The Yellowstone River Cumulative Effects Analysis—15 Years in the Making

The Upper Yellowstone
Examining the Confluence of Past Lessons and Future Needs

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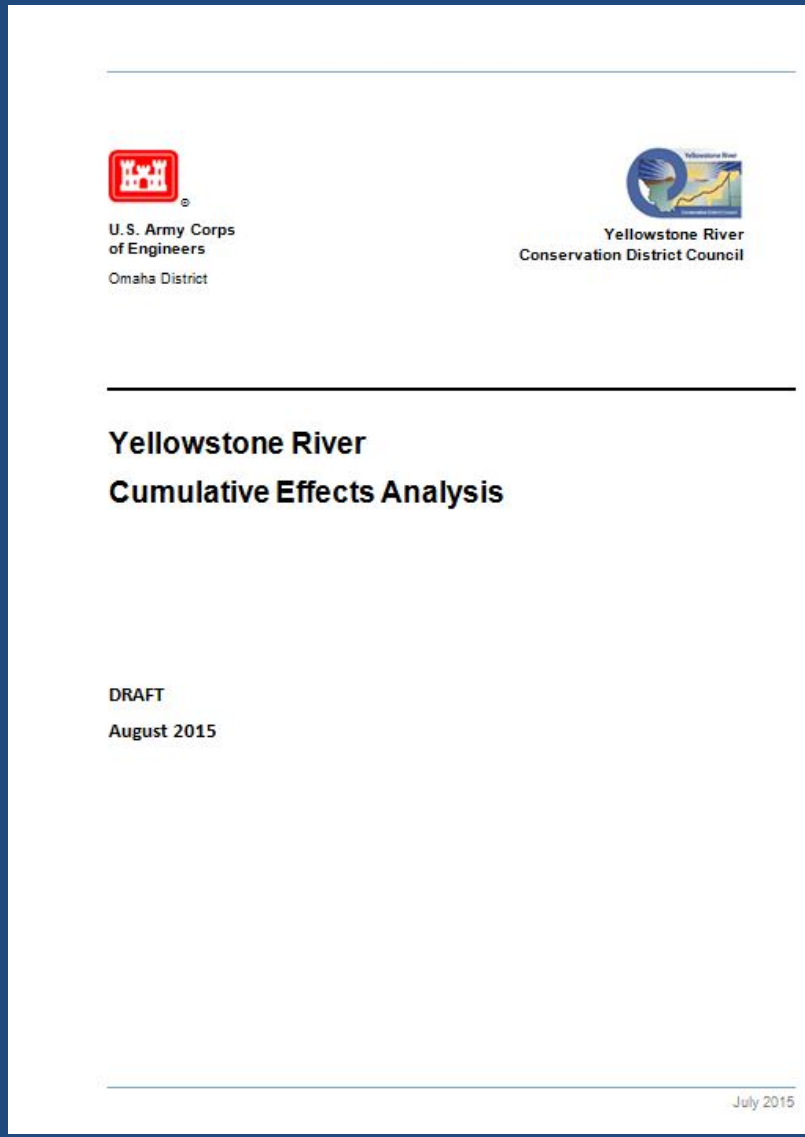
The Yellowstone River CEA

Authorized by the Water Resources Development Act of 1999

"The Secretary shall conduct a comprehensive study of the Yellowstone River from Gardiner, Montana to the confluence of the Missouri River to determine the hydrologic, biological and socioeconomic cumulative impacts on the river".


U.S. Army Corps of Engineers
Omaha District

Yellowstone River Conservation District Council

Yellowstone River
Cumulative Effects Analysis

DRAFT
August 2015

July 2015

~400 page report
11 Appendices --1830pp

State of Montana Involvement

- Yellowstone River Conservation District Council
  - Technical Advisory Committee (TAC)
  - Resource Advisory Committee (RAC)

- 2004 Cost-Share Agreement with COE

CEA Project Elements

- Evaluate the cumulative hydraulic, biological, and socioeconomic impacts of human activity on the Yellowstone River.

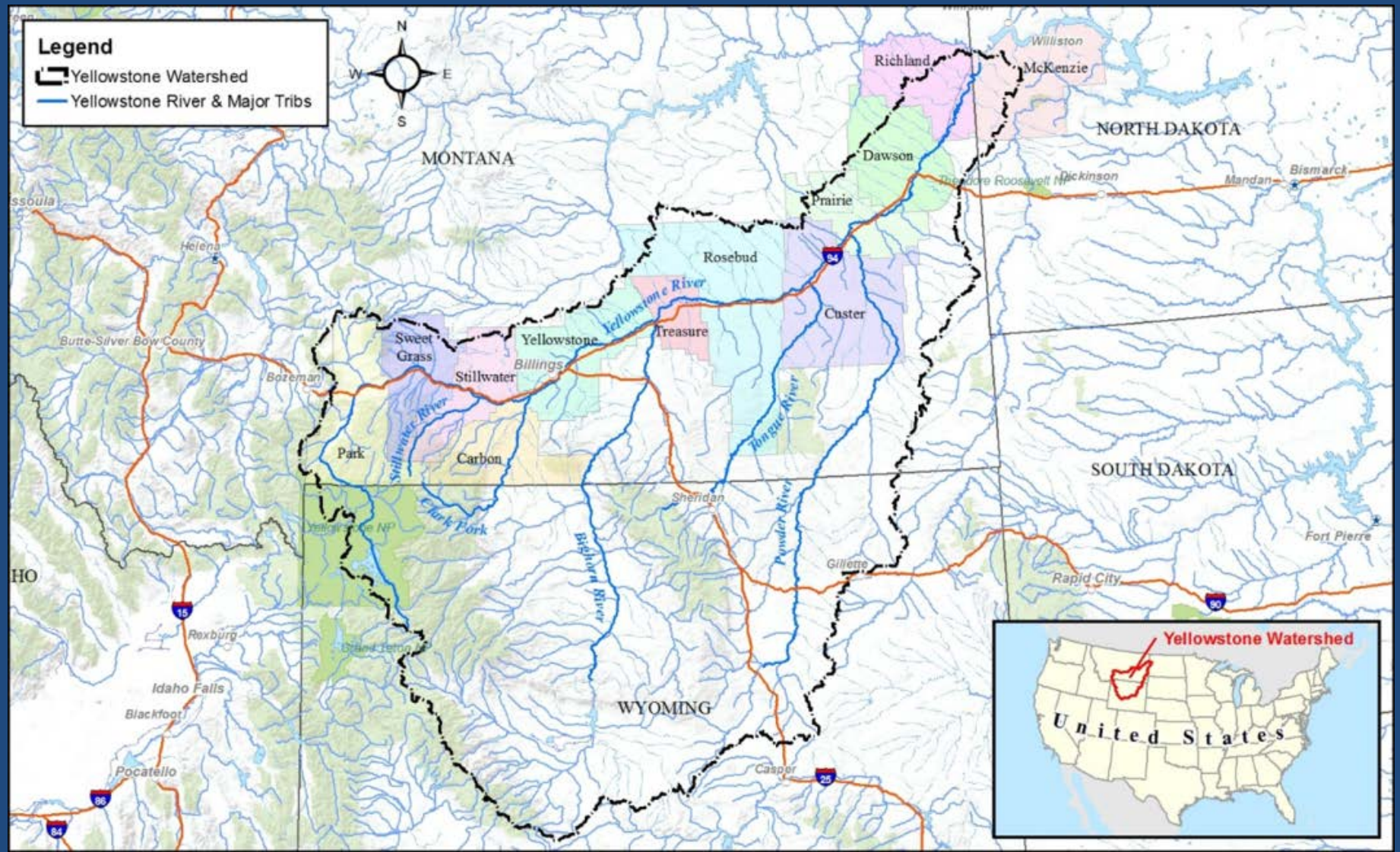
- Develop recommended management practices.

Primary Project Components

- Hydrology
- Hydraulics
- Geomorphology
- Riparian
- Wetlands
- Water Quality
- Avian
- Fisheries
- Land Use
- Socioeconomics
- Cumulative Effects

Project Extent

Gardiner MT to the Missouri River confluence (565 River Miles)

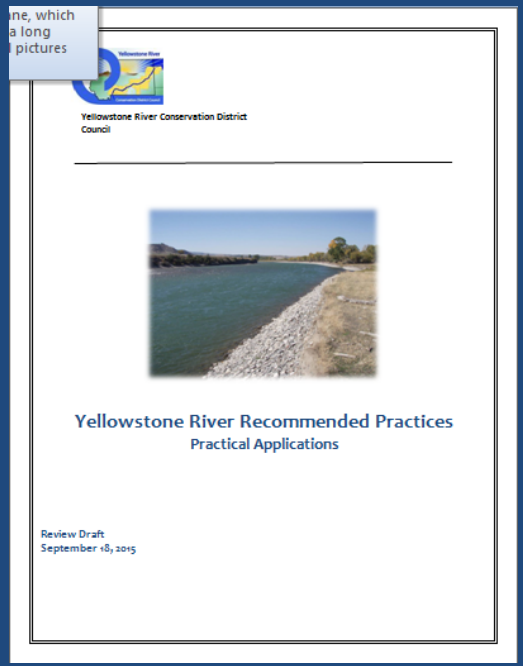


Yellowstone River Recommended Practices

- Floodplain Restoration
- Bank Armoring
- Side Channel Blockage Removal
- Riparian/Wetland Management
- Invasive Woody Plant Control
- Noxious Weed Control
- Nutrient Reduction
- Solid Waste Removal
- Irrigation Water Management

YRCDC Position Statements

- Oil/Gas/Brine Water Pipeline Crossing
- Altered Flows
- CMZ Maps
- Fish Passage and Entrainment
- Watercraft Safety



MONTANA.GOV
OFFICIAL STATE WEBSITE

MONTANA State Library

Data

Yellowstone River Clearinghouse

About

This web page provides a single point of access to Yellowstone River data and publications. It is a single point of access for information associated with the River, such as maps, GIS data, and reports. The most recent resources resulted from the Yellowstone River Corridor Comprehensive Study, also known as the Cumulative Effects Assessment. Read More.

Quick Links to Yellowstone Clearinghouse Resources

- Interactive Online Map Viewer - explore the most commonly used Yellowstone River GIS layers overlaid on imagery, topographic, or other reference backgrounds.
- Reach Story Map 1- Explore Yellowstone River Physical Features: Overview (Reach narratives organized by county)
- Reach Story Map 2- Explore Yellowstone River Physical Features: Details and Recommendations (Reach narratives organized by reach)
- Cumulative Effects Analysis (CEA) Final Report
- Recommended Practices and Position Statements
- Imagery
- LiDAR Elevation Data
- Land Use Mapping
- Hydraulic Models
- Physical Features Inventory

Yellowstone River Reach Narratives

Reach PC10

County	Park	**Upstream River Mile**	514.6
Classification	PCM: Partially confined meandering	**Downstream River Mile**	511
General Location	To downstream of Deep Creek; Weeping wall, Jumpin	**Length**	3.60 mi (5.79 km)
General Comments			

Narrative Summary

Reach PC10 is extends from the Pine Creek Bridge to below the mouth of Deep Creek. The reach is approximately 3.5 miles long, extending from RM 511.0 to RM 514.5. This is an especially unique section of the Yellowstone River where spring creeks that parallel the channel support a nationally recognized cold water fishery. The reach is also semi-confined by very coarse grained glacial alluvial terraces. Sediment recruitment from the terraces drives bar formation, resulting in locally rapid bank migration, and in some cases, threats to the spring creeks. This was exemplified during the 1996/1997 floods, when the river migrated tens of feet into high glacial terraces, delivering vast amounts of gravel to the channel. At one location near the Deep Creek confluence, a home on a ~30 foot high glacial terrace was undermined and deliberately burnt down to prevent its collapse into the river. Just downstream of this site, rapid point bar growth drove westward channel migration towards a prized spring creek, which created a real risk of Yellowstone River avulsion into that channel. Efforts to prevent an avulsion included sediment removal from the rapidly enlarging point bar, bank protection, and construction of a long floodplain dike between the spring creek and the river. This single bendway experienced approximately 750 feet of migration between 1948 and 1999, which translates to an average migration rate of 14.7 feet per year.

Approximately 14 percent of the bankline is armored, primarily by rock riprap (3,753 feet) and flow deflectors (1,197 feet). Between 2001 and 2011, the net length of bank armor increased by 1,037 feet, although 50 feet of flow deflectors were eroded out during that time. There are also over two miles of floodplain dikes in the reach, most of which run parallel to the river to isolate the spring creeks. Several thousand feet of side channels have been blocked in Reach PC10; one large channel that was blocked prior to 1950 extends downstream for several thousand feet into Reach PC11. There is a high concentration of emergent wetlands in these abandoned side channels.

The total bankfull channel area in Reach PC10 increased from 151 acres in 1950 to 191 acres in 2001, suggesting channel enlargement, either due to floods or flow concentrations in the main channel due to side channel loss and diking.

Land uses in Reach PC10 include irrigated ground, multi-use (non-irrigated and undeveloped), and exurban residential development. Whereas in 1950 there were 512 acres under flood irrigation, by 2011 that had been reduced to 17 acres. The expansion of irrigation during that time included 136 acres of sprinkler, and another 56 acres of pivot irrigation. Most of the land, over 900 acres, is used as non-irrigated agricultural land. There has also been about 180 acres of exurban development in Reach PC10, much of which is part of the Jumping Rainbow Ranch downstream of Deep Creek. Some of this development, such as the location of the house that was undermined in 1997, is in the Channel Migration Zone. In the upstream portion the reach, a gravel pit on a large point bar (RM 513.8) encroaches into the Channel Migration Zone. Because of the extensive levee construction in the reach to protect spring creeks, 38 percent of the CMZ has been restricted from the natural CMZ footprint. The reach is very popular for recreational boating and fishing; the Pine Creek Fishing Access Site is located just below the Pine Creek Bridge on the left bank.

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 1,530 cfs to 1,480 cfs with human development, a reduction of 3.3 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.

Yellowstone River Reach Narratives — Reach PC10

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
2 Year (cfs)	19,500	19,400	-0.5%
100 Year (cfs)	36,800	36,800	0.0%

"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.

Bankfull Channel Area (Ac)

1950	1976	1995	2001	1950-2001
151.0			190.6	39.7

Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.

Physical Features

	2011 Length (ft)	% of Bankline	2001-2011 Change
Rock RipRap	3,753	10.3%	1,086
Concrete Riprap	0	0.0%	0
Flow Deflectors	1,197	3.3%	-50
Total	**4,950**	**13.5%**	**1,037**

There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.

Length of Side Channels Blocked (ft)

Pre-1950s	Post-1950s
7,000	1,454

Numerous side channels have been blocked by small dikes.

Floodplain Turnover

	1950 - 1976	1976 - 2001
Total Acres		
Acres/Year		
Acres/Year/Valley Mile		

1950-2001 In-channel riparian encroachment (negative number indicates retreat)

acres

The rate of floodplain turnover reflects how many acres of land are eroded by the river. Tunover is associated with the creation of riparian habitat.

Open Bar Area

	Point Bars	Bank Attached	Mid-Channel	Total
Change in Area '50 - '01 (Ac)				

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.

Floodplain Isolation

	Acres	% of FP
5 Year		
100 Year		

Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.

Restricted Migration Area

Acres	% of CMZ
252.8	38%

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.

Land Use

	1950	2011
Agricultural Land (Ac)	1,329.9	1,061.1
Ag. Infrastructure (Ac)	30.9	54.8
Exurban (Ac)	0.0	178.9
Urban (Ac)	0.0	0.0
Transportation (Ac)	0.8	1.0

	1950	2011
Flood (Ac)	512.4	17.1
Sprinkler (Ac)	0.0	135.9
Pivot (Ac)	0.0	56.1

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.

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
Riverine	22.5	9.7
Emergent	165.1	71.2
Scrub/Shrub	49.1	21.1

Total Wetland Acres: **236.7**

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).

Russian Olive (2001) (Appx. 100-yr Floodplain)

Acres	%
0.1	0.2%

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.

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.

A story map about the Yellowstone River

Explore Yellowstone River Features: Reach Details and Recommendations

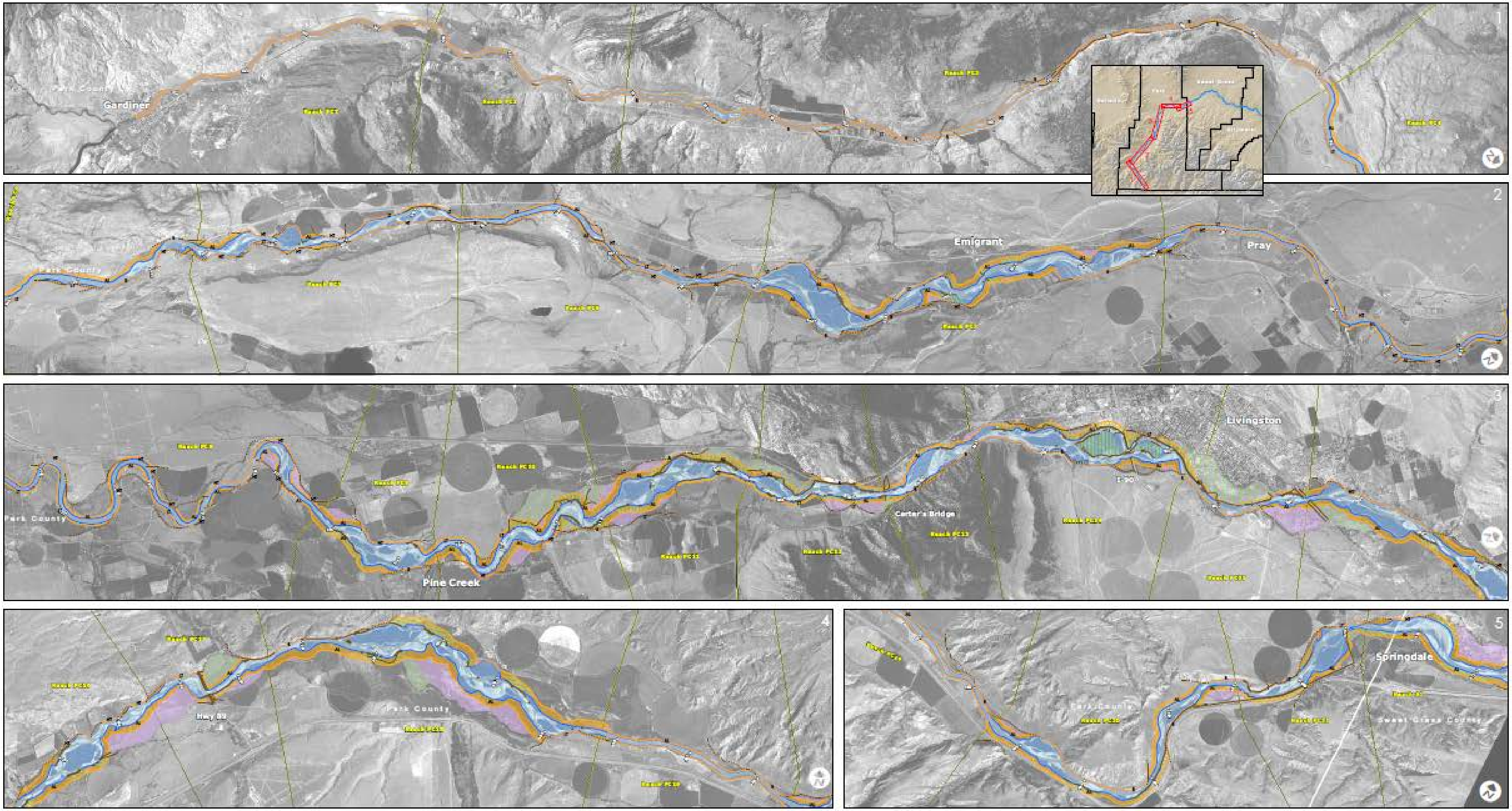
Reach PC10

CEA-Related observations in Reach PC10 include:

- Extensive dike construction - Floodplain dikes constructed to protect spring creek fisheries have narrowed the active meander corridor
- Exurban encroachment into the Channel Migration Zone (CMZ) has occurred on terrace surfaces
- Gravel pit and recreational pond development in a meander core may contribute to avulsion risk in the reach.
- Rapid dike construction and armoring following major flooding (1996/1997).
- Increase in primary channel length (sinuosity) with loss of side channels.
- Isolation of 38 percent of the CMZ, mostly avulsion hazard areas that support spring creeks.

Recommended Practices:

- YRRP 1.2 - Floodplain Restoration – Public Highways and County Roads
- YRRP 1.3 - Side Channel Blockage Removal - Side Channel Restoration
- YRRP 3.2 - Invasive Woody Plant Control - Russian Olive Control
- Selective side channel restoration at RM 511.5 (may be difficult to reactivate side channels without affecting developed spring creek fishery)
- CMZ Management due to current restriction of 38 percent of the Channel Migration Zone



1999 Channel

Historic Migration Zone (1948-1999) *area of mapped channel occupation based on 1948 and 1999 air photos (see Fig. 2)*

Erosion Buffer: *-100-yr erosion buffer based on reach-scale mean migration rates; extended from 1999 banklines*

AL Alluvium: recent river deposits (see Fig. 1)

LT Low Terrace: 10-20 ft high *-see Fig. 1*

HT High Terrace: 20-40 ft high *-see Fig. 1* HT Outwash Terrace

B Bedrock (undifferentiated) *-no buffer applied (see Fig. 1)*

Avulsion Potential Zone *-area with relic channel resonance prone to reactivation*

Restricted Migration Area *area of CMZ or avulsion zones isolated by bank and floodplain protection features*

Composite CMZ *area encompassing 1948-1999 channel, and erosion buffer*

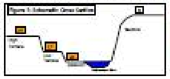
Reaches

Counties:

Barbs

Bank Protection, Dikes and Transportation Encroachments

Geologic Breaks: *-mapped contact between geologic units (see Fig. 1)*



Yellowstone River Channel Migration Zone

Park County, Montana

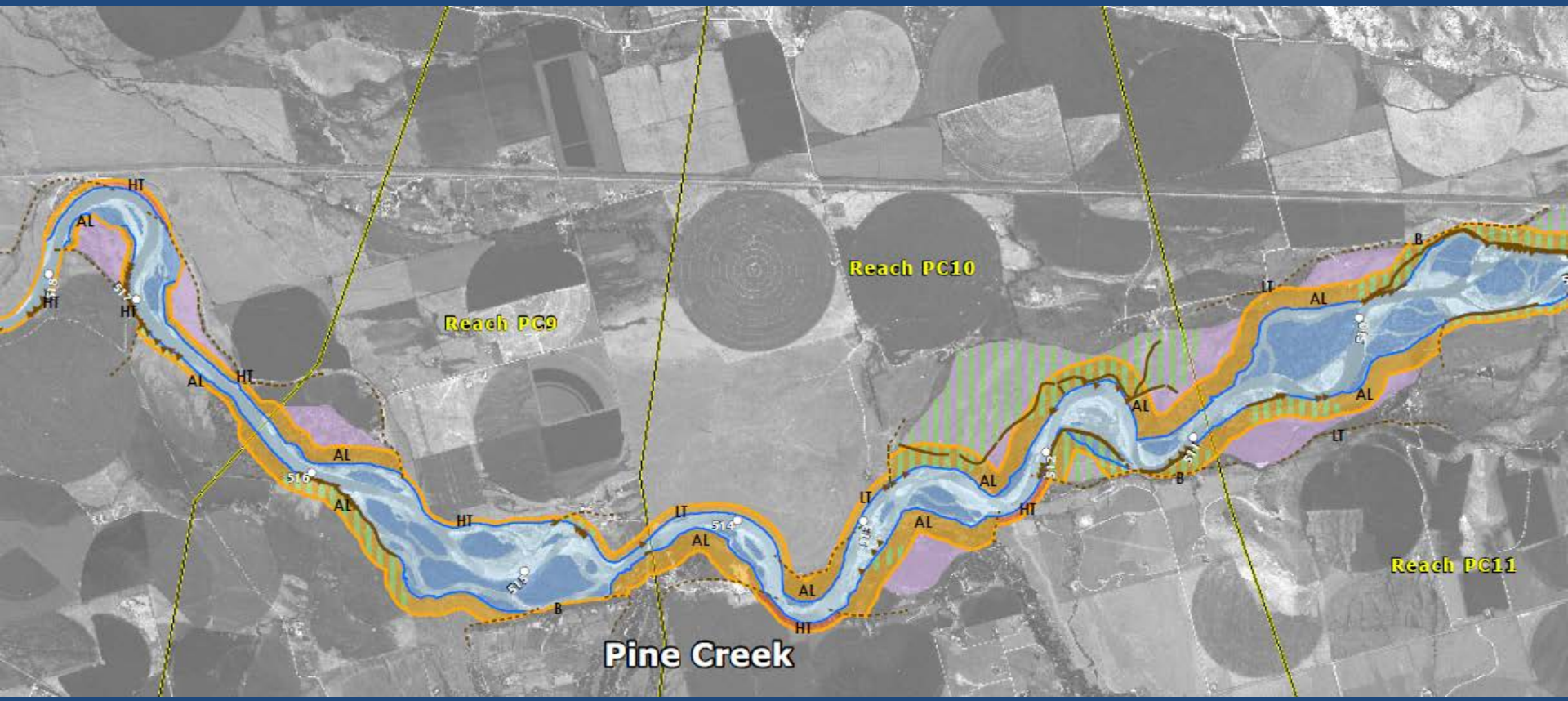
1:36,000

Development and Purpose of A Channel Migration Zone

The boundaries on this map are intended to provide a basic screening tool to help guide management decisions on the Yellowstone River and ARE NOT intended to provide regulatory boundaries or override site-specific assessments. This map identifies a 100-year migration corridor for the Yellowstone River based on measured migration rates between 1948 and 1999. It includes the 1999 channel, historic channel locations since 1948, and an erosion buffer based on measured rates of lateral movement. Also identified are areas with relic channels prone to reactivation (Avulsion Potential Zone).

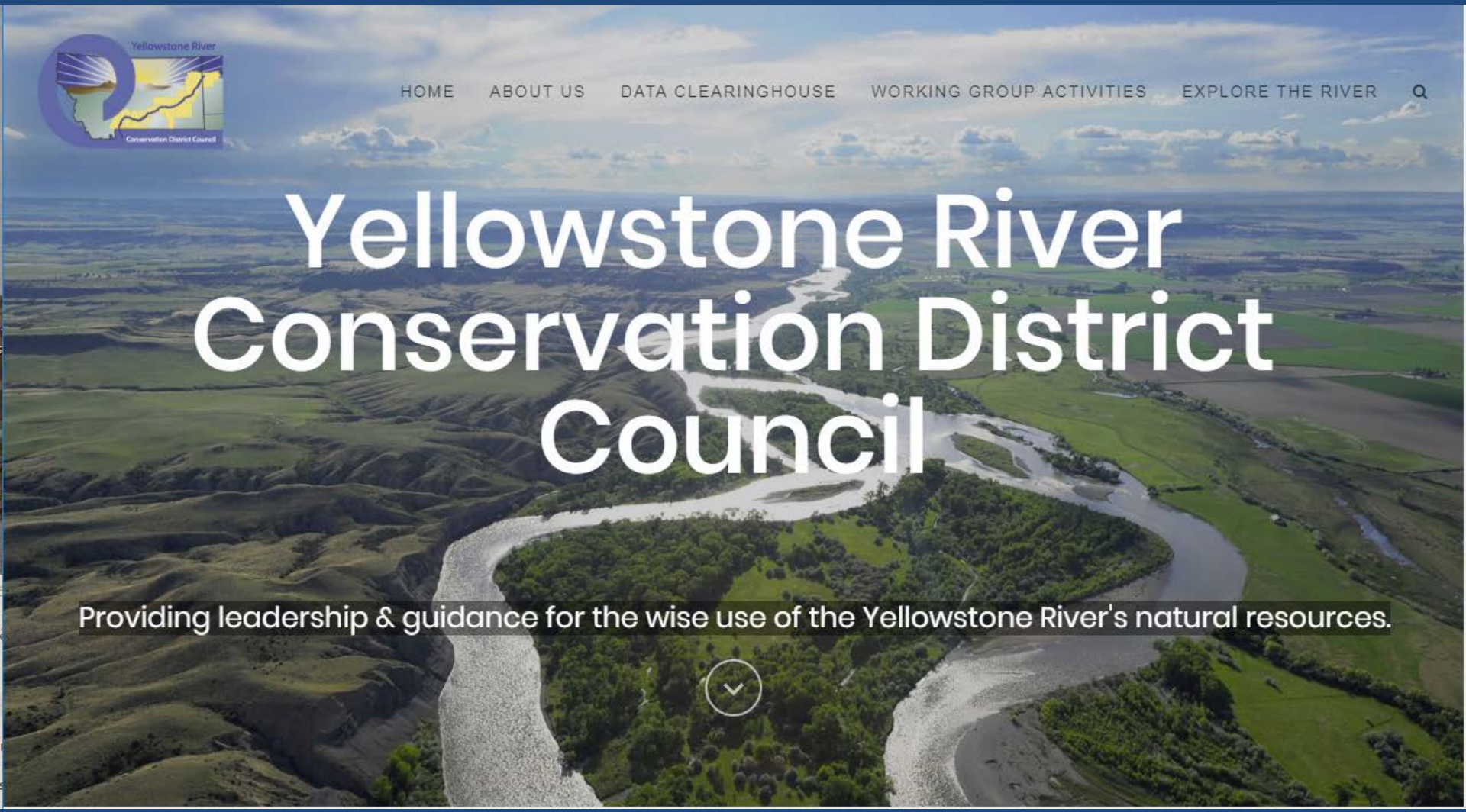
This map was revised in early 2009 to incorporate high resolution topographic data. For more information on CMZ map development, see companion report, "Yellowstone River Channel Migration Zone Mapping," prepared for Custer County Conservation District and Yellowstone River Conservation District Council, February 20, 2009.

For more information on the Yellowstone River Conservation District Council, see http://dnrc.mt.gov/cardd/yellowstonerivercouncil.


Reach PC9
Reach PC10
Reach PC11
Pine Creek
HT
AL
LT
B
518
517
516
515
514

Recent Work

Huntley Project, 1909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Providing leadership & guidance for the wise use of the Yellowstone River's natural resources.

Irrigation Water Management

Objectives:

1. Collaborate with Conservation Districts, state agencies, federal agencies, and non-profit organizations throughout the Yellowstone River Basin to identify outreach and project opportunities.

2. Review the Montana 2015 State Water Plan findings and key recommendations that pertain to irrigation water management and water use efficiency in the Yellowstone River Basin.

3. Identify and prioritize irrigation water management projects within the Yellowstone River Basin.

4. Develop a 10-year project priority strategy with potential project sponsors and funding sources identified.

Invasive Woody Plant Control

Objectives:

1. Collaborate with Conservation Districts, state agencies, federal agencies, and non-profit organizations throughout the Yellowstone River Basin to identify outreach and project opportunities.

2. Develop specific educational and project approaches to address the relatively new invader, Common Buckthorn. Explore opportunities to work with the Montana Department of Agriculture with their Montana Noxious Weed Education Campaign and their Noxious Weed Trust Fund Grant Program.

3. Russian Olive and Salt Cedar: Identify mainstem reaches and tributaries for focused outreach efforts and project implementation. This process will require close collaboration with county weed districts and landowners.

4. Develop a ten-year project priority plan.

YOU'RE INVITED TO:

Help identify specific irrigation water management project opportunities in the Yellowstone River Basin

REGIONAL OPEN HOUSES

Huntley	**Tuesday, Sept. 18** Yellowstone Valley Electric Co-op - 150 Co-op Way
Forsyth	**Wednesday, Sept. 19** Rosebud Co. Library - 201 N. 9th Ave.
Glendive	**Thursday, Sept. 20** Moose Lodge - 415 N. Merrill Ave.
Big Timber	**Tuesday, Oct. 16** Carnegie Public Library - 314 McLeod St.

6 - 8 p.m. *Complimentary dinner provided*

Hosted by: Yellowstone River Conservation District Council

Providing leadership and guidance for the wise use of the Yellowstone River's natural resources

For more information, contact Dan Rostad: 406-930-0594

Woody Invasive Outreach Video