervals so that the ponded water extends up to the base of the upstream check dam. The discharge channel through the buffer to the receiving stream should be stabilized with geotextiles or riprap to minimize erosion. A level lip spreader can also be used to redirect runoff into sheet flow. Level lip spreaders can cause sediments to settle immediately upstream and require maintenance to operate effectively.

Operation and Maintenance

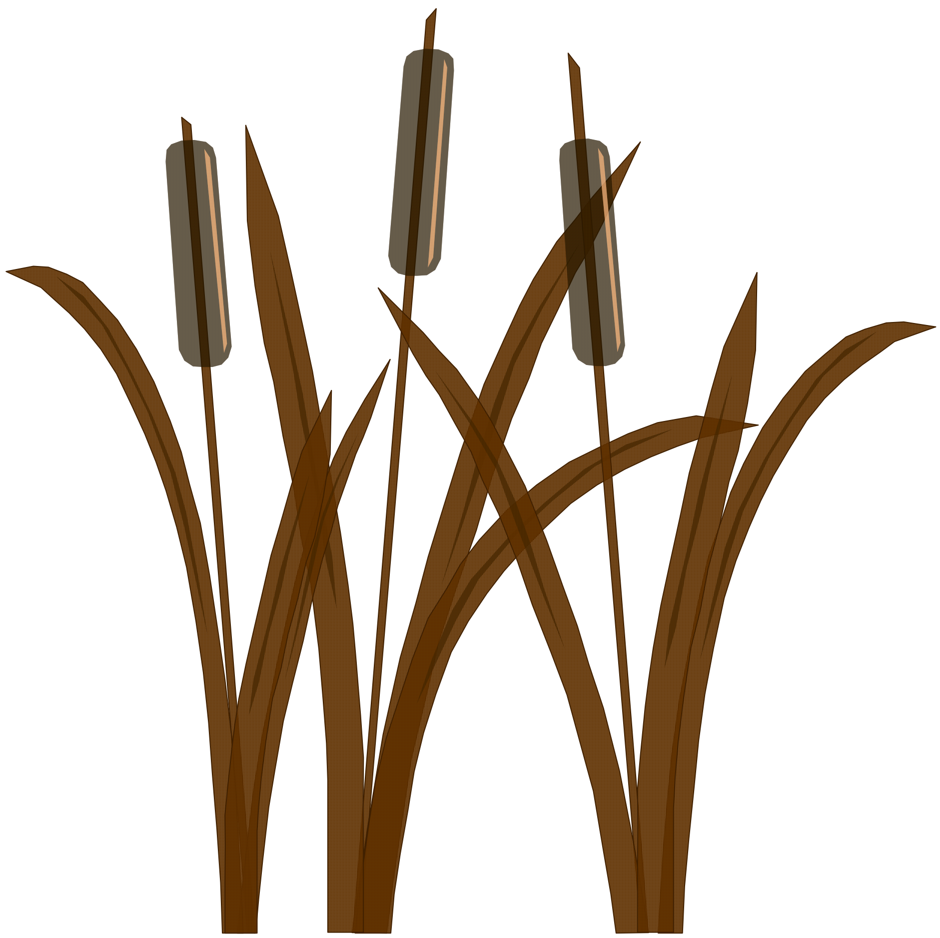
Concentrated channel flow can destroy the continuity of the buffer. Some method to eliminate channelized flow must be provided to ensure sheet flow conditions. Sediment accumulation along the edges of the buffer will have to be removed and areas of concentrated flow will have to be modified. Periodic harvesting of vegetation may be required where nutrient loads are high in order to remove the nutrients it contains, maintain plant growth, and promote nutrient uptake.

Appendix A

Biofiltration Systems

Vegetal Retardance Cover Type

(Vegetation Condition/Height/Slope)



APPENDIX A: Biofiltration Systems - Vegetal Retardance Cover Type (Vegetation Condition/Height/Slope)

Species listed are primarily introduced species noted for good to excellent erosion control traits.

Vegetal Retardance / n[1]		**Cover**	**Average Condition/Height[3]/Slope**
A /	0.170[1] .37-.06[2]	Reed Canarygrass[5] Creeping Foxtail	Excellent/20-36"+ /5-10%
B /	0.098[1] .31-.04[2]	Smooth Bromegrass[5] Reed Canarygrass[5] Tall Fescue Grass-Legume-Forb Mixture Timothy[4]/Brome/Orchardgrass[4]/ Tall Fescue/Tall Wheatgrass/ Alfalfa[4]/Forbs	Good / 12-20" /5-10%
C /	0.057[1] .27-.032[2]	Redtop Smooth Bromegrass[5] Intermediate Wheatgrass Pubescent Wheatgrass Western Wheatgrass Grass-Legume-Forb Mixtures Bromegrass, Orchardgrass[4]/ Sod or Bunch Wheatgrasses[4]/ Alfalfa[4]/Forbs	Good / 6-15" / < 5%
D /	0.046[1] .20-.03[2]	Kentucky bluegrass Red Fescue Grass-Legume-Forb Mixture Sheep Fescue[4]/Hard Fescue[4]/ Bromegrass[5]/Sod or Bunch Wheatgrasses[4]/Alfalfa[4]/Forbs	Good / 2-6" / < 5%
E /	0.030[1] .83-.024[2]	Kentucky Bluegrass	Burned / 0-1" / < 5%

1 n values were selected using Velocity & Hydraulic Radius (VR) Product = 2

2 n values vary according to product velocity and hydraulic radius (low velocity and shallow flows result in higher Mannings "n"; high velocity and deep flows result in lower Mannings "n"). Refer to SCS-TP-61 "Handbook of Channel Design for Soil and Water Conservation" for experimental results of Vegetal Retardance/VR/Mannings "n" relationships.

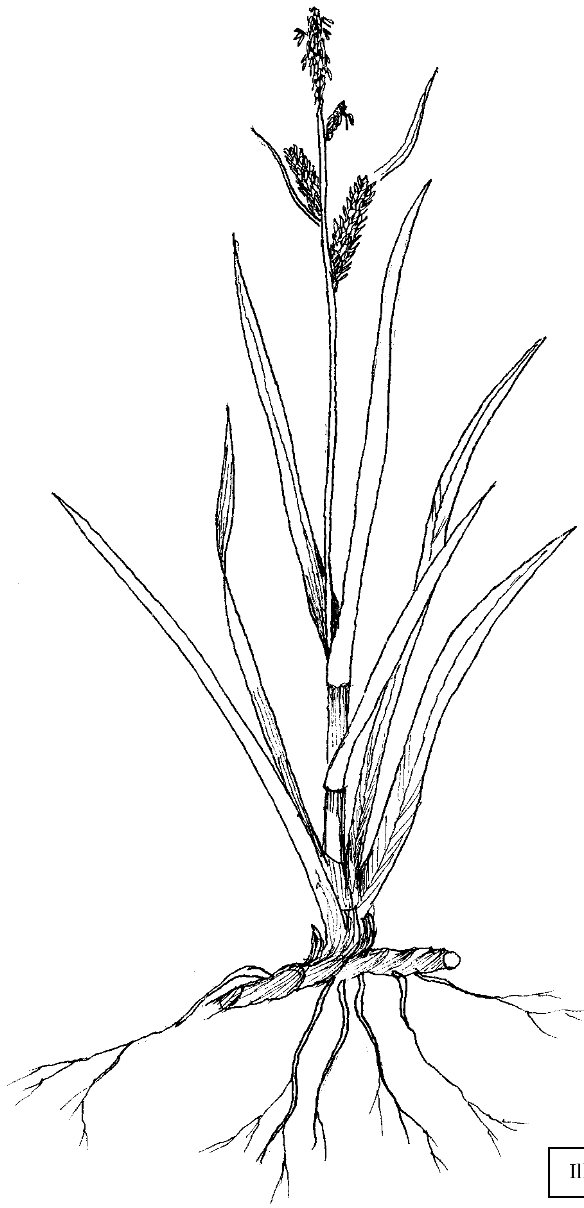
3 During normal critical flow periods, if vegetation has been mowed or flattened due to snow cover, the appropriate vegetal retardance and n value should be used, for example, smooth bromegrass mowed to 4 inch stubble height, use D / 0.046.

4 These are bunchgrasses or bunch type legumes and should be used only in seed mixtures and on slopes less than or equal to 5 percent.

5 Reed canarygrass and smooth bromegrass are commonly found in Northern Idaho, some consider these species to be weedy.

Appendix B

Plant Information Tables



Illustrated by G. Bentrup

HERBACEOUS SPECIES	PLANT ATTRIBUTES					Contour Buffer Strip	Cross Wind Trap Strip	Field Border	Filter Strip	Grass Buffer Strip	Grassed Waterway	Herbaceous Wind Barrier	Riparian Forest Buffer	Riparian Herbaceous Cover	Shallow Water Areas for Wildlife	Streambank/Shoreline Protection	Vegetative Barriers	Winter Grazing and Feed Areas	Wildlife Upland Habitat	342 Seeding Rates PLS LBS/AC ***
GRASSES	GROWTH[1] CHARACTERISTICS	TOLERANCE TO SALINITY[2] PONDING[3]	PRECIPITATION (INCHES)	STEM DIAMETER	CRITICAL AREA SUITABILITY[4]															
Bentgrass, Redtop**	IMBC	L - 1	18+	<1/8”	E						X		X	X	X	X		X		1
Bluegrass, Big	NMBC	L - 4	9-18	1/8 to 1/4”	G			X	X										X	3
Bluegrass, Canada	IMRC	L - 2	18+	1/8-1/4	G	X		X	X	X	X					X				2
Bromegrass, Meadow	IMRC	M - 3	14+	1/8 to 1/4”	G	X		X	X	X	X		X	X				X	X	15
Bromegrass, Smooth*	IMRC	M - 2	14+	1/8 to 1/4”	E	X		X	X	X	X					X	X	X		9
Bromegrass, Mountain**	NMBC	L - 4	16+	1/8 to 1/4”	E								X	X		X			X	15
Fescue, Hard	ISBC	L - 4	14+	<1/8”	G	X		X	X	X	X						X		X	6
Fescue, Red	ISRC	L - 3	18+	<1/8”	G	X		X	X	X	X					X				6
Fescue, Sheep	ISBC	L - 4	10+	<1/8”	G	X		X	X	X	X						X		X	6
Fescue, Tall*	IMBC	H - 2	18+	>1/4”	G	X	X	X	X	X	X	X		X	X	X		X		8
Foxtail, Creeping*	IMRC	M - 1	18+	1/8 to 1/4”	E	X		X	X	X	X		X	X	X	X		X		4
Hairgrass, Tufted	NMBC	L - 2	18+	1/8 to 1/4”	G						X		X	X	X	X				2
Orchardgrass	IMBC	L - 2	18+	>1/4”	G	X		X	X	X	X							X	X	6
Saltgrass, Inland	NMRW	H - 2	15+	1/8 to 1/4”	G			X	X				X	X	X	X	X			4
Timothy	IMBC	L - 2	18+	>1/4”	F	X		X	X	X	X		X	X	X	X		X		4
Wheatgrass, Standard Crested	ISBC	M - 2	9+	<1/8”	G	X		X	X									X	X	8
Wheatgrass, Fairway Crested	ISBC	M - 2	14+	<1/8”	G	X		X	X		X							X	X	8
Wheatgrass, Newhy	IMBC	H - 2	14+	1/8 to 1/4”	F				X		X			X				X		12
Wheatgrass, Intermediate	IMRC	M - 3	12+	>1/4”	G	X	X	X	X	X	X	X					X	X	X	12
Wheatgrass, Pubescent	IMRC	M - 3	12+	>1/4”	G	X	X	X	X	X	X	X					X	X	X	12
Wheatgrass, Siberian	IMBC	M - 3	7+	<1/8”	G	X		X	X		X							X	X	9
Wheatgrass, Slender**	NMBC	H - 3	10+	<1/8”	G				X	X			X	X	X	X			X	9
Wheatgrass, Tall	IMBC	H - 3	12+	>1/4”	G		X	X	X		X	X			X	X	X	X	X	15
Wheatgrass, Streambank & Thickspike	NSRC	M - 3	8+	1/8 to ¼”	F	X		X	X	X	X								X	9
Wheatgrass, Western	NSRC	H - 2	12+	1/8 to 1/4”	E	X		X	X	X	X		X	X	X	X	X	X	X	9
Wildrye, Basin	NTBC	M - 2	10+	>1/4”	F		X	X	X			X	X	X		X		X	X	10
Wildrye, Blue**	NTBC	L - 3	16+	>1/4”	G			X					X	X		X		X	X	7
Wildrye, Mammoth	IMBC	L - 3	7+	>1/4”	F	X	X	X	X	X		X								22
Wildrye, Russian	IMBC	H - 3	8+	>1/4”	G			X	X									X	X	9

1/ N = Native, I = Introduced; Stature T = Tall, M = Mid, S = Short; B = Bunchgrass, R = Rhizomatous; C = Cool season, W = Warm season; 2/ Salinity Tolerance H = High, M = Moderate, L = Low;
3/ 1 = Ponded several weeks, 2 = Ponded only few days on surface, 3 = Water not ponded on surface, 4 = No water table; 4/ E = Excellent, VG = Very Good, G = Good, F = Fair, P = Poor
***These species are prolific spreaders and may cause invasive problems; **Short-Lived - use only for quick establishment - use no more than 15% in mixtures; *** Broadcast rates should be 1.5 times higher. Wildlife – consider species for cover, nesting habitat and/or as a food source.**

HERBACEOUS SPECIES	PLANT ATTRIBUTES					Contour Buffer Strip	Cross Wind Trap Strip	Field Border	Filter Strip	Grass Buffer Strip	Grassed Waterway	Herbaceous Wind Barrier	Riparian Forest Buffer	Riparian Herbaceous Cover	Shallow Water Areas for Wildlife	Streambank/Shoreline Protection	Vegetative Barriers	Winter Grazing AFO/CAFO	Wildlife Upland Habitat	342 Seeding Rates PLS LBS/AC ***
	GROWTH [1] CHARACTERISTICS	TOLERANCE TO SALINITY [2] PONDING [3]	PRECIPITATION (INCHES)	STEM DIAMETER	CRITICAL AREA SUITABILITY [4]															
GRAINS, SMALL																				
Barley	IMBC	H - 3	12+	1/8 to 1/4"	F		X		X			X							X	50
Triticale	IMBC	L - 3	9+	1/8 to 1/4"	G		X		X			X							X	60
Sorghum/Sudan grass	ITBC	M - 3	17+	>1/4"	G		X		X			X							X	25
Wheat	IMBC	L - 3	12+	1/8 to 1/4"	F		X		X			X						X	X	60
LEGUMES/FORBS ****																				
Alfalfa, Crown Type	ITBC	L - 3	9+	1/8 to 1/4"	G			X											X	8
Alfalfa, Creeping Root	IMRC	L - 3	9+	>1/4"	G	X		X	X	X	X								X	8
Burnet, Small	IMRC	L - 4	14+	<1/8"	G	X		X	X	X			X	X				X	X	30
Clover, Alsike	ISBC	L - 2	18+	<1/8"	G	X		X	X	X	X		X	X	X	X			X	5
Clover, Ladino & White	ISRC	L - 2	18+	>1/4"	G	X		X	X	X	X		X	X	X	X			X	5
Clover, Strawberry	ISBC	H - 2	13-20	1/8 to 1/4"	G	X		X	X	X	X		X	X	X	X			X	6
Flax, Blue	IMBC	L - 4	10+	1/8 to 1/4"	F			X		X									X	6
Flax, Lewis	NMBC	L - 4	10+	1/8 to 1/4"	F			X		X									X	6
Kochia, Forage	IMBC	M - 4	7+	1/8 to 1/4"	F		X	X										X	X	1
Milkvetch, Cicer	ISRC	M - 3	15+	1/8 to 1/4"	F	X		X	X	X			X	X	X	X		X	X	10
Penstemon, Firecracker	NMBC	L - 4	10+	>1/4"	F			X		X									X	6
Penstemon, Rocky Mountain	NMBC	L - 4	18+	>1/4"	F			X		X									X	6
Penstemon, Venus	NMBC	L - 4	16+	>1/4"	F			X		X									X	3
Sainfoin	IMBC	L - 3	18+	>1/4"	F			X											X	35
Sweetclover, Yellow/White **	IMBC	M - 4	9+	>1/4"	G	X	X			X									X	6
Sunflower, Little	NMBC	H - 4	12+	>1/4"	F		X	X											X	20
Trefoil, Birdsfoot	IMBC	L - 2	18+	>1/4"	G	X		X		X									X	7

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3/ 1 = Ponded several weeks, 2 = Ponded only few days on surface, 3 = Water not ponded on surface, 4 = No water table; 4/ E = Excellent, VG = Very Good, G = Good, F = Fair, P = Poor
*These species are prolific spreaders and may cause invasive problems; **Short-Lived – use only for quick establishment - use no more than 15% in mixtures; *** Broadcast rates should be 1.5 times higher;
**** Legumes and forbs should be used in seed mixtures only and should comprise no more than 15 percent of mixture. Wildlife – consider species for cover, nesting habitat and/or as a food source.

SHRUBS - TREES	PLANT ATTRIBUTES					Root Type	Root From Cuttings	Deposition Tolerance	Flood Tolerance	Salinity Tolerance	Drought Tolerance	Riparian Forest Buffer	Shallow Water Areas for Wildlife	Streambank/Shoreline Protection	Vegetative Barriers	Winter Grazing	Wildlife Upland Habitat	Commercially Available
COMMON NAME	SCIENTIFIC NAME	SIZE - FORM	ELEVATION RANGE	RIPARIAN ZONE	PLANT INDICATOR STATUS													
Alder, Red	Alnus rubra	Sm. Tree	Mid - High	3, 4	FAC	SS	P	M	M	L	L	X		X			X	X
Alder, Sitka	Alnus viridis ssp. sinuata	Sm. Tree	Mid - High	2, 3	FACW	SS	P	M	M	L	L	X		X			X	X
Alder, Thinleaf	Alnus incana spp. tenuifolia	Sm. Tree	Mid – High	2, 3	FACW	SS	P	M	M	L	L	X		X			X	X
Aspen, Quaking	Populus tremuloides	Med. Tree	Mid - High	4	FAC	S	P	L	L	L	M					X	X	X
Birch, Water	Betula occidentalis	Sm. Tree	Mid - High	2, 3	FACW	DS	P	M	M	L	L	X		X			X	X
Boxelder	Acer negundo	Med. Tree	Low – Mid	4	FAC	MS	P	H	H	H	H	X	X	X			X	X
Buffaloberry, Silver	Shepherdia argentea	Lg. Shrub	Low - Mid	3, 4	FACU	R	P	M	M	H	H	X		X	X	X	X	X
Cinquefoil, Shrubby	Dasiphora floribunda	Sm. Shrub	Low – Mid	3, 4	FACW	SS	P	L	H	L	H		X				X	X
Chokecherry	Prunus virginiana	Med. Shrub	Low – Mid	4	FACU	R	G	L	L	L	M			X			X	X
Cottonwood, Black	Populus trichocarpa	Lg. Tree	Low – Mid	4	FACW	SF	VG	H	H	L	M	X		X		X	X	X
Cottonwood, Fremont	Populus fremontii	Lg. Tree	Low – Mid	4	FACW	SF	VG	H	H	L	M	X		X		X	X	X
Cottonwood, Narrowleaf	Populus angustifolia	Lg. Tree	Mid	4	FACW	SF	VG	H	H	L	M	X		X		X	X	X
Current, Golden	Ribes aureum	Med. Shrub	Low – Mid	3, 4	FAC	R	F	L	L	H	H	X		X		X	X	X
Current, Wax	Ribes cereum	Med. Shrub	Mid	3, 4	FACU	R	F	L	L	M	H	X				X	X	X
Dogwood, Redosier	Cornus sericea	Med. Shrub	Mid	2, 3, 4	FACW	S	F	L	H	L	M	X	X	X			X	X
Elderberry, Blue	Sambucus nigra ssp. cerulea	Lg. Shrub	Mid	4	FAC	R	P	M	M	L	M	X					X	X
Elderberry, Red	Sambucus racemosa	Med. Shrub	Mid – High	4	FACU	R	P	M	M	L	M	X					X	X
Hawthorn, Black	Crataegus douglasii	Sm. Tree	Low – Mid	3, 4	FAC – U	DS	P	M	L	L	H	X		X	X	X	X	X
Pine, Lodgepole	Pinus contorta	Conifer	Mid - High	3, 4, 5	FACW - U	S	P	L	H	L	L	X	X				X	X
Rose, Wood’s	Rosa woodsii	Sm. Shrub	Low – Mid	2, 3, 4	FACU	R	F	M	M	L	H	X		X	X		X	X
Serviceberry	Amelanchier alnifolia	Lg. Shrub	Low - Mid	4, 5	FACU	R	P	L	L	L	M	X					X	X
Silverberry	Elaeagnus commutata	Sm. Shrub	Low – Mid	3, 4	FAC	R	VG	H	H	M	M	X	X	X		X	X	X
Snowberry, Common	Symphoricarpos albus	Sm. Shrub	Mid – High	3, 4	FACU	S	VG	M	M	L	M	X		X			X	X
Spruce, Engelmann and White	Picea engelmannii and P. glauca	Conifer	Mid - High	3, 4, 5	FACW - U	S	P	L	H	L	L	X	X				X	X
Sumac, Skunkbush	Rhus trilobata	Med. Shrub	Low - mid	4	FACU	R	P	H	M	L	H	X		X		X	X	X
Syringa (mock-orange)	Philadelphus lewisii	Sm. Shrub	Low - Mid	3, 4	FACU - U	FS	P	L	L	L	L	X		X			X	X

ELEVATION RANGE: Low- 2000- 4500 ft, Middle- 4500- 7000 ft, High- 7000- 10000 ft; RIPARIAN ZONE: 1- Toe Zone, 2- Bank Zone, 3- Overbank Zone, 4- Transition Zone, 5- Upland;
PLANT INDICATOR STATUS: OBL- obligate, FACW- facultative wet, FAC- falcultative, FACU- facultative upland, U- upland;
ROOT TYPE: DS- deep spreading, FS- fibrous spreading, MS- moderately spreading, S- shallow, SS- shallow spreading, R- rhizomatous; ROOT FROM CUTTING: F- fair, G- good, VG- very good, P- poor;
TOLERANCES: L- low, M- moderate, H- high; WILDLIFE: consider species for food, cover and/or nesting habitat

WILLOWS	PLANT ATTRIBUTES																	
COMMON NAME	SCIENTIFIC NAME	SIZE -FORM	ELEVATION RANGE	RIPARIAN ZONE	PLANT INDICATOR STATUS	Root Type	Root From Cuttings	Deposition Tolerance	Flood Tolerance	Salinity Tolerance	Drought Tolerance	Riparian Forest Buffer	Shallow Water Areas for Wildlife	Streambank/Shoreline Protection	Vegetative Barriers	Winter Grazing	Wildlife Upland Habitat	Commercially Available
Willow, Bebb	Salix bebbiana	Lg. Shrub	Low - Mid	4	FACW	DS	G	H	H	L	L	X	X	X			X	
Willow, Black	Salix nigra	Lg. Tree	Low - Mid	4	FACW	DS	G	M	M	L	L	X		X			X	
Willow, Booth	Salix boothii	Med. Shrub	Mid	2, 3	FACW	DS	F	H	M	L	L	X	X	X			X	
Willow, Coyote	Salix exigua	Med. Shrub	Low - Mid	2, 3, 4	OBL	R	VG	H	H	L	L	X	X	X			X	
Willow, Drummond	Salix drummondiana	Med. Shrub	Mid - High	2, 3	FACW	DS	G	H	H	L	L	X	X	X			X	
Willow, Geyer	Salix geyeriana	Med. Shrub	Mid	2, 3	OBL	DS	G	H	H	L	L	X	X	X			X	
Willow, Golden (White)	Salix alba	Lg. Tree	Low – Mid	4	FACW	DS	VG	H	H	L	M	X		X			X	
Willow, Laurel	Salix pentandra	Lg. Shrub	Low - Mid	4, 5	FAC - U	DS	VG	M	H	L	L	X		X			X	
Willow, Lemmon	Salix lemmonii	Med. Shrub	Mid - High	2, 3	FACW	DS	G	H	M	L	L	X	X	X			X	
Willow, MacKenzie	Salix prolixa	Sm. Tree	Low - Med	2, 3	OBL	DS	G	H	M	L	L	X	X	X			X	
Willow, Pacific	Salix lucida ssp. lasiandra	Sm. Tree	Low - Mid	4	FACW	DS	G	H	M	L	L	X		X			X	
Willow, Peachleaf	Salix amygdaloides	Sm. Tree	Low	4	FACW	DS	VG	H	H	L	L	X		X			X	
Willow, Plainleaf	Salix planifolia	Sm. Shrub	Mid - High	2, 3	OBL	DS	F	H	M	L	L	X	X	X			X	
Willow, Sitka	Salix sitchensis	Sm. Tree	Low - Mid	3	FACW	DS	M	H	M	L	L	X		X			X	
Willow, Scouler	Salix scouleriana	Lg. Shrub	Low - Mid	4, 5	FAC	DS	F	H	M	L	M	X		X			X	
Willow, Yellow	Salix lutea	Med. Shrub	Low	2, 3	FACW - OBL	DS	G	M	M	L	L	X	X	X			X	
Willow, Wolf	Salix wolfii	Sm. Shrub	Mid - High	2, 3	OBL	DS	F	H	H	L	L	X	X	X			X	

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