

County	Park	Upstream River Mile	516.3
Classification	PCA: Partially confined anabranching	Downstream River Mile	514.6
General Location	To Pine Creek	Length	1.70 mi (2.74 km)

Narrative Summary

Reach PC9 extends from just below Mallard’s Rest to Pine Creek. It is a partially confined anabranching reach type, indicating that it has side channels and wooded islands with some valley wall influence. Reach PC9 is one of the shortest reaches in the CEA study at 1.7 miles. It is a short, fairly anomalous section of river that extends upstream from the mouth of Pine Creek and Pine Creek Bridge. This reach is anomalous because of its rates of change over the past 20 years. This includes sediment deposition, severe bank erosion and avulsions. The reach is located just upstream of a “pinch point” in the valley that is created by a glacial outwash terrace on the west bank and the Pine Creek outwash fan on the right bank. The Pine Creek Bridge was built on this pinch point, which is a stable bridge location. Because of the constriction at the bridge, however, sediment transport patterns appear interrupted which has caused sediment deposition and unstable channel dynamics upstream. Much of this erosion appears to have happened between 1991 and 2005, suggesting that the 1996 and 1997 floods drove substantial channel change.

Reach PC9 showed an increase in bankfull channel area of over 30 acres between 1950 and 2001, which may reflect the impact of the 1996/1997 floods on channel form. Air photos from as recently as 1991 show a broad expanse of forested islands, whereas the 2005 and 2011 imagery show extensive open bars and active bank erosion. In places, erosion into islands since 1991 has exceeded 500 feet. This has been accompanied by an increase in side channel length of almost 7,000 feet in the reach as islands have been eroded and dissected.

In 2011, almost 3,000 feet of rock riprap lined the banks in Reach PC9, as well as 677 feet of flow deflectors. This represents almost 20 percent of the total bankline in the reach.

Similar to other reaches in Park County, the extent of flood irrigation has dropped in the reach since 1950, and the amount of sprinkler and pivot irrigation has increased somewhat proportionately. Exurban land uses in the reach have expanded from 0 acres in 1950 to 82 acres in 2011, and all of that development is on the east side of the river just upstream of Pine Creek Bridge. The dominant land use remains agriculture, however, with 27 acres in flood irrigation, 142 acres in sprinkler, and 93 acres in pivot. Another 300 acres are in non-irrigated agriculture. There are almost 100 acres of emergent wetlands in Reach PC9, reflecting a large wet meadow complex on the southeast side of the river.

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 now 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 1,520 cfs to 1,470 cfs with human development, a reduction of 3.9 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 PC9 include:

- Major post-1995 changes in channel geomorphology upstream of natural constriction point.

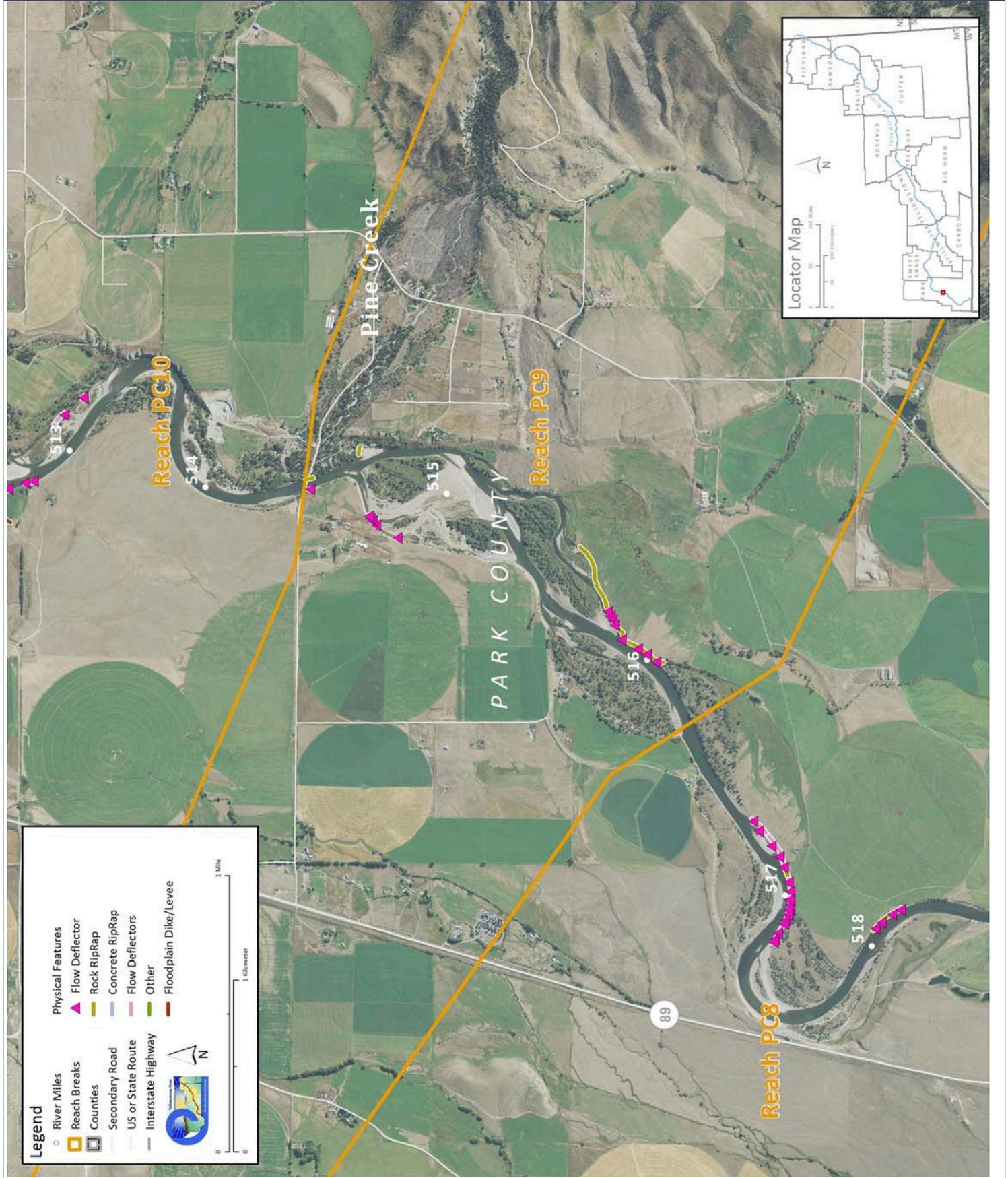
Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach PC9 include:

- Channel Migration Zone (CMZ) management

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)	19,500	19,400	-0.5%			
100 Year (cfs)	36,800	36,800	0.0%			
Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.
	115.1			147.4	32.3	
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	2,894	14.4%	154			
Concrete Riprap	0	0.0%	0			
Flow Deflectors	677	3.4%	-79			
Total	3,571	17.7%	75			
Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	Numerous side channels have been blocked by small dikes.			
	0	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 Acres/Year Acres/Year/Valley Mile			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)						
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 100 Year						
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.			
	40.4	11%				
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)	756.6	615.4	Flood (Ac)	198.1	26.9	
Ag. Infrastructure (Ac)	4.2	39.3	Sprinkler (Ac)	0.0	142.4	
Exurban (Ac)	0.0	81.6	Pivot (Ac)	0.0	93.3	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	4.8	4.1				
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.	
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	1.1	0.6	113.6			
Emergent	94.8	55.2				
Scrub/Shrub	17.7	10.3				
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	0.2%				
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.	

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP

