UPPER YELLOWSTONE RIVER PHYSICAL FEATURES INVENTORY REPORT

GARDINER TO SPRINGDALE

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Natural Resources Conservation Service
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USDA NRCS Natural Resources Conservation Service Montana

PREPARED FOR THE
UPPER YELLOWSTONE RIVER TASK FORCE
AND
PARK CONSERVATION DISTRICT

BY
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INTRODUCTION

This report summarizes a physical features inventory conducted in 1998 at the request of the **Governor's Upper Yellowstone River Task Force** (UYTF). The USDA Natural Resources Conservation Service was requested to organize and coordinate the inventory by the Park Conservation District, (Park CD), and the UYTF. The report will assist the UYTF and its partners to, " develop a shared understanding of the issues and uses that impact the Upper Yellowstone River .... for the purpose of encouraging a comprehensive approach to actions taken along the river to ensure that its integrity remains intact while balancing the needs of communities and landowners to protect property". •

A physical features inventory of the Yellowstone River between Gardiner and Livingston, Montana, was conducted by the Water Quality Bureau of the Montana Department of Health and Environmental Sciences (now the Montana Department of Environmental Quality), in September of 1987. The findings were presented in a report titled, "Yellowstone River Inventory Reach II, Gardiner to Livingston", in December of 1989. The report summarized the quantity and condition of streambanks, channel alterations, and other structural aspects of the river. Four distinct reaches were identified and the results were summarized accordingly. Sections describing the history, hydrology, geomorphology, soils, water quality, fisheries, water use and reservations, and land ownership and land use are a part of the 1989 report. Please refer to the original 1989 report for a discussion of these topics. Data from the 1987 inventory is presented within this report for purposes of comparing quantitative change in specific features over the eleven year period.

The stated purpose of the 1998 inventory was to collect resource information indicating the degree of physical feature change in the river since the previous 1987 inventory in a timely and consistent manner. The information will be used as an initial screening tool to evaluate priorities and to guide further analysis planned by the UYTF in order to carry out their stated goal of conducting a cumulative effects study. It is also to serve as an educational/informational tool to raise visibility of the UYTF and an awareness of UYTF activities. A third purpose is to educate participants in methods and procedures transferable to other watersheds in Montana.

The information collected can serve to indicate the relative degree of change observed for most of the features identified in the 1987 report. In order to establish a baseline for the remainder of the Yellowstone River in Park County, the 1998 inventory was extended to the Springdale Bridge near the Park County line.

Additional, 'new' information categories collected were water quality samples at nine points along the river, cobble size distribution, and the presence of floodplain alterations.

• Executive Order 17-97, Governor Marc Raciot, dated November 5, 1997.

Please refer to the appropriate sections of this report for a discussion of these inventory attributes.

A little over 96 miles of main and side channels were inventoried. The total inventory was broken into 14 segments based primarily on length and accessibility. The upper 10 segments were compiled individually and then broken into reaches comparable to the four reaches utilized in the 1987 inventory. The four segments from the Interstate Bridges above Livingston to the Springdale Bridge were broken into two reaches for purposes of comparison.

It is only with the cooperation and active participation of the UYTF, private citizens, and many local, state and federal agencies who assisted in this effort that the task was successfully completed over a three day period in April of 1998. Thanks are extended to all who participated or who otherwise supported the project. The success of such projects is largely due to the faith which local leaders place in community-based decision making. Participants of the survey are listed in ***Appendix C.***

INVENTORY METHODS AND PROCEDURES

The 1998 inventory of the Upper Yellowstone River was completed on April 22 and 23. Eight teams of two to four people inventoried one of eleven assigned segments and recorded specific physical features. Drift boats were provided and crewed by local guide service operators who donated their time and equipment. Segments from the mouth of the Gardiner River to the Gardiner Airport (0) and through Yankee Jim Canyon (3) were walked and/or driven in consideration of safety issues. The segment through Livingston from the Park Clinic Access Site to Mayor's Landing (10) was walked. Each team was assigned a 'team leader' who was responsible to oversee notetaking and delineation of features. One team was assigned to each segment, however, three multi-channel segments, (7,8 and 12) were floated with two teams. Teams were assigned to the left or right braids to improve accuracy and efficiency. Information for the multi-channel reaches was then compiled onto the 134 aerial photos that were provided by the Montana Department of Transportation.

Prior to the actual inventory, participants were instructed in the methodology and procedures to be used to denote features. Classroom instruction was given in the categories of physical features assessment, water quality sampling, bedload size sampling, and photography. An equal amount of on-stream training for each topic followed at a site near the City Park in Livingston.

Training was also provided in Rapid Bioassessment Protocol, commonly used to sample macroinvertibrates (aquatic bugs) as an educational element. Macroinvertibrates were not sampled as part of the 1998 inventory due to time constraints and the cost of sample analysis.

PHYSICAL FEATURES:

Examples from the 1987 inventory were reviewed to insure as much consistency as possible. The 1987 aerial photos for each respective segment were carried during the inventory to assist in the comparison of recorded features and changes that may have taken place in channel condition and location. Feature types were recorded by code directly on low elevation aerial photography , (scale = 200 feet/inch), provided by the Montana Department of Transportation, (flown 3/30/98). Linear features were measured directly on the photos using a 6" ruler. Non-linear features were counted. All feature types were also recorded by photo number on a spreadsheet using a consecutive numbering system going downstream. Left and right banks were distinguished for features not extending the entire width of the channel. Comments for each feature were recorded in notebooks as needed to explain unusual circumstances or any other pertinent information. Each team prepared a synopsis of their observations at the end of each day for the segment observed. A summary of each team's observations begins on page 4. All data entries were checked for completeness and scale following the inventory, and corrections were made as appropriate.

Feature definitions and codes used in the 1998 inventory :

Feature definitions and codes were selected to assure consistency with the previous inventory.

Stream Channel Change (SC)- perennial channel area created since 1987, > 25 lf lateral movement. (length)

Channel Alterations

Blanket Rock Riprap (BRR) - man-placed rock. (length)
Rock Jetty (RJ) - man placed rock oriented 90^0 or more to bank. (number)
Car Bodies (CB)- intact cars within normal high-water (bankfull) mark. (number)
Rock Barb (RB)- man placed rock oriented less than 90^0 to bank. (number)
Other Alterations (OA)- alterations to channel not covered above, i.e. bridges, pilings, etc. (number)

Bank Condition

Eroding Bank (EB) - unstable bank zone actively contributing sediment to channel during normal bankfull flow events. generally up to 10 ft. in height. (length and height)
Bank Mass Wasting (BMW) - very unstable bank zone actively contributing sediment the full height of bank during normal bankfull flow events. Generally over 10 ft. in height. (length and height)
Unvegetated Non-Eroding Bank (UNV) - Stable banks not supporting vegetation. (length and height)

Irrigation Diversion (ID) - man placed material to divert flows for irrigation. (number)
(IH) (IP) -Irrigation Headgates or Pump Stations - Irrigation water diversion points. (number)
Flood Plain Alteration (FPA) - Dikes or fill placed to restrict access of flows. (length and height)
Embedded or mobile large, woody debris. (EMB or MOB) - (single or multiple stems) Note jams.
Information Site (IS) - records reference to note entry or photograph. (number)

Water Quality

The purpose of water quality sampling in association with the inventory is to give the Task Force a "snapshot" view of water quality constituents to help indicate any potential areas or tributaries needing more detailed investigation. Samples were taken from nine locations during the 1998 inventory. One additional sample was run as a QA/QC duplicate. Samples were analyzed for Total Suspended Solids, Nutrients, Metals and Common Ions. Personnel from the Montana Department of Environmental Quality, Data Management and Monitoring Bureau provided training in the use of established procedures for water quality sample site selection, collection, preservation and security.

Streamflow, in cubic-feet per second, based on permanent USGS gaging station measurements, is presented below. Based on respective historical records of station median daily streamflow, the flows during the inventory were moderately above average for the date. Differences in real streamflow volume between the 1987 and 1998 inventory dates (or photo dates) were not sufficient to impair relative visibility of the linear features inventoried.

		April 22				April 23		
USGS Station	**April 22, 1998**	**MIN**	**MEAN**	**MAX**	**April 23, 1998**	**MIN**	**MEAN**	**MAX**
Corwin Springs	1740	1540	1730	1840	2260	1840	2250	2480
Carter Bridge	1950	1870	1950	2100	2300	2070	2300	2700
Shields River	312	290	312	333	376	333	376	417

BED MATERIAL SIZE DISTRIBUTION

An attempt was made to sample the median size (diameter) of material that was deposited as bed material on the point bars as water receded following the high water event of 1997. A modification of the standard pebble count procedure described by M.G. Wolman was used. This procedure expresses numbers of bed material particles by size-class distribution. The intent is to gain some understanding about the variability of bed material size and distribution along a downstream profile to guide future investigative efforts. Measurements were taken using a transect along the top of the lower one-third of point bars. One hundred particles were measured at random, their B or intermediate axis measured and recorded on the sample form. Calculations were then made to determine the median or D_{50} particle size.

PHOTOGRAPHY
Teams were provided with 100 ASA Ektachrome slide film. Over 500 slides were taken. Participants were instructed to use the photography to illustrate common conditions, unique circumstances, stable features, possible reference sites, and to serve as a basis for establishment of permanent photo points from which change can be visibly ascertained over time. All slides taken are maintained on file at the Park Conservation District offices. The location and nature of each frame taken was recorded in a segment notebook. The location was also noted on the respective aerial photographs for future reference. For the purposes of this electronic document representative photos of features within each segment are included. ***Select this text for a listing of all photos included***.

INVENTORY FINDINGS

PHYSICAL FEATURES
A number of the features inventoried appear to have increased considerably while others have shown no major change or, in a few cases actually declined. ***Table 1*** itemizes inventory results by each of the 14 segments inventoried. ***Table 2*** summarizes results by left and right bank for each segment. ***Table 3*** provides a comparison of the 1987 and 1998 inventories using the original reach classification. ***Table*** 4 provides the same comparison for selected features, but is segregated by the 14 segments used in 1998 for a finer comparison. Narrative findings are presented by segment. Comments are taken from segment summaries provided by each team.

General observations on the inventory were that the unvegetated non-eroding bank (UNV) feature did not prove to be a useful category as it proved difficult to interpret, particularly with respect to continuity with the 1987 inventory. As it was agreed this category should generally be disregarded, these observations do not appear on the photos appearing in this document. Scour caused by back-to-back years of flooding removed much of the above ground vegetation, however, roots and sprouts appear viable to recover. Debris counts proved difficult to track so a rating system (using a scale of 1-10) was developed following the inventory to characterize the relative amount of large woody debris deposited as flood waters receded. The 1998 aerial photos were used as an aid in this effort.

Main and side channel bank length for the segments between Livingston and Springdale was measured using an electronic planimeter. Only those primary side channels exhibiting features of perennial flow such as well defined, vegetated islands and flow paths were included. No spring creek or tributaries were measured. For consistency, measurements from the 1987 inventory were used to calculate total bank length for segments 1 to 9.

The measurement of linear features using two un-rectified aerial photo flights precludes the use of the linear data in an absolute sense. Checks for scale accuracy on both flights yielded small errors, however, this information should be used in a relative sense only.

Segment 0 - Mouth of Gardiner River to McConnell access

Segment length is 19,625 lf. Gradient is 0.43 percent. This segment is characterized by relatively steep stream gradient and boulder sized bed material. No cobble size measurements were taken since no true point bars were observed in this section. The channel is entrenched within steep, little vegetated, valley walls and bedrock outcrops. Bank stability is relatively good as few modifications to the channel or streambanks were noted. The majority of bank erosion occurs on the left bank, due primarily to slope and drainage modifications caused by the old railroad right-of-way. Effects of scour on the narrow band of riparian vegetation appears to be temporary as regrowth has already begun to occur. The upper portion is surrounded by relatively dense development encroaching to the edge of the terrace, although well above the flood plain. No major changes were observed relative to the 1987 inventory.

The Gardiner Waste Water Treatment Plant discharges treated water to the river under a NPDES permit.

In general, this segment is very stable.

Segment 1 - McConnell access to Corwin Springs

Similar to Segment 0 in character for the first several miles. Length is 24,450 lf. Valley slope is 0.20 percent. Channel character changes as the grade decreases. Homes and development begins to encroach more closely on the river. The channel is less entrenched. More mass wasting begins to occur as soils and natural bank armor decreases in size through the flatter stretches. A few areas of bedload deposition were noted. One streamside debris dump (mostly metal) was observed. The riprap observed was placed primarily for protection of highway fill. No major changes occurred relative to the 1987 inventory.

In general, this segment is fairly stable during normal flows. Most of the unstable features noted appear accelerated by high water as the river has little floodplain available in which to dissipate energy.

Segment 2 - Corwin Springs access to Yankee Jim access

The stream is still somewhat entrenched and is similar to segment 1. Length is 31,005 lf. Valley slope is 0.24 percent. Long , 20 to 30 feet high mass wasting banks are the predominate erosional feature along this segment. A scarcity of adequate woody riparian plants at the toe of low to moderately high banks may contribute to the problem as may effects of the bridge at Corwin Springs. Bank alterations to protect developments increase over upper segments. Some of the efforts appear to be unsuccessful, particularly the past use of car bodies. Additional rock riprap has been added. This segment has the second highest number of car bodies in the river, although now five less than recorded for this segment in 1987.

In general, this is the first segment where bank protection efforts become very evident, mostly in a few developed areas, yet the river is still fairly natural overall.

Segment 3 - Yankee Jim access to Carbella access
Length is 18,700 lf. Valley slope is 0.27 percent. Much of this segment is characterized by steep, narrow, and well armored canyon walls. The main feature is the significant length of rip-rap placed to protect highway fill material. One or two small slumps are associated with the old railroad grade. Few erosional areas were observed. Although high water has scoured much of the above ground woody riparian vegetation, the combination of large boulders, bedrock and resprouting vegetation appear sufficient to prevent excessive bank erosion.

The mouth of Yankee Jim Canyon represents the end of Reach 1 used in the 1987 inventory. Below this point, the valley opens up, grade is less and channel width becomes greater.

Other than about 500 lf of riprap, (apparently due to scale differences between photos), there has been practically no change in physical features. The main change observed is in the lower mile or so where substantial homesite development has occurred in upland areas. Tom Miner Creek has added a relatively large amount of sediment during high water runoff as evidenced by the debris fan at the mouth. One livestock confinement area adjacent to the river was noted.

Segment 4 - Carbella access to gravel pit access
Length is 36,720 lf. Valley slope is 0.07 percent. This segment has relatively few channel and bank alterations. The channel down to a mile or so above Point of Rocks is characterized by a singular, stable channel with good woody vegetation growing along the banks. Below this point, it is less confined; grade flattens and the stream becomes wider with resulting deposition of bedload and sediment. Below the highway bridge, the channel type is extremely braided. An associated moderate amount of channel change has occurred creating large mid-channel bars. Eroding banks have more than doubled since 1987. These features appear the result of recent flood events. The majority of erosional features are located in this lower section. Practically no alterations have occurred since 1987. A relatively small amount of large woody debris has accumulated in this section.

Segment 5 - Gravel pit access to Emigrant access

Length is 68,690 lf. Valley slope is 0.09 percent. This segment represents the predominant appearance of the valley section of the river; the stream alternating between sections of confined, singular channel with fairly stable conditions and sections of multiple side channels braiding across the wider floodplain until confined by more erosion resistant larger bed and bank material. The first major irrigation diversion point occurs here. Change in the number and extent of alterations has not been significant, however a few small areas of bank protection appear to have failed. Bank riprap accounts for about 7% of total bank length. The majority of alterations were placed to protect roads and homes. Fairly extensive channel changes (2400 lf) have occurred apparently as a result of the flooding. The number of actively eroding banks has more than doubled as well, to about 20% of total bank length. The multi-channel areas have trapped a moderate amount of large woody debris.

A significant number of new homes have been built adjacent to the river. 14 new homes within 200 feet of the river were counted.

Segment 6 - Emigrant access to Lock Leven access

Length of the channel segment is 61,575 l f.   Valley slope is 0.24   percent. The braided conditions continue similar to segment 5 for several miles downstream of the Emigrant Bridge. The bulk of noted channel change and erosion occurs in this section. About 14% of the channel banks are eroding, again primarily in the several miles below the bridge. This is not a lot different than in 1987.   A relatively large amount of woody debris occurs in this area.

Not much change in the amount of rock riprap was recorded.   Most bank protection has been placed to protect the highway and pasture land. About 2% of bank length is armored. However, the amount of channel change (12%), is significant and likely represents the loss of some bank previously counted as rip rapped.

The lower section of this reach is characterized by a singular, channel confined between banks made up of large cobble material. Participants noted that juniper bank vegetation was robust for the most part and withstood flooding well. A significant number of new homesites and development has occurred on uplands in the lower portion of this segment.

Segment 7 - Lock Leven access to Pine Creek Bridge

This segment length is 34,050 lf. Valley slope is 0.23 percent. Participants noted the reach is fairly uniform in grade and entrenchment. The upper three-fourths of the reach is single channel. Banks are fairly stable where vegetation is adequate to protect them. About 8% of total bank length is armored.   A considerable amount (4445') of rock riprap and 35 rock barbs/jetties have been placed since the previous inventory primarily to protect agricultural land.   Present unstable banks are relatively uncommon (5%) although one large mass waste bank occurs below Mallards Rest fishing access. Large woody debris was noted primarily in the braided areas above Pine Creek Bridge.

Segment 8 - Pine Creek Bridge to Carters Bridge
This segment length is 41,170 lf. Valley slope is 0.29 percent. This section contained the greatest overall bank and channel features recorded. Below Pine Creek Bridge are located long, high mass wasting banks. This segment contains the greatest percent of such features, (8.3%). About 16% of the bank length has rock riprap placed. Some of the original riprap has failed and is now categorized as eroding bank. The channel has moved its full width in several places. About 8800 lf of channel movement section was noted. There is now about double the amount of eroding bank (EB &BMW), or 33% of total bank length. About 62 more rock barb and jetty structures were counted than present in 1987. 6 car bodies are no longer present. Although dikes and other features that modify the flood plain were not recorded earlier, there are now about 9000 lf of dikes in place along the west (left) side of this segment. Channel and bank changes are accompanied by a dramatic increase noted on the photos of newly developed, large point and mid channel gravel bars. D^{50} size of the bar material is 5 size classes smaller than measured in the previous segment 7, possibly indicating less gradient and preventing this smaller material from passing through the section.
This segment also contained the greatest number of large woody debris stems.

Segment 9 - Carters Bridge to Park Clinic access
Segment length is 23460 lf. Valley slope is 0.26 percent The stream begins to come into contact with the town where extensive alterations have been made to the west (left) side of the channel. This segment contains the second greatest amount - 26%, of banks protected by riprap. About 2,765 feet of rock bank protection and 14 rock barb/jetty structures have been added since 1987. About 20% of the west bank channel length has been diked to protect developed areas. The eastern bank of this segment is largely stable, although little flood plain is available. Stability is controlled by the steep and rocky slopes of Livingston Peak.

The large number of cars once found in this segment (53), are now down to only 2 observed.

A mile downstream of Carter Bridge and again immediately upstream of the Interstate Bridge, extensive deposition has occurred, creating large mid channel gravel bars. The Interstate Bridge is the limit of the 1987 inventory

Segment 10 - Park Clinic to Mayor’s Landing access
Segment length is 11,024 lf. Valley slope is 0.23 percent. This segment is similar to 9 except that after the Interstate, more floodplain is available on the east (right) bank. An interesting feature here is that a relatively new earth dike makes up about 71% of the left bank length. The segment contains the greatest percent of banks protected with rock,

about 28%. The feature is mainly associated with the dikes. Several old dumps and debris piles were noted along the route, also.

The channel aspect is much the same as the previous reach with extensive aggredation taking place. At the lower end of this short reach, the channel location and grade is again controlled by erosion resistant rock outcrops on the right (east) bank and a sill across the riverbed.

Segment 11 - Mayor's Landing access to Shields River Bridge access
Segment length is 38,016 lf. Valley gradient is 0.20 percent. Although no records are available for comparison, it appears that flooding caused significant change in stability and channel configuration. 10,300 lf or about 13.5% of bank length is protected with placed rock. About 13% of the banks are actively eroding or wasting material into the river.

Immediately downstream of the landing is an old landfill adjacent to the river. Some car and other debris was observed on an actively eroding bank here.

It was noted that the railroad and highway bridge fills create effective floodplain blockages that impede the passage of flood flows through this section without greatly increasing the velocity of flood waters. Downstream of the bridge, quite a bit of deposition has occurred. The left (north) bank of the stream is bordered by relatively new home development.. A significant amount of bank mass wasting on the high banks is occurring and may threaten these homes if accelerated. Much of the balance of the left (north) bank is fringed with development. Channel movement is controlled by bedrock outcrops.

The Shields River Bridge fill material also creates the same conditions as those for the upper bridges.

Segment 12 - Shields River Bridge access to Pig Farm access (private)
The segment length is 48,656 lf. Valley gradient is 0.16 percent. Debris accumulation is significant in the upper 7/8ths of this segment, both gravel material and large woody debris. Over 30% of the banks were put in an erosional category. Participants noted that while even well vegetated banks had been damaged, those with good diverse woody vegetation were damaged less extensively. Long, wide mid channel bars have developed creating diverse stages of side channel development. Some of the side channels are over 200 ft wide. Participants noted that historic evidence of these very dynamic channel changing conditions can be seen on the photos. A fair amount of bank protection activities have taken place. About 9% of bank length has had rock protection placed in addition to 32 rock jetty/barb structures.

The mouth of the Shields River has deposited a lot of debris and gravel in the channel, evidence of a significant amount of bedload movement.

The lower 1/8 of the segment has changed little through this entrenched section, although some of the high bank toes have been scoured of vegetation. Bedrock outcrops and sills in the streambed maintain the single channel conditions.

Segment 13 - Pig Farm access to Springdale access
Segment length is 54,468 lf. Valley slope is 0.18 percent. This upper 1/3rd of this segment continues with a single channel. Bedrock control gives a pool and drop sequence to the river. Much of the banks are stable with good vegetation and large rock material. The flood plain is narrow and confined.

The lower 2/3rds again shows evidence of gradient change with the stream becoming wider and meandering in a braided pattern. Extensive deposition and lateral movement has occurred. Large areas of woody and gravel debris are found. The river comes in contact with the interstate and railroad corridor resulting in quite a bit of mostly successful placement of large rock to protect these facilities.   About 12% of the banks have been treated in this manner. As in the previous two segments, the left (north) bank is largely bedrock material.   The inventory ended at the access below the Springdale Bridge

WATER QUALITY

A detailed analysis of the samples is not presented here as the information is not sufficient, however several areas are identified for more detailed study. The samples showed no exceedences of state water quality standards. Several upper river samples do have somewhat elevated levels of nitrate + nitrite.   Ammonia levels in the first two samples also appear higher than expected for well aerated surface waters. Further analysis of this area may be useful to document the origin(s) of these forms of nitrogen.

In a downstream direction constituents either increase due to concentration or decrease due to dilution pretty much as expected.

Suspended sediment and turbidity have been identified as the major causes of pollution in the Upper Yellowstone. Previous studies have identified four drainages in Yellowstone National Park as the primary sources of sediment loads: the Lamar-Tower drainage; the Yellowstone River from Lake to Tower; Soda Butte Creek; and the Gardiner River. Suspended solids levels measured during the April inventory do not reflect the elevated levels commonly measured during high flow events.

Several tributaries to the Yellowstone have been identified that contribute significant amounts of heavy metals to the river from abandoned mines. Soda Butte, Daisy and Fisher Creeks have been prioritized as high for future reclamation work.

Total suspended sediment levels measured during the 1998 inventory fluctuated slightly downriver and likely indicate some additional sources of sediment are found along the river or in tributaries. The Shields River Mouth station, (#513) showed a significantly higher TSS level, (51.3 mg/l), than levels found in the Yellowstone River above that point, ($\leq$20.0 mg/l). Several metals also showed elevated levels contained within waters of the

Shields River. While much of the Shields River geology and soils are different than the Yellowstone, additional monitoring work to identify potential sources of sediment and metals appears to be warranted.

Lab analysis results are presented in Table 5 on page 14. The U.S.Geological Survey sampled water quality at gaging stations near Corwin Springs, MT and near Livingston, MT for a number of years. For purposes of comparison, Tables 6 and 7 list statistics for selected constituents at these two stations. Water quality sampling at the stations was discontinued in 1994.

The U.S.G.S. began a full scale National Water-Quality Assessment (NAWQA) Program on the Yellowstone River system in Wyoming and Montana in 1997. Intensive water quality and biological data collection is scheduled to begin in 1999. At least two study sites are proposed in Park County. For more information on the study schedule, scope of work and purpose, please contact the U.S.G.S. (307)778-2931; Internet: http://wyoming.usgs.gov/YELL/yell.html.

Table 6 STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM OCT. 1969 TO SEPT. 1992 AT USGS GAGING STATION - CORWIN SPRINGS, MT

WATER QUALITY CONSTITUENT	SAMPLE SIZE	MAXIMUM	MINIMUM	MEAN
AMMONIA, mg/l	25	**0.37**	**0.00**	**0.085**
NITRATE + NITRATE , mg/l	21	1.90	<0.10	0.263
CALCIUM, mg/l	33	23.0	7.9	14.918
MAGNESIUM, mg/l	33	7.10	2.70	4.891
SODIUM, mg/l	33	28.00	5.60	17.621
POTASSIUM, mg/l	10	5.90	1.50	3.530
CHLORIDE, mg/l	34	22.00	2.10	9.944
SULFATE, mg/l	43	81.00	7.50	32.160
BORON, mg/l	17	0.65	0.06	0.335
IRON, mg/l	3	0.160	0.024	---
pH, units	42	8.70	6.40	7.49
SPECIFIC CONDUCT-ANCE, us/cm	64	432.00	80.00	214.23
SUSPENDED SEDMT, mg/l	48	975	3	119
SUSPENDED SEDMT, tons/day	48	35800	6.6	n/a
HARDNESS, mg/l	29	82	1	55.3
WATER TEMP. ^{0}C	76	19.5	0.0	n/a

Data provided by U.S. Geological Survey, WRD, 301 South Park Ave., Helena, MT

TABLE 7 STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM OCT. 1969 TO SEPT. 1992 AT USGS GAGING STATION - LIVINGSTON, MT

WATER QUALITY CONSTITUENT	SAMPLE SIZE	MAXIMUM	MINIMUM	MEAN
AMMONIA, mg/l	92	0.53	<0.01	0.073
NITRATE + NITRATE , mg/l	223	1.20	<0.05	0.149
CALCIUM, mg/l	259	35.00	8.60	19.610
MAGNESIUM, mg/l	259	11.00	2.00	6.211
SODIUM, mg/l	258	30.00	4.90	15.989
POTASSIUM, mg/l	259	6.70	1.10	3.849
CHLORIDE, mg/l	259	20.00	1.00	8.160
SULFATE, mg/l	259	55.00	3.00	26.833
IRON, mg/l	193	0.33	<0.001	0.040
BORON, mg/l	39	0.423	0.05[i]	0.269
pH, units	253	8.9	6.40	n/a
SPECIFIC CONDUCT-ANCE, us/cm	253	382	83	228
SUSPENDED SEDMT, mg/l	103	643	2	41
SUSPENDED SEDMT, tons/day	144	18100	7.3	n/a
HARDNESS, mg/l	231	130	32	74
WATER TEMP. ^{0}C	253	20.0	0.0	n/a

Data provided by U. S. Geological Survey, WRD, 301 South Park Ave., Helena, MT

In general, the waters of the Upper Yellowstone are of relatively good quality. The Yellowstone River is classified as a B-1 use classification under the Montana Water Quality Act. Waters classified as B-1 are suitable for drinking, culinary and food processing purposes following conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply uses.

BED MATERIAL SIZE DISTRIBUTION

Findings indicate that factors other than channel slope may play a role in size distribution of bed material. The sampling procedure was chosen as a means to depict the median size of bedload material moved during flooding events. In reality, this procedure may have only sampled material deposited as flood flows receded. Due to the complexity of the stream, and the difficulty in locating true point bar features, it is likely that more sophisticated procedures to describe and understand bedload movement will be required.

Table 8 shows the median particle size determined through the transect method. ***Table 9*** gives valley slope for the segments inventoried. Figure 2 illustrates the variation in size over the length of the river. A regression analysis showed no correlation of particle size to slope class using this data

CONCLUSION

Based on our observations, it is apparent that the Yellowstone River has undergone considerable changes in several segments since the 1987 inventory was performed. In particular, segments 7, 8, and 9 have experienced a number of bank protection treatments in an effort to mitigate channel changes. All segments in the middle and lower sections of the study area have a relatively high percentage of eroding banks. The changes appear largely due to the effects of and in reaction to the high water events, which occurred in 1996 and 1997. Analysis of gage data at Livingston shows that there has been a 6 percent increase in annual flow in the ten year period following 1987, as compared to the ten year period preceding 1987. This increase in flow is partially due to the large amount of open area created as a result of the 1988 fires in Yellowstone National Park and adjacent areas in the watershed.

In terms of vegetative health on the stream banks, 1987 had the lowest flow in the twenty year period analyzed at 66 percent of average, with 1985 being 82 percent of average, and 1986 being 111 percent of average. As a result, streambank vegetation in the three year period prior to the 1987 inventory was minimally stressed by high flows. In contrast, the 1995 flow was 102 percent of average, the 1996 flow was 141 percent of average, and the 1997 flow was 163 percent of average, giving the streambank vegetation little chance for recovery prior to the 1998 inventory.

The purpose of this inventory was to quantify physical changes to the river in the study area. It is recommended that the impacts of these changes be studied further, particularly the long-term impacts to the river and its associated values, ie. aquatic life, riparian and floodplain functions, upland land uses, and economics. A detailed hydrologic study is also planned which may help to explain some of the changes and offer some prediction as to their effect on these resources.

Nearly all obstructions in the flood plain such as bridges and abutment fills were observed to have an impact on the function of the channel's transport of sediment and bedload. It is recommended that any studies to evaluate floodplain function also evaluate ways to mitigate such impacts.

APPENDIX C 1998 Survey Participants

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APPENDIX D TASK FORCE MISSION AND MEMBERS

What is the Upper Yellowstone River Task Force? Created by Governor Racicot to address problems arising from the large floods of 1996 and 1997, the Upper Yellowstone River Task Force is a structured non-regulatory organization that works to accomplish its important mission in a consensus-building manner, that stresses education, cooperation, broad-based community involvement and voluntary participation.

The members of the Task Force represent a wide cross-section of citizens and local, state and federal agency representatives working to, "develop a shared understanding of the issues and uses that impact the upper Yellowstone River… for the purpose of encouraging a comprehensive approach to actions taken along the upper Yellowstone River so as to ensure that its integrity remains intact while balancing the needs and communities and landowners to protect property".

Those wishing more detailed information regarding any aspect of the Task Force and its activities are encouraged to contact John Bailey, Chair (406-222-1673) or Liz Galli-Noble, Coordinator (406-222-2899). Mailing address: Upper Yellowstone River Task Force, 5242 Highway 89 South, Livingston, MT 59047.

Listed below are the current Task Force members:

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Chair

Mike Atwood
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Citizen Member

Martin Davis
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