BSDMS Summary Report

33 Yellowstone River at U.S. 89 near Emigrant, MT

Site Location:

Site ID: 33

Site Name: Yellowstone River at U.S. 89 near Emigrant, MT

County: Park

Nearest City: Emigrant

State: MT

Latitude: 451515

Longitude: 1105203

USGS Station ID: 6191500

Route Number: 89

Route Class: US

Service Level: Mainline

Route Direction: NA

Highway Mile Point: 20.417

Stream Name: Yellowstone River

River Mile:

Contact:

Steve Holnbeck
USGS, Montana District
(406) 457-5929
holnbeck@usgs.gov
or
Charles Parrett
U.S. Geological Survey, Montant District
(502) 457-5928

Publication:

An unpublished level-2 analysis was performed by USGS and is planned for submittal to MDT (February 1994) under the title: "Analysis of scour potential for bridge structure no. P00011020+04171 Yellowstone River 11M SW Emigrant, MT".

Site Description:

The site is located 11 miles southwest of Emigrant, Montana and drains an area of about 2,844 square miles. Annual-peak-discharge data were collected for 42 years at the USGS streamflow-gaging station "Yellowstone River at Corwin Springs, Montana" (06191500). The largest recorded peak discharge at the gage was 32,000 cubic feet per second (cfs) in 1918. The next two largest peak discharges occurred in 1974 (30,900 cfs) and 1911 (25,800 cfs). Selected flood-frequency data for the gage (Omang, 1992), adjusted for drainage area, give 100-year and 500-year peak discharge estimates at the bridge equal to 31,900 cfs and 35,700 cfs, respectively. Bed material was sampled within the bridge opening and because material was coarse and armoring was observed, the sampling method used was a random-count procedure performed by hand in the field. Although the watershed has been subject to recent fires and land-use changes, their overall effect on basin sediment yields is believed to be relatively minor. The watershed is thus presumed to be fairly stable in terms of sediment yield and channel-change potential. The station history for the USGS gage (06191500) indicates only minor shifts, generally on the order of a tenth of a foot or less. An example of channel stability during high flows is demonstrated by a rating, which has been used at the gage since 1979. Runoff measured at the gage for the period 1979-present (1994) included three floods that had peaks ranging from 21,900 cfs to 24,700 cfs (69 to 77 percent of 100-year flood peak). Although

the gage is about 13 miles upstream from the bridge, channel stability at the two locations is presumed to be similar. Measured scour holes were observed to change over time, however, the change was considered minor and thus, clear-water scour was presumed to occur during measurements. In performing level-2 analyses at the 100-year and 500-year floods, shear-stress calculations for the streambed indicated that live-bed scour was only marginally more likely to occur, compared to clear-water scour. In contrast, comparison of critical and mean velocities indicated clear-water scour conditions. Taking into account other factors, including the presence of armoring at the site and the fact that only minor rating shifts have occurred at the USGS gage, lead to the conclusion that clear-water scour predominates at the site. The presence of riprap and greater main-channel flow depth on the left side indicates that the left bridge opening has been subjected to some form of abutment scour. A comparison of cross sections surveyed in 1992 and 1993 and at the time of construction confirm that about 2 feet of abutment scour has occurred. Left abutment scour is probably caused by flow impingement, rather than by the factors accounted for in prediction equations, such as return of overbank flood-plain flow to the main channel. Based on a comparison of sections, contraction scour was found to not be a factor. Data describing piers, abutments, and other horizontal and vertical features are based on USGS survey work for measuring on-site scour, to perform a level-2 analysis, and to perform beta-level verification of the BRISTARS model using scour-related data from the site (planned).

Elevation Reference

Datum: MSL

MSL (ft):

Description of Reference Elevation:

Benchmark is US Coast and Geodetic Survey (USCGS) monument number Z565 (1988 datum) equal to elevation 4964.63, located on right upstream corner of bridge and set in concrete walkway.

Stream Data

Drainage Area (sq mi):	2844	**Floodplain Width:**	Narrow
Slope in Vicinity(ft/ft):	0.0022	**Natural Levees:**	Unknown
Flow Impact:	Straight	**Apparent Incision:**	None
Channel Evolution	Premodified	**Channel Boundary:**	Alluvial
Armoring:	High	**Banks Tree Cover:**	Low
Debris Frequency:	Occasional	**Sinuosity:**	Sinuous
Debris Effect:	Local	**Braiding:**	None
Stream Size:	Medium	**Anabranching:**	Locally

BSDMS Summary Report

33 Yellowstone River at U.S. 89 near Emigrant, MT

Flow Habit: Perennial

Bed Material: Gravel

Valley Setting: Moderate

Bars: Unknown

Stream Width Variability: Unknown

Roughness Data

Manning's n Values

	Left Overbank	Channel	Right Overbank
High:	0.06	0.035	0.06
Typical	0.06	0.035	0.06
Low:	0.06	0.035	0.06

Bed Material

Measurement Number	Yr	Mo	Dy	Sampler	D95 (mm)	D84 (mm)	D50 (mm)	D16 (mm)	SP	Shape	Cohesion
1	1993	11	18	Hand	190	150	73	28	2.65		Non-Cohesive

Bed Material Comments

Measurement No: 1

Bridge Data

Structure No: P00011020+04171

Length(ft): 450

Width(ft): 32

Number of Spans: 4

Vertical Configuration: Sloping

Low Chord Elev (ft): 4956.18

Upper Chord Elev (ft): 4957.58

Overtopping Elev (ft):

Skew (degrees): 35

Guide Banks: None

Waterway Classification: Main

Year Built: 1958

Avg Daily Traffic:

Plans on File: Yes

Parallel Bridges No

Upstream/Downstream: N/A

Continuous Abutment: No

Distance Between Centerlines:

Distance Between Pier Faces:

Bridge Description:

Bridge is skewed 35 degrees to flow and consists of riveted plate girders having four spans supported by three concrete tapered piers. No flow angle of attack on piers was noted in the field. Channel-geometry data are referenced to left edge of bridge opening. Stationing of piers is based on site surveys for level-2 work and does not relate to bridge-plan stationing. Although flow impact to the bridge was indicated to be straight, the presence of riprap on the left bank and greater flow depth on left side of main channel indicate that flow tends to impinge on the left side.

Abutment Data

Left Station: 0

Right Station: 450

Left Skew (deg): 35

Right Skew (deg) 35

Left Abutment Length (ft):

Right Abutment Length (ft)

Left Abutment to Channel Bank (ft):

Right Abutment to Channel Bank (ft):

Left Abutment Protection:

Right Abutment Protection

Contracted Opening Type: III

Embankment Skew (deg):	35
Embankment Slope (ft/ft):	1.5
Abutment Slope (ft/ft)	1.5
Wingwalls:	No
Wingwall Angle (deg):	0

Pier Data

Pier ID	Bridge Station(ft)	Alignment	Highway Station	PierType	# Of Piles	Pile Spacing(ft)
1	100	-30	0	Single		
2	227	-30	0	Single		
3	352	-30	0	Single		

Pier ID	Pier Width(ft)	Pier Shape	Shape Factor	Length(ft)	Protection	Foundation
1	3	Sharp		34	None	Poured
2	3	Sharp		34	None	Poured
3	3	Sharp		34	None	Poured

Pier ID	Top Elevation(ft)	Bottom Elevation(ft)	Foot or Pile Cap Width(ft)	Cap Shape	Pile Tip Elevation(ft)
1	4931.67	4924.67	8.5	Square	
2	4932.59	4925.59	10	Square	
3	4932.51	4925.51	8.5	Square	

Pier Description

Pier ID 1

Because pier is tapered, avg width and length are indicated. Channel-geometry data at exit and approach sections (8/28/92) was used to estimate reference surface at bridge for determining scour depth at pier 1 and to confirm lack of thalweg influence and lack of contraction scour.

BSDMS Summary Report

33 Yellowstone River at U.S. 89 near Emigrant, MT

Pier ID 2

Because pier is tapered, avg length and width are indicated. Stationing is based on field measurements and does not relate to bridge plans. Pier elevations relate to datum of MDT dwg. no. 3895, which closely approximates USCGS datum used in survey of sections (+/- 0.2 ft).

Pier ID 3

See description for pier 2.

Pier Scour Data

Pier ID	Date	Time	USOrDS
1	5/21/93	16:10	Upstream
1	5/27/93	10:00	Upstream
1	6/30/93	10:30	Upstream
1	6/12/96	12:00	Upstream
1	6/9/97	13:30	Upstream
2	5/21/93	16:10	Upstream
2	5/27/93	10:00	Upstream
2	6/30/93	10:30	Upstream
3	5/21/93	16:10	Upstream
3	5/27/93	10:00	Upstream
3	6/30/93	10:30	Upstream

Pier ID	Scour Depth	Accuracy (ft)	Side Slope (ft/ft)	TopWidth (ft)	Apprch Vel (ft/s)	Apprch Depth(ft)	Effective Pier Width	Skew to Flow(deg)
1	2.5	0.5	6.8	34	8	8.7	3.1	0
1	2.3	0.5	9.8	46	8.2	8.3	3.1	0
1	1.9	0.5	4.8	18	4.9	6.6	3.1	0
1	4	0.5	6.75	60	9.7	9.8	3.1	0
1	4	0.5	7	40	9.1	9.75	3.1	0
2	1.6	0.3	15.3	49	7.6	8.2	3.2	0
2	1.8	0.3	11.1	41	8	7.8	3.1	0
2	1.1	0.3	7.7	18	4.8	6.2	3.2	0
3	0.3	0.3	2.5	6	3.3	7.4	3.1	0
3	0.4	0.3	2.5	6	3.6	6.8	3.1	0
3	0.4	0.3	2.5	11	3.5	6	3.1	0

BSDMS Summary Report

33 Yellowstone River at U.S. 89 near Emigrant, MT

PierID	Sediment Transport	Bed Material	BedForm	Trough (ft)	Crest (ft)	Sigma	Debris Effects
1	Clear-water	Non-cohesive	Unknown			2.3	Unknown
1	Clear-water	Non-cohesive	Unknown			2.3	Unknown
1	Clear-water	NON-COH	Unknown			2.3	Unknown
1	Unknown	Non-Cohesive	Unknown				Unknown
1	Unknown	Non-Cohesive	Unknown				Unknown
2	Clear-water	Non-cohesive	Unknown			2.3	Unknown
2	Clear-water	Non-cohesive	Unknown			2.3	Unknown
2	Clear-water	Non-cohesive	Unknown			2.3	Unknown
3	Clear-water	Non-cohesive	Unknown			2.3	Unknown
3	Clear-water	Non-cohesive	Unknown			2.3	Unknown
3	Clear-water	Non-cohesive	Unknown			2.3	Unknown

PierID	D95 (mm)	D84 (mm)	D50 (mm)	D16 (mm)
1	190	150	73	28
1	190	150	73	28
1	190	150	73	28
1				
1				
2	190	150	73	28
2	190	150	73	28
2	190	150	73	28
3	190	150	73	28
3	190	150	73	28
3	190	150	73	28

Pier Scour Comments

Pier ID 1 **Time:** 16:10 **US/DS:** Upstream

Measurements made from bridge w/sounding wt and reel. Because current-meter measurements were not taken, approach velocity was estimated using surveyed channel-geometry data, streamflow data, and REW and LEW elevations input to HP2 option of WSPRO.

Pier ID 1 **Time:** 10:00 **US/DS:** Upstream

See 5/21/93 comments for P1. For all P1 cases, reference surface for estim-ating pier scour, top width, and side slope was determined on the basis of surveyed sections (8/28/92) at approach and exit.

Pier ID 1 **Time:** 10:30 **US/DS:** Upstream

See 5/21/93 and 5/27/93 comments for P1. Also, for all P1 measurements, determination of scour first required adjusting section for 35-degree skew. The skew adjustment generally applies to all sections measured and all resultant scour measurements.

Pier ID 1 **Time:** 12:00 **US/DS:** Upstream

See 5/21/93 comments for P1. Reference surface for estimating pier scour, top width, and side slope was determined on the basis of surveyed sections (8/2/92) at approach and exit and bridge opening (9/23/92).

Pier ID 1 **Time:** 13:30 **US/DS:** Upstream

See 5/21/93 comments for P1. Reference surface for estim-ating pier scour, top width, and side slope was determined on the basis of surveyed sections (8/2/92) at approach and exit and bridge opening (9/23/92).

Pier ID 2 **Time:** 16:10 **US/DS:** Upstream

See 5/21/93 comments for P1 for explanation of how flow velocity was estimated at P2. All scour determinations first required adjusting section for 35-degree skew to flow.

Pier ID 2 **Time:** 10:00 **US/DS:** Upstream

See 5/21/93 comments for P2.

Pier ID 2 **Time:** 10:30 **US/DS:** Upstream

See 5/21/93 comments for P2.

Pier ID 3 **Time:** 16:10 **US/DS:** Upstream

Scour variables for P3 were estimated on the basis of measurements and results for 9/23/92, 5/27/93, and 6/30/93. Also see 5/21/93 comments for P1.

Pier ID 3 **Time:** 10:00 **US/DS:** Upstream

See 5/21/93 comments for P1.

BSDMS Summary Report

33 Yellowstone River at U.S. 89 near Emigrant, MT

Pier ID 3 **Time:** 10:30 **US/DS:** Upstream

All measurements at P3 to date involve estimation of velocity using HP2 output of WSPRO. See 5/21/93 comments for P1.

Abutment Scour

ContractionScour

Measurement Number	Contracted Date	Contracted Time	Uncontracted Date	Uncontracted Time	US/DS	Scour Depth(ft)
1	6/9/97					1.25
2	6/12/96					1

Measurement Number	Accuracy	Contracted Avg Vel(ft/s)	Contracted Discharge(cfs)	Contracted Depth(ft)	Contracted Width(ft)
1	0.5		33300	9.79	325
2	0.5		31900	9.76	325

Measurement Number	Uncontracted Avg Vel(ft/s)	Uncontracted Discharge(cfs)	Uncontracted Depth(ft)	Uncontracted Width(ft)	Channel Contraction Ratio
1			7.28	440	
2			6.79	440	

Measurement Number	Pier Contraction Ratio	Scour Location	Eccent-ricity	Sediment Transport	Bed Form	Debris Effects
1		Main Channel		Unknown	Unknown	Unknown
2		Main Channel		Unknown	Unknown	Unknown

BSDMS Summary Report

33 Yellowstone River at U.S. 89 near Emigrant, MT

Measurement Number	D95 (mm)	D84 (mm)	D50 (mm)	D16 (mm)	Sigma Bed Material	Bed Material
1						Non-Cohesive
2						Non-Cohesive

Contraction Scour Comments

Measurement No. 1

Contraction scour estimated from comparing real-time upstream bridge face bed elevation during June, 1997 flood with baseline upstream bridge face bed elevation surveyed on 9/23/92.

Measurement No. 2

Contraction scour estimated from comparing real-time upstream bridge face bed elevation during June, 1996 flood with baseline upstream bridge face bed elevation surveyed on 9/23/92.

Stage and Discharge Data

Peak Discharge					Flow		Peak Stage					Stage	Water	Return
year	mo	dy	hr	mi	(cfs)	Qacc	year	mo	dy	hr	mi	(ft)	Temp (C)	Period(yr)
					33300							4948.7		100
					31900							4948		100
1993	6	30	10:30	30	8570	90					0			
1993	5	27	10:00	0	17100	90					0			2
1993	5	21	16:10	10	17600	90					0			2
1992	9	23		0	1380	85					0			

Hydrograph

Hydrograph Number	Year	Month	Day	Hr	Min	Sec	Stage(ft)	Discharge (cfs)

Supporting Files

Photos of the Site (Dscn prefix; .jpg formats):

#	Description
246.	Picture from upstream left bank

247. Looking upstream from left bank