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|-------------------------|------------------------|------------------------------|---------------------|
| County | Yellowstone | Upstream River Mile | 383.5 |
| Classification | UB: Unconfined braided | Downstream River Mile | 368.3 |
| General Location | Laurel to Billings | Length | 15.20 mi (24.46 km) |

Narrative Summary

Reach B1, located in Yellowstone County, extends from the mouth of the Clark Fork River to Billings. It is approximately 15.4 miles long, extending from RM 367.0 to 382.4. It is an Unconfined Braided (UB) reach type indicating minimal influence of the valley wall coupled by extensive open gravel bars and low flow channels. Human impacts in Reach B1 include early bridge construction and stream corridor narrowing, flow consolidation through diking and bank armoring, and loss of side channel due to physical blockages and apparent downcutting. Flow alterations in this reach have been substantial; the mean annual flood has dropped an estimated 17 percent due to human influences, and summer low flows have dropped by 42 percent.

In total there are 57,118 feet of bank armor in Reach B1, which equates to 10.82 miles of bank armor in a 15.4 mile long reach of river. Concrete riprap is the most prevalent type of armor, with about 5.5 miles present in 2011, even after the loss of 2,870 feet of concrete armor protection between 2001 and 2011. There are almost four miles of rock riprap, over 4,000 feet of which was constructed since 2001. There are also 7,616 feet of flow deflectors in the reach, and about 2,500 feet of those flow deflectors were built between 2001 and 2011. The most rapid expansion of armor occurred between 1950 and 1995, when the total length of bank protection expanded from 14,872 feet to 47,339 feet.

Numerous bank armor structures have been eroded out in Reach B1. Typically flanked, failed armor was identified at the following locations:

- RM 383L: 330 feet of flow deflectors totally lost
- RM 382.3R: lower 175 feet of concrete riprap flanked
- RM 281.5R: upper 400 feet of concrete riprap flanked: Idled crude oil pipeline is less than 200 feet behind this flanked armor
- RM 380.2R: lower 600 feet of concrete armor flanked
- RM 377.8: upper 540 feet of concrete armor flanked
- RM 373.8R: upper 300 feet and lower 270 feet of concrete armor flanked

The loss of side channel length through time has been extensive. Prior to 1950, almost a mile of side channels had been blocked on the south side of the river at RM 373.8 and at the South Billings Blvd Bridge at RM 371. Since 1950, another 14,800 feet have been blocked by dikes. One major blockage is located about 2 miles upstream of the Duck Creek Bridge at RM 381 and another near the gravel pit/trailer park complex at RM 373. Other side channels have been lost passively, without blockages. In total, Reach B1 has been characterized by a loss of seven miles of side channel length between 1950 and 2001, the majority of which occurred between 1976 and 1996.

A review of available data indicate that the loss of side channels in Reach B1 is both directly and indirectly related to bank stabilization within the reach. Between 1950 and 1976, a series of dikes were constructed upstream of South Billings Blvd to block the course of a primary channel, isolating several thousand feet of channel. Womack (2000) notes that “the greatest measureable change has occurred due to abandonment of secondary channels, primarily due to construction of dikes and secondarily due to channel armoring. A relatively short dike at the upstream end of a braided reach can have a disproportionate effect, because it may effectively eliminate miles of channel”. These blockages are associated with some of the braiding parameter reduction in Reach B1. However, the most loss of side channels occurred after 1976, when the dikes above South Billings Blvd. were already in place. Some of these channels were abandoned due to blockage by dikes, and other locations of channel abandonment and braiding parameter reduction show no apparent direct relationship to physical features.

The side channels that were passively abandoned in Reach B1 are commonly perched above the main Yellowstone River channel. This perching indicates that abandonment may be related to downcutting of the main channel. Womack (2000) noted that width to depth ratios decreased in heavily armored reaches due to flow consolidation in a single channel. Womack suggests that channel confinement and consolidation into fewer channels has resulted in downcutting and reduction in width to depth ratio. Flow alterations have also likely contributed to side channel abandonment.

Several bridges were constructed in Reach B1 prior to 1950. These bridges all constrict the natural meander corridor of the river and have been associated with channel downcutting. Womack (2000) showed seven feet of degradation immediately upstream of the South Billings Blvd Bridge.

The primary land use in the reach is non-irrigated agriculture although several thousand acres of agricultural land has been developed since 1950. In 2011, there were about 3,000 acres of land under flood irrigation and 240 acres under pivot in Reach B1. Between 1950 and 2011, the extent of urban/exurban land use expanded from 310 acres to over 2,000 acres. The development has extended into the Channel Migration Zone (CMZ). A total of 810 acres of CMZ are developed, with 242 acres of ground developed for urban/exurban use and 84 acres in pivot irrigation. Another 470 acres of land in the CMZ are under flood irrigation. As a consequence of extensive development in the CMZ, about 25 percent of the total CMZ footprint has become restricted due to armoring and dike construction.

There is one animal handling facility within 300 feet of the north riverbank just downstream of the Duck Creek Bridge at RM 377.7.

A total of 610 acres of the historic 100-year floodplain has become isolated from the river, which is 14 percent of the total 100-year floodplain footprint. Most of the 100-year floodplain isolation is due to transportation infrastructure. Similarly, about 13 percent of the 5-year floodplain (270 acres) has been isolated by transportation infrastructure. There are 184 acres of flood irrigated land in the 5-year floodplain, and 73 acres in pivot. Whereas most of the isolated 100-year floodplain area is behind the I-90 corridor in the city of Billings, most of the isolated 5-year area is in the stream corridor, which supports the interpretation that some downcutting in the reach has perched historic channels and floodplain area.

There are several pipeline crossings in Reach B1. At RM 382, two pipelines cross under the river; one is a natural gas pipeline owned by NW Energy LLC, and the other is an idled crude oil pipeline owned by Conoco Phillips. The idled crude oil pipeline follows the river close to the bank at RM 281.5R where concrete armor has been flanked. There are four pipelines at South Billings Blvd; the one of these pipelines that was built to carry crude oil has been idled under nitrogen. The other pipelines are all natural gas.

Over 400 acres of wetland have been mapped in the reach, with most of that (270 acres) emergent wetland marsh that is located primarily in the active stream corridor and in abandoned channels. A total of 42 acres of Russian olive have been mapped in the reach, and these trees are dispersed throughout the corridor.

Reach B1 was sampled as part of the avian study. The average species richness in Reach B1 was 8.0, which indicates the average number of species observed during site visits to the reach in cottonwood habitats. The average species richness for sites evaluated is 8. One bird Species of Concern (SOC), the Black-Billed Cuckoo, was identified in the reach. Three bird species identified by the Montana Natural Heritage Program as Potential Species of Concern (PSOC) were also found, including the Black and White Warbler, Chimney Swift, and Ovenbird. Since 1950, Reach B1 has lost all of its forest that would be considered at low risk of cowbird infestation due to its separation from agricultural infrastructure. In 1950, about 3.5 acres of forest per valley mile were identified as low risk and by 2001 that forest area had been reduced to zero.

Reach B1 was sampled as part of the fisheries study. A total of 31 fish species were sampled in the reach, and none of these species have been identified by the Montana Natural Heritage Program as Species of Concern (SOC).

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been substantial in this reach. The mean annual flood is estimated to have dropped from 22,800 cfs to 18,900 cfs, a drop of about 17 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 2,900 cfs to 2,000 cfs with human development, a reduction of 31 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 3,836 cfs under unregulated conditions to 2,227 cfs under regulated conditions at the Billings gage, a reduction of 42 percent.

CEA-Related observations in Reach B1 include:

- Blockage of miles of side channel
- Extensive armoring with CMZ encroachment
- Passive loss of major side channels due to downcutting and flow alterations

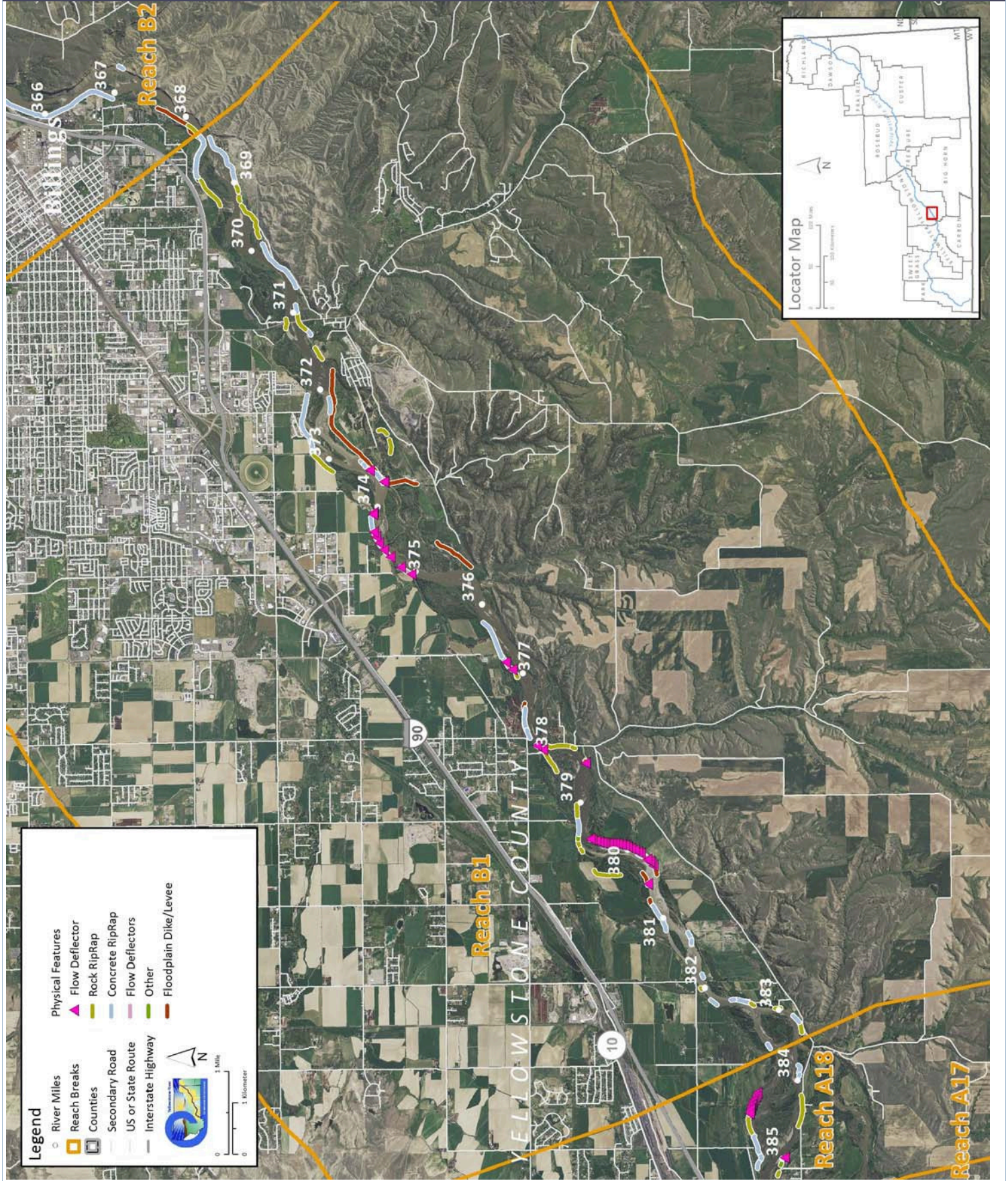
Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach B1 include:

- Side channel restoration at RM 381 and RM 373
- Pipeline crossing management – natural gas pipeline at RM 382
- Flanked armor removal at RM 383, RM 382.3, RM 281.5, RM 380.2, RM 377.8, and RM 373.8
- CMZ management due to extent of current CMZ restriction (25 percent)
- Russian olive removal
- Pipeline management at crossings and also where concrete armor has flanked where idled crude oil pipeline runs parallel to bank at RM 285.1R
- Nutrient management at corrals that are part of an animal handling facility within 300 feet of river at RM 377.7 just downstream of Duck Creek Bridge.

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) | 42,700 | 38,500 | -9.8% | | | |
| 100 Year (cfs) | 76,200 | 73,700 | -3.3% | | | |
| 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. |
| | 1,809.2 | 1,745.6 | 1,505.2 | 1,696.7 | -112.5 | |
| 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 | 20,753 | 12.9% | 4,418 | | | |
| Concrete Riprap | 28,749 | 17.8% | -2,870 | | | |
| Flow Deflectors | 7,616 | 4.7% | 2,553 | | | |
| Total | 57,118 | 35.5% | 4,102 | | | |
| Length of Side Channels Blocked (ft) | Pre-1950s | Post-1950s | Numerous side channels have been blocked by small dikes. | | | |
| | 4,970 | 14,812 | | | | |
| 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 | 490.8 | 362.9 | 209.05 acres | | | |
| Acres/Year | 18.9 | 14.5 | | | | |
| Acres/Year/Valley Mile | 1.4 | 1.1 | | | | |
| 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 | 267.4 | 13% | | | | |
| 100 Year | 610.6 | 14% | | | | |
| 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. | | | |
| | 1,285.4 | 25% | | | | |
| 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) | 9,453.9 | 7,931.3 | Flood (Ac) | 2,905.2 | 2,922.5 | |
| Ag. Infrastructure (Ac) | 221.2 | 354.2 | Sprinkler (Ac) | 0.0 | 26.1 | |
| Exurban (Ac) | 142.1 | 710.4 | Pivot (Ac) | 0.0 | 241.0 | |
| Urban (Ac) | 174.6 | 1,542.1 | | | | |
| Transportation (Ac) | 102.1 | 151.0 | | | | |
| 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. | |
| | 57.0 | 119.4 | 176.4 | 8.0% | | |
| 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 | 81.4 | 6.2 | 421.6 | | | |
| Emergent | 269.3 | 20.4 | | | | |
| Scrub/Shrub | 70.9 | 5.4 | | | | |
| 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. | | | |
| | 41.6 | 1.8% | | | | |
| 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. | |
| | 3.5 | 0.0 | 0.0 | -3.5 | | |

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP

