

County	Dawson	Upstream River Mile	94.6
Classification	PCM/I: Partially confined meandering/islands	Downstream River Mile	89
General Location	Glendive	Length	5.60 mi (9.01 km)

Narrative Summary

Reach D6 is located in Dawson County at Glendive. The reach is a 5.6 mile long Partly Confined Meandering reach type, extending from Black Bridge at RM 89.0 to downstream of Glendive at RM 94.6. The partial confinement is imposed by terraces and Hell Creek Formation bluff line. The reach is fairly straight, with minor bendways and several densely vegetated islands. Within Reach D6, the Yellowstone River has been directly affected by both urban/exurban development and the I-94 transportation corridor.

Reach D6 has almost a mile of bank armor including 2,930 feet of rock riprap, 1,200 feet of concrete riprap, and 760 feet of flow deflectors as mapped in 2011. About 8.3 percent of the total bankline is armored. Between 2001 and 2011, about 1,300 feet of rock riprap and 200 feet of flow deflectors were built, whereas 354 feet of concrete riprap were destroyed.

Prior to the 1950s, about three miles of side channel were blocked in the reach by physical features. Since then another three miles have been blocked such that a total of six miles of side channel have been blocked in this urbanized section of the Yellowstone River. The side channel losses occurred under the Interstate and near the mouth of Glendive Creek. In 1950, the side channel under the Interstate was almost three miles long before being blocked off.

Floodplain dikes have isolated historic floodplain area. There are 14,700 feet of floodplain dikes mapped in the reach, most of which was built between 1950 and 1976. There are also 23,736 feet of transportation encroachments. The encroachments associated with the railroad have been in place since 1950; however the length of bridge approaches increased substantially from 1950 to 1976, which is when I-94 was constructed. The large West Glendive Dike (RM 93.5) was constructed in 1957 by the US Army Corps of Engineers to protect the west Glendive area from Yellowstone River flooding.

There are five bridge crossings in Reach D6. The uppermost crossing is referred to as the BNSF "Black Bridge", which is a 1325 foot-long steel truss bridge at RM 94.5. There is a natural gas pipeline crossing at the bridge. Just downstream at RM 93.6, the "Old Bell Street Bridge" is a 1,290 foot long bridge that was originally built in 1894, then destroyed by ice in 1899, and rebuilt in 1924. It is currently preserved as a pedestrian bridge. Approximately 0.1 mile downstream, the Towne Street Bridge is a 1,318 foot-long steel girder/floor beam structure that was built in 1958. About 1.3 miles downstream from that structure, I-94 consists of two bridges built in 1968. These bridges are 2,013 and 1,973 feet long, and both are steel girder/floor beam structures. The I-94 bridges restrict about 200 acres of the CMZ.

Some of the most severe ice jamming in Montana occurs in Glendive. A total of 30 ice jam floods have occurred in the Glendive area since 1890 (COE, 2009). Descriptions of these and even older ice jams include loss of life (1894, 1899), bridge failure (1899) and major flooding (1899, 1936, 1969, 1986 and 1994). In 1980, FEMA concluded that the West Glendive Levee did not provide adequate protection from ice jam flooding (COE, 2009). According to the COE (2009), the majority of ice jams form downstream of the I-94 Bridge and its embankment, which acts as a flow obstruction on the left floodplain of the Yellowstone River. This embankment cuts off a side channel of the Yellowstone, "which may have historically provided a relief for floodwaters to flow around the ice jams" (COE, 2009).

Similar to many reaches on the Lower Yellowstone, the river has gotten smaller since 1950. At that time, the bankfull channel area in Reach D6 was 810 acres, and by 2001 it was 640 acres, which is a reduction of 21 percent. This has been accompanied by the encroachment of 134 acres of riparian vegetation into old channel areas. On the floodplain, however, riparian clearing has been notable; since 1950 over 400 acres of riparian vegetation was converted to another land use, which was 32 percent of the entire 1950s riparian footprint.

Floodplain turnover rates in Reach D6 have dropped from 4 acres per year prior to 1976 to 2 acres per year since then. This is also a common trend on the lower river, as the influences of bank armor and reduced flow energy have collectively slowed rates of channel change.

Land use is dominated by agriculture and urban/exurban development; although there is over 1,300 acres of urban, exurban, and transportation-related land uses, there are still over 3,100 acres of agricultural land. Most is non-irrigated, but 502 acres are in flood irrigation and 280 are in pivot. Between 1950 and 2011 approximately two square miles of land was converted to Urban and Exurban uses in the Glendive area. Much of this growth occurred in the now-leveed area on the west side of the river.

About 18 percent of the total 100-year floodplain has become isolated due to human development and most of that isolated floodplain area is behind floodplain dikes. The 5-year floodplain is even more affected; 51 percent of the historic 5-year floodplain is no longer inundated at that frequency.

Reach D6 was sampled as part of the fisheries study. A total of 27 fish species were sampled in the reach including three identified by the Montana Natural Heritage Program as a Species of Concern (SOC): the Blue Sucker, Sauger, and Sturgeon chub.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 100-year flood has dropped from 146,000 cfs pre-development to 125,000 cfs currently, which is a 14 percent reduction. The 2-year flood, which strongly influences overall channel form, has dropped by 22 percent. Summer base flows have dropped by 54 percent with human development, from 6,990 cfs to 3,210 cfs, a 54 percent reduction. In contrast, fall and winter base flows have both increased between 60 percent (winter) and 75 percent (fall). Fall and winter base flows are currently 2,030 and 2,110 cfs, respectively.

CEA-Related observations in Reach D6 include:

- Loss of side channels due to physical features
- Shrinking of channel due to flow consolidation and reduced high flows.
- Extensive transportation encroachment
- Dike construction post-1950 to facilitate urban/exurban development in West Glendive

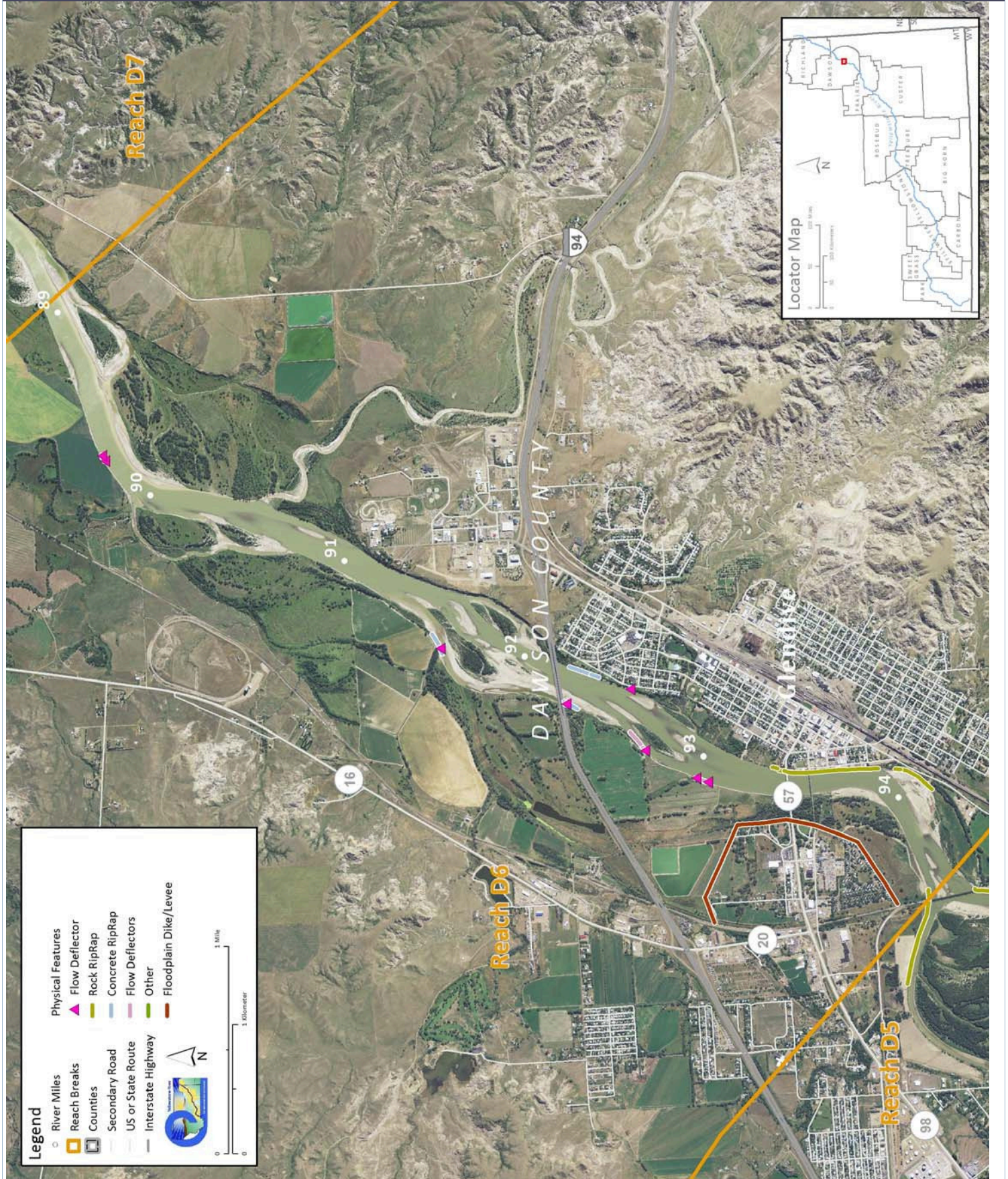
Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach D6 include:

- Bank armor removal at RM 92.8L
- Russian olive removal

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.		
2 Year (cfs)	69,400	54,200	-21.9%			
100 Year (cfs)	146,000	125,000	-14.4%			
Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	Bankfull channel area is the total footprint of the river inundated at approx. the 2-year flood.
	810.6	695.8	659.4	640.3	-170.4	
Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.		
Rock RipRap	2,933	5.0%	1,278			
Concrete Riprap	1,188	2.0%	-345			
Flow Deflectors	762	1.3%	173			
Total	4,882	8.3%	1,106			
Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	Numerous side channels have been blocked by small dikes.			
	16,884	16,597				
Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Turnover is associated with the creation of riparian habitat.		
Total Acres	103.6	49.8				
Acres/Year	4.0	2.0				
Acres/Year/Valley Mile	0.8	0.4	134.35 acres			
Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.	
Change in Area '50 - '01 (Ac)	37.4	9.5	7.4	54.3		
Floodplain Isolation	Acres	% of FP	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.			
5 Year	528.6	52%				
100 Year	354.0	18%				
Restricted Migration Area	Acres	% of CMZ	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.			
	326.0	18%				
Land Use	1950	2011	1950	2011	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.	
Agricultural Land (Ac)	3,201.5	3,067.3	Flood (Ac)	304.1	502.4	
Ag. Infrastructure (Ac)	27.4	70.7	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	231.2	Pivot (Ac)	0.0	279.4	
Urban (Ac)	563.1	987.6				
Transportation (Ac)	110.3	169.6				
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.	
	274.9	134.3	409.2	32.0%		
National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).		
Riverine	47.0	9.1	154.5			
Emergent	88.9	17.1				
Scrub/Shrub	18.6	3.6				
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.			
	7.1	0.5%				
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.	
	21.8	4.3	24.8	3.0		

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP

