

<b>County</b>	Park	<b>Upstream River Mile</b>	499.9
<b>Classification</b>	PCA: Partially confined anabranching	<b>Downstream River Mile</b>	495.6
<b>General Location</b>	To just upstream of Hwy 89 bridge	<b>Length</b>	4.30 mi (6.92 km)

## Narrative Summary

Reach PC16 is 4.3 miles long, extending from the KPRK Bridge (Hwy 89) in Livingston almost to the Highway 89 Bridge downstream. Within the reach, the river makes a large swing from a northerly trend to an easterly trend. The reach is dynamic, as multiple wooded islands, and intermittently flows along the north valley wall. In 2001, there were about 4.2 miles of side channels in the reach, indicating that there is as almost much side channel as main channel in this segment of the Yellowstone River. In some areas the river corridor is over 2,000 feet wide.

There are over 8,000 feet of bank armor in Reach PC16, about 6,500 feet of which is rock riprap. In 2011, there were 1,700 feet of flow deflectors in the reach, after about 200 feet had been destroyed between 2001 and 2011. These flow deflectors were on a large meander bend; they were flanked, and the river has migrated to the southeast about 200 feet beyond their original location. This erosion also damaged a large diversion structure. Bank armor covers about 18 percent of the total bankline. There are also 8,200 feet of mapped floodplain dikes in the reach. Prior to 1950, a 1,900-foot long channel was blocked at its upper end by the highway and Railroad Bridge approaches at the KPRK Bridge.

Land uses in Reach PC16 are mixed, including urban/exurban, irrigated agriculture, and non-irrigated agriculture. In 1950, over 660 acres were in flood irrigation and by 2011 that number had been reduced to 70 acres, with 173 acres being converted to sprinkler irrigation and 246 to pivot. Exurban development is most dense on the left (north) bank of the river, where the valley wall consists of erosion-resistant sandstone that is out of the Channel Migration Zone.

Over 200 acres of wetlands have been mapped in Reach PC16, most of which are emergent marshes and wet meadows. Most of these wetlands are in non-irrigated hay pastures.

There is one pipeline crossing in this reach. The crossing is near Rustad Lane, and is a natural gas line owned by NW Energy, LLC.

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 relatively small in this reach. 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 1,580 cfs to 1,510 cfs with human development, a reduction of 4.4 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.

CEA-Related observations in Reach PC16 include:

- Flanking of flow deflectors and sever erosion behind.

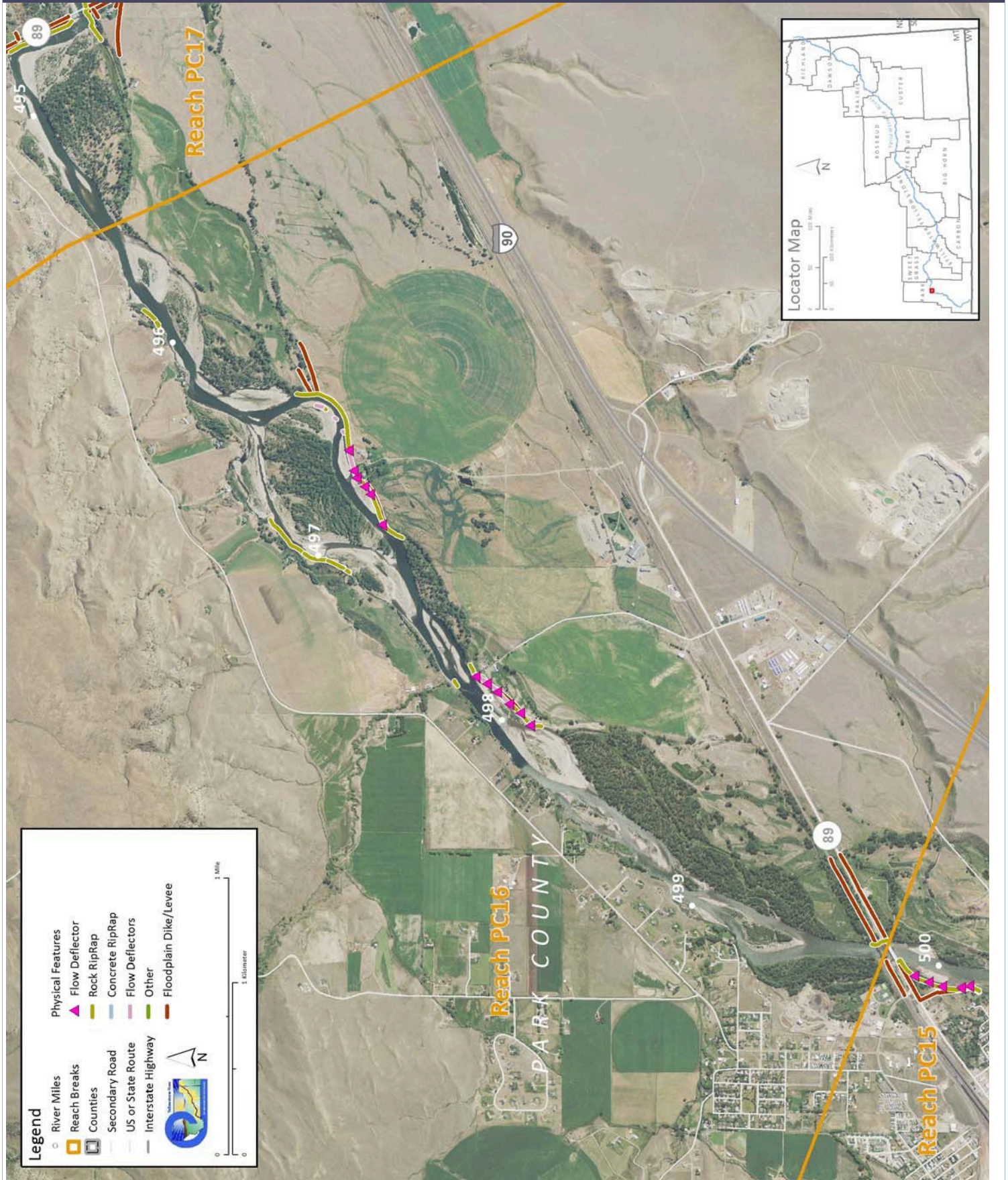
Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach PC16 include:

- Side channel restoration below transportation embankment at RM 499.4L
- Flanked bank armor removal at RM 496.8
- CMZ Management due to current restriction of 14 percent of the Channel Migration Zone
- Pipeline Practices at natural gas crossing at RM 497.9 (natural gas may have special consideration in Practice)
- Irrigation diversion management at Vallis Ditch Diversion at RM 496.5

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.

<b>Discharge</b>	<b>Undev.</b>	<b>Developed</b>	<b>% Change</b>	<b>"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.</b>		
2 Year (cfs)	20,600	20,500	-0.5%			
100 Year (cfs)	38,700	38,600	-0.3%			
<b>Bankfull Channel Area (Ac)</b>	<b>1950</b>	<b>1976</b>	<b>1995</b>	<b>2001</b>	<b>1950-2001</b>	<b>Bankfull channel area is the total footprint of the river inundated at approx. the 2-year flood.</b>
	253.3			308.0	54.7	
<b>Physical Features</b>	<b>2011 Length (ft)</b>	<b>% of Bankline</b>	<b>2001-2011 Change</b>	<b>There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.</b>		
Rock Riprap	6,474	14.2%	2,276			
Concrete Riprap	0	0.0%	0			
Flow Deflectors	1,703	3.7%	-206			
<b>Total</b>	<b>8,178</b>	<b>18.0%</b>	<b>2,069</b>			
<b>Length of Side Channels Blocked (ft)</b>	<b>Pre-1950s</b>	<b>Post-1950s</b>	<b>Numerous side channels have been blocked by small dikes.</b>			
	1,901	0				
<b>Floodplain Turnover</b>	<b>1950 - 1976</b>	<b>1976 - 2001</b>	<b>1950-2001 In-channel riparian encroachment (negative number indicates retreat)</b>	<b>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.</b>		
<b>Total Acres Acres/Year/Valley Mile</b>			acres			
<b>Open Bar Area</b>	<b>Point Bars</b>	<b>Bank Attached</b>	<b>Mid-Channel</b>	<b>Total</b>	<b>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.</b>	
<b>Change in Area '50 - '01 (Ac)</b>						
<b>Floodplain Isolation</b>	<b>Acres</b>	<b>% of FP</b>	<b>Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.</b>			
5 Year						
100 Year						
<b>Restricted Migration Area</b>	<b>Acres</b>	<b>% of CMZ</b>	<b>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.</b>			
	139.8	14%				
<b>Land Use</b>	<b>1950</b>	<b>2011</b>	<b>1950</b>	<b>2011</b>	<b>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.</b>	
Agricultural Land (Ac)	1,961.2	1,530.1	<b>Flood (Ac)</b>	662.0	69.8	
Ag. Infrastructure (Ac)	46.6	155.8	<b>Sprinkler (Ac)</b>	0.0	172.9	
Exurban (Ac)	1.0	208.4	<b>Pivot (Ac)</b>	0.0	245.7	
Urban (Ac)	7.7	69.4				
Transportation (Ac)	32.4	32.8				
<b>1950s Riparian Vegetation Converted to a Developed Land Use (ac)</b>	<b>To Irrigated</b>	<b>To Other Use</b>	<b>Total Rip. Converted</b>	<b>% of 1950s Rip.</b>	<b>Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.</b>	
<b>National Wetlands Inventory</b>	<b>Acres</b>	<b>Acres per Valley Mi</b>	<b>Total Wetland Acres</b>	<b>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).</b>		
Riverine	10.6	2.7	<b>216.5</b>			
Emergent	154.4	39.4				
Scrub/Shrub	51.5	13.1				
<b>Russian Olive (2001) (Appx. 100-yr Floodplain)</b>	<b>Acres</b>	<b>%</b>	<b>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.</b>			
	0.8	0.1%				
<b>Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)</b>	<b>1950</b>	<b>1976</b>	<b>2001</b>	<b>Change 1950-2011</b>	<b>Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.</b>	

## PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP

