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|-------------------------|--|------------------------------|---------------------|
| County | Rosebud | Upstream River Mile | 208.1 |
| Classification | PCM/I: Partially confined meandering/islands | Downstream River Mile | 195.9 |
| General Location | Sheffield | Length | 12.20 mi (19.63 km) |

Narrative Summary

Reach C14 is 12.2 miles long and is located near Sheffield, which is about 15 miles upstream of Miles City. The reach straddles the Rosebud/Custer County Line. The reach is characterized by a dominant main thread that shows a distinct meandering pattern, with several islands persisting where meander bends have historically cut off. The river intermittently flows along the south valley wall. As a result it is classified as Partially Confined Meandering with Islands (PCM/I). In this section of river the valley bottom is consistently about 1.8 miles wide, and bound by Tertiary-age Fort Union Formation. The active meanderbelt of the Yellowstone River is about 3,000 feet wide.

The large meander features in Reach C14 have experienced significant migration since 1950 and also in recent years; one site at RM 204.5 migrated 977 feet southward between 1950 and 2001, and then over the next ten years continued to migrate another 400 feet so that it is now at the toe of the active rail line. At RM 200.5, the river has migrated 700 feet northward since 2001; eroding out irrigated lands and threatening structures.

As of 2011 there were about four miles of armor protecting 17 percent of the total bankline in Reach C14, including 15,087 feet of rock riprap and 6,300 feet of flow deflectors. Most of the rock riprap is protecting the rail line as it flows along the south bluff of Fort Union Formation, whereas flow deflectors are more commonly used to protect agricultural land. Between 2001 and 2011, about 3,000 feet of flow deflectors were evidently destroyed. Barbs can be seen in the river at RM 205.3R; the bank behind has since been partially armored with rock riprap. Another barb was flanked at RM 204.7L, and the river has migrated over 200 feet behind that structure towards the rail line. Another series of barbs were flanked at RM 203.6L and have since been replaced by rock riprap. Those flanked rock structures are visible on the 2011 air photos almost 200 feet out into the channel. At RM 200.8L, new riprap was built after older armor scoured out in 2011, which was followed by hundreds of feet of northward bank migration during the 2011 flood. Some of the new riprap appears to be trenched behind the bank. About 1,300 feet of rock riprap mapped in 2001 on the left bank at RM 196.9 has been flanked, and is now up to 70 feet out in the river.

Prior to 1950, about 3 miles of side channels were blocked in Reach C14. Chute channels formed through meander tabs have been blocked by small dikes such as at RM 198. Several historic anabranching channels appear to have been blocked prior to 1950 such as at RM 207.8. These areas provide excellent restoration/mitigation opportunities for side channel re-activation.

Similar to other reaches downstream of the Bighorn River confluence, the river channel has become smaller in Reach C14 since 1950. In 1950, the bankfull footprint was about 38 acres larger than it was in 2001, and riparian mapping shows about 208 acres of riparian encroachment into old channel areas. Floodplain turnover rates are also slightly lower; from 1950-1975 the average annual rate of floodplain turnover was 15.6 acres per year, and since 1975 it has been 12.5 acres per year.

Over two thousand acres of the 100-year floodplain has become isolated from the river due to flow alterations, agricultural development, and the abandoned railroad grade. In total, 40 percent of the entire historic 100-year floodplain has become isolated. Most of the isolation is associated with agricultural land development (29 percent of the historic floodplain), with another 10 percent of the isolation due to the abandoned rail grade. Isolation of the 5-year floodplain has been even more substantial; 2,321 acres or 59 percent of the 5-year floodplain has become isolated at that frequency event. Much of this isolated 5-year floodplain is on flood irrigated fields north of the river.

Bank armor on the north side of the river commonly narrows the natural meanderbelt of the river, which has resulted in large extents of the CMZ being restricted to migration. About 740 acres which represents 16 percent of the total CMZ has become restricted by physical features.

Four ice jams have been reported in the reach, including February of 1996, 1997, and 1998, and March of 2003. All of the ice jams in the 1990s were associated with lowland flooding.

One dump site was mapped on the left bank at RM 196.3.

Reach C14 has seen extensive riparian clearing since 1950s. Typically, riparian clearing for agriculture occurred prior to 1950 along the Yellowstone River. In this reach, however, 760 acres of riparian area were cleared since 1950, which represents 30 percent of the total 1950s riparian corridor. In several cases, this includes riparian clearing on large meander tabs. With this clearing, the reach has seen a substantial loss of forest area considered at low risk of cowbird parasitism. In 1950, the reach had 91.8 acres of such forest per valley mile and by 2001 that forest extent had dropped to 51.4 acres per valley mile.

Reach C14 has fairly extensive mapped wetland area; there are over 45 acres of mapped wetlands per valley mile, most of which is emergent marsh and wet meadow. A total of 22 acres of Russian olive were mapped in the reach, which reflects an abrupt reduction in Russian olive extent relative to upstream, where Reaches C10 through C13 have on the order of 200 acres of RO over similar valley distances.

Reach C14 was sampled as part of the fisheries study. A total of 36 species were sampled in the reach, including Sauger which has been identified as Species of Concern by the Montana Natural Heritage Program.

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 by 18 percent and the 2-year flood, which strongly influences overall channel form, has dropped by 24 percent. Low flows have also been

impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,850 cfs to 3,070 cfs with human development, a reduction of 37 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,330 cfs under unregulated conditions to 3,390 cfs under regulated conditions, a reduction of 47 percent.

Fall and winter base flows have increased in Reach C14 by about 60 percent.

CEA-Related observations in Reach C14 include:

- Passive side channel abandonment due to flow alterations
- Flanking of barb structures on migrating meander bends
- Extensive floodplain isolation by agricultural dikes and abandoned railroad grade
- Pre-1950s blocking of side channels by agricultural dikes
- Armoring of bluff pool habitat against active railroad
- Floodplain isolation by the abandoned Milwaukee rail line on the north bank
- Post-1950s riparian clearing for irrigation development

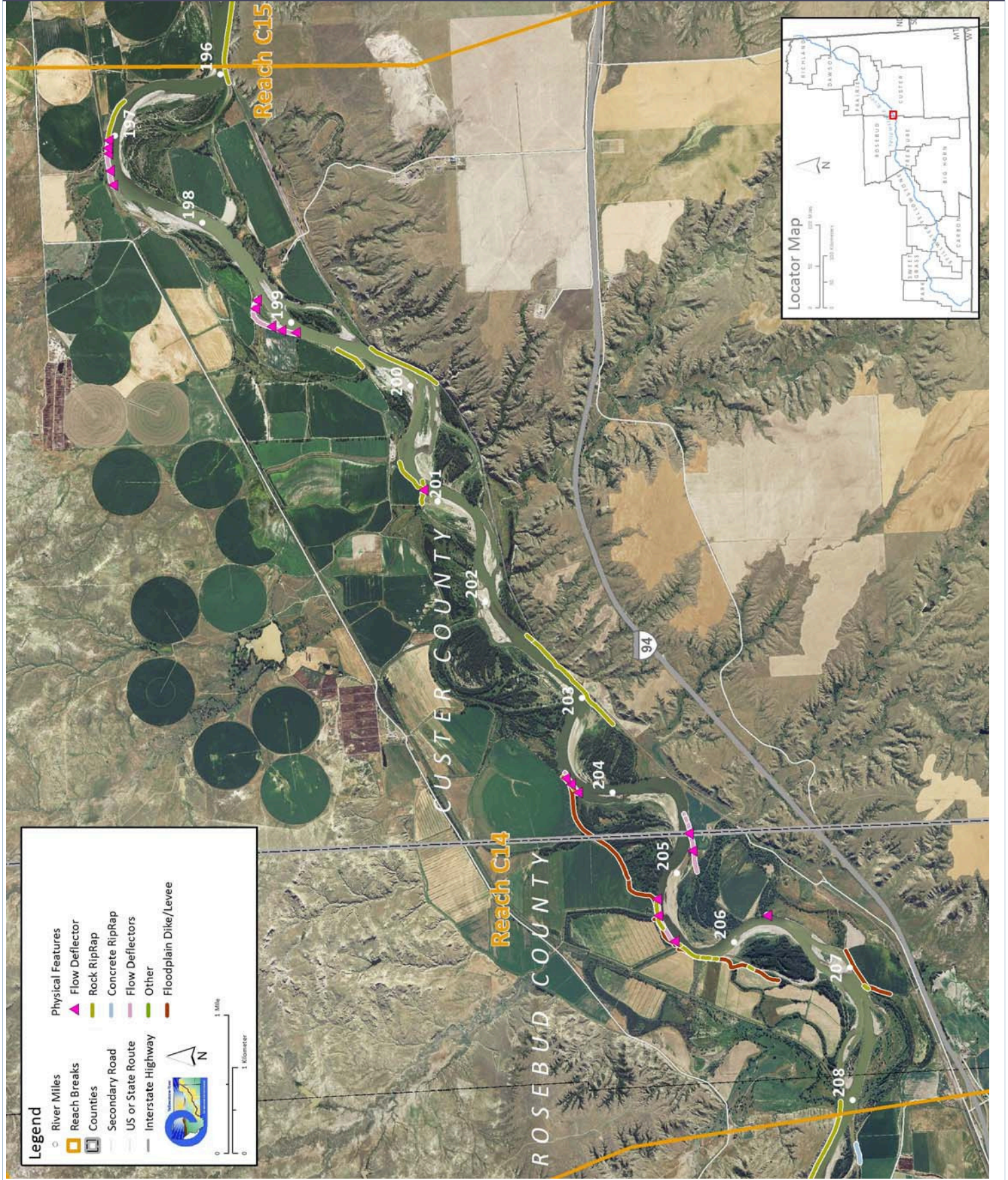
Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach C14 include:

- Removal of flanked barb at RM 205.3
- Side channel reactivation at RM 208L
- CMZ Management due to extent of CMZ restriction (11 percent)
- Dump removal on left bank at RM 196.3L
- 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) | 61,900 | 47,300 | -23.6% | | | |
| 100 Year (cfs) | 120,000 | 98,600 | -17.8% | | | |
| 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. |
| | 1,355.6 | 1,388.0 | 1,289.0 | 1,318.2 | -37.5 | |
| 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 | 15,087 | 11.7% | 1,773 | | | |
| Concrete Riprap | 0 | 0.0% | 0 | | | |
| Flow Deflectors | 6,295 | 4.9% | -2,958 | | | |
| Total | 21,381 | 16.6% | -1,185 | | | |
| Length of Side Channels Blocked (ft) | Pre-1950s | Post-1950s | Numerous side channels have been blocked by small dikes. | | | |
| | 14,986 | 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 | 406.4 | 311.8 | 207.7 acres | | | |
| Acres/Year | 15.6 | 12.5 | | | | |
| Acres/Year/Valley Mile | 1.6 | 1.3 | | | | |
| 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) | -68.8 | 25.9 | -32.3 | -75.2 | | |
| 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 | 2,320.7 | 59% | | | | |
| 100 Year | 2,048.9 | 40% | | | | |
| 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. | | | |
| | 739.2 | 16% | | | | |
| 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) | 9,424.9 | 9,016.5 | Flood (Ac) | 2,516.5 | 3,398.1 | |
| Ag. Infrastructure (Ac) | 76.7 | 105.6 | Sprinkler (Ac) | 0.0 | 0.0 | |
| Exurban (Ac) | 0.0 | 6.4 | Pivot (Ac) | 0.0 | 660.0 | |
| Urban (Ac) | 0.0 | 0.0 | | | | |
| Transportation (Ac) | 130.9 | 171.4 | | | | |
| 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. | |
| | 755.3 | 4.8 | 760.1 | 30.0% | | |
| 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 | 48.6 | 5.0 | 462.9 | | | |
| Emergent | 292.7 | 30.0 | | | | |
| Scrub/Shrub | 121.6 | 12.5 | | | | |
| 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. | | | |
| | 21.6 | 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. | |
| | 91.8 | 25.4 | 51.4 | -40.4 | | |

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP

