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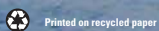
Channel-Morphology Data for the Tongue River and Selected Tributaries, Southeastern Montana, 2001-02

Chase - Channel-Morphology Data for the Tongue River and Selected Tributaries, Southeastern Montana, 2001-02

Open-File Report 2004-1260

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COVER PHOTOGRAPH: Tongue River at State Line near Decker, Montana. Photograph by Katherine J. Chase, U.S. Geological Survey, taken October 21, 2002.

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By Katherine J. Chase

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**U.S. Department of the Interior
U.S. Geological Survey**

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Conversion Factors, Datum, and Acronyms

Multiply	By	To obtain
cubic foot per second (ft ³ /s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
foot per foot (ft/ft)	1.0	meter per meter
inch (in.)	25.4	millimeter (mm)
mile (mi)	1.609	kilometer
square foot (ft ²)	0.09290	square meter
square mile (mi ²)	2.59	square kilometer

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88), to the National Geodetic Vertical Datum of 1929 (NGVD 29), or to local datum, as noted. Horizontal coordinate information is referenced to the North American Datum of 1927 (NAD 27).

Acronyms used in this report:

BLM	Bureau of Land Management
GPS	Global Positioning System
DNRC	Montana Department of Natural Resources and Conservation
NAD 27	North American Datum of 1927
NAVD 88	North American Vertical Datum of 1988
NGVD 29	National Geodetic Vertical Datum of 1929
NGS	National Geodetic Survey
RM	Reference mark
USGS	U.S. Geological Survey

Photographs by U.S. Geological Survey personnel

Glossary

Bankfull cross-sectional area The cross-sectional area of a stream channel at bankfull stage measured perpendicular to the streamflow.

Bankfull discharge The stream discharge generally considered to be the single discharge that is most effective for moving sediment, forming or removing bars, and forming or changing bends and meanders, all of which result in the average morphological characteristics of channels (Dunne and Leopold, 1978).

Bankfull-recurrence interval The average interval, in years, between annual peak discharges that equal or exceed bankfull discharge.

Bankfull stage The elevation above gage datum of the water surface corresponding to bankfull discharge.

Bankfull-wetted perimeter The length of the contact between the stream of flowing water and its containing channel, measured perpendicular to streamflow at bankfull discharge.

Bankfull width The width of the bankfull channel measured at a section perpendicular to the streamflow.

Entrenchment ratio The vertical containment of a river defined as the ratio of the flood-prone width to the bankfull width (Rosgen, 1996).

Flood-prone width The width across a flood plain, measured perpendicular to the streamflow, at a water-surface elevation corresponding to twice the maximum depth of the bankfull channel (Rosgen, 1996).

Gage datum The horizontal surface used as a zero point for measurement of stage or gage height. At some gages, the gage datum has been determined relative to the national datum (NGVD 1988 or NAVD 1929) so that stages can be converted to elevations above the national datum.

Left bank Left side of stream, looking downstream.

Local datum The assumed elevation of a survey mark, such as a steel pin, from which all elevation measurements are calculated and reported.

Maximum bankfull depth The maximum depth of the bankfull channel measured perpendicular to streamflow.

Mean bankfull depth The mean depth of the bankfull channel measured perpendicular to streamflow.

Right bank Right side of stream, looking downstream.

Rosgen classification A system of describing river channels based on channel geometry, stream plan-view patterns, and streambed material (Rosgen, 1996).

Sinuosity The ratio of the channel length to the valley length.

Terrace A level surface in a stream valley above the present flood plain that results from channel downcutting.

Thalweg The lowest point in a stream channel.

Width/depth ratio The ratio of bankfull width to mean bankfull depth.

Channel-Morphology Data for the Tongue River and Selected Tributaries, Southeastern Montana, 2001-02

by Katherine J. Chase

Abstract

Coal-bed methane exploration and production have begun within the Tongue River watershed in southeastern Montana. The development of coal-bed methane requires production of large volumes of ground water, some of which may be discharged to streams, potentially increasing stream discharge and sediment load. Changes in stream discharge or sediment load may result in changes to channel morphology through changes in erosion and vegetation. These changes might be subtle and difficult to detect without baseline data that indicate stream-channel conditions before extensive coal-bed methane development began. In order to provide this baseline channel-morphology data, the U.S. Geological Survey, in cooperation with the Bureau of Land Management, collected channel-morphology data in 2001-02 to document baseline conditions for several reaches along the Tongue River and selected tributaries.

This report presents channel-morphology data for five sites on the mainstem Tongue River and four sites on its tributaries. Bankfull, water-surface, and thalweg elevations, channel sections, and streambed-particle sizes were measured along reaches near streamflow-gaging stations. At each site, the channel was classified using methods described by Rosgen. For six sites, bankfull discharge was determined from the stage-discharge relation at the gage for the stage corresponding to the bankfull elevation. For three sites, the step-backwater computer model HEC-RAS was used to estimate bankfull discharge. Recurrence intervals for the bankfull discharge also were estimated for eight of the nine sites. Channel-morphology data for each site are presented in maps, tables, graphs, and photographs.

Introduction

The Tongue River drains about 3,920 mi² from the Montana-Wyoming border to its confluence with the Yellowstone River at Miles City (fig. 1). Major tributaries include Prairie Dog Creek, Hanging Woman Creek, Otter Creek, and Pumpkin Creek. Principal land uses in the area are farming and livestock production, and surface water is used primarily for irrigation.

Coal-bed methane exploration and production have begun within the Tongue River watershed of southeastern Montana.

The development of coal-bed methane requires the production of large volumes of ground water. Some of this produced water may be discharged to intermittent or perennial streams, potentially increasing stream discharge and sediment load. Changes in stream discharge or sediment load over time may result in changes to stream-channel morphology through changes in erosion and vegetation. Changes in stream-channel morphology can affect land, including wetlands, adjacent to the stream and aquatic habitat within the stream. Changes might be subtle and difficult to determine without baseline data that indicate stream-channel conditions before extensive coal-bed methane development began. In order to provide baseline channel-morphology data, the U.S. Geological Survey (USGS), in cooperation with the Bureau of Land Management (BLM), began a study in 2001 to collect data that document current or baseline channel morphology for several reaches along the Tongue River and selected tributaries. In the future, the cross sections and profiles can be resurveyed and the results compared to assess channel changes over time.

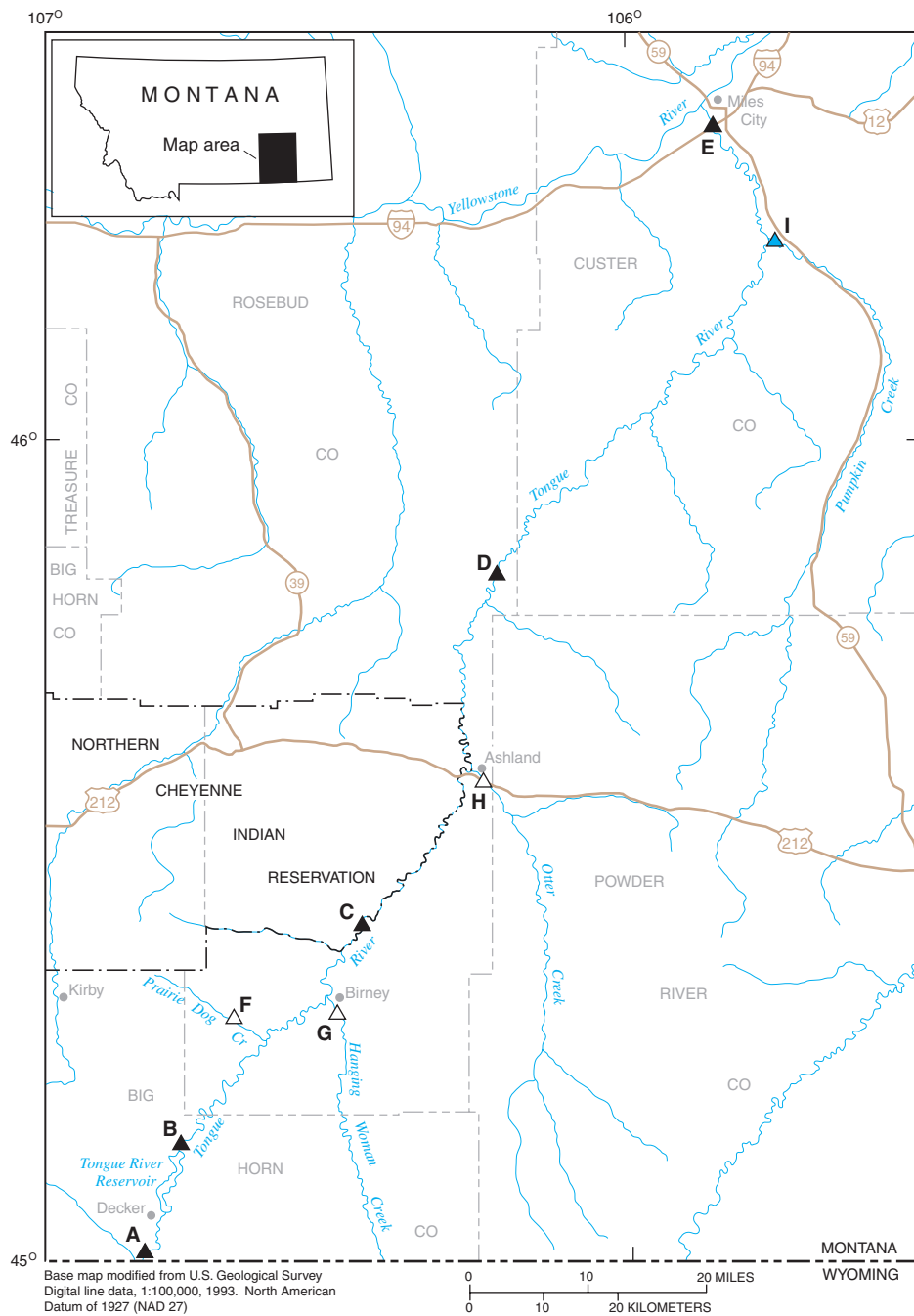
Purpose and Scope

The purpose of this report is to present channel-morphology data collected at five sites on the mainstem Tongue River and four sites on Tongue River tributaries—Prairie Dog Creek, Hanging Woman Creek, Otter Creek, and Pumpkin Creek (fig. 1). Data were collected during 2001-02. Each site is located at or near an active or discontinued USGS streamflow-gaging station. Data were used to calculate channel-morphology characteristics and to classify the stream at each site using methods described by Rosgen (1996). The frequency of bankfull discharge was then estimated based on flood-frequency data for eight of the nine sites. Data collected at each site are summarized in maps, tables, photographs, and graphs showing profiles, cross sections, and streambed-material particle-size distribution.

Methods

A representative reach near an active or discontinued gaging station was identified for each of the nine study sites. Bankfull discharge was determined for each reach using methods described by Dunne and Leopold (1978) and Emmett (1975).

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EXPLANATION

- CHANNEL-MORPHOLOGY SITE-Site letter, name, and streamflow-gaging station number or site number
- ▲ ACTIVE (2002) STATION △ DISCONTINUED STATION ▲ MISCELLANEOUS MEASUREMENT SITE
- | | |
|--|---|
| <ul style="list-style-type: none"> A Tongue River at State Line, near Decker, Mont. (06306300) B Tongue River at Tongue River Dam, near Decker, Mont. (06307500) C Tongue River at Birney Day School Bridge, near Birney, Mont. (06307616) D Tongue River below Brandenburg Bridge, near Ashland, Mont. (06307830) | <ul style="list-style-type: none"> E Tongue River at Miles City, Mont. (06308500) F Prairie Dog Creek near Birney, Mont. (06307528) G Hanging Woman Creek near Birney, Mont. (06307600) H Otter Creek at Ashland, Mont. (06307740) I Pumpkin Creek at mouth, near Miles City, Mont. (461450105444601) |
|--|---|

Figure 1. Location of study reaches along Tongue River and selected tributaries, southeastern Montana.

For the five mainstem sites, survey-grade Global Positioning System (GPS) equipment was used to survey location and elevation data for construction of longitudinal profiles of terrace elevation (where available), left- and right-bankfull elevation, left- and right-water surface elevation (at the time of the survey), and stream-thalweg elevation. Location and elevation points also were surveyed along one or three cross sections perpendicular to the stream at each site. The ends of the cross sections were marked with yellow-capped steel pins. Each cross section included a portion of the flood plain as well as the bankfull channel. The surveyed points for each profile and cross section were plotted in plan view, and distances along lines connecting each set of profile or cross-section points were calculated. These distance and elevation data are presented in graphs showing longitudinal profiles and cross sections. Distance data for the mainstem cross sections are rounded to the nearest foot in the tables and graphs.

At Tongue River mainstem sites A and B (fig. 1), local benchmarks and USGS gage reference marks were used for vertical control during the survey. At site A, elevations were referenced to the gaging-station datum. The gaging-station datum is reported as referenced to NGVD 29 according to a survey by the U.S. Army Corps of Engineers. This datum was converted to NAVD 88 using the National Geodetic Survey (NGS) computer program VERTCON (National Geodetic Survey, 2002a). At site B, elevations were referenced to the Montana Department of Natural Resources and Conservation (DNRC) datum for the dam and reservoir. At Tongue River mainstem sites C, D, and E, vertical-control monuments from the NGS (referenced to NAVD 88) were available (National Geodetic Survey, 2002b) and the GPS survey was referenced to the NGS as well as USGS gage reference marks.

At each tributary site, an automatic level, survey rod, and fiberglass tape were used to survey distance and elevation data for plotting longitudinal profiles and three cross sections. The fiberglass tape was stretched along the stream centerline and used to measure stream-centerline distance for plotting profiles. The fiberglass tape also was used to measure distance from one bank to another for plotting cross sections. Cross sections did not extend beyond the bankfull channel. The ends of sections were marked with steel pins, some with yellow caps and some without yellow caps. Elevations were referenced to a local (arbitrary) datum. Because the tributaries are narrower than the mainstem Tongue River, distances are rounded to the nearest tenth of a foot in the tables and graphs. Gaging-station reference marks also were surveyed where they could be found.

Theoretically, for a stream reach where flow is uniform or gradually varied, a bankfull-elevation profile would slope evenly downstream, approximately parallel to the water-surface profile. In addition, left- and right-bankfull elevations typically would be equal at a given location on a single-channel stream. However, at most of the sites, bankfull elevations varied to some extent along the stream and between the left and the right bank. Therefore, a best-fit line was drawn through either the left- or the right-bankfull elevation points, depending on the quality of the bankfull indicators (as noted during the survey)

and on how well the survey points aligned. At most of the sites, this best-fit line was used to determine bankfull elevation at the gaging station and at the cross sections. At some cross sections at the tributary sites, this bankfull elevation was above the surveyed ground elevation at one or both ends of the cross section. At the ends of these cross sections, the ground surface was assumed to extend vertically from the surveyed end point(s) up to the elevation of the bankfull water surface. For sites D and G (Tongue River below Brandenburg Bridge and Hanging Woman Creek), best-fit lines were not necessary because each of those gaging stations was at a cross section, and the left- and right-bankfull elevations were well-aligned and relatively consistent near the gaging station.

Bankfull-elevation data and cross-section measurements were used to calculate bankfull width, mean bankfull depth, maximum bankfull depth, bankfull cross-sectional area, width/depth ratio, and bankfull-wetted perimeter for each surveyed section. At five sites, three cross sections were surveyed and the morphological variables were averaged to produce overall values for the reach. The bankfull water-surface slope was calculated for each reach.

At each of the five mainstem sites and one tributary site (Hanging Woman Creek), bankfull discharge was determined from the most current stage-discharge relation at the gage for the stage corresponding to the bankfull elevation. At the other three tributary sites, either the most recent stage-discharge relation at the gage was not reliable or gage reference marks were not found, so the step-backwater computer model HEC-RAS version 3.0.1 (U.S. Army Corps of Engineers, 2001a,b,c) was used to estimate the bankfull discharge. HEC-RAS calculates water-surface elevations at one or more sections for a given discharge, Manning's roughness, and either a water-surface elevation or energy-grade slope at the section farthest downstream. Discharge was varied on a trial basis until the calculated water-surface elevations at the sections matched the surveyed bankfull elevations. The frequency of bankfull discharge was then estimated based on flood-frequency data for eight of the nine sites. Flood-frequency data for sites A, B, D, E, G, H, and I were previously determined by Parrett and Johnson (2004). Flood-frequency data for site C were not previously published and were determined by fitting a log-Pearson Type III distribution to the recorded annual peak discharges using methods described by Parrett and Johnson (2004). Flood-frequency data for site F were not determined because that gaging station had only 5 years of record.

Additional data were collected to describe the flood-prone width, entrenchment ratio, sinuosity, streambed-material sizes, and channel roughness and erosion conditions at each site. The flood-prone width was estimated by first determining the maximum depth of the bankfull channel at the cross section. Then a range-finder was set at the elevation corresponding to twice the maximum bankfull depth to measure the horizontal distance to the ground surface (perpendicular to the flow) on each side of the stream at that elevation, and the two distances were summed. The entrenchment ratio was calculated by dividing flood-prone width by bankfull width. Sinuosity was calculated

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from channel and valley lengths measured on 7.5-minute topographic maps. The pebble-count method was used to determine streambed-particle size distribution for each reach (Wolman, 1954). The pebble-count data were drawn on a log-normal graph along with the streambed-material size classes (silt/clay, <0.062 mm; sand, 0.062 to <2 mm; gravel, 2 mm to <64 mm; cobble, 64 to <256 mm; boulder \geq 256 mm). The predominant streambed material (the size class containing the highest percentage of observations) is indicated on the graph for each site. In addition, Manning's roughness coefficient (Chow, 1959) was estimated, and substantial bank erosion was noted in the field and sketched on maps.

Finally, the channel type for each site was classified using methods described by Rosgen (1996). Reservoir operations, bridges, and channel modifications may affect the channel geometry, bed material, and the Rosgen channel type. Thus, at site B, the channel might have been affected by operation of Tongue River Reservoir, while at sites C and D, the channels might have been affected by the Birney Day School Bridge and the Brandenburg Bridge, respectively. At site E, the channel was straightened. Nevertheless, these structures and modifica-

tions have been in place for a long period of time. The Tongue River Reservoir was formed when the dam was constructed in 1940 (Yadon, 1997), Birney Day School Bridge was constructed in 1970 (Montana Department of Transportation, 2003), Brandenburg Bridge was constructed in 1963 (Montana Department of Transportation, 2003), and the Miles City channel was constructed in 1901 (Robert Mitchell, Bureau of Land Management, oral commun., 2003). These channel reaches appear to be relatively stable, and the baseline data presented in this report represent current (2001-02) conditions and are useful for monitoring purposes.

Summary of Channel-Morphology Data Used for Determination of Channel Type

Channel-morphology data were collected at five sites on the mainstem Tongue River and four sites on Tongue River tributaries. These data are summarized in the following table:

Site letter and abbreviated name	Width/depth ratio (foot per foot)	Bankfull water-surface slope ¹ (foot per foot)	Entrenchment ratio (foot per foot)	Sinuosity ¹ (foot per foot)	Bankfull discharge ¹ (cubic feet per second)	Bankfull-recurrence interval ¹ (years)	Rosgen channel type ²	Predominant streambed material ¹
Mainstem Tongue River								
A. State Line	³ 35	0.001	³ 2.8	1.6	1,950	1.3	C6c	Silt/clay
B. Tongue River Dam	³ 37	.002	³ 3.1	1.3	1,500	1.3	C3	Cobble
C. Birney Day School Bridge	⁴ 33	.001	³ 1.6	1.6	975	1.1	C6c	Silt/clay
D. Brandenburg Bridge	³ 30	.002	³ 1.1	1.8	1,270	1.4	F4	Gravel
E. Miles City	³ 39	.001	³ 1.4	1.8	1,640	1.2	C4c	Gravel
Tributaries								
F. Prairie Dog Creek	⁴ 22	.004	⁴ 1.8	1.2	12	-- ⁵	C4c	Gravel
G. Hanging Woman Creek	⁴ 8.8	.014	⁴ 5.4	2.1	20	1.2	E4	Gravel
H. Otter Creek	⁴ 14	.0003	⁴ 1.7	2.2	25	1.4	F6	Silt/clay
I. Pumpkin Creek	⁴ 15	.0003	⁴ 2.0	2.5	65	1.1	C6c	Silt/clay

¹Value for entire reach.

²Value for entire reach from Rosgen (1996). Reservoir operations, bridges, and channel modifications may affect the Rosgen channel type as described in the section "Methods."

³Value at surveyed section.

⁴Average of values for three cross sections.

⁵Recurrence interval not available, only 5 years of record.

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Channel-Morphology Data

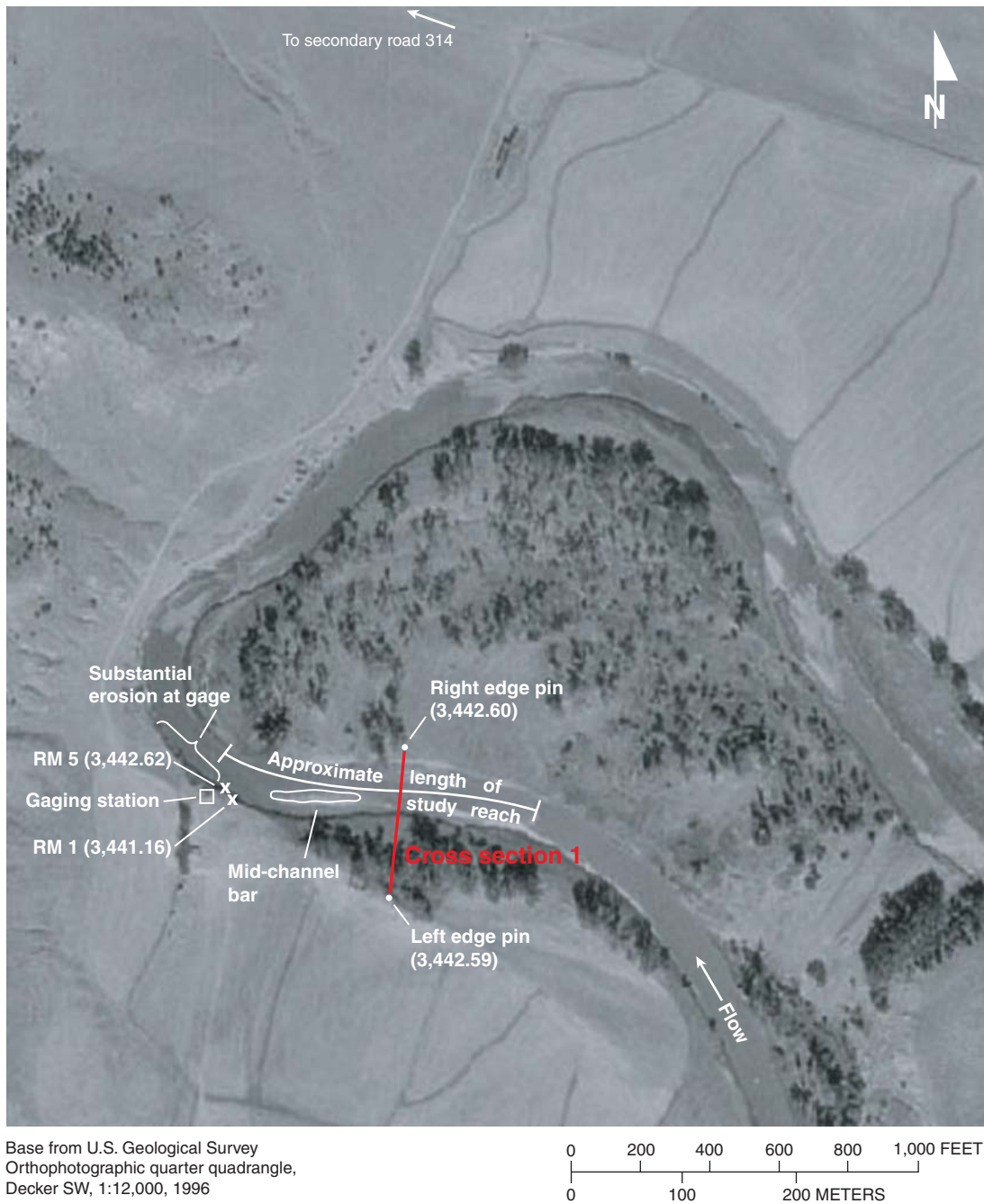


Figure A1. Location of representative study reach, streamflow-gaging station, cross section, and reference marks (RM) for Tongue River at State Line, near Decker, Mont. Elevations, in feet, referenced to gaging-station datum (reported as NGVD 29), then converted to NAVD 88 using the National Geodetic Survey computer program VERTCON (National Geodetic Survey, 2002a).

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06306300 Tongue River at State Line, near Decker, Mont.

The Tongue River at State Line, near Decker gaging station is located at latitude 45°00'32", longitude 106°50'08" (NAD 27), in NW¹/₄NW¹/₄NE¹/₄ sec. 33, T. 9 S., R. 40 E., of Big Horn County, Hydrologic Unit 10090101. The water-stage recorder is situated on the left bank 1 mi north of Wyoming-Montana State line, 1.4 mi southeast of Decker, 1.6 mi upstream from Badger Creek, and at river mile 200.9. The period of record is from August 1960 to the current year (2002). The gage datum is reported as 3,429.14 ft (NGVD 29) according to a survey by the U.S. Army Corps of Engineers. This datum was converted to 3,431.40 ft (NAVD 88) using the NGS program VERTCON (National Geodetic Survey, 2002a). The surveyed elevations for this site are referenced to the converted datum (NAVD 88).

Table A1. Stream- and channel-morphology data for Tongue River at State Line site

Survey date	10/21/2002	Bankfull-wetted perimeter (feet)	148
Topographic quadrangle map name and date	Decker, Mont. (1967)	Bankfull water-surface slope (foot/foot)	.001
Drainage area (square miles)	1,477	Flood-prone width (feet)	398
Streamflow at time of survey (cubic feet per second)	130	Entrenchment ratio (foot/foot)	2.8
Stage at time of survey (feet)	2.5	Sinuosity (foot/foot)	1.6
Bankfull stage (feet)	5.8	Channel length (feet)	19,800
Bankfull width (feet)	140	Valley length (feet)	12,300
Mean bankfull depth (feet)	4.0	Manning's n (estimated)	.03
Maximum bankfull depth (feet)	4.4	Bankfull discharge (cubic feet per second)	1,950
Bankfull cross-sectional area (square feet)	560	Bankfull-recurrence interval (years)	1.3
Width/depth ratio (foot/foot)	35	Channel type (Rosgen, 1996)	C6c



Figure A2. Tongue River at State Line site from right bank looking upstream from cross section. Photograph taken October 21, 2002.

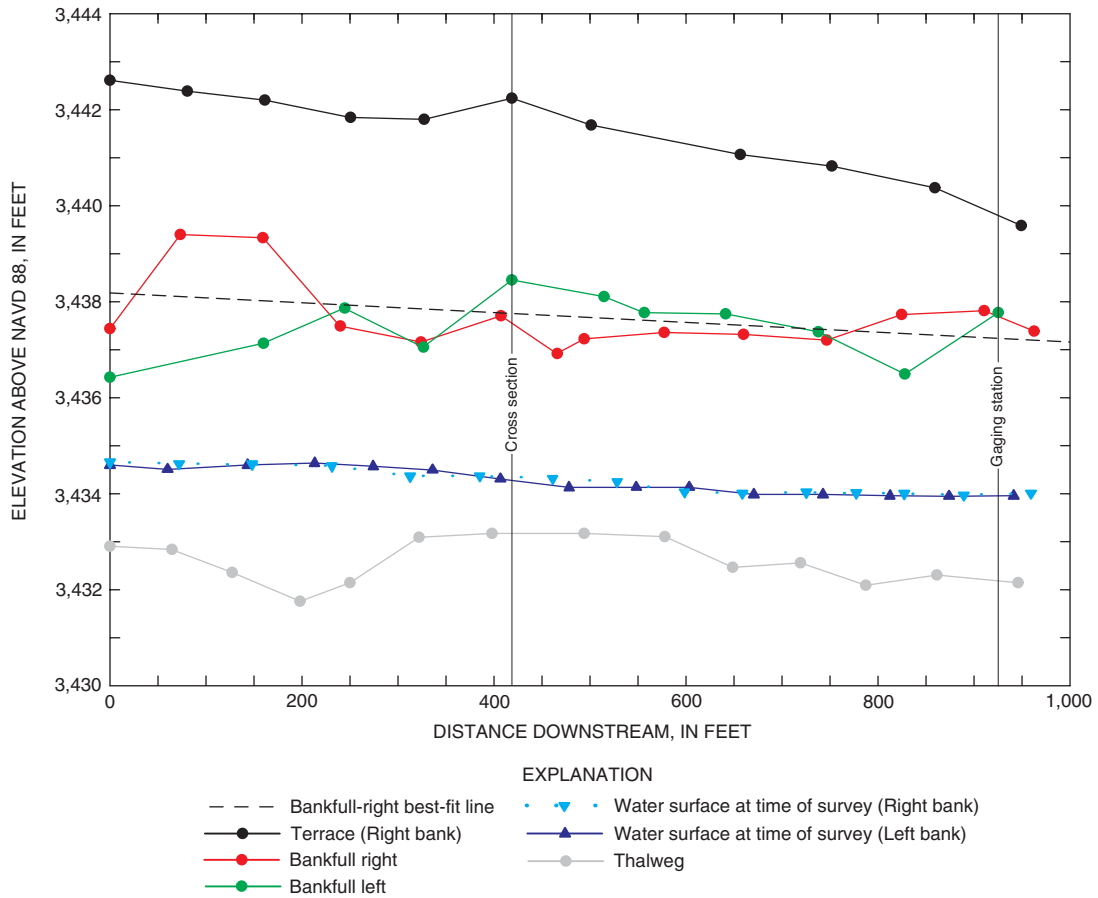


Figure A3. Surveyed profiles of representative reach for Tongue River at State Line site. Elevations referenced to gaging-station datum (reported as NGVD 29), then converted to NAVD 88 using the National Geodetic Survey computer program VERTCON (National Geodetic Survey, 2002a).



Figure A4. Tongue River at State Line site gaging station looking upstream. Arrows indicate approximate bankfull elevation at cross section. Photograph taken October 21, 2002.

10 Channel-Morphology Data for the Tongue River and Selected Tributaries, Southeastern Montana, 2001-02

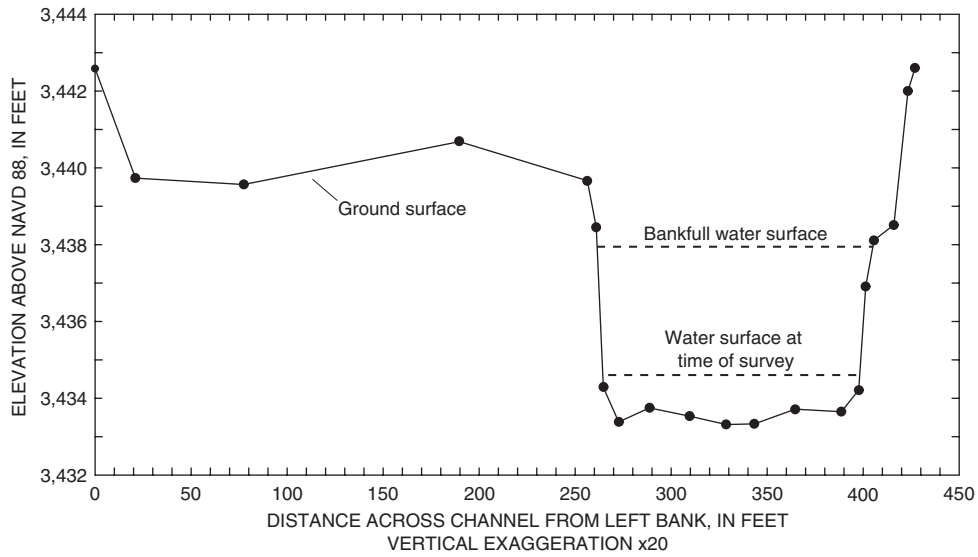


Figure A5. Cross section at Tongue River at State Line site. Elevations referenced to gaging-station datum (reported as NGVD 29), then converted to NAVD 88 using the National Geodetic Survey computer program VERTCON (National Geodetic Survey, 2002a).

Table A2. Distance and elevation data for cross section at Tongue River at State Line site

[Elevations referenced to gaging-station datum reported as NGVD 29 then converted to NAVD 88 using the National Geodetic Survey program VERTCON (National Geodetic Survey, 2002a)]

Distance from left bank (feet)	Elevation (feet above NAVD 88)
0	¹ 3,442.59
21	3,439.74
78	3,439.57
190	3,440.69
256	3,439.66
261	3,438.45
265	3,434.29
273	3,433.39
289	3,433.75
310	3,433.54
329	3,433.32
343	3,433.34
365	3,433.71
389	3,433.65
398	3,434.21
401	3,436.91
406	3,438.11
416	3,438.51
423	3,442.00
427	¹ 3,442.60

¹Ground elevation at cross-section pin.



Figure A6. Tongue River at State Line site from left bank looking downstream from cross section. Base of survey rod is at bankfull elevation. Gaging station is downstream at center of photograph. Photograph taken October 21, 2002.



Figure A7. Representative reach for Tongue River at State Line site looking downstream. Gaging station is near center of photograph. Photograph taken October 21, 2002.

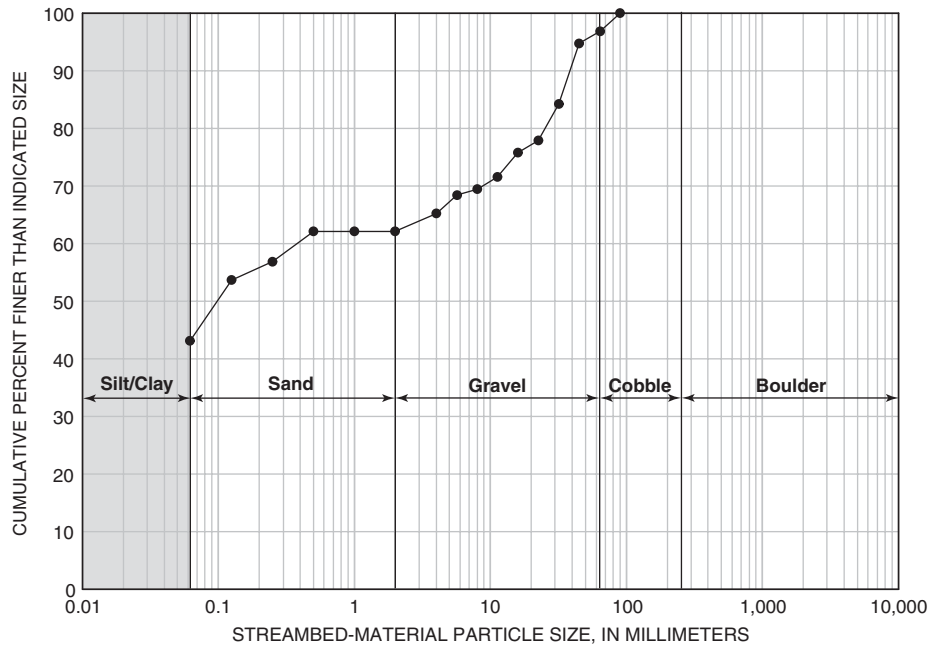


Figure A8. Distribution of streambed-material particle size for Tongue River at State Line site. Shaded area indicates predominant streambed-material size.

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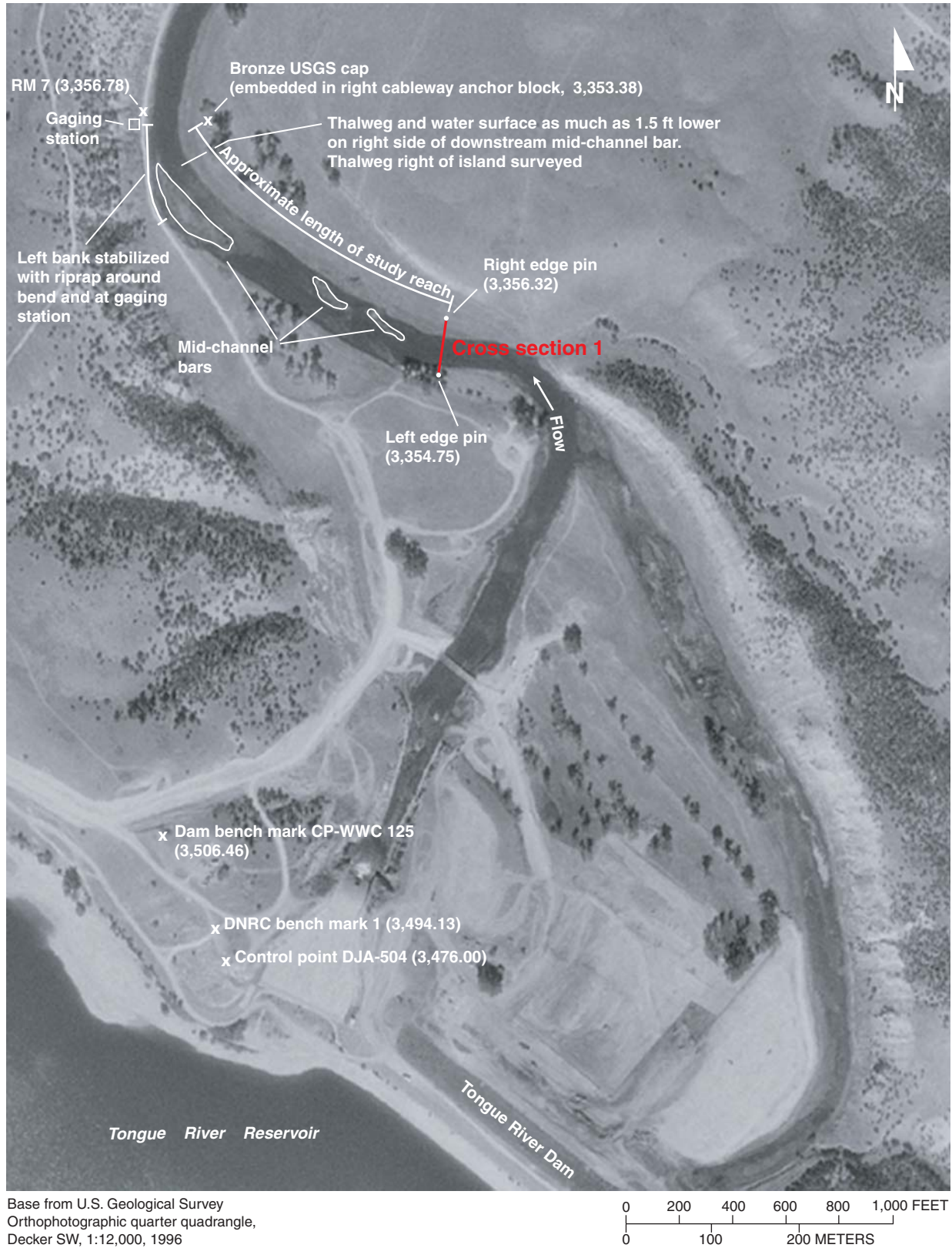


Figure B1. Location of representative study reach, streamflow-gaging station, cross section, reference mark (RM), and bench marks and control points for Tongue River at Tongue River Dam, near Decker, Mont. Elevations, in feet, referenced to datum from Montana Department of Natural Resources and Conservation (DNRC).

06307500 Tongue River at Tongue River Dam, near Decker, Mont.

The Tongue River at Tongue River Dam gaging station is located at latitude 45°08'29", longitude 106°46'15" (NAD 27), in SW¹/₄SE¹/₄SE¹/₄ sec. 12, T. 8 S., R. 40 E., of Big Horn County, Hydrologic Unit 10090101. The water-stage recorder is situated on the left bank 0.5 mi downstream from Tongue River Dam, 4 mi upstream from Post Creek, 8 mi northeast of Decker, 16 mi southeast of Kirby, and at river mile 188.4. The period of record is from May 1939 to the current year (2002). The gage datum is 3,344.40 ft (NGVD 29) according to a survey by the Bureau of Reclamation. Prior to Aug. 5, 1975, the gage datum was 10.00 ft lower. The surveyed elevations used in this study for this site are referenced to a datum from the Montana Department of Natural Resources and Conservation (DNRC), which is 0.42 ft higher than the current gage datum. The DNRC datum can be referenced by surveying the bench marks or the control point near the Tongue River Dam (fig. B1). A bronze cap embedded in the right bank cableway anchor block was surveyed along with the gage reference marks. The gage information does not include a reference mark (RM) number or an elevation for this bronze cap.

Table B1. Stream- and channel-morphology data for Tongue River at Tongue River Dam site¹

Survey date	10/23/2002	Bankfull-wetted perimeter (feet)	118
Topographic quadrangle map name and date	Tongue River Dam, Mont. (1967)	Bankfull water-surface slope (foot/foot)	.002
Drainage area (square miles)	1,770	Flood-prone width (feet)	351
Streamflow at time of survey (cubic feet per second)	134	Entrenchment ratio (foot/foot)	3.1
Stage at time of survey (feet)	² 11	Sinuosity (foot/foot)	1.3
Bankfull stage (feet)	² 13	Channel length (feet)	26,400
Bankfull width (feet)	112	Valley length (feet)	20,000
Mean bankfull depth (feet)	3.0	Manning's n (estimated)	.03
Maximum bankfull depth (feet)	4.1	Bankfull discharge (cubic feet per second)	1,500
Bankfull cross-sectional area (square feet)	336	Bankfull-recurrence interval (years)	1.3
Width/depth ratio (foot/foot)	37	Channel type (Rosgen, 1996)	C3

¹The Rosgen channel type might be affected by operation of Tongue River Reservoir which was formed when the dam was constructed in 1940.

²Stage at time of survey and bankfull stage include a 10-foot datum correction. According to the gaging station description (on file at the USGS Montana District Office, Helena, Mont.), this 10-foot correction is added to the record to avoid negative gage heights at low stages.



Figure B2. Tongue River at Tongue River Dam site from left bank near gaging station looking upstream. Photograph taken October 23, 2002.

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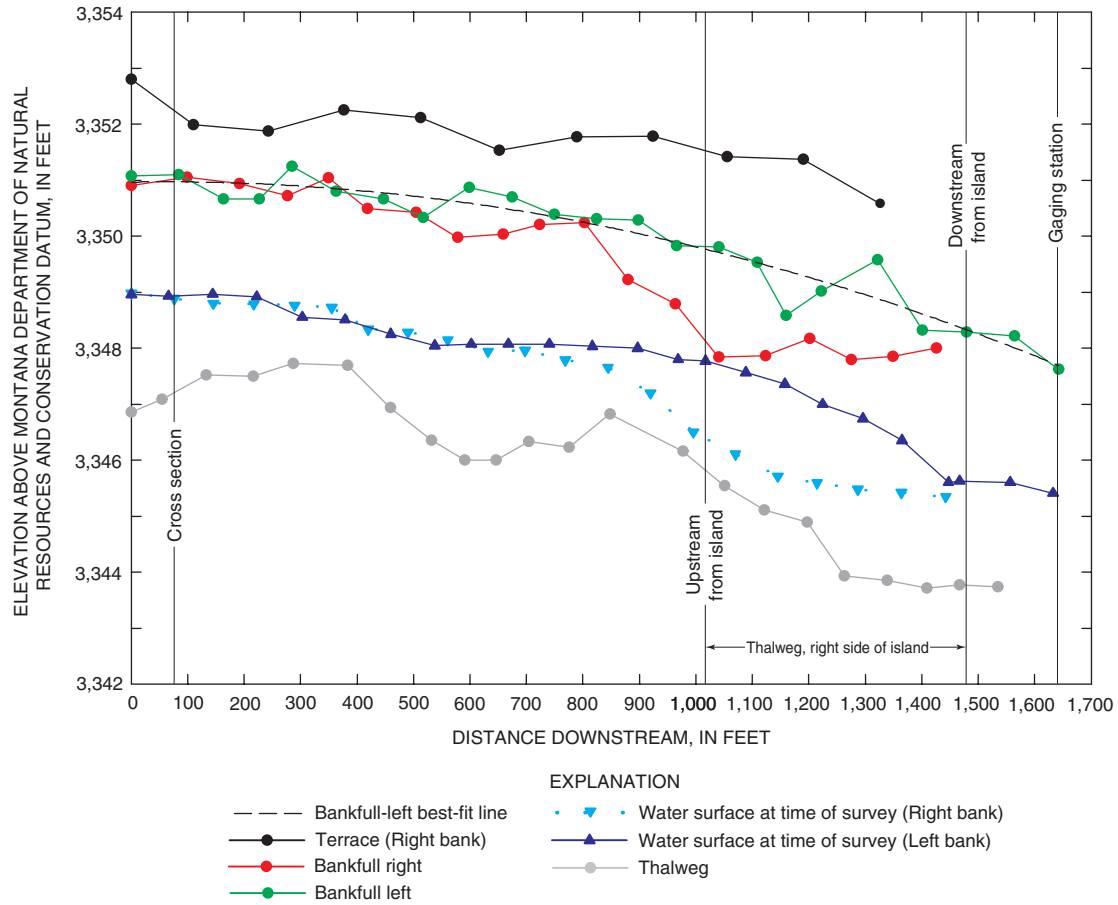


Figure B3. Surveyed profiles of representative reach for Tongue River at Tongue River Dam site.



Figure B4. Tongue River at Tongue River Dam site from left bank looking downstream. Hydrographer is standing at bankfull elevation. Photograph taken October 23, 2002.

Table B2. Distance and elevation data for cross section at Tongue River at Tongue River Dam site

[Elevations are referenced to datum from Montana Department of Natural Resources and Conservation (DNRC)]

Distance from left bank (feet)	Elevation (feet above DNRC datum)
0	¹ 3,354.75
15	3,353.47
34	3,353.58
47	3,352.39
55	3,350.60
58	3,349.09
61	3,348.91
69	3,348.33
81	3,348.45
92	3,347.99
103	3,347.82
114	3,347.20
123	3,346.97
127	3,346.91
139	3,347.26
150	3,347.98
163	3,348.88
167	3,351.26
179	3,352.60
196	3,353.25
208	3,355.30
215	¹ 3,356.32

¹Ground elevation at cross-section pin.

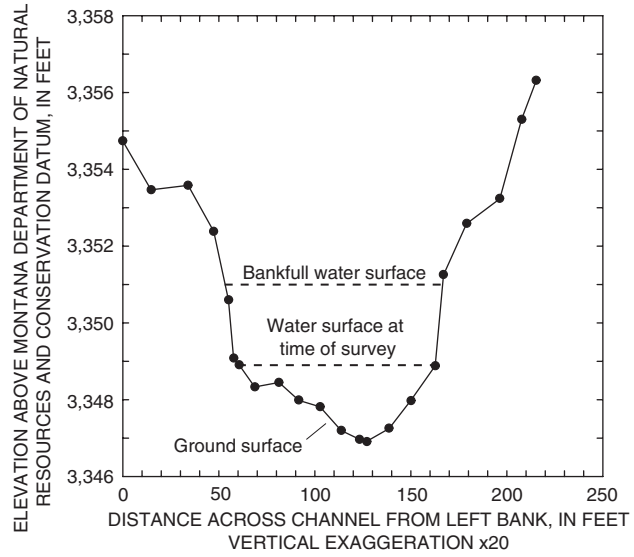


Figure B5. Cross section at Tongue River at Tongue River Dam site.



Figure B6. Tongue River at Tongue River Dam site at mid-stream of cross section looking downstream. Photograph taken October 23, 2002.



Figure B7. Tongue River at Tongue River Dam site from left bank looking upstream at cross section. Arrows indicate approximate bankfull elevation at cross section. Photograph taken October 23, 2002.

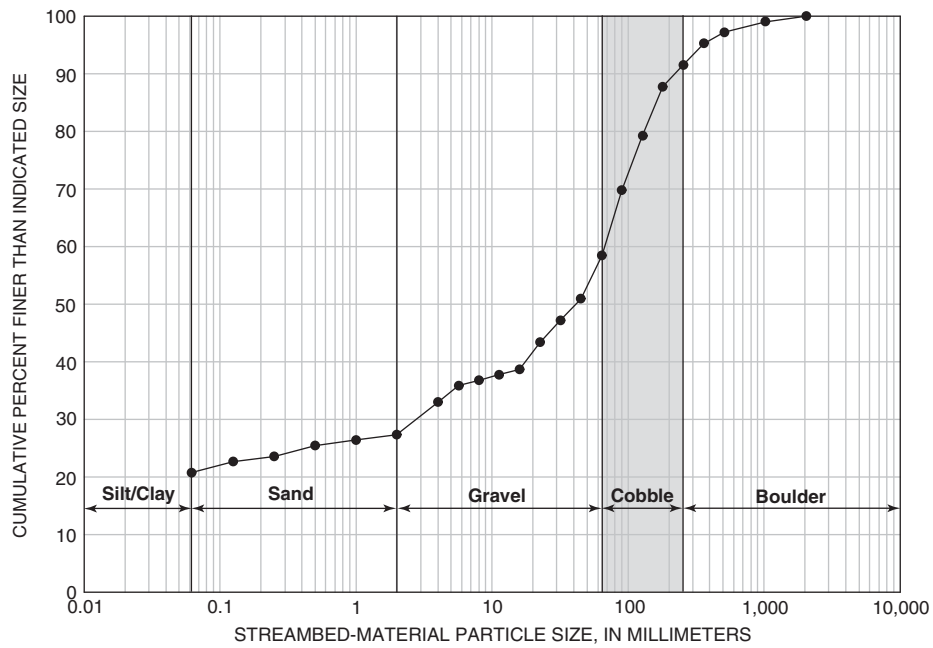
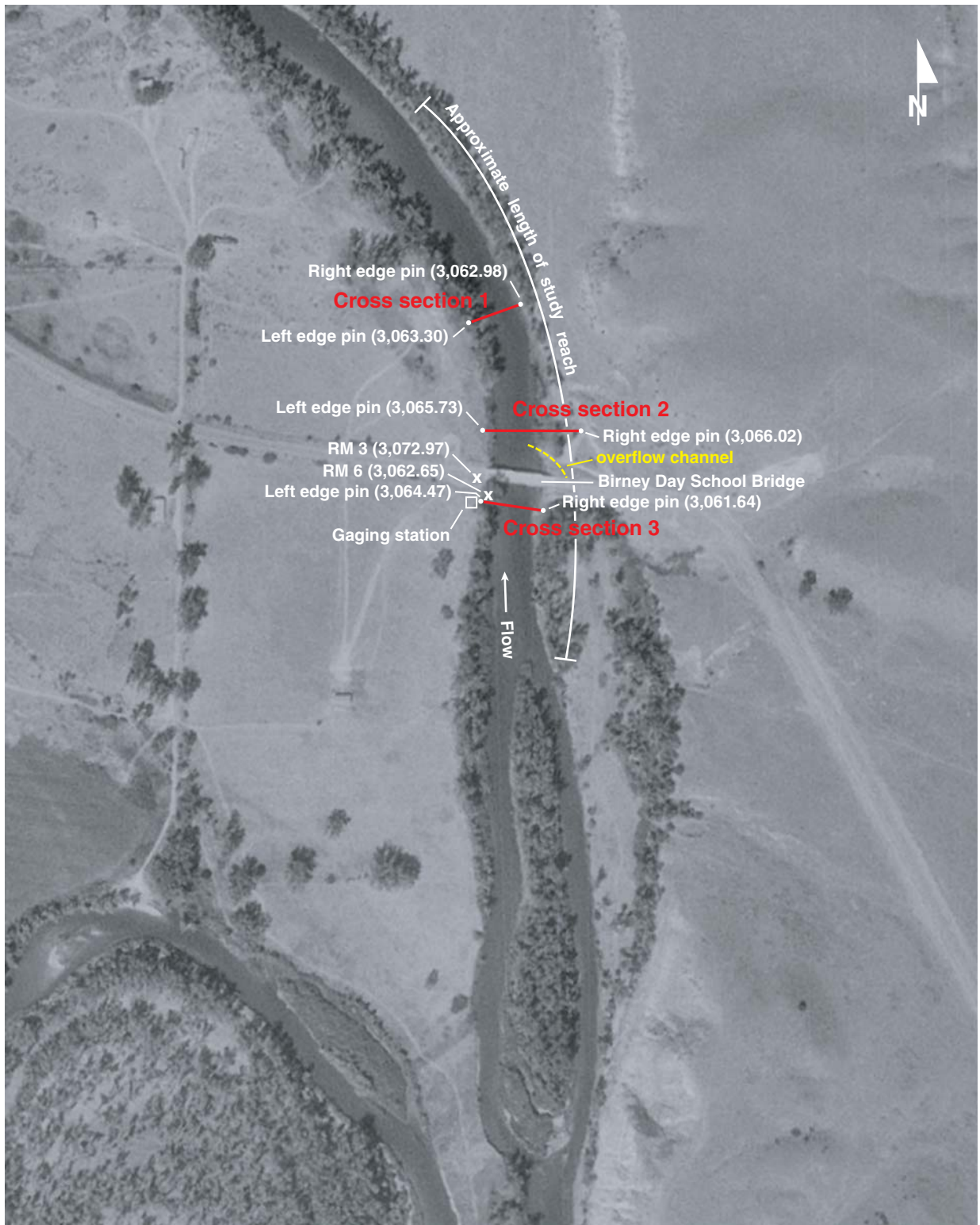


Figure B8. Distribution of streambed-material particle size for Tongue River at Tongue River Dam site. Shaded area indicates predominant streambed-material size.



Base from U.S. Geological Survey
Orthophotographic quarter quadrangle,
Decker SW, 1:12,000, 1996

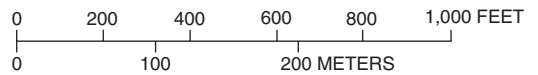


Figure C1. Location of representative study reach, streamflow-gaging station, cross sections, and reference marks (RM) for Tongue River at Birney Day School Bridge, near Birney, Mont. Elevations, in feet, referenced to NAVD 88.

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06307616 Tongue River at Birney Day School Bridge, near Birney, Mont.

The Tongue River at Birney Day School Bridge gaging station is located at latitude 45°24'42", longitude 106°27'26" (NAD 27), in SE¹/₄SW¹/₄SW¹/₄ sec. 8, T. 5 S., R. 43 E., of Rosebud County, Hydrologic Unit 10090102. The water-stage recorder is situated on the left bank, 60 ft upstream from Bureau of Indian Affairs bridge, 0.2 mi east of Birney Day School, 5.5 mi downstream from Cook Creek, 6.5 mi northeast of Birney, and at river mile 144.3. The period of record extends from October 1979 to the current year (2002). The gage datum reported in the gage record for this site was derived from a 7.5-minute topographic quadrangle map and was not used for this study. Instead, the surveyed elevations were referenced to NAVD 88.

Table C1. Stream- and channel-morphology data for Tongue River at Birney Day School Bridge site¹

[Symbol: --, no data]

Channel characteristic	Value at cross section			Average or value
	1	2	3	
Survey date: 10/22/2002				
Topographic quadrangle map name and date: Birney Day School, Mont. (1966)				
Drainage area (square miles): 2,621				
Streamflow at time of survey (cubic feet per second): 99				
Stage at time of survey (feet): 1.2				
Bankfull stage (feet)	--	--	3.6	--
Bankfull width (feet)	123	114	115	² 117
Mean bankfull depth (feet)	3.6	3.7	3.4	² 3.6
Maximum bankfull depth (feet)	5.0	4.5	4.0	² 4.5
Bankfull cross-sectional area (square feet)	443	422	391	² 419
Width/depth ratio (foot/foot)	34	31	34	² 33
Bankfull-wetted perimeter (feet)	130	121	122	² 124
Bankfull water-surface slope (foot/foot)	--	--	--	³ .001
Flood-prone width (feet)	--	--	180	--
Entrenchment ratio (foot/foot)	--	--	1.6	--
Sinuosity (foot/foot)	--	--	--	³ 1.6
Channel length (feet)	--	--	--	³ 5,010
Valley length (feet)	--	--	--	³ 3,040
Manning's n (estimated)	--	--	--	³ .03
Bankfull discharge (cubic feet per second)	--	--	--	³ 975
Bankfull-recurrence interval (years)	--	--	--	³ 1.1
Channel type (Rosgen, 1996) ¹	--	--	--	³ C6c

¹The bridge between cross sections 2 and 3, constructed in 1970, might affect the classification of the channel (fig. C1). However, the channel is probably no longer changing in response to the bridge construction, and these baseline data are useful for monitoring purposes.

²Average of values for three cross sections.

³Value for entire reach.

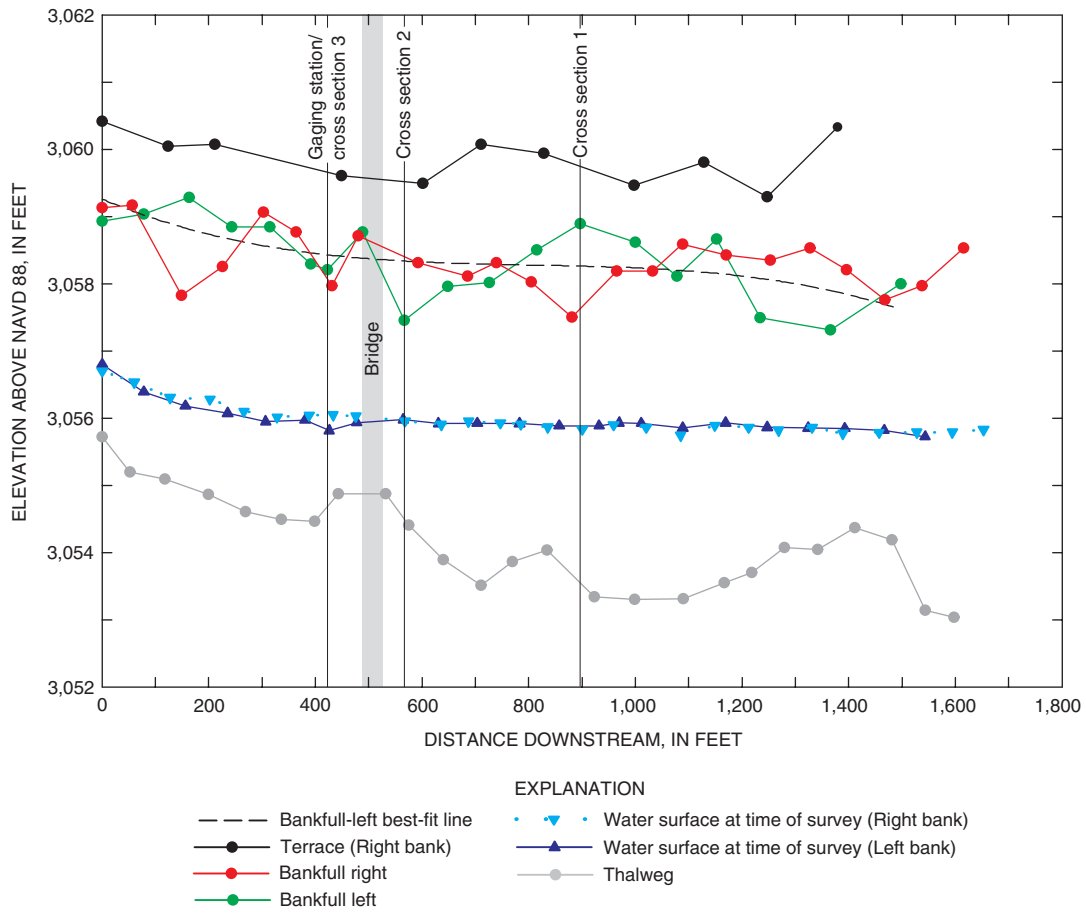


Figure C2. Surveyed profiles of representative reach for Tongue River at Birney Day School Bridge site.



Figure C3. Tongue River at Birney Day School Bridge site from left bank near cross section 1. View is looking upstream at cross section 2 and Birney Day School Bridge. Photograph taken October 22, 2002.

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Table C2. Distance and elevation data for cross section 1 at Tongue River at Birney Day School Bridge site

Distance from left bank (feet)	Elevation (feet above NAVD 88)
0	¹ 3,063.30
8	3,060.64
9	3,058.90
11	3,056.78
22	3,056.20
31	3,055.93
44	3,055.08
58	3,054.48
70	3,054.12
82	3,053.85
90	3,053.55
99	3,053.26
104	3,053.65
113	3,054.05
121	3,054.70
130	3,055.80
131	3,058.20
133	3,059.47
148	3,059.95
157	¹ 3,062.98

¹Ground elevation at cross-section pin.

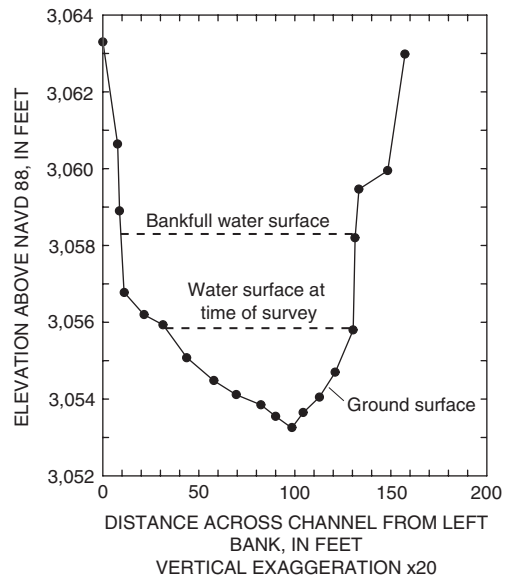


Figure C4. Cross section 1 at Tongue River at Birney Day School Bridge site.

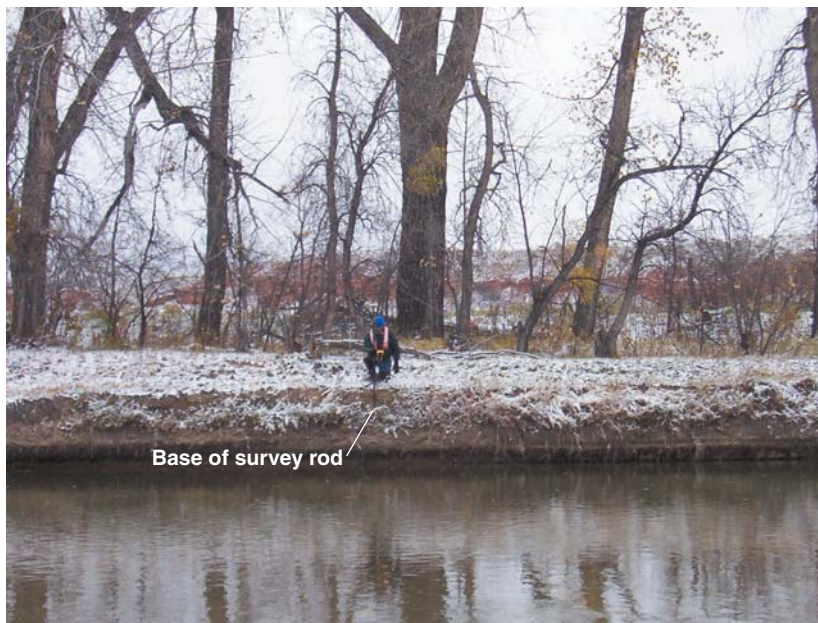


Figure C5. Tongue River at Birney Day School Bridge site from left bank near cross section 1. Base of survey rod is at approximate bankfull elevation. Note erosion of the right bank. Photograph taken October 22, 2002.

Table C3. Distance and elevation data for cross section 2 at Tongue River at Birney Day School Bridge site

Distance from left bank (feet)	Elevation (feet above NAVD 88)
0	¹ 3,065.73
3	3,064.94
17	3,063.13
25	3,059.59
29	3,057.46
31	3,055.84
38	3,054.32
48	3,054.96
65	3,055.36
79	3,054.91
91	3,054.28
102	3,053.89
113	3,054.09
124	3,054.26
133	3,054.22
141	3,055.89
143	3,058.10
144	3,059.44
169	3,059.61
186	3,058.14
192	3,061.09
210	3,062.59
239	3,063.07
271	3,063.48
291	¹ 3,066.02

¹Ground elevation at cross-section pin.

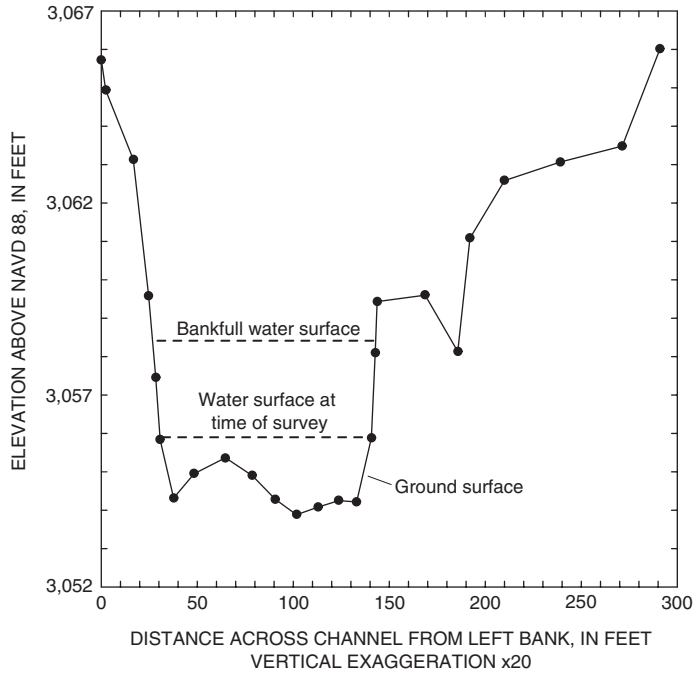


Figure C6. Cross section 2 at Tongue River at Birney Day School Bridge site.



Figure C7. Tongue River at Birney Day School Bridge site from right bank at cross section 2 looking downstream at cross section 1. Arrows indicate approximate bankfull elevation at cross section 1. Photograph taken October 22, 2002.

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Table C4. Distance and elevation data for cross section 3 at Tongue River at Birney Day School Bridge site

Distance from left bank (feet)	Elevation (feet above NAVD 88)
0	¹ 3,064.47
7	3,063.64
15	3,060.94
21	3,058.30
26	3,055.82
34	3,055.02
48	3,055.26
63	3,055.30
77	3,055.09
91	3,054.53
104	3,054.63
117	3,054.90
129	3,054.85
134	3,056.05
136	3,057.98
174	3,060.58
180	¹ 3,061.64

¹Ground elevation at cross-section pin.

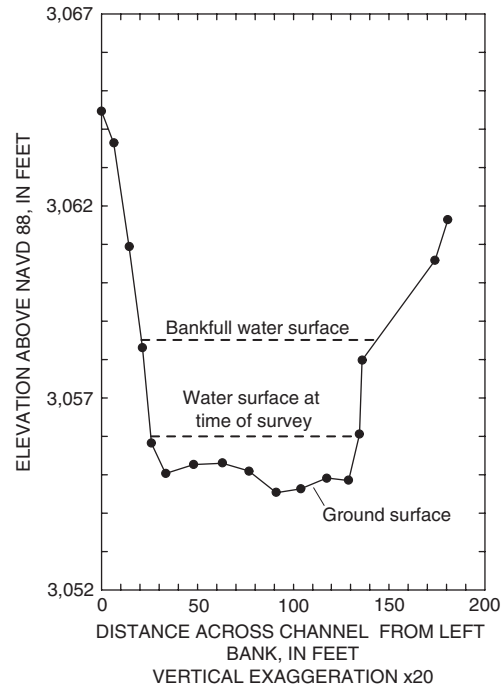


Figure C8. Cross section 3 at Tongue River at Birney Day School Bridge site.



Figure C9. Tongue River at Birney Day School Bridge site from left bank looking downstream. Gaging station is at cross section 3, on left bank behind hydrographer. Photograph taken October 22, 2002.

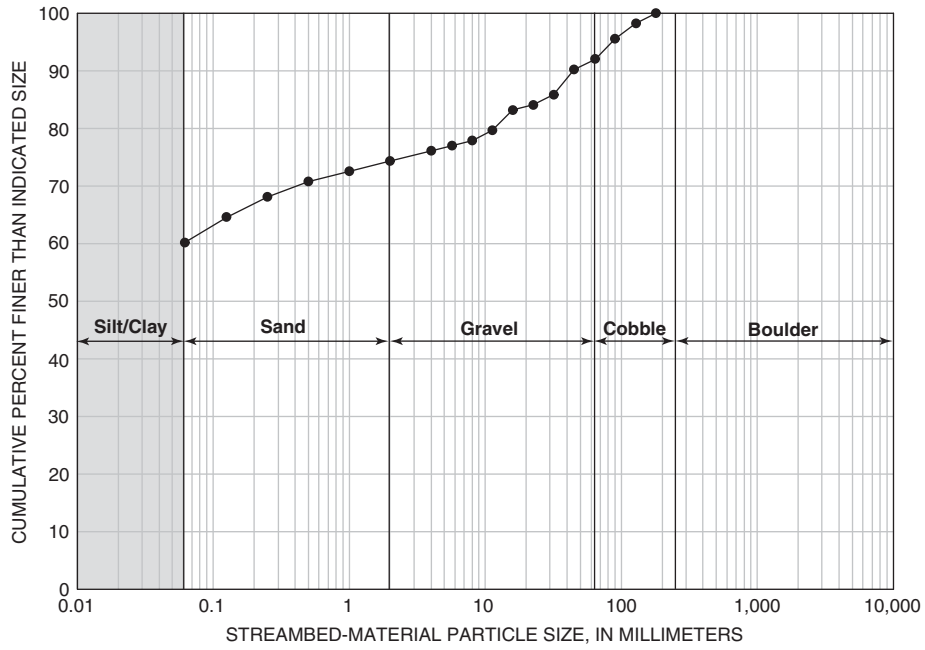


Figure C10. Distribution of streambed-material particle size for Tongue River at Birney Day School Bridge site. Shaded area indicates predominant streambed-material size.



Base from U.S. Geological Survey
Orthophotographic quarter quadrangle,
Decker SW, 1:12,000, 1996

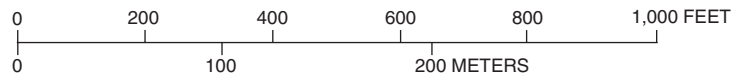


Figure D1. Location of representative study reach, streamflow-gaging station, cross section, and reference marks (RM) for Tongue River below Brandenburg Bridge, near Ashland, Mont. Elevations, in feet, referenced to NAVD 88.

06307830 Tongue River below Brandenburg Bridge, near Ashland, Mont.

The Tongue River below Brandenburg Bridge gaging station is located at latitude 45°50'24", longitude 106°13'22" (NAD 27), in SE¹/₄SW¹/₄NE¹/₄ sec. 14, T. 1 N., R. 44 E., of Rosebud County, Hydrologic Unit 10090102. The water-stage recorder is situated on the right bank downstream from the county bridge, 22 mi north of Ashland, and at river mile 81.3. The period of record is from October 1973 to September 1984, and July 2000 to the current year (2002). The gage datum reported in the gage record for this site was derived from a 7.5-minute topographic quadrangle map and was not used for this study. Instead, surveyed elevations were referenced to NAVD 88.

Table D1. Stream- and channel-morphology data for Tongue River below Brandenburg Bridge site¹

Survey date	10/23/2002	Bankfull-wetted perimeter (feet)	105
Topographic quadrangle map name and date	Brandenburg, Mont. (1971)	Bankfull water-surface slope (foot/foot)	.002
Drainage area (square miles)	3,948	Flood-prone width (feet)	107
Streamflow at time of survey (cubic feet per second)	113	Entrenchment ratio (foot/foot)	1.1
Stage at time of survey (feet)	3.1	Sinuosity (foot/foot)	1.8
Bankfull stage (feet)	6.0	Channel length (feet)	17,300
Bankfull width (feet)	98	Valley length (feet)	9,650
Mean bankfull depth (feet)	3.3	Manning's n (estimated)	.03
Maximum bankfull depth (feet)	4.6	Bankfull discharge (cubic feet per second)	1,270
Bankfull cross-sectional area (square feet)	323	Bankfull-recurrence interval (years)	1.4
Width/depth ratio (foot/foot)	30	Channel type (Rosgen, 1996) ¹	F4

¹The bridge upstream from the surveyed section, constructed in 1963, might affect the classification of the channel (fig. D1). However, the channel is probably no longer changing in response to the bridge construction, and these baseline data are useful for monitoring purposes.



Figure D2. Tongue River below Brandenburg Bridge site from bridge looking upstream. Photograph taken October 23, 2002.

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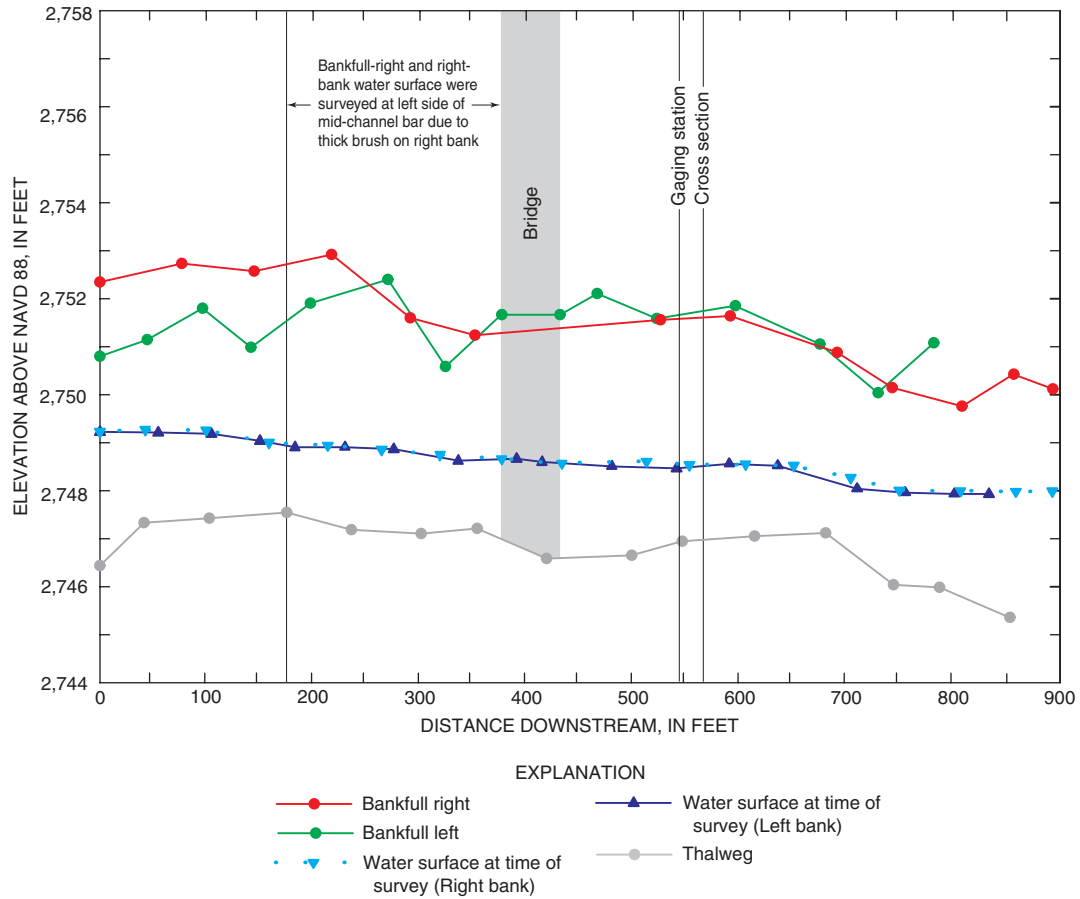


Figure D3. Surveyed profiles of representative reach for Tongue River below Brandenburg Bridge site. Bankfull best-fit line was not plotted because cross section is very close to gaging station, and left and right bankfull-elevation points were consistent near the gaging station.



Figure D4. Tongue River below Brandenburg Bridge site from right bank at gaging station and cross section. Cross section location is flagged with orange ribbon. Photograph taken October 23, 2002.

Table D2. Distance and elevation data for cross section at Tongue River below Brandenburg Bridge site

Distance from left bank (feet)	Elevation (feet above NAVD 88)
0	¹ 2,754.56
6	2,754.11
16	2,753.67
17	2,751.62
18	2,749.09
24	2,748.55
35	2,747.09
46	2,747.80
54	2,747.41
63	2,746.92
75	2,747.29
86	2,748.59
99	2,749.02
112	2,749.73
115	2,752.09
131	2,757.97
159	2,759.05
194	¹ 2,760.46

¹Ground elevation at cross-section pin.

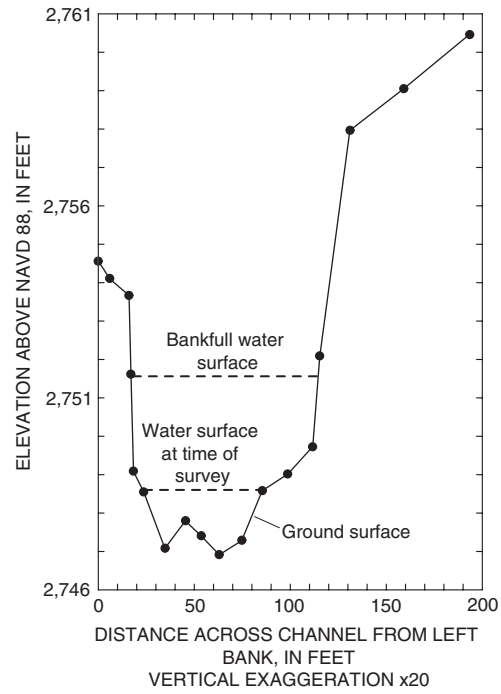


Figure D5. Cross section at Tongue River below Brandenburg Bridge site.



Figure D6. Tongue River below Brandenburg Bridge site from bridge looking downstream. End of study reach is at fallen tree on outside of bend. Photograph taken October 23, 2002.



Figure D7. Tongue River below Brandenburg Bridge site from bridge looking downstream at right bank, gaging station, and irrigation diversion. Photograph taken October 23, 2002.

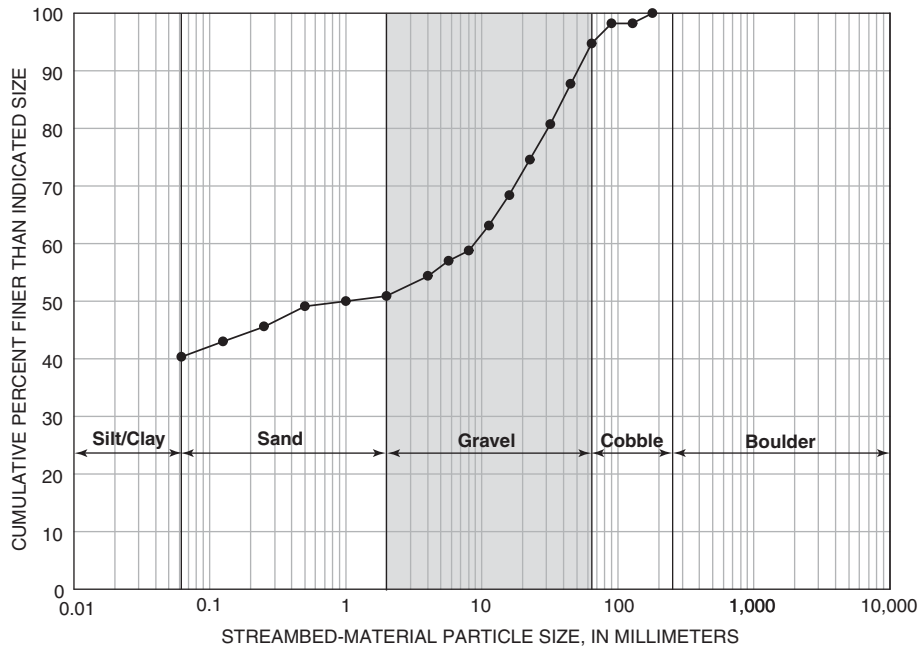
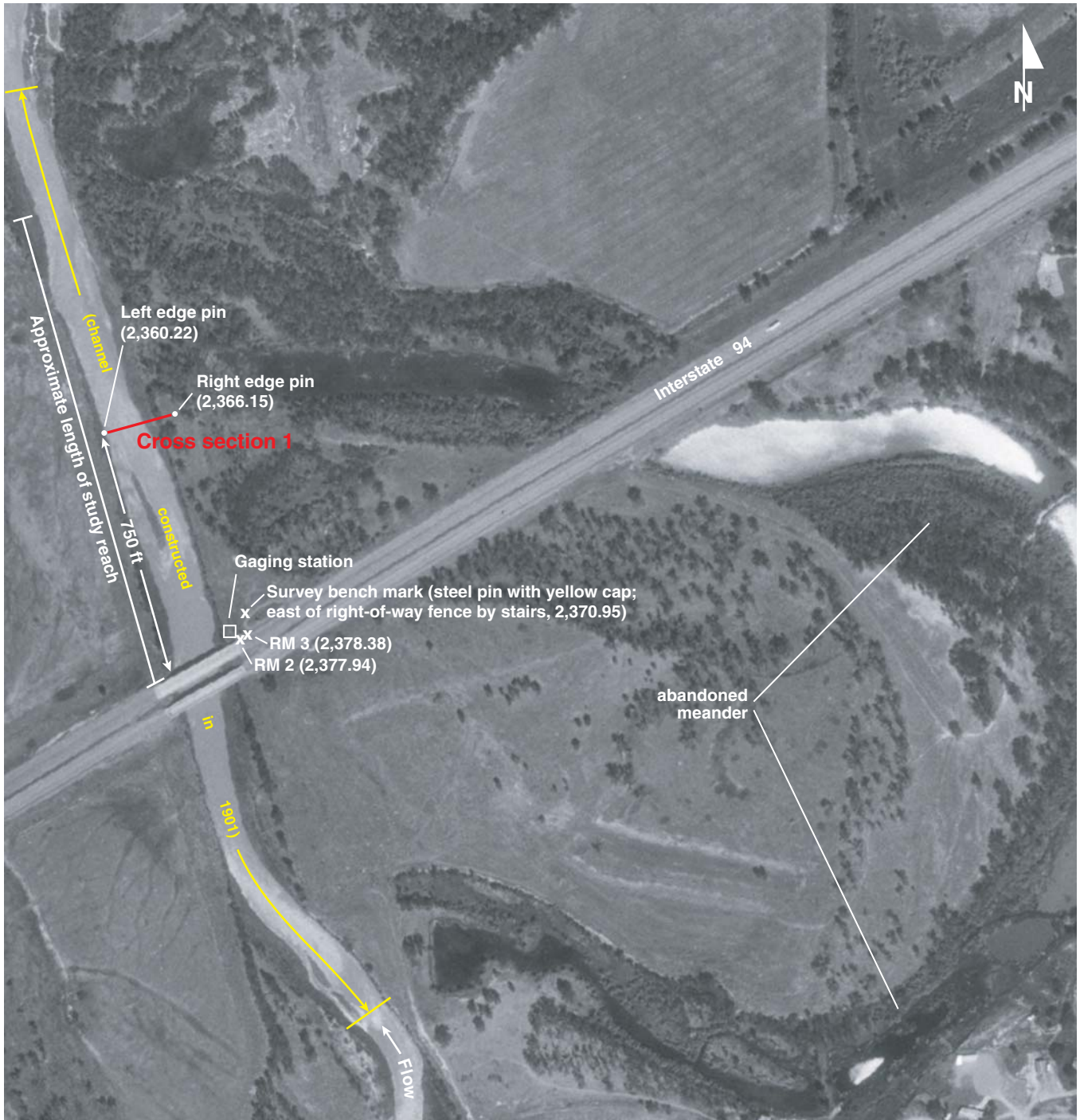


Figure D8. Distribution of streambed-material particle size for Tongue River below Brandenburg Bridge site. Shaded area indicates predominant streambed-material size.



Base from U.S. Geological Survey
 Orthophotographic quarter quadrangle,
 Decker SW, 1:12,000, 1998

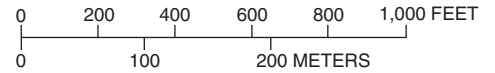


Figure E1. Location of representative study reach, streamflow-gaging station, cross section, reference marks (RM), and survey bench mark for Tongue River at Miles City, Mont.. Elevations, in feet, referenced to NAVD 88.

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06308500 Tongue River at Miles City, Mont.

The Tongue River at Miles City gaging station is located at latitude 46°23'05", longitude 105°50'41" (NAD 27), in SE¹/₄SE¹/₄SE¹/₄ sec. 4, T. 7 N., R. 47 E., of Custer County, Hydrologic Unit 10090102. The water-stage recorder is situated on the right bank 1.5 mi south of Miles City and at river mile 2.3. The period of record is from April 1938 to April 1942 and April 1946 to the current year (2002). The gage datum reported in the gage record for this site was derived from a 7.5-minute quadrangle map and was not used for this study. Instead, surveyed elevations were referenced to NAVD 88.

Table E1. Stream- and channel-morphology data for Tongue River at Miles City site¹

Survey date	09/25/2002	Bankfull-wetted perimeter (feet)	155
Topographic quadrangle map name and date	Miles City, Mont. (1968)	Bankfull water-surface slope (foot/foot)	.001
Drainage area (square miles)	5,397	Flood-prone width (feet)	212
Streamflow at time of survey (cubic feet per second)	30	Entrenchment ratio (foot/foot)	1.4
Stage at time of survey (feet)	2.3	Sinuosity (foot/foot)	1.8
Bankfull stage (feet)	5.3	Channel length (feet)	31,300
Bankfull width (feet)	147	Valley length (feet)	17,400
Mean bankfull depth (feet)	3.8	Manning's n (estimated)	.03
Maximum bankfull depth (feet)	4.8	Bankfull discharge (cubic feet per second)	1,640
Bankfull cross-sectional area (square feet)	559	Bankfull-recurrence interval (years)	1.2
Width/depth ratio (foot/foot)	39	Channel type (Rosgen, 1996)	C4c

¹The channel at this site was constructed in 1901 to replace a meander bend. However, this reach appears to be relatively stable, and these baseline data are useful for monitoring purposes.



Figure E2. Tongue River at Miles City site from bridge looking downstream. Photograph taken September 25, 2002.

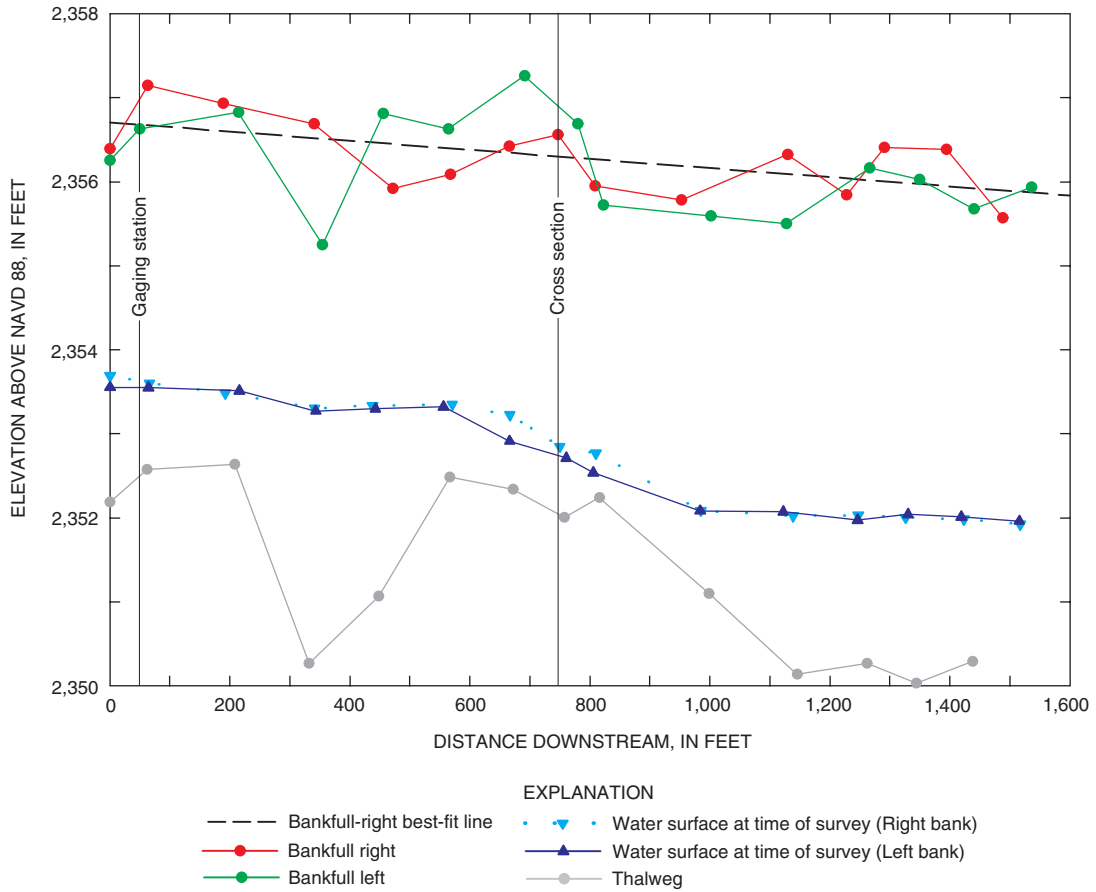


Figure E3. Surveyed profiles of representative reach for Tongue River at Miles City site.



Figure E4. Tongue River at Miles City site from right bank at cross section. Arrow indicates approximate bankfull elevation. Photograph taken September 25, 2002.

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Table E2. Distance and elevation data for cross section at Tongue River at Miles City site

Distance from left bank (feet)	Elevation (feet above NAVD 88)
0	¹ 2,360.22
5	2,358.63
10	2,357.59
16	2,356.69
20	2,353.51
36	2,352.87
51	2,352.71
56	2,352.72
66	2,352.52
77	2,352.38
90	2,352.55
101	2,352.82
112	2,352.65
123	2,352.17
131	2,351.62
138	2,351.86
145	2,352.00
151	2,352.56
157	2,352.85
159	2,353.26
160	2,353.14
161	2,355.69
163	2,356.56
183	2,357.22
232	2,365.43
241	¹ 2,366.15

¹Ground elevation at cross-section pin.

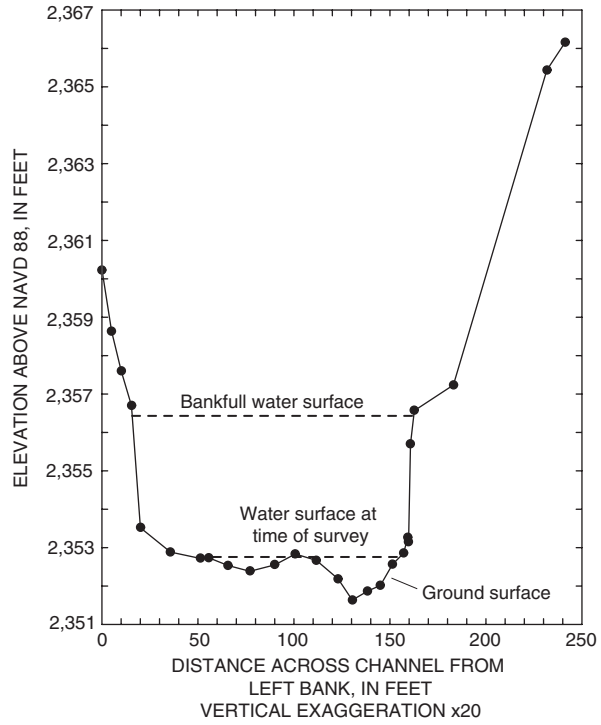


Figure E5. Cross section at Tongue River at Miles City site.



Figure E6. Tongue River at Miles City site from middle of cross section looking upstream. Photograph taken September 25, 2002.



Figure E7. Tongue River at Miles City site from left bank at cross section. Arrow indicates approximate bankfull-right elevation. Photograph taken September 25, 2002.

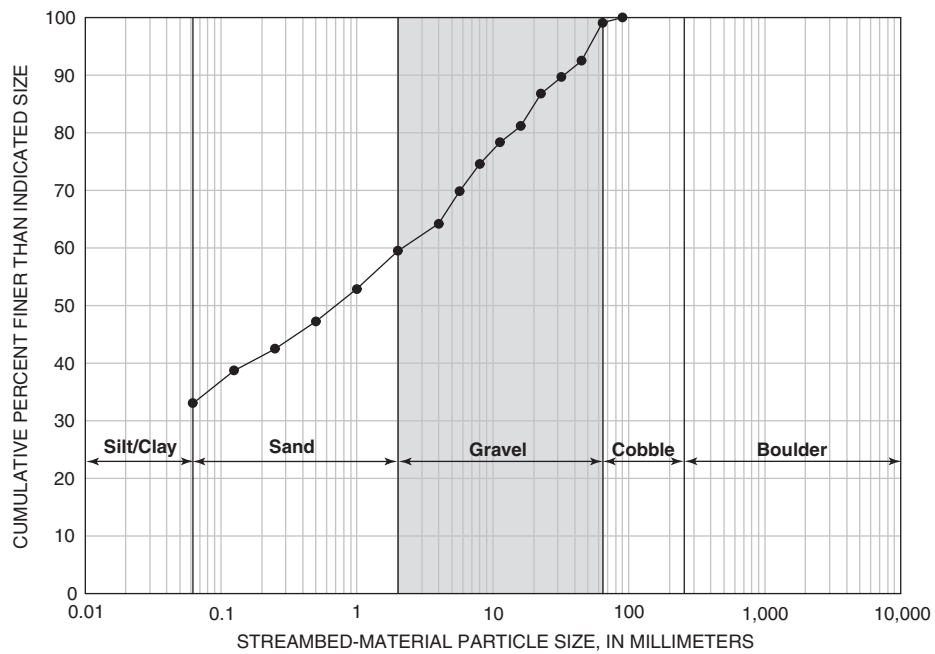


Figure E8. Distribution of streambed-material particle size for Tongue River at Miles City site. Shaded area indicates predominant streambed-material size.

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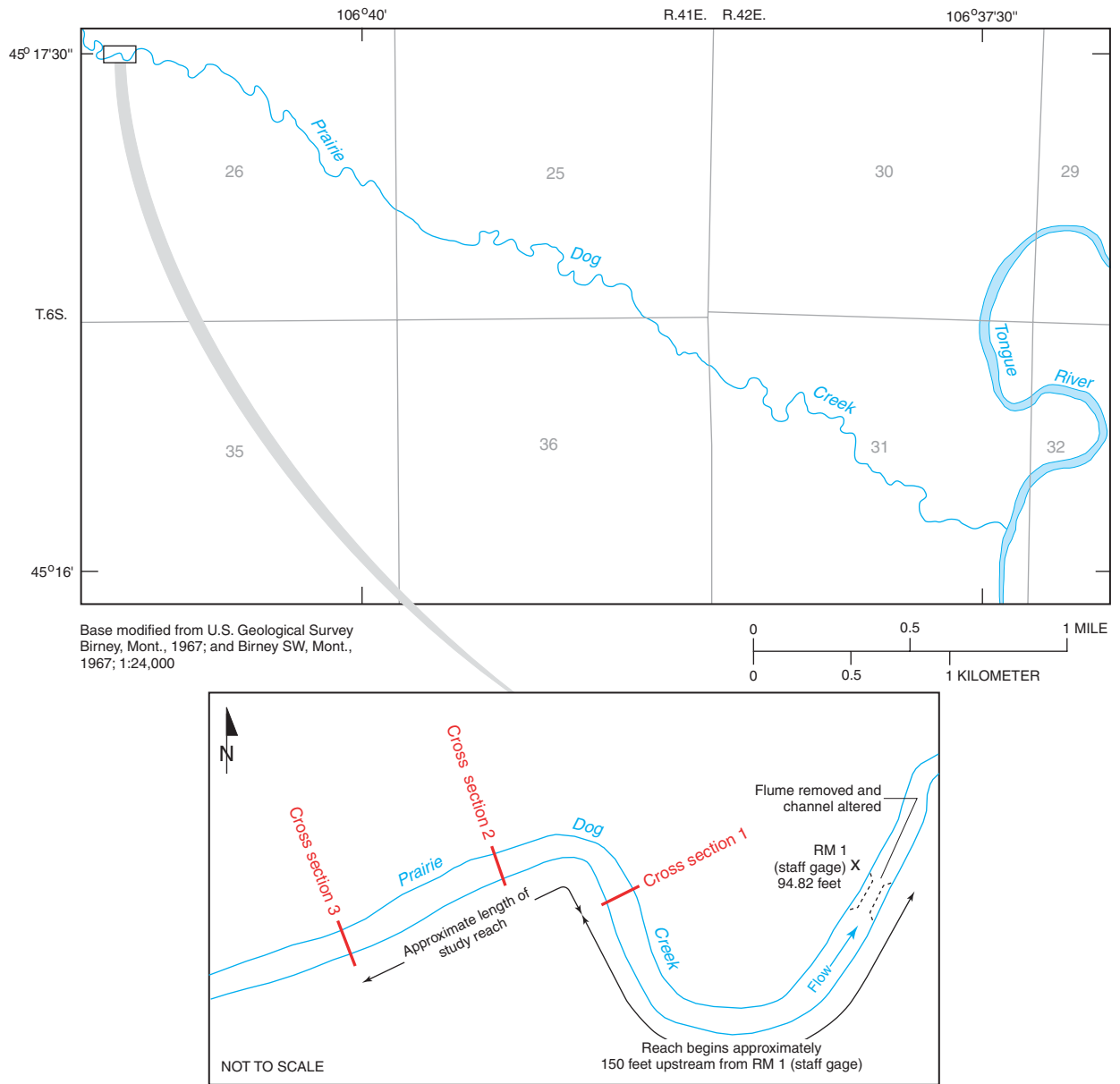


Figure F1. Location of representative study reach, staff gage, cross sections, and reference mark (RM) for Prairie Dog Creek near Birney, Mont.. Elevation, in feet, referenced to local datum.

06307528 Prairie Dog Creek near Birney, Mont.

The Prairie Dog Creek near Birney gaging station was located at latitude 45°17'28", longitude 106°40'56" in SE¹/₄NW¹/₄NW¹/₄, sec. 26, T. 6 S., R. 41 E., Rosebud County, Hydrologic Unit 10090101. The water-stage recorder was situated on the left bank, 8.6 mi west of Birney, and at river mile 3.3. The period of record was from 1979 to 1984. The gage datum for this site was derived from a 7.5-minute topographic quadrangle map and was not used for this study. Instead, surveyed elevations were referenced to a local datum. This local datum can be referenced by surveying the ground elevations at the pins marking the ends of each cross section. Ground elevations at the cross-section pins are listed in tables F2, F3, and F4.

Table F1. Stream- and channel-morphology data for Prairie Dog Creek near Birney site

[Symbol: --, no data or not available, only 5 years of record]

Channel characteristic	Value at cross section			Average or value
	1	2	3	
Survey date: 10/16/2001				
Topographic quadrangle map name and date: Birney SW, Mont. (1967)				
Drainage area (square miles): 19.6				
Streamflow (cubic feet per second): No flow during survey				
Stage (feet): No flow during survey				
Bankfull stage (feet)	--	--	--	--
Bankfull width (feet)	19	15	10	¹ 15
Mean bankfull depth (feet)	.6	.6	1.0	¹ .7
Maximum bankfull depth (feet)	1.1	.8	1.5	¹ 1.1
Bankfull cross-sectional area (square feet)	11	9	10	¹ 10
Width/depth ratio (foot/foot)	32	25	10	¹ 22
Bankfull-wetted perimeter (feet)	20	16	12	¹ 16
Bankfull water-surface slope (foot/foot)	--	--	--	² .004
Flood-prone width (feet)	31	24	22	¹ 26
Entrenchment ratio (foot/foot)	1.6	1.6	2.2	¹ 1.8
Sinuosity (foot/foot)	--	--	--	² 1.2
Channel length (feet)	--	--	--	² 23,100
Valley length (feet)	--	--	--	² 18,700
Manning's n (estimated)	--	--	--	² .028
Bankfull discharge (cubic feet per second) ³	--	--	--	² 12
Bankfull-recurrence interval (years)	--	--	--	⁴ --
Channel type (Rosgen, 1996)	--	--	--	² C4c

¹Average of values for three cross sections.

²Value for entire reach.

³HEC-RAS computer model (version 3.0.1, U.S. Army Corps of Engineers, 2001a,b,c) used to estimate bankfull discharge.

⁴Recurrence interval not available, only 5 years of record.

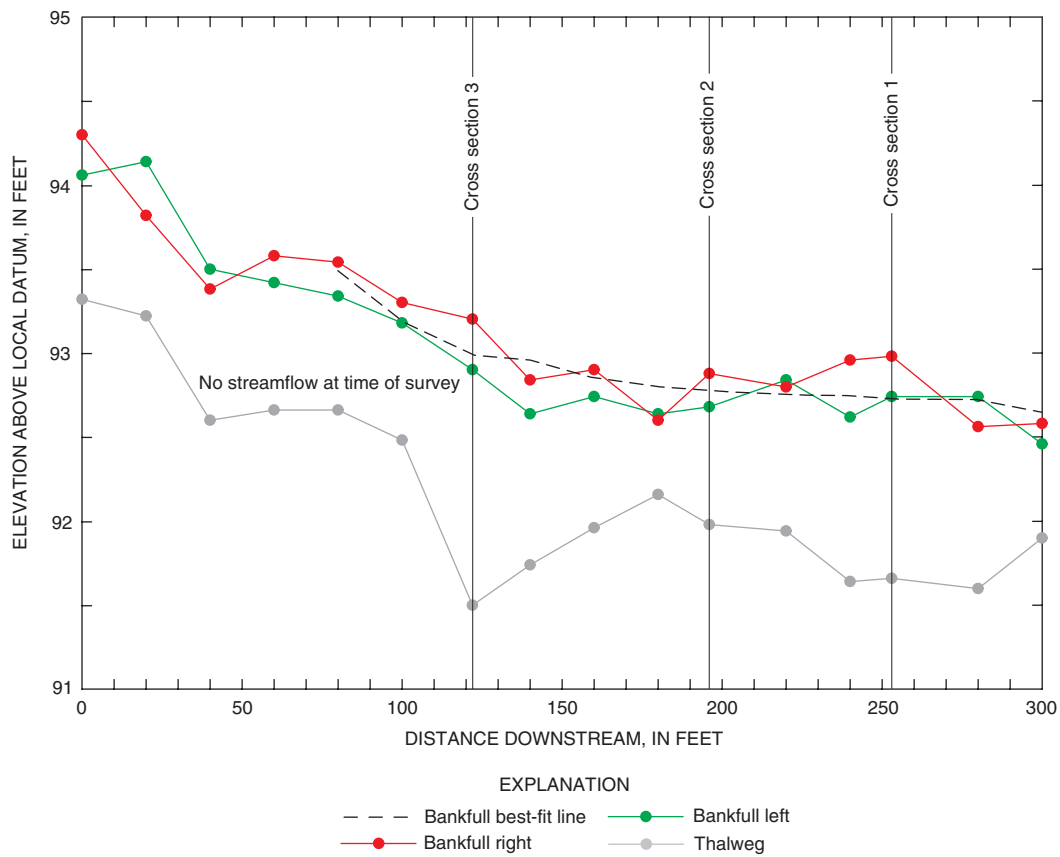


Figure F2. Surveyed profiles of representative reach for Prairie Dog Creek near Birney site. Best-fit line was derived from step-backwater computer model HEC-RAS (U.S. Army Corps of Engineers, 2001a,b,c).



Figure F3. Prairie Dog Creek near Birney site looking upstream at cross section 1. Photograph taken October 16, 2001.

Table F2. Distance and elevation data for cross section 1 at Prairie Dog Creek near Birney site

Distance from left bank (feet)	Elevation above local datum (feet)
0.0	¹ 92.74
4.0	92.08
5.0	91.72
6.0	91.66
7.0	91.76
8.0	91.84
9.0	91.86
10.0	91.98
11.0	92.12
12.0	92.14
13.0	92.10
14.0	92.14
15.0	92.20
16.0	92.26
17.0	92.26
18.0	92.30
19.0	¹ 92.98

¹Ground elevation at cross-section pin.

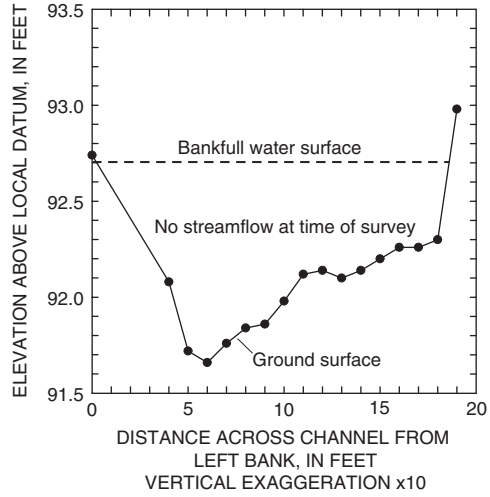


Figure F4. Cross section 1 at Prairie Dog Creek near Birney site.



Figure F5. Bankfull elevation (base of surveying rod) at Prairie Dog Creek near Birney site between cross sections 1 and 2. Photograph taken October 16, 2001.

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Table F3. Distance and elevation data for cross section 2 at Prairie Dog Creek near Birney site

Distance from left bank (feet)	Elevation above local datum (feet)
0.0	¹ 92.68
1.0	92.50
2.0	92.22
3.0	92.06
4.0	91.98
5.0	92.12
6.0	92.14
7.0	92.18
8.0	92.14
9.0	92.16
10.0	92.14
11.0	92.12
12.0	92.14
13.0	92.04
14.0	92.10
15.0	¹ 92.88

¹Ground elevation at cross-section pin.

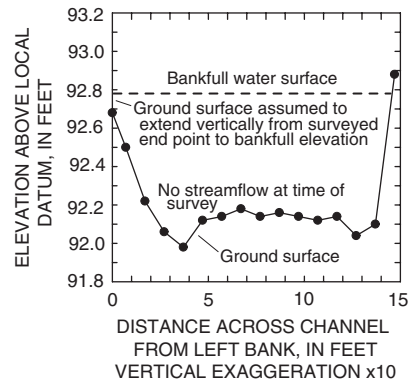


Figure F6. Cross section 2 at Prairie Dog Creek near Birney site.



Figure F7. Prairie Dog Creek near Birney site near mid-channel looking downstream at cross section 2. Photograph taken October 16, 2001.

Table F4. Distance and elevation data for cross section 3 at Prairie Dog Creek near Birney site

Distance from left bank (feet)	Elevation above local datum (feet)
0.0	¹ 92.90
1.0	92.12
2.0	91.82
3.0	91.72
4.0	91.78
5.0	91.50
6.0	91.52
7.0	91.74
8.0	92.16
9.0	92.56
10.0	¹ 93.20

¹Ground elevation at cross-section pin.

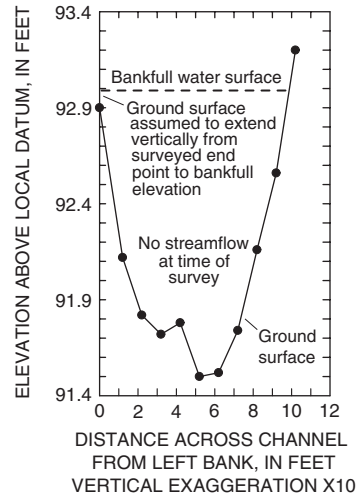


Figure F8. Cross section 3 at Prairie Dog Creek near Birney site.



Figure F9. Prairie Dog Creek near Birney site from right bank looking upstream at cross sections 2 (foreground) and 3 (behind hydrographer). Photograph taken October 16, 2001.

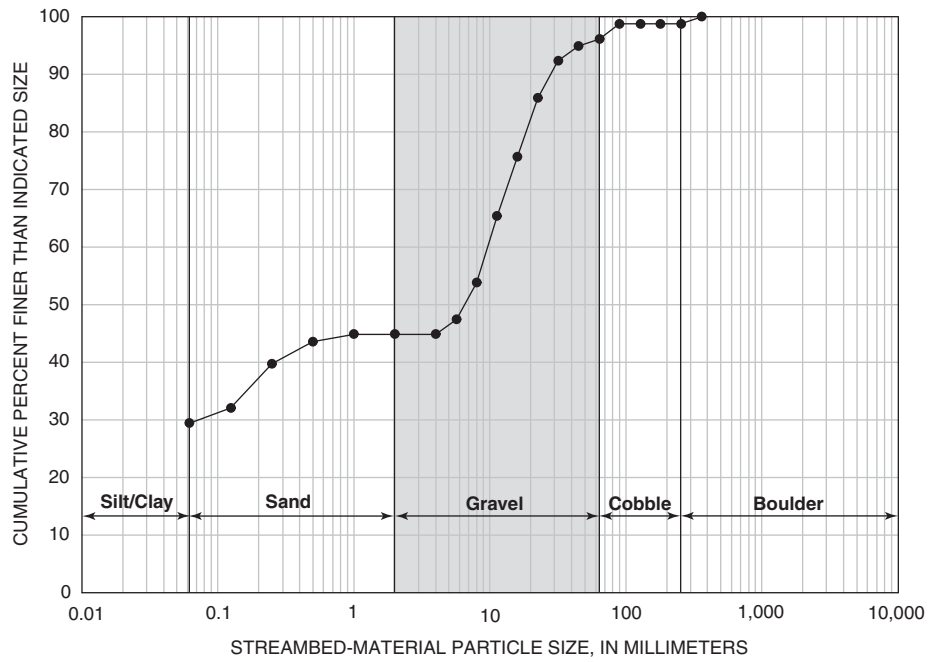


Figure F10. Distribution of streambed-material particle size for Prairie Dog Creek near Birney site. Shaded area indicates predominant streambed-material size.

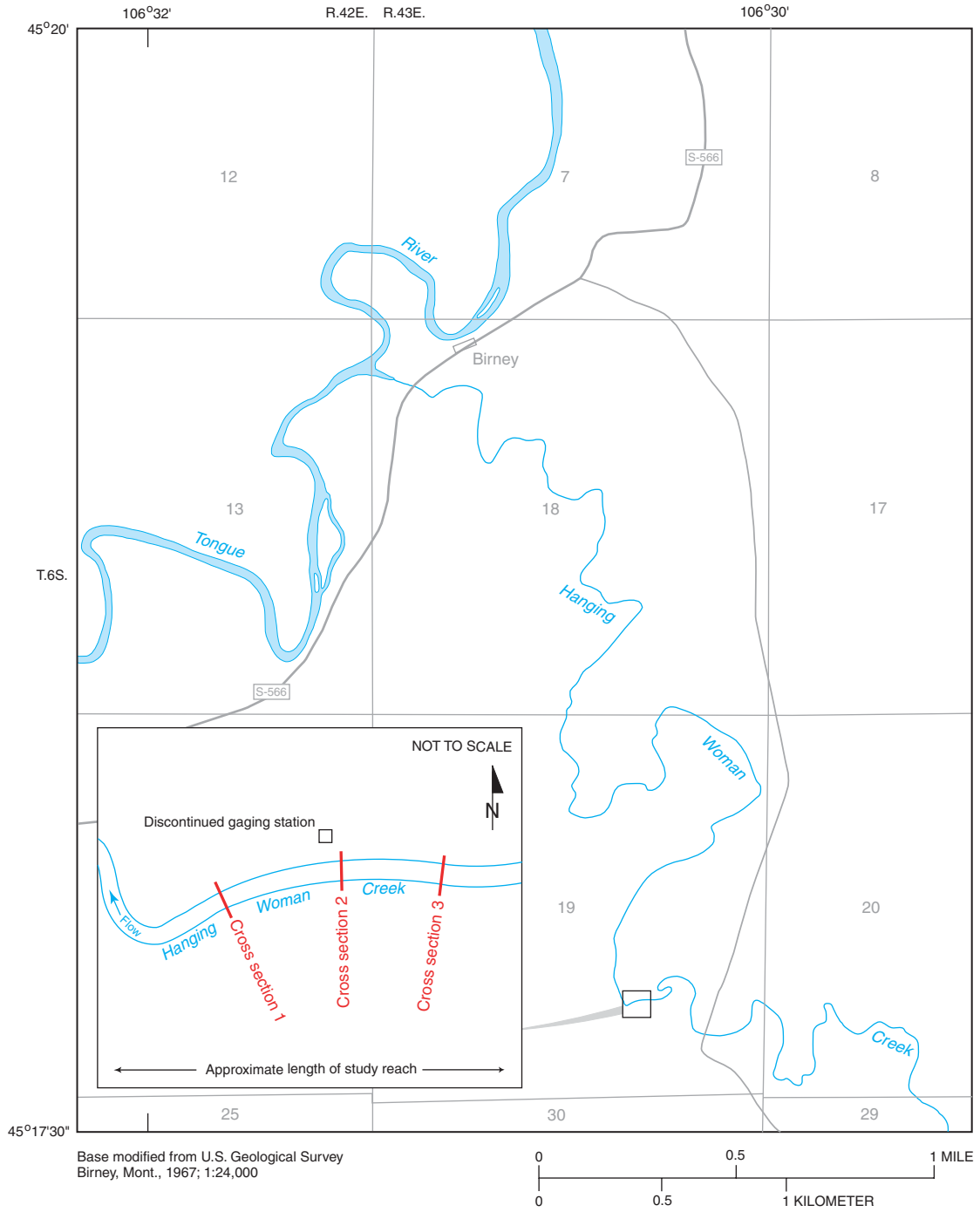


Figure G1. Location of representative study reach, discontinued streamflow-gaging station, and cross sections for Hanging Woman Creek near Birney, Mont..

06307600 Hanging Woman Creek near Birney, Mont.

The Hanging Woman Creek near Birney gaging station is located at latitude 45°17'57", longitude 106°30'28" in N¹/₂NW¹/₄SE¹/₄, sec. 19, T. 6 S., R. 43 E., Rosebud County, Hydrologic Unit 10090101. The water-stage recorder is situated on the right bank 0.5 mi downstream from a bridge on the Birney-Otter road, 1.2 mi south of Birney, 1.2 mi downstream from East Fork, and at river mile 3.3. The period of record is from 1974 to 1995. The gage datum for this site was derived from a 7.5-minute topographic quadrangle map and was not used for this study. Instead, surveyed elevations were referenced to a local datum. This local datum can be referenced by surveying the ground elevation at the pins marking the ends of each cross section. Ground elevations at the cross-section pins are listed in tables G2, G3, and G4.

Table G1. Stream- and channel-morphology data for Hanging Woman Creek near Birney site

[Symbol: --, no data, value not calculated or measured]

Survey date: 10/16/2001				
Topographic quadrangle map name and date: Birney, Mont. (1967)				
Drainage area (square miles): 470				
Streamflow at time of survey (cubic feet per second): 0.13				
Stage at time of survey (feet): ¹ 2.35				
Channel characteristic	Value at cross section			Average or value
	1	2	3	
Bankfull stage (feet) ¹	--	3.4	--	--
Bankfull width (feet)	6.0	6.5	8.0	² 6.8
Mean bankfull depth (feet)	.7	1.0	.7	² 0.8
Maximum bankfull depth (feet)	1.2	1.6	1.2	² 1.3
Bankfull cross-sectional area (square feet)	4.2	6.5	5.6	² 5.4
Width/depth ratio (foot/foot)	8.6	6.5	11.4	² 8.8
Bankfull-wetted perimeter (feet)	7.4	8.5	9.4	² 8.4
Bankfull water-surface slope (foot/foot)	--	--	--	³ .014
Flood-prone width (feet)	28	48	32	² 36
Entrenchment ratio (foot/foot)	4.7	7.4	4.0	² 5.4
Sinuosity (foot/foot)	--	--	--	³ 2.1
Channel length (feet)	--	--	--	³ 20,300
Valley length (feet)	--	--	--	³ 9,900
Manning's n (estimated)	--	--	--	³ .03
Bankfull discharge (cubic feet per second)	--	--	--	³ 20
Bankfull-recurrence interval (years)	--	--	--	³ 1.2
Channel type (Rosgen, 1996)	--	--	--	³ E4

¹Although the gaging station has been discontinued, the electric-tape gage inside the gage house was operational at the time of the survey.

The bankfull stage at the gage was used with the most recent stage-discharge relation to estimate bankfull discharge.

²Average of values for three cross sections.

³Value for entire reach.

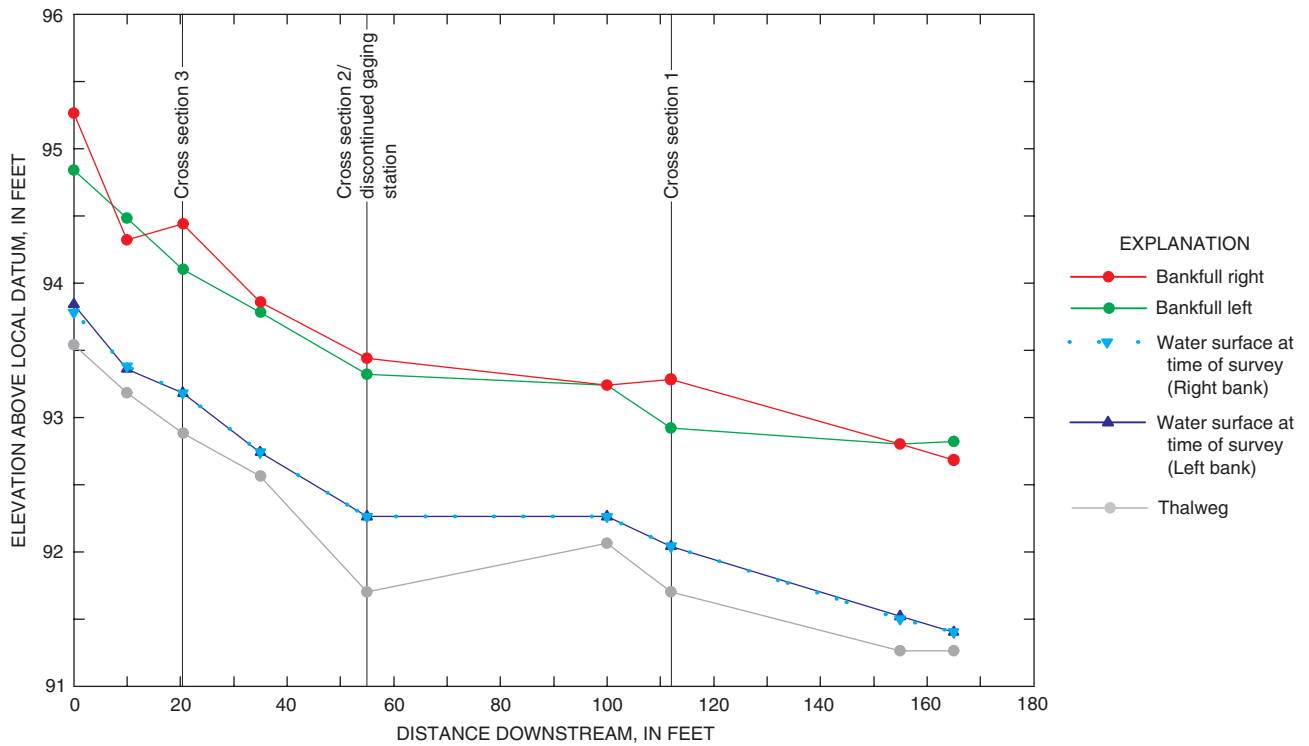


Figure G2. Surveyed profiles of representative reach for Hanging Woman Creek near Birney site. Bankfull best-fit line was not plotted because cross section 2 is at the gaging station, and left and right bankfull-elevation points were consistent near the gaging station. Bankfull-left elevation was used to calculate mean bankfull depth, maximum bankfull depth, and bankfull width at each cross section.

Table G2. Distance and elevation data for cross section 1 at Hanging Woman Creek near Birney site

Distance from left bank (feet)	Elevation above local datum (feet)
3.0	¹ 92.92
4.0	92.70
4.5	92.04
5.0	91.72
6.0	91.82
7.0	91.70
7.3	92.04
8.0	92.70
9.0	92.94
10.0	93.28
11.0	92.90
12.0	93.12
13.0	¹ 93.28

¹Ground elevation at cross-section pin.

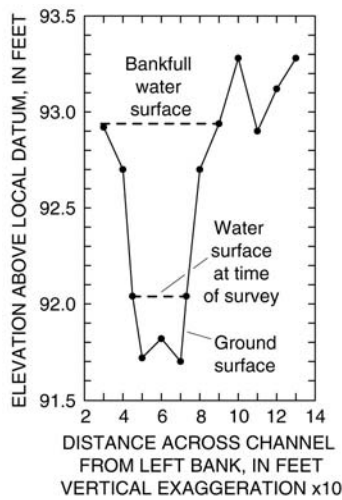


Figure G3. Cross section 1 at Hanging Woman Creek near Birney site.



Figure G4. Hanging Woman Creek near Birney site from left bank near discontinued gaging station. Photograph taken in 1976.

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Table G3. Distance and elevation data for cross section 2 at Hanging Woman Creek near Birney site

Distance from left bank (feet)	Elevation above local datum (feet)
0.5	¹ 93.32
1.0	92.88
1.5	92.26
2.0	91.78
3.0	91.70
4.0	91.94
5.0	92.20
5.5	92.26
6.0	92.72
7.0	¹ 93.44

¹Ground elevation at cross-section pin.

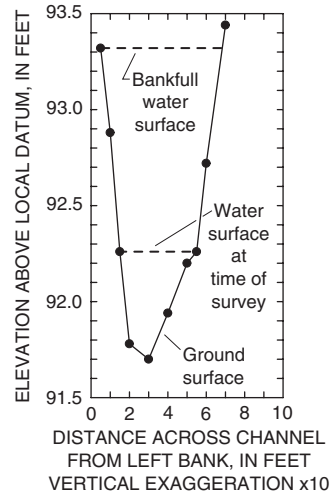


Figure G5. Cross section 2 at Hanging Woman Creek near Birney site.



Figure G6. Hanging Woman Creek near Birney site looking upstream at discontinued gaging station intake and cross section 2. Photograph taken in 1981.

Table G4. Distance and elevation data for cross section 3 at Hanging Woman Creek near Birney site

Distance from left bank (feet)	Elevation above local datum (feet)
1.5	¹ 94.10
2.0	94.00
3.0	93.32
4.0	93.18
3.5	93.02
5.0	92.88
6.0	93.00
6.5	93.18
7.0	93.40
8.0	93.62
9.0	93.96
10.0	¹ 94.44

¹Ground elevation at cross-section pin.

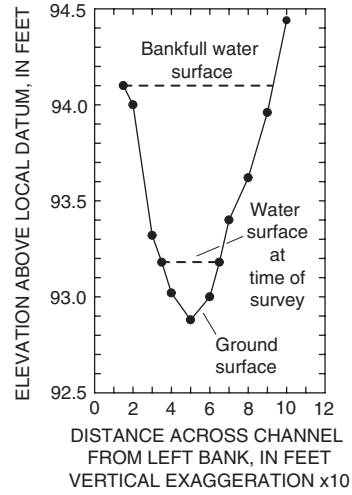


Figure G7. Cross section 3 at Hanging Woman Creek near Birney site.

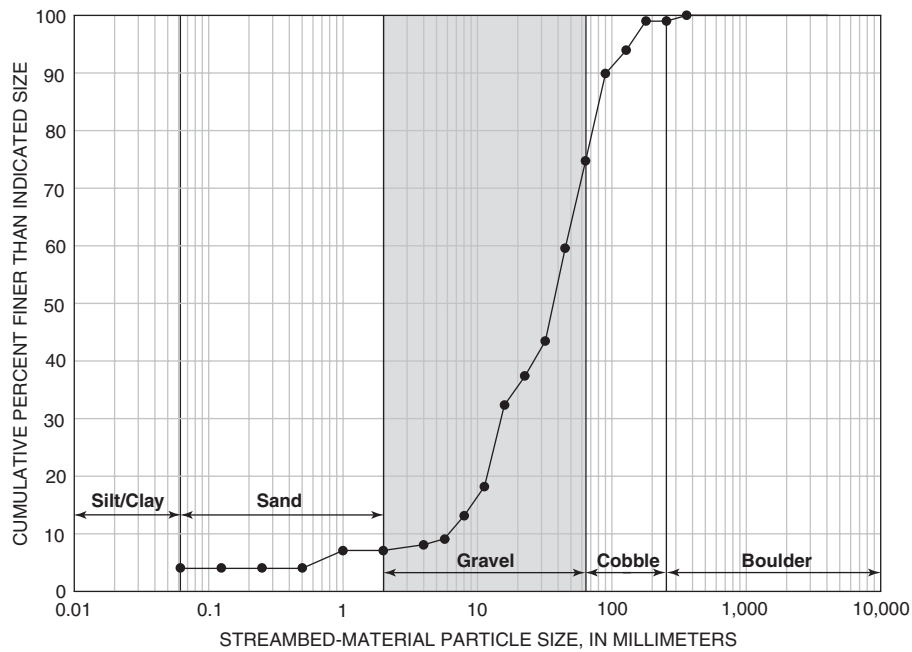


Figure G8. Distribution of streambed-material particle size for Hanging Woman Creek near Birney site. Shaded area indicates predominant streambed-material size.

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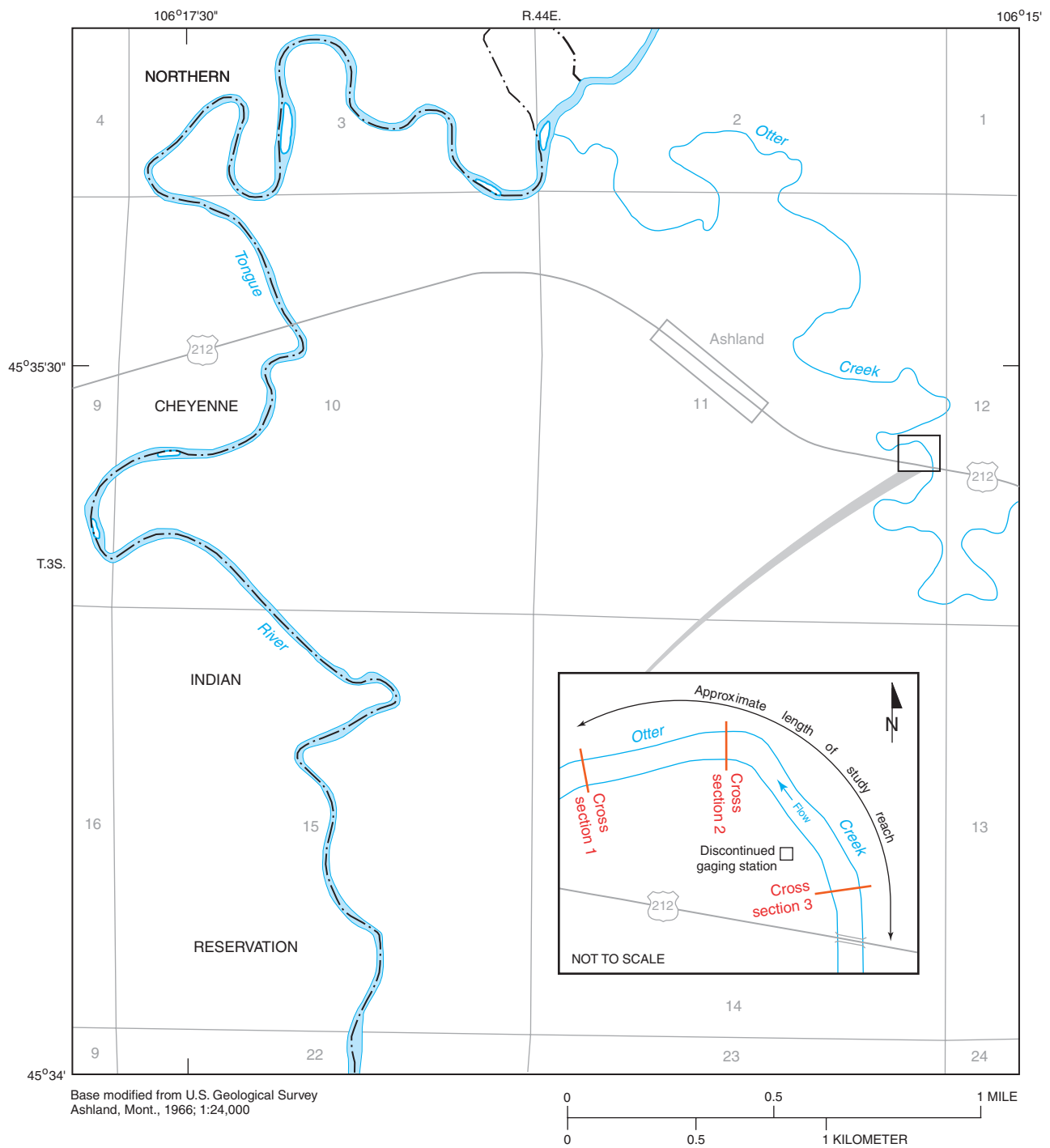


Figure H1. Location of representative study reach, discontinued streamflow-gaging station, and cross sections for Otter Creek at Ashland, Mont.

06307740 Otter Creek at Ashland, Mont.

The Otter Creek at Ashland gaging station was located at latitude 45°35'18", longitude 106°15'17" in NE¹/₄NE¹/₄SE¹/₄, sec. 11, T. 3 S., R. 44 E., Rosebud County, Hydrologic Unit 10090102. The water-stage recorder was situated on the left bank 200 ft downstream from the bridge on U.S. Highway 212, 0.3 mi southeast of Ashland, and at river mile 2.7. The period of record is from 1973 to 1995. The gage datum for this site was derived from a 7.5-minute topographic quadrangle map and was not used for this study. Instead, surveyed elevations were referenced to a local datum. This local datum can be referenced by surveying the ground elevation at the pins marking the ends of each cross section. Ground elevations at the cross-section pins are listed in tables H2, H3, and H4.

Table H1. Stream- and channel-morphology data for Otter Creek at Ashland site

[Symbol: --, no data, value not calculated or measured]

Channel characteristic	Value at cross section			Average or value
	1	2	3	
Survey date: 10/16/2001				
Topographic quadrangle map name and date: Ashland, Mont. (1966)				
Drainage area (square miles): 707				
Streamflow at time of survey (cubic feet per second): 1.5				
Stage at time of survey (feet): No stage recorder available				
Bankfull stage (feet)	--	--	--	--
Bankfull width (feet)	22	17	19	¹ 19
Mean bankfull depth (feet)	1.1	1.5	1.7	¹ 1.4
Maximum bankfull depth (feet)	1.7	2.2	1.9	¹ 1.9
Bankfull cross-sectional area (square feet)	24	26	32	¹ 27
Width/depth ratio (foot/foot)	20	11	11	¹ 14
Bankfull-wetted perimeter (feet)	24	20	22	¹ 22
Bankfull water-surface slope (foot/foot)	--	--	--	² .0003
Flood-prone width (feet)	53	23	24	¹ 33
Entrenchment ratio (foot/foot)	2.4	1.4	1.3	¹ 1.7
Sinuosity (foot/foot)	--	--	--	² 2.2
Channel length (feet)	--	--	--	² 28,300
Valley length (feet)	--	--	--	² 12,700
Manning's n (estimated)	--	--	--	² .028
Bankfull discharge (cubic feet per second) ³	--	--	--	² 25
Bankfull-recurrence interval (years)	--	--	--	² 1.4
Channel type (Rosgen, 1996)	--	--	--	² F6

¹Average of values for three cross sections.²Value for entire reach.³HEC-RAS computer model (version 3.0.1, U.S. Army Corps of Engineers, 2001a,b,c) used to estimate bankfull discharge.

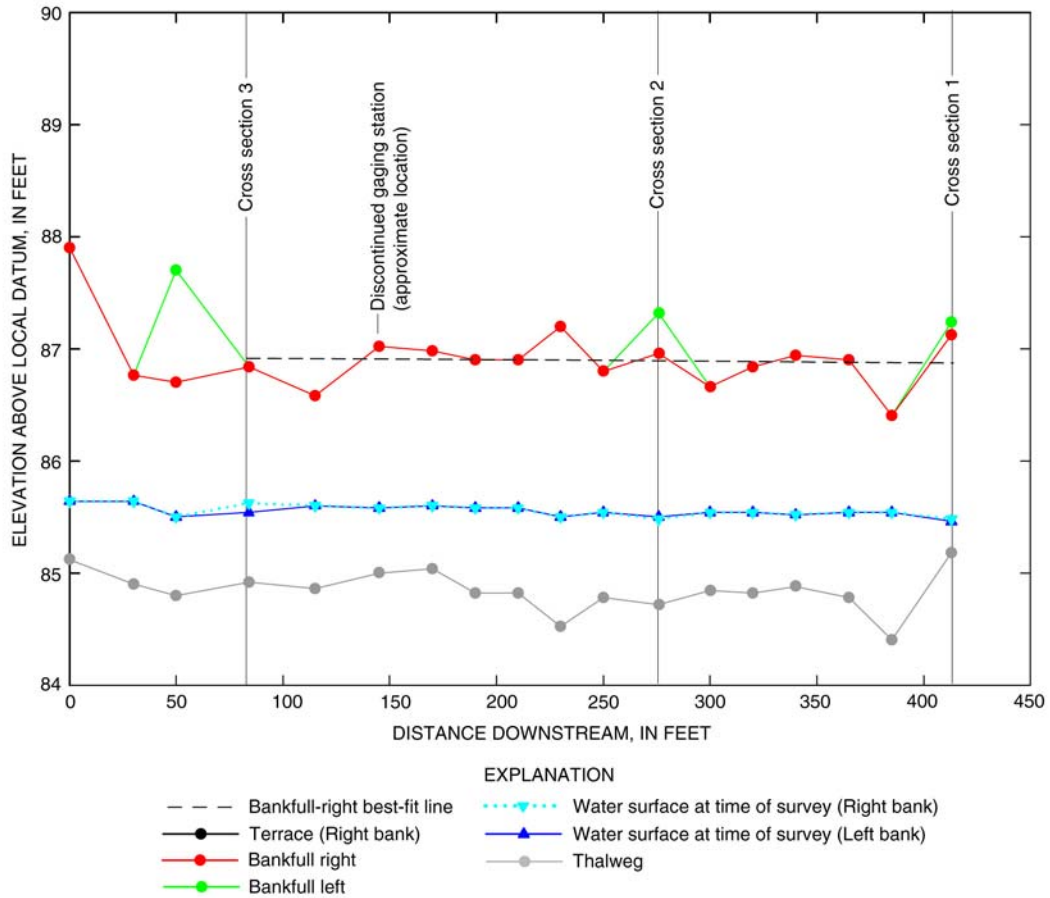


Figure H2. Surveyed profiles of representative reach for Otter Creek at Ashland site. Best-fit line derived from step-backwater computer model HEC-RAS (U.S. Army Corps of Engineers, 2001a,b,c).

Table H2. Distance and elevation data for cross section 1 at Otter Creek at Ashland site

Distance from left bank (feet)	Elevation above local datum (feet)
0.0	¹ 87.24
1.0	86.08
3.0	85.78
5.0	85.46
6.0	85.36
8.0	85.18
10.0	85.28
12.5	85.48
14.0	85.60
16.0	85.80
18.0	86.06
20.0	86.28
23.0	¹ 87.12

¹Ground elevation at cross-section pin.

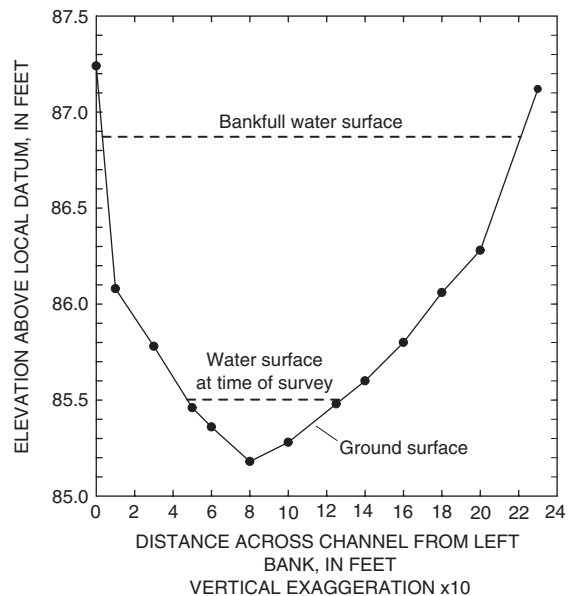


Figure H3. Cross section 1 at Otter Creek at Ashland site.

Table H3. Distance and elevation data for cross section 2 at Otter Creek at Ashland site

Distance from left bank (feet)	Elevation above local datum (feet)
0.0	¹ 87.32
2.0	86.54
4.0	85.50
6.0	84.88
8.0	84.76
10.0	84.90
12.0	84.84
14.0	84.72
16.0	84.86
17.0	85.06
17.5	85.48
18.0	¹ 86.96

¹Ground elevation at cross-section pin.

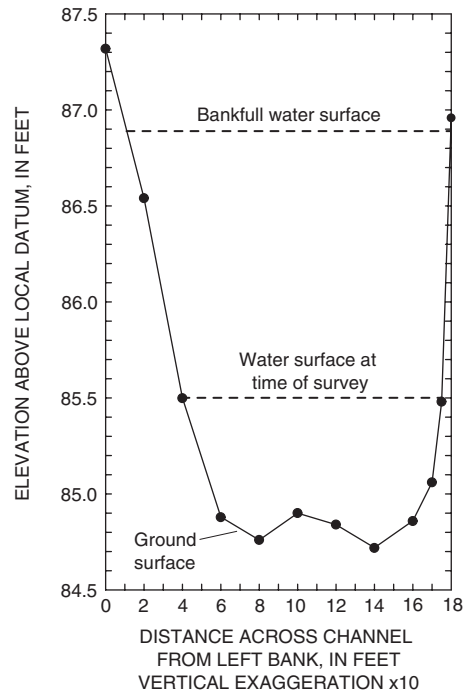


Figure H4. Cross section 2 at Otter Creek at Ashland site.



Figure H5. Otter Creek at Ashland site from right bank at cross section 2 looking upstream at gaging station and bridge. Date of photograph unknown.

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Table H4. Distance and elevation data for cross section 3 at Otter Creek at Ashland site

Distance from left bank (feet)	Elevation above local datum (feet)
0.0	¹ 86.84
1.0	86.18
2.0	85.54
3.0	85.12
5.0	85.08
7.0	85.10
9.0	85.02
11.0	84.92
13.0	84.99
15.0	85.00
17.0	85.02
18.0	85.02
18.5	85.62
19.0	¹ 86.84

¹Ground elevation at cross-section pin.

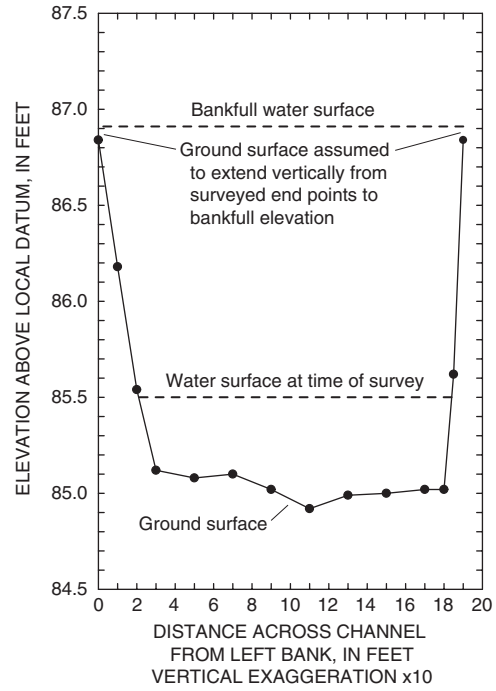


Figure H6. Cross section 3 at Otter Creek at Ashland site.

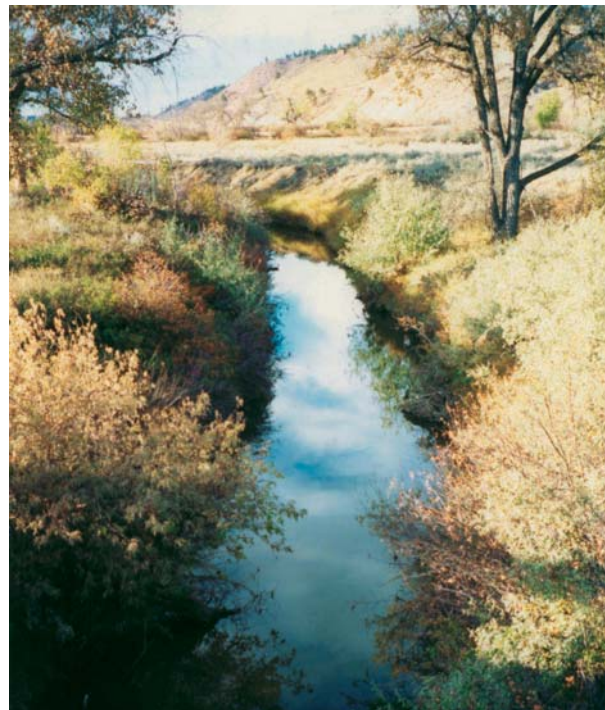


Figure H7. Otter Creek at Ashland site from bridge looking downstream at study reach. Photograph taken October 16, 2001.

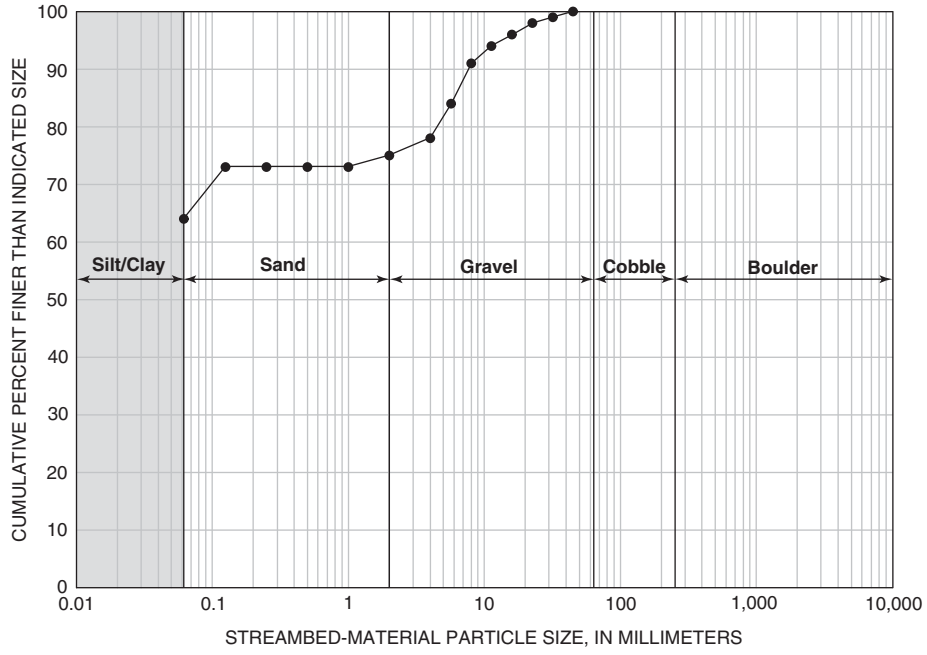


Figure H8. Distribution of streambed-material particle size for Otter Creek at Ashland site. Shaded area indicates predominant streambed-material size.

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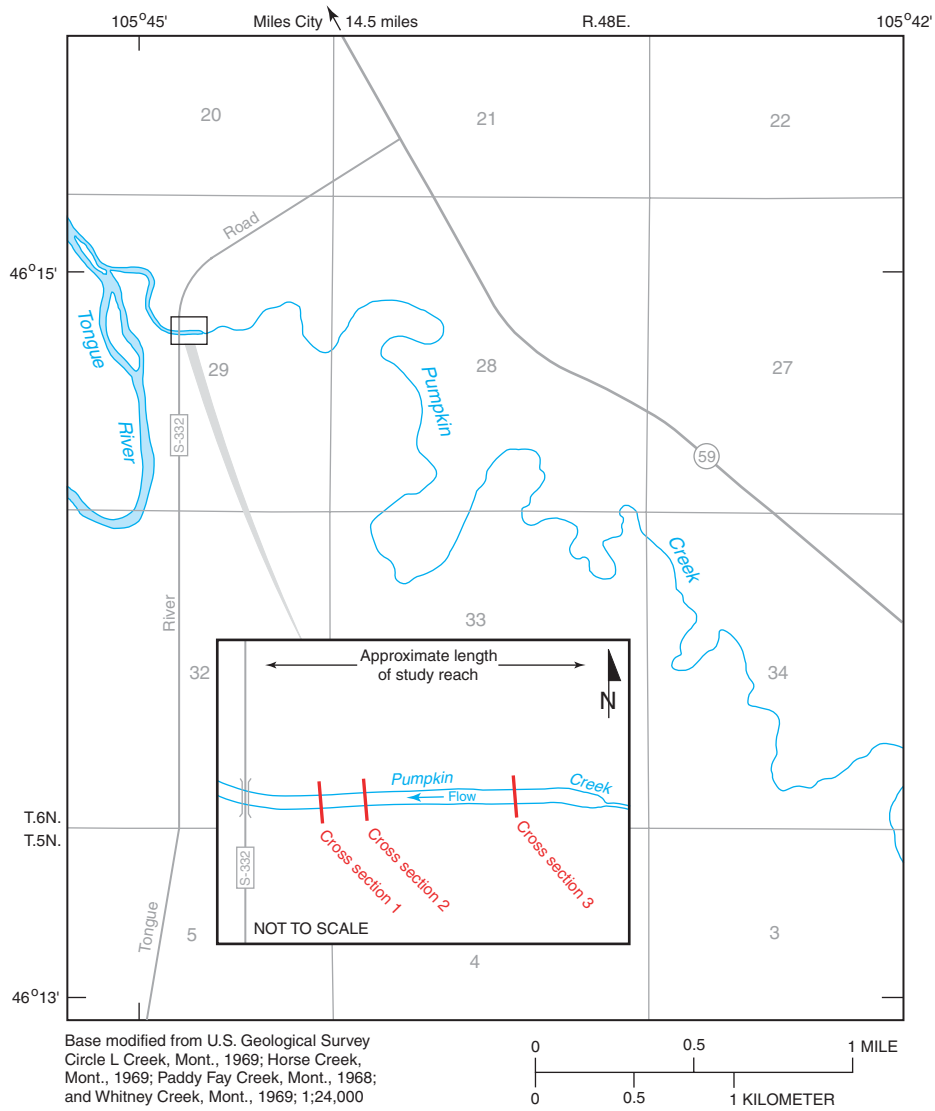


Figure II. Location of representative study reach and cross sections for Pumpkin Creek at mouth, near Miles City, Mont.

461450105444601 Pumpkin Creek at mouth, near Miles City, Mont.

The Pumpkin Creek study reach is located at latitude 46°14'50", longitude 105°44'46" in SW¹/₄SW¹/₄NE¹/₄, sec. 29, T. 6 N., R. 48 E., Custer County, Hydrologic Unit 10090102. The study reach is situated immediately upstream from Highway S-332, approximately 0.4 river mile upstream from the mouth, and 7.1 miles downstream from discontinued gaging station Pumpkin Creek near Miles City, Mont. (06308400). Flow-frequency information from the gaging station was used to estimate the bankfull-recurrence interval at the site. The gaging station period of record is from 1973 to 1978 and from 1980 to 1985. Surveyed elevations for this site are referenced to a local datum. This local datum can be referenced by surveying the ground elevations at the pins marking the ends of each cross section. Ground elevations at the cross-section pins are listed in tables I2, I3, and I4.

Table I 1. Stream- and channel-morphology data for Pumpkin Creek at mouth site

[Symbol: --, no data, value not calculated or measured]

Channel characteristic	Value at cross section			Average or value
	1	2	3	
Survey date: 10/17/2001				
Topographic quadrangle map name and date: Horse Creek, Mont. (1969)				
Drainage area at gaging station 06308400 upstream from study reach (square miles): 697				
Streamflow at time of survey (cubic feet per second): 0.12				
Stage at time of survey (feet): No stage recorder available				
Bankfull stage (feet)	--	--	--	--
Bankfull width (feet)	36	36	25	¹ 32
Mean bankfull depth (feet)	2.0	2.1	2.7	¹ 2.3
Maximum bankfull depth (feet)	2.8	2.7	3.2	¹ 2.9
Bankfull cross-sectional area (square feet)	72	76	67	¹ 72
Width/depth ratio (foot/foot)	18	17	9.2	¹ 15
Bankfull-wetted perimeter (feet)	40	40	30	¹ 37
Bankfull water-surface slope (foot/foot)	--	--	--	² .0003
Flood-prone width (feet)	63	63	61	¹ 62
Entrenchment ratio (foot/foot)	1.8	1.8	2.4	¹ 2.0
Sinuosity (foot/foot)	--	--	--	² 2.5
Channel length (feet)	--	--	--	² 26,600
Valley length (feet)	--	--	--	² 10,800
Manning's n (estimated)	--	--	--	² .027
Bankfull discharge (cubic feet per second) ³	--	--	--	² 65
Bankfull-recurrence interval from gaging station upstream (years) ³	--	--	--	² 1.1
Channel type (Rosgen, 1996)	--	--	--	² C6c

¹Average of values for three cross sections.²Value for entire reach.³HEC-RAS computer model (version 3.0.1, U.S. Army Corps of Engineers, 2001a,b,c) used to estimate bankfull discharge.

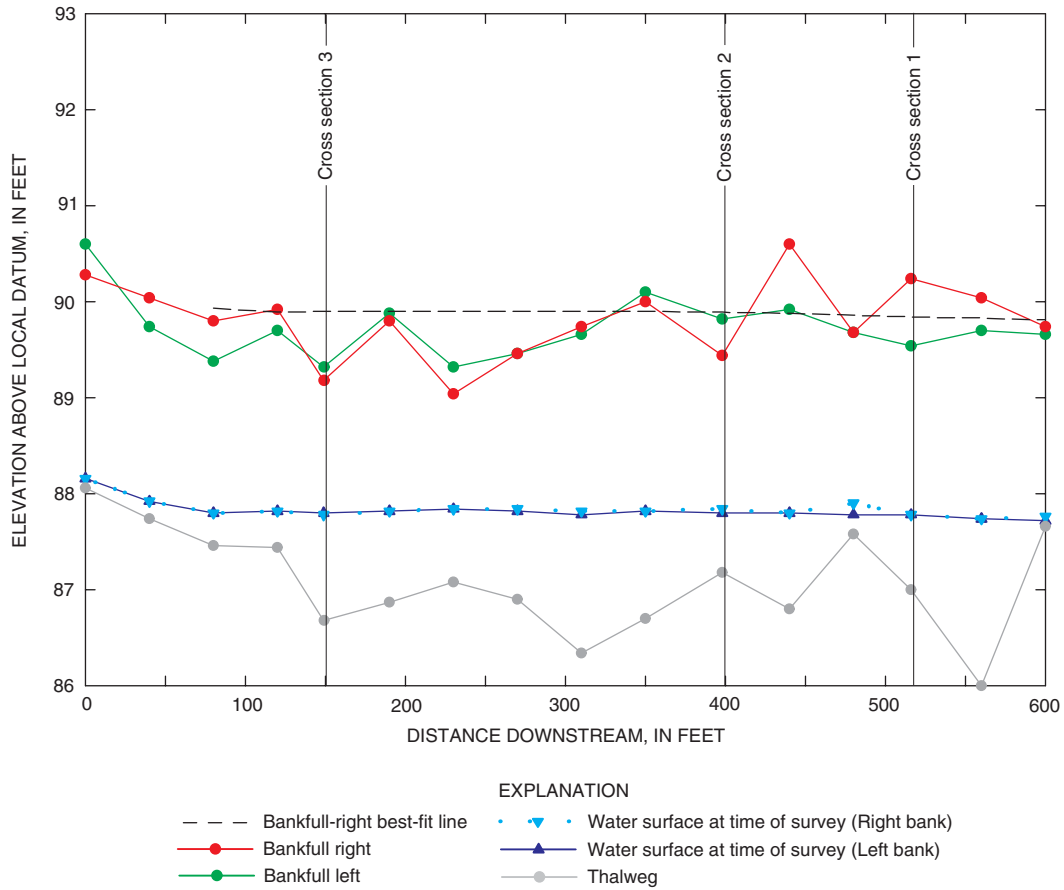


Figure 12. Surveyed profiles of representative reach for Pumpkin Creek at mouth site. Best-fit line was derived from step-backwater computer model HEC-RAS (U.S. Army Corps of Engineers, 2001a,b,c).



Figure 13. Pumpkin Creek at mouth site from left bank looking upstream at cross section 3. Photograph taken October 17, 2001.

Table 1 2. Distance and elevation data for cross section 1 at Pumpkin Creek at mouth site

Distance from left bank (feet)	Elevation above local datum (feet)
0.0	¹ 89.54
2.0	87.78
6.0	87.10
10.0	87.10
14.0	87.00
18.0	87.26
22.0	87.80
24.0	88.14
26.0	87.78
30.0	88.58
34.0	88.64
36.0	¹ 90.24

¹Ground elevation at cross-section pin.

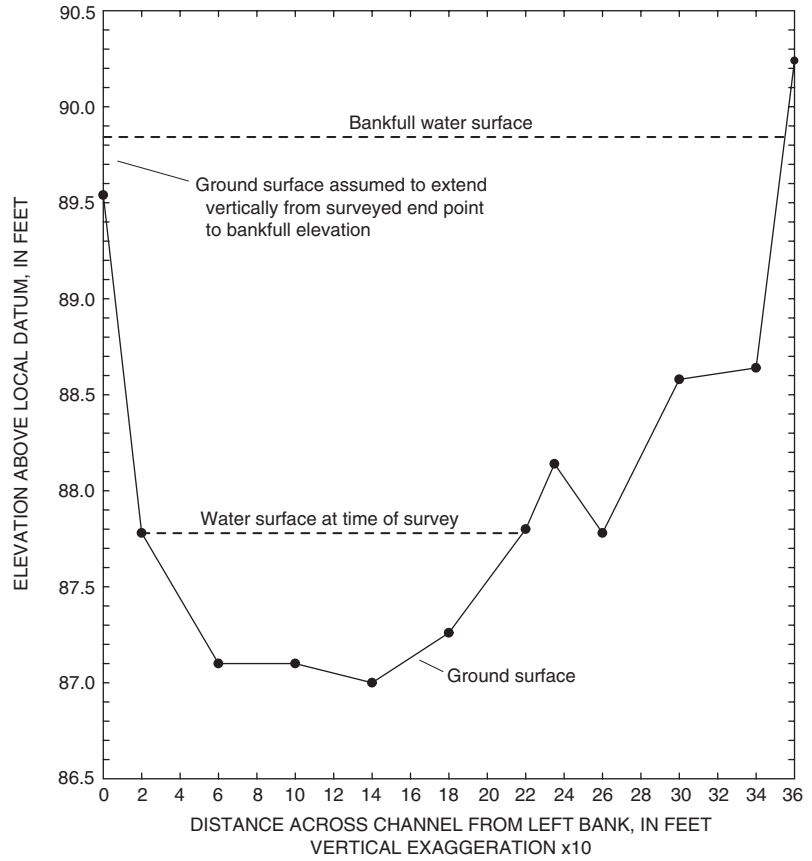


Figure 14. Cross section 1 at Pumpkin Creek at mouth site.



Figure 15. Pumpkin Creek at mouth site from mid-stream at cross section 3 looking downstream at cross sections 2 and 1, and bridge at Highway S-332. Photograph taken October 17, 2001.

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Table I 3. Distance and elevation data for cross section 2 at Pumpkin Creek at mouth site

Distance from left bank (feet)	Elevation above local datum (feet)
0.0	¹ 89.82
2.0	87.92
4.0	87.84
6.0	87.86
10.0	87.80
14.0	87.56
18.0	87.54
22.0	87.38
26.0	87.18
30.0	87.46
34.0	87.84
35.0	87.76
36.0	¹ 89.44

¹Ground elevation at cross-section pin.

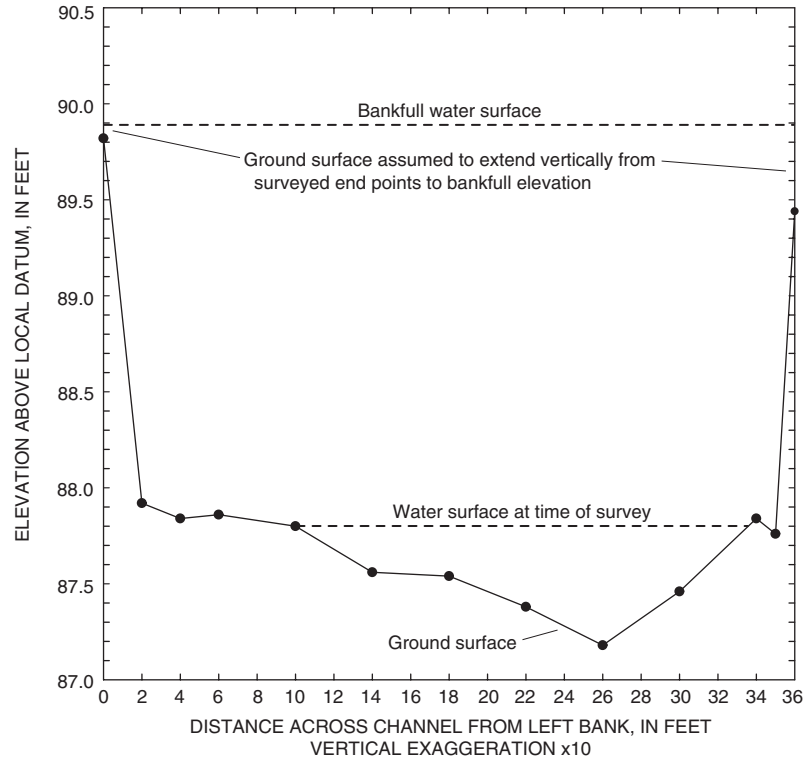


Figure 16. Cross section 2 at Pumpkin Creek at mouth site.

Table I 4. Distance and elevation data for cross section 3 at Pumpkin Creek at mouth site

Distance from left bank (feet)	Elevation above local datum (feet)
0.0	¹ 89.32
0.5	87.80
2.5	87.06
4.5	87.06
6.5	87.02
8.5	86.86
10.5	87.76
12.5	86.68
14.5	86.68
16.5	86.84
18.5	87.02
20.5	87.18
22.0	87.78
24.5	¹ 89.18

¹Ground elevation at cross-section pin.

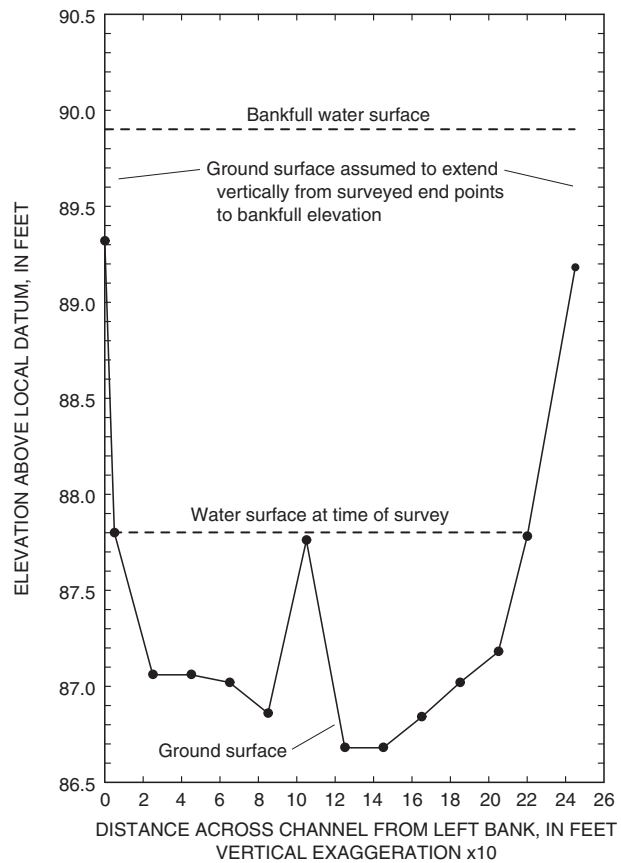


Figure 17. Cross section 3 at Pumpkin Creek at mouth site.

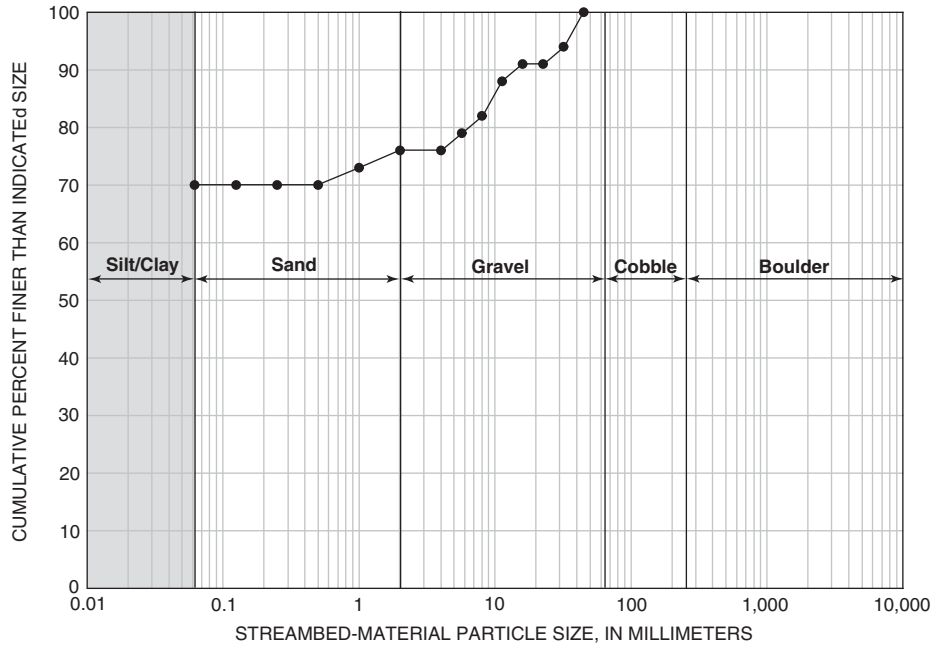


Figure 18. Distribution of streambed-material particle size for Pumpkin Creek at mouth site. Very fine, deep silt covered most of channel at the time of the survey. Shaded area indicates predominant streambed-material size.

APPENDIX 1

HEC-RAS model input data for Prairie Dog Creek
near Birney, Mont. (06307528)

HEC-RAS Version 3.0.1 Mar 2001
 U.S. Army Corp of Engineers
 Hydrologic Engineering Center
 609 Second Street, Suite D
 Davis, California 95616-4687
 (916) 756-1104

```

X      X  XXXXXX   XXXX       XXXX       XX       XXXX
X      X X                X  X       X  X       X
X      X X                X          X  X       X  X       X
XXXXXXXX XXXX   X          XXX XXXX   XXXXXXXX   XXXX
X      X X                X          X  X       X  X       X
X      X X                X  X       X  X       X  X       X
X      X  XXXXXX   XXXX       X  X       X  X       XXXXX

```

PROJECT DATA

Project Title: PrairieDogCreek2
 Project File : Prairie.prj
 Run Date and Time: 7/22/2003 4:41:15 PM

Project in English units

PLAN DATA

Plan Title: Plan 03
 Plan File : p:\TongueR\HECRAS\Prairie.p03

Geometry Title: Geom 01
 Geometry File : p:\TongueR\HECRAS\Prairie.g01

Flow Title : Flow 01
 Flow File : p:\TongueR\HECRAS\Prairie.f01

Plan Summary Information:

Number of: Cross Sections	=	12	Multiple Openings	=	0
Culverts	=	0	Inline Weirs	=	0
Bridges	=	0			

Computational Information

Water surface calculation tolerance	=	0.003
Critical depth calculaton tolerance	=	0.003
Maximum number of interations	=	20
Maximum difference tolerance	=	0.1
Flow tolerance factor	=	0.001

Computation Options

Critical depth computed only	where necessary
Conveyance Calculation Method:	At breaks in n values only
Friction Slope Method:	Average Conveyance
Computational Flow Regime:	Subcritical Flow

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GEOMETRY DATA

Geometry Title: Geom 01
 Geometry File : p:\TongueR\HECRAS\Prairie.g01

CROSS SECTION

RS: 3.4

INPUT

Description:

Station Elevation Data		num= 10							
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	93.34	1.2	93.28	2.2	92.98	3.2	92.88	4.2	92.94
5.2	92.66	6.2	92.68	7.2	92.9	8.2	93.32	9.2	93.54

Manning's n Values		num= 3			
Sta	n Val	Sta	n Val	Sta	n Val
0	.028	0	.028	9.2	.028

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	0	9.2		20	20		.1	.3

CROSS SECTION

RS: 3.2

INPUT

Description:

Station Elevation Data		num= 10							
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	93.18	1.2	93.1	2.2	92.8	3.2	92.7	4.2	92.76
5.2	92.48	6.2	92.5	7.2	92.72	8.2	93.14	9.2	93.3

Manning's n Values		num= 3			
Sta	n Val	Sta	n Val	Sta	n Val
0	.028	0	.028	9.2	.028

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	0	9.2		22	22		.1	.3

CROSS SECTION

RS: 3

INPUT

Description:

Station Elevation Data		num= 11							
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	92.9	1.2	92.12	2.2	91.82	3.2	91.72	4.2	91.78
5.2	91.5	6.2	91.52	7.2	91.74	8.2	92.16	9.2	92.56
10.2	93.2								

Manning's n Values		num= 3			
Sta	n Val	Sta	n Val	Sta	n Val
0	.028	0	.028	10.2	.028

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	0	10.2		18	18		.1	.3

CROSS SECTION

RS: 2.8

INPUT

Description:

Station Elevation Data		num=		11					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	92.64	1.2	92.36	2.2	92.06	3.2	91.96	4.2	92.02
5.2	91.74	6.2	91.76	7.2	91.98	8.2	92.4	9.2	92.8
10.2	92.84								

Manning's n Values		num=		3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.028	0	.028	10.2	.028

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	0	10.2		20	20		.1	.3

CROSS SECTION

RS: 2.6

INPUT

Description:

Station Elevation Data		num=		10					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	92.74	1.2	92.58	2.2	92.28	3.2	92.18	4.2	92.24
5.2	91.96	6.2	91.98	7.2	92.2	8.2	92.62	9.2	92.9

Manning's n Values		num=		3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.028	0	.028	9.2	.028

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	0	9.2		20	20		.1	.3

CROSS SECTION

RS: 2.4

INPUT

Description:

Station Elevation Data		num=		16					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	92.86	.7	92.64	1.7	92.4	2.7	92.24	3.7	92.16
4.7	92.3	5.7	92.32	6.7	92.36	7.7	92.32	8.7	92.34
9.7	92.32	10.7	92.3	11.7	92.32	12.7	92.22	13.7	92.28
14.7	93.06								

Manning's n Values		num=		3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.028	.7	.028	14.7	.028

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	.7	14.7		16	16		.1	.3

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CROSS SECTION

RS: 2

INPUT

Description:

Station Elevation Data		num=		16					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	92.68	.7	92.5	1.7	92.22	2.7	92.06	3.7	91.98
4.7	92.12	5.7	92.14	6.7	92.18	7.7	92.14	8.7	92.16
9.7	92.14	10.7	92.12	11.7	92.14	12.7	92.04	13.7	92.1
14.7	92.88								

Manning's n Values		num=		3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.028	0	.028	14.7	.028

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	0	14.7		24	24	24		.1	.3

CROSS SECTION

RS: 1.8

INPUT

Description:

Station Elevation Data		num=		16					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	92.84	.7	92.46	1.7	92.18	2.7	92.02	3.7	91.94
4.7	92.08	5.7	92.1	6.7	92.14	7.7	92.1	8.7	92.12
9.7	92.1	10.7	92.08	11.7	92.1	12.7	92	13.7	92.06
14.7	92.8								

Manning's n Values		num=		3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.028	0	.028	14.7	.028

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	0	14.7		20	20	20		.1	.3

CROSS SECTION

RS: 1.4

INPUT

Description:

Station Elevation Data		num=		17					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	92.62	4	92.06	5	91.7	6	91.64	7	91.74
8	91.82	9	91.84	10	91.96	11	92.1	12	92.12
13	92.08	14	92.12	15	92.18	16	92.24	17	92.24
18	92.28	19	92.96						

Manning's n Values		num=		3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.028	0	.028	19	.028

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	0	19		13	13	13		.1	.3

CROSS SECTION

RS: 1

INPUT

Description:

Station Elevation Data		num=		17					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	92.74	4	92.08	5	91.72	6	91.66	7	91.76
8	91.84	9	91.86	10	91.98	11	92.12	12	92.14
13	92.1	14	92.14	15	92.2	16	92.26	17	92.26
18	92.3	19	92.98						

Manning's n Values		num=		3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.028	0	.028	19	.028

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	0	19		27	27		.1	.3

CROSS SECTION

RS: .8

INPUT

Description:

Station Elevation Data		num=		17					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	92.74	4	92.02	5	91.66	6	91.6	7	91.7
8	91.78	9	91.8	10	91.92	11	92.06	12	92.08
13	92.04	14	92.08	15	92.14	16	92.2	17	92.2
18	92.24	19	92.56						

Manning's n Values		num=		3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.028	0	.028	19	.028

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	0	19		20	20		.1	.3

CROSS SECTION

RS: 0.6

INPUT

Description:

Station Elevation Data		num=		17					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	92.46	4	92.32	5	91.96	6	91.9	7	92
8	92.08	9	92.1	10	92.22	11	92.36	12	92.38
13	92.34	14	92.38	15	92.44	16	92.5	17	92.5
18	92.54	19	92.58						

Manning's n Values		num=		3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.028	0	.028	19	.028

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	0	19		0	0		.1	.3

APPENDIX 2

HEC-RAS model input data for Otter Creek
at Ashland, Mont. (06307740)

HEC-RAS Version 3.0.1 Mar 2001
 U.S. Army Corp of Engineers
 Hydrologic Engineering Center
 609 Second Street, Suite D
 Davis, California 95616-4687
 (916) 756-1104

```

X      X  XXXXXX   XXXX       XXXX       XX       XXXX
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X      X X                X            X  X      X X      X
XXXXXXXX XXXX   X            XXX XXXX   XXXXXXXX   XXXX
X      X X                X            X X      X  X      X
X      X X                X  X         X  X      X  X      X
X      X  XXXXXXX   XXXX       X  X      X  X      XXXXXX
    
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PROJECT DATA

Project Title: OtterCreekatAshland
 Project File : otterckatashland2.prj
 Run Date and Time: 7/22/2003 4:17:48 PM

Project in English units

PLAN DATA

Plan Title: Plan 01
 Plan File : p:\TongueR\HECRAS\otterckatashland2.p01

Geometry Title: OtterCreek01
 Geometry File : p:\TongueR\HECRAS\otterckatashland2.g01

Flow Title : OtterCreek01
 Flow File : p:\TongueR\HECRAS\otterckatashland2.f01

Plan Summary Information:

Number of: Cross Sections =	17	Multiple Openings =	0
Culverts =	0	Inline Weirs =	0
Bridges =	0		

Computational Information

Water surface calculation tolerance =	0.003
Critical depth calculaton tolerance =	0.003
Maximum number of interations =	20
Maximum difference tolerance =	0.1
Flow tolerance factor =	0.001

Computation Options

Critical depth computed only where necessary	
Conveyance Calculation Method:	At breaks in n values only
Friction Slope Method:	Average Conveyance
Computational Flow Regime:	Mixed Flow

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GEOMETRY DATA

Geometry Title: OtterCreek01
 Geometry File : p:\TongueR\HECRAS\otterckatashland2.g01

CROSS SECTION
 RS: 3.4

INPUT

Description:

Station Elevation Data		num=		14					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	86.76	1	86.16	2	85.52	3	85.1	5	85.06
7	85.08	9	85	11	84.9	13	84.97	15	84.98
17	85	18	85	18.5	85.6	19	86.76		

Manning's n Values		num=		3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.035	0	.027	19	.035

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	0	19		20	20		.1	.3

CROSS SECTION
 RS: 3.2

INPUT

Description:

Station Elevation Data		num=		14					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	86.7	1	86.06	2	85.42	3	85	5	84.96
7	84.98	9	84.9	11	84.8	13	84.87	15	84.88
17	84.9	18	84.9	18.5	85.5	19	86.7		

Manning's n Values		num=		3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.035	0	.027	19	.035

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	0	19		34	34		.1	.3

CROSS SECTION
 RS: 3

INPUT

Description:

Station Elevation Data		num=		14					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	86.84	1	86.18	2	85.54	3	85.12	5	85.08
7	85.1	9	85.02	11	84.92	13	84.99	15	85
17	85.02	18	85.02	18.5	85.62	19	86.84		

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .035 0 .027 19 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 0 19 31 31 31 .1 .3

CROSS SECTION
 RS: 2.875*

INPUT

Description:

Station Elevation Data num= 20
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 86.58 1.03 86.23 1.62 85.87 2.07 85.6 3.1 85.15
 3.25 85.14 4.88 85.03 5.17 85.02 6.5 85.02 7.24 85.04
 8.12 85.01 9.31 84.97 9.75 84.95 11.38 84.86 13.25 84.93
 15.12 84.95 17 84.99 17.94 85.05 18.41 85.66 18.88 86.58

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .035 0 .027 18.88 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 0 18.88 30 30 30 .1 .3

CROSS SECTION
 RS: 2.75*

INPUT

Description:

Station Elevation Data num= 20
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 87.02 1.07 86.47 1.68 86.13 2.14 85.85 3.2 85.37
 3.36 85.34 5.04 85.16 5.34 85.15 6.71 85.14 7.48 85.16
 8.39 85.15 9.61 85.11 10.07 85.09 11.75 85 13.5 85.07
 15.25 85.09 17 85.16 17.88 85.26 18.31 85.9 18.75 87.02

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .035 0 .027 18.75 .35

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 0 18.75 25 25 25 .1 .3

68 Channel-Morphology Data for the Tongue River and Selected Tributaries, Southeastern Montana, 2001-02

CROSS SECTION

RS: 2.625*

INPUT

Description:

Station Elevation Data									
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	86.98	1.1	86.61	1.73	86.28	2.2	86	3.31	85.49
3.46	85.45	5.2	85.2	5.51	85.19	6.93	85.16	7.72	85.19
8.66	85.19	9.92	85.15	10.39	85.13	12.12	85.04	13.75	85.11
15.38	85.14	17	85.22	17.81	85.38	18.22	86.04	18.62	86.98

Manning's n Values					
Sta	n Val	Sta	n Val	Sta	n Val
0	.035	0	.027	18.62	.035

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	0	18.62		20	20	20		.1	.3

CROSS SECTION

RS: 2.5*

INPUT

Description:

Station Elevation Data									
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	86.9	1.14	86.5	1.79	86.18	2.27	85.9	3.41	85.36
3.57	85.31	5.36	84.98	5.68	84.97	7.14	84.93	7.95	84.96
8.93	84.98	10.23	84.94	10.71	84.92	12.5	84.82	14	84.89
15.5	84.93	17	85.04	17.75	85.25	18.12	85.92	18.5	86.9

Manning's n Values					
Sta	n Val	Sta	n Val	Sta	n Val
0	.035	0	.027	18.5	.035

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	0	18.5		20	20	20		.1	.3

CROSS SECTION

RS: 2.375*

INPUT

Description:

Station Elevation Data									
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	86.9	1.17	86.61	1.84	86.3	2.34	86.02	3.51	85.45
3.68	85.39	5.52	84.99	5.85	84.97	7.36	84.91	8.19	84.96
9.2	84.99	10.53	84.95	11.04	84.93	12.88	84.82	14.25	84.89
15.62	84.94	17	85.07	17.69	85.34	18.03	86.03	18.38	86.9

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .035 0 .027 18.38 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 0 18.38 20 20 20 .1 .3

CROSS SECTION
 RS: 2.25*

INPUT

Description:

Station Elevation Data num= 20
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 87.2 1.2 86.41 1.89 86.11 2.41 85.83 3.61 85.23
 3.79 85.15 5.68 84.68 6.02 84.66 7.57 84.59 8.43 84.64
 9.46 84.69 10.84 84.65 11.36 84.63 13.25 84.52 14.5 84.59
 15.75 84.65 17 84.8 17.62 85.12 17.94 85.82 18.25 87.2

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .035 0 .027 18.25 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 0 18.25 20 20 20 .1 .3

CROSS SECTION
 RS: 2.125*

INPUT

Description:

Station Elevation Data num= 20
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 86.8 1.24 86.77 1.95 86.48 2.48 86.2 3.72 85.57
 3.89 85.48 5.84 84.94 6.19 84.92 7.79 84.83 8.67 84.89
 9.73 84.95 11.15 84.91 11.68 84.89 13.62 84.78 14.75 84.85
 15.88 84.91 17 85.09 17.56 85.45 17.84 86.18 18.12 86.8

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .035 0 .027 18.12 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 0 18.12 26 26 26 .1 .3

70 Channel-Morphology Data for the Tongue River and Selected Tributaries, Southeastern Montana, 2001-02

CROSS SECTION

RS: 2

INPUT

Description:

Station Elevation Data		num=		12					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	87.32	2	86.54	4	85.5	6	84.88	8	84.76
10	84.9	12	84.84	14	84.72	16	84.86	17	85.06
17.5	85.48	18	86.96						

Manning's n Values		num=		3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.035	0	.027	18	.035

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	0	18		24	24	24		.1	.3

CROSS SECTION

RS: 1.85714*

INPUT

Description:

Station Elevation Data		num=		22					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	86.66	1.64	86.61	1.88	86.52	3.76	85.61	4.93	85.26
5.63	85.05	7.51	84.92	8.21	84.95	9.39	85.02	9.86	85
11.27	84.95	13.14	84.84	13.89	84.88	14.81	84.95	15.37	84.99
15.93	85.04	16.11	85.07	16.86	85.2	17.32	85.27	17.6	85.43
18.02	85.69	18.71	86.66						

Manning's n Values		num=		3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.035	0	.027	18.71	.035

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	0	18.71		20	20	20		.1	.3

CROSS SECTION

RS: 1.57142*

INPUT

Description:

Station Elevation Data		num=		22					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	86.84	1.43	86.3	1.63	86.23	3.27	85.57	4.29	85.3
4.9	85.14	6.53	84.99	7.14	84.99	8.16	85.01	8.57	84.99
9.8	84.93	11.43	84.82	12.59	84.88	14.04	84.99	14.91	85.06
15.79	85.14	16.08	85.18	17.24	85.35	17.96	85.45	18.4	85.58
19.05	85.86	20.14	86.84						

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .035 0 .027 20.14 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 0 20.14 20 20 20 .1 .3

CROSS SECTION
 RS: 1.42857*

INPUT

Description:

Station Elevation Data num= 22
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 86.94 1.32 86.22 1.51 86.16 3.02 85.62 3.96 85.39
 4.53 85.26 6.04 85.1 6.61 85.08 7.55 85.08 7.93 85.06
 9.06 84.99 10.57 84.88 11.94 84.96 13.66 85.09 14.69 85.17
 15.71 85.27 16.06 85.31 17.43 85.5 18.29 85.61 18.8 85.73
 19.57 86.02 20.86 86.94

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .035 0 .027 20.86 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 0 20.86 25 25 25 .1 .3

CROSS SECTION
 RS: 1.28571*

INPUT

Description:

Station Elevation Data num= 22
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 86.9 1.21 85.97 1.39 85.93 2.78 85.51 3.64 85.32
 4.16 85.2 5.55 85.04 6.07 85.01 6.94 84.98 7.29 84.95
 8.33 84.89 9.71 84.78 11.3 84.86 13.27 85.02 14.46 85.11
 15.64 85.23 16.04 85.27 17.62 85.49 18.61 85.6 19.2 85.71
 20.09 86.01 21.57 86.9

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .035 0 .027 21.57 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 0 21.57 20 20 20 .1 .3

72 Channel-Morphology Data for the Tongue River and Selected Tributaries, Southeastern Montana, 2001-02

CROSS SECTION

RS: 1.1

INPUT

Description:

Station Elevation Data		num= 22		Sta		Elev		Sta		Elev	
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	86.4	1.11	85.45	1.27	85.42	2.53	85.12	3.32	84.97		
3.8	84.88	5.06	84.71	5.54	84.66	6.33	84.61	6.64	84.58		
7.59	84.51	8.86	84.4	10.65	84.5	12.89	84.67	14.23	84.78		
15.57	84.91	16.02	84.96	17.81	85.2	18.93	85.32	19.6	85.42		
20.61	85.73	22.29	86.4								

Manning's n Values		num= 3		Sta		n Val	
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.035	0	.027	22.29	.035		

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	0	22.29		28	28	28		.1	.3

CROSS SECTION

RS: 1

INPUT

Description:

Station Elevation Data		num= 13		Sta		Elev		Sta		Elev	
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	87.24	1	86.08	3	85.78	5	85.46	6	85.36		
8	85.18	10	85.28	12.5	85.48	14	85.6	16	85.8		
18	86.06	20	86.28	23	87.12						

Manning's n Values		num= 3		Sta		n Val	
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.035	0	.027	23	.035		

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	0	23		0	0	0		.1	.3

APPENDIX 3

HEC-RAS model input data for Pumpkin Creek
at mouth, near Miles City, Mont. (461450105444601)

74 Channel-Morphology Data for the Tongue River and Selected Tributaries, Southeastern Montana, 2001-02

HEC-RAS Version 3.0.1 Mar 2001
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street, Suite D
Davis, California 95616-4687
(916) 756-1104

```
X      X  XXXXXX      XXXX      XXXX      XX      XXXX
X      X X          X  X      X  X      X  X      X
X      X X          X          X  X      X  X      X
XXXXXXXX XXXX      X          XXX XXXX      XXXXXX      XXXX
X      X X          X          X  X      X  X          X
X      X X          X  X      X  X      X  X          X
X      X  XXXXXX      XXXX      X  X      X  X      XXXXX
```

PROJECT DATA

Project Title: PumpkinCreeknrMilesCity
Project File : PumpkinCknrMilesCity.prj
Run Date and Time: 7/22/2003 4:37:13 PM

Project in English units

PLAN DATA

Plan Title: Plan 01
Plan File : p:\TongueR\HECRAS\PumpkinCknrMilesCity.p01

Geometry Title: Geom 01
Geometry File : p:\TongueR\HECRAS\PumpkinCknrMilesCity.g01

Flow Title : Flow 01
Flow File : p:\TongueR\HECRAS\PumpkinCknrMilesCity.f01

Plan Summary Information:

Number of:	Cross Sections =	14	Mulitple Openings =	0
	Culverts =	0	Inline Weirs =	0
	Bridges =	0		

Computational Information

Water surface calculation tolerance =	0.003
Critical depth calculaton tolerance =	0.003
Maximum number of interations =	20
Maximum difference tolerance =	0.1
Flow tolerance factor =	0.001

Computation Options

Critical depth computed only where necessary	
Conveyance Calculation Method:	At breaks in n values only
Friction Slope Method:	Average Conveyance
Computational Flow Regime:	Subcritical Flow

GEOMETRY DATA

Geometry Title: Geom 01

Geometry File : p:\TongueR\HECRAS\PumpkinCknrMilesCity.g01

CROSS SECTION

RS: 3.4

INPUT

Description:

Station Elevation Data		num=		12					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	89.66	2	88.44	6	87.76	10	87.76	14	87.66
18	87.92	22	88.46	23.5	88.8	26	88.44	30	89.24
34	89.3	36	89.74						

Manning's n Values		num=		3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.027	0	.027	36	.027

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	0	36		40	40		.1	.3

CROSS SECTION

RS: 3.2

INPUT

Description:

Station Elevation Data		num=		12					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	89.7	2	88.78	6	88.1	10	88.1	14	88
18	88.26	22	88.8	23.5	89.14	26	88.78	30	89.58
34	89.64	36	90.04						

Manning's n Values		num=		3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.027	0	.027	36	.027

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	0	36		44	44		.1	.3

CROSS SECTION

RS: 3

INPUT

Description:

Station Elevation Data		num=		12					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	89.54	2	87.78	6	87.1	10	87.1	14	87
18	87.26	22	87.8	23.5	88.14	26	87.78	30	88.58
34	88.64	36	90.24						

76 Channel-Morphology Data for the Tongue River and Selected Tributaries, Southeastern Montana, 2001-02

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .027 0 .027 36 .027

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 0 36 36 36 36 .1 .3

CROSS SECTION
 RS: 2.8

INPUT

Description:

Station Elevation Data num= 12
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 89.68 2 88.36 6 87.68 10 87.68 14 87.58
 18 87.84 22 88.38 23.5 88.72 26 88.36 30 89.16
 34 89.22 36 89.68

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .027 0 .027 36 .027

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 0 36 40 40 40 .1 .3

CROSS SECTION
 RS: 2.4

INPUT

Description:

Station Elevation Data num= 13
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 89.92 2 87.54 4 87.46 6 87.48 10 87.42
 14 87.18 18 87.16 22 87 26 86.8 30 87.08
 34 87.46 35 87.38 36 90.02

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .027 0 .027 36 .027

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 0 36 42 42 42 .1 .3

CROSS SECTION
 RS: 2

INPUT

Description:

Station Elevation Data num= 13
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 89.82 2 87.92 4 87.84 6 87.86 10 87.8
 14 87.56 18 87.54 22 87.38 26 87.18 30 87.46
 34 87.84 35 87.76 36 89.44

Appendix 3. Pumpkin Creek at mouth, near Miles City, Mont. 77

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .027 0 .027 36 .027

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 0 36 48 48 48 .1 .3

CROSS SECTION
 RS: 1.83333*

INPUT

Description:

Station Elevation Data num= 23
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 90.01 .95 88.26 1.83 87.47 3.65 87.35 4.75 87.32
 5.48 87.33 8.55 87.28 9.13 87.28 12.35 87.09 12.79 87.07
 16.15 87.03 16.44 87.04 19.95 87.05 20.1 87.04 23.75 86.7
 24.08 86.7 26.08 86.84 28.08 86.99 30.08 87.17 31.58 87.39
 32.08 87.48 33.08 87.5 34.08 90

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .027 0 .027 34.08 .027

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 0 34.08 48 48 48 .1 .3

CROSS SECTION
 RS: 1.66666*

INPUT

Description:

Station Elevation Data num= 23
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 89.66 .86 87.82 1.65 87.15 3.31 86.98 4.3 86.92
 4.96 86.92 7.74 86.89 8.27 86.88 11.18 86.73 11.58 86.7
 14.62 86.64 14.88 86.67 18.06 86.84 18.19 86.82 21.5 86.34
 22.17 86.34 24.17 86.49 26.17 86.64 28.17 86.82 29.67 87.12
 30.17 87.24 31.17 87.38 32.17 89.74

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .027 0 .027 32.17 .027

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 0 32.17 40 40 40 .1 .3

78 Channel-Morphology Data for the Tongue River and Selected Tributaries, Southeastern Montana, 2001-02

CROSS SECTION

RS: 1.5*

INPUT

Description:

Station Elevation Data										num=	23
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev		
0	89.46	.77	88.02	1.48	87.47	2.96	87.26	3.85	87.16		
4.44	87.16	6.93	87.13	7.4	87.13	10.01	87	10.37	86.98		
13.09	86.9	13.33	86.93	16.17	87.27	16.29	87.25	19.25	86.63		
20.25	86.63	22.25	86.78	24.25	86.94	26.25	87.11	27.75	87.49		
28.25	87.65	29.25	87.89	30.25	89.46						

Manning's n Values						num=	3
Sta	n Val	Sta	n Val	Sta	n Val		
0	.027	0	.027	30.25	.027		

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	0	30.25		40	40	40		.1	.3

CROSS SECTION

RS: 1.33333*

INPUT

Description:

Station Elevation Data										num=	23
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev		
0	89.32	.68	88.13	1.31	87.72	2.62	87.45	3.4	87.31		
3.92	87.32	6.12	87.3	6.54	87.29	8.84	87.2	9.15	87.18		
11.56	87.08	11.77	87.12	14.28	87.63	14.38	87.6	17	86.84		
18.33	86.84	20.33	86.99	22.33	87.16	24.33	87.33	25.83	87.77		
26.33	87.98	27.33	88.32	28.33	89.04						

Manning's n Values						num=	3
Sta	n Val	Sta	n Val	Sta	n Val		
0	.027	0	.027	28.33			

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	0	28.33		40	40	40		.1	.3

CROSS SECTION

RS: 1.16666*

INPUT

Description:

Station Elevation Data										num=	23
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev		
0	89.88	.59	88.75	1.13	88.46	2.27	88.15	2.95	87.97		
3.4	87.97	5.31	87.96	5.67	87.96	7.67	87.89	7.94	87.87		
10.03	87.75	10.21	87.81	12.39	88.48	12.48	88.44	14.75	87.54		
16.42	87.54	18.42	87.7	20.42	87.87	22.42	88.04	23.92	88.56		
24.42	88.8	25.42	89.26	26.42	89.8						

Manning's n Values						num=	3
Sta	n Val	Sta	n Val	Sta	n Val		
0	.027	0	.027	26.42	.027		

Appendix 3. Pumpkin Creek at mouth, near Miles City, Mont. 79

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	0	26.42		41	41	41		.1	.3

CROSS SECTION

RS: 1

INPUT

Description:

Station Elevation Data	num=	14							
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	89.32	.5	87.8	2.5	87.06	4.5	87.06	6.5	87.02
8.5	86.86	10.5	87.76	12.5	86.68	14.5	86.68	16.5	86.84
18.5	87.02	20.5	87.18	22	87.78	24.5	89.18		

Manning's n Values	num=	3			
Sta	n Val	Sta	n Val	Sta	n Val
0	.027	0	.027	24.5	.027

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	0	24.5		29	29	29		.1	.3

CROSS SECTION

RS: 0.8

INPUT

Description:

Station Elevation Data	num=	13							
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	89.92	.5	88.56	2.5	87.82	4.5	87.82	6.5	87.78
8.5	87.62	12.5	87.44	14.5	87.44	16.5	87.6	18.5	87.78
20.5	87.94	22	88.54	24.5	89.95				

Manning's n Values	num=	3			
Sta	n Val	Sta	n Val	Sta	n Val
0	.027	0	.027	24.5	.027

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	0	24.5		40	40	40		.1	.3

CROSS SECTION

RS: 0.6

INPUT

Description:

Station Elevation Data	num=	13							
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	89.8	.5	88.58	2.5	87.84	4.5	87.84	6.5	87.8
8.5	87.64	12.5	87.46	14.5	87.46	16.5	87.62	18.5	87.8
20.5	87.96	22	88.56	24.5	89.38				

Manning's n Values	num=	3			
Sta	n Val	Sta	n Val	Sta	n Val
0	.027	0	.027	24.5	.027

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	0	24.5		0	0	0		.1	.3