UNITED STATES DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE

ECOLOGICAL SITE DESCRIPTION

GENERAL SITE INFORMATION

Site Type	Lotic Riparian Complex
Site ID	058CY001ND
Site Name	Northern Rolling Plains, Northeastern Part, Perennial Riparian Complex (Valley Type VIII, C5 Stream Type)

Major Land Resource Area(s)

Number	Name
58C	Northern Rolling Plains, Northeastern Part

For further information regarding MLRAs, refer to: http://soils.usda.gov/survey/geography/mlra/index.html

Site Concept	This site covers the lotic riparian complexes of plant community components along reaches of the Little Missouri River in MLRA 58C. This is a perennial stream that drains a relatively small sized watershed and empties into the Missouri River (Lake Sakawea) in the northeast portion of Dunn County. The site concepts are based on the C5 stream type (predominantly sandy channel materials) and fluvial surfaces including a floodplain (with a plant community component of stable, bank holding obligate vegetation), a primary floodplain step plant community (with a community component of willows and grasses) that can dissipate energy and trap sediments during high flow events, a secondary floodplain step plant community where woody recruitment is taking place, and a low terrace (dominated by Eastern Cottonwood and Western wheatgrass). This site also has a high terrace that is disconnected from the floodplain and is characterized by a silver sagebrush/ western wheatgrass plant community.

Original Site Description Approval

Site Date	
Site Approval	
Site Authors	M. Meehan, J. Printz, K. Sedivec
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Site Reviewers	J. Repp, M. Moseley
Approval Date	

Revisions

Revision Date	
Reviser	
Revision Approval	
Approval Date	
Revision Notes	

REPRESENTATIVE PHYSIOGRAPHIC FEATURES

Narrative	This site occurs within the Little Missouri River Watershed, located in the Badlands portion of the Northwestern Great Plains Region of North Dakota (Severson and Sieg 2006). The landscape of the Unglaciated Plains is classified as a semiarid rolling plain of shale and sandstone with areas of buttes and badlands. The Little Missouri River flows through a landscape that remained untouched by recent glacial active. The valley of the Little Missouri River follows a route cut by the Pleistocene glaciers through the soft silts and clays of the Sentinel Butte and Bullion Creek Formations. The valley's dimensions are a function of geologic substrate; the valley is deep and constrained by the badlands (Bluemle 1973). The surrounding landscape is highly erosive leading to the entrenchment of the river and the formations of multiple terraces. The floodplain is composed primarily of sands with silts and clays present in the banks.

	Minimum	**Maximum**
Elevation (feet)	1875	2800
Valley Slope (percent)	0.5	2.5

Fluvial Surface/Landform 1 [1/]	Floodplain	
	Minimum	**Maximum**
Water Table Depth (inches)	surface	18
Water Table Duration (days) [2/]	365	365
Water Table Frequency (months) [3/]	January	December
Flooding Frequency	Very Frequent	Very Frequent
Flooding Duration	Long	Very Long
Ponding Depth (inches)	None	None
Ponding Frequency	None	none
Ponding Duration	None	none
Runoff Class	Negligible	Negligible

[1/] Landforms are numbered as they change laterally away from the channel.
[2/] Enter the number of days the water table is above 6 ft depth.
[3/] Enter the beginning and ending month of elevated water table (above 6 ft depth).

Fluvial Surface/Landform 2 [1/]	Primary Floodplain Step	
	Minimum	**Maximum**
Water Table Depth (inches)	surface	72
Water Table Duration (days) [2/]	365	365
Water Table Frequency (months) [3/]	January	December
Flooding Frequency	Frequent	Frequent
Flooding Duration	Brief	Long
Ponding Depth (inches)	None	None
Ponding Frequency	None	None
Ponding Duration	None	None
Runoff Class	Negligible	Negligible

[1/] Landforms are numbered as they change laterally away from the channel.
[2/] Enter the number of days the water table is above 6 ft depth.
[3/] Enter the beginning and ending month of elevated water table (above 6 ft depth).

Fluvial Surface/Landform 3 [1/]	Secondary Floodplain Step	
	Minimum	**Maximum**
Water Table Depth (inches)	surface	>72
Water Table Duration (days) [2/]	0	270
Water Table Frequency (months) [3/]	March	November
Flooding Frequency	Frequent	Frequent
Flooding Duration	Brief	Brief
Ponding Depth (inches)	None	None
Ponding Frequency	None	None
Ponding Duration	None	None
Runoff Class	Negligible	Negligible

[1/] Landforms are numbered as they change laterally away from the channel.

[2/] Enter the number of days the water table is above 6 ft depth.
[3/] Enter the beginning and ending month of elevated water table (above 6 ft depth).

Fluvial Surface/Landform 4 [1/]	Low Terrace	
	Minimum	**Maximum**
Water Table Depth (inches)	surface	>72
Water Table Duration (days) [2/]	0	120
Water Table Frequency (months) [3/]	April	July
Flooding Frequency	Occasional	Occasional
Flooding Duration	Very brief	Brief
Ponding Depth (inches)	None	none
Ponding Frequency	None	none
Ponding Duration	None	none
Runoff Class	Very Low	Very Low

[1/] Landforms are numbered as they change laterally away from the channel.
[2/] Enter the number of days the water table is above 6 ft depth.
[3/] Enter the beginning and ending month of elevated water table (above 6 ft depth).

Fluvial Surface/Landform 5 [1/]	High Terrace	
	Minimum	**Maximum**
Water Table Depth (inches)	>72	-
Water Table Duration (days) [2/]	0	0
Water Table Frequency (months) [3/]	-	-
Flooding Frequency	Rare	Rare
Flooding Duration	Extremely Brief	Very Brief
Ponding Depth (inches)	None	None
Ponding Frequency	None	None
Ponding Duration	None	None
Runoff Class	Very Low	Low

[1/] Landforms are numbered as they change laterally away from the channel.
[2/] Enter the number of days the water table is above 6 ft depth.
[3/] Enter the beginning and ending month of elevated water table (above 6 ft depth).

REPRESENTATIVE CLIMATIC FEATURES

Narrative	MLRA 58C is considered to have a continental climate – cold winters and hot summers, low humidity, light rainfall, and much sunshine. Extremes in temperature are characteristic. The climate is the result of this MLRA's location in the geographic center of North America. There are few natural barriers on the northern Great Plains. The air masses move unobstructed across the plains and account for rapid changes in temperature. Annual precipitation ranges from 10 to 16 inches per year. The normal average annual temperature is about 42.3°F. January is the coldest month with average temperatures ranging from about 8.2° F (Watford City, ND) to about 16°F (Medora, ND). July is the warmest month with temperatures averaging from about 68° F (Fairfield, ND) to about 71° F (Medora, ND). The range of normal average monthly temperatures between the coldest and warmest months is about 58° F. This large annual range attests to the continental nature of this MLRA's climate. Winds average about 11 miles per hour annually, ranging from about 13 miles per hour during the spring to about 10 miles per hour during the summer. Daytime winds are generally stronger than nighttime and occasional strong storms may bring brief periods of high winds with gusts to more than 50 miles per hour. Growth of native cool-season plants begins in late March and continues to early to mid July. Native warm-season plants begin growth in mid May and continue to the end of August. Green up of cool-season plants can occur in September and October when adequate soil moisture is present.

See Climatic Data Sheet for more details (Section II of the Field Office Technical Guide) or reference the following climatic web site: http://www.wrcc.dri.edu/climsum.html

	Minimum	Maximum
Frost-free period (days)	103	143
Freeze-free period (days)	123	163
Annual effective precipitation (inches)	10	16

Monthly precipitation (inches) and temperature (degrees F) distribution

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precip. Avg.	0.36	0.37	0.61	1.28	2.21	2.99	2.16	1.54	1.51	1.13	0.60	0.37
Temp. Min	1.1	8.7	18.3	29.7	41.2	50.1	54.8	53.3	42.5	31.6	17.5	5.8
Temp. Max.	22.5	30.4	41.3	56.3	68.7	77.2	83.9	84.0	60.1	58.3	38.4	26.7

Climate Stations

Number	Name	State	Period of Records	
			From	To
322809	Fairfeild	ND	1931	2012
323705	Grassy Butte 2 ENE	ND	1987	2012
324571	Keene 3 S	ND	1950	2012
325813	Medora	ND	1948	2012
329233	Watford City	ND	1919	2012
329246	Watford City 14 S	ND	1951	2012

INFLUENCING WATER FEATURES

Narrative	This site is a lotic, fluvial system that includes the area influenced by the stream and its associated ground water on very low gradients (< 2%) that include adjacent floodplains and terraces. The stream occurs in alluvial valley fill and sediments supplied are sandy and clayey materials from adjacent badlands and prairie landscapes. The potential natural channel is the expression that has the best combinations of energy dissipation, sediment transfer, floodplain development and the associated high quality values associated with the system. It is rarely found in this site due to past disturbances and the extreme level of entrenchment and widening of the stream system.

Level II Rosgen Stream Type Classification

Valley Type(s)	**Valley Type VIII: Wide, gentle valley slope with well-developed floodplain adjacent to river terraces.** Valley Type VIII is most readily identified by the presence of multiple river terraces positioned laterally along broad valleys with gentle, down-valley elevation relief. Alluvial terraces and floodplains are the predominant depositional landforms which produce a high sediment supply. Soils are developed predominantly over alluvium originating from combined riverine and lacustrine depositional processes. Stream types "C" or "E," which have slightly entrenched, meandering channels that develop a riffle/pool bed-form, are normally seen in the Type VIII valley. However, "F," and "G" stream types can also be found, depending on local stream and riparian conditions.		
Reference Stream Type	The C5 stream types are systems with moderate to high sinuosities, gentle to moderately steep channel gradients, and moderate to high channel width/depth ratios. The C5 stream type is a riffle/pool stream found in valleys with well developed floodplains. The C5 stream channels within this site are found in valley type VIII.		
Channel Material(s)	Sand dominated bed with smaller accumulations of gravel and occasional silt/clay. Streambanks comprised of sandy/silt/clay mixture with dense root mat.		
Stream Succession Scenario[1/]	C5→Gc5 →F5 →Bc →C5		
Channel Evolution Stage[1/]	I → II → III → IV → V		
Delineative Criteria		**Low**	**High**
Entrenchment Ratio (floodprone width / bankfull width)[2/]		2.2	200
Width/Depth Ratio (bankfull width / bankfull depth at riffle)[2/]		10	60
Sinuosity (stream length / valley length) [2/]		1.1	1.6
Slope Range[2/]		0.004	0.02
Channel Materials D_{50} (particle size index, mm)		0.07	0.56
Channel Materials D_{84} (particle size index, mm)		0.45	2.4

Information from Rosgen, 1996 and modified as needed for site description. Delineative criteria are for the stream type and may represent a larger range of values than exists for the reference channel.

[1/] Describe succession of channel types and their associated channel evolution stage (I – V)

[2/] Expressed as ft/ft.

Stream & Valley Cross-Sections (C5 Channel – stable analogue)

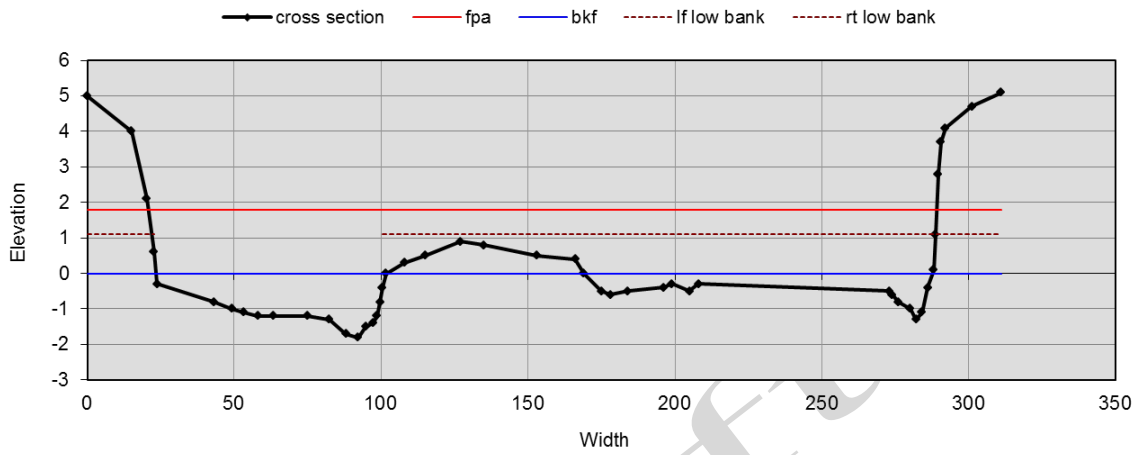


Figure 1 – Typical stream cross-section. *An example of phase 3.2 (C5 entrenched stable analogue) that replicates the features of the potential natural channel phase of state 1.*

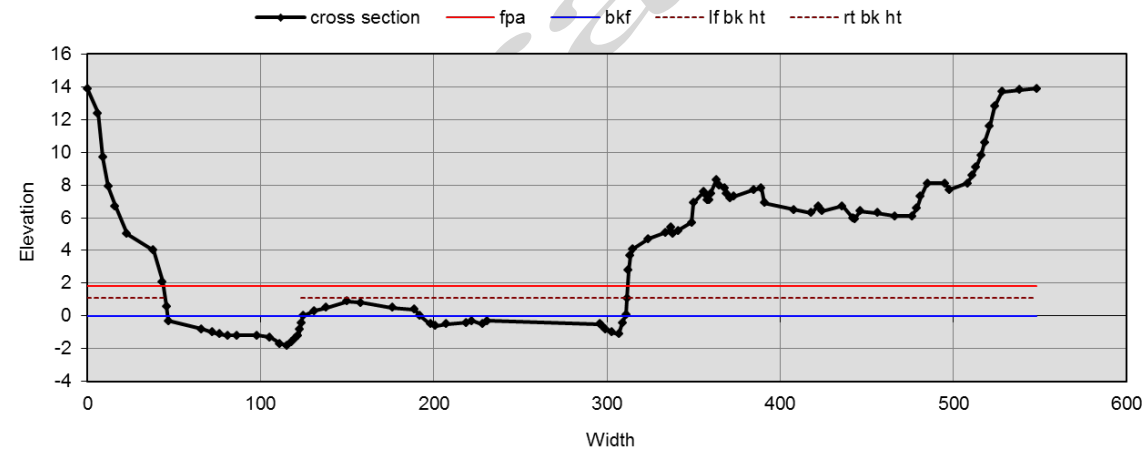


Figure 2 – Typical valley cross-section. *Valley cross-section of phase 3.2. Note the cut bank on left that indicated incision in the past.*

Stream & Valley Cross-Sections (F5 Channel)

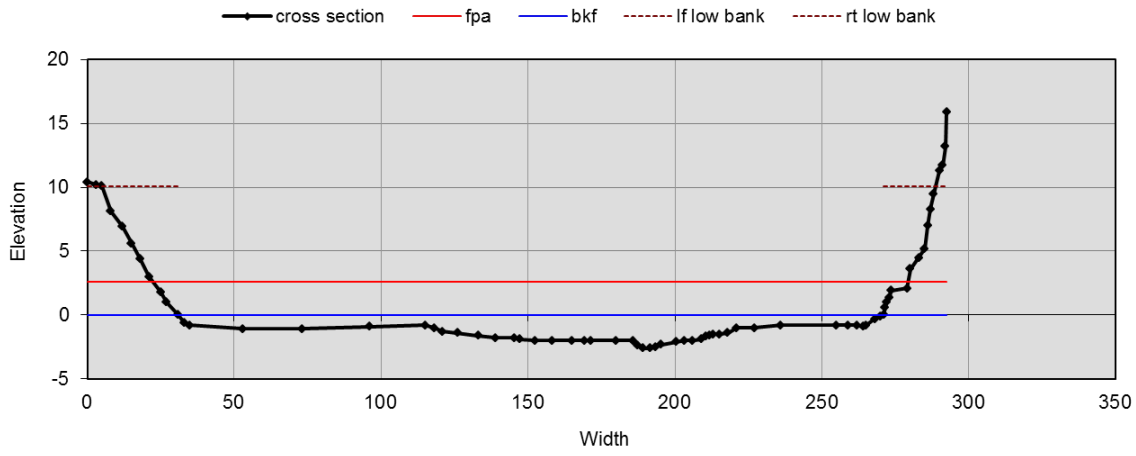


Figure 1 – Typical stream and valley cross-section. *Cross-section of phase 2.2 (widened unstable channel) that has lost connectivity with the floodplain.*

Stream & Valley Cross-Sections (Bc5 Channel – most prevalent stable analogue)

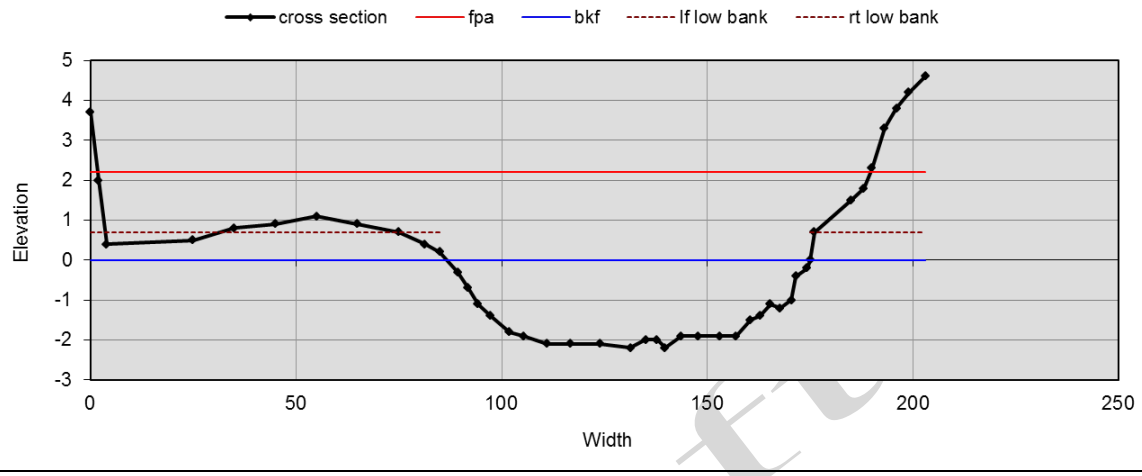


Figure 1 – Typical stream cross-section. *Bc5 channel cross-section that may be prevalent within the site (phase 3.1)*

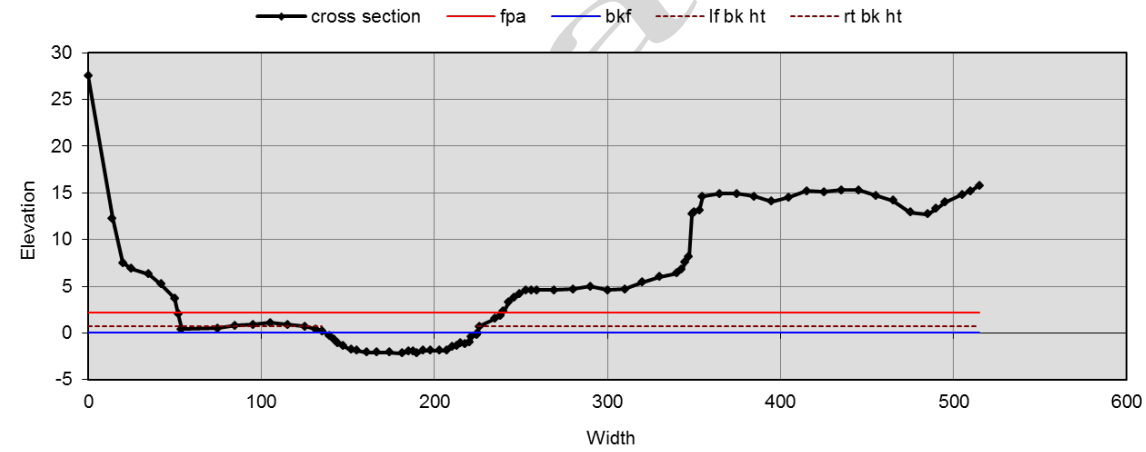


Figure 2 – Typical valley cross-section. *Entrenched Bc5 channel of state 3 phase 1. Note the cut bank on left that indicated incision in the past.*

REPRESENTATIVE SOIL FEATURES

Narrative	The soils in MLRA 58C of the Little Missouri River floodplain are deposits of several different geological formations. In the southern part the deposits are from Upper Cretaceous sediments of the Hell Creek and Fox Hills formations. In the central part the deposits are from a mixture of the Paleocene Epoch sediments in the Fort Union Group (Ludlow, Slope, Bullion Creek, Sentinel Butte Formations). In the northeastern part of the MLRA the river has been modified by past glaciation. The modified pattern of the river has caused extenstive down cutting through glacial drift and sedimentary bedrock of the Sentinel Butte and Bullion Creek Formations (Bluemle 2000). This change in the river pattern has also caused extensive erosion throughout MLRA 58C. During periods of snow melt and heavy rains the exposed sediments of the badland areas are easily eroded . The sediments are all concentrated into the tributaries and the Little Missouri River, which cause a heavy sediment load during these periods that have influenced the development of soils on the floodplain. When the sediments keep burying the surface layer, the soil development process needs to start over. These soils are classified as Entisol soil order, which describes the beginning processes of soil development. The soils of the flood plain have also been influenced from the sediments of the geological formations listed above., and other geological sediments that are further south of MLRA 58C. Typically the sediments and soils of the river system consist of a mixture of sediments (sands, silts, clays,and gravels) due to the flow events of the river. There is no soil development on the edge of the river channel (floodplain) due to constant re-working of the sediments, time has not allowed soil development; this zone is considered a miscellaneous land type called “Riverwash”. As you increase in elevation from the channel edge, the soils on the primary and secondary steps are Typic or Aeric Fluvaqents and typically the particle size family class is Sandy, Coarse-Loamy or Loamy. There are stratified thin layers of sediments that range from sand to clay loams throughout the soil profile. The soils are frequently flooded and the water table will fluctuate with the depth of water in the river channel. The soils on the low terraces are Oxyaquic Ustifluvents and the particle size family class is Sandy. The parent material does have stratified thin layers of sediments that range from sands to loams. These soils are occasionally flooded and the water table will also fluctuate with the depth of water in the river channel. The soils of the high terraces are Ardic Ustifluvents and the particle size family class is Coarse-Loamy or Loamy. These soils are rarely flooded and do not have a water table, it is noted that faint relic mottles are present in the soil profile, indicating that water had a role in the soil development. The soils on the high terraces have been on a stable landform for many years, and are developing mollic colors in the surface layer.

Fluvial Surface/Landform 1	Floodplain		
Soil Features Narrative	This component of the floodplain is a Miscellaneous Area called “Riverwash”. Areas of Riverwash consist of Sand, Silt, Clay, and Gravel which are unstable due to the frequency of flooding that continually re-works the sediment.		
Parent Materials - Kind	Alluvium		
Bedrock - Kind			
Typical Surface Texture (<2mm)	Sand		
Surface Texture Modifier	Extremely Gravelly		
		Minimum	**Maximum**
Surface Fragments ≤10” (% cover)		25	90
% Coarse Fragments >2mm (% volume in 10–20” layer)		10	90
Drainage Class		Very Poorly	Poorly
Saturated Hydraulic Conductivity Class		1.417 in/hr	100.00 in/hr
Depth to Bedrock (inches)		Variable	Variable
Depth to Redoximorphic Features (inches)		0	0
Depth of Fine Roots (1-2mm)		None	None
Electrical Conductivity (mmhos/cm)		0	4
Sodium Adsorption Ratio within 16” Depth		0	0
Calcium Carbonate Equivalent within Surface 10”		0	0
Soil Reaction within Surface 4 Inches		6.1	7.8
Available Water Capacity (inches)		.03	.04

Fluvial Surface/Landform 2	Primary Floodplain Step
Soil Features Narrative	This soil component is a coarse-loamy, mixed, superactive, calcareous, frigid Aeric Fluvaquent. There is no named soil series for this component in this MLRA. The soils on this landform have minimal development (AC and C horizons) due to flooding frequency. A water table will fluctuate with the water depth of the river throughout the year. Recent sediment deposition from 2011 spring flooding and buried horizons was noted during the field investigation. Sand and gravel deposits occurred at 140 cm. at the site.
Parent Materials - Kind	Alluvium
Bedrock - Kind	
Typical Surface Texture (<2mm)	Sandy Loam to Sand
Surface Texture Modifier	Fine to Very Gravelly

	Minimum	**Maximum**
Surface Fragments ≤10" (% cover)	none	60
% Coarse Fragments >2mm (% volume in 10–20" layer)	none	60
Drainage Class	Poorly	Somewhat Poorly
Saturated Hydraulic Conductivity Class	1.417 in/hr	100.00 in/hr
Depth to Bedrock (inches)	>60	-
Depth to Redoximorphic Features (inches)	0	1
Depth of Fine Roots (1-2mm)	0	3
Electrical Conductivity (mmhos/cm)	0	4
Sodium Adsorption Ratio within 16" Depth	0	0
Calcium Carbonate Equivalent within Surface 10"	0	25
Soil Reaction within Surface 4 Inches	6.6	8.4
Available Water Capacity (inches)	.03	.19

Fluvial Surface/Landform 3	Secondary Floodplain Step
Soil Features Narrative	The soil component on this landform is similar to the Primary step soil. It classifies as a fine-loamy, mixed, superactive, calcareous, frigid Aeric Fluvaquent at the site investigated. There is no named soil series for this component in this MLRA. The soils on this landform have minimal development (A and C horizons) due to flooding frequency. A water table will fluctuate with the water depth of the river throughout the year. Recent sediment deposition from 2011 spring flooding and buried horizons were noted during the field investigation. Sand and gravel deposits occurred at 120 cm. at the site.
Parent Materials - Kind	Alluvium
Bedrock - Kind	
Typical Surface Texture (<2mm)	Sandy Loam or Loamy Sand
Surface Texture Modifier	Fine

	Minimum	**Maximum**
Surface Fragments ≤10" (% cover)	10	70
% Coarse Fragments >2mm (% volume in 10–20" layer)	none	40
Drainage Class	Poorly	Somewhat Poorly
Saturated Hydraulic Conductivity Class	1.417 in/hr	100.00 in/hr
Depth to Bedrock (inches)	>60	-
Depth to Redoximorphic Features (inches)	0	1
Depth of Fine Roots (1-2mm)	0	9
Electrical Conductivity (mmhos/cm)	0	4
Sodium Adsorption Ratio within 16" Depth	0	0
Calcium Carbonate Equivalent within Surface 10"	0	25
Soil Reaction within Surface 4 Inches	6.6	8.4
Available Water Capacity (inches)	.05	.17

Fluvial Surface/Landform 4	Low Terrace

Soil Features Narrative	The soil component on this landform is similar to Hanly series. Hanly is a sandy floodplain soil with a varying range of surface and subsurface textures, but is in the Sandy family class. The range of the surface textures are listed below. The soil observed in the field would be saturated during flooding events and has a fluctuating water table that is associated with the depth of the river water throughout the year. This soil classified as a Sandy, mixed, frigid Aquic Ustifluvents. Sediment deposition from the spring flood of 2011 ranged from ½ to 2 inches was noted during the field investigation on this landform. Buried horizons and stratified layers of loams to sands were noted in the subsurface during the field investigation. Drainage class; due to the water table it is moderately well to somewhat poorly drained, if no water table existed it would be the Hanly soil series which is somewhat excessive to excessively drained.		
Parent Materials - Kind	Alluvium		
Bedrock - Kind			
Typical Surface Texture (<2mm)	Sandy Loam or Loamy Sand		
Surface Texture Modifier	Fine		
		Minimum	**Maximum**
Surface Fragments ≤10" (% cover)		0	1
% Coarse Fragments >2mm (% volume in 10–20" layer)		0	10
Drainage Class		Somewhat Poorly	Moderately Well
Saturated Hydraulic Conductivity Class		1.417 in/hr	100.00 in/hr
Depth to Bedrock (inches)		>60	-
Depth to Redoximorphic Features (inches)		2	12
Depth of Fine Roots (1-2mm)		0	24
Electrical Conductivity (mmhos/cm)		0	0
Sodium Adsorption Ratio within 16" Depth		0	0
Calcium Carbonate Equivalent within Surface 10"		0	15
Soil Reaction within Surface 4 Inches		6.6	8.4
Available Water Capacity (inches)		.05	.14

Fluvial Surface/Landform 5	High Terrace		
Soil Features Narrative	The soil component on this landform is Glendive. Glendive is a coarse-loamy floodplain soil with a varying range of surface and subsurface textures. The most common surface textures are listed below. One of the sites described during the soils investigation had an organic duff layer (Oe horizon) from the woodlands that were present. Surface textures on the investigated sites ranged from loam to very fine sandy loam. No sediment deposition was noted on this landform. There was a thin layer of sediment deposited in the lower areas of this landform, from the spring flood of 2011. Hanly soils do occur as inclusions on this landform. Relic mottles occurred at 45 inches, which indicate that water has influenced the development of the soil.		
Parent Materials - Kind	Alluvium		
Bedrock - Kind			
Typical Surface Texture (<2mm)	Sandy Loam, Loamy Sand, or Loam		
Surface Texture Modifier	Fine		
		Minimum	**Maximum**
Surface Fragments ≤10" (% cover)		0	0
% Coarse Fragments >2mm (% volume in 10–20" layer)		0	15
Drainage Class		Well	Somewhat Excessive
Saturated Hydraulic Conductivity Class		1.417 in/hr	14.17 in/hr
Depth to Bedrock (inches)		>60	-
Depth to Redoximorphic Features (inches)		relict mottles at 45	>60
Depth of Fine Roots (1-2mm)		0	36 inches
Electrical Conductivity (mmhos/cm)		0	0

Sodium Adsorption Ratio within 16" Depth	0	0
Calcium Carbonate Equivalent within Surface 10"	0	15
Soil Reaction within Surface 4 Inches	6.6	8.4
Available Water Capacity (inches)	.10	.19

COMMUNITY PHASE INFORMATION

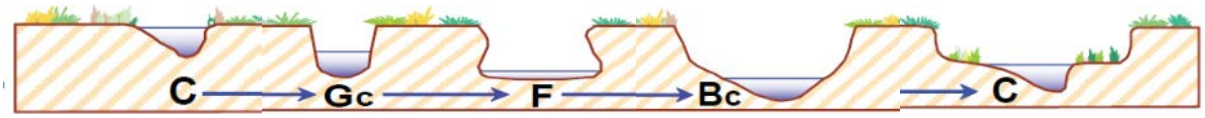
Fluvial Geomorphology, Channel Evolution, and Stream Type Succession of the Site

The site has a potential C5 channel type in an alluvial valley with a broad floodplain, floodplain step, and low terrace fluvial surfaces. The site has a succession scenario (channel evolution) of C5→Gc5 →F5 →Bc →C5 (similar to Rosgen scenario #9 with the addition of a Bc channel type in the stable analogue state).

The state and transition model includes these channel types as phases and depicts the characteristics of potential stream types (C5 in alluvial valleys). The phases are arranged in the order of channel evolution and are grouped by their inherent stability. State 1 is the potential natural channel and has the best expression of vegetative communities, stability, habitat, and resilience. State 2 is the most unstable and apt to change quickly. The Gc channel phase depicted may not always be present in the evolution of the channel when bed materials prevent vertical stability, or with looser materials, it will exist only for a short period before widening into the more characteristic F channel. State 3 phases are considered stable analogues; they have inherent stability, although with a more limited ability to form floodplains and terraces due to the entrenchment of the stream. There is a natural progression from the B5c to the C5 channel. Proper management of the uplands is critical to this progression.

Transition 1A occurs in response to severe flooding combined with disturbance to the riparian vegetation that reduce resistance and resilience, allowing the channel to widen and/or deepen resulting in the loss of beneficial and stabilizing banks vegetation (PCC1 is usually completely gone after this transition). Transition 2A occurs when management and conditions facilitate the development of floodplains, raising of the water table, and return of beneficial bank vegetation. The channel bottom changes from flat to parabolic and the entire stream is more capable of transporting water, sediments, and nutrients and is more capable of dispersing energy from high flows. There is also a significant increase in water storage in the adjacent soils.

The end point of channel evolution is the entrenched C5 channel with floodplains, floodplain step, and low terrace with appropriate plant community components. The phase has high stability (if bank vegetation is maintained) and is in balance with energy, water, and sediment supplied by the catchment. Transition 3A is similar to 1A where the stable analogue is destabilized as a result of disturbance and at risk of channel scour during high flow events; resulting in a further entrenched version of the phases in state 2. Removal of disturbances and reestablishment of beneficial vegetation will facilitate the transition back to state 3 and the development of stable channels through the community pathways.



Ecological Dynamics of the Site

The site occurs on low gradient, alluvial valleys, with sandy channel materials on the Little Missouri River and other perennial reaches of streams within MLRA 58C. The potential (or reference) reach consists of a C5 channel with a broad relatively flat floodplain that has a low terrace that supports a riparian forest component. The potential channel is slightly entrenched (entrenchment ratio 4-10, considerably more floodplain than stream bankfull width), has a wide and shallow channel (width/depth ratio >12), moderate to high sinuosity. Channel materials are predominately sands with a small amount of gravels.

The entire system has experienced historic and anthropogenic disturbances (drought, flood, fire, overgrazing, crop production, and energy development). These disturbances resulted in the system becoming entrenched, thus true reference areas can not be located. The best examples of what this site used to be are found in the stable analogues of C5 channels that are moderately confined, but adequately express the plant community components.

Plant Communities and Fluvial Surfaces:
The site exhibits 3-5 plant community components. There is no significant instream plant community associated with these streams. The first plant community is a herbaceous community associated with the floodplain. The floodplain step, low terraces, and high terraces support plant communities comprised of trees, shrubs, and herbaceous plants.

PCC1: The greenline plant community, which occurs at the water's edge (PCC1) is a graminoid-shrub dominated community that is characterized by common threesquare (*Schoenoplectus pungens*), and dwarf spikerush (*Eleocharis parvula*) with an overstory of sandbar willow (*Salix interior*). The greenline community generally occurs within the

bankfull elevation (or slightly higher) and is maintained by seasonal flows and a local water table. Considerable scouring occurs in this portion of the floodplain on an annual basis so the plants in this community are adapted to this frequent disturbance and function to protect and stabilize banks. Sandbar willow and common threesquare have deep roots that bind bank materials and maintain bank stability in most high flow events.

This plant community is subject to damage by natural forces that include extreme flooding and ice jams. In addition to the natural forces, these communities are often compromised by anthropogenic actions including channel modification (bridges, fords, crossings, straightening, ect.), overgrazing, crop production, and energy development. Disturbance can result in the plant community being replaced by shallow rooted upland species that are not capable of protecting and stabilizing banks; resulting in the formation of tensile cracks, bank sloughing, accelerated lateral and vertical movement (unstable state). In the unstable channel phases PCC1 has been lost and the stream is subject to extreme bank and bed erosion.

PCC2: The next plant community component (moving away from the channel) occurs on a floodplain step and consists of shrub dominated community that is characterized by sandbar willow. Recruitment of woody species is common in this community and regeneration (seedlings) of eastern cottonwood (*Populus deltoids*) and willow species is common. The understory of this willow dominated community is characterized by prairie cordgrass (*Spartina pectinata*), Canada wildrye (*Elymus canadensis*), and American licorice (*Glycyrrhiza lepidota*). This community is subject to scouring in high flow events and sediment deposition. The plant species in this community have adaptations to withstand high flow events that dissipate energy and trap sediments.

This plant community is also susceptible to flooding, ice jams, channel modification (bridges, fords, crossings, straightening, ect.), overgrazing, crop production, and energy development. Similarly, disturbance can result in the plant community being replaced by shallow rooted upland species. The loss of PCC2 leaves the floodplain step vulnerable to scouring and avulsion because the new plant community has a diminished capacity to dissipate energy and trap sediments during high flow events. In unstable channels phases (2.1 and 2.2) PCC2 is either severely reduced in size or eliminated.

PCC3: Wider portions of the valley bottom allow for the formation of a secondary floodplain step that support young cottonwood and patches of silver buffalo berry (*Shepherdia argentea*) with a graminoid component characterized by prairie sandreed (*Calamovilfa longifolia*) and western wheatgrass (*Pascopyrum smithii*). This component is not continuous and tends to occur in patches and stringers along portions of the stream where the valley is not as constrained and disturbances have not removed woody species (woody species can be sheared off during ice jams and are subject to grazing by livestock and wildlife resulting in them being lost over time). This community is subject to high flow events; however, it is not subject to annual events.

PCC4: Low terraces that support mature stands of cottonwood are common throughout the valley. Similar to PCC3 the understory of this community is characterized by prairie sandreed and western wheatgrass. This plant community is subject to flooding, but only during 20 year events.

PCC5: This component is actually PCC4 that is no longer connected to the stream as a result of massive erosion and the subsequent entrenchment of the stream. These high terraces occur where there has been significant entrenchment of the stream channel. The majority of this entrenchment happened within the last 100 years. On many high terraces there are old cottonwoods, a remnant from when the community was still part of the active floodplain. This community is now dominated by silver sagebrush (*Artemisia cana*) and western wheatgrass and has been described as a Loamy Terrace ecological site, or dominated by silver sagebrush and prairie sandreed and has been described as a Sandy Terrace ecological site. It may be incorporated into the riparian complex or left as an associated site that was formerly part of the riparian complex.

These disconnected components now have their own states, phases, and transitions and function an idependent ecological site. In time the old cottonwoods will die and only the remaining alluvial soils will testify to the former floodplain attributes.

Disturbances:
The site has endured many disturbances that have altered the form and function of the stream. Historic records do not describe local conditions well but there is evidence that years of drought followed by above-average rainfall caused extreme entrenchment of the stream channel: in many cases the former nature of the gradually sloping, highly sinuous C type stream was replaced by deep, actively eroding gullies that widened and flattened over time. Several reaches of

this site exhibit the almost gorge-like aspect of wide and deep channels. In some places, rehabilitation of the stream has rebuilt floodplains and low terraces that support cottonwoods within the wider gorges.

The absence of fire from the adjacent ecosystem has also altered the natural fire frequency. The riparian areas probably burned less often than the surrounding uplands but fire was undoubtedly a factor in creating and maintaining the plant communities.

Decades of improper livestock grazing have denuded streambanks and led to the entrenchment of several reaches and the total replacement of critical riparian species within the floodplain that are necessary for maintaining the integrity of the banks, trapping sediments, and reducing the energy of high flows. Overgrazing or long term exclusion of grazing tends to facilitate the invasion of Kentucky bluegrass, a shallow rooted upland species, resulting in decreased bank stality and increased erosion and runoff.

Recently, oil and gas drilling and development have had a major impact on many of these watersheds that include this ecological site. Hard stream crossings and the increase in miles of road have affected channels and sediment supplies. There is also the potential of discharges from the well pads that could adversely affect water quality as well as aquatic and terrestrial wildlife.

Hydrologic Modifications:
Most of the direct hydrologic alteration has come from roads, livestock grazing and oil and gas development. There are some reaches that have been disturbed by channel straightening, bridge, and concrete crossing construction. There are very few instances of irrigation water withdrawals in the lower portions of the watersheds. Changes to the upland vegetation have probably disrupted the hydrology of the watersheds: invasions of smooth brome, Kentucky bluegrass, and crested wheatgrass on rangelands and increased woody cover due to lack of fire are likely causes. The effects of climate change are unknown but should be monitored in the future.

Invasive Species: PCC1 is not prone to a domination by invasive species. However, invasive species were observed in the remaining plant community components. Invasive species observed within this site include: leafy spurge (*Euphorbia esula*), quackgrass (*Elymus repens*), smooth brome (*Bromus inermis*), Kentucky bluegrass (*Poa pratensis*), and spotted knapweed (*Centaurea stoebe*).

Water Quality:
The waters associated with this site should have superior water quality and moderate sediment loads. Sediment loads are naturally high due to the erodibility of the surrounding badlands landscapes. At times when sediments enter the system from breached beaver dams or from background bank erosion they will be occluded but should clear up rapidly if the downstream beaver dams are in place where they can trap the sediments. Where agriculture is present runoff can add contaminants to the stream, increases nutrient loads, pesticide residues, and fertilizers. Animal waste can be a problem where animals are allowed unrestricted access to the stream. Besides wastes entering the waters, livestock can break down banks (especially where the stabilizing bank vegetation has been removed) and cause excess erosion and increased sediment loads. Another concern to water quality within the watershed are disturbances induced by energy development such as increased traffic on bridges and crossing causing incease sediment loads and the potential hazards associated with a spill.

The primary beneficial uses identified in the State's water quality standards are aquatic life and recreation. Protection for aquatic life means surface waters should be suitable for the propagation and support of fish and other aquatic biota, including aquatic macroinvertebrates, and that contaminants will not adversely affect wildlife in the area. Protection of surface waters for recreation means waters should be suitable for direct body contact activities such as bathing and swimming and for secondary contact activities such as boating, fishing, and wading. Other beneficial uses identified in the State's water quality standards are municipal and domestic water (e.g. water suitable for drinking after appropriate treatment), agriculture (e.g., stock watering and irrigation), and industrial (e.g., washing and cooling). These uses apply to all classified rivers, streams, lakes, and reservoirs.

Based on the 2012 Section 303(d) List of Impaired Waters Needing Total Maximum Daily Loads (TMDLs), the North Dakota Department of Health (NDDoH) has identified a 124 mile segment of the Little Missouri River from its confluence with Little Beaver Creek downstream to its confluence with Andrew's Creek as impaired for recreational uses due to excessive bacteria concentrations and an 83 mile segment of the Little Missouri River from its confluence with Beaver Creek downstream to its confluence with Cherry Creek as impaired for recreational uses due to excessive E. coli bacteria concentrations. The primary sources of the bacteria contamination are run off from unconfined animal

feeding operations and from livestock grazing in riparian areas. Other stressors negatively affecting the water quality of the Little Missouri River are riparian habitat degradation and siltation.

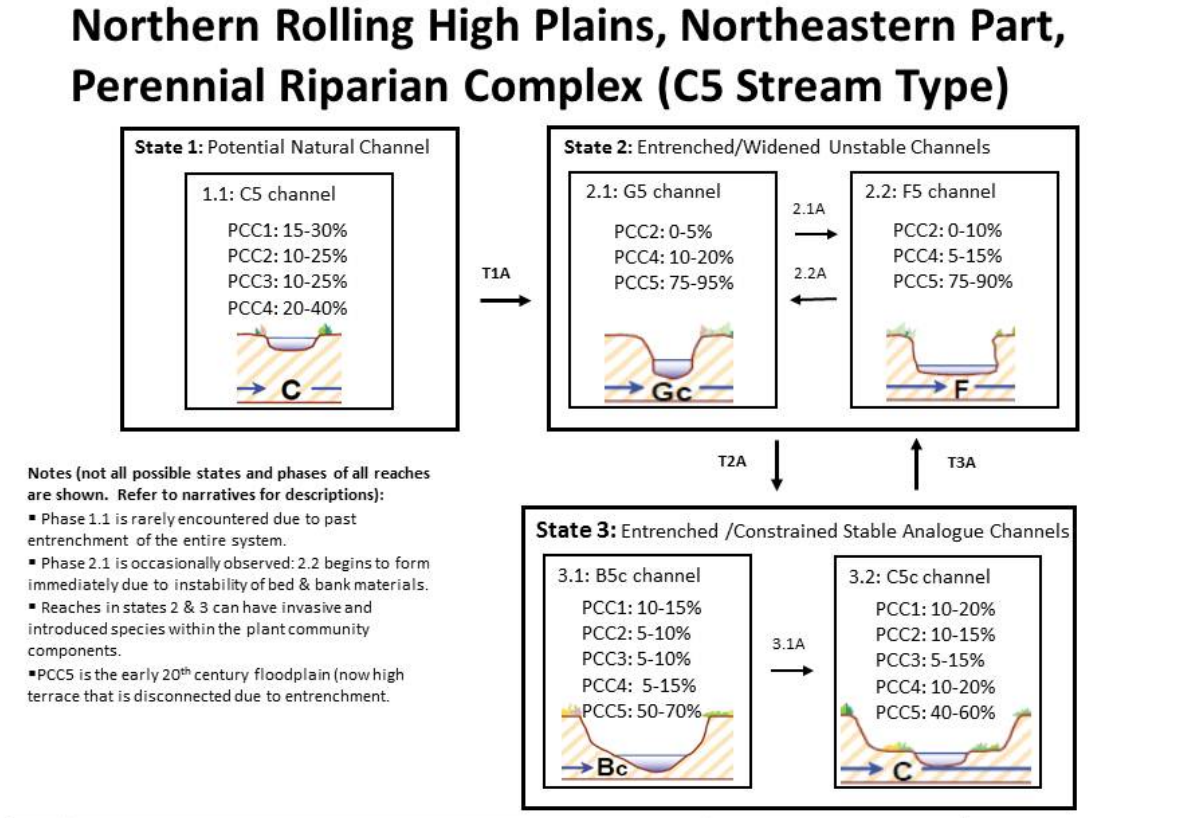
Plant Communities and Transitional Pathways (Narrative)

A State and Transition Model (STM) for the Northern Rolling Plains, Northeastern Part Riparian Complex C5 ecological site (058CY001ND) is depicted in Figure 1. Thorough descriptions of each state, transition, plant community, and pathway follow the model. This model is based on available experimental research, field observations, and interpretations by experts. It is likely to change as knowledge increases.

The plant communities will differ across the MLRA due to the naturally occurring variability in the extent of fluvial surfaces, soils, and influence of surface water and ground water in the hyporheic zone. The biological processes on this site are complex; therefore, representative values are presented in a land management context. The species lists are representative and are not botanical descriptions of all species occurring, or potentially occurring, on this site. They are not intended to cover every situation or the full range of conditions, species, and responses for the site.

Both percent species composition by weight and percent canopy or foliar cover are used in this ESD. Most observers find it easier to visualize or estimate percent canopy for woody species (trees and shrubs). Species composition by dry weight remains an important descriptor of the herbaceous community and of the community as a whole. Woody species are included in species composition for the site.

This STM includes only native communities and states. The converted communities are described in the Ecological Dynamics section above.



I.D.	Plant Association	Fluvial Surface/Landform
1	Sandbar willow/Common threesquare	Floodplain
2	Sandbar willow/ Prairie cordgrass	Primary Floodplain Step
3	Plains cottonwood/Silver buffaloberry	Secondary Floodplain Step
4	Plains cottonwood/Western wheatgrass	Low Terrace
5	Silver sagebrush/Western wheatgrass or Silver sagebrush/ Prairie Sandreed	High Terrace

Draft 2: 11/2014

Figure 3: *State and Transition Model*

STATE 1 SECTION

State Number	1
State Name	Potential Natural Channel
State Narrative	This state includes the phase and plant community components believed to be the potential natural channel and incorporates the natural channel for the gradient and valley fill materials (C5) and fluvial surfaces that are freshened intermittently in order to produce the characteristic types of vegetation. This state is rarely found in this site due to past disturbances and the extreme level of entrenchment and widening of the stream system. This stream type is suited to handle the energy, water, and sediments supplied by the watershed and promote the plant community components that provide stability to the system. If undisturbed, this phase can supply the highest benefits and services from the riparian complex including, but not limited to: diverse, resilient plant community components that can withstand high flow events, significant fish and wildlife habitat, resistance to invasion by introduced species, highest potential water quality and quantity, and ground water recharge and release. The natural disturbance regime within this state would have included grazing by native ungulates, frequent drought for variable lengths of time, infrequent fires usually associated with periods drought. Due to the fire tolerant nature of the plant species occupying these sites, these events served to replace old growth with new, vigorous sprouts and remove non-sprouting species (e.g. Rocky Mountain juniper - which may have been introduced to the site from neighboring upland ecological sites). Fire frequency would have been less on these sites as compared to the adjoining upland ecological sites due to increased fuel moisture associated with the greener vegetation; grazing by native herbivores which would have been attracted to these areas by the greener vegetation and reliable water supply, especially during periods of below normal precipitation or late summer months when upland vegetation is less palatable.

State 1 Photos

Photo 1. *Characteristic C5 channel type for the site. Due to decades of disturbances to this system, the best references were found in state 3, phase 3.2.*

Photo 2. *Sandbar willows occupy the floodplain steps that receive water and sediments from bankfull events (they can be found in PCC1 and PCC3, but mostly PCC2).*

Photo 3. *Bankfull events create favorable conditions for cottonwood establishment on the floodplain steps (PCC2 and PCC3).*

Photo 4. *Young cottonwoods on the secondary floodplain step.*

Photo 5.*Buffoloberry resprouting after being sheared off during a spring flood event (PCC3).*

Photo 6. *Cottonwood gallery of the low terrace (PCC4). The wide valleys of this site support the formation of low terraces.*

Photo 7. *Beaver activity helps development of favorable wetland vegetation.*

State 1 Community Phases

Community Phase Number	1.1
Community Phase Name	C5 Potential Natural Channel
Community Phase Narrative	This channel and its associated fluvial surfaces and plant community components represent the highest expression of functioning and ecological services of the site. The stream meanders through sediment eroded from the adjacent badlands creating fresh fluvial surfaces (at a fine scale) for vegetation development. Streambanks have high percentages of stabilizing vegetation and channels are relatively deep with continuous flow connecting to downstream sites. Habitat for amphibians and fish is very good. There are generally four major fluvial surfaces with distinct plant community components (PCC1, PCC2, PCC3, and PCC4) on each. Floodplains have willows and herbaceous, stabilizing vegetation and are mostly under the bankfull area. Floodplain steps (generally between bankfull and floodprone elevations) are dominated by willows (PCC2), cottonwoods (PCC3), and some grasses and forbs. Above the floodprone area are wide, relatively flat terraces with riparian forest and grasses.

Plant Community Components

PCC	Plant Association	Fluvial Surface/Landform[1/]	Composition (%)
1	Sandbar willow/Common threesquare	Floodplain	15-30
2	Sandbar willow/ Prairie cordgrass	Primary Floodplain Step	10-25
3	Eastern cottonwood/ Silver buffaloberry/ Prairie sandreed	Secondary Floodplain Step	10-25
4	Eastern cottonwood/ Western wheatgrass	Low Terrace	20-40

[1/] Corresponds to fluvial surfaces/landforms in the Physiographic Features and Representative Soil Features sections.

T1A Transition to Entrenched/Widened Unstable Channels State (State 2) from Reference State (State 1)

Entrenchment of C channel due to loss of riparian vegetation (obligate and facultative wet plant functional groups), increased bank erosion, and down cutting. This transition is often associated with an extended period of drought followed by a high flow event. This transition may be initiated by drought and/or improper grazing, resulting in the loss of riparian vegetation.

STATE 2 SECTION

State Number	2
State Name	Entrenched and/or Widened, Unstable Channels
State Narrative	This state represents a set of degraded channels (G5c – F5) that have crossed a threshold by becoming vertically and laterally unstable resulting in moderately deep entrenchment and loss of floodplain and floodplain step connectivity and vegetation. There are unfavorable changes to these plant community components from depression of the local water table, influencing plant vigor, competition, and composition. This may also provide an advantage to invasive plant species to invade the stressed site. They are difficult, if not impossible to restore without changing profile, pattern, and dimension of the stream.

2.1A Community Phase Change to 2.2

Lateral movement with significant bank erosion, increased sediment load and increase in width/depth ratio. This pathway happens almost immediately; the G5 channel cannot resist widening due to sandy bank materials.

2.2A Community Phase Change to 2.1

Increased vertical instability and entrenchment from further loss of vegetation (similar to T1A). This may be caused by disturbances that remove stabilizing vegetation, natural flooding, ice or beaver dam failure. Significant increase in bank erosion although some stabilizing vegetation may increase.

State 2 Photos

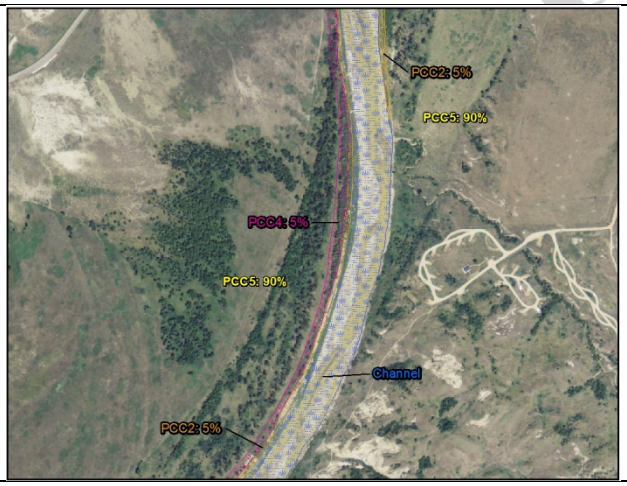


Photo 1. *Aerial view of F5 channel, phase 2.2, showing arrangement of community components.*

Photo 2. *F5 channel has flat bottom and near vertical sides: these channels are actively eroding.*

Photo 3. *The lack of bank stabilizing vegetation results in bank failures causing stable channels to transition into state 2.*

Photo 4. *The entrenchment of the stream that occurs in state 2 results in the formation of a high terrace that is disconnected from the channel.*

State 2 Community Phases

Community Phase Number	2.1
Community Phase Name	G5 Channel (active entrenchment)
Community Phase Narrative	This channel phase is the result of loss of floodplain connectivity and vegetation (PCC1 and PCC3 and possibly PCC2) resulting in rapid vertical instability and deep entrenchment. Due to the loose, sandy bed and bank materials, this phase is transitory. The forces which cause the entrenchment continue to shape the channel into the next phase (F5) through bank sloughing and accelerated lateral movement.

Plant Community Components

PCC	Plant Association	Fluvial Surface/Landform[1/]	Composition (%)
2	Sandbar willow/ Prairie cordgrass	Primary Floodplain Step	0-5
4	Eastern cottonwood/ Western wheatgrass	Low Terrace	10-20
5	Silver sagebrush/ Western wheatgrass Silver sagebrush/ Praire sandreed	High Terrace (disconnected)	75-95

[1/] Corresponds to fluvial surfaces/landforms in the Physiographic Features and Representative Soil Features sections.

Community Phase Number	2.2
Community Phase Name	F5 Channel (Entrenched/ Widened)
Community Phase Narrative	This channel continues the lateral expansion of phase 2.1 resulting in an F5 channel. These channels are highly unstable and further disturbances can force these to quickly transform back into vertically unstable G5c channels. These channels are generally disconnected from the floodplain except for during extreme flooding events. As a result, PCC1 is non-existent and water tables in terraces are further lowered. Fish and wildlife habitat and water quality values are significantly lowered or absent. If carefully managed, these channels can begin to build new floodplains; allowing for increased sinuosity and the re-establish floodplain vegetative communities, both of which help dissipate energy.

Plant Community Components

PCC	Plant Association	Fluvial Surface/Landform[1/]	Composition (%)
2	Sandbar willow/ Prairie cordgrass	Primary Floodplain Step	0-10
4	Eastern cottonwood/ Western wheatgrass	Low Terrace	5-15
5	Silver sagebrush/ Western wheatgrass Silver sagebrush/ Praire sandreed	High Terrace (disconnected)	75-90

[1/] Corresponds to fluvial surfaces/landforms in the Physiographic Features and Representative Soil Features sections.

T2A Transition to Entrenched/Constrained Stable Analogue Channels State (State 3) from Entrenched/Widened Unstable Channels State (State 2)

Rehabilitation of entrenchment with stabilizing herbaceous vegetation (increased connectivity and/or formation of new flood plain and return to better energy and sediment balance). Multiple plant community components present on fluvial surfaces. May be significant decreases in bank height ratios (<1.2).

T3A Transition to Entrenched/Widened Unstable Channels State (State 2) from Entrenched/Constrained Stable Analogue Channels State (State 3)

Disturbance results in entrenchment of C channel due to loss of vegetation (obligate and facultative wet plant functional groups), increased bank erosion, and down cutting.

STATE 3 SECTION

State Number	3
State Name	Entrenched / Constrained Stable Analogue Channels
State Narrative	This state includes channels that, after experiencing vertical and lateral instability and entrenchment, develop new floodplains within the entrenchment. Floodplain plant community components return to the incipient floodplains and streams develop new connectivity. Channel forming processes at bankfull are better able to handle the energy, flow, and sediments. Channels begin as B5c channels and with careful management, are able to develop C5 morphology with associated (although truncated) floodplains and terraces. Water tables are elevated and expand laterally. There is increased connectivity of upstream and downstream habitats resulting in improved fish and wildlife habitat and enhanced water quality. Some streams that have had the riparian vegetation removed and/or significantly changed may not develop the native plant community components. Where invasive species now dominant the floodplain marginal bank stabilization will occur.

State 3 Photos

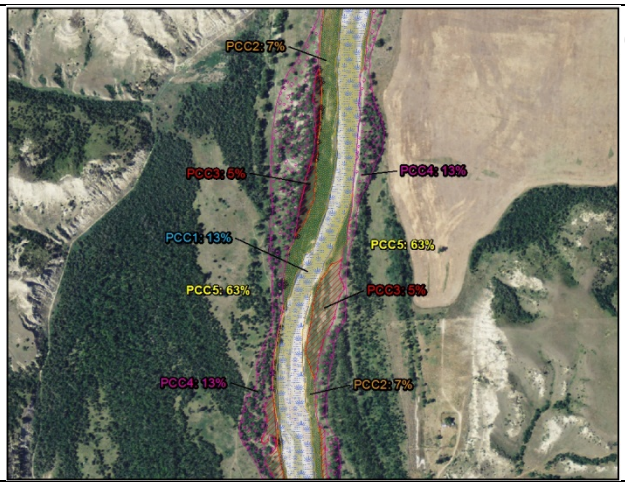


Photo 1. *Aerial view of B5c channel, phase 3.1, showing the arrangement of community components.*

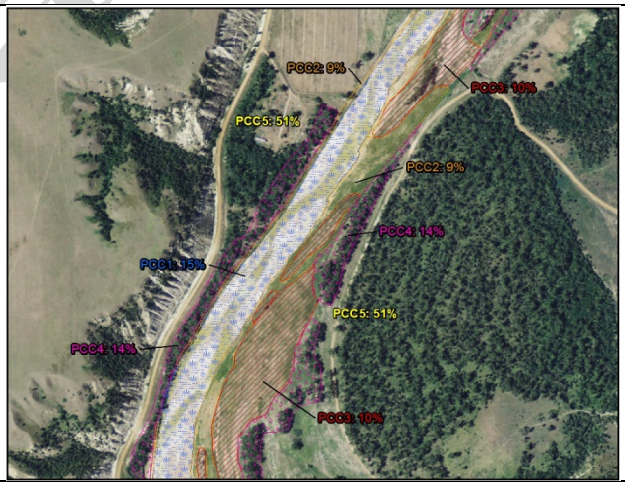


Photo 2. *Aerial view of C5 channel (phase 3.2), showing the arrangement of community components.*

Photo 3. *B5c channel, phase 3.1, is the most prevalent stable analogue for the site.*

Photo 4. *In phase 3.1 a new floodplain is established and PCC1 is reestablished.*

3.1A Community Phase Change to 3.2

The B5c channel will eventually (with proper management that increases bank stabilizing vegetation and normal flow variability) develop a small floodplain within the entrenched area, forming sand bars and slight cut banks. Increase of desirable greenline vegetation, sediment trapping, expansion of water table, and widening of flood plain (increased

sinuosity, energy, and sediment transport balance). This pathway may require particularly long time periods to complete due to the stability of phase 3.1.

State 3 Community Phases

Community Phase Number	3.1
Community Phase Name	Entrenched / Constrained B5c (stable analogue)
Community Phase Narrative	This phase represents the channel evolution from F5 to B5c resulting from a reduction in the near vertical, unstable banks associated with the F5 channel to somewhat more stable, parabolic shaped B5c channel. This phase represents the initial re-establishment of stream connectivity to its floodplain. Narrow floodplains are established where desirable bank stabilizing vegetation can grow. Local water tables are raised creating better conditions for terrace vegetation as well. The limited floodplain and associated stabilizing vegetation makes this phase unstable "At-Risk" phase which can quickly transition to the F5 channel via transitional pathway T3A. Further rehabilitation of this phase may be limited by energy development, inappropriate livestock grazing, invasive species, or other disturbances (drought, large floods). If the native vegetation is not present or sources are not locally available, the phase is considered to be at-risk of crossing a threshold (T3A) to state 2.

Plant Community Components

PCC	Plant Association	Fluvial Surface/Landform[1/]	Composition (%)
1	Sandbar willow/Common threesquare	Floodplain	10-15
2	Sandbar willow/ Prairie cordgrass	Primary Floodplain Step	5-10
3	Eastern cottonwood/ Silver buffaloberry/ Prairie sandreed	Secondary Floodplain Step	5-10
4	Eastern cottonwood/ Western wheatgrass	Low Terrace	5-15
5	Silver sagebrush/ Western wheatgrass Silver sagebrush/ Praire sandreed	High Terrace (disconnected)	50-70

[1/] Corresponds to fluvial surfaces/landforms in the Physiographic Features and Representative Soil Features sections.

Community Phase Number	3.2
Community Phase Name	Entrenched / Constrained C5 (stable analogue)
Community Phase Narrative	This phase represents the best possible combination of attributes and values possible after the original C5 channel and floodplain have been altered by entrenchment and accelerated lateral movement. This phase represents the development of a new floodplain, through lateral movement that creates cut banks, and deposits new sand bars on the insides of bends. The original plant community components of the floodplain are rehabilitated, although constrained by the entrenchment, limiting their lateral extension. The local water table is able to rise and extend the groundwater influence laterally to the terraces. Incipient vegetation which does not have superior bank holding attributes makes can make this an "At-Risk" channel. This rehabilitated channel is probably not possible without careful management of livestock grazing, control of invasive species, and limiting water diversions. Disturbances that remove vegetation and affect bank stability (i.e. excessive trampling, fire, ice, energy development, and prolonged flood) can result in a transition to one of the phases in State 2.

Plant Community Components

PCC	Plant Association	Fluvial Surface/Landform[1/]	Composition (%)
1	Sandbar willow/Common threesquare	Floodplain	10-20
2	Sandbar willow/ Prairie cordgrass	Primary Floodplain Step	10-15
3	Eastern cottonwood/ Silver buffaloberry/ Prairie sandreed	Secondary Floodplain Step	5-15

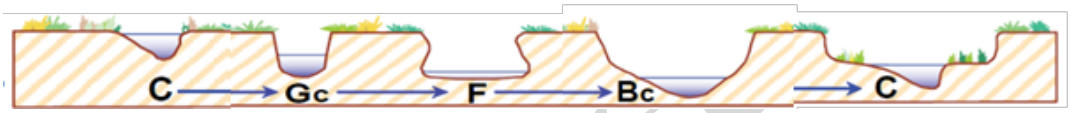
4	Eastern cottonwood/ Western wheatgrass	Low Terrace	10-20
5	Silver sagebrush/ Western wheatgrass Silver sagebrush/ Praire sandreed	High Terrace (disconnected)	40-60

[1/] Corresponds to fluvial surfaces/landforms in the Physiographic Features and Representative Soil Features sections.

Community Phase Comparisons – Geomorphic Evaluation Criteria

Narrative

Little Missouri River (and other local perennial stream reaches) comparison of states and phases. C → G → F → Bc →C succession scenario (phases 1.1, 2.1, 2.2, 3.1, 3.2, and 3.3). Phase 1.1 is the reference.



The metric in the Table below demonstrate the degree of departure from reference condition (Phase 1.1) for each phase and is designed to aid in the identification of threshold.

*Generalizations were made for the metrics of phases 1.1 and 2.1 for stream type within MLRA 58C, since these phases have not been observed in the field.

Phase	ER	Degree of Channel Incision (BHR)		W/D Ratio State (W/D / W/Dref)			Degree of Confinement (MWR / MWRref)			Bank Erosion Hazard Index (BEHI)	
		BHR	Rating	W/D	Ratio	Rating	MWR	Ratio	Rating	Score	Rating
1.1*	4	1.0	Stable	50	1.0	Stable	30.0	1.0	Un-confined	10	Low
2.1*	1.0	2.0	Deeply Incised	110	0.45	Highly Unstable	1.0	0.03	Severely Confined	48	Extreme
2.2	1.1	1.8	Deeply Incised	180	0.28	Highly Unstable	3.3	0.11	Confined	46	Extreme
3.1	2.1	1.3	Slightly Incised	70	1.4	Mod. Unstable	10.2	0.34	Mod. Confined	24	Moderate
3.2	3.5	1.1	Stable	55	1.1	Stable	25.0	0.83	Un-confined	10	Low

PLANT COMMUNITY COMPONENTS

Narrative	Plant community components described for this site represent the closest approximation to the characteristic plant communities associated with fluvial surfaces. Plant communities on new sand bars, floodplains or recently scoured areas develop incipient and pioneer vegetation that can subsequently develop into more stabilizing and characteristic plant communities. These plant communities exist on specific fluvial surfaces (PCC1 on floodplains, PCC2 on primary floodplain steps, PCC3 on secondary floodplain steps, and PCC4 on low terraces). These communities exist over the entire length of the site and vary slightly to moderately in plant community composition. Dominant plant associations can always be identified though. Plant community components are numbered from stream side outward to edge of riparian complex.

PCC	Plant Association	Fluvial Surface/Landform	Phases
1	Sandbar willow/Common threesquare	Floodplain	1.1, 3.1, 3.2, 3.3
2	Sandbar willow/ Prairie cordgrass	Primary Floodplain Step	1.1, 2.1, 2.2, 3.1, 3.2, 3.3
3	Eastern cottonwood/ Silver buffaloberry/ Prairie sandreed	Secondary Floodplain Step	1.1, 2.1, 2.2, 3.1, 3.2, 3.3
4	Eastern cottonwood/ Western wheatgrass	Low Terrace	1.1, 2.1, 2.2, 3.1, 3.2, 3.3
5	Silver sagebrush/ Western wheatgrass Silver sagebrush/ Praire sandreed	High Terrace (disconnected)	2.1, 2.2, 3.1, 3.2, 3.3

Plant Community Component 1

Narrative	This plant community is critical to maintaining the characteristic C channel morphology. Floodplain plant community representing the greenline vegetation and the stabilizing vegetation under the bankfull elevation. Most plants in potential condition are obligates; the soils are saturated most of the growing season on the floodplain immediately adjacent to the channel. Wetland indicator status is from the PLANTS database (http://plants.usda.gov/wetland.html) for USFWS Region 4 (ND, SD, MT - eastern, WY - eastern).

[PCC1] Plant Type – Woody Plant Overstory/Understory **0% of Community Composition**

Plant Symbol	Common Name	Scientific Name	Over-story (%)	Avg. DBH (in.)	Percent Canopy Cover		Avg. Canopy Height (feet)	
					Low	High	Bottom	Top
	none							

[PCC1] Plant Type - Grass/Grasslike **75% of Community Composition**

Group		Plant Symbol	Common Name	Scientific Name	Wetland Indicator Status	Annual Production (Lbs./Acre)		Percent Foliar Cover	
No.	Name					Low	High	Low	High
1	Perennial grass	PASM	Western wheatgrass	*Pascopyrum smithii*	FACU	0	50	0	1
		SPPE	Prairie cordgrass	*Spartina pectinata*	FACW	50	100	0	5
2	Grass-likes	SCPU10	Common threesquare	*Schoenoplectus pugens*	OBL	100	500	25	75
		ELPA5	Dwarf spikerush	*Eleocharis parvula*	OBL	100	500	20	60

[PCC1] Plant Type - Forbs **1% of Community Composition**

Group		Plant Symbol	Common Name	Scientific Name	Wetland Indicator Status	Annual Production (Lbs./Acre)		Percent Foliar Cover	
No.	Name					Low	High	Low	High
1	Forbs	EQLA	Smooth horsetail	*Equisetum laevigatum*	FACW	0	50	0	1

[PCC1] Plant Type - Shrubs **24% of Community Composition**

Group		Plant Symbol	Common Name	Scientific Name	Wetland Indicator Status	Annual Production (Lbs./Acre)		Percent Foliar Cover	
No.	Name					Low	High	Low	High
1	Shrubs	SAIN3	Sandbar willow	*Salix interior*	FACW	100	500	0	10

[PCC1] Plant Type – Other; Ferns, Mosses, etc **0% of Community Composition**

Group		Plant Symbol	Common Name	Scientific Name	Wetland Indicator Status	Percent Canopy Cover		Percent Foliar Cover	
No.	Name					Low	High	Low	High
	none								

[PCC1] Annual Production by Plant Type Table

	Annual Production (air-dry lbs/ac) [1/]		
Plant Type	**Low**	**RV**	**High**
Grass/Grasslikes	250	559	1,150
Forbs	0	11	50
Shrubs/Vines	100	178	500
Trees	0	0	0
Totals	350	748	1,700

[1/] NI = Not Inventoried: annual weight not determined.

[PCC1] Percent Canopy and Ground Cover by Material Type

Summary Category	Low	High
Foliar Cover	90	100
Bare Ground	0	10
Basal Cover	0	5
Total Ground Cover	90	100
Ground Cover Between-Plant Cover	0	10
Ground Cover Under-Plant Cover	10	50
Total Litter	10	50

[PCC1] Soil Surface Cover

Soil Surface Category	Low	High
Bedrock		
Boulders		
Cobbles		
Gravel		
Rock Fragment		
Soil	95	100
Stones		

[PCC1] Canopy Gaps

	Canopy Gaps				
Gap Size (feet)	**<1**	**1–2**	**2.1–3**	**3.1–6**	**>6**
Percent	0	0	0	0	100

Plant Community Component 2

Narrative	This plant community is on the primary floodplain step only slightly higher in elevation than the saturated plant community, PCC1. The primary floodplain step supports a shrub dominant community comprosed primarly of sandbar willow. The dominant graminoid species is prairie cordgrass with lesser amounts of Canada wildrye, Macoun's wildrye, common threesquare, western wheatgrass, and scratchgrass; various forbs include American licorice, white prairie aster, cuman ragweed, and rough cocklebur. Non-native species such as Kentucky bluegrass, quackgrass, smooth brome, leafy spurge, and sweetclover (both yellow and white) may also be present. The non-native species grasses replace the native sedges and grasses that comprise the fibrous rooted functional groups within the reference plant community. Wetland indicator status is from the PLANTS database (http://plants.usda.gov/wetland.html) for USFWS Region 4 (ND, SD, MT - eastern, WY - eastern).

[PCC2] Plant Type – Woody Plant Overstory/Understory **5% of Community Composition**

Plant Symbol	Common Name	Scientific Name	Over-story (%)	Avg. DBH (in.)	Percent Canopy Cover		Avg. Canopy Height (feet)	
					Low	High	Bottom	Top
PODE3	Eastern cottonwood	*Populus deltoides*	1		0	1	1	10

[PCC2] Plant Type - Grass/Grasslike **30% of Community Composition**

Group		Plant Symbol	Common Name	Scientific Name	Wetland Indicator Status	Annual Production (Lbs./Acre)		Percent Foliar Cover	
No.	Name					Low	High	Low	High
1	Warm-season perennial grasses	SPPE	Prairie cordgrass	*Spartina pectinata*	FACW	200	1800	20	60
		MUAS	Scratchgrass	*Muhlenbergia asperifolia*	FACW	0	50	0	1
2	Cool-season perennial grasses	ELCA4	Canada wildrye	*Elymus Canadensis*	FACU	0	50	0	10
		ELRE4	Quackgrass	*Elymus repens*	FAC	0	50	5	15
		PASM	Western wheatgrass	*Pascopyrum smithii*	FACU	0	50	0	5
		ELMA8	Macoun's barley	*Elyhordeum macounii*	FAC	50	100	0	1
		BRIN2	Smooth brome	*Bromus inermis*		0	50	0	1
		POPR	Kentucky bluegrass	*Poa pratensis*	FACU	0	50	0	1
3	Grass-likes	SCPU10	Common threesquare	*Schoenoplectus pugens*	OBL	0	50	0	1

[PCC2] Plant Type - Forbs **25% of Community Composition**

Group		Plant Symbol	Common Name	Scientific Name	Wetland Indicator Status	Annual Production (Lbs./Acre)		Percent Foliar Cover	
No.	Name					Low	High	Low	High
1	Forb	GLLE3	American licorice	*Glycyrrhiza lepidota*	FACU	500	1000	5	25
		SYFA	White prairie aster	*Symphyotrichum falcatum*	FAC	0	50	0	5
		XAST	Rough cocklebur	*Xanthium strumarium*	FAC	0	50	0	1
		EUES	Leafy spurge	*Euphorbia esula*		0	50	0	10
		AMPS	Cuman ragweed	*Ambrosia psilostachya*	FAC	0	50	0	5

[PCC2] Plant Type - Shrubs **40% of Community Composition**

Group		Plant Symbol	Common Name	Scientific Name	Wetland Indicator Status	Annual Production (Lbs./Acre)		Percent Foliar Cover	
No.	Name					Low	High	Low	High
1	Shrubs	SAIN3	Sandbar willow	*Salix interior*	FACW	500	1500	10	30
		SAAM2	Peachleaf willow	*Salix amygdaloides*	FACW	50	100	0	5

[PCC2] Plant Type – Other; Ferns, Mosses, etc **0% of Community Composition**

Group		Plant Symbol	Common Name	Scientific Name	Wetland Indicator Status	Percent Canopy Cover		Percent Foliar Cover	
No.	Name					Low	High	Low	High
	none								

[PCC2] Annual Production by Plant Type Table

	Annual Production (air-dry lbs/ac) [1/]		
Plant Type	**Low**	**RV**	**High**
Grass/Grasslikes	250	1,500	2,250
Forbs	500	800	1,200
Shrubs/Vines	550	1,000	1,600
Trees[1]	NI	NI	NI
Totals	1,300	3,300	5,050

[1/] NI = Not Inventoried: annual weight not determined.

[PCC2] Percent Canopy and Ground Cover by Material Type

Summary Category	Low	High
Foliar Cover	75	100
Bare Ground	5	15
Basal Cover	0	0
Total Ground Cover	85	95
Ground Cover Between-Plant Cover	30	60
Ground Cover Under-Plant Cover	0	25
Total Litter	30	60

[PCC2] Soil Surface Cover

Soil Surface Category	Low	High
Bedrock		
Boulders		
Cobbles		
Gravel		
Rock Fragment	0	58
Soil	42	100
Stones		

[PCC2] Canopy Gaps

	Canopy Gaps				
Gap Size (feet)	**<1**	**1–2**	**2.1–3**	**3.1–6**	**>6**
Percent	5-10	15-20	15-20	30-35	25-30

Plant Community Component 3

Narrative	This plant community is on secondary floodplain steps only slightly higher in elevation than PCC2. The secondary floodplain step community provides favorable habitat for the regeneration of eastern cottonwood. Dominant grass species include prairie sandreed and western wheatgrass with lesser amounts of Canada wildrye, marsh muhly, and barnyardgrass; various forbs include American licorice, manyflowered aster, white sage, black medick, and smooth horsetail. Non-native species such as Kentucky bluegrass, smooth brome, leafy spurge, and sweetclover (both yellow and white) may also be present. The non-native grass species replace the native sedges and grasses that comprise the fibrous rooted functional groups within the reference plant community. Wetland indicator status is from the PLANTS database (http://plants.usda.gov/wetland.html) for USFWS Region 4 (ND, SD, MT - eastern, WY - eastern).

[PCC3] Plant Type – Woody Plant Overstory/Understory **20% of Community Composition**

Plant Symbol	Common Name	Scientific Name	Over-story (%)	Avg. DBH (in.)	Percent Canopy Cover		Avg. Canopy Height (feet)	
					Low	High	Bottom	Top
PODE3	Eastern cottonwood	*Populus deltoides*	<5	0.3	0	1	5	13

[PCC3] Plant Type - Grass/Grasslike **60% of Community Composition**

Group		Plant Symbol	Common Name	Scientific Name	Wetland Indicator Status	Annual Production (Lbs./Acre)		Percent Foliar Cover	
No.	Name					Low	High	Low	High
1	Cool-season perennial grasses	ELCA4	Canada wildrye	*Elymus Canadensis*	FACU	0	50	0	5
		BRIN2	Smooth brome	*Bromus inermis*		0	50	10	30
		PASM	Western wheatgrass	*Pascopyrum smithii*	FACU	100	500	10	30
		POPR	Kentucky bluegrass	*Poa pratensis*	FACU	0	50	0	5
2	Warm-season perennial grasses	CALO	Prairie sandreed	*Calamovilfa longifolia*		50	100	5	25
		MURA	Marsh muhly	*Muhlenbergia racemosa*	FACW	0	50	0	1
3	Annual grasses	ECCR	Barnyardgrass	*Echinochloa crus-galli*	FACW	0	50	0	1

[PCC3] Plant Type - Forbs **20% of Community Composition**

Group		Plant Symbol	Common Name	Scientific Name	Wetland Indicator Status	Annual Production (Lbs./Acre)		Percent Foliar Cover	
No.	Name					Low	High	Low	High
1	Forbs	ARLU	White sagebrush	*Artemisia ludoviciana*	FACU	0	50	0	1
		EUES	Leafy spurge	*Euphorbia esula*		0	200	0	20
		EQLA	Smooth horsetail	*Equisetum laevigatum*	FACW	50	100	0	5
		GLLE3	American licorice	*Glycyrrhiza lepidota*	FACU	100	500	0	5
		SYERP2	Manyflowered Aster	*Symphyotrichum ericoides*	FAC	0	50	0	1
		MELU	Black medick	*Medicago lupulina*	FACU	0	50	0	1
		CHENO	Goosefoot	*Chenopodium*		0	50	0	1

[PCC3] Plant Type - Shrubs **0% of Community Composition**

Group		Plant Symbol	Common Name	Scientific Name	Wetland Indicator Status	Annual Production (Lbs./Acre)		Percent Foliar Cover	
No.	Name					Low	High	Low	High
1	Shrubs	SHAR	Silver buffaloberry	*Shepherdia argentea*		NI	NI	NI	NI

[PCC3] Plant Type – Other; Ferns, Mosses, etc **0% of Community Composition**

Group		Plant Symbol	Common Name	Scientific Name	Wetland Indicator Status	Percent Canopy Cover		Percent Foliar Cover	
No.	Name					Low	High	Low	High
	none								

[PCC3] Annual Production by Plant Type Table

	Annual Production (air-dry lbs/ac) [1/]		
Plant Type	**Low**	**RV**	**High**
Grass/Grasslikes	150	500	850
Forbs	150	500	1,000
Shrubs/Vines	0	0	0
Trees[1]	NI	NI	NI
Totals	300	1,000	1,850

[1/] NI = Not Inventoried: annual weight not determined.

[PCC3] Percent Canopy and Ground Cover by Material Type

Summary Category	Low	High
Foliar Cover	40	70
Bare Ground	25	40
Basal Cover	0	5
Total Ground Cover	60	90
Ground Cover Between-Plant Cover	25	40
Ground Cover Under-Plant Cover	0	5
Total Litter	25	40

[PCC3] Soil Surface Cover

Soil Surface Category	Low	High
Bedrock		
Boulders		
Cobbles		
Gravel		
Rock Fragment		
Soil	99	100
Stones		

[PCC3] Canopy Gaps

	Canopy Gaps				
Gap Size (feet)	**<1**	**1–2**	**2.1–3**	**3.1–6**	**>6**
Percent	0	0	0	45	55

Plant Community Component 4

Narrative	The plant community occurs on low terraces adjacent to PCC2 and PCC3 is dominated by mature eastern cottonwood and western wheatgrass. It provides the only source of coarse woody debris to the system and is important habitat for animals as cover, food, and shelter; it is often a travel corridor as well. Non-native species which occur on this site include Kentucky bluegrass, smooth bromegrass , leafy spurge, yellow sweetclover, and knapweed. Rocky Mountain juniper also will be found on invading into this plant community component from adjacent upland sites. Wetland indicator status is from the PLANTS database (http://plants.usda.gov/wetland.html) for USFWS Region 4 (ND, SD, MT - eastern, WY - eastern).

[PCC4] Plant Type – Woody Plant Overstory/Understory **60% of Community Composition**

Plant Symbol	Common Name	Scientific Name	Over-story (%)	Avg. DBH (in.)	Percent Canopy Cover		Avg. Canopy Height (feet)	
					Low	High	Bottom	Top
PODE3	Eastern cottonwood	*Populus deltoides*	60	0.86	0	15	10	25.4

[PCC4] Plant Type - Grass/Grasslike **30% of Community Composition**

Group		Plant Symbol	Common Name	Scientific Name	Wetland Indicator Status	Annual Production (Lbs./Acre)		Percent Foliar Cover	
No.	Name					Low	High	Low	High
1	Cool-season perennial grasses	ELCA4	Canada wildrye	*Elymus Canadensis*	FACU	0	50	0	1
		PASM	Western wheatgrass	*Pascopyrum smithii*	FACU	100	500	0	5
		HECO26	Needle and thread	*Hesperostipa comata*		50	100	0	5
		ACHY	Indian ricegrass	*Achnatherum hymenoides*		0	50	0	5
		KOMA	Prairie Junegrass	*Koeleria macrantha*		0	50	0	5
		POPR	Kentucky bluegrass	*Poa pratensis*	FACU	0	150	0	40
		BRIN2	Smooth brome	*Bromus inermis*		0	50	0	5
2	Warm-season perennial grasses	CALO	Prairie sandreed	*Calamovilfa longifolia*		100	1500	10	50
		SCSC	Little bluestem	*Schizachyrium scoparium*	FACU	0	750	0	40
		ARLO16	Red threeawn	*Aristida longespica*		0	50	0	1
		BOGR2	Blue grama	*Bouteloua gracillis*		0	50	0	5

[PCC4] Plant Type - Forbs **10% of Community Composition**

Group		Plant Symbol	Common Name	Scientific Name	Wetland Indicator Status	Annual Production (Lbs./Acre)		Percent Foliar Cover	
No.	Name					Low	High	Low	High
1	Forbs	DACA7	White prairie clover	*DACA7*		0	200	0	1
		ARLU	White sagebrush	*Artemisia ludoviciana*	FACU	0	50	0	5
		DAPU5	Purple prairie clover	*Dalea purpurea*		0	50	0	1
		POVE	Whorled milkwort	*Polygala verticillata*		0	20	0	1
		CHVI10	Hairy false goldenaster	*Chrysopsis villosa*		0	50	0	10
		COUM	Bastard toadflax	*Comandra umbellata*		0	15	0	1
		GACO5	Scarlet beeblossom	*Gaura coccinea*		0	15	0	1
		SYFA	White prairie aster	*Symphyotrichum falcatum*		0	15	0	10
		CEAR4	Field chickweed	*Cerastium arvense*		0	15	0	1
		LIRI	Stiffstem flax	*Linum rigidum*		0	15	0	1
		CHSE6	Thymeleaf sandmat	*Chamaesyce serpyllifolia*		0	15	0	1
		SOMI2	Missouri goldenrod	*Solidago missouriensis*		0	50	0	1
		EUES	Leafy spurge	*Euphorbia esula*		0	50	0	1
		OLRIR	Stiff goldenrod	*Oligoneuron rigidum*		0	50	0	20
		ANNE	Field pussytoes	*Antennaria neglecta*		0	50	0	5
		AMPS	Cuman ragweed	*Ambrosia psilostachya*	FAC	0	50	0	10
		MEOF	Sweetclover	*Melilotus officinalis*	FACU-	0	500	0	20

		MELU	Black medick	*Medicago lupulina*	FACU	0	50	0	5
		MESA	Alfalfa	*Medicago sativa*		0	200	0	5

[PCC4] Plant Type - Shrubs **0% of Community Composition**

Group		Plant Symbol	Common Name	Scientific Name	Wetland Indicator Status	Annual Production (Lbs./Acre)		Percent Foliar Cover	
No.	Name					Low	High	Low	High
1	Shrubs	SHAR	Silver buffaloberry	*Shepherdia argentea*		50	500	0	20
		SYOC	Western snowberry	*Symphoricarpos occidentalis*		0	50	0	5
		ARCA13	Silver sagebrush	*Artemisia cana*		100	750	0	5
		ARTR	Skunkbrush sumac	*Rhus trilobata*		0	50	0	5

[PCC4] Plant Type – Other; Ferns, Mosses, etc **0% of Community Composition**

Group		Plant Symbol	Common Name	Scientific Name	Wetland Indicator Status	Percent Canopy Cover		Percent Foliar Cover	
No.	Name					Low	High	Low	High
	none								

[PCC3] Annual Production by Plant Type Table

	Annual Production (air-dry lbs/ac) [1/]		
Plant Type	**Low**	**RV**	**High**
Grass/Grasslikes	150	1,600	3,200
Forbs	0	750	1,500
Shrubs/Vines	150	800	1,500
Trees	NI	NI	NI
Totals	300	3,150	6,200

[1/] NI = Not Inventoried: annual weight not determined.

[PCC4] Percent Canopy and Ground Cover by Material Type

Summary Category	Low	High
Foliar Cover	60	90
Bare Ground	0	5
Basal Cover	0	5
Total Ground Cover	70	95
Ground Cover Between-Plant Cover	10	50
Ground Cover Under-Plant Cover	50	80
Total Litter	70	90
Litter Between-Plant Cover	10	30
Litter Under-Plant Cover	50	80

[PCC4] Soil Surface Cover

Soil Surface Category	Low	High
Bedrock	0	0
Boulders	0	0
Cobbles	0	0
Duff	0	0
Embedded Litter	0	0
Gravel	0	0
Visible Lichen	0	0
Moss	0	5
Rock Fragment	0	0
Soil	95	100
Stones	0	0

[PCC4] Standing and Downed Wood

Material Type (downed wood size classes)	Low % Cover	High % Cover	Decomposition Class [1/]
Fine-small (<0.40" dia.; 1-hour fuels)	0	75	
Fine-medium (0.40-0.99" dia.; 10-hour fuels)			
Fine-large (1.00-2.99" dia.; 100-hour fuels)			
Coarse-small (3.00-8.99" dia.; 1,000-hour fuels)	0	30	
Coarse-large (>9.00" dia.; 10,000-hour fuels)			
Material Type (standing wood; snag type)	**Low No./Ac**	**High No./Ac**	
Tree snags [2/] (Hard [3/])			
Tree snags [2/] (Soft [3/])			

[1/] Enter predominant class. N=no or little integration with the soil surface; I=partial to nearly full integration with the soil surface.
[2/] Snags are >4.0" diameter at 4.5' above ground and > 6.0' height -- if less diameter OR height use applicable downed wood type; for Pinyon and Juniper, use 1.0' above ground.
[3/] Hard=tree is dead with most or all of bark intact; Soft=most of bark has sloughed off.

[PCC4] Canopy Gaps

	Canopy Gaps				
Gap Size (feet)	**<1**	**1–2**	**2.1–3**	**3.1–6**	**>6**
Percent	0	0	43	14	43

Plant Community Component 5

Narrative	The plant community occurs on high terraces that are disconnected from the riparian complex due to past entrenchment. Two upland ecological sites have been documented to occur on the high terraces, a loamy terrace and a sandy terrace. The plant communities associated with the loamy terrace ecological site are dominated by silver sagebrush and western wheatgrass. The plant communities associated with the sandy terrace dominated by silver sagebrush and prairie sandreed.

ECOLOGICAL SITE INTERPRETATIONS

Management Implications

The potential natural channel or reference channel that is documented in State 1 is rarely found due to past disturbances and the extreme level of entrenchment and widening of the stream system. To recover State 1 connectivity between the channel and the original floodplain would need to be reestablished. This will not happen naturally within this site and would only be accomplished through a significant input of time and resources that is not economically feasible. Thus, management goals should be directed at maintaining the stable channels documented in State 3 (especially phase 3.2) and not at recovering the reference state.

Grazing management to maintain stable analogue channels found in State 3. Control the timing, frequency, and intensity of grazing animals. When developing a plan timing needs to consist of shorter grazing periods, and allow for adequate periods of rest to maintain sufficient stubble height and riparian vegetation to shield and stabilize banks during high flow events. Another aspect of timing that needs to be addressed in a plan is season of use. Spring grazing can be beneficial to riparian ecosystems when located in pastures that also include upland ecological sites, as upland vegetation is more palatable at this time, resulting in more uniform utilization. Fall and winter grazing also promotes the health of riparian ecosystems as bank compaction is not generally a concern at this time since banks are either dry or froze. When grazing in the fall and winter it is critical to monitor utilization to maintain adequate stubble height. It is important to monitor utilization of woody species when grazing in the fall and winter as use of these species is increased due to increased palatability. To mitigate for soil compaction and other negative impacts to riparian ecosystems when in pastures with upland ecological sites, off–site water and supplements need to be included in the management plan. It is important to understand that overgrazing results in reduced root mass of native species and shifts the competitive advantage to shallow rooted introduced graminoid species: including Kentucky bluegrass and quackgrass. This invasion results in decreased bank stability and infiltration, increasing sedimentation and runoff. Exclusion of grazing from riparian ecosystems also favors shallow rooted introduced graminoid species: including smooth bromegrass and Kentucky bluegrass.

Grazing management to facilitate the transition from State 2 (unstable channels) to State 3 (stable analogue channels). Utilizing a high intensity low frequency grazing system helps break down the streambanks of the F channel and facilitates the development of a new floodplain within the entrenchment. Spring grazing is recommended to aid in the development of the new floodplain. It is critical to manage grazing during new floodplain development to promote the growth of riparian species and the return of PCC1 to stabilize banks. Sufficient recover period is essential to allow for the return of riparian species. This could be achieved through deferment, rest, or the creation of separate riparian pastures. However, it is important to maintain grazing activity within the adjacent uplands to prevent the spread of introduced species.

Animal Community

The channels that make up both State 1 and State 3 (the stable analogues) are utilized by a variety of terrestrial and aquatic wildlife species. The channels in States 1 and 3 have a well developed floodplain that supports riparian plant communities comprised of a variety of plant lifeforms including graminoids, shrubs, and trees. The diversity in plant species and communities associated with these sites provides higher value habitat for a greater diversity of wildlife species. Terrestrial species utilize the site for water, food, and cover. The healthy riparian community associated with this site supports willows and other woody species that stabilize banks and provide instream cover, providing habitat for aquatic species. However, the uplands associated with State 3 are vulnerable to invasion by the non-native graminoid species Kentucky bluegrass and smooth bromegrass, which have been linked to a decrease in plant community diversity and a decline in wildlife habitat. When these species become established within the floodplain there is a decrease in bank stability and water quality, resulting in decreased suitable habitat for aquatic species.

The following species have been observed utilizing channels in State 3 associated with this site:

- Avian: magpie, gray catbird, eastern kingbird, western kingbird, black-capped chickadee, prairie falcon, turkey vulture, Canada goose, redtailed hawk, American Kestral, western flycatcher, wild turkey
- Mammals: white-tailed deer, fox squirrel, American elk, raccoon, American mink, American beaver, and coyote.
- Insects: dragonflies
- Crustaceans: crayfish
- Reptiles: prairie rattlesnake

The State 2 stream channels have lost connectivity with the floodplain making them difficult for terrestrial wildlife species to access. PCC1 is lost in State 2; the loss of PCC1 is accompanied by a loss of instream habitat due to decreased shading. Channels in State 2 Phase 2 which are classified as a F channel have shallower water providing less usable habitat for fish and other aquatic species. There is no floodplain associated with these sites; thus there is little to no shading of the stream from the adjacent plant community. The shallow water depths and loss of shade contribute to elevated water temperatures and a decline in suitable habitat for aquatic species.

The following species have been observed utilizing F channels associated with this site:

- Avian: belted kingfisher, chickadee, western flycatcher, American crow, great blue heron, and spotted towhee.
- Mammals: white-tailed deer, coyote, raccoon, and American mink.
- Amphibians: northern leopard frog

For additional information on wildlife species that utilize riparian ecosystems in western North Dakota please refer to the following resources:

- Grondahl, C. and S. Gomes. No Date. Songbirds of North Dakota. NorthDakota Game and Fish Department, Bismarck, ND. Jamestown, ND: NorthernPrairie Wildlife Research Center Online. http://www.npwrc.usgs.gov/resource/birds/songbird/songbird.htm
- Gomes, Scott. No Date. Marshbirds and shorebirds of North Dakota. North Dakota Game and Fish Department, Bismarck, ND. Jamestown, ND: Northern Prairie Wildlife Research Center Online. http://www.npwrc.usgs.gov/resource/birds/marshbrd/index.htm
- Gomes, Scott. No Date. Hawks, eagles, and falcons of North Dakota. North Dakota Game and Fish Department, Bismarck, ND. Jamestown, ND: Northern Prairie Wildlife Research Center Online. http://www.npwrc.usgs.gov/resource/birds/hawks/index.htm
- North Dakota Game and Fish Department. 1986. Fishes of North Dakota. North Dakota Game and Fish Department, Bismarck, ND. Northern Prairie Wildlife Research Center Online. http://www.npwrc.usgs.gov/resource/fish/ndfishes/index.htm
- Hoberg, Ted and Cully Gause. 1992. Reptiles and amphibians of North Dakota. North Dakota Outdoors 55(1):7-19. Jamestown, ND: Northern Prairie Wildlife Research Center Online. http://www.npwrc.usgs.gov/resource/herps/amrepnd/index.htm
- Seabloom, Robert W., Richard D. Crawford, and Michael G. McKenna. 1978. Vertebrates of southwestern North Dakota: Amphibians, reptiles, birds, mammals. Institute for Ecological Studies, University of North Dakota, Grand Forks, ND. Jamestown, ND: Northern Prairie Wildlife Research Center Online. http://www.npwrc.usgs.gov/resource/mammals/mammswnd/index.htm
- http://www.mammalsociety.org/mammals-north-dakota
- http://gf.nd.gov/wildlife/fish-wildlife/id/mammals
- Hagen, Sandra K., Patrick T. Isakson, and Steve R. Dyke. 2005. North Dakota Comprehensive WildlifeConservation Strategy. North Dakota Game and Fish Department. Bismarck, ND. 454 pp. http://gf.nd.gov/gnf/conservation/docs/North-Dakota-Wildlife-Action-Plan.pdf

Hydrologic Regime

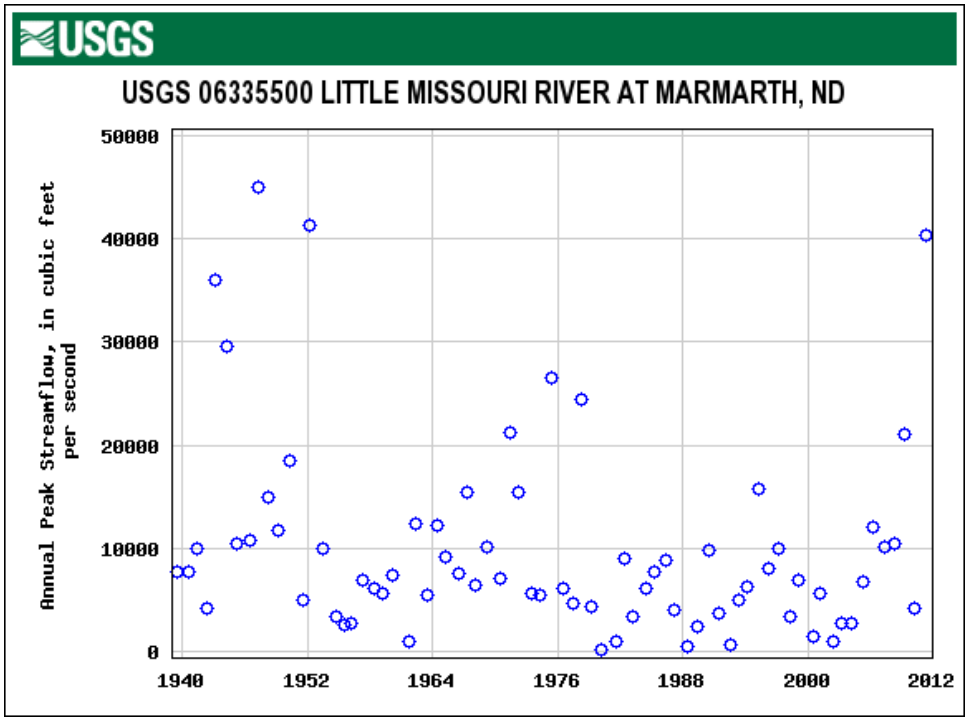
The headwaters of the Little Missouri River are located in northeastern Wyoming. The flows of the Little Missouri River are a function of ground water and runoff. The majority of the land within the basin of the Little Missouri River is rangeland. Changes in climate, landuse, woody encroachment in the uplands, and oil and gas development have resulted in a reduction of peak flows over the last 60 to 80 years that has significantly impacted the hydrology of the system resulting in decreased streamflows and floodplain development (Miller and Friedman 2009). Peak flows typically occur in late March and early April in concurrence with snow-melt, ice breakup, and spring rain. The system is currently recovering from the last major flood that occurred in 2011. Floods of this magnitude occur approximately every 20 to 30 years within this system with smaller magnitude floods recur once every 5 to 10 years.

USGS Streamflow Data is available for the upper portion of the Little Missouri River at Marmarth, ND (06335500), the middle portion of the Little Missouri River at Medora, ND (06336000), and the lower portion of the Little Missouri

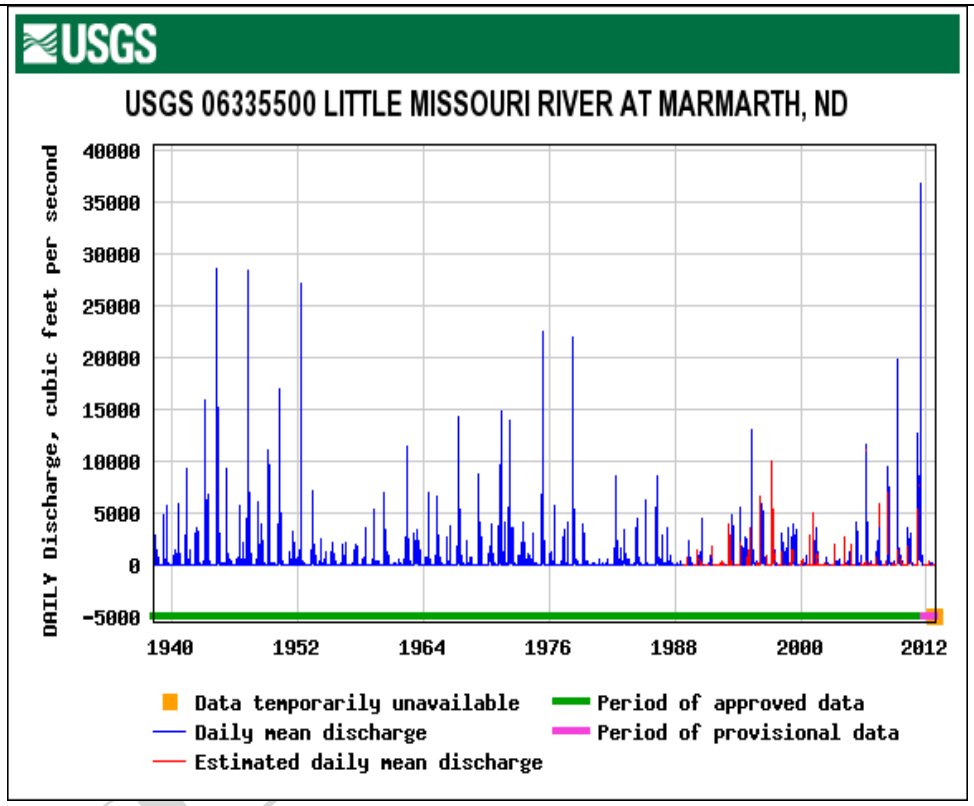
River at Watford City, ND (06337000). The Little Missouri River is an undammed, free flowing river. Additional information is available at the USGS National Water Information Website: http://waterdata.usgs.gov/nwis/ .

The Little Missouri River watershed encompasses an area of 5,318,400 acres of which, 3,040,000 acres are located in North Dakota.

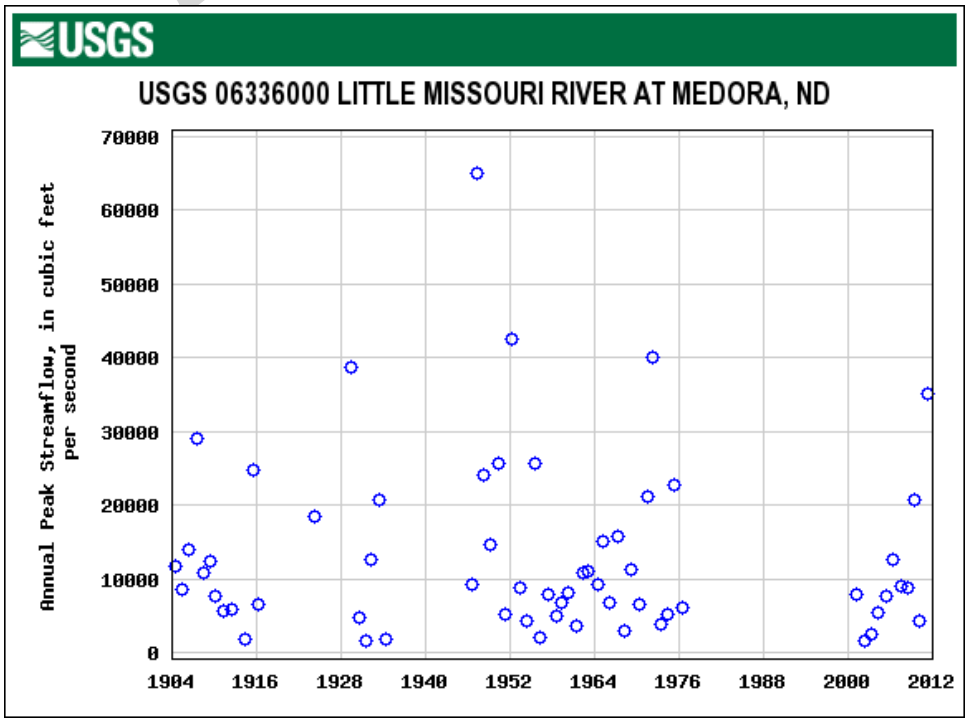
The following graphs depict long and short changes in the peak and daily flows at gauges located on the upper (Marmarth, ND), middle (Medora, ND), and lower (Watford City, ND) portions of the Little Missouri River.



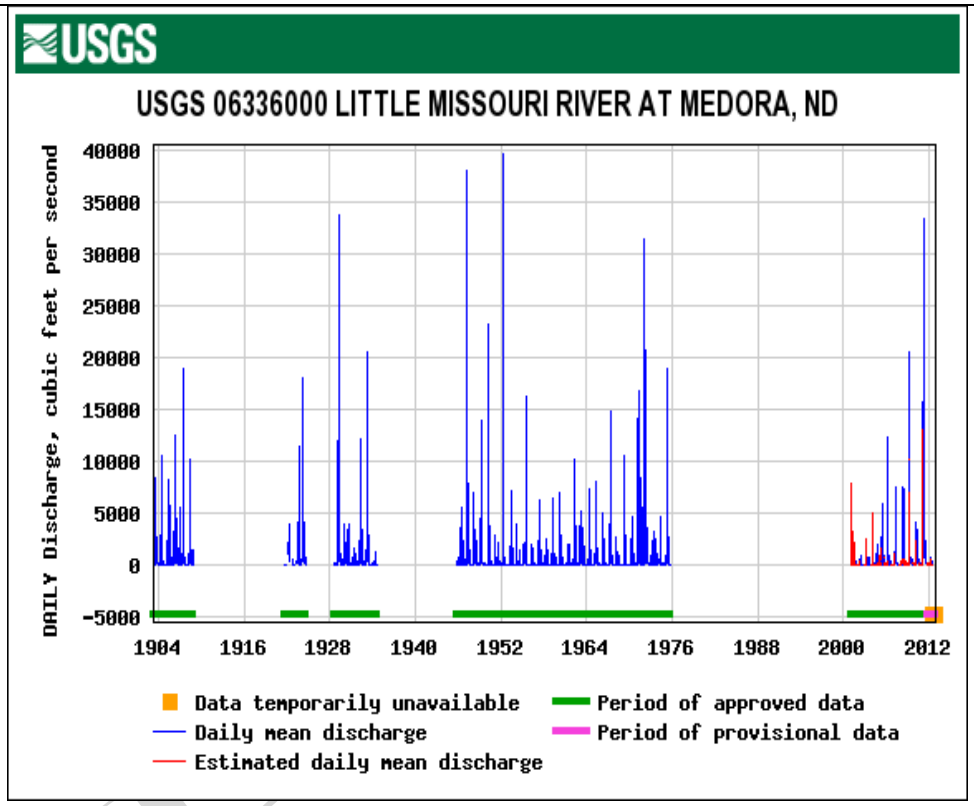
Marmarth, ND annual peak streamflow.



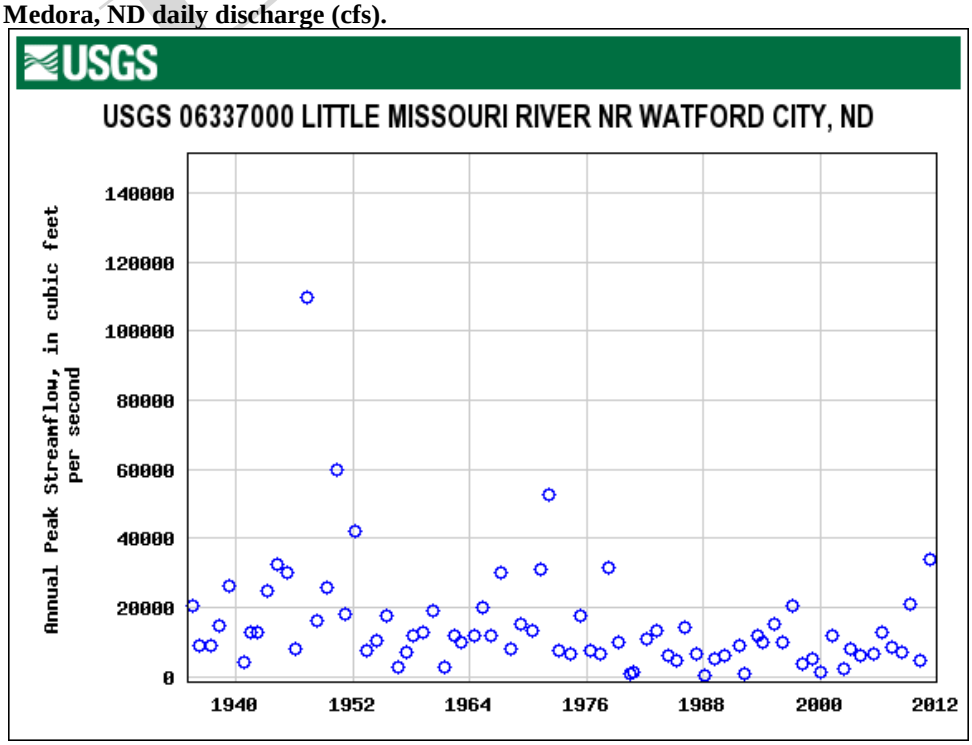
Marmarth, ND daily discharge (cfs).



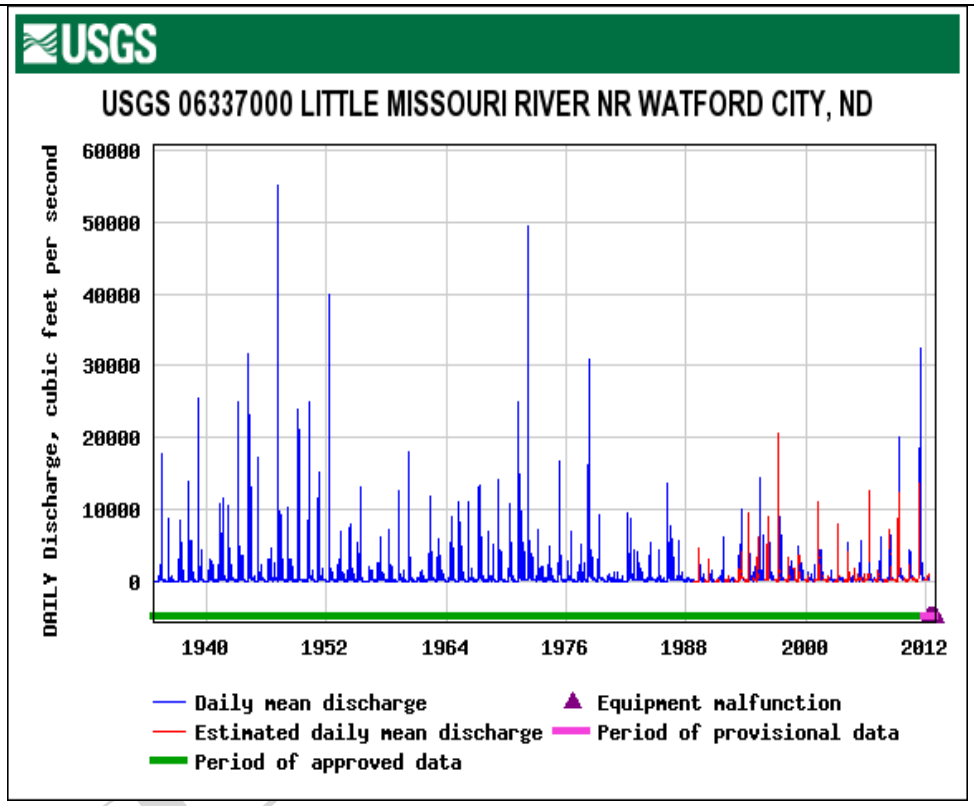
Medora, ND annual peak streamflow.



Medora, ND daily discharge (cfs).



Watford City, ND annual peak streamflow.



Watford City, ND daily discharge (cfs).

Recreational Uses

Portions of this stream fall within both the North and South Units of Theadore Roosevelt National Park and within the Dakota Prairie National Grasslands making it popular for recreational uses including: canoeing, fishing, camping, hiking, biking, horseback riding, and hunting.

Wood Products

Despite the wooded areas found in association with the Little Missouri River, wood products are not harvested from this area.

SUPPORTING INFORMATION

Associated Sites

Site Name	Site Number	Narrative
Northern Rolling Plains, Northeastern Part, Intermittent Riparian Complex	058CY000ND	This site description cover intermittent streams that are tributaries to the perennial streams in MLRA 58C.
Loamy terrace	NA	This site develops on the high terraces that are adjacemt to the site but are no longer hydrologically influenced by the stream.
Sandy terrace	NA	This site develops on the high terraces that are adjacent to the site but are no longer hydrologically influenced by the stream.

Similar Sites

Site Name	Site Number	Narrative
Northern Rolling Plains, Northeastern Part, Intermittent Riparian Complex	058CY000ND	This site description cover intermittent streams that are tributaries to the perennial streams in MLRA 58C.

Inventory Data References (Narrative)

Information presented was derived from NRCS clipping data, literature, field observations (based on 4 sampled sites and observations from numerous others), and personal contacts with range-trained personnel (i.e., used professional opinion of agency specialists, observations of land managers, and outside scientists).

Inventory Data References

Data Source	# of Records	Sample Period	State	County
Carlson McCain/NRCS	2	8/2012	ND	Billings

State Correlation

State	Date	Narrative
		Not Correlated Yet

Type Location

	Degrees	Minutes	Seconds	Decimal
Latitude	47	35	10	866
Longitude	103	16	50	772
	Datum	**Zone**	**Northing**	**Easting**
UTM	NAD83	13	5271758	629266
State	ND	**Township**	**Range**	**Section**
County	McKenzie	147N	99W	3
General Description	Reference for Phase 2.2 is near the CCC Campground and is the boundary between the North Unit of Theadore Roosevelt National Park and land managed by the US Forest Service.			

	Degrees	Minutes	Seconds	Decimal
Latitude	47	13	13	043
Longitude	103	37	51	847
	Datum	**Zone**	**Northing**	**Easting**
UTM	NAD83	13	5230553	603644
State	ND	**Township**	**Range**	**Section**
County	Billings	143N	102W	8
General Description	Reference for Phase 3.1 (Buckhorn Ranch Site) is managed by the US Forest Service. Collection point for vegetative data.			

	Degrees	Minutes	Seconds	Decimal
Latitude	47	14	28	979
Longitude	103	37	12	208
	Datum	**Zone**	**Northing**	**Easting**
UTM	NAD83	13	5232912	604436
State	ND	**Township**	**Range**	**Section**
County	Billings	144N	102W	33
General Description	Reference for Phase 3.1 (Elkhorn Ranch Site) is managed by the US Forest Service and Park Service.			

	Degrees	Minutes	Seconds	Decimal
Latitude	47	18	36	946
Longitude	103	37	49	545
	Datum	**Zone**	**Northing**	**Easting**
UTM	NAD83	13	5240552	603517
State	ND	**Township**	**Range**	**Section**
County	Billings	144N	102W	8
General Description	Reference for Phase 3.2 (Goldberry Site) is managed by the US Forest Service. Collection point for vegetative data.			

Relationship to Other Established Classifications

Utilizing Rosgen's Classification of Natural Channels to determine states, community phases, and the stream succession scenario.

Other References

Bestelmeyer, B., J.R. Brown, K.M. Havstad, B. Alexander, G. Chavez, J.E. Herrick. 2003. *Development and use of state and transition models for rangelands.* J. Range Manage. 56(2):114-126.

Bestelmeyer, B.,A.J. Tugel, G.L. Peacock, D.G. Robinett, P.L. Shaver, J.R. Brown, J.E. Herrick, H. Sanchez, and K.M. Havstad. 2009. *State-and-Transition Models for Heterogeneous Landscapes: A Strategy for Development and Application.* Rangeland Ecology and Management 62:1-15.

Briske, D. D., S. D. Fuhlendorf, and F. E. Smeins. 2006. *A Unified Framework for Assessment and Application of Ecological Thresholds*. Rangeland Ecology and Management 59:225–236.

Briske, D. D., B. T. Bestelmeyer, T. K. Stringham, and P. L. Shaver. 2008. *Recommendations for Development of Resilience-Based State-And-Transition Models*. Rangeland Ecology and Management 61:359–367.

Harrelson C. C., Rawlins, C. L. and Potyondy J. P. 1994. *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, General Technical Report RM-245, USDA - Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, 61 pages. Available at: http://www.stream.fs.fed.us/publications/documentsStream.html

Herrick, J.E. J.W. Van Zee, K.M. Havstad, L.M. Burkett, and W.G. Whitford. 2005. *Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems. Volume I Quick Start.* USDA - ARS Jornada Experimental Range, Las Cruces, New Mexico. Available at: http://usda-ars.nmsu.edu/monit_assess/monmanual_main.php.

Herrick, J.E. J.W. Van Zee, K.M. Havstad, L.M. Burkett, and W.G. Whitford. 2005. *Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems. Volume II: Design, Supplementary Methods and Interpretation.* USDA - ARS Jornada Experimental Range, Las Cruces, New Mexico. Available at: http://usda-ars.nmsu.edu/monit_assess/monmanual_main.php.

Kovalchik, B.L. and L.A. Chitwood, 1990. *Use of Geomorphology in the Classification of Riparian Plant Associations in Mountainous Landscapes of Central Oregon, U.S.A.* Forest Ecology and Management 33/34:405-418.

Miller, J.R. and J.M. Friedman. 2009. *Influence of flow variability on floodplain formation and destruction, Little Missouri River, North Dakota*. Geological Societ y of America Bulletin 121(5-6):752-759.

Poole, G.C. and C.H. Berman, 2001. *An Ecological Perspective on In-Stream Temperature: Natural Heat Dynamics and Mechanisms of Human-Caused Thermal Degradation.* Environmental Management 27:787-802.

Pringle, C.M., R.J. Naiman, G. Bretschko, J. R. Karr, M.W. Osgood, J.R. Webster, R.L. Welcomme, and M.J. Winterbourn. 1988. *Patch Dynamics in Lotic Systems: the Stream as Mosaic*. The North American Benthological Society 7(4):503-524

Rosgen, D.L., 1994. *A Stream Classification System.* Catena, 22 169199. Elsevier Science, Amsterdam.

Rosgen, D.L., 1996. *Applied River Morphology*. Wildland Hydrology Books, Pagosa Springs, Colorado, and Ft. Collins, CO.

Rosgen, D.L., 2006. *A Watershed Assessment for River Stability and Sediment Supply (WARSSS)*. Wildland Hydrology Books, Fort Collins, CO.

Schoeneberger, P.J., D.A. Wysocki, E.C. Benham, and W.D. Broderson (editors). 2002. *Field Book for Describing and Sampling Soils, Version 2.0*. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE.

Stringham, T.K., W.C. Krueger, and P.L. Shaver. 2003. *State and Transition Modeling: An Ecological Process Approach.* J. Range Manage 56: 106-113.

USDA, NRCS. 2008. (Electronic) *Field Office Technical Guide*. Available online at: http://efotg.nrcs.usda.gov/efotg_locator.aspx.

USDA, Natural Resource Conservation Service. 2004. *National Forestry Handbook*. Available online at: http://soils.usda.gov/technical/nfhandbook/

USDA, NRCS. 2007. *The PLANTS Database*. National Plant Data Center, Baton Rouge, LA 70874-4490 USA. Available online at: http://plants.usda.gov

USDA, NRCS. 2003. *National Range and Pasture Handbook*. Available online at: http://www.glti.nrcs.usda.gov/technical/publications/nrph.html

USDA, NRCS *Soil Survey Manuals* for appropriate counties within MLRA 58C.

USDA, NRCS, 2007. Southerland, W. B., *Technical Supplement 3E, National Engineering Handbook 654, Rosgen Stream Classification Technique – Supplemental Materials.*

USDA, USFS, 2010. *Fire Effects Information System Database*. Available online at: http://www.fs.fed.us/database/feis/

USDI, USGS, 2010. *National Water Information System*. Available online at: http://waterdata.usgs.gov/nwis/

Stream Visual Assessment Protocol Ver. 2 (SVAP2) Reference Worksheet

Author(s)/Participant(s)	M. Meehan, J. Printz				
Contact For Lead Author	Carlson McCain – Bismarck, ND				
Date	8/21/12	**Approval Date**		**Approved By**	
Notes	Assessment is based on best example of stable analogue (phase 3.2).				

Stream Assessment Reach. These descriptions apply to multiple reaches and represent the nominal reference or stable analogue conditions for the entire lotic riparian complex ecological site. Evaluate as many reaches as necessary to arrive at an assessment. The SVAP2 assessment for a reach should be completed during base flows when habitat feature limitations are likely to be most visible.

Stream Assessment Elements. These descriptions of assessment elements present a description of the potential of the site (either the reference or stable analogue state and community phase) and represent a score of 9 or 10 (excellent). Deviation from these conditions will indicate a lower score.

1. Channel Condition	Active channel and floodplain are connected throughout reach and flooded at regular intervals. CEM Stage I = 10, CEM Stage V = 9
2. Hydrologic Alteration	Bankfull or higher flows occur according to the flow regime that is characteristic of the site, generally every 1 to 2 years and no dams, dikes, or development in the flood plain, or water control structures are present and natural flow regime prevails.
3. Bank Condition (score left and right banks separately)	Banks are stable; protected by roots of natural vegetation, wood, and/or rock: No fabricated structures present on bank. No excessive erosion or bank failures. No uncontrolled or unprotected recreational or livestock access
4. Riparian Area Quantity (score left and right banks separately)	Natural plant community extends at least two bankfull widths or more than the entire active flood plain and is generally contiguous throughout property. (Streams in narrow, steep valleys with limited floodplains will have narrower riparian areas.).
5. Riparian Area Quality (score left and right banks separately)	Natural and diverse riparian vegetation with composition, density and age structure appropriate for the site. No invasive species or concentrated flows through area. Plant community has expected mix of native species (grasses, shrubs, and trees) of multiple age classes. In non-forested complexes, native grasses provide root masses that contribute to formation of undercut but stable banks; non-native invasive species are absent or small percentage of total cover
6. Canopy Cover	**Warm Water Streams** - 5% to 20% of water surface shaded within the length of the stream in landowner's property. (Do not score this element if the lotic riparian complex does not include woody shrubs and/or trees as components of the reference plant community.
7. Water Appearance	Water is very clear, or clarity appropriate to site (e.g., Plains and Southwestern streams contain relatively high loads of suspended sediments, thus streams are generally turbid during seasonal high flows. Similarly glacial-fed streams are naturally turbid. In such cases, water clarity should be scored according to suspended sediment conditions appropriate for the reference site. If streams have clear water under non-stormy conditions, submerged features in stream (rocks, wood) are visible at depths of 3 to 6 feet. No motor oil sheen on surface; no evidence of metal precipitates in streams.
8. Nutrient Enrichment	Clear water, or clarity appropriate to site, along entire reach, and moderate algal growth present.
9. Manure or Human Waste Presence	Livestock access to stream is controlled to protect site conditions and no discharge of animal waste or sewage enters stream directly. Note over-use of deer, elk or other wildlife as evidenced by loss of vegetation, especially willows and herbaceous species.
10. Pools	**Low-gradient streams (<2%)** - More than two deep pools/reach, each separated by riffle or fast water and with greater than 30% of the pool bottom obscured by depth, wood, or other cover. Shallow pools also present.
11. Barriers to Aquatic Species Movement	No artificial barriers that prohibit movement of aquatic organisms during any time of the year.
12. Fish Habitat Complexity	Ten or more habitat features available, at least one of which is considered optimal in reference sites (single logs, wood accumulations or jams, deep pools, secondary pools, overhanging vegetation, large boulders, clusters of small boulders, turbulent water, undercut banks, thick root mats, aquatic plants, side-channels, floodplain wetlands, alcoves).
13. Aquatic Invertebrate Habitat	At least nine types of habitat present A combination of wood with riffles should be present and suitable in addition to other types of habitat (If woody debris is not a component, consider reference site's optimal habitat type needed for high score, such as cobble substrates, boulder clusters, turbulent water, undercut banks, root mats, aquatic plants, leaves and other plant material deposited in stream).
14. Aquatic Invertebrate Community	Invertebrate community is diverse and well represented by group I or intolerant species. One or two species do not dominate. (Mayflies, caddis flies, stoneflies, riffle beetles).
15. Riffle Embeddedness	Not applicable for sand-bed or naturally silty/clayey streams, characteristic of lowlands, prairies, and bottomlands.)
16. Salinity (if applicable)	No wilting, bleaching, leaf burn or stunting of native riparian vegetation (check for oil/gas development contributions). No streamside salt-tolerant vegetation present unless naturally saline soils are present in the floodplain or terraces.