

County	Sweet Grass	Upstream River Mile	456.4
Classification	PCS: Partially confined straight	Downstream River Mile	453.3
General Location	Below Big Timber	Length	3.10 mi (4.99 km)

Narrative Summary

Reach A6 is approximately 3.1 miles long, and is located below Big Timber. The reach is classified as Partially Confined Straight (PCS), which indicates some valley wall influences on river form and minimal meandering. Within this reach, the river consistently follows the northern bluff line of the river valley which is comprised of Cretaceous-age Hell Creek Formation sandstones and mudstones. The other side of the river consists of low floodplain and terrace deposits. Because of the valley wall confinement, migration rates are low in the reach and the Channel Migration Zone (CMZ) is narrow.

Similar to other reaches in Region A, the overall footprint of the river channel has increased in size since 1950. In 1950, the channel footprint was 161 acres but by 2001 it had expanded to 202 acres.

About 7 percent of the banks in Reach A6 are armored, and most of that bank protection is flow deflectors (2,165 feet). There is another 650 feet of rock riprap, all of which was constructed between 2001 and 2011.

One side channel in Reach A6 was blocked prior to 1950. It is about 2,700 feet long and is blocked by a dike as well as flow deflectors along the bank. The side channel currently hosts riverine and emergent wetland areas.

Land use in Reach A6 is predominantly agricultural, although there almost 200 acres of exurban development on the low terraces between the river and I-90. Most of the agricultural land is non-irrigated, although there are 760 acres of ground under flood irrigation and another 64 acres under pivot. A total of 35 acres of flood irrigated land are in the Channel Migration Zone.

Reach A6 has seen 28 percent (18 acres) of its riparian corridor converted to developed land uses since 1950. Most of that (17 acres) was conversion to irrigation.

This area of the upper Yellowstone River has seen three severe floods in the last 20 years. The 1996 and 1997 floods were very damaging, early-June events that peaked at 37,100 and 38,000 cfs, respectively. At the time, these were considered to be sequential 100-year floods. Then in late June of 2011, the river peaked at 40,600 cfs, which is currently the flood of record at Livingston. This flood exceeded a 100-year event, with both the 1996/1997 events considered to have exceeded a 75-year flood.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 12,600 to 12,100 cfs, a drop of about 4 percent. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 1,910 cfs to 1,630 cfs with human development, a reduction of 15 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760 cfs under unregulated conditions to 1,680 cfs under regulated conditions at the Livingston gage, a reduction of 4.6 percent.

The reduction in flows is evident by the contraction of the 5-year floodplain area in Reach A6 by 4.8 acres, or 30 percent.

CEA-Related observations in Reach A6 include:

- Riparian clearing in support of irrigation.
- Side Channel Blockage
- Contraction of 5-year floodplain due to flow alterations.

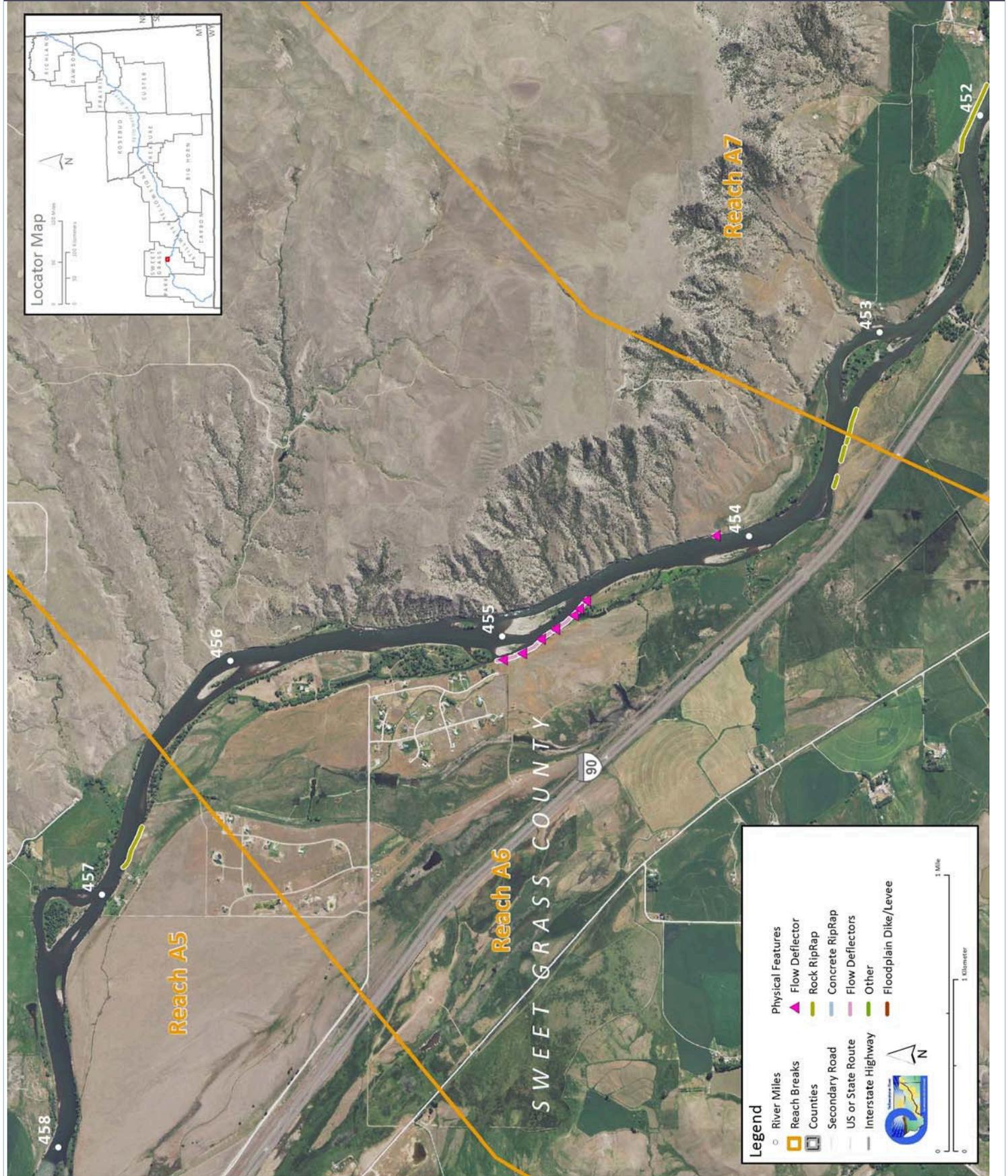
Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach A6 include:

- Side channel restoration at RM 454.5

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)	24,500	24,000	-2.0%			
100 Year (cfs)	45,500	45,200	-0.7%			
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.
	160.9	160.3	176.7	201.9	41.0	
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	648	2.1%	648			
Concrete Riprap	0	0.0%	0			
Flow Deflectors	2,165	6.9%	42			
Total	2,814	9.0%	690			
Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	Numerous side channels have been blocked by small dikes.			
	2,691	0				
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	11.5	22.6	-6.51 acres			
Acres/Year	0.4	0.9				
Acres/Year/Valley Mile	0.2	0.3				
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)						
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	4.8	30%				
100 Year	0.0	0%				
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.			
	20.1	6%				
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)	1,821.9	1,538.8	Flood (Ac)	936.4	761.1	
Ag. Infrastructure (Ac)	16.8	6.4	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	198.5	Pivot (Ac)	0.0	64.1	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	19.1	77.4				
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.	
	16.9	0.8	17.7	28.0%		
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	14.3	5.1	38.6			
Emergent	23.3	8.3				
Scrub/Shrub	1.1	0.4				
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.			
	0.1	0.0%				
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.	
	0.8	0.0	0.7	-0.1		

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP

